

Combined Heat and Power in Scotland, Wales, Northern Ireland and the regions of England in 2015

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 2016. This article updates statistics published in the September 2015 edition of Energy Trends and provides a breakdown of CHP in the Devolved Administrations and English regions in 2015¹.

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 2014 and 2015 there was a net increase of 21 CHP schemes in the database (50 new schemes and the removal of 29 schemes), but a net decrease of 202 MWe in capacity. Good Quality CHP² capacity in the UK fell from 5,894 MWe (revised 2014 figure) to 5,692 MWe in 2015.

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 2013 to 2015. During this time, the total number of schemes increased from 2,032 to 2,102, however the capacity decreased from 5,925 MWe to 5,692 MWe. With the exception of Wales, the North East and Eastern regions, the number of schemes increased in all regions over the period 2013 to 2015. Over this period, the electrical capacity decreased in the North East, South East, Wales and North West regions and increased in all other areas. The largest fall in capacity in the period 2013-2015 was in the North East, substantially due to capacity serving an oil terminal ceasing to operate as a CHP plant and a significant downgrading of capacity at a site in the chemical sector. The falls seen in the other regions were also substantially due to losses of capacity in the industrial sectors, with loss of capacity in the chemicals sector in the South East and North West regions and the loss of capacity at an oil refinery in Wales.

¹ Similar articles on CHP have appeared in previous Energy Trends publications from 2001 to 2015. 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, up to date information on the status of a few significant schemes has resulted in a revision down in the capacity for 2015 and some of the earlier years. This was especially the case for the North East region.

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 2013-2015

	Number of Schemes			Electrical Capacity (MWe)		
	2013	2014	2015	2013	2014	2015
England	1,712	1,753	1,773	5,140	5,077	4,906
East Midlands	107	109	115	105	111	128
Eastern	169	166	169	291	304	319
London	271	291	298	177	199	199
North East	112	110	110	637	538	373
North West	268	280	282	796	780	780
South East	292	292	295	948	948	891
South West	139	142	141	86	82	88
West Midlands	170	175	174	107	112	111
Yorkshire/Humberside	184	188	189	1,995	2,004	2,016
Scotland	130	135	137	512	546	525
Wales	122	119	117	214	208	183
Northern Ireland	68	74	75	59	62	78
UK Total	2,032	2,081	2,102	5,925	5,894	5,692

Table 1B: Trend in CHP electricity and heat generated over the period 2013-2015

	Electricity Generated (GWh)			Heat Generated (GWh)		
	2013	2014	2015	2013	2014	2015
England	16,144	16,233	16,503	35,472	33,192	32,064
East Midlands	569	579	588	1,387	1,323	1,343
Eastern	1,218	1,327	1,417	1,975	1,984	2,078
London	491	585	584	1,187	1,221	1,225
North East	1,080	1,223	1,177	5,045	4,690	4,042
North West	3,226	2,772	2,580	9,018	8,026	7,725
South East	3,338	3,200	2,919	7,251	6,704	6,449
South West	365	377	387	638	470	474
West Midlands	414	443	450	731	764	745
Yorkshire/Humberside	5,442	5,726	6,401	8,239	8,010	7,984
Scotland	2,357	2,503	2,426	5,802	5,893	5,750
Wales	882	738	609	2,571	2,361	1,929
Northern Ireland	210	224	363	508	515	582
UK Total	19,593	19,698	19,900	44,353	41,962	40,325

The region with the highest proportion of the UK's electrical capacity is still the Yorkshire and Humberside region with a 35 per cent share. Also, the average capacity of CHP schemes in this region was higher than in any other region.

The proportion of electricity generated in the North East in 2015 was just 5.9 per cent of the total, which is lower than in previous editions of this paper, owing to more up to date information on the status of one scheme in that region.

Regarding heat generation, as with electricity generation, more up to date information on the status of a scheme in the North East means that the share of total heat generated for that region (10 per cent) is lower than in previous editions of this paper.

