

Renewable electricity in Scotland, Wales, Northern Ireland and the regions of England in 2017

Introduction

This article provides information and analysis on the amount of electricity from renewable sources, disaggregated below UK level. It includes information on capacity, generation and number of operational sites, as well as derived load factors, for the four UK countries and the nine English regions. In addition, information is given for UK Local Authorities.^{1 2 3} It updates that published in the September 2017 edition of *Energy Trends*

The totals published here are consistent with that published for the UK in Table 6.4 of the Digest of United Kingdom Energy Statistics 2018 (DUKES), and use similar categories⁴. However, there are some minor differences at national level with those published in DUKES as further work is carried out to locate sites for this publication. These data cover all renewable electricity schemes, including those accredited under the Renewables Obligation (RO), Feed in Tariff (FiT) and Contracts for Differences support mechanisms and those not eligible for support, such as pre-April 2002 large-scale hydro and non-CHP energy from waste schemes.

The tables below, and previous *Energy Trends* articles, show snapshots of the position at the time of publication for 2017. Consistent time-series data for each year from 2003 for data shown in Tables 1 to 3 and for Local Authority data from 2014, are available as Excel spreadsheets at:

www.gov.uk/government/statistics/regional-renewable-statistics.

Key points – 2017:

- England had the most renewable capacity and generation, largely due to the three biomass units at Drax in Yorkshire and the Humber.
- Scotland had the highest capacity per £ of GVA.
- Scotland had the highest generation per £ of GVA.
- The highest technology growth in capacity was onshore wind, primarily in Scotland, driven by large-scale schemes supported by the RO. Next highest was offshore wind, primarily in the East of England. After this was solar PV in the South West, followed closely by the East Midlands and Northern Ireland, and finally biomass and waste, with Wales showing the largest increase, followed closely by the South West and West Midlands.
- For the third consecutive year (in 18 years), England continues to have the highest onshore wind load factor though Scotland is now no longer the lowest which implies that there have been fewer significant outages and curtailments than were noted in previous years for some large Scottish wind farms.

¹ Offshore wind is allocated to the region to which its output is connected. The exceptions are Robin Rigg, which comes ashore at Seaton, Cumbria but whose generation is associated with Scotland, and Burbo Bank, which comes ashore in Wales but whose generation is associated with the North West. https://orsted.co.uk/-/media/WWW/Docs/Corp/UK/Project-Summaries/Project-Summary_Burbo-Bank-Extension.ashx?la=en&hash=81E63DC2093EDF092966228DA9E3D7602051C15F&hash=81E63DC2093EDF092966228DA9E3D7602051C15F

² Part of the tables published by the Department for Business, Energy & Industrial Strategy (BEIS) that show a range of renewable electricity data for the devolved administrations and regions of England: www.gov.uk/government/statistics/regional-renewable-statistics

³ Where disclosure of confidential generation data was likely at the site level, this has been addressed, where possible, by replacing this with data from publicly available sources. Where this is not possible, the data has been removed, and added to the unallocated row at the bottom of the Local Authority listings.

⁴ On occasion, it has been necessary to combine some renewable sources into categories so that information about individual sites provided in confidence (rather than from publicly available sources) to Ricardo Energy & Environment and (BEIS) is not disclosed.

Special feature – Sub-national renewable electricity

The largest new schemes (including capacity increases) in 2017 were as follows:

Onshore wind	Pen y Cymoid (capacity increase) Kilgallioch (capacity increase) Beinneun (capacity increase) Ray Wind Farm Clyde Wind Farm Extension (Clyde 2)	72 MW 222 MW 109 MW 54 MW 172 MW
Offshore wind	Dudgeon Offshore Wind Farm Race Bank Galloper Wind Farm Walney Offshore Wind Phase III Rampion	402 MW 548 MW 72 MW 330 MW 183 MW
Solar PV	Henley Hall Lough Road Bann Road	22 MW 32 MW 46 MW
Biomass and waste	Mersey Bioenergy Widnes Biomass CHP Margam REP	20 MW 40 MW

UK country summary

Table 1 and Chart 1 show that there were 5,643 non-Solar PV sites in England generating electricity from renewable sources, with 4,343 non-Solar PV sites in Scotland, 1,092 in Wales and 1,355 in Northern Ireland. In addition, there were 697,907 solar PV sites reported for England, 54,945 for Scotland, 53,257 for Wales and 23,696 for Northern Ireland⁵.

⁵No geographical information was available for a further 106,673 PV schemes, 277 wind schemes, 51 hydro schemes and 12 anaerobic digestion schemes

Table 1: Number of sites generating electricity from renewable sources, 2017¹

	Wind ²	Onshore Wind	Offshore Wind	Wave and tidal	Solar PV	Hydro	Landfill gas	Sewage gas	AD	Biomass and Waste ³	Total excluding PV	Total
England	4,039	4,009	30	2	697,907	344	369	168	404	317	5,643	703,550
East Midlands	429	426	3	-	83,354	27	39	15	77	30	617	83,971
East of England	888	879	9	-	98,666	6	72	15	58	30	1,069	99,735
North East	271	268	3	-	45,510	17	20	7	14	15	344	45,854
North West	517	509	8	-	81,096	73	49	24	38	45	746	81,842
London	31	31	-	-	22,904	-	5	10	4	14	64	22,968
South East	109	104	5	-	105,815	24	71	35	29	29	297	106,112
South West	820	820	-	1	115,420	124	39	18	68	53	1,123	116,543
West Midlands	176	176	-	-	65,248	23	30	19	77	51	376	65,624
Yorkshire and the Humber	798	796	2	1	79,894	50	44	25	39	50	1,007	80,901
Northern Ireland	1,160	1,160	-	-	23,696	69	20	2	82	22	1,355	25,051
Scotland	3,453	3,448	5	15	54,945	703	49	8	54	61	4,343	59,288
Wales	690	687	3	1	53,257	293	26	16	28	38	1,092	54,349
Other Sites	277	277	-	-	106,673	51	-	-	12	-	340	107,013
UK Total	9,619	9,581	38	18	936,478	1,460	464	194	580	438	12,773	949,251

Components may not add exactly to totals because of rounding.

Totals for England, Northern Ireland, Scotland and Wales may not match DUKES exactly due to reallocation of Other sites.

1 As at 31 December 2017.

2 Offshore Wind is allocated to regions/countries where the cabling comes ashore.

3 Four of these sites are sites that co-fire renewables with fossil fuels (see also note 4, below).

4 This is the proportion of non-fossil fuelled capacity used for co-firing of renewables based on the proportion of generation accounted for by the renewable source. This estimate has not been disaggregated into regional values since the figure will vary annually, and is not dedicated renewable capacity.

5 Includes bioenergy sources co-fired with fossil fuels.

Table 2: Installed capacity of sites generating electricity from renewable sources, 2017¹

	Wind ²	Onshore Wind	Offshore Wind	Wave and tidal	Solar PV	Hydro	Landfill gas	Sewage gas	AD	Biomass and Waste ³	MW Total
England	9,086.6	3,071.1	6,015.5	0.1	10,885.2	41.6	880.2	225.5	344.0	3,850.7	25,314.0
East Midlands	911.4	447.0	464.4	-	1,474.0	4.9	68.0	20.5	68.1	148.1	2,694.9
East of England	2,561.8	474.1	2,087.7	-	1,924.3	0.1	185.6	19.2	62.5	245.0	4,998.5
North East	593.1	486.9	106.3	-	213.7	8.2	45.0	11.5	22.5	161.5	1,055.4
North West	2,155.3	479.5	1,675.8	-	536.0	9.9	134.8	31.4	33.4	209.2	3,110.0
London	11.3	11.3	-	-	113.2	-	25.8	51.7	5.3	188.0	395.2
South East	1,360.7	108.3	1,252.4	-	2,058.7	1.4	166.6	36.1	29.8	301.9	3,955.2
South West	342.2	342.2	-	-	3,180.7	11.3	100.5	15.3	47.8	160.7	3,858.5
West Midlands	15.4	15.4	-	-	841.5	1.2	60.9	23.6	48.4	186.2	1,177.3
Yorkshire and the Humber	1,135.4	706.4	429.0	0.1	543.1	4.7	93.0	16.3	26.2	2,250.1	4,068.9
Northern Ireland	1,186.6	1,186.6	-	-	253.0	10.4	23.3	0.2	43.4	33.6	1,550.6
Scotland	7,790.2	7,543.8	246.4	17.9	310.3	1,643.3	115.8	7.2	44.9	250.5	10,180.2
Wales	1,756.8	1,030.8	726.0	0.4	1,050.3	168.1	46.7	12.5	17.2	140.8	3,192.9
Other Sites	15.1	15.1	0.0	0.0	276.8	11.1	0.0	0.0	10.4	-	313.3
UK Total	19,835.2	12,847.4	6,987.9	18.4	12,775.7	1,874.6	1,066.1	245.5	459.9	4,275.6	40,551.0
Co-firing ⁴					-			-		6.2	6.2

Components may not add exactly to totals because of rounding.

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1 As at 31 December 2017.

2 Offshore Wind is allocated to regions/countries where the cabling comes ashore.

3 Four of these sites are sites that co-fire renewables with fossil fuels (see also note 4, below).

4 This is the proportion of non-fossil fuelled capacity used for co-firing of renewables based on the proportion of generation accounted for by the renewable source. This estimate has not been disaggregated into regional values since the figure will vary annually, and is not dedicated renewable capacity.

5 Includes bioenergy sources co-fired with fossil fuels.

Table 3: Generation of electricity from renewable sources, 2017¹

	Wind ²	Onshore Wind	Offshore Wind	Wave and tidal	Solar PV	Hydro	Landfill gas	Sewage gas	AD	Biomass and Waste ⁵	GWh Total
England	25,120.6	7,250.7	17,869.9	-	9,966.3	116.5	3,590.5	886.1	1,843.3	21,817.5	63,340.7
East Midlands	2,682.7	1,048.1	1,634.6	-	1,341.7	18.6	253.2	97.1	366.2	694.5	5,454.1
East of England	6,758.4	1,123.8	5,634.6	-	1,794.5	0.4	771.9	76.2	349.0	1,268.2	11,018.7
North East	1,404.8	1,179.9	224.9	-	192.9	14.1	140.0	34.0	102.6	537.1	2,425.5
North West	6,268.0	1,168.4	5,099.7	-	475.3	31.2	433.6	122.2	154.7	887.4	8,372.4
London	17.0	17.0	-	-	102.4	-	154.3	147.6	29.0	631.1	1,081.5
South East	3,716.9	233.2	3,483.6	-	1,926.4	4.1	770.4	153.6	161.0	972.6	7,705.0
South West	741.5	741.5	-	-	2,908.9	30.3	410.0	56.9	262.7	481.8	4,892.1
West Midlands	35.9	35.9	-	-	736.0	3.5	275.3	119.4	275.3	632.2	2,077.6
Yorkshire and the Humber	3,495.4	1,702.9	1,792.5	-	488.0	14.3	381.7	79.2	142.7	15,712.5	20,313.9
Northern Ireland	2,504.2	2,504.2	-	-	184.6	29.0	106.2	0.6	256.1	185.0	3,265.7
Scotland	17,475.1	16,860.4	614.6	4.2	275.3	5,395.1	445.5	36.0	220.4	1,484.9	25,336.4
Wales	4,873.8	2,442.4	2,431.3	-	903.0	370.7	141.6	44.6	92.9	660.8	7,087.4
Other Sites	30.0	30.0	-	-	195.8	16.8	-	-	57.1	-	299.6
UK Total	50,003.7	29,087.7	20,915.9	4.2	11,524.9	5,928.1	4,283.8	967.3	2,469.7	24,148.2	99,329.8

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1 As at 31 December 2017.

2 Offshore Wind is allocated to regions/countries where the cabling comes ashore.

3 Four of these sites are sites that co-fire renewables with fossil fuels (see also note 4, below).

4 This is the proportion of non-fossil fuelled capacity used for co-firing of renewables based on the proportion of generation accounted for by the renewable source. This estimate has not been disaggregated into regional values since the figure will vary annually, and is not dedicated renewable capacity.

5 Includes bioenergy sources co-fired with fossil fuels.

In capacity terms, England had more than two and a half times more renewable electricity capacity than Scotland (Table 2 and Chart 3). This is mainly because of England’s considerable bioenergy (88 per cent of the UK’s bioenergy capacity) and solar PV capacity (85 per cent of the UK’s solar PV capacity). For similar reasons, generation from renewable sources in England during 2017 was two and a half times higher than Scotland, with the higher utilisation rates of bioenergy offset by the lower rates of the more intermittent solar PV which accounted for 16 per cent of English renewable generation (Table 3, Chart 7).

Regional analysis by technology

In England, the number of renewable sites (excluding solar PV) in each region varies from 64 in London to 1,123 in the South West (Table 1 and Chart 2). The highest capacity in England (including solar PV) is in the East of England, followed by Yorkshire and the Humber and the South East (Table 2 and Chart 4). In the East of England, 51 per cent of capacity is from wind (42 per cent offshore and 9 per cent onshore) and 38 per cent is from solar PV. In Yorkshire and the Humber, 55 per cent of capacity is from biomass and waste (mostly from Drax dedicated biomass), 28 per cent from wind and 13 per cent is from solar PV. In the South East, 52 per cent of capacity is from solar PV, 34 per cent from wind (32 per cent offshore and 3 per cent onshore) and 8 per cent from biomass and waste.

