



GB Electricity Market Summary

FULL YEAR 2017

Recorded Levels of GB Generation by Fuel (based upon Ofgem & NG Embedded Forecasts & FUELHH data):

GAS: 13.7GW (-6%)
COAL: 2.4GW (-26%)

RENEWABLES: 9.5GW (+21%)
INTERCONNECTION: 1.8GW (-12%)

NUCLEAR: 7.5GW (-1%)

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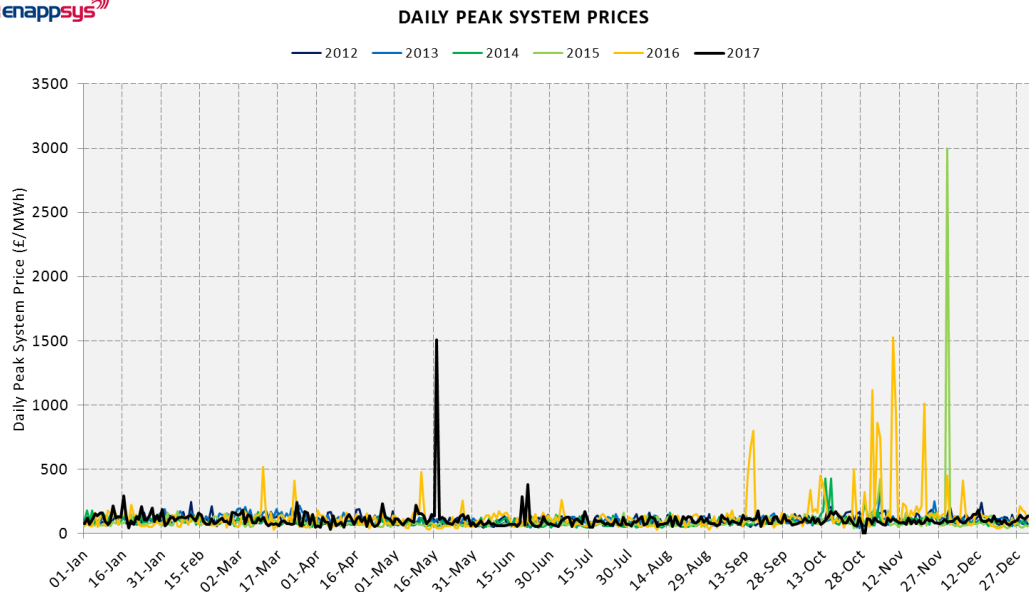
EXECUTIVE SUMMARY

2017 saw very strong levels of renewable generation, with this pushing down levels of fossil fuel generation levels, and with this mostly stemming from strong levels of wind generation in the year.

The high levels of wind generation resulted from increased levels of offshore wind capacity and from stormy weather. Whilst 2018 is unlikely to see the same frequency of storms, levels of wind generation are likely to increase once again now that the Western Link interconnector is operational.

In 2017, 1.49TWh or 3.2% of wind generation was wasted as wind farms in Scotland were turned down or off due to their output not being able to be used by the market. The Western Link will instead make it possible for an additional 2.2GW of excess wind to be moved into England and to be used rather than merely wasted. This should increase the levels of wind generation being used within the power system.

Otherwise, the most notable activity in 2017 came with greatly reduce levels of peak market prices in the second half of 2017:



This came as from October 2017, the previous system of holding plants required to ensure minimum margin levels in reserve (and unable to act commercially) came to an end to be replaced by the Capacity Mechanism.

This added ~3.5GW of capacity back into the market and able to act commercially whilst also introducing new plants into the market at the same time. This coupled with windy conditions led to comfortable margins and greatly reduced levels of peak price activity.

Otherwise in the market, coal plants continue to see declining levels of generation at 20.7TWh for the year (down from 27.9TWh), but did see activity peak up as gas prices peaked offering the potential for more coal generation if the European gas market hits supply issues.

Gas plants continued to provide the most generation in the year at 119.6TWh (down from 127.0TWh), whilst renewable plants increased generation to 83.2TWh (from 68.6TWh). This resulted in the first year when fossil fuels provided less than half the total generation required by the market, whilst renewables provided over a quarter of the total for the first time.

