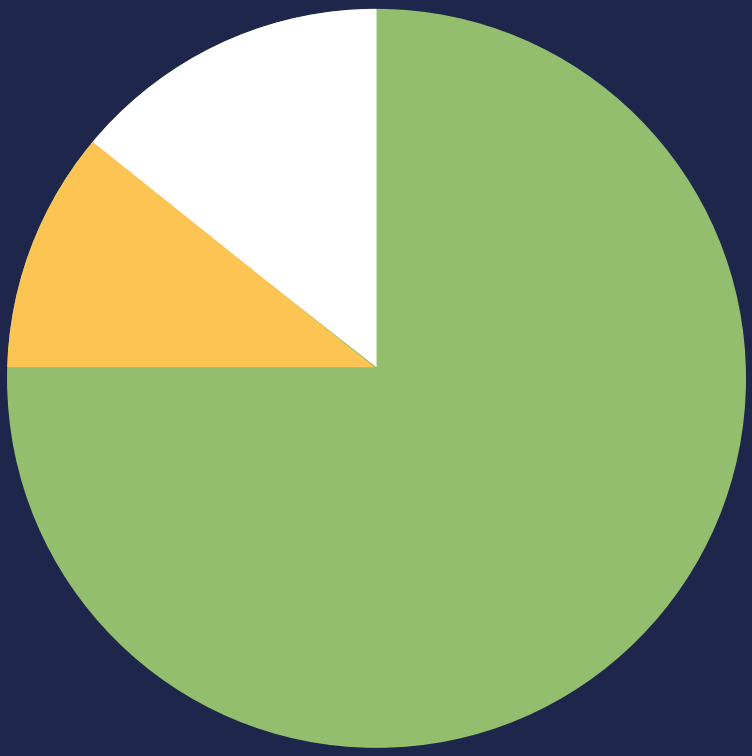
Global Electricity Review

March 2020

EMBER
COAL TO CLEAN ENERGY POLICY

Up-to-date data and insights on the transition to fossil-free electricity

2020



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2020

Introduction

Ember is an independent climate think-tank accelerating the global electricity transition.

We have rebranded from "Sandbag", where every January for the last 6 years, we have released a report called "European Power Sector Review", analysing Europe's rapid electricity transition. This is our first annual review of the global power sector.

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This report has two aims.

First, to be the earliest authoritative report to give unbiased insights into last year's global electricity generation changes. It incorporates 2019 electricity generation data covering 85% of world's electricity generation, and informed estimates of the remaining 15%. For the key four regions, we have taken 2019 as follows:

- China - China Electricity Council (CEC) from 21st January
- United States - Energy Information Administration (EIA) 26th February
- India - Central Electricity Authority (CEA) from 31st January
- European Union - via Ember's 'European Power Sector Review' from 5th February

Second, to make the entire dataset free and easy to download for others to perform their own analysis.

DOWNLOAD THE DATASET

The spreadsheet contains a complete dataset of 224 countries, with generation by fuel type by year from 2000 to 2019.

Whilst BP and the IEA do a similar task, BP publish 4 months later and through the analytical lens of an oil and gas major, and the IEA data is delayed for 1-2 years, is under copyright and not easily accessible.

In a world racing to reduce power sector greenhouse gas emissions we want to give people access to critical information as quickly as possible.

We hope you enjoy reading this report,

Harry Benham, Chairman of Ember

Bryony Worthington, Founder of Sandbag and Non-Executive Director of Ember

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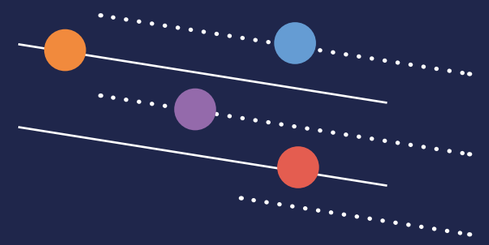

Key Findings

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Key Findings Summary

The following pages give evidence on each of these key findings and discuss their implications.

#1

Global coal-fired electricity generation fell by 3% in 2019, leading to a 2% fall in CO_2 power sector emissions. Both of these are the biggest falls since at least 1990. Coal collapsed in the EU and the US; but Chinese coal generation rose and for the first time was responsible for half of global coal generation. The carbon-intensity of global electricity is now 15% lower than in 2010.

#2

But falling coal generation is not yet the "new normal", which means limiting climate change to 1.5 degrees is looking extremely difficult. The coal fall in 2019, as well as relying on the structural shift towards wind and solar, relied on many other one-off factors. Progress is being made on reducing coal generation, but with nothing like the urgency needed to meet global climate goals, especially in Asia.

#3

Wind and solar generation rose by 15% in 2019, generating 8% of the world's electricity. Compound growth rate of 15% of wind and solar generation is needed every year to meet the Paris climate agreement. This was achieved in 2019 and lower prices provide hope it can be sustained. However, maintaining this high growth rate as volumes scale up will require a concerted effort from all regions.

#4

The US coal collapse is undermined by a switch to gas, whereas the EU is leap-frogging from coal to wind and solar. Coal generation collapsed by 24% in the EU and 16% in the US in 2019, and is now half the level of 2007 in both the EU and US. Since 2007, US CO2 power sector emissions fell by 19-32%, whereas they fell by 43% in the EU.

#1

Global coal-fired electricity generation fell by 3% in 2019, leading to a 2% fall in CO_2 power sector emissions. Both of these are the biggest falls since at least 1990. Coal collapsed in the EU and the US; but Chinese coal generation rose and for the first time was responsible for half of global coal generation. The carbon-intensity of global electricity is now 15% lower than in 2010.

Coal generation fell 3% (-259 TWh)
This is because:

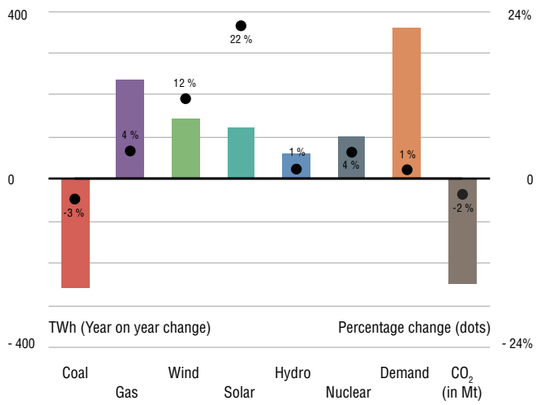
1. Electricity demand increased by the least in a decade due to low economic growth and mild winter months. It rose by +357 TWh in 2019, almost half the 2010-2019 average of +643 TWh.
2. Wind and solar generation rose by 15% (+270 TWh).
3. Coal-to-gas switching in the US (113 TWh) and the EU (73 TWh).
4. Nuclear generation rose by the highest this century (+101 TWh), following one-off re-starts in South Korea and Japan, and new plants in China.

Global power sector CO2 emissions fell 2%. This takes into account the 4% rise in gas generation; although doesn't include the climate impact of the methane leaks. It includes a fall in oil generation and the small improvement in China's coal fleet efficiency.

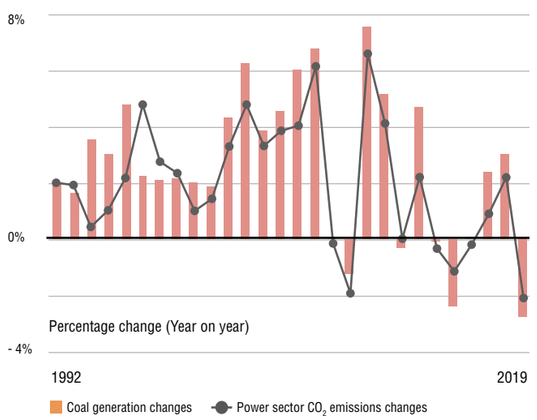
The falls are the biggest since at least 1990, when the IEA started reporting.

This is true for both the 3% fall in coal generation and the 2% fall in power sector CO2 emissions.