Chart 1: Number of sites by country¹

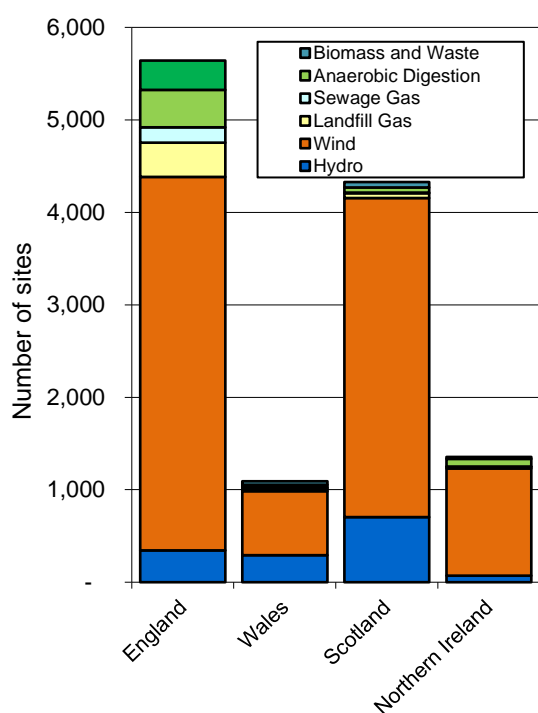
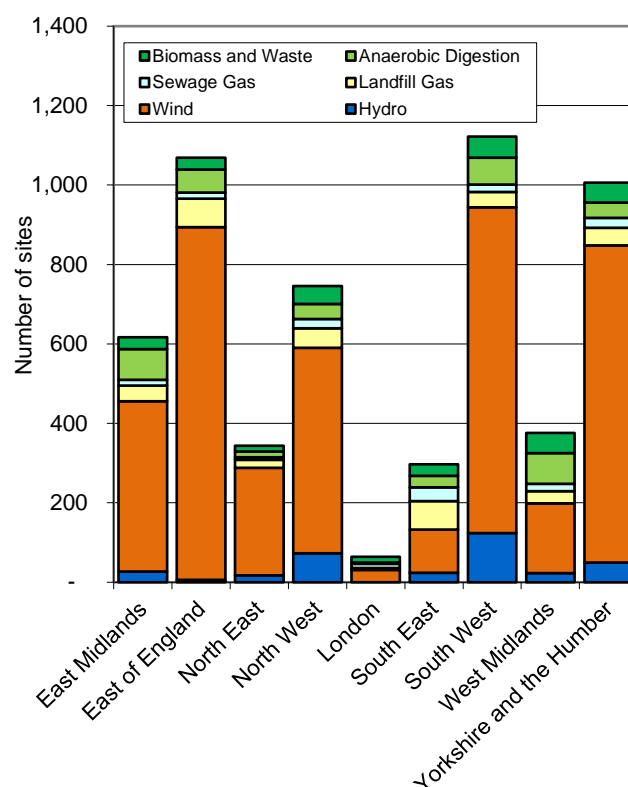


Chart 2: Number of sites by English region¹



1. Excludes Solar PV, due to the high numbers of small-scale schemes, disproportionate to all other technologies. Wave and Tidal are included with offshore wind.

The East of England has 17 per cent of the UK’s landfill gas capacity. The South East (with 16 per cent of the UK’s landfill gas capacity), and the North West (with 13 per cent of the UK’s landfill gas capacity), are the other English regions with notably large shares. The East of England, North West and the South East regions together accounted for 46 per cent of UK generation from landfill gas.

England has 85 per cent of the total UK solar capacity and 86 per cent of the total UK generation.

Special feature – Sub-national renewable electricity

The South West accounts for 25 per cent of the total UK solar capacity (25 per cent of the generation), the South East 16 per cent (17 per cent of the generation) and the East of England 15 per cent (16 per cent of the generation), reflecting the construction of more schemes in areas with higher than average solar irradiance⁶.

England accounts for 46 per cent of wind capacity and 50 per cent of generation. About two-thirds of England's wind capacity is offshore (6 GW), which also represents 86 per cent of the UK's 7 GW of offshore capacity. The Burbo Bank Extension currently operates the largest offshore turbines of 8 MW each.

Scotland had 39 per cent of the UK's wind capacity and produced 35 per cent of the output (Tables 2 and 3; Charts 5a, 5b, 9a and 9b). 97% of Scotland's wind capacity was from onshore wind, showing no change on the previous year. This comprises 3,448 onshore wind sites, including the UK's largest, Whitelee (539 MW) followed closely by Clyde (522.4 MW). Other regions with high wind capacity are:

- East of England with 10.5 percent offshore (11 per cent generation), due to Race Bank (548 MW), Greater Gabbard (504 MW), Dudgeon (402 MW) and Sheringham Shoal (317 MW), and 2.4 per cent onshore (2 per cent generation)
- the North West with 2.4 per cent onshore capacity (2 per cent of generation) and 8.4 per cent offshore capacity (10 per cent of generation) that includes Walney plus extension (698 MW) and Burbo Bank plus extension (349 MW)
- Wales has 8.0 per cent onshore capacity (8.4 per cent of generation), and 10.4 per cent offshore capacity (11.6 per cent of generation) (Tables 2 and 3).

Ninety-two per cent of the UK generation from sewage took place in England. The major sewage gas generating regions were, the South East (16 per cent), London (15 per cent), the North West (13 per cent) and the West Midlands (12 per cent). This is reflected in capacity terms with London being the highest (21 per cent), followed by the South East (15 per cent), the North West (13 per cent) and the West Midlands (10 per cent).

90 per cent of the UK generation from biomass and waste (including that used for co-firing) took place in England, with nearly two thirds in Yorkshire and the Humber (65 per cent) mostly from Drax, followed by Scotland (6 per cent), East of England (5 per cent) and the South East (4 per cent). Excluding bioenergy sources used for standard co-firing (which cannot be allocated to regions – see note 4 to Table 2), Yorkshire and the Humber more than half of capacity to generate from biomass and waste (53 per cent of the UK total), mostly from the three 645 MW converted units at Drax. This is followed by the South East (7 per cent) and Scotland (6 per cent).

⁶ JRC Solar radiation and photovoltaic electricity potential http://re.jrc.ec.europa.eu/pvgis/cmmaps/eu_cmsaf_opt/G_opt_UK.png.

