

EnAppSys
ENERGY INSIGHT

European Electricity Fuel Mix Summary

Q1 2019

January to March

Renewables: 265.2TWh (+2%)

Fossil Fuels: 233.6TWh (-21%)

Nuclear: 204.4TWh (-4%)

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Executive Summary

With 2019 seeing a particularly warm start to the day the first quarter from January through to the end of March saw slightly reduced levels of generation as indicated from aggregated Entsoe data sources.

Within this activity the levels of renewable generation in Q1 2019 took a backward step from the levels noted in Q1 2018 as levels of noted hydro generation dropped off significantly from the high levels noted in the previous year. In particular levels of run-of-river hydro were significantly down from the previous period.

This 24% year-to-year drop in levels of hydro generation contributed to an 8% drop in overall renewable levels, but despite this other renewable generation sources saw a rise in output, with an 8% rise in wind and 14% rise in solar output noted year-to-year for the first quarter.

In the quarter, overall wind levels hit a new record high at a combined power output of 103,993MW, with this being up from the record high of 97,759MW noted in Q1 2018. This came as for the second quarter in a row (and second on record) wind produced more generation than hydro across European markets.

With a number of plant outages and closures impacting nuclear plants Q1 2019 the overall nuclear output levels were lower than in any first quarter since the start of 2015. This led to a 4% drop in nuclear generation year-on-year.

Despite drops in levels of generation at nuclear and renewable plants, fossil fueled plants also saw a drop in levels of generation by 10%, year-on-year, as overall generation levels dropped.

The quarter saw indicated levels of generation from gas-fired plants overtake that from coal, lignite or gas-to-coal fired plants for the first time in recent history. This is a dramatic shift from Q1 2015 when gas plants provided 61.3TWh and coal/lignite plants a total of 159.6TWh with the emissions in Europe coming down as a result.

A key contributor to this trend has been Britain where the higher than usual carbon taxes have and this has seen a particularly significant transition from coal to gas, but the rising

EU ETS price have also been a factor across the rest of Europe. A number of countries have also actively sought to accelerate the closure of coal-fired plants.

These levels are depended on correct reporting into the Entsoe data service, but have enough complete data to show key market trends and to within a degree of tolerance provide a complete view of fuel mix activity across Europe.

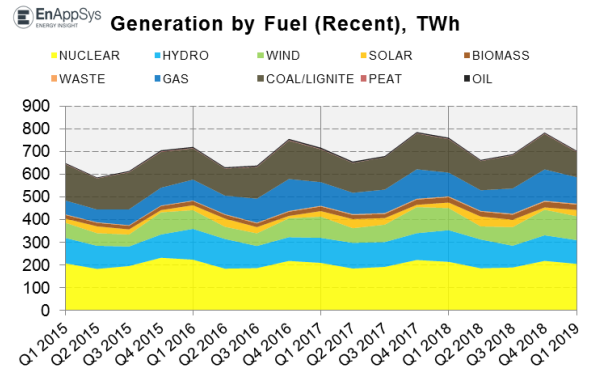
On a simplified basis 38% of generation came from renewables, 33% from fossil fuels and 29% from nuclear plants.

Looking in more detail, 29% came from nuclear plants, 17% from gas plants, 16% from coal/lignite, 15% from hydro, 15% from wind, 4% from solar, 3% from biomass and the remaining 1% from oil, peat and waste.

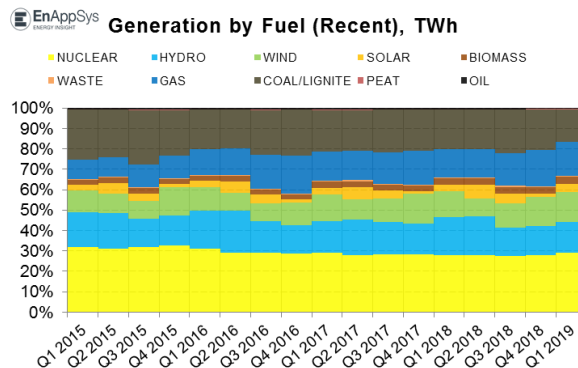
Fuel Activity Overview

On a simplified basis of splitting generation into fossil fuels, nuclear and renewable (including biomass and waste), the first quarter of 2019 (January to March) saw the highest share of generation come from renewable sources with a total of 265.2TWh of generation.