2019 global electricity generation changes



Global coal generation & power sector emissions changes



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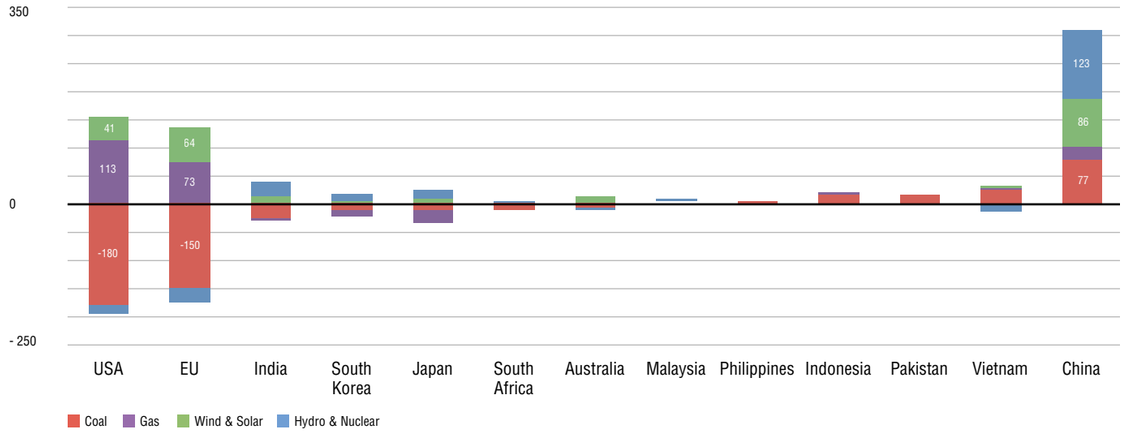
2019 global electricity generation changes in key coal consuming countries



Coal collapsed in the EU and the US; but China coal rose and is now responsible for half of global coal generation

Coal generation collapsed by 24% in the EU and 16% in the US due to a combination of new wind and solar installations, more gas generation and a small drop in electricity demand.

China saw the biggest increase in coal generation, 77 TWh (2%), pushing it to 50.2% of global coal generation. In China, wind, solar, nuclear and hydro all saw increases, but this was not enough to meet another year of rapid electricity demand growth. It grew at 4.7%, over three times the global average, despite its weakest economic growth in 30 years. To meet this demand, both coal and gas generation increased. Chinese coal fleet efficiency increased by 0.3%, the lowest fall since 2006 when reporting began.

Some Asian countries also saw an increase in coal: Indonesia (+11%) Malaysia (+5%) and Philippines (+12%) saw higher electricity demand which was met almost exclusively with coal, with near-zero wind and solar being built. Pakistan commissioned a new coal plant, which replaced oil generation. Vietnam coal increased (+34%) caused by a record drought, despite a huge surge in solar capacity built.

But some Asian countries saw less coal: incredibly even India (-3%) fell as electricity demand growth paused, new solar was added and hydro had bumper conditions. Coal fell in South Korea (-5%) and Japan (-4%) due to nuclear restarts, and a fall in electricity demand.

#2 But falling coal is not yet the "new normal", which means limiting climate change to 1.5 degrees is looking extremely difficult.

The coal fall in 2019, as well as relying on the structural shift towards wind and solar, relied on many other one-off factors. Progress is being made on reducing coal generation, but with nothing like the urgency needed to meet global climate goals, especially in Asia.

The 3% (-259 TWh) fall in global coal generation is not yet the "new normal" - it happened largely due to one-off factors.

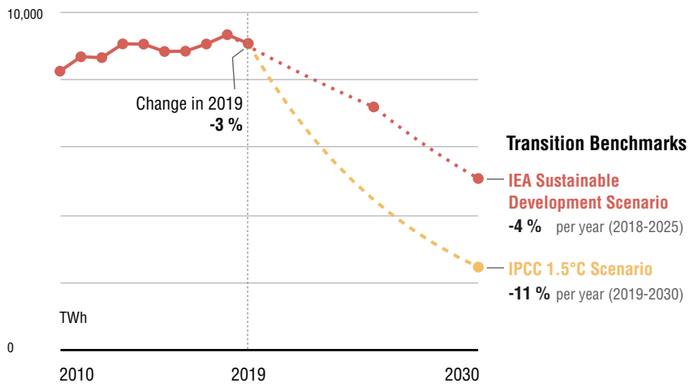
Electricity demand increased by the least in a decade, by 357 TWh in 2019, which was almost half the 2010-2019 average of 643 TWh. The 73 TWh of coal-to-gas switching in the EU cannot be repeated, as the economics in 2019 swung firmly against coal, and few new gas plants are being built.

Nuclear generation rose by 101 TWh, of which 39 TWh was restarts in South Korea and Japan. However, the 270 TWh increase in wind and solar was bigger than the 259 TWh fall in coal. Sustaining the decrease in emissions seen this year will require increasing investments in zero emissions capacity and increasing energy efficiency.

Coal generation needs to collapse by 11% per year to keep to 1.5 degrees.

Even if the record 3% fall in coal were to happen every year, it still wouldn't be enough. The IPCC's 1.5 degrees median scenario shows coal generation must collapse at 11% per year to 2030. The IEA's Sustainable Development Scenario requires year-on-year falls of 4% every year from 2018 to 2025.

Coal generation with future scenarios



The lack of urgency on coal - especially in the top 10 coal-generating countries - means limiting climate change to 1.5 degrees is looking extremely difficult.

Ten countries account for 87% of the world's coal generation. Whilst progress is being made in most countries on coal, none of the top 10 coal countries have yet made commitments to reduce coal that are consistent with the IEA's Sustainable Development Scenario, let alone the tougher IPCC 1.5 degrees scenario. The only one of these countries to set a coal phase-out date is Germany, of 2038, which is not consistent with what is required to meet 1.5 degrees.

Country	Percentage of global coal generation in 2019	Generation TWh (% change in 2019)	GW opened in 2019*	GW closed in 2019*	Coal phase-out date
1. China	50.2%	4560 (+2%)	43.8	7.0	-
2. India	11.0%	999 (-3%)	8.1	0.8	-
3. United States	10.6%	966 (-16%)	0	16.5	-
4. Japan	3.1%	285 (-4%)	1.3	0.1	-
5. South Korea	2.5%	223 (-5%)	0.2	0	-
6. South Africa	2.2%	198 (-4%)	1.6	0.5	-
7. Germany	1.9%	172 (+25%)	0	1.2	2038
8. Russia	1.8%	166 (0%)	0.9	1.4	-
9. Indonesia	1.8%	163 (+11%)	2.4	0	-
10. Australia	1.6%	144 (-4%)	0	0	-

*Source: Global Energy Monitor

#3

Wind and solar generation rose by 15% in 2019, generating 8% of the world's electricity.

Compound growth rate of 15% of wind and solar generation is needed every year to meet the Paris climate agreement. This was achieved in 2019 and lower prices provide hope it can be sustained. However, but maintaining this high growth rate as volumes scale up, will require a concerted effort from all regions.

Wind and solar generation grew by 15% (+270 TWh) in 2019.

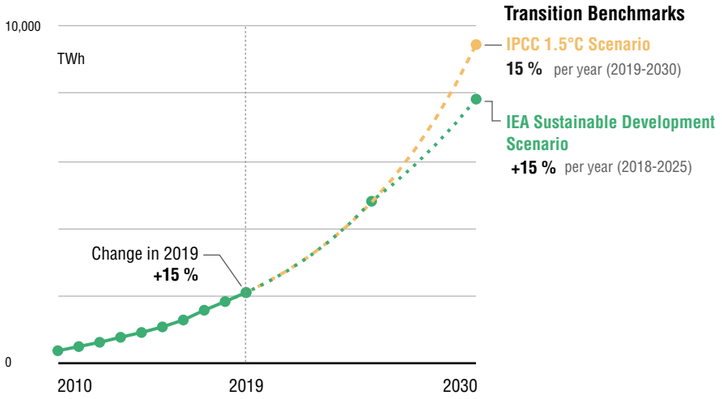
The wind and solar growth rate of 15% must be maintained to meet the emissions reductions needed for the Paris climate agreement.