Chart 3: Renewable capacity by country

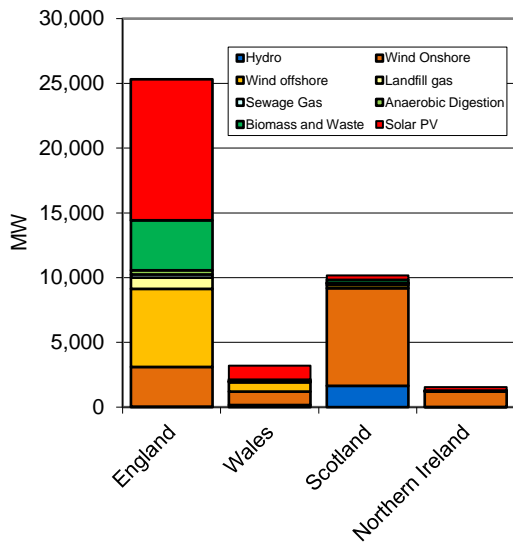


Chart 4: Renewable capacity by English region

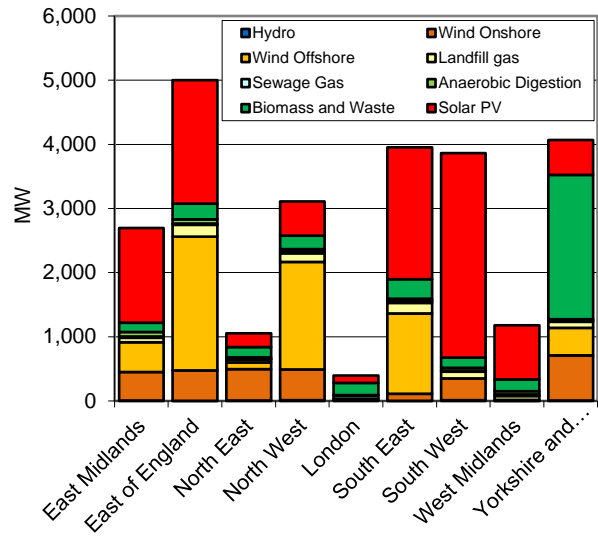


Chart 5a: Onshore wind capacity by country

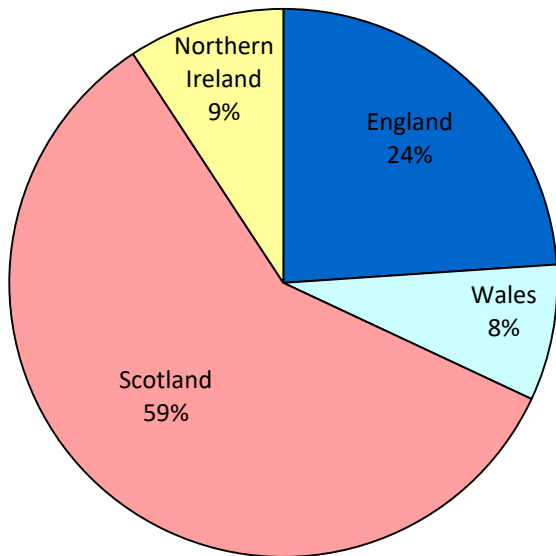


Chart 5b: Offshore wind capacity by country

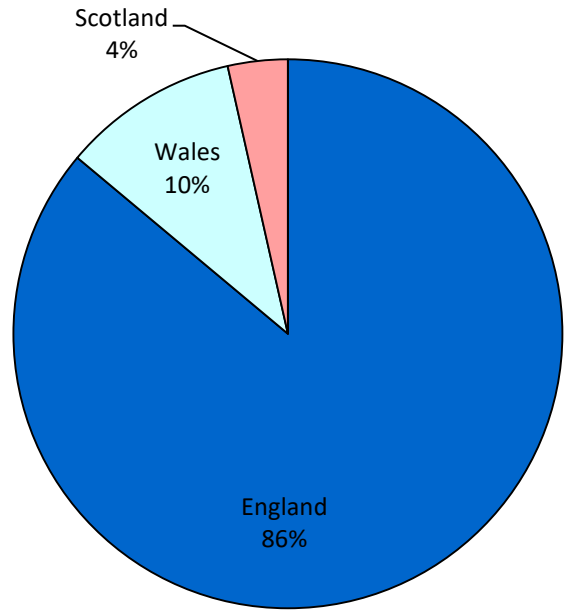


Chart 6a: Onshore wind capacity by English region

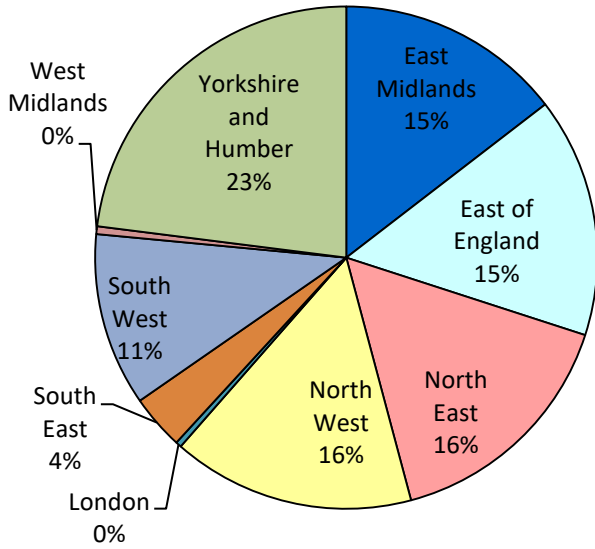


Chart 6b: Offshore wind capacity by English region

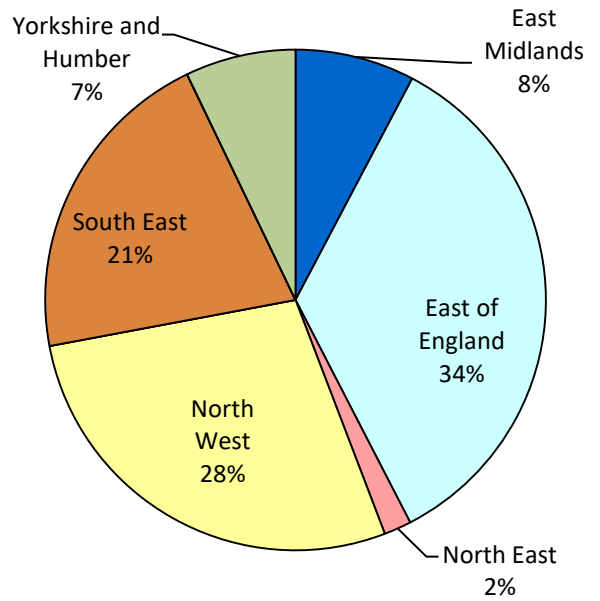


Chart 7: Renewable generation by country

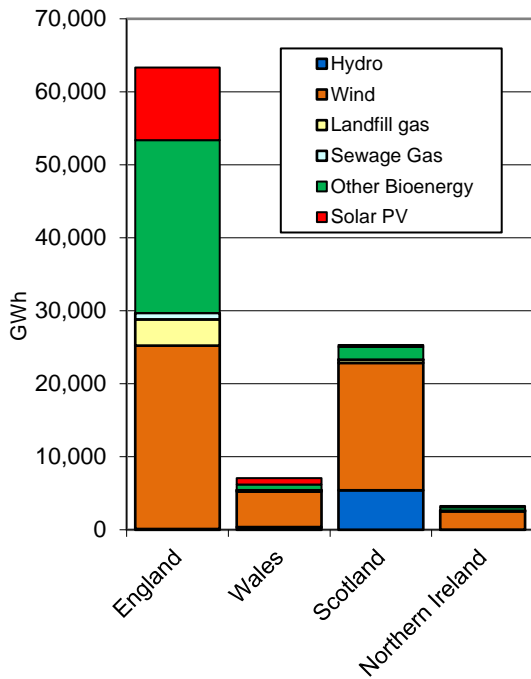


Chart 8: Renewable generation by English region

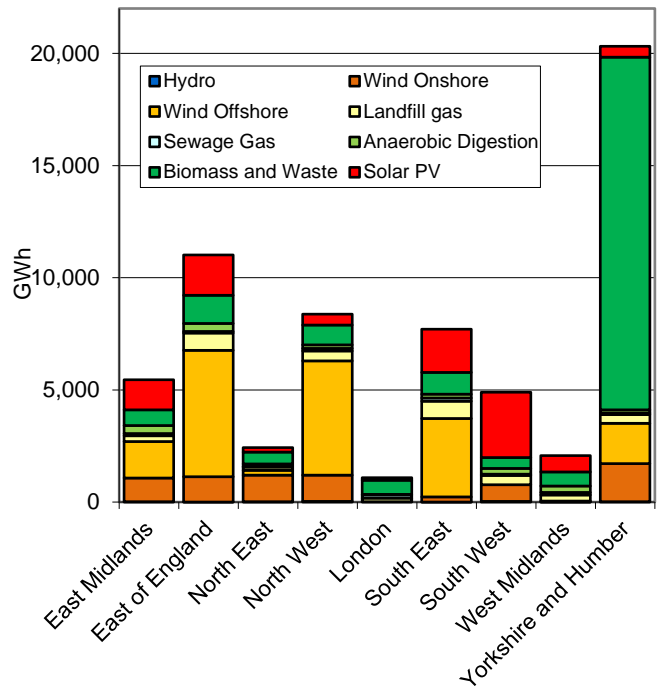


Chart 9a: Onshore wind generation by country

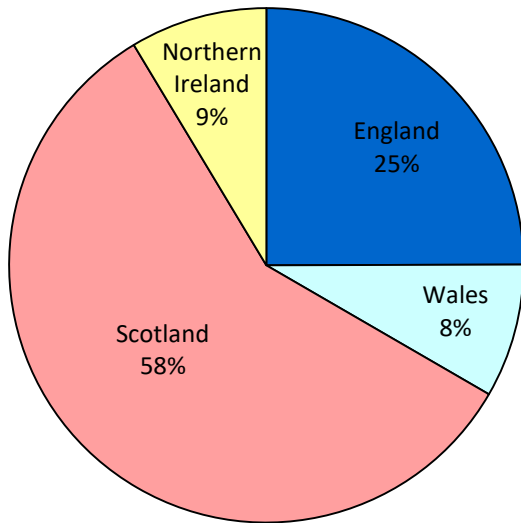


Chart 9b: Offshore wind generation by country

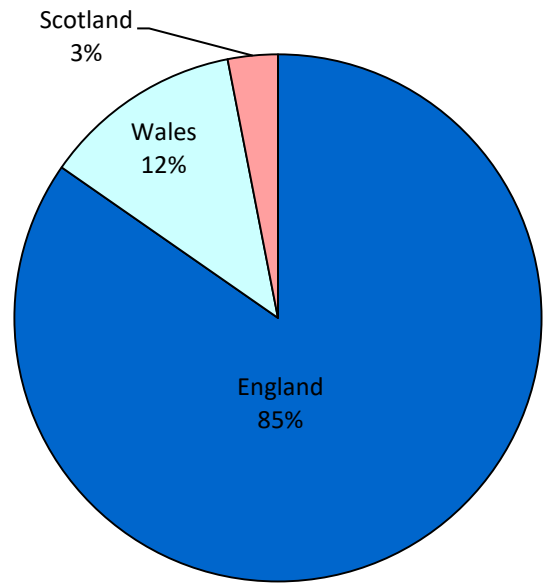


Chart 10a: Onshore wind generation by English region

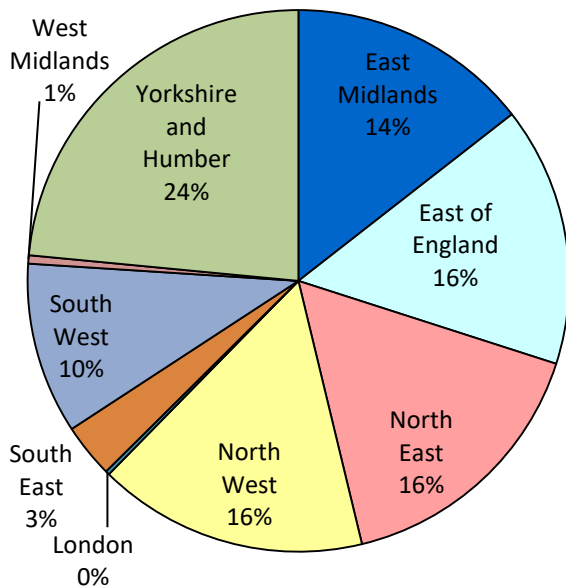
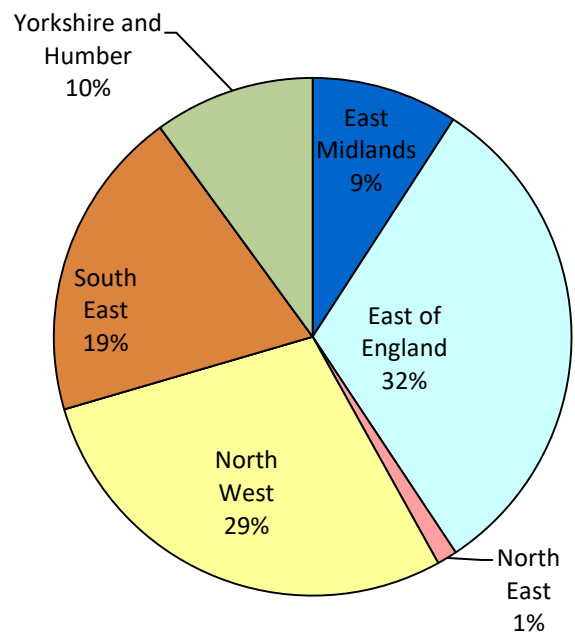


Chart 10b: Offshore wind generation by English region



Regional trends: 2017

In terms of change to total renewables generating capacity, Scotland (+1,355 MW), East of England (+1,100 MW), North West (+510 MW), Northern Ireland (+437 MW) and Wales (+331 MW) have all shown considerable growth this year. The growth in overall renewables capacity in the UK has primarily come from onshore wind (40 per cent), offshore wind (35 per cent) and solar (18 per cent). Table 4 summarises the schemes that accounted for much of the capacity growth in 2017 for each region.

Special feature – Sub-national renewable electricity

Total UK onshore wind capacity has increased by 40 per cent with capacity increases to Pen y Cymoedd (72 MW), Kilgallioch (222 MW) and Beinneun (109 MW), plus new installations at Ray Wind Farm (54 MW), Clyde Wind Farm Extension (Clyde 2) (172 MW). Total UK offshore wind capacity has increased 35 per cent with the Dudgeon Offshore Wind Farm (402 MW), Race Bank (548 MW), Galloper Wind Farm (72 MW), Walney Offshore Wind Phase III (330 MW) and Rampion (183 MW).

Total UK solar PV capacity has increased by 18 per cent in 2017 which was driven by the pending closure of RO and the reduction in FiT financial support mechanisms, as well as decreasing technology costs. Fewer large solar farms were built this year, with most of the large solar farms being built in Northern Ireland including Lough Road PV (32 MW) and Bann Road PV (46 MW).

Biomass and wastes accounted for 5.5 per cent of the total growth in capacity. This includes the Mersey Bioenergy Widnes Biomass CHP (20 MW) and Margam REP (40 MW) biomass schemes and the Municipal Solid Waste Combustion schemes at Liberty Steel Lochaber (17 MW), EnviRecover (15.5 MW) and European Metal Recycling Ltd (17.4 MW).

Regional trends: 2003-2017

Between 2003 and 2017, overall **capacity** from renewables in the UK increased more than ten-fold (1,073 per cent). Faster rates of growth were recorded in individual regions. These include:

- East Midlands (3,307 per cent), largely from solar PV and wind
- Yorkshire and the Humber (3,097 per cent), primarily due to Drax
- the South West (3,177 per cent), from primarily solar PV
- Northern Ireland (3,097 per cent), mainly from onshore wind
- the South East (2,361 per cent), largely from solar PV and offshore wind
- East of England (1,835 per cent), also driven by solar PV and offshore wind
- the North West (1,489 per cent) from offshore wind
- the North East (1,205 per cent) from onshore wind (see charts 11 and 12).

Between 2003 and 2017, there was a 837 per cent increase in overall **generation** from renewables in the UK, but faster rates of growth were recorded in Northern Ireland (3,031 per cent), Yorkshire and the Humber (3,019 per cent), the East Midlands (1,161 per cent), the South West (981 per cent), the North West (875 per cent), the South East (872 per cent) and the North East (842 per cent), (see charts 13 and 14).

The reason for these differences in growth rates for both capacity and generation is not only dependent on the local resource (such as wind and solar), but also (notably in the case of Drax), the availability of existing fossil fuel capacity suitable for conversion to biomass. There was very little use of some technologies in some regions driven primarily by resource availability (e.g. wind in London and hydro in the East of England).

Table 4: Regional capacity growth, 2017

Region	Key Technology	Growth (MW)	Key Schemes
East Midlands	Solar PV	118	Langar Lane plus medium and small-scale projects
	Onshore Wind	43	Bishopthorpe plus medium and small-scale projects
	Biomass and Waste	27	Derby and Derbyshire Waste Treatment Centre, The Sawmill,
East of England	Offshore Wind	1,023	Dudgeon, Race Bank, Galloper Wind Farm
	Solar PV	41	Triangle Solar Farm Park
	Biomass and Waste	17	MEPALCHP
North East	Onshore Wind	90	Ray Wind Farm, Red Gap Moor Wind Farm, Moor House Wind
	Offshore Wind	40	Blyth
	AD	6	Dean Group Business Park - Hartlepool
	Solar PV	3	Mainly medium and small-scale projects
North West	Offshore Wind	390	Burbo Bank Extension (Burbo Bank 2), Walney Offshore Wind Phase III
	Solar PV	57	Mainly medium and small-scale projects
	Onshore Wind	38	Beck Burn (resubmission)
	Biomass and Waste	25	Mersey Bioenergy Widnes Biomass CHP - FULL
London	Solar PV	3	Primarily FiT
	Sewage gas	-	7 Mogden STW, Deephams STW (replacement schemes with small capacities)
South East	Offshore Wind	183	Rampion
	Solar PV	69	Land to the north and south of Snettisham Lane (Wilsom) plus medium and small-scale projects
South West	Solar PV	120	Lower Severalls Farm plus medium and small-scale projects
	Biomass and Waste	44	Sevenside Energy Recovery Centre
West Midlands	Solar PV	96	Henley Hall, Land On The East Side Of Fosse Way
	Biomass and Waste	41	EnviRecover, European Metal Recycling Ltd
	Sewage gas	-	11 MINWORTH SEWAGE WORKS (CLOSED)
Yorkshire and Humber	Onshore Wind	41	Ovenden Moor (Repower) plus numerous small-scale projects
	Solar PV	32	Mainly medium and small-scale projects
	Biomass and Waste	28	Ferrybridge Multifuel 1 ('C') Power Station, Holbrook Community Renewable Energy Centre, Equitix ESI CHP (Sheffield) Limited
Northern Ireland	Onshore Wind	301	Brockaghboy Full, Wheelhouse Energy (NI) Limited, Slieve
	Solar PV	116	Ballinderry Road Solar Phase 1 (Lisburn), Lough Road PV, Bann Road PV (includes second Bann record)
	AD	11	Tully Quarry AD Plant plus small-scale projects
Scotland	Onshore Wind	1,212	Kilgallioch, Beinneun, Bhlairaidh Wind Farm, Brockloch Rig (Windy Standard 3), Clyde Wind Farm Extension (Clyde 2), Aikengall II - Wester Dod Community Wind Farm
	Offshore Wind	59	Hywind Scotland Pilot Park (Hywind 2) and Demonstrator
	Plant Biomass	24	Liberty Steel Lochaber
Wales	Onshore Wind	187	Pen y Cymoedd, Garreg Llwyd (GB)
	Solar PV	95	Mainly medium and small-scale projects
	Biomass and Waste	47	Margam REP