Chart 1: CHP generation by area in 2015

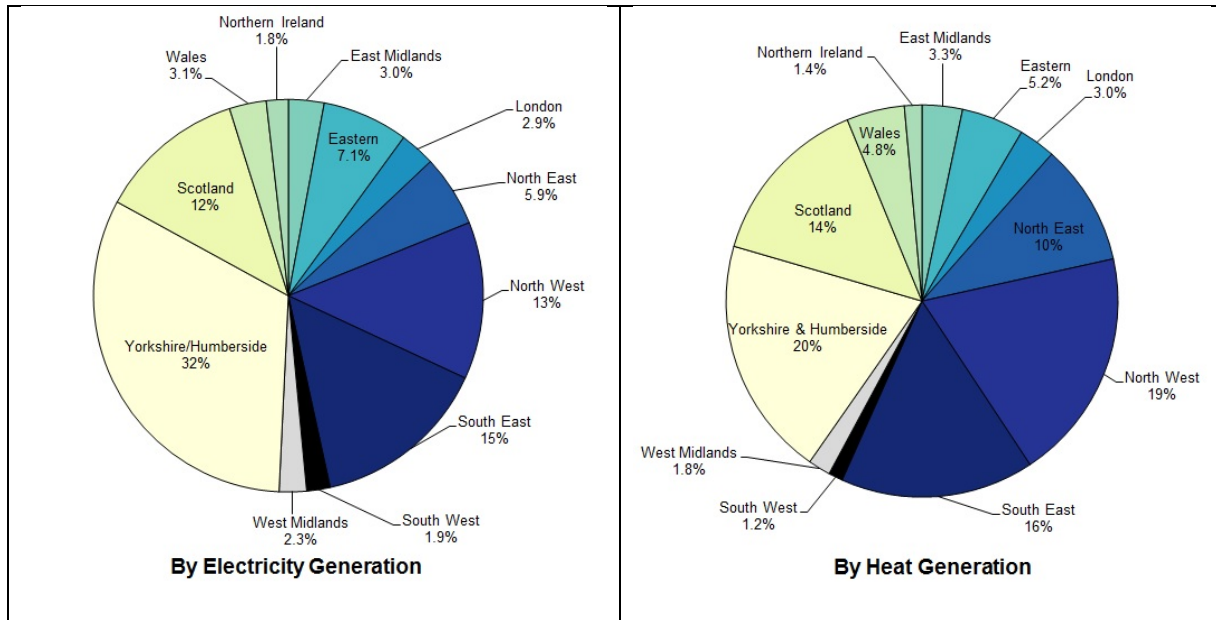


Table 2 shows an overview of CHP plant data broken down between the English regions and devolved administrations. CHP capacity utilisation can be expressed by the Load Factor (LF). LF is the actual generation as a proportion of the theoretical maximum power that can be generated for a given total installed capacity (TPC). The power output that is actually generated is the total power output (TPO). For 2015, the TPC was 8,441 MWe⁵ and the TPO was 37,940 GWh, giving a LF of 51.3 per cent, which is one percentage point lower than in 2014 (revised).

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 exemplified by the high LF. in some regions where industrial CHP capacity and power generated is a significant proportion of the total, such as the following regions (dominant industrial sectors in each region given in parentheses): Eastern region (Food and Drink), Wales (Iron and Steel) and Scotland (Refineries). Conversely, the LF. is lowest of all in London, where non-industrial CHP capacity and power generated is a large proportion of the total.

Over time the LF. has decreased in industry and the proportion of total capacity and power generation coming from the non-industrial sectors has increased. These two factors have acted to reduce the overall LF. of all CHP in the UK.

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 2015

	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	1,773	4,906	7,410	16,171	66,860	16,503	32,540	32,064	50.1%
East Midlands	115	128	173	604	2,754	588	972	1,343	64.2%
Eastern	169	319	319	884	4,711	1,417	1,457	2,078	52.1%
London	298	199	231	966	2,718	584	796	1,225	39.3%
North East	110	373	468	1,116	7,571	1,177	1,994	4,042	48.6%
North West	282	780	884	4,086	13,112	2,580	3,712	7,725	47.9%
South East	295	891	2,093	3,295	13,114	2,919	7,698	6,449	42.0%
South West	141	88	88	190	1,299	387	410	474	53.2%
West Midlands	174	111	126	501	1,991	450	597	745	54.1%
Yorkshire/Humberside	189	2,016	3,027	4,529	19,590	6,401	14,903	7,984	56.2%
Scotland	137	525	678	2,523	11,234	2,426	3,528	5,750	59.4%
Wales	117	183	275	827	3,924	609	1,497	1,929	62.2%
Northern Ireland	75	78	78	189	1,160	363	376	582	54.7%
UK Total	2,102	5,692	8,441	19,711	83,178	19,900	37,940	40,325	51.3%