These levels were roughly the same as in Q4 2018, but down 8% from the levels in Q1 2018. More detail about the split within renewables is detailed in the



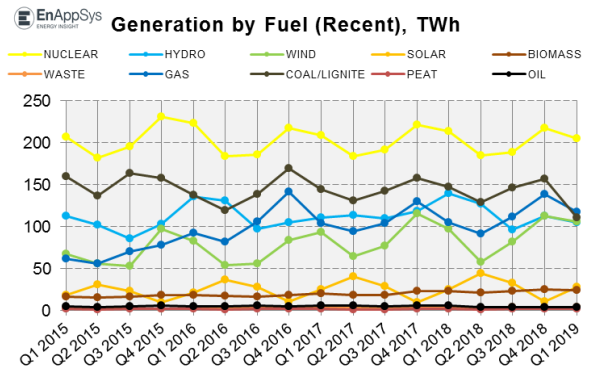
Renewables section of this report.



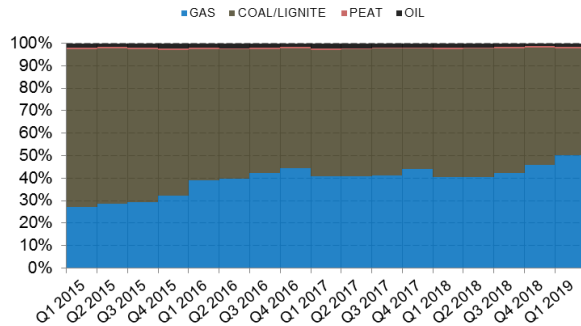
Following on from renewables, the next largest share of generation came from fossil fueled generators in the market, with these generating a total of 233.6TWh in the quarter. These levels were down 22% from the previous quarter and down 10% from Q1 2018.

The largest source of fossil fuel generation in the quarter was from gas-fired plants, with gas plants providing 117.0TWh, with this being down 15% down from the levels in the previous quarter but up 12% from in Q1 2018.

The European markets have in general been more reliant upon coal than upon gas and in Q1 2015 gas-fired plants generated 61.3TWh



EnAppSys Fossil Generation by Fuel (Recent), TWh



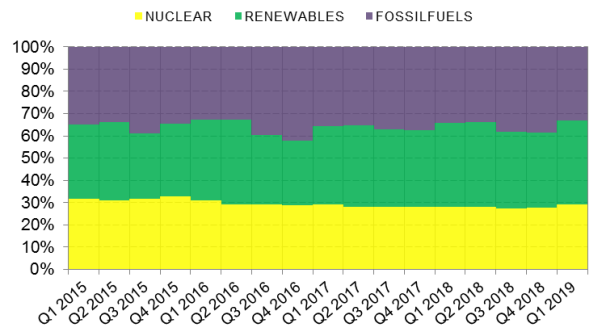
versus 159.6TWh for coal/lignite power sources.

From this period to the latest quarter, levels of generation at gas-fired plants have risen by 91% (almost doubling) whilst levels of generation from coal sources have dropped by 31% (almost a third).

This trend has been driven by the rising carbon costs and by the accelerated closures of coal stations in markets across Europe. In the future the most significant will be in Germany where coal is set to be phased out on an accelerated basis, with Germany burning the largest share of the high-carbon lignite coal.

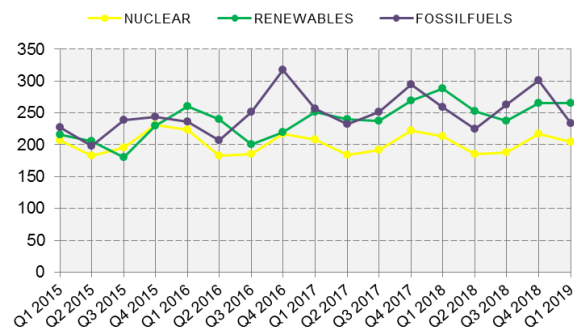
Countries such as Estonia continue to generate a large share of their electricity from oil (or shale oil) sources and so this fuel source generated 4.0TWh in Q1 2019. This was down 24% from Q1 2018 and compares against the 1.7TWh from peat sources.

EnAppSys Generation by Fuel (Recent), TWh



The remainder of the generation noted across Europe was provided by nuclear plants, with these volumes predominantly being produced within the French power market.

EnAppSys Generation by Fuel (Recent), TWh



The total generation from this source amounted to 204.4TWh and with nuclear plants being phased out and not fully replaced in numerous markets across Europe over the coming decades these generation volumes will have to be replaced by alternate generation sources.

These levels were down 6% from the previous quarter and down 4% from Q1 2018 as nuclear plants generally produced lower levels of output than the historic norms.

On a simplified basis 38% of generation came from renewables, 33% from fossil fuels and 29% from nuclear plants.

Looking in more detail, 29% came from nuclear plants, 17% from gas plants, 16% from coal/lignite, 15% from hydro, 15% from wind, 4% from solar, 3% from biomass and the remaining 1% from oil, peat and waste.