Chart 11: Trends in capacity from renewables by country

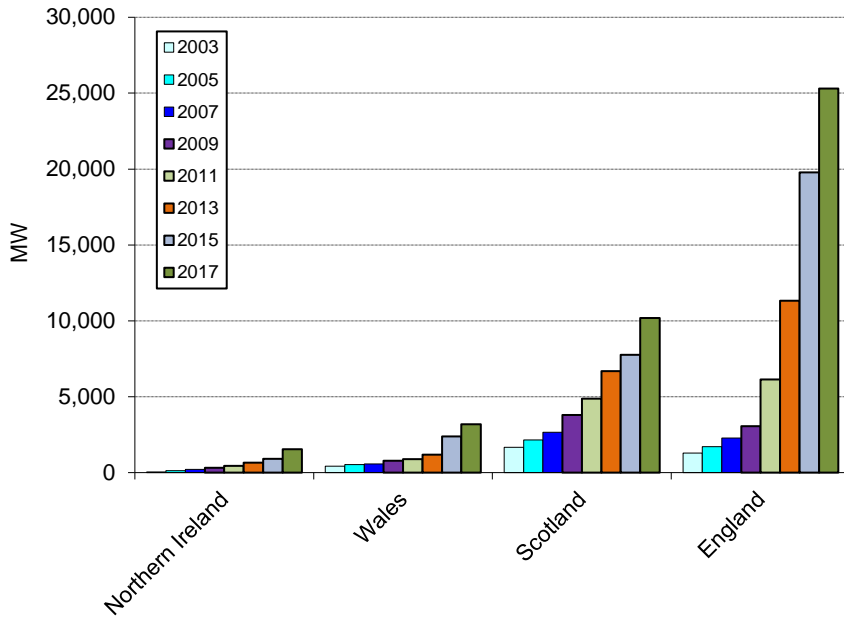


Chart 12: Trends in capacity from renewables by English region

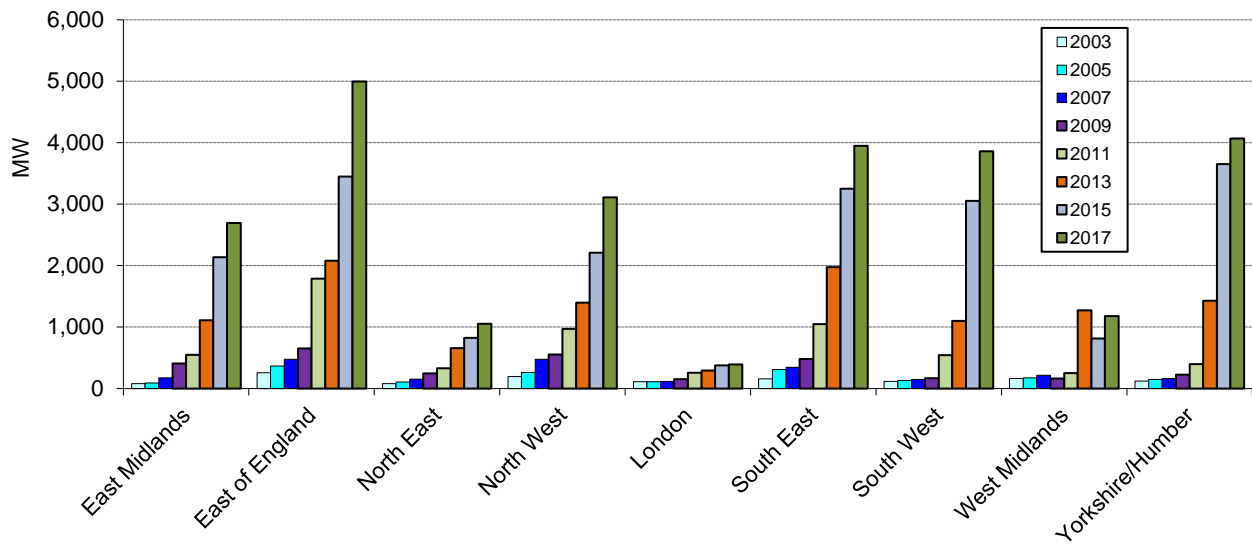


Chart 13: Trends in generation from renewables by country

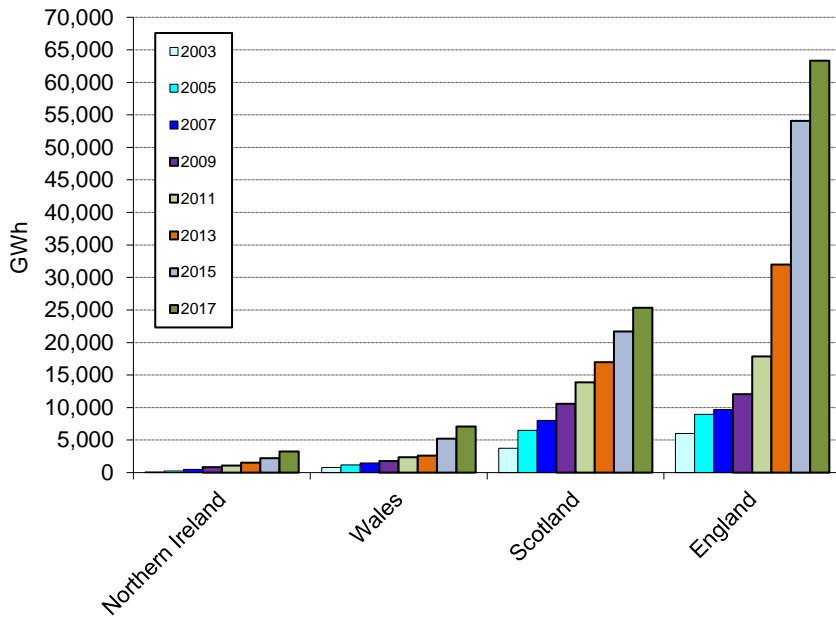
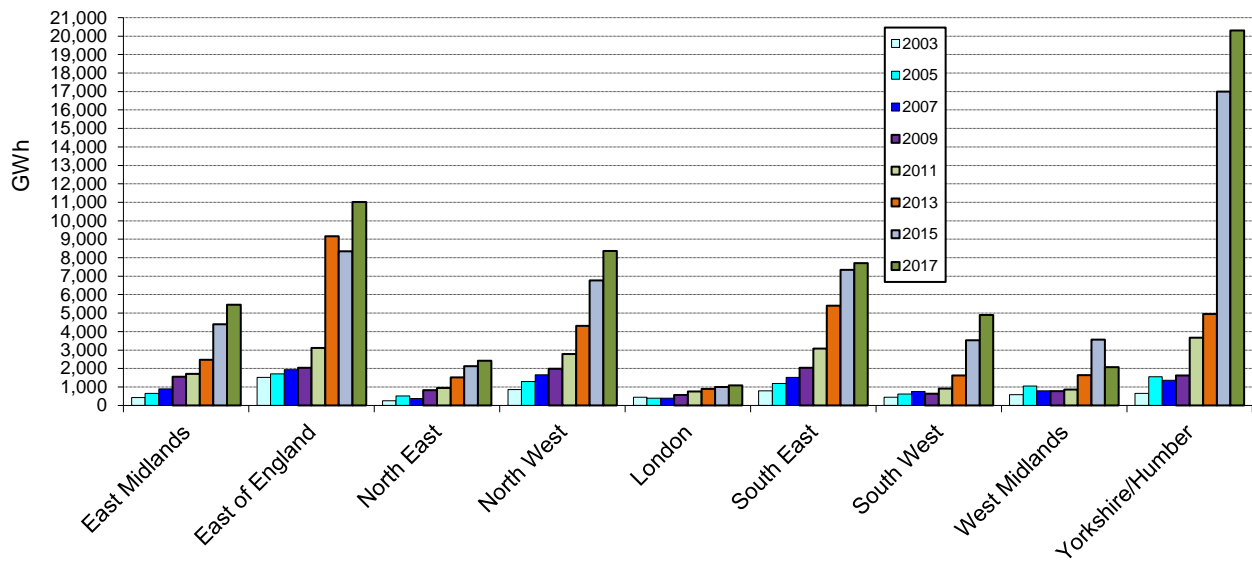


Chart 14: Trends in generation from renewables by English region



Time series data for several technologies also show interesting trends. In the case of the installed capacity for solar PV, following a period of rapid growth encouraged by the RO and FiT schemes, the rate of growth now seems to have slowed down (Chart 15), which is also reflected in the corresponding generation figures (Chart 16), this is probably a combination of effects due to the closure of the RO, a reduction in FiT financial support mechanisms, and the rapid exploitation of prime development sites.

Chart 15: Rate of growth of solar PV capacity by country

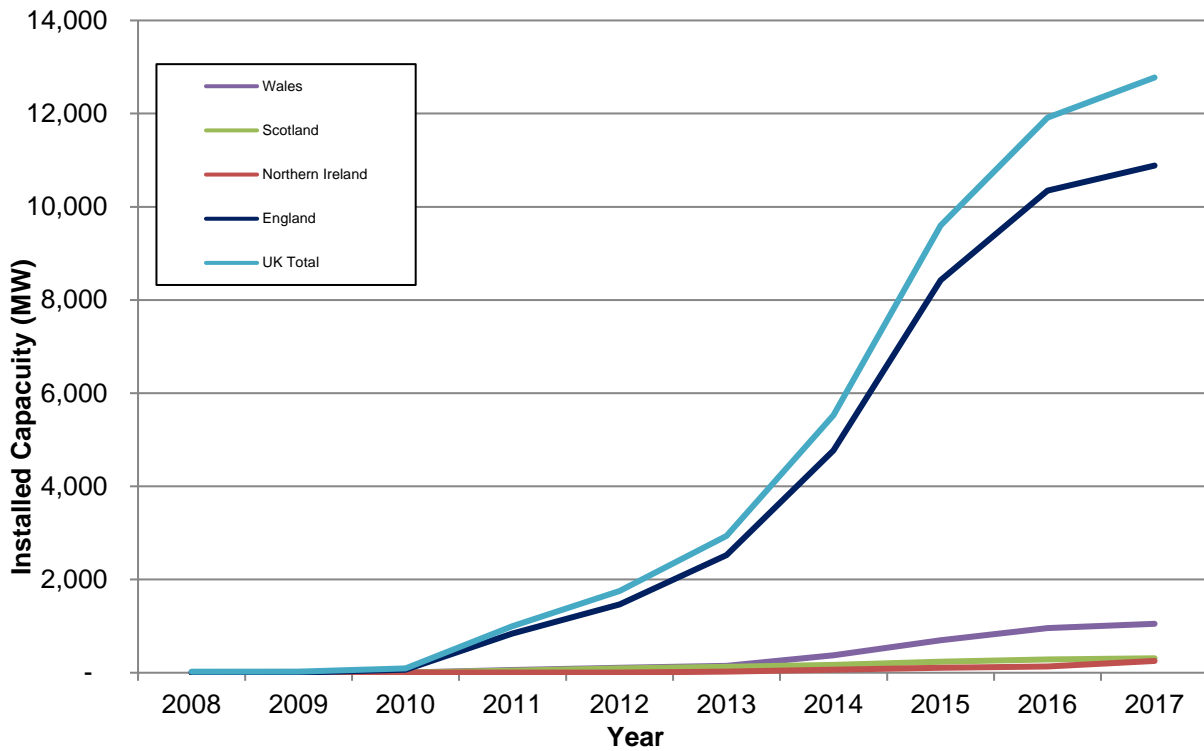
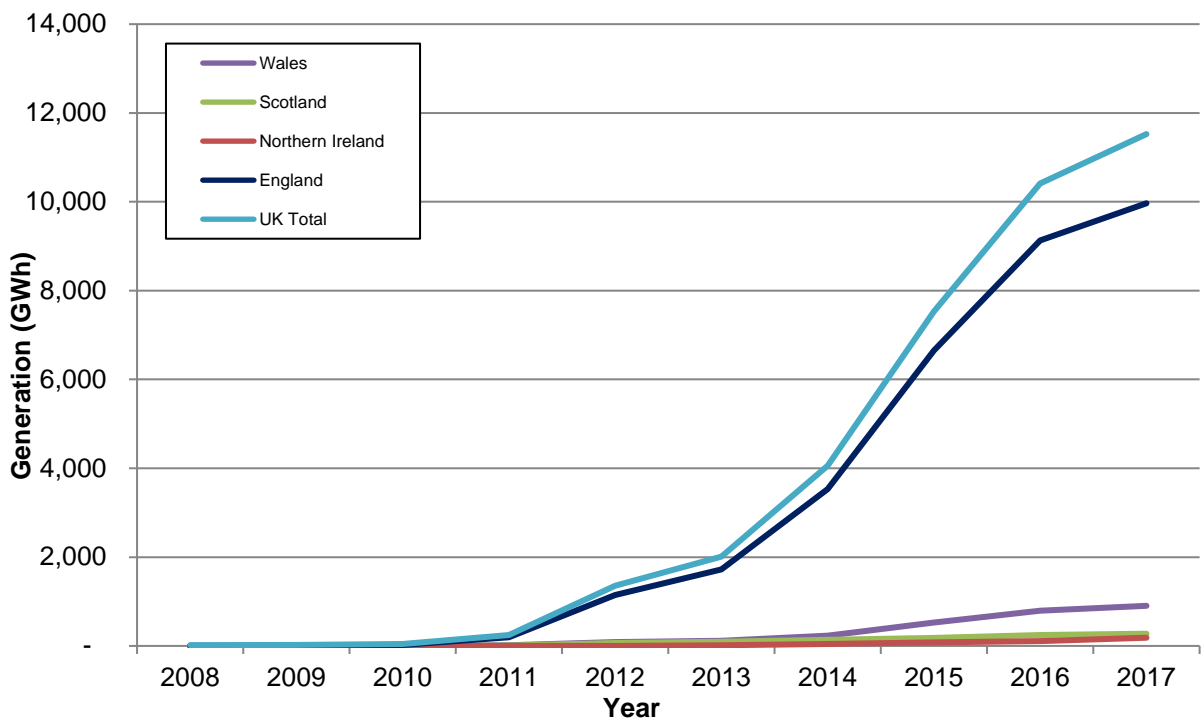


Chart 16: Rate of growth of solar PV generation by country



In the case of landfill gas, the rate of exploitation of prime sites reached saturation several years ago (Chart 17) but interestingly, there is no similar plateauing of generation data but instead decreases with time. This is because biogas production rates reduce with time as the biodegradable resource gets exploited (Chart 18). This is further discussed in the section on load factor analysis.