The wind and solar generation rise of 270 TWh was the second biggest on record, but the growth rate is slowing - the 15% growth rate was the lowest this century.

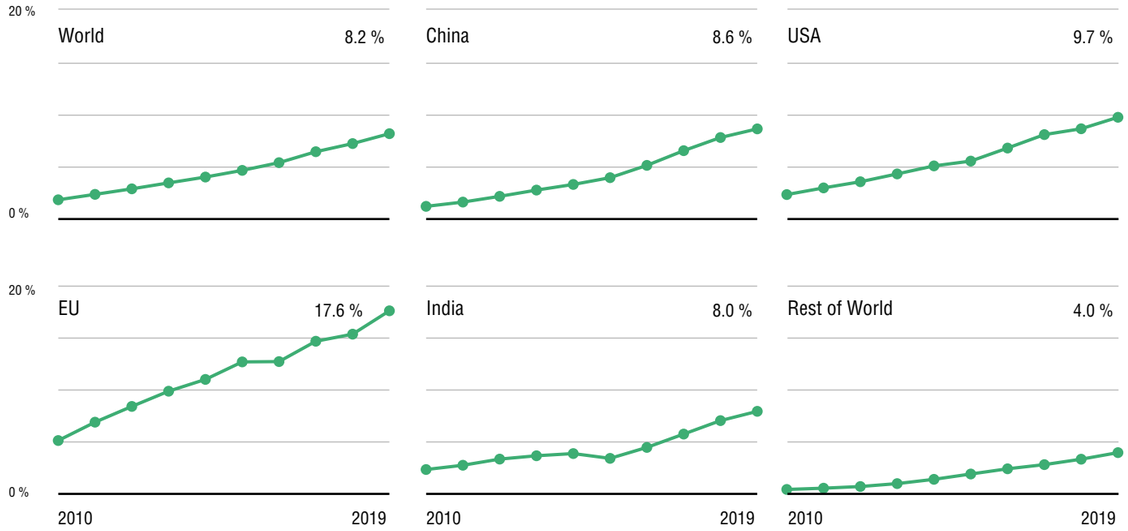
Of the four key regions, China showed the fastest growth of 16% (+86 TWh) and the US the slowest with 11% (+41 TWh); India and EU both recorded 13% growth rates (+13 TWh and +64 TWh respectively). Five further countries added 40 TWh between them: Japan, Brazil, Mexico, Australia and Vietnam.

Compound growth of 15% is needed for many years, to meet both the IEA's Sustainable Development Scenario, and also the IPCC's 1.5 degree median case.

Wind + solar generation with future scenarios



Wind + solar share of electicity mix by region



Wind and solar generated 8% of the world's electricity in 2019, up from only 3% in 2013.

Record low wind and solar prices in 2019 should give hope that compound growth rates can be maintained.

In the biggest countries, wind and solar made up a sizeable amount of national electricity production in 2019: 8% in India, 9% in China and 11% in the US. The EU stands out, with 18% - more than double the global average - coming from wind and solar.

The Rest of the World generated only 4% of its electricity from wind and solar in 2019. Some of the lowest rates are: South Korea with 2.9%, Philippines 2.2%, Ukraine 1.3%, Taiwan 1.0%, Kazakhstan 1.0%. Malaysia 0.7%, Iran 0.4% Saudi Arabia 0.2%, Russia 0.1%, and Indonesia 0.1%, and Iran 0.1%.

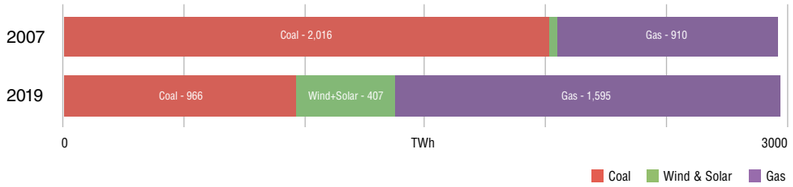
Record solar prices were established in Portugal where French developer Akuo won a project with a price of US$16/MWh. Record wind prices were established in Brazil with a price of US$21/MWh.

#4

The US coal collapse is undermined by a switch to gas, whereas the EU leap-frogged from coal to wind and solar. Coal generation collapsed by 24% in the EU and 16% in the US in 2019, and is now half the level of 2007 in both the EU and US. Since 2007, US CO2 power sector emissions fell by 19-32%, whereas they fell by 43% in the EU.

United States

United States electricity generation

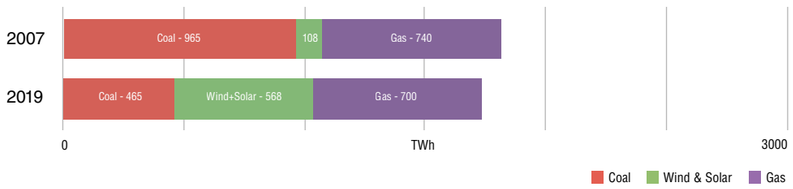


US since 2007:

- Coal halved
- Replaced 35% with wind and solar
- Replaced 65% with gas generation

European Union

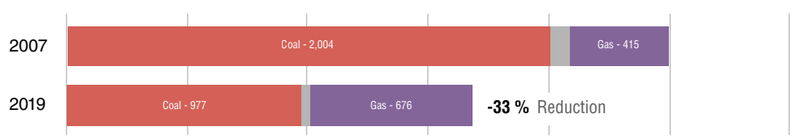
European Union electricity generation



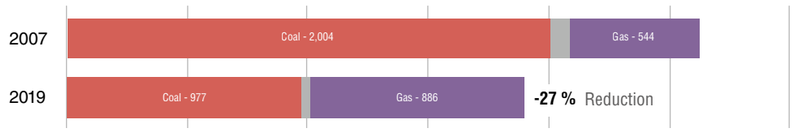
EU since 2007:

- Coal halved
- Replaced entirely with wind and solar
- Gas generation unchanged
- In 2019, wind and solar generation exceeded coal generation for the first time in the EU

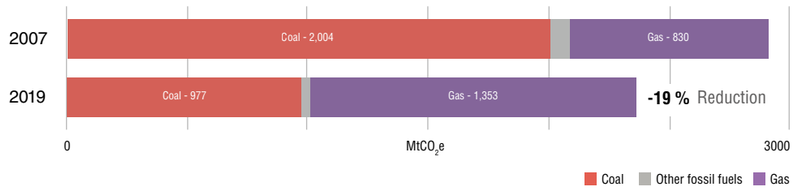
United States power sector CO_2 emissions



Factoring in methane leakage - based on 100-year warming period



Factoring in methane leakage - based on 20-year warming period

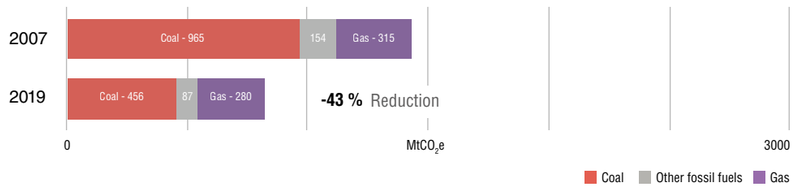


The calculation uses a methane leakage rate of 2.3% for U.S gas production, as documented in **EDF's 2015 research.** *Note, we didn't include EU gas methane as the generation was broadly unchanged.*

US since 2007:

- CO_2 fell 32%
- CO_2e fell 27%, when including methane leaks on 100-year warming period.
- CO_2e fell 19%, when including methane leaks on 20-year warming period.