*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

** 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. However, there has been a significant decrease in the GVA per unit of heat and electrical capacity in the North East region (41 per cent since 2013), meaning that CHP is a less significant part of this region's economy than was thought in the 2015 edition of this article. This is due to more up to date information coming to light in respect of one large scheme in this region. Consequently, CHP now plays a less significant part of the economy of the North East than in the North West. There have also been notable decreases in the heat capacity per unit of GVA in Scotland and the South East. This is substantially due to the removal of significant boiler capacity at two schemes, one in each of these two 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	42.54	18.93
North West	27.26	5.20
North East	23.40	7.83
Scotland	20.43	4.25
Wales	15.23	3.38
South East	13.75	3.72
England	11.74	3.56
Eastern	6.37	2.30
East Midlands	6.35	1.35
Northern Ireland	5.50	2.28
West Midlands	4.36	0.97
London	2.65	0.55
South West	1.57	0.73
UK total	12.18	3.52

*GVA is provisional gross value added in 2014 (workplace based)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.

⁶www.ons.gov.uk/economy/grossvalueaddedgva/bulletins/regionalgrossvalueaddedincomeapproach/december2015

Special feature - CHP

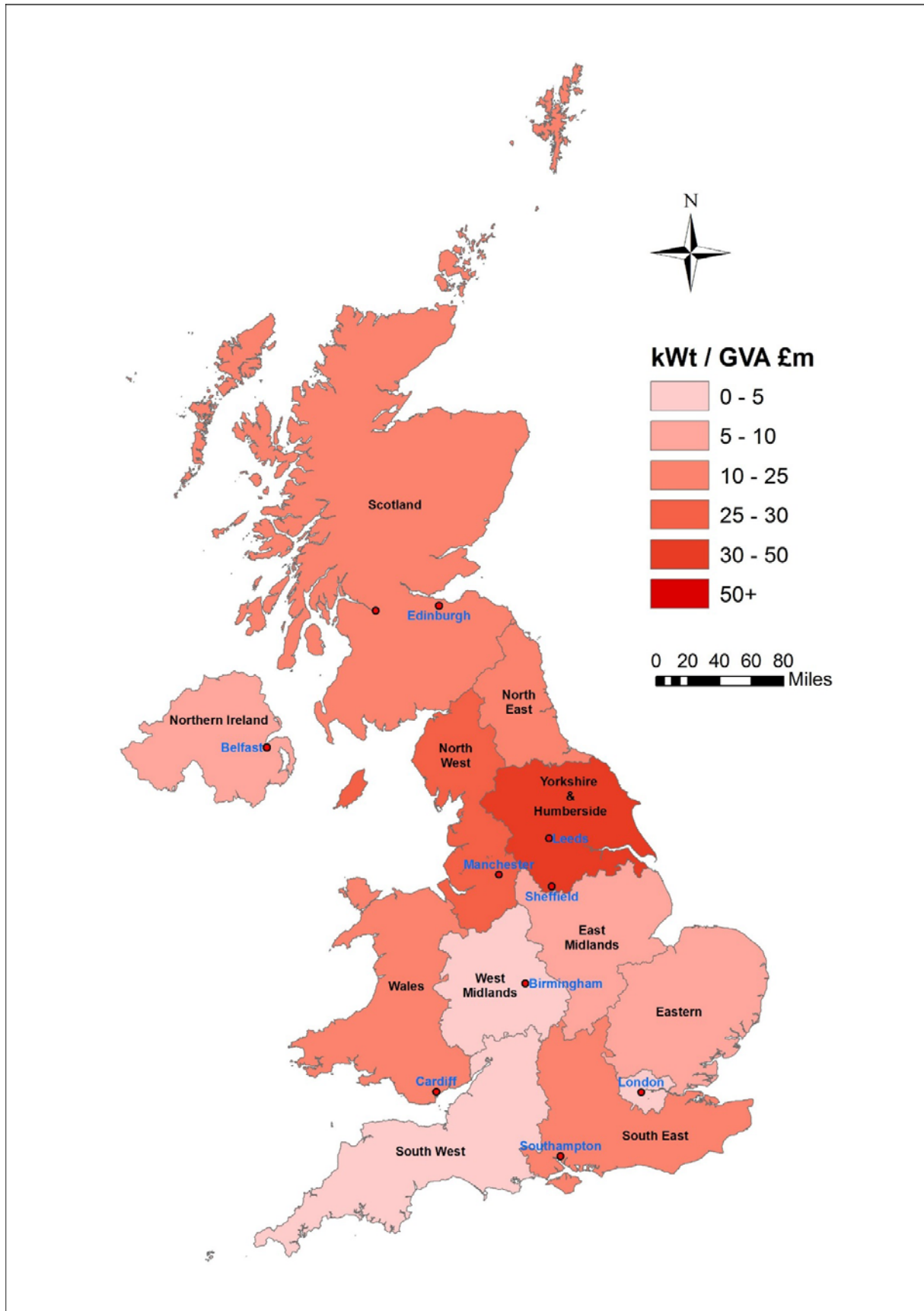
Over 60 per cent of all CHP capacity in the oil refineries and oil and gas terminals sector can be found in the Yorkshire and Humber region and 85 per cent of capacity in the chemicals sector is to be found in three regions: North East, Yorkshire/Humber and the North West. Over half of the capacity in the Paper, Publishing and Printing sector is located in the South East region. The Eastern region is the single largest region for CHP capacity in the Food, Beverages and Tobacco sector, which is substantially explained by the heavy concentration of the heat intensive sugar beet industry in this region. These are longstanding patterns. Points of note arising from this year's statistics are the loss of all metal products capacity in the East Midlands and mineral products capacity in Yorkshire and the Humber. These are due to the closure of one scheme in each of these regions. The Other industrial Branches⁷ sector has seen an increase in capacity in Northern Ireland owing to the commissioning of one significant plant in that region.