Chart 17: Rate of growth of landfill gas capacity by country

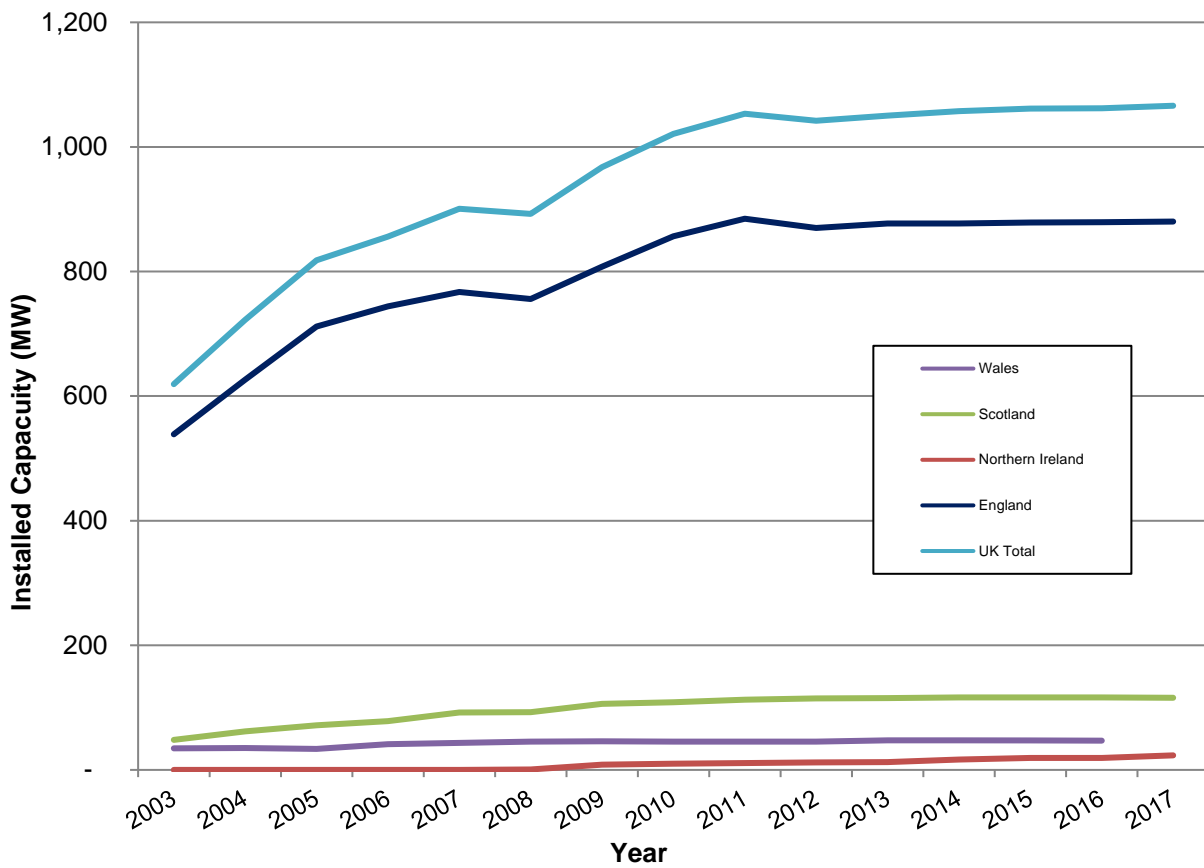
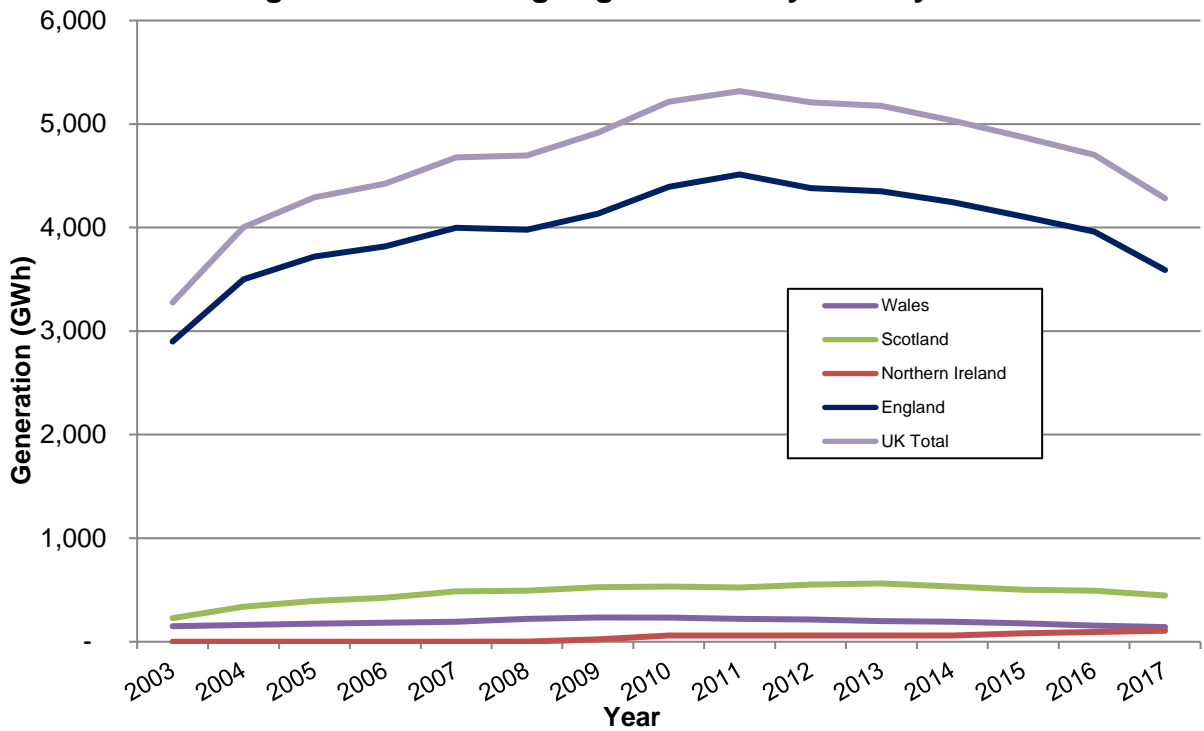


Chart 18: Rate of growth of landfill gas generation by country

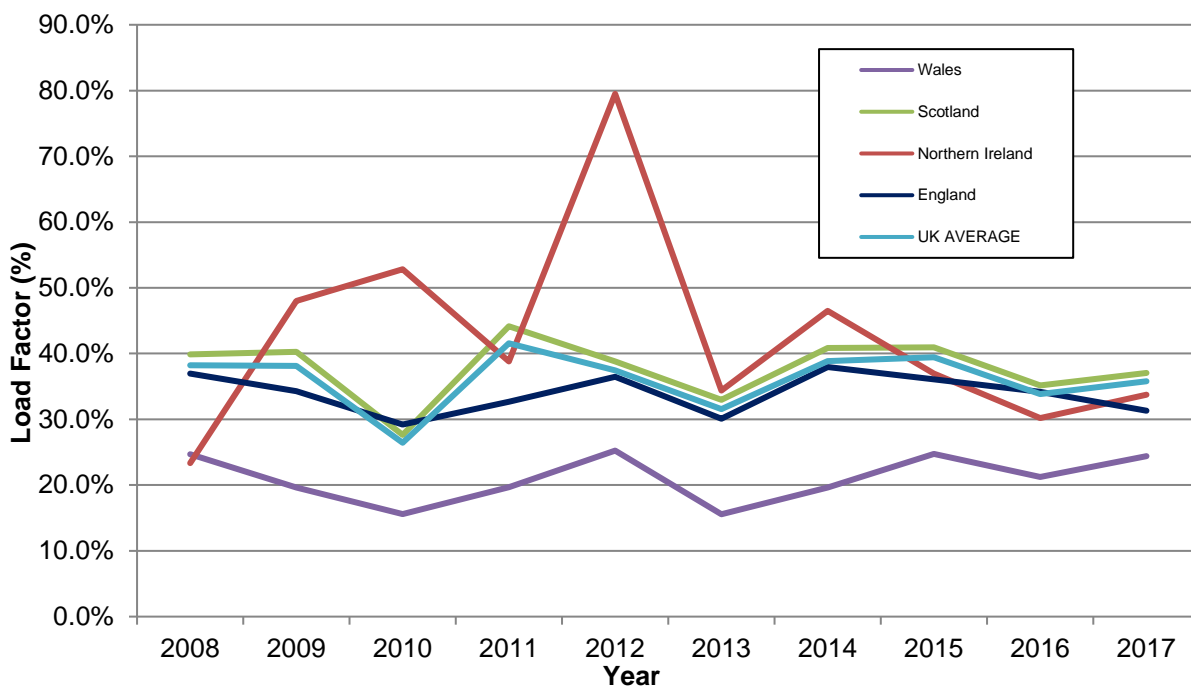


Load factor analysis

Load factors for the various technologies, presented on an unchanged configuration basis ^{7 8}, are shown in Table 5 from data provided in Tables 2 and 3 of this article⁹, together with time-series data in several charts¹⁰.

The load factors for hydro range from 47.4 per cent in the East Midlands to 22.4 per cent in the North East, with the UK average (mean) and median values for the UK overall of 35.8 and 31.1 per cent respectively. Rainfall for 2017 was slightly lower than for 2016 and the third lowest recorded over a 10-year period; this is reflected in the low load factors for hydro though (with the exception of England) this is not as low as might have been expected compared with the previous year. Chart 19 shows the time series variation in load factors and whilst Scotland generally follows variations in annual rainfall, Wales, England and Northern Ireland exhibit more unusual behaviour with a time lag following the record high rainfall in 2011.

Chart 19: Hydro load factor on an unchanged configuration basis, by UK country



⁷ Previously, load factors were presented in terms of installed capacity and expressed the average hourly quantity of electricity generated as a percentage of the average capacity at the beginning and end of the year. These can still be found in the load factor time-series spreadsheets, available at: www.gov.uk/government/collections/renewables-statistics. However, this method does not consider the impact of new schemes being constructed but not operating fully in the year. This can result in a distorted picture, depending on the timing and magnitude of new capacity coming on stream, and can even result in values >100%. The *unchanged configuration* basis for load factor calculations has therefore been used in this article.

The term “load factor on an unchanged configuration basis” describes the amount of electricity generated from schemes that have been operating throughout the whole of the calendar year with the same installed capacity configuration. The formula for calculating this is:

$$\frac{\text{Electricity generated during the year (MWh)}}{\text{Installed capacity of schemes operating throughout the year with an unchanged capacity configuration (MW) x hours in year}}$$

Installed capacity of schemes operating throughout the year with an unchanged capacity configuration (MW) x hours in year

In view of the interest shown nationally in this measure, this is now calculated for several renewable technologies. These data are only reported where the region contains three or more operational schemes. The England figure includes data from all English schemes regardless of how many were operational within each region of England.

⁸ A limitation of this analysis is the availability of Renewables Obligation Certificates (ROCs) data, which may not be complete when DUKES is compiled (April 2018) as 2017 data is still provisional. This can have an impact on the schemes included in the unchanged configuration definition as new data could include or remove schemes.