European Union power sector CO_2 emissions



EU since 2007:

- CO_2 emissions fell by 43%

Detailed Regional Analysis

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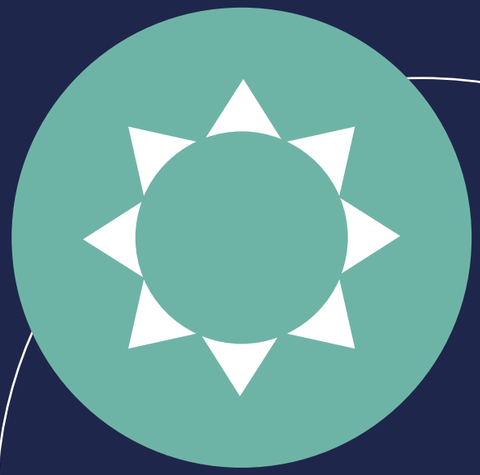


World

Key Messages

- *Coal generation fell a record 3%, but falling coal is not yet the "new-normal"*. Coal fell because wind and solar generation rose, electricity demand growth slowed, gas replaced coal in the US and the EU, and nuclear plants restarted in South Korea and Japan. These were more one-off factors than structural.

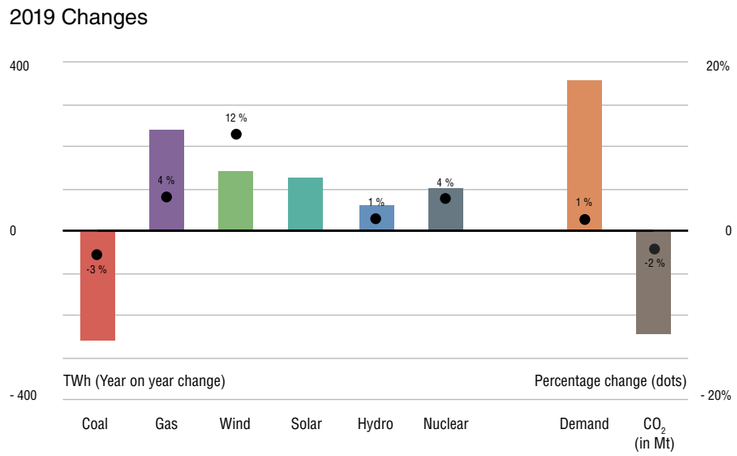
- *Global CO2 power sector emissions fell by a record 2%*. coal was partly offset by a 4% rise in gas generation, which tempered the fall in CO2 emissions. The carbon intensity of electricity fell by 3% over the year. The carbon intensity of global electricity is now 15% lower than ten years ago.

- *2019 saw lowest electricity demand growth since 2009*. This was because of weak GDP growth and a mild winter.

- *Wind and solar growth rose* by 270 TWh, the second biggest rise on record. But the growth rate is slowing - the 15% growth rate was the lowest this century.

What happened in 2019?

Electricity demand rose by 1.4%, the least in a decade. Coal generation fell by a record 3%. All other forms of generation rose. Wind and solar rose but set no records. Gas increased in US and EU. Nuclear grew at a record 4% due to restarts in Japan and South Korea. CO2 emissions fell 2%.

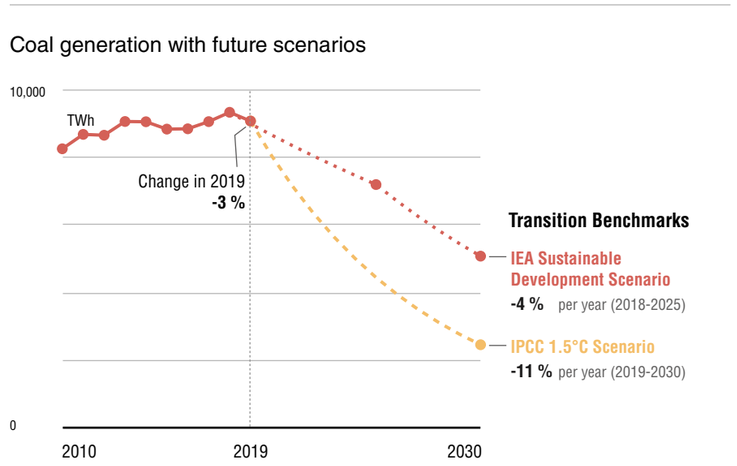


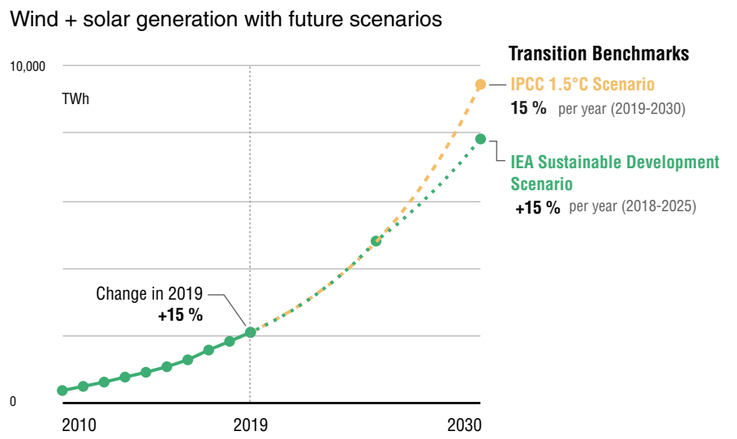
Is the transition happening fast enough?

No. It's not clear yet that falling coal generation is the "new normal".

Coal generation will need to fall at 11% per year every year until 2030, to meet the IPCC's median scenario for 1.5 degrees. Even the less ambitious IEA Sustainable Development scenario needs drops of 4% per year.

Compound growth rate of 15% of wind and solar generation is needed every year to meet the Paris climate agreement. This was achieved in 2019 and lower prices provide hope it can be sustained. However, maintaining this growth rate, as the absolute volume increases, will require a concerted effort from all regions.





World

Electricity demand growth slowed

Electricity demand rose by 1.4%, the slowest increase since the 2009 recession. This was due to low GDP growth of 3%, and also because of the weather - especially milder winter months in the US and EU.

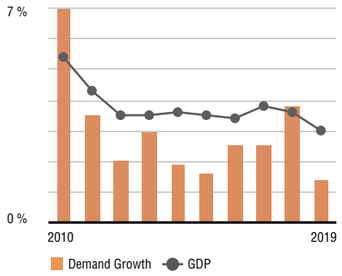
Fossil-free generation growth set no records

Nuclear generation rose at the fastest rate this century, because of restarts in Japan and South Korea, and also new capacity installed in China. Hydro generation rose, but mostly due to wet conditions in China and India. In China, where most new hydro is being built, hydro capacity was up only 4 GW, compared to 16 GW average this decade.

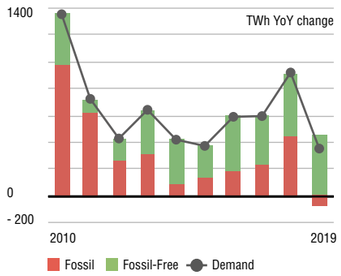
Wind and solar generation growth slowed to 15 % (+270 TWh)

The wind and solar generation rise of 265 TWh was the second biggest on record, but the growth rate slowed - the 14% growth rate was the lowest this century. Of the four key regions, China showed the fastest growth of 16% (+86 TWh) and the US the slowest with 11% (+41 TWh); India and EU both recorded 13% growth rates (+13 TWh and +64 TWh respectively). Five further countries added 40 TWh between them, mostly solar: Japan, Brazil, Mexico, Australia and Vietnam.