⁷ Other industrial branches includes sewage treatment works, textiles and clothing and footwear

Table 4: Distribution of CHP capacity across the regions and economic sectors in 2015

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	80.2%	89.7%	86.0%	78.4%	89.2%	80.7%	100.0%	74.4%	84.0%	92.6%
East Midlands	0.0%	1.2%	0.0%	0.0%	6.6%	0.0%	7.2%	8.1%	6.4%	7.1%
Eastern	7.2%	1.3%	0.0%	0.0%	43.8%	0.0%	0.0%	13.8%	5.4%	8.1%
London	3.6%	1.0%	0.0%	0.0%	6.0%	14.3%	0.0%	6.6%	16.2%	14.1%
North East	50.5%	21.6%	0.0%	0.0%	0.0%	0.0%	26.3%	4.4%	8.1%	2.0%
North West	0.0%	29.1%	4.9%	24.2%	17.5%	5.6%	51.5%	10.5%	11.2%	3.9%
South East	0.0%	0.2%	19.3%	50.6%	4.9%	6.5%	0.0%	10.4%	13.4%	26.4%
South West	0.0%	0.7%	0.0%	0.0%	1.8%	6.5%	15.1%	5.5%	4.6%	6.2%
West Midlands	0.0%	0.0%	0.0%	2.1%	0.1%	47.7%	0.0%	9.4%	8.6%	3.5%
Yorkshire and Humber	18.9%	34.7%	61.8%	1.5%	8.5%	0.0%	0.0%	5.8%	10.0%	21.4%
Scotland	0.0%	6.5%	11.9%	15.1%	4.6%	0.8%	0.0%	10.2%	9.4%	4.3%
Wales	18.0%	2.9%	2.1%	6.6%	1.1%	9.2%	0.0%	9.3%	3.8%	1.1%
Northern Ireland	1.7%	1.0%	0.0%	0.0%	5.1%	9.4%	0.0%	6.1%	2.7%	2.0%
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 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 2015, gas turbine based schemes accounted for 71 per cent of total CHP capacity but only 6 per cent of the total number of CHP schemes.
- The North West is 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 North East.
- Reciprocating Engines constitute the vast majority of all CHP schemes (93 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 consistent with these areas being large population centres and the high incidence of leisure centres, hotels and retail outlets, which are to be found in such areas and which almost exclusively rely on reciprocating engine technology for CHP.