¹⁰ Gaps in the time-series were due to insufficient data with which to accurately report AD UCLF time series statistics

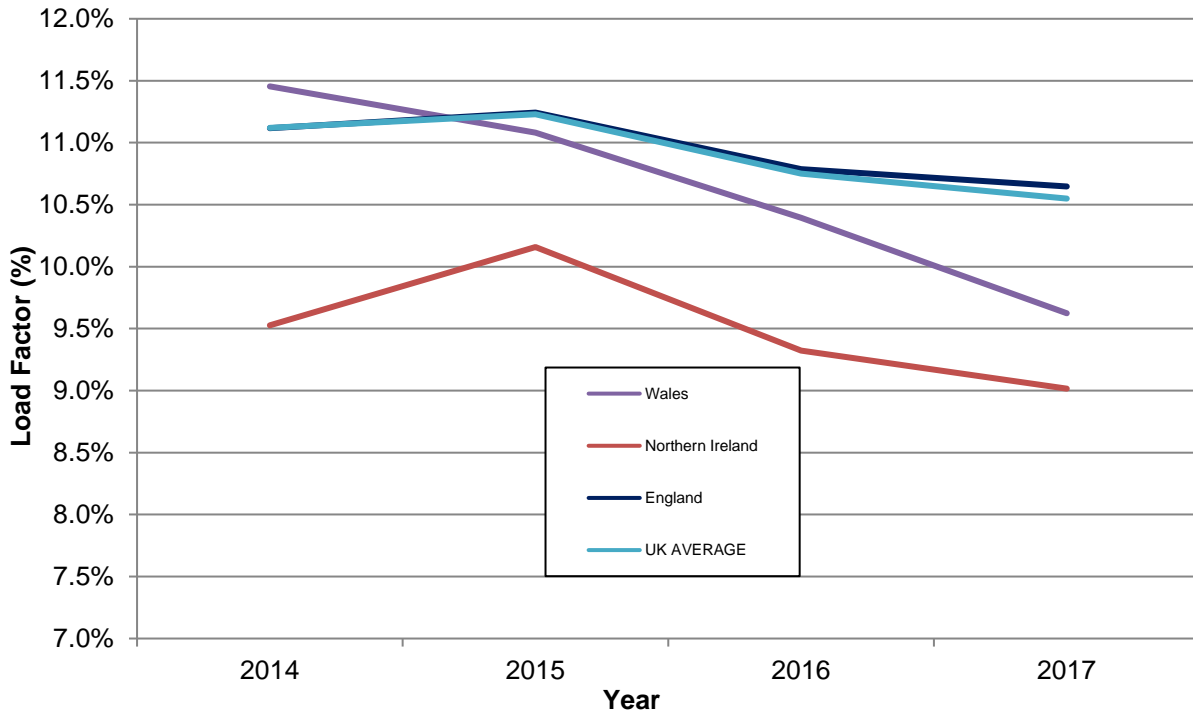
Table 5: Regional load factors on an unchanged configuration basis, 2017

	Onshore Wind	Offshore Wind	Solar PV	Hydro	Hydro (small scale)	Hydro (large scale)	Landfill gas	Sewage gas	AD	Biomass and Waste
England	27.8%	40.7%	10.6%	31.3%	38.5%	12.9%	46.5%	46.0%	60.0%	77.2%
East Midlands	27.3%	40.2%	10.5%	47.4%	47.4%		42.2%	54.1%	75.6%	70.0%
East of England	27.7%	39.9%	10.8%				47.5%	45.4%	68.8%	65.3%
North East	28.9%	37.9%		22.4%	74.3%	12.9%	35.6%	33.2%	36.4%	61.5%
North West	29.3%	43.0%	10.0%	38.6%	38.6%		36.4%	44.5%	49.2%	70.1%
London			10.1%				72.2%	32.7%		72.2%
South East	23.9%	36.7%	11.0%	28.4%	28.4%		53.4%	49.7%	58.1%	61.9%
South West	25.8%		10.6%	27.8%	27.8%		46.5%	42.5%	63.9%	17.3%
West Midlands			10.2%	23.5%	23.5%		51.6%	57.7%	76.0%	72.7%
Yorkshire and the Humber	27.8%	47.7%	10.1%	36.1%	36.1%		46.7%	57.6%	37.2%	83.0%
Northern Ireland	26.3%		9.0%	33.7%	33.7%		52.4%		82.1%	66.5%
Scotland	27.2%	33.4%	10.2%	37.0%	38.9%	36.9%	43.4%	56.8%	49.1%	76.9%
Wales	26.7%	38.2%	9.6%	24.4%	33.1%	23.0%	34.4%	40.4%	75.3%	77.0%
UK AVERAGE	27.3%	40.0%	10.5%	35.8%	37.9%	35.6%	45.8%	46.1%	63.2%	77.1%
MEDIAN	27.3%	39.0%	10.2%	31.1%	34.9%	23.0%	46.6%	45.4%	63.9%	70.1%

Special feature – Sub-national renewable electricity

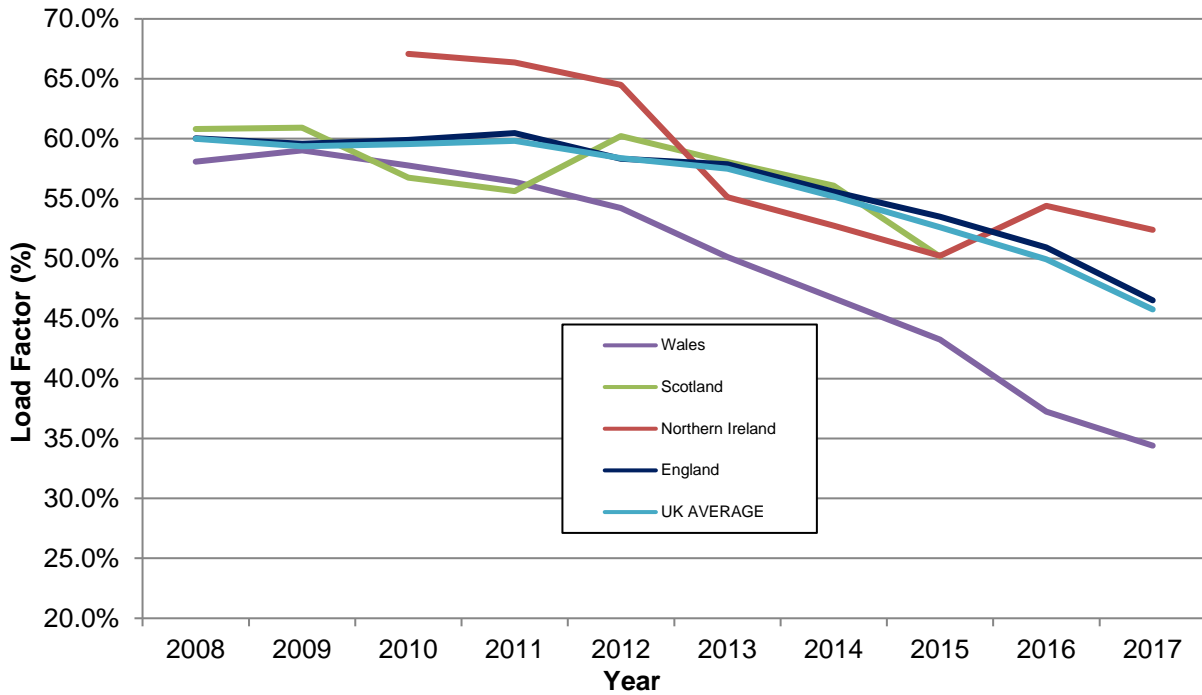
Load factors for solar PV range from 9 per cent in Northern Ireland to 11 per cent in the South East, reflecting the differences in solar irradiance levels in the UK. The UK average is 10.5 per cent, with Scotland and the West Midlands jointly occupying the median of 10.2 per cent. Average daily hours of sunshine in 2017 were slightly less than that for 2016 which is reflected in the correspondingly lower load factors (Chart 20).

Chart 20: Solar PV load factor on an unchanged configuration basis, by UK country



For landfill gas, the load factors vary from 72.2 per cent for London to 34.4 per cent in Wales, with UK mean and median values of 45.8 and 46.6 per cent respectively. Chart 21 shows that the landfill gas load factor has been steadily decreasing each year and this could be attributed to reductions in the quantity of waste landfilled since the early 2000s leading to less efficient gas abstraction. In the case of Northern Ireland, there was a growth in capacity and load factors as new sites were exploited but this has now settled down to similar values to the rest of the UK.

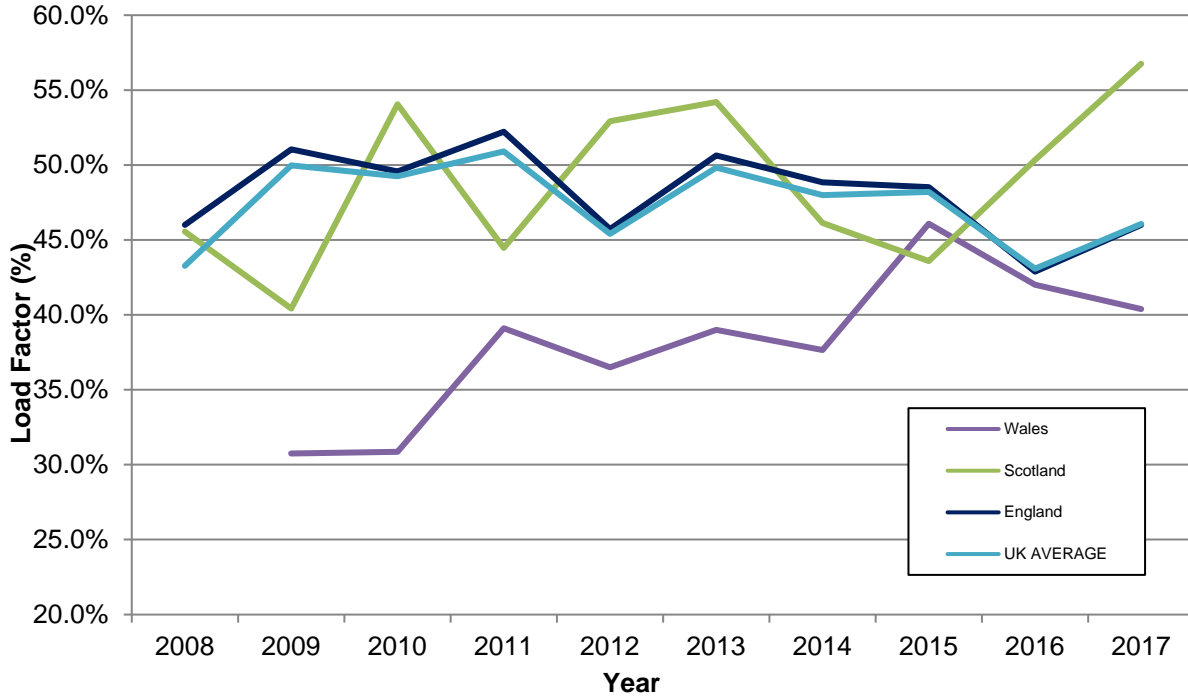
Chart 21: Landfill gas load factor on an unchanged configuration basis, by UK country



Special feature – Sub-national renewable electricity

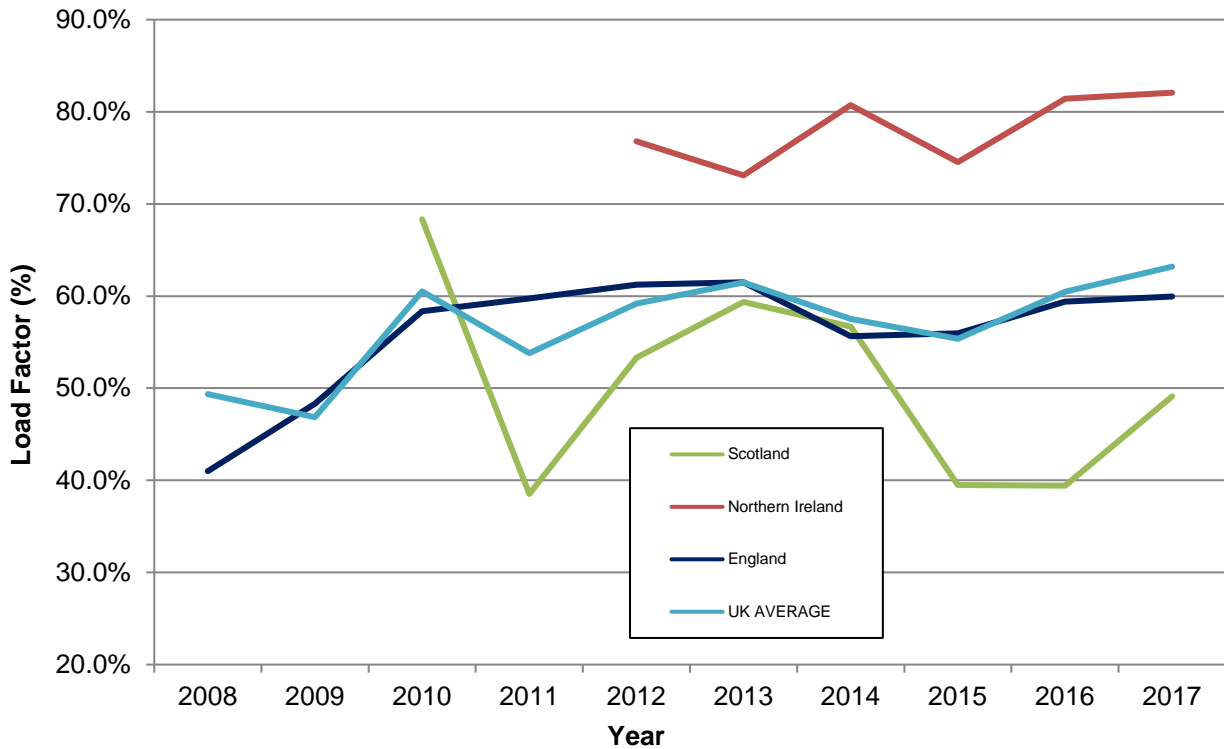
Sewage gas load factors range from 40 to 58 per cent (Chart 22) but historically there have been some unaccounted for low load factors for Wales and extreme changes for Scotland. Unfortunately, there are insufficient reliable data with which to report on the time series performance of sewage gas in Northern Ireland.