Statistics

The following tables contain some of the key statistics relating to the quarter:

	Q1-2017	Q2-2017	Q3-2017	Q4-2017	Q1-2018	Q2-2018	Q3-2018	Q4-2018	Q1-2019
TOTAL GENERATION BY FUEL (TWh)									
Biomass	20.1	18.0	18.1	23.3	23.3	21.4	22.6	25.1	23.6
Coal/Lignite	144.5	131.2	142.2	157.6	147.3	128.6	145.9	156.6	110.9
Gas	104.2	94.5	103.7	129.7	104.7	90.9	111.2	138.1	117.0
Hydro	110.2	113.1	109.4	118.0	139.6	126.9	95.9	112.7	104.7
Nuclear	208.8	183.9	191.1	221.6	213.3	185.0	188.4	217.6	204.4
Oil	5.8	5.3	5.1	5.2	5.2	4.2	4.2	4.1	4.0
Peat	1.8	1.1	0.8	1.4	1.7	1.1	1.5	2.0	1.7
Solar	24.7	40.2	29.2	9.9	24.5	43.8	32.6	10.1	27.9
Waste	3.3	3.5	3.6	3.6	3.7	3.2	4.0	4.0	3.6
Wind	93.3	64.6	76.6	115.0	97.3	57.4	82.0	112.9	105.4
FOSSIL FUELS	256.3	232.0	251.8	294.0	258.9	224.8	262.7	300.8	233.6
NUCLEAR	208.8	183.9	191.1	221.6	213.3	185.0	188.4	217.6	204.4
RENEWABLE (INCLUDES WASTE)	251.5	239.4	236.8	269.8	288.4	252.8	237.1	264.8	265.2
TOTAL	716.6	655.3	679.7	785.4	760.6	662.7	688.1	783.2	703.3
Fossil Fuel Percentage	36%	35%	37%	37%	34%	34%	38%	38%	33%
Clean Percentage	64%	65%	63%	63%	66%	66%	62%	62%	67%
Renewable Share of Clean Power	55%	57%	55%	55%	57%	58%	56%	55%	56%
SHARE OF GENERATION (%)									
Biomass	2.8%	2.7%	2.7%	3.0%	3.1%	3.2%	3.3%	3.2%	3.4%
Coal/Lignite	20.2%	20.0%	20.9%	20.1%	19.4%	19.4%	21.2%	20.0%	15.8%
Gas	14.5%	14.4%	15.3%	16.5%	13.8%	13.7%	16.2%	17.6%	16.6%
Hydro	15.4%	17.3%	16.1%	15.0%	18.4%	19.2%	13.9%	14.4%	14.9%
Nuclear	29.1%	28.1%	28.1%	28.2%	28.0%	27.9%	27.4%	27.8%	29.1%
Oil	0.8%	0.8%	0.8%	0.7%	0.7%	0.6%	0.6%	0.5%	0.6%
Peat	0.3%	0.2%	0.1%	0.2%	0.2%	0.2%	0.2%	0.3%	0.2%
Solar	3.5%	6.1%	4.3%	1.3%	3.2%	6.6%	4.7%	1.3%	4.0%
Waste	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.6%	0.5%	0.5%
Wind	13.0%	9.9%	11.3%	14.6%	12.8%	8.7%	11.9%	14.4%	15.0%
TOTAL GENERATION BY FUEL (TWh)									
Biomass					16.2	18.3	20.1	23.3	23.6
Coal/Lignite					159.6	137.8	144.5	147.3	110.9
Gas					61.3	92.0	104.2	104.7	117.0
Hydro					112.2	135.8	110.2	139.6	104.7
Nuclear					206.9	222.9	208.8	213.3	204.4
Oil					4.3	5.0	5.8	5.2	4.0
Peat					1.7	1.7	1.8	1.7	1.7
Solar					18.2	21.5	24.7	24.5	27.9
Waste					2.4	2.5	3.3	3.7	3.6
Wind					67.0	82.5	93.3	97.3	105.4
FOSSIL FUELS					227.0	236.5	256.3	258.9	233.6
NUCLEAR					206.9	222.9	208.8	213.3	204.4
RENEWABLE (INCLUDES WASTE)					215.8	260.6	251.5	288.4	265.2
TOTAL					649.7	720.0	716.6	760.6	703.3
Fossil Fuel Percentage					35%	33%	36%	34%	33%
Clean Percentage					65%	67%	64%	66%	67%
Renewable Share of Clean Power					51%	54%	55%	57%	56%
CHANGE SINCE Q1 2015 (%)									
Biomass						13%	24%	44%	46%
Coal/Lignite						-14%	-9%	-8%	-31%
Gas						50%	70%	71%	91%
Hydro						21%	-2%	24%	-7%
Nuclear						8%	1%	3%	-1%
Oil						16%	33%	20%	-8%
Peat						-1%	8%	-1%	2%
Solar						18%	36%	35%	53%
Waste						4%	37%	58%	54%
Wind						23%	39%	45%	57%
FOSSIL FUELS						4%	13%	14%	3%
NUCLEAR						8%	1%	3%	-1%
RENEWABLE (INCLUDES WASTE)						21%	17%	34%	23%

Renewables

The quarter saw renewables generate 265.2TWh of power, with this being roughly the same as in Q4 2018, but down 8% from the levels recorded in Q1 2018.