Table 5: CHP electrical capacity (MWe) by area and prime mover in 2015

	Gas Turbines*	Steam Turbines	Gas and Steam Turbines Subtotal	Reciprocating Engines	Total
England	3,561	339	3,901	1,005	4,906
East Midlands	-	-	59	69	128
East of England	-	-	195	124	319
London	-	-	53	147	199
North East	-	-	311	62	373
North West	-	-	649	131	780
South East	-	-	695	195	891
South West	18	0	18	70	88
West Midlands	-	-	16	95	111
Yorkshire and The Humber	1,848	57	1,905	111	2,016
Scotland	382	81	463	61	525
Wales	130	36	141	43	183
Northern Ireland	-	-	31	48	78
Grand Total	-	-	4,536	1,157	5,692

*Includes Combined Cycle Gas Turbines (CCGT)

The CHP market continues to be dominated by large-scale (>10MWe) plant, with 77 per cent of all installed capacity being in this size range. The regional distribution of CHP by capacity tranche is given in Table 6. Over time there has been a very gradual fall in the proportion of total capacity falling within the >10 MWe capacity tranche, with all of the other capacity tranches increasing their share of the total over time. The regions with the greatest capacity from schemes with capacity greater than 10 MWe are Yorkshire and The Humber, followed by the South East, North West, Scotland and the North East. Again, this is a reflection of the location of the types of industrial installation requiring especially large capacity CHP. The largest share of capacity greater than 10 MWe is to be found in the oil refineries sector, followed by chemicals and then paper. As already discussed, oil refinery and chemical operators are heavily represented in the Yorkshire and the Humber and North West regions, while paper production is heavily represented in the South East.

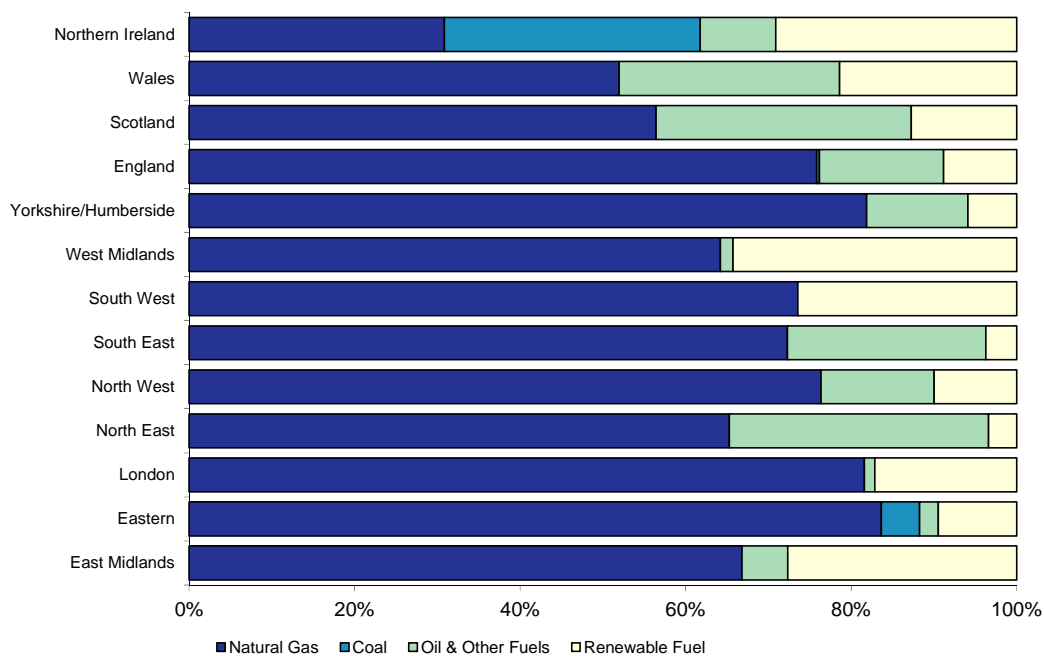
Table 6: CHP electrical capacity (MWe) by area and size in 2015