Chart 22: Sewage gas load factor on an unchanged configuration basis, by UK country



For AD, load factors can vary significantly as, depending on the feedstock, full plant output post commissioning of new schemes is not fully achieved for between 3-6 months as shown by the variations in Chart 23. This year saw only an 8 per cent increase in installed capacity but a UK load factor of 63.2% which represents the highest recorded to date. There continues to be insufficient reliable data with which to report on Wales. The load factors for Northern Ireland remain high compared with GB data for reasons still unknown.

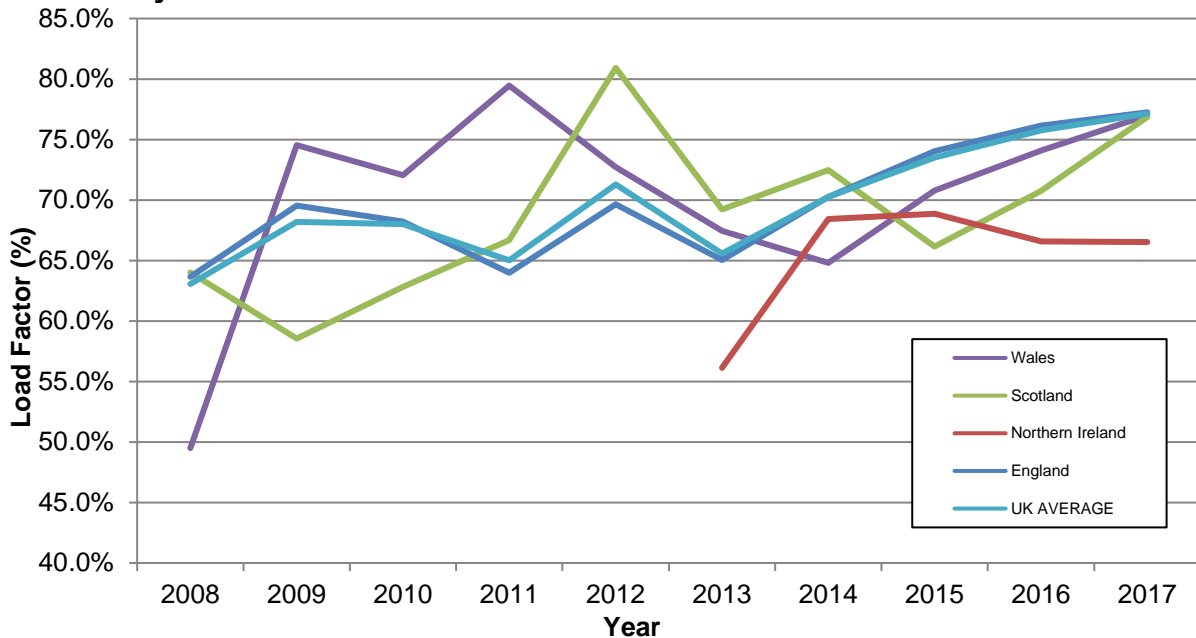
Chart 23: AD load factor on an unchanged configuration basis, by UK country



Special feature – Sub-national renewable electricity

The regional variation in load factors for biomass and waste ranges from 83.0 per cent in Yorkshire and the Humber (due to the high utilisation rates of Drax), to 17.3 per cent in the South West (due to ongoing issues with several Advanced Conversion Technology (ACT) schemes in the region). Interestingly, the load factors for England, Scotland and Wales now show convergence in Chart 24.

Chart 24: Biomass and waste load factor on an unchanged configuration basis, by UK country



For onshore wind, the load factors ranged from 23.9 per cent in the South East to 31.9 per cent in the West Midlands, with East Midlands occupying the median position at 27.3 per cent.

Chart 25 shows the annual variation in onshore wind load factors compared to the UK's average wind speed¹¹. Over the 15-year period from 2001 to 2015, 2015 was the windiest year, slightly exceeding 2008; the least windy year was 2010. Thus, 2015's load factors for both onshore and offshore wind were the highest in the sixteen-year time-period. The average wind speed for 2017 (8.8 knots) was more than for 2016 (8.4 knots) which is reflected in the correspondingly higher load factors for this year's onshore wind.

¹¹ Source: Energy Trends table ET 7.2, available at: www.gov.uk/government/statistics/energy-trends-section-7-weather. Further information on the methodology used is given in Energy Trends Special feature article, Dagnall, S.P., Janes, M. and Tipping, A, March 2006, 'UK Onshore Wind capacity factors 1998-2004', Energy Trends, p28

Chart 25: Annual variation in wind speed and UK onshore wind load factor on an unchanged configuration basis

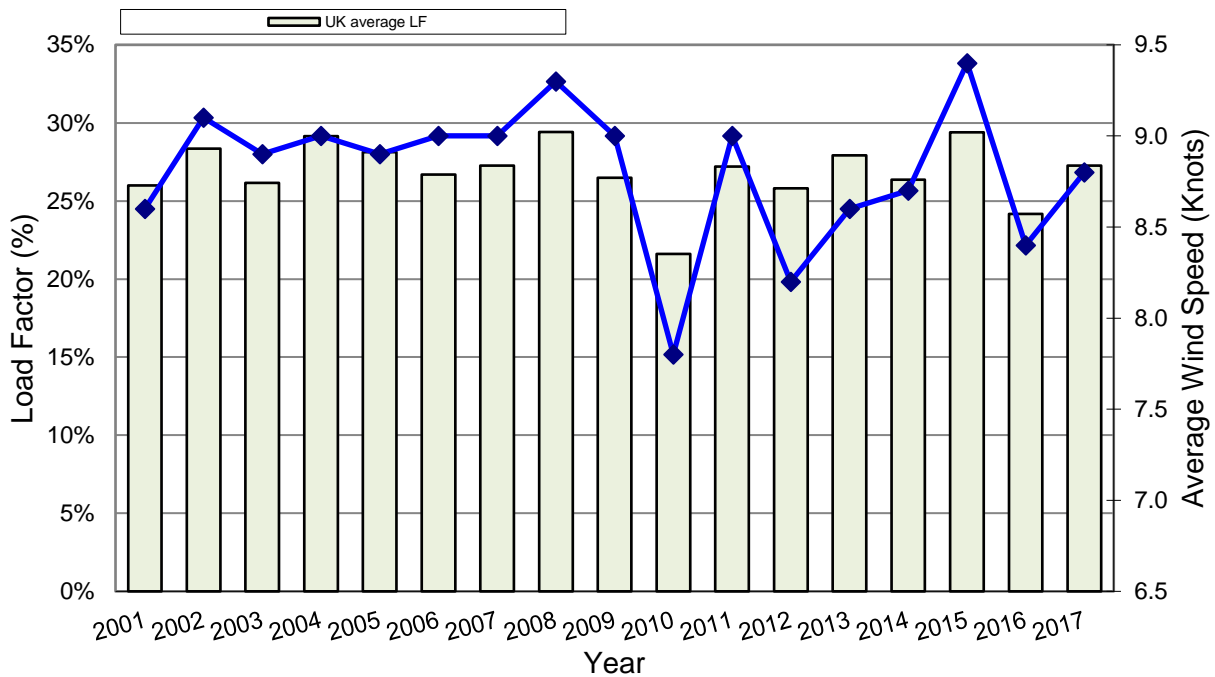
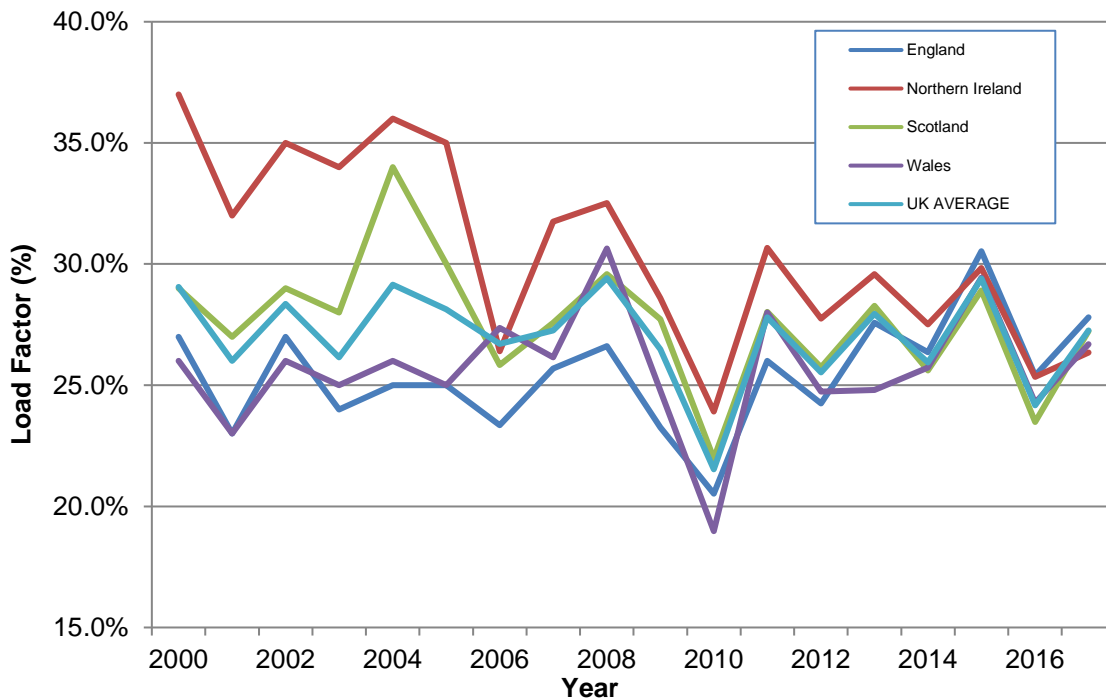


Chart 26 compares the onshore wind load factors for the four UK countries. For most of the seventeen years, the highest load factors have been experienced in the windier countries, Northern Ireland (averaging 30.8 per cent) followed by Scotland (averaging 27.6 per cent), Wales (averaging 25.6 per cent) and England (averaging 25.3 per cent). However, in 2014- 2016, Scotland's load factor fell beneath that of the other three countries, due to continued outages and curtailments at some of Scotland's largest wind farms. In 2017, Scotland's load factor for onshore wind remains less than that for England it is now greater than that for both Northern Ireland and Wales. In England, the North West continues to have the highest load factor of the English regions (29.3 per cent) closely followed by the North East (27.8 per cent).

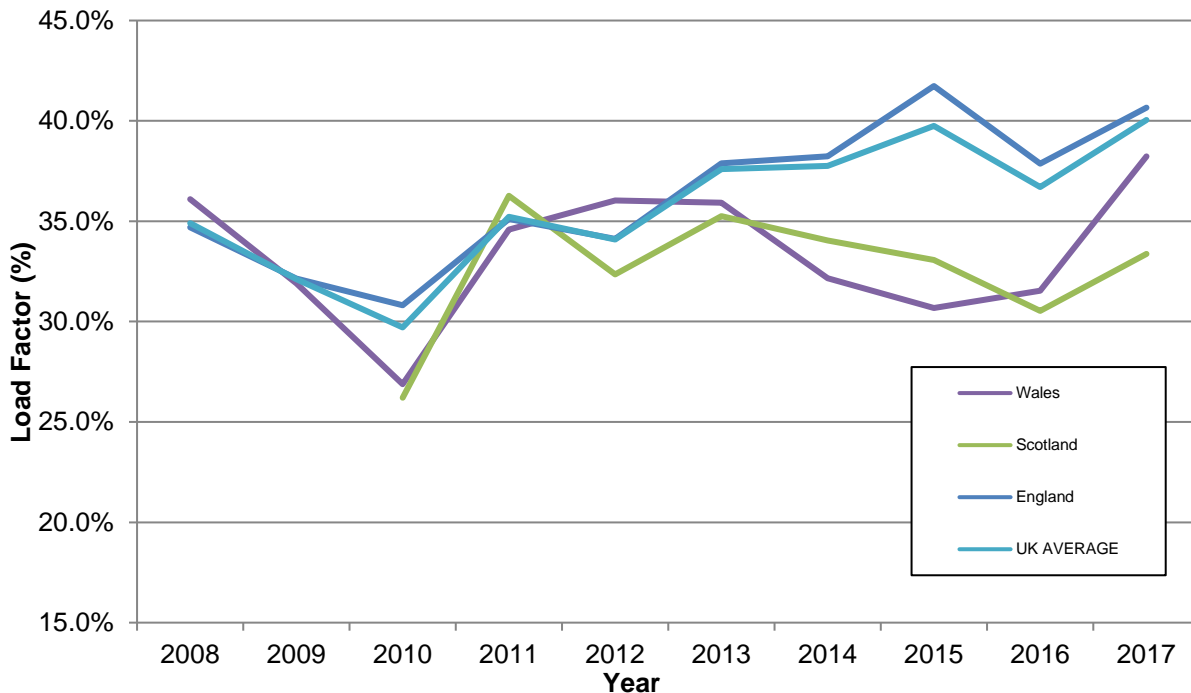
Chart 26: Onshore wind load factor on an unchanged configuration basis, by UK country



Special feature – Sub-national renewable electricity

Offshore wind load factors ranged from 33.4 per cent in Scotland to 40.7 per cent on average in England, with Yorkshire and the Humber achieving 47.7 per cent, driven by high-performing sites including Westernmost Rough (which utilises the largest turbines operational throughout 2017, at 6 MW, though now superseded by BBE's 8 MW turbines, and Humber Gateway), followed by the North West at 43 per cent. The East of England and Wales (38.2 per cent) jointly occupy the median position at 39 per cent. Chart 27 shows the effect of the variation in average wind speed data described above.