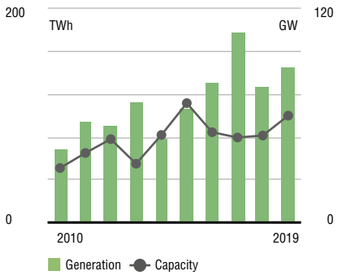
Electricity Demand Change



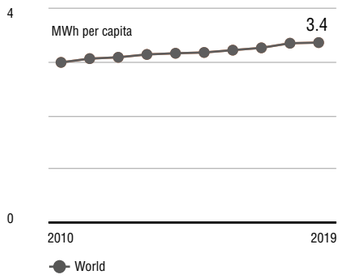
Fossil & Fossil-Free Generation Change



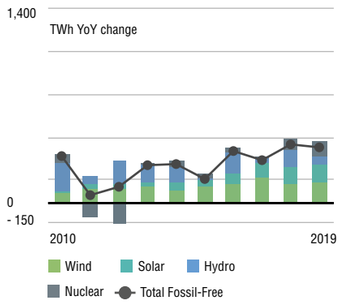
Wind Generation & Capacity Change



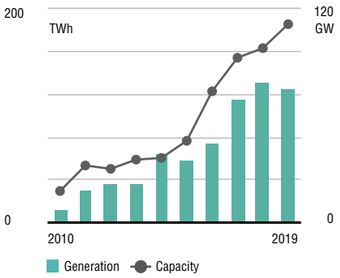
Electricity Demand per Capita



Fossil-Free Generation Change



Solar Generation & Capacity Change



Coal generation fell a record 3 %

Coal fell 3% (-259 TWh), as coal collapsed in the EU and the US, but rose in China. This is because wind and solar generation rose, electricity demand increased by the least in a decade, gas replaced coal in the US and the EU, and nuclear plants restarted in South Korea and Japan.

New coal-fired generation capacity continues to rise, driven primarily by new additions in China. The overall utilisation of coal-fired plants continues on a downward trend, falling from 54% in 2018 to 51% in 2019. This will reduce coal profitability.

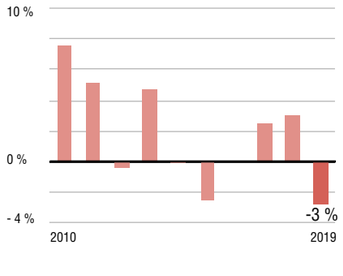
Gas generation rose 4 %

This happened mostly as a result of gas generation replacing coal in the EU and US.

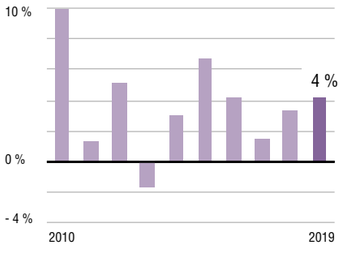
CO_2 emissions fell 2 %

This doesn't take into account the climate impact of methane leaks from the additional gas generation.The carbon intensity of electricity fell by 3% over the year. At 442 gCO_2/kWh, it is now 15% lower than the start of this decade, as fossil-free generation has grown faster than fossil.

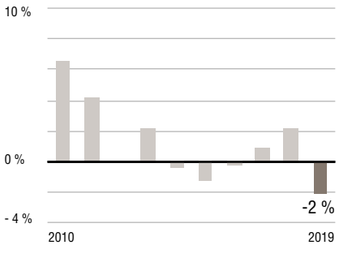
Coal Generation Change



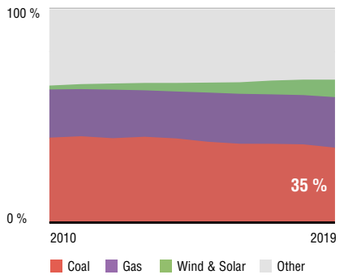
Gas Generation Change



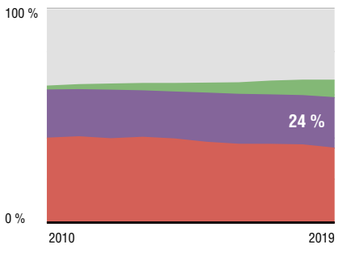
CO_2 Emissions Change



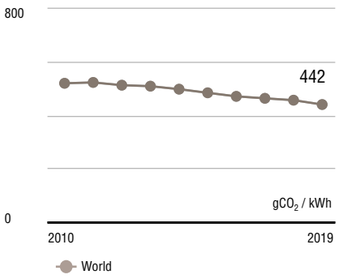
Coal in the Electricity Mix



Gas in the Electricity Mix



CO_2 Intensity Of Electricity



China

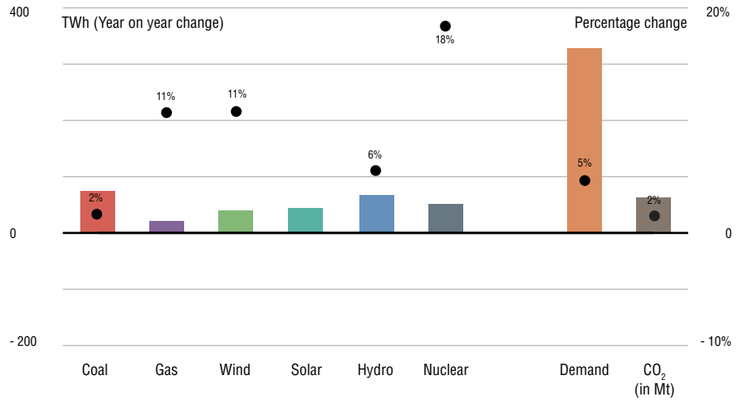
Key Messages

- *China in 2019, for the first time, was responsible for more than half of the world's coal generation.* Since 2015, when the Paris Climate Agreement was signed, China's coal generation has risen by 17%, whereas coal generation in the rest of the world has fallen by 9%.
- *Coal generation rose by 2% in 2019.* This is because the rise in wind, solar, nuclear and hydro was not enough to meet electricity demand growth.
- *China's electricity demand increased by 4.7%, over three times the global average of 1.3%.* Chinese electricity demand per capita is now higher than in the UK, but less than half that in the US.
- *Wind and solar generation grew by 86 TWh. The year on year growth rate of 16% was the lowest for China this century.* The year on year growth rate of 16% was the lowest for China this century. A pick-up in new wind was offset by another big fall in solar installations. New wind installations were 26 GW, below the 34 GW installed in 2015; new solar installations were 30 GW, below the 53 GW installed in 2017.
- *Nuclear growth continuing, but new hydro is slowing.* New nuclear added 54 TWh, on 4 GW of new capacity. The 69 TWh increase in hydro generation was driven by more rain, as new hydro installations slowed.

What happened in 2019?

Wind, solar, hydro and nuclear all increased, but not by as much as electricity demand. This necessitated an increase of 2% in coal generation. Gas generation rose 11%, but from a small base. These led to a 2% rise in CO_2 emissions.

2019 Changes



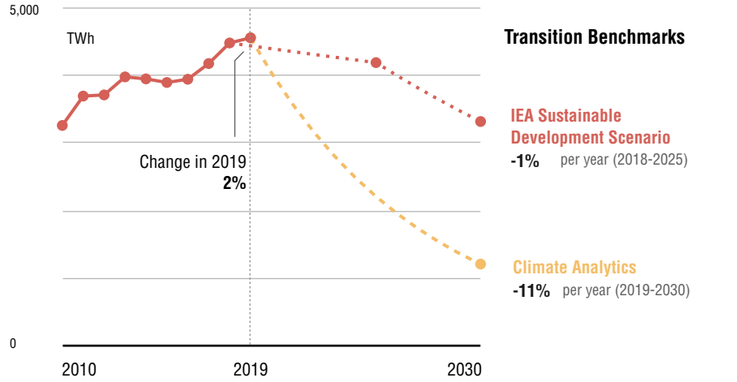
Is the transition happening fast enough?

No. Coal generation rose in China in 2019, but it needs to be falling. Building new coal power plants shows investment is not aligned with reducing climate change.

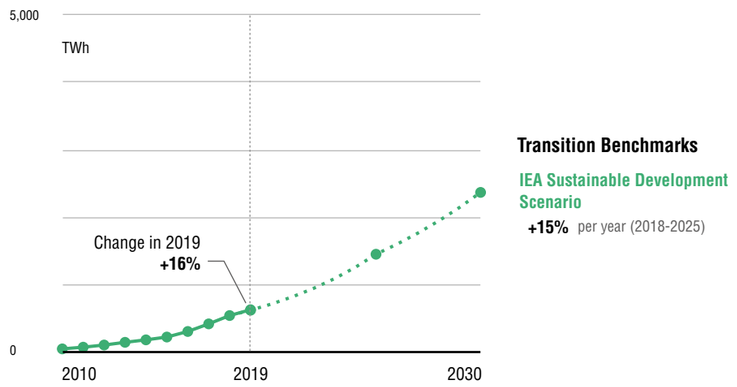
Chinese electricity demand growth rose at twice the rate modelled in the IEA Sustainable Development Scenarios, making the challenge of limiting coal generation very tricky.