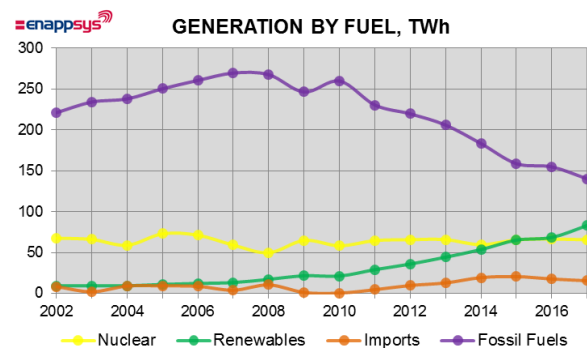
Nuclear plants continued to see similar levels of generation at 65.7TWh (down from 66.6TWh), whilst electricity imports reduced to 15.7TWh (from 17.8TWh) as power was being exported to France for some of the winter period due to their issues with nuclear plants.

In 2017, 39.2% of electricity came from gas power stations, 27.35 from renewables, 21.6% from nuclear plants, 6.8% from coal plants and 5.2% from electricity imports.

FUEL ACTIVITY

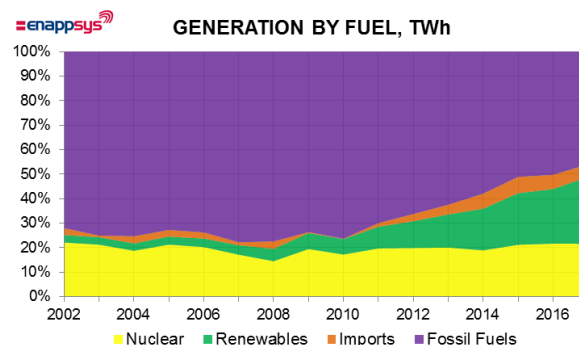
2017 saw a fuel mix that broadly matched up with the levels achieved in 2017, although with higher levels of renewable generation translating into reduced levels of fossil fuel generation.

Coal continued to see very low levels of generation in the year, down 26% from the low levels in the previous year, but did see generation levels pick up around the high gas prices towards the end of 2017. These prices came due expected gas field outages and due to a fire at Baumgarten later in the year.



Levels of coal-fired generation have decreased more recently and gas prices have fallen

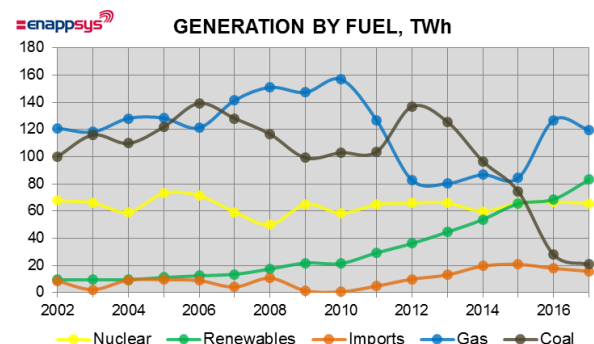
back, but have the potential to rise if any further issues occur within the European gas network, with it too early to say that coal is finished as a source of power generation.



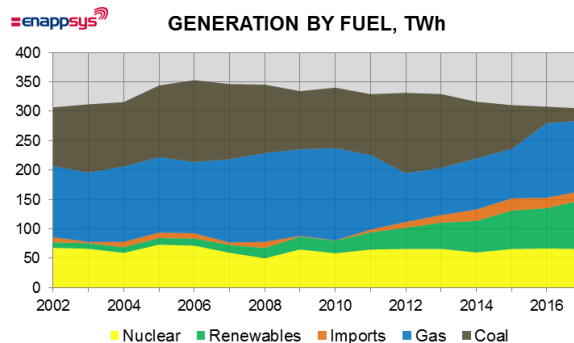
In the year gas generated 119.6TWh of power (down from 127.0TWh), with this amounting to 39.2% of total electricity supply in the year. Added

to this, coal plants generated 20.7TWh (down from 27.9TWh), with coal plants supplying 6.8% of total generation and with combined fossil fuels providing 140.3TWh (down from 154.9TWh and equivalent to 46.0% of total generation).

This marks the first year on record where fossil fuels have provided less than half of total electricity generation requirements and this has come about primarily due to very strong levels of wind generation.



For the second year running, renewables provided the second largest share of generation



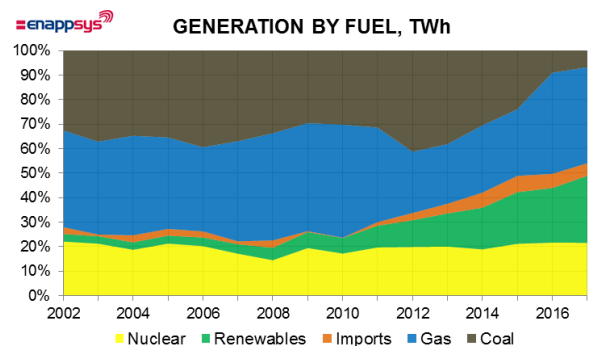
and this amounted to 83.2TWh of generation (up from 68.6TWh in 2016). This amounted to 27.3% of the overall fuel mix, meaning that renewables exceeded a quarter of total supply for the first time in 2017.