	<= 100 kWe	> 100 kWe to 1 MWe	>1 MWe to 2 MWe	> 2 MWe to 10 MWe	> 10 MWe +	Total
England	33	242	180	673	3,777	4,906
East Midlands	2	16	19	-	-	128
East of England	3	24	19	-	-	319
London	6	43	17	-	-	199
North East	3	9	8	49	305	373
North West	5	39	32	99	605	780
South East	5	41	34	132	679	891
South West	3	22	15	49	0	88
West Midlands	3	25	14	69	0	111
Yorkshire and The Humber	4	24	23	70	1,895	2,016
Scotland	2	16	16	64	426	525
Wales	3	15	-	-	123	183
Northern Ireland	1	16	-	-	-	78
Grand Total	39	289	203	792	4,369	5,692

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 2015 for each region



Natural gas represented 71 per cent of all fuel burned in CHP in 2015, which is slightly higher than in 2014 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. Previously, natural gas represented less than half of the fuel consumed in the North East. However, up to date information on one large scheme means that natural gas now represents the majority of fuel consumption in that region. The proportion of fuel consumption that is natural gas remains low in Northern Ireland, reflecting the relatively low penetration of the natural gas network. The availability of natural gas is expected to improve in Northern Ireland as the planned expansions of the transmission and distribution network to the west of the region are implemented.

In 2015, coal was only consumed in Northern Ireland and the Eastern region. In the 2015 edition of this article, coal was also consumed in the North East and South East, but a reconfiguration of plant in these two regions has removed coal as a fuel source. The total number of schemes burning coal and the overall consumption of coal is at an all time low.

Other notable developments regarding fuel types consumed at CHP schemes include:

- An increase in the proportion of renewable fuel consumed in London due to a significant conversion of a power only waste incineration plant to CHP;
- A fall in the proportion of natural gas consumption in Wales due to the closure of oil refinery capacity;
- An appreciable fall in the proportion of renewable fuel consumed in the Eastern region due to a significant fall in the outputs of one renewable scheme that can be considered CHP outputs, with a consequential fall in the renewable fuel consumption included in the CHP statistics.

Summary

The Yorkshire and the Humber region continues to be the region of the UK with the greatest level of installed CHP capacity, CHP electricity generation and heat generation, accounting for 35 per cent of all capacity and 32 per cent of all electricity generated and 20 per cent of all heat generated. Other regions with high levels of CHP capacity are the South East, North West and Scotland. This is substantially explained by the significant presence of heat intensive industries, such as oil refining, chemicals production and paper in these regions.

Although there has been a steady decline over a number of years, industry still accounts for the overwhelming majority of installed CHP capacity, power and heat generation. With CHP playing a key role in meeting the energy demand of the oil refineries, chemicals and paper sectors, and the tendency of industrial sites in these sectors to concentrate in certain geographical areas, CHP is seen to play an especially important role in the economies of the Yorkshire and the Humber the North West, North East, and Scotland. Other notable examples of the concentration of CHP capacity in the regions include over 50 per cent of capacity in the paper sector being located in the South East and nearly 44 per cent of capacity in the food and drink sector being located in the Eastern region, where the heat intensive manufacture of sugar from sugar beet is concentrated.

London and the South East account for larger than average proportions of capacity installed in the Transport, Commerce and Administration and Other sectors. This is consistent with these regions being large population centers, with large demands placed upon services such as leisure centres, hotels, hospitals and retail outlets.

The region with the largest consumption of renewable fuel consumed in CHP is Scotland, followed by the North West and Yorkshire and the Humber. The region with the largest proportion of renewable fuel consumption is the West Midlands, followed by Northern Ireland and the East Midlands.

Special feature - CHP

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