Solar and wind need compound growth of 15% per year to triple generation by 2030. Although generation rose by 16% in 2019, the new capacity of wind and solar built in 2019 was not enough to maintain this growth rate for next year.

Coal generation with future scenarios



Wind + solar generation with future scenarios



China

Electricity demand continued to soar

Electricity demand rose by 4.7% in 2019, more than three times the global average of 1.4%. The large rise was despite China's slowest GDP growth in 30 years, and follows on the back of a huge 8% rise in 2018. Electricity demand per capita is now 53% above the global average. At 5.2 MWh, per capita demand now exceeds the level in the UK, but remains less than half the level in the US.

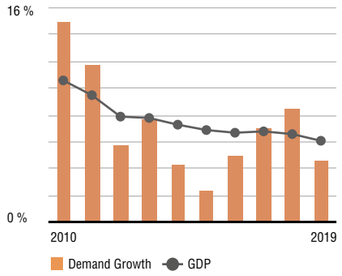
Fossil-free generation added less than electricity demand

Fossil-free generation grew by 10% (+227 TWh), which was less than the 329 TWh growth in electricity demand, necessitating a rise in fossil (coal) generation of 102 TWh to meet extra demand. Hydro generation was driven more by heavy rains rather than new capacity - hydro capacity was up only 4 GW, compared to 16 GW average this decade. Nuclear generation increased as 4 GW more capacity came online.

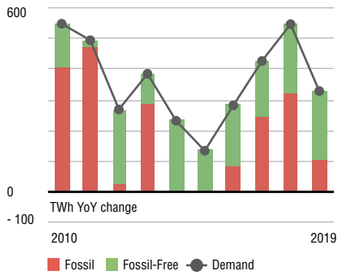
Wind and solar generation growth slowed to 16 % (+86 TWh)

Growth of 86 TWh (40 TWh of wind and 46 TWh of solar) was the lowest growth since 2016. But the growth rate of 16% was the lowest this century. New wind installations were 26GW, below the 34GW installed in 2015. New solar installations were 30GW, below the 53GW installed in 2017.

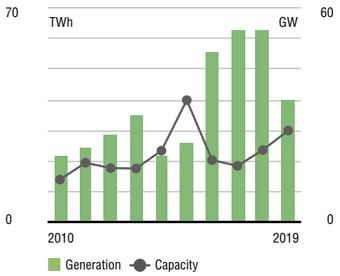
Electricity Demand Change



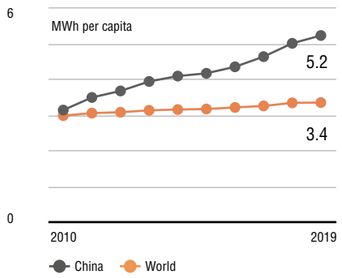
Fossil & Fossil-Free Generation Change



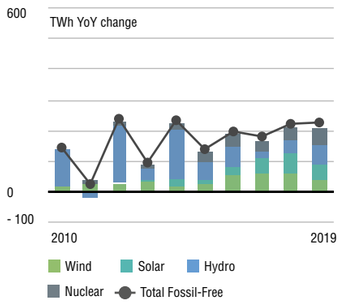
Wind Generation & Capacity Change



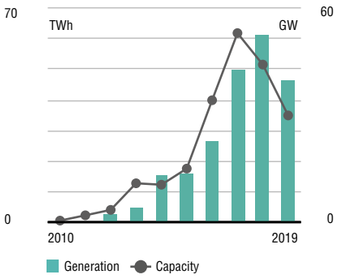
Electricity Demand per Capita



Fossil-Free Generation Change



Solar Generation & Capacity Change



Coal rose to half of the world's coal generation

Coal-fired generation rose 2% in 2019. Since 2015, China's coal generation has risen by 17%, compared to a fall of 9% in the rest of the world. For the first time, China is now responsible for over 50% of global coal generation. At 62%, coal's relative share of the electricity mix is falling, but only because total electricity demand has increased even more dramatically. This hides the absolute rise in coal generation which has doubled in 12 years. China continued to build coal power plants, adding 44 GW in 2019. Coal utilisation fell in 2019 as a result.

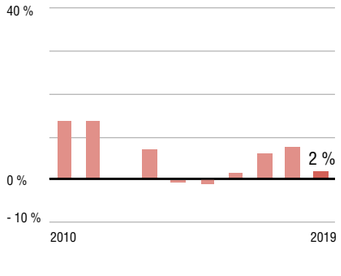
Gas rose from a low base

Gas-fired generation rose by 11% in 2019, increasing to 3% of the electricity mix. 6 GW of new gas capacity was built in 2019.

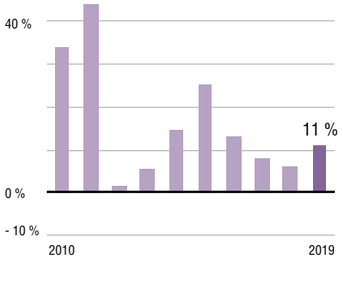
CO_2 emissions rose 1.6 % with coal and gas generation

Despite huge investment in new coal plants, the reported carbon intensity of the Chinese coal fleet improved just 0.3% in 2019, the lowest improvement since reporting began in 2006. China's carbon intensity of electricity has fallen by 24% since 2019. However at 576 gCO2/kWh it is still 30% above the global average. The high efficiency of its coal fleet only goes so far in limiting the impact of the high coal generation in China.

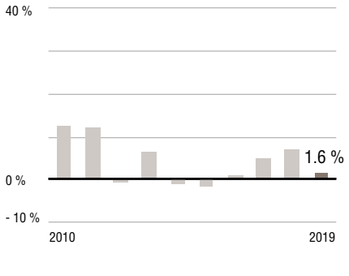
Coal Generation Change



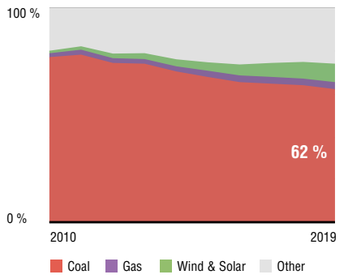
Gas Generation Change



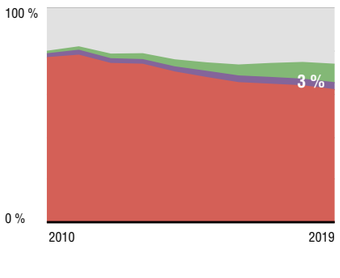
CO_2 Emissions Change



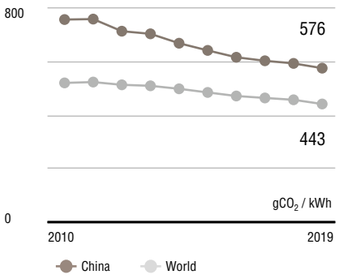
Coal in the Electricity Mix



Gas in the Electricity Mix



CO_2 Intensity Of Electricity



United States

Key Messages

- *Coal generation fell by a record 16% (-180 TWh) in 2019, to the lowest level since 1975*. This was due to a 113 TWh increase in gas generation, a 58 TWh fall in electricity demand, and a 36 TWh rise in wind and solar.

- *The fall in CO2 emissions was undermined by the "gas bridge"*. Power sector CO2 emissions fell by 8% in 2019, as coal's 16% fall was tempered by the rise in gas emissions. When including the methane leaks, the additional gas generation means that the drop in US emissions is even smaller. New gas generation capacity continues to be built apace, with 7 GW more in 2019, cumulatively adding over 100 GW last decade. This enabled the switch from coal to gas.