Going forwards, levels of support for renewables will remain tight until 2025, although there are a number

of very large offshore wind farms expected to come online and the carbon price support that raises the cost of carbon in the UK is set to be fixed.

This will allow for increased levels of renewable generation, but could allow for coal seeing increased levels of generation in future years and will result in a slowed shift towards further renewable penetration.

Levels of nuclear generation in the year remained very consistent at 65.7TWh, but with nuclear providing much less power than wind and at a higher cost, the requirement for new nuclear stations looks much reduced to the apparent need a decade ago. Nuclear plant generation amounted to 21.6% of total electricity supply, with these levels being slightly down from the 66.6TWh recorded in the previous year.



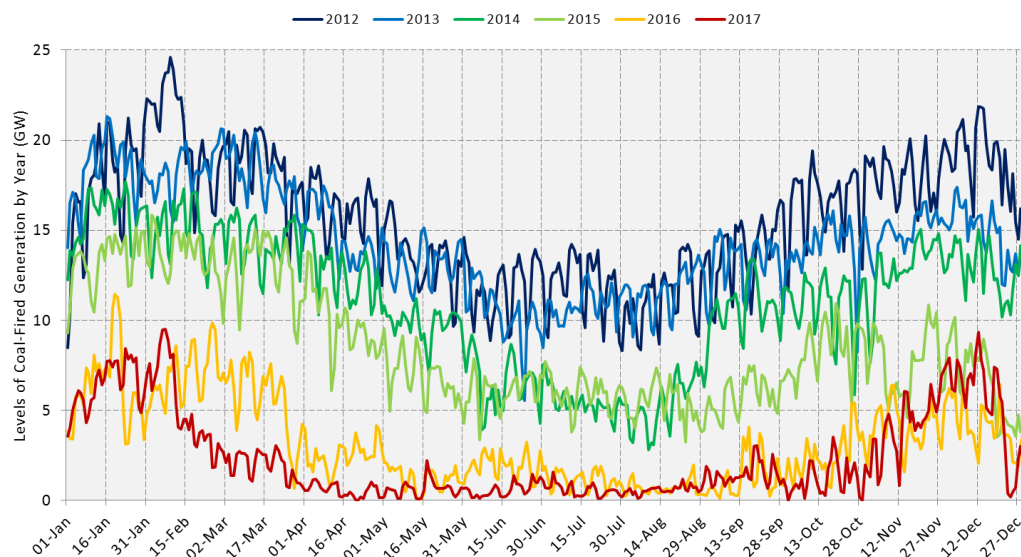
In 2017, 39.2% of generation came from gas-fired plants, 27.3% from renewables, 21.6% from nuclear, 6.8% from coal stations and 5.2% from interconnections.

Generally the year saw very little change against the backdrop of 2016, with the exception being the growth in levels of renewable generation as a number of large offshore wind farms came online and with the potential for higher levels of coal-fired generation being highlighted by the increased coal burn during a period of high gas prices in November and December.

This increased coal burn over this period can be seen in the following chart, with coal generation dropping off over the Christmas period as the demand for electricity generation declined:



LEVELS OF DAILY COAL GENERATION BY YEAR



Otherwise the trends in the fuel mix were very consistent with those noted in the previous year.

Statistics

The following tables contain some of the key statistics relating to 2017 and some previous years:

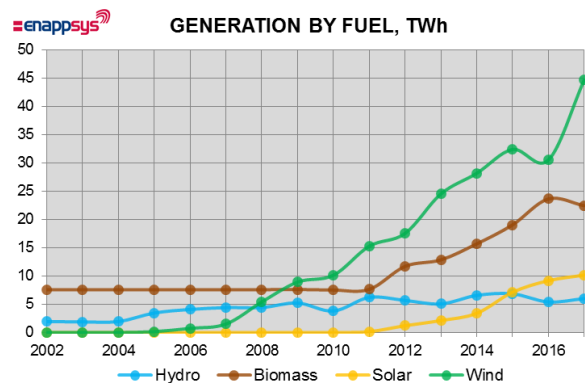
*GB Only (Excludes Northern Ireland)	2009	2010	2011	2012	2013	2014	2015	2016	2017
TOTAL GENERATION BY FUEL (TWh)									
Coal	99.10	102.95	103.48	136.84	125.74	96.65	74.46	27.92	20.67
Gas	147.32	156.89	127.01	82.86	80.23	86.72	84.35	126.98	119.59
Imports	1.32	0.58	4.77	9.88	13.02	19.48	20.75	17.81	15.71
Nuclear	64.97	58.44	64.75	65.81	65.93	59.74	65.68	66.58	65.72
Renewables	21.75	21.45	29.24	36.09	44.51	53.75	65.35	68.64	83.20
TOTAL	334.46	340.30	329.24	331.48	329.43	316.34	310.58	307.93	304.90
SHARE OF GENERATION (%)									
Coal	29.6%	30.3%	31.4%	41.3%	38.2%	30.6%	24.0%	9.1%	6.8%
Gas	44.0%	46.1%	38.6%	25.0%	24.4%	27.4%	27.2%	41.2%	39.2%
Imports	0.4%	0.2%	1.4%	3.0%	4.0%	6.2%	6.7%	5.8%	5.2%
Nuclear	19.4%	17.2%	19.7%	19.9%	20.0%	18.9%	21.1%	21.6%	21.6%
Renewables	6.5%	6.3%	8.9%	10.9%	13.5%	17.0%	21.0%	22.3%	27.3%
INCREASE TO 2016 (%)									
Coal	-79.1%	-79.9%	-80.0%	-84.9%	-83.6%	-78.6%	-72.2%	-26.0%	0.0%
Gas	-18.8%	-23.8%	-5.8%	44.3%	49.1%	37.9%	41.8%	-5.8%	0.0%
Imports	1088.3%	2604.7%	229.8%	59.1%	20.7%	-19.3%	-24.3%	-11.8%	0.0%
Nuclear	1.2%	12.5%	1.5%	-0.1%	-0.3%	10.0%	0.1%	-1.3%	0.0%
Renewables	282.6%	287.9%	184.5%	130.6%	86.9%	54.8%	27.3%	21.2%	0.0%
Fossil Fuels									
Fossil Fuel Share	73.7%	76.4%	70.0%	66.3%	62.5%	58.0%	51.1%	50.3%	46.0%
Renewable Share	6.5%	6.3%	8.9%	10.9%	13.5%	17.0%	21.0%	22.3%	27.3%

RENEWABLES

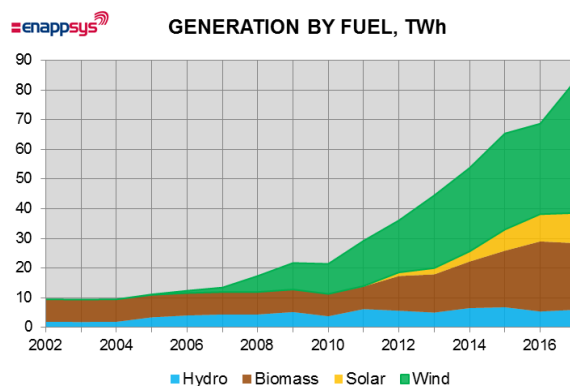
Having seen levels of renewable generation grow at a slower rate in 2016, the very strong levels of wind generation noted in 2017 were sufficient for renewable output levels to climb significantly.

This contributed to renewable generation levels of 83.2TWh (up from 68.6TWh), with this amounting to 27.3% of total generation in the year. This marks the first time that renewables have exceeded a quarter of total power supply in any given year. This amounted to 53.6% of total renewable generation in the year.

Renewables now generate more than six times the amount of generation they did ten years ago and the impact has been an 84% decline in levels of coal-fired generation and a 15% decline in levels of gas-fired generation over this period.



Wind farms have seen the biggest growth over this period, with generation increasing more than forty-times over the past decade to hit 44.6TWh in 2017 (up from 30.5TWh in 2016). These high levels in 2017 came about as the year saw a number of storms that contributed to high generation levels and as a number of offshore wind farms came online during the year.