Chart 27: Offshore wind load factor on an unchanged configuration basis, by UK country



Local authority analysis

Tables 6 to 8 rank the top five Local Authorities (LAs), per: number of installations, installed capacity, and generation for key technologies; this is also shown graphically in Charts 28 to 30.

For overall **number of sites**, Cornwall remains the top ranked (17,384), reflecting the large number of solar PV schemes installed in the South West. In terms of individual technologies, the top ranking LAs for number of installations for onshore wind, PV, hydro, landfill gas, anaerobic digestion and plant biomass are, respectively: The Orkney Islands, Cornwall, Highland, Thurrock, Shropshire and Mendip.

Highland became the top ranked this year for overall **capacity**, primarily from wind and hydro, followed closely by Selby, primarily from Plant Biomass (Drax Dedicated Biomass). In terms of installed capacity of individual technologies, the top ranking LAs for onshore wind, PV, hydro, landfill gas, anaerobic digestion and plant biomass are, respectively: Highland, Wiltshire, Highland, Thurrock, Shropshire and Selby.

The top ranked LAs for **generation** was Selby, primarily from Plant Biomass, but in terms of individual technologies, the top ranking LAs for onshore wind, PV, hydro, landfill gas, anaerobic digestion and plant biomass are, respectively: Highland, Cornwall, Highland, Thurrock, Shropshire and Selby.

Cornwall and Wiltshire continue to have large numbers of PV sites with correspondingly high capacity and generation which represents the installation of large solar farms. Interestingly, Sunderland and County Durham between them have an unusually large number of PV sites, especially for a region

with low solar irradiance, however, they have much lower capacities and generation. This large number of small schemes probably represents the uptake of domestic installations.

The Highland's overall capacity and generation is driven by the construction of large-scale wind farms. Whilst the Orkneys has the highest number of wind sites, almost 3 times that of the Highland's, it has little capacity or generation; most likely because these are mainly small projects meeting local needs. Although much wind capacity exists in Scotland, grid connection issues mean there are currently limitations on how much can be exported to other parts of the UK until this has been resolved.

Shropshire continues to show the highest number of AD facilities as well as capacity and generation, and probably reflects the availability of AD feedstock because of the high levels of livestock farming undertaken in this District.

Chart 28: Top five Local Authorities ranked by number of sites

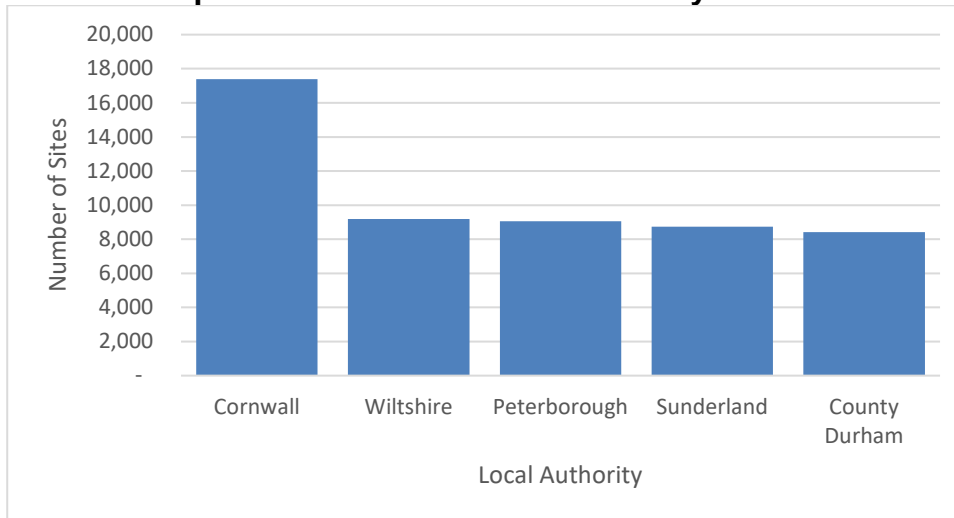


Chart 29: Top five Local Authorities ranked by capacity

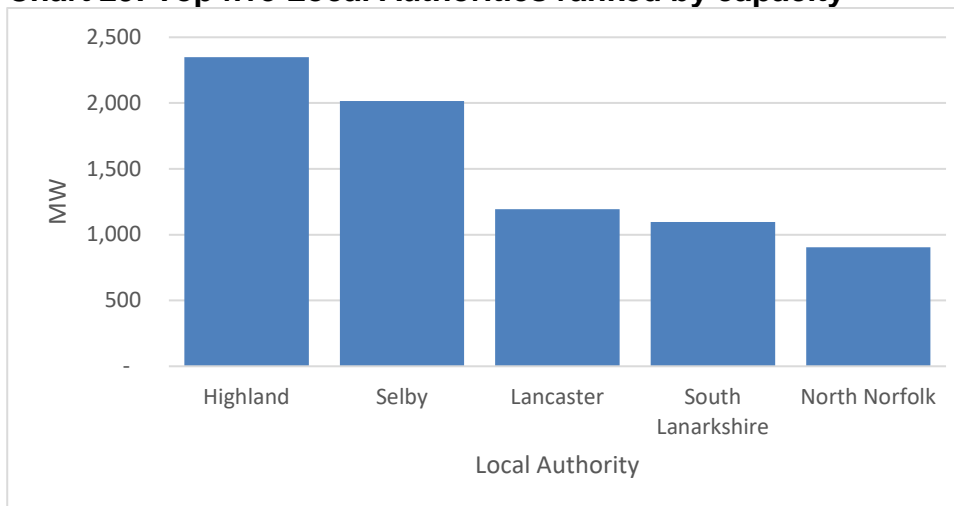


Chart 30: Top five Local Authorities ranked by generation

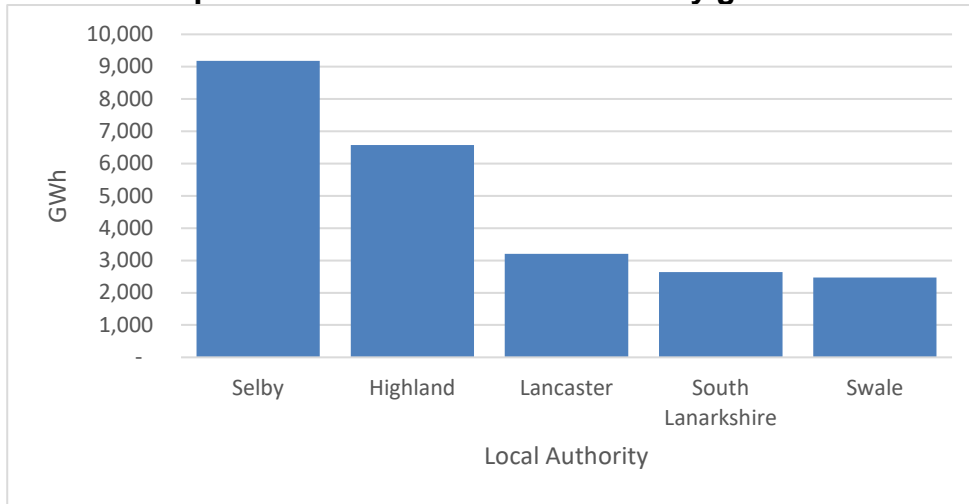


Table 6: Local Authority: Number of sites generating electricity from renewable sources, 2017¹

											Number		
Onshore Wind	Solar PV		Hydro		Landfill gas	Anaerobic Digestion		Plant Biomass		Total ²			
Orkney Islands	773	Cornwall	16,924	Highland	278	Thurrock	10	Shropshire	34	Mendip	29	Cornwall	17,384
Aberdeenshire	572	Wiltshire	9,153	Argyll & Bute	115	Doncaster	8	Herefordshire County of	20	Dumfries & Galloway	14	Wiltshire	9,179
Cornwall	427	Peterborough	9,053	Gwynedd	113	North Lanarkshire	8	Strabane	18	Herefordshire County of	10	Peterborough	9,061
Dumfries & Galloway	293	Sunderland	8,733	Perth & Kinross	88	Warrington	8	Dumfries & Galloway	15	East Riding of Yorkshire	8	Sunderland	8,742
Highland	249	County Durham	8,291	Dumfries & Galloway	83	Wiltshire	8	East Lindsey	9	Sheffield	8	County Durham	8,411
								East Lindsey	8				
								East Lindsey	8				
								East Lindsey	8				
UK Total	9,586		942,550		1,507		464		585		372		955,383

Table 7: Local Authority: Installed capacity of sites generating electricity from renewable sources, 2017¹

											MW		
Onshore Wind	Solar PV		Hydro		Landfill gas	Anaerobic Digestion		Plant Biomass		Total ²			
Highland	1,484	Wiltshire	581	Highland	804	Thurrock	44	Shropshire	19	Selby	1,958	Highland	2,348
South Lanarkshire	1,055	Cornwall	581	Argyll & Bute	296	Central Bedfordshire	33	Redcar and Cleveland	10	Fife	77	Selby	2,015
South Ayrshire	653	South Cambridgeshire	284	Perth & Kinross	278	Warrington	32	Herefordshire County of	9	Slough	63	Lancaster	1,194
Scottish Borders	637	Shropshire	227	Dumfries & Galloway	152	North Lanarkshire	26	Breckland	9	Sheffield	62	South Lanarkshire	1,096
Aberdeenshire	577	Pembrokeshire	201	Stirling	85	Aylesbury Vale	21	East Lindsey	8	Neath Port Talbot	56	North Norfolk	905
UK Total	12,853		12,823		1,886		1,066		469		3,055		40,630

Table 8: Local Authority: Generation of electricity from renewable sources, 2017¹

											GWh		
Onshore Wind	Solar PV		Hydro		Landfill gas	Anaerobic Digestion		Plant Biomass		Total ²			
Highland	3,282	Cornwall	531	Highland	3,108	Thurrock	173	Shropshire	102	Selby	9,081	Selby	9,180
South Lanarkshire	2,497	Wiltshire	531	Perth & Kinross	776	Aylesbury Vale	133	Redcar and Cleveland	55	Fife	428	Highland	6,577
Scottish Borders	1,574	South Cambridgeshire	269	Argyll & Bute	583	Havering	128	Herefordshire County of	49	Allerdale	362	Lancaster	3,203
Aberdeenshire	1,465	Shropshire	186	Dumfries & Galloway	446	Central Bedfordshire	127	Breckland	48	Dumfries & Galloway	353	South Lanarkshire	2,637
Dumfries & Galloway	1,096	Pembrokeshire	173	Stirling	313	Warrington	122	Strabane	46	Sheffield	328	Swale	2,472
UK Total	29,113		11,505		5,917		4,284		2,518		20,059		99,372

¹ Top five ranked Local Authorities (LAs). Where more than five schemes are listed, this indicates that more than one LA has the same ranking.

² Totals include offshore wind sites allocated to nearest Local Authority.

Comparison with economic activity

Economic activity in each country or region can be measured in terms of Gross Value Added (GVA). Table 9 shows that Scotland continues to show the largest generating capacity from renewables in terms of capacity per unit of GVA, followed closely by Wales and Northern Ireland. Scotland shows the largest generation per unit of GVA, due to Drax, followed by Yorkshire and the Humber and Wales. Among the English regions, the highest generating capacity per unit of GVA after Yorkshire and the Humber is the East of England, followed by the South West and the East Midlands. In terms of Generation per unit of GVA, Yorkshire and the Humber is followed by the East of England, the East Midlands and the North West.

Table 9: Density of renewables generation in different areas

	Electrical generating capacity from renewable sources kW/GVA (£million) ^{1,2}	Electricity generated from renewable sources kWh/GVA (£million) ¹
England	16.90	42,277
East Midlands	26.93	54,493
East of England	33.92	74,763
North East	20.83	47,864
North West	18.67	50,272
London	0.97	2,648
South East	15.26	29,750
South West	30.33	38,428
West Midlands	9.30	16,412
Yorkshire and the Humber	36.27	181,060
Northern Ireland	41.64	87,700
Scotland	75.95	189,024
Wales	53.59	118,945
UK average	23.02	56,665

1. GVA is Gross Value Added as published as Total GVA in Regional Gross Value Added (Income Approach), December 2015 at: www.ons.gov.uk/economy/grossvalueaddedgva/bulletins/regionalgrossvalueaddedbalanceduk/1998to2016

2. Excludes capacity attributable to co-firing of bioenergy which has not been allocated to regions (see footnote 4 to Table 2).

Revisions

Historic revisions this year were only carried out to the 2015 and 2016 datasets. Whilst this has resulted in changes to both capacity and generation for all but two regions (including the minor changes to Northern Ireland), these are primarily due to the reassignment of unknown FiT data from the Other category. These revisions are summarised in the following table:

Table 10: Historic capacity and generation revisions

Year	2015		2016	
	MW	GWh	MW	GWh
England				
East Midlands	115	66	145	238
East of England	0	0	0	0
North East	15	4	25	21
North West	52	21	93	96
London	11	4	17	11
South East	100	32	148	149
South West	226	67	293	278
West Midlands	61	27	103	108
Yorkshire and the Humber	0	0	0	0
Northern Ireland	0	-1	1	-3
Scotland	102	113	183	376
Wales	81	32	151	170
Other	-692	-406	-1169	-1544
TOTAL	72	-42	-10	-99

Further information

For further details on the sub-national renewable analysis in this article please contact:

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