The largest source of renewable generation in the quarter was from wind farms (both onshore and offshore) and in Q1 2019 wind farms continued for the second quarter in a row (and the second quarter on record) to be the largest provider of renewable generation within Europe.

This came as wind farms generated 105.4TWh of power, with this being down 7% from the previous quarter, but up 8% from Q1 2018. On an overall basis since the first quarter in 2015, wind farms have seen levels of generation rise by 57%, but with this slowing slightly from 2017 onwards.

Historically hydro plants have always contributed the largest share of renewable generation in Europe and hydro plants generated 104.7TWh in the quarter. These levels were low and down 7% from the previous quarter and 25% from the previous year.

These levels of hydro generation are down 7% from the levels in Q1 2015 with relatively limited capacity being built out across Europe.

Solar plants do not generate as much power as other renewable sources across Europe even in summer and with Q1 2019 being in the winter half of the year, these plants generated 27.9TWh. These levels were up 14% from Q1 2018 and up 53% from the levels noted back in Q1 2015.

The next largest share of renewable generation came from biomass plants (with much of this being coal plant conversions) and these generated 23.6TWh in the quarter.

The output of these plants is generally fairly static, but these plants were up 1% from the same period in Q1 2018 and 46% up from Q1 2015 following changes in levels of overall capacity.

Energy to waste plants generated a low 4.0TWh, but this was still up 54% from the levels in Q1 2015.

In the quarter, 39.7% of power came from wind, 39.5% from biomass, 10.5% from solar, 8.9% from biomass and the remaining 1.4% from waste to energy.

Statistics

The following table contains some of the key statistics relating to the quarter:

	Q1-2017	Q2-2017	Q3-2017	Q4-2017	Q1-2018	Q2-2018	Q3-2018	Q4-2018	Q1-2019
TOTAL GENERATION BY FUEL (TWh)									
Biomass	20.1	18.0	18.1	23.3	23.3	21.4	22.6	25.1	23.6
Hydro	110.2	113.1	109.4	118.0	139.6	126.9	95.9	112.7	104.7
Solar	24.7	40.2	29.2	9.9	24.5	43.8	32.6	10.1	27.9
Waste	3.3	3.5	3.6	3.6	3.7	3.2	4.0	4.0	3.6
Wind	93.3	64.6	76.6	115.0	97.3	57.4	82.0	112.9	105.4
TOTAL	251.5	239.4	236.8	269.8	288.4	252.8	237.1	264.8	265.2
Primary Renewable Source	HYDRO	HYDRO	HYDRO	HYDRO	HYDRO	HYDRO	HYDRO	WIND	WIND
SHARE OF RENEWABLES (%)									
Biomass	8.0%	7.5%	7.6%	8.6%	8.1%	8.5%	9.5%	9.5%	8.9%
Hydro	43.8%	47.2%	46.2%	43.7%	48.4%	50.2%	40.4%	42.6%	39.5%
Solar	9.8%	16.8%	12.3%	3.7%	8.5%	17.3%	13.8%	3.8%	10.5%
Waste	1.3%	1.4%	1.5%	1.3%	1.3%	1.3%	1.7%	1.5%	1.4%
Wind	37.1%	27.0%	32.4%	42.6%	33.7%	22.7%	34.6%	42.6%	39.7%
TOTAL GENERATION BY FUEL (TWh)									
Biomass					16.2	18.3	20.1	23.3	23.6
Hydro					112.2	135.8	110.2	139.6	104.7
Solar					18.2	21.5	24.7	24.5	27.9
Waste					2.4	2.5	3.3	3.7	3.6
Wind					67.0	82.5	93.3	97.3	105.4
TOTAL					215.8	260.6	251.5	288.4	265.2
Primary Renewable Source					HYDRO	HYDRO	HYDRO	HYDRO	WIND
CHANGE SINCE Q1 2015 (%)									
Biomass						13%	24%	44%	46%
Hydro						21%	-2%	24%	-7%
Solar						18%	36%	35%	53%
Waste						4%	37%	58%	54%
Wind						23%	39%	45%	57%

Notes on the Report

The figures used in the report refer to data provided through Entsoe which have been aggregated into a European total. This data does sometimes suffer from outages in reporting, but is generally complete.

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

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.

The company has a European platform which covers underlying activity across all European markets with more detailed information available across Ireland, Belgium and the Netherlands with additional content in other regions being continuously built out.

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