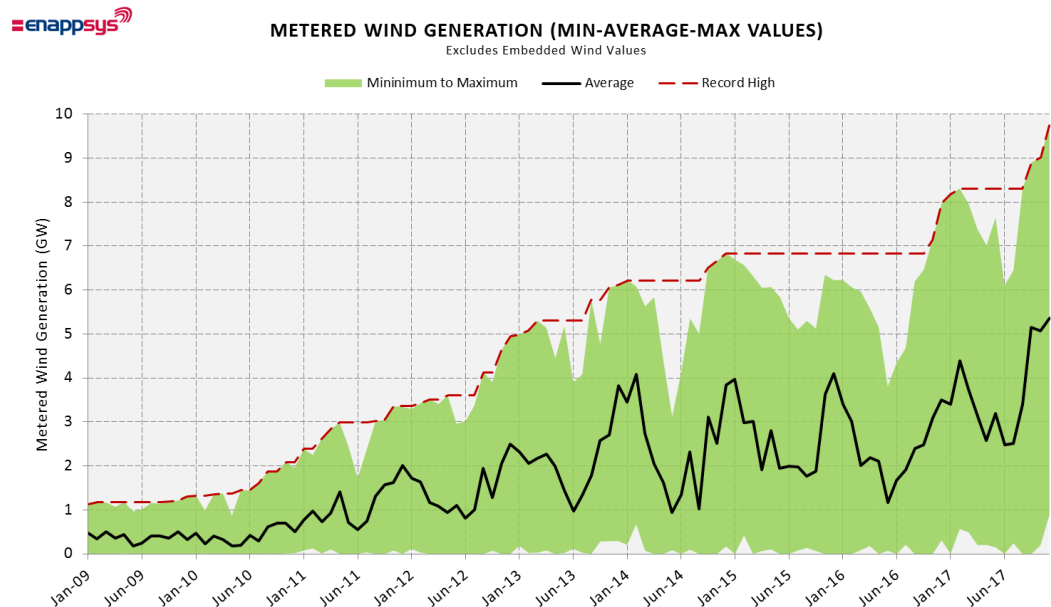


Towards the end of the year, wind farms were particularly consistent, with wind farms exceeding 2GW of output 88% of the time and 5GW of output for 60% of the time. The peak levels of wind generation were less common, with 7GW being exceeded for 40% of the time and 10GW for 3% of the time, but with a new

highest levels of wind generation being set at just over 12GW during one half-hourly period.

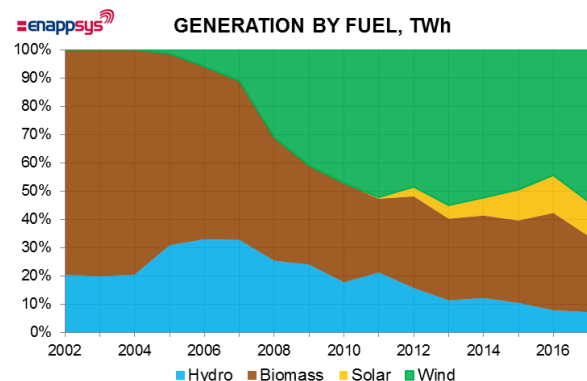
The year was one in which levels of wind generation hit new heights as offshore wind farms came online and this came despite the new Western Link interconnector – that will

move 2.2GW of excess wind from Scotland to England – not coming online until very late in 2017: (this chart excludes embedded wind farms)



The next highest levels of renewable generation came from biomass plants which provided 22.4TWh of power (down from 23.6TWh in 2016), with this amounting to 27.0% of renewable generation in the year.

Solar farms provided the next highest levels of generation at 10.2TWh (up from 9.2TWh), with this amounting to 12.2% of renewable generation. These levels come despite solar capacity now being very high, but with solar only able to generate over a small time window.



Hydro plants provided the smallest share of generation over the year, despite also benefitting from the stormy weather conditions, generating 6.0TWh (up from 5.4TWh in 2016) or 7.2% of total renewable generation.

In 2017 wind farms provided 14.6% of total generation, biomass 7.4%, solar 3.3% and hydro 2.0%, with this amounting to a total of 27.0% of renewable generation.

Statistics

The following tables contain some of the key statistics relating to the year and some previous years:

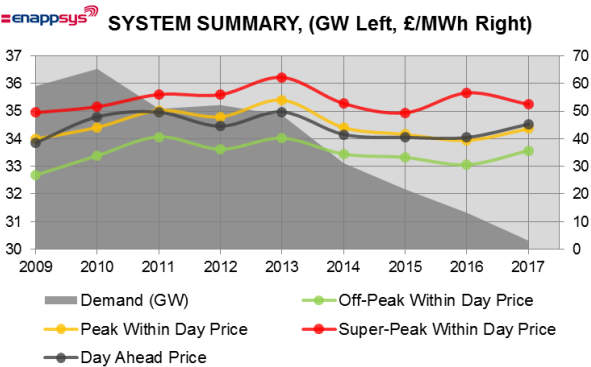
*GB Only (Excludes Northern Ireland)	2009	2010	2011	2012	2013	2014	2015	2016	2017
TOTAL GENERATION BY FUEL (TWh)									
Biomass	7.61	7.51	7.62	11.69	12.84	15.67	19.03	23.61	22.43
Hydro	5.22	3.80	6.21	5.68	5.06	6.56	6.84	5.40	6.00
Solar	0.00	0.01	0.16	1.21	2.12	3.39	7.13	9.15	10.15
Wind	8.92	10.12	15.26	17.51	24.49	28.13	32.35	30.48	44.62
TOTAL RENEWABLES	21.75	21.45	29.24	36.09	44.51	53.75	65.35	68.64	83.20
SHARE OF RENEWABLE GENERATION (%)									
Biomass	35.0%	35.0%	26.1%	32.4%	28.9%	29.2%	29.1%	34.4%	27.0%
Hydro	24.0%	17.7%	21.2%	15.7%	11.4%	12.2%	10.5%	7.9%	7.2%
Solar	0.0%	0.0%	0.5%	3.4%	4.8%	6.3%	10.9%	13.3%	12.2%
Wind	41.0%	47.2%	52.2%	48.5%	55.0%	52.3%	49.5%	44.4%	53.6%
LARGEST RENEWABLE SOURCE	WIND	WIND	WIND	WIND	WIND	WIND	WIND	WIND	WIND
INCREASE TO 2016 (%)									
Biomass	194.9%	198.5%	194.3%	91.8%	74.6%	43.1%	17.9%	-5.0%	0.0%
Hydro	14.9%	57.7%	-3.4%	5.7%	18.6%	-8.6%	-12.3%	11.0%	0.0%
Solar		96497.3%	6395.2%	737.0%	379.2%	199.9%	42.5%	10.9%	0.0%
Wind	400.4%	340.8%	192.4%	154.9%	82.2%	58.6%	37.9%	46.4%	0.0%
Total	282.6%	287.9%	184.5%	130.6%	86.9%	54.8%	27.3%	21.2%	0.0%

DEMAND, MARGIN AND PRICES

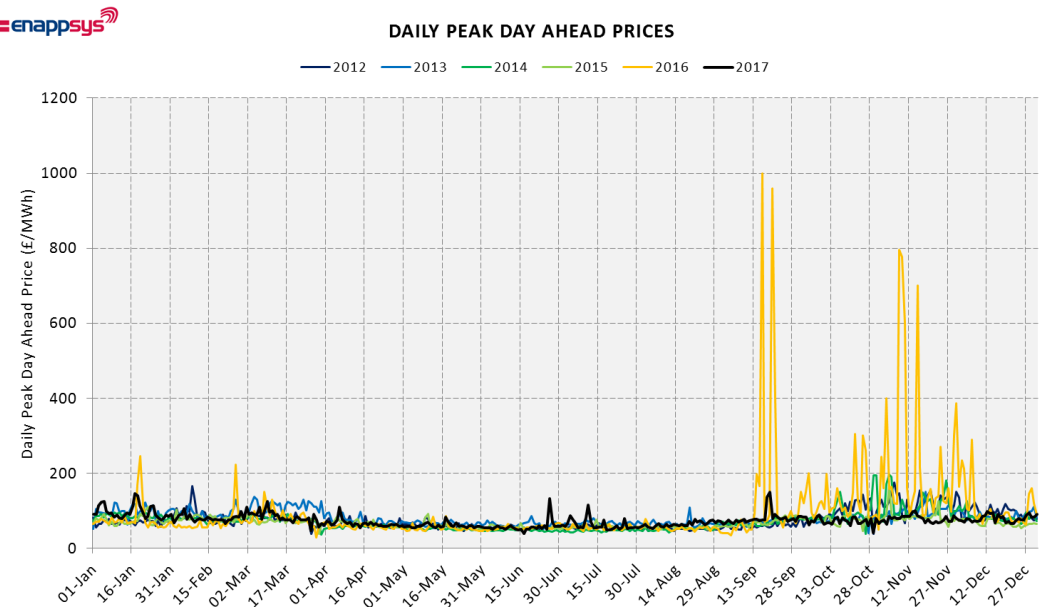
The market in 2017 saw significant change from the previous year as market prices were considerably reduced due to the wider levels of margin in the market.

Levels of demand in 2017 totalled 287.5TWh (down 6% from 305.2TWh in 2016) as levels of demand in the market continued to decline on an on-going basis. This decline has been driven by reduced residential and industrial electricity usage.

Market prices also declined from the previous year, but more significantly the peaks also reduced from very high levels in 2016, to levels that were below the norm for the market. This came following periods of very tight margin in 2016 that resulted in scarcity pricing, with 2017 instead seeing ample margins throughout the second half of the year aided by strong levels of wind generation.