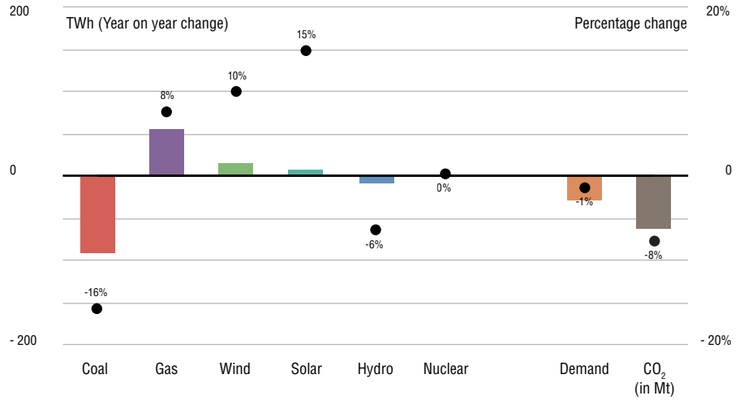
- *Wind and solar growth was lower than in any other region*. Wind and solar generation grew at 11% (+41 TWh). This is the lowest of any major region: China grew at 16% (+86 TWh) India 13% (+13 TWh) and EU 13% (+64 TWh).

- *The small fall in US electricity demand in 2019 is mostly weather-related*. Demand continues to be very high, with US citizens still using four times the global average.

What happened in 2019?

Coal generation collapsed 16%, as the switch into gas accelerated. It was also helped by a rare fall in electricity demand, and by some new wind and solar.

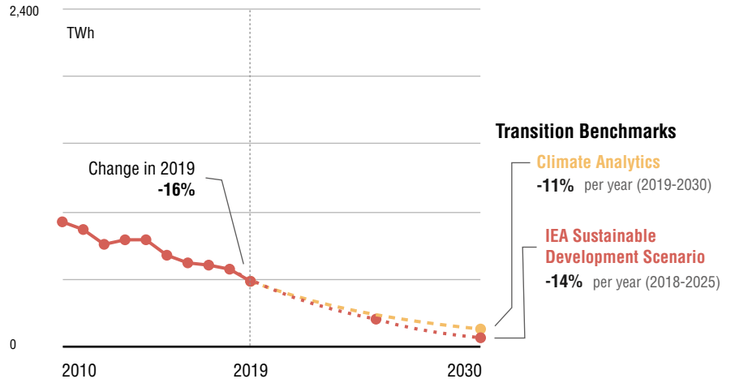
2019 Changes



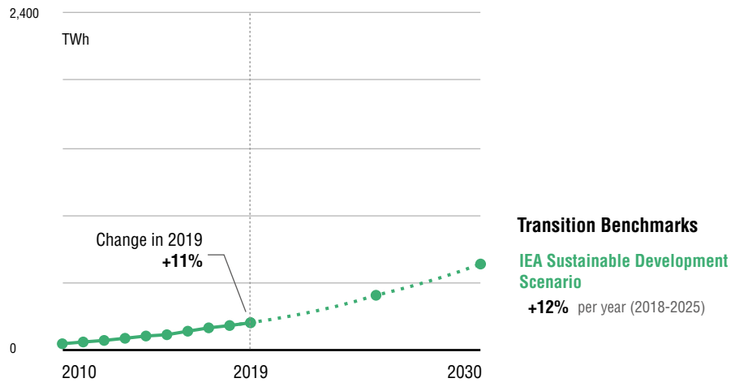
Is the transition happening fast enough?

No. The "unprecedented" fall in US coal needs to happen every year. Coal generation must be mostly phased-out by 2030, and without increasing gas generation. Wind and solar need compound growth at 12% every year to meet the IEA SDS. The 2019 growth rate had already slowed to 11%.

Coal generation with future scenarios



Wind + solar generation with future scenarios



United States

Electricity demand fell due to a mild winter

Electricity demand fell 1.4%, correcting for a large rise in 2018. Weather was the biggest driver: 2019 winter months were warm, correcting for a colder 2018. Industrial demand declined at 5% as economic growth slowed. US electricity demand per capita is one of the highest in the world. The average US citizen uses almost four times more electricity than the global average, and more than twice the European or Chinese per capita levels.

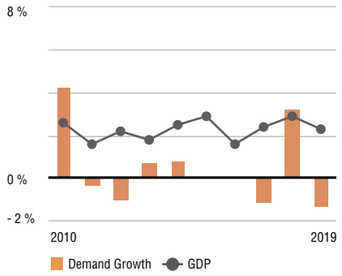
Fossil-free generation barely grew because of weak wind and solar growth

Nuclear generation was unchanged, and hydro generation fell, after a wet year in 2018.

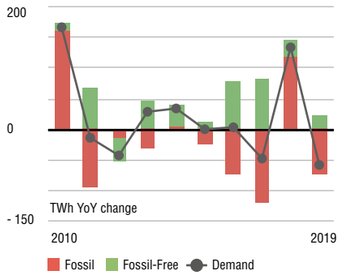
Wind and solar generation grew at only 11% (+41 TWh)

This is the lowest of any major region: China grew at 16% (+86 TWh) India 13% (+13 TWh) and EU 13% (+64 TWh). Wind and solar generation increased by 41 TWh (+27 TWh of wind, 14 TWh of solar). Neither solar nor wind set new records for new installations: 9GW of solar was installed, below the 11GW record in 2016, and 9GW of wind was installed, below the 13GW record in 2012.

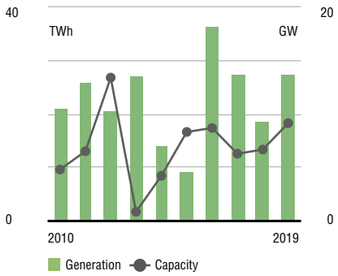
Electricity Demand Change



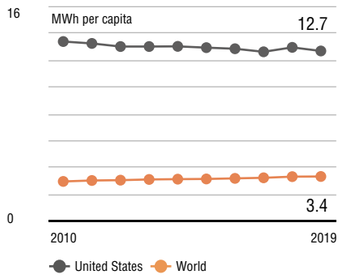
Fossil & Fossil-Free Generation Change



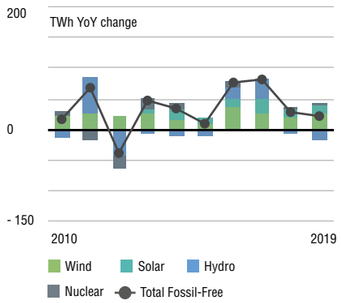
Wind Generation & Capacity Change



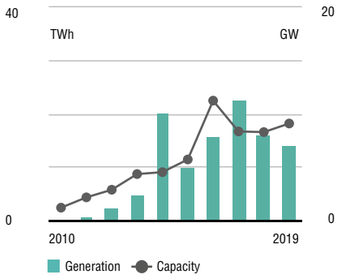
Electricity Demand per Capita



Fossil-Free Generation Change



Solar Generation & Capacity Change



Strictly embargoed until 00.01GMT on 9th March

Coal generation collapsed - and was replaced largely with gas generation

Coal generation fell by 16% (-180 TWh), to 24% of total generation. This was due to a 113 TWh increase in gas generation, a 58 TWh fall in electricity demand, and a 41 TWh rise in wind and solar. This fall is the largest on record, and the fifth year of consecutive falls. It brings US coal generation to half its 2007 level, and the lowest since 1975.

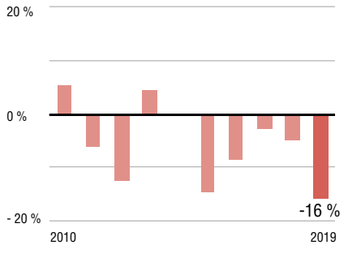
Gas generation continued to soar

It rose by 8%, and now stands at 38% of the electricity mix. New gas capacity continues to be built apace, with 7 GW more in 2019, cumulatively adding over 100 GW last decade.