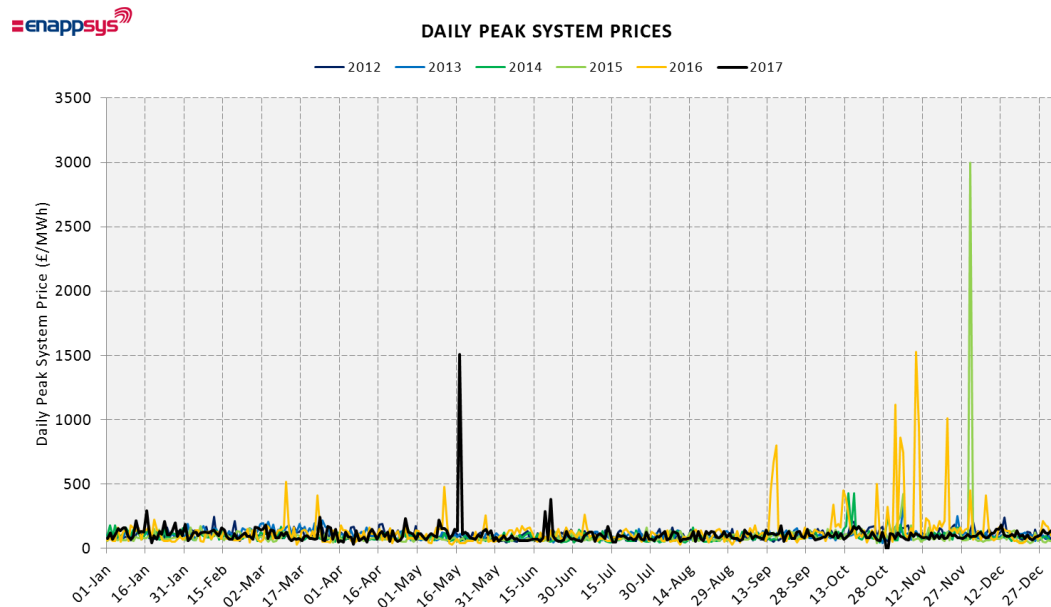
This change in market prices can be best seen through a set of charts, with the first chart showing peak day ahead prices by day for each year since 2012:



This chart shows in black the peak day ahead prices in 2017 and in other colours the peak prices in previous years, with the peaks in 2017 being much lower than those in the two previous years.

These two years saw the activity of a reserve service called Supplementary Balancing Reserve (SBR) that allowed National Grid to make up the shortfall in system margin via specially contracted plants. These plants whilst accounted for in the margin could not act commercially and so this left the system with a negative commercial margin over the past two years driving the high prices.

A similar chart shows the same activity for peak system prices in 2017 against previous years:



Again 2017 was notable for the lack of activity, except for on one day early on in the year.

Statistics

The following table contains some of the key statistics relating to the year and some previous years:

*GB Only (Excludes Northern Ireland)	2010	2011	2012	2013	2014	2015	2016	2017
WHOLESALE PRICES (£/MWh)								
Day Ahead Price	47.92	49.61	44.54	49.69	41.55	40.51	40.47	45.27
Within Day Price (MIDP)	41.75	47.83	45.21	50.58	42.10	39.94	39.01	44.73
WITHIN DAY PRICE BREAKDOWN (£/MWh)								
Off-Peak Hours	33.88	40.69	36.23	40.21	34.46	33.24	30.62	35.67
Peak Hours (excl Superpeak)	44.12	50.17	47.95	53.96	44.03	41.58	39.43	43.64
Superpeak Hours	51.60	56.00	55.96	62.18	52.74	49.40	56.58	52.44
DEMAND (MW)	38,321	36,907	37,327	37,078	35,536	35,479	34,746	32,820
AVAILABILITY (MW)					53,830	52,250	49,895	50,465
MARGIN (MW)					18,294	16,771	15,149	17,645
DEMAND (TWh)	335.7	323.3	327.9	324.8	311.3	310.8	305.2	287.5
AVAILABILITY (TWh)					471.6	457.7	438.3	442.1
MARGIN (TWh)					160.3	146.9	133.1	154.6
WHOLESALE PRICE INCREASE TO 2016								
Day Ahead Price	-6%	-9%	2%	-9%	9%	12%	12%	0%
Within Day Price (MIDP)	7%	-6%	-1%	-12%	6%	12%	15%	0%
WITHIN DAY PRICE INCREASE TO 2016								
Off-Peak Hours	5%	-12%	-2%	-11%	4%	7%	17%	0%
Peak Hours (excl Superpeak)	-1%	-13%	-9%	-19%	-1%	5%	11%	0%
Superpeak Hours	2%	-6%	-6%	-16%	-1%	6%	-7%	0%
DEMAND INCREASE TO 2016	-14%	-11%	-12%	-11%	-8%	-7%	-6%	0%

CARBON EMISSIONS

Rough estimates for levels of carbon emissions can be derived by using simple metrics for CO₂ emissions per MWh of generation. In this section, emissions are assumed to be 0.902 teCO₂/MWh for coal, 0.400 for gas, 0.015 for nuclear and 0.025 for renewables. This calculation excludes effective carbon emissions from imports and does not account for varying plant efficiencies.

In 2017, carbon emissions were estimated by this method to be around 69.6Mt, down 12% from the 78.7Mt estimated for 2016. This only accounts for electricity generation and does not include other sources of carbon emissions.

These levels are most significantly 56% down from the 158.5Mt estimated for 2012 and the long-term drop in emissions stems from the reduced use of coal plants in the market whilst the drop from 2016 to 2017 has come from the increased levels of wind generation in the market.

The level of carbon intensity in 2017 was estimated to be 0.231teCO₂/MWh, down from 0.256teCO₂/MWh in 2016 and 0.478teCO₂/MWh in 2012.

Statistics

The following table contains some of the key statistics relating to the year and some previous years:

*GB Only (Excludes Northern Ireland)	2009	2010	2011	2012	2013	2014	2015	2016	2017
CARBON EMISSIONS (million tonnes)									
Coal	89.39	92.86	93.34	123.43	113.42	87.18	67.16	25.18	18.64
Gas	58.93	62.75	50.80	33.14	32.09	34.69	33.74	50.79	47.84
Imports	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nuclear	0.97	0.88	0.97	0.99	0.99	0.90	0.99	1.00	0.99
Renewables	0.54	0.54	0.73	0.90	1.11	1.34	1.63	1.72	2.08
TOTAL	149.83	157.03	145.84	158.47	147.61	124.11	103.52	78.69	69.55
SHARE OF EMISSIONS (%)									
Coal	59.7%	59.1%	64.0%	77.9%	76.8%	70.2%	64.9%	32.0%	26.8%
Gas	39.3%	40.0%	34.8%	20.9%	21.7%	27.9%	32.6%	64.5%	68.8%
Imports	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Nuclear	0.7%	0.6%	0.7%	0.6%	0.7%	0.7%	1.0%	1.3%	1.4%
Renewables	0.4%	0.3%	0.5%	0.6%	0.8%	1.1%	1.6%	2.2%	3.0%
CARBON INTENSITY (te/MWh)	0.448	0.461	0.443	0.478	0.448	0.392	0.333	0.256	0.231
Based upon: (teCO₂/MWh)									
Coal	0.902								
Gas	0.400								
Nuclear	0.015								
Renewables	0.025								

NOTES ON THE REPORT

The figures used in the report refer to GB only, against DECC figures that refer to GB and Northern Ireland. This selection has been made since Northern Ireland is separated from GB and is more closely linked to the electricity grid of the Republic of Ireland.

Generation levels by fuel from 2009 are based upon National Grid FUELHH data, which gives the operationally metered totals by fuel, down to a 5 minute resolution.

Prior to 2009, individual plant data has been aggregated from our databased matching of National Grid fuel-type relationships.

To account for embedded wind and solar, the National Grid forecasts for these generators have been used as if they were output figures. Embedded hydro and biomass have been accounted for using analysis of Ofgem data on certificate awards.

Within this report, levels of offshore wind have not been split apart from the wind total. This is because this can only be reliably done using metered volumes at a generating unit level. This is not a publically available data stream and figures cannot be distributed. FPNs at wind farms do not correlate well with metered volumes and so cannot be used reliably.

Price and demand data primarily comes from Elexon (as does the FUELHH data), with the exception of the APX day-ahead prices.

ABOUT ENAPPSYS

EnAppSys provides services to companies in the energy and power markets, specifically by providing data, information and consultancy services.

The company has a GB power market database stretching back to 2002 and an online platform that provides readily available information ranging from forwards market prices to historic generator operations.

Enappsys is focused on providing information and analytical services covering the energy sector and is actively growing the business to provide products with enhanced analysis and forecasting capabilities and extending the geographic and sector coverage beyond the UK and the electricity market.

The company's business objective is to make available timely, optimal and insightful information, analysis and systems to the energy sector to ensure all sizes of company have the best available tools and information to make informed decisions and to optimise their business strategy.

To find out more about EnAppSys contact the company at about@enappsys.com or visit the company's website at www.enappsys.com.