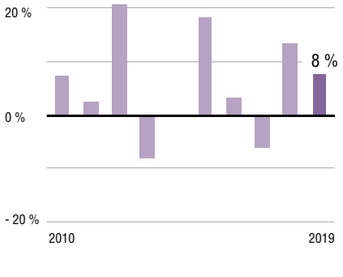
CO_2 emissions fell by 8%, coal's fall was tempered by the rise in gas emissions

When you include methane leaks from gas generation the fall in US greenhouse gas emissions is reduced. The carbon intensity of US electricity continued to fall, and is slightly below the global average. However, because the average US citizen uses so much electricity, the absolute CO2 emissions per person is over three times higher than the global average in the power sector.

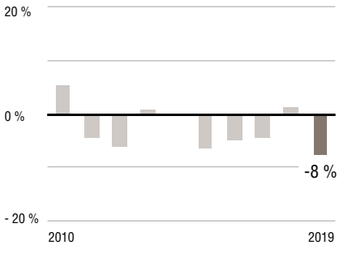
Coal Generation Change



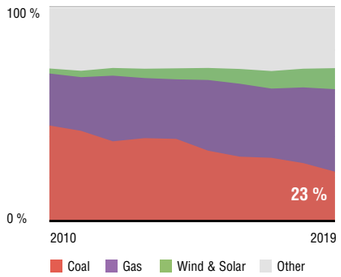
Gas Generation Change



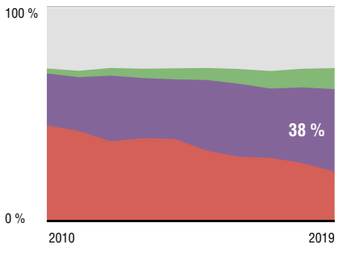
CO_2 Emissions Change



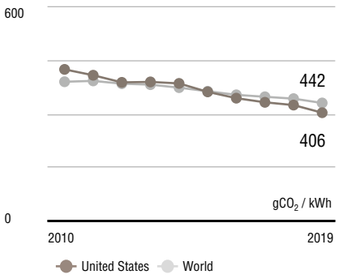
Coal in the Electricity Mix



Gas in the Electricity Mix



CO_2 Intensity Of Electricity



European Union

- *Coal generation collapsed by 24%, leading to a 13% fall in power sector emissions*. Coal fell due to a rise in wind and solar generation, switching from coal to gas driven by increases in the EU carbon price, and a small fall in electricity demand.

- *Since 2007, coal generation has halved, replaced entirely with wind and solar, leaving gas generation unchanged*. The carbon intensity of EU electricity is now 42% below the global average.

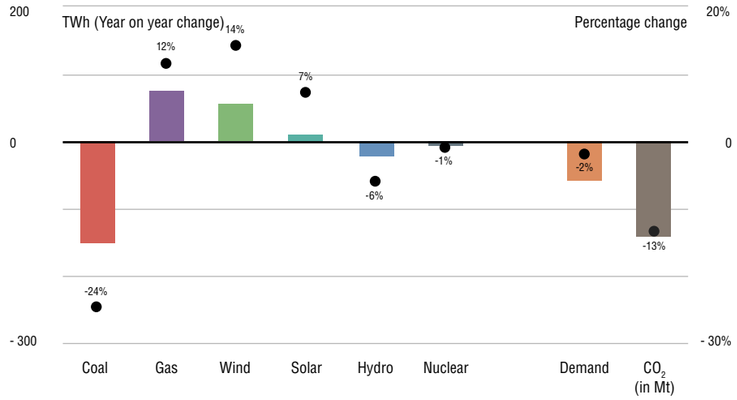
- *Wind and solar growth is healthy*. Although it set no records, falling costs and a positive policy landscape for wind and solar in Europe means that growth will accelerate.

- *Germany, Greece and Hungary made new commitments to phasing-out coal*. This means a total of 15 EU countries have committed to phase-out coal, and will ensure coal generation falls rapidly through the 2020's.

What happened in 2019?

Coal collapsed by 24%. This was caused partly by wind and solar generation, and partly by carbon pricing driving a switch from coal to gas. New wind and solar generation increased by 14% and 7% respectively in 2019, bringing their share of electricity generation up to a new high of 18%.

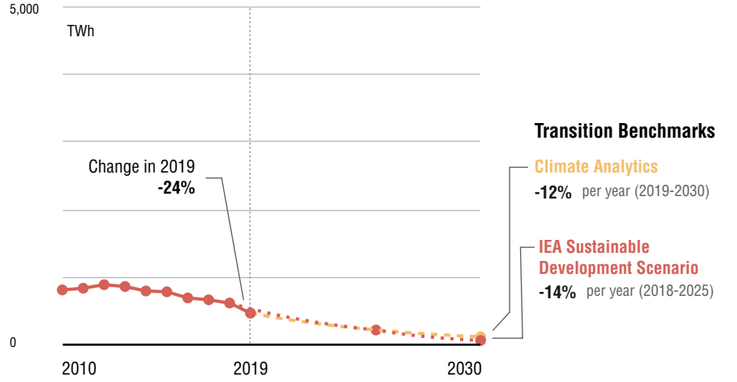
2019 Changes



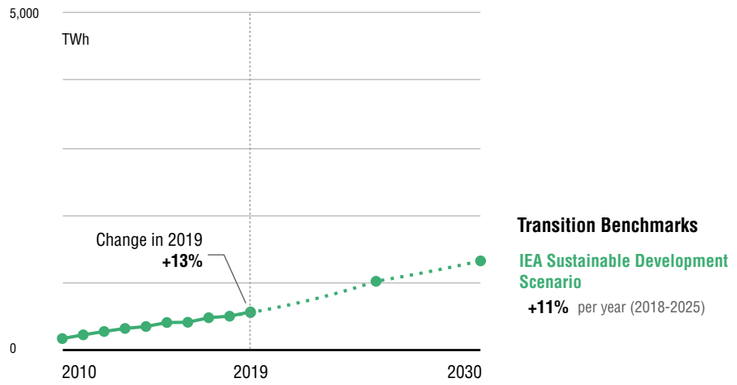
Is the transition happening fast enough?

Yes, if current progress holds. The EU is putting climate at the heart of policy, promising net-zero emissions by 2050, and to increase its 2030 CO2 target. Coal generation fell by 24% in 2019. With 15 coal countries committing to total phase-out by 2030, coal will continue to collapse. Germany and Poland are the main obstacles to phasing out coal by 2030. Wind and solar generation grew at 13% in 2019, and solar and offshore wind capacity are both growing sufficiently to maintain the growth rates.

Coal generation with future scenarios



Wind + solar generation with future scenarios



European Union

→ Electricity demand fell due to a mild winter

Electricity demand fell 1.7% in 2019, falling in most countries, because of warm winter months. Electricity demand per person is still almost double the world average but the gap is narrowing as world consumption rises. Anticipated rises in electricity demand from electric cars and electrification of heat and industry are not yet showing.

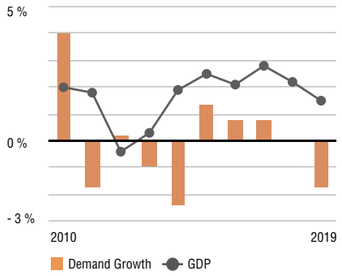
→ Fossil-free generation increase driven by wind

Hydro and nuclear generation fell slightly, with drier conditions affecting hydro, and outages at French and UK nuclear plants.

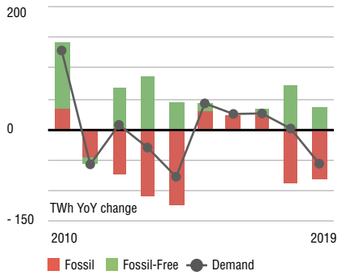
→ Wind and solar generation increased in 2019 by 13% (+64 TWh)

Wind generation saw a large increase, helped by new offshore installations. However German onshore wind slowed on new planning laws. Solar generation showed a strong rise, with capacity additions doubling over 2018. Spain leapt to become the largest solar installer in the EU. The growth of wind and solar continues to be concentrated in western Europe, with eastern European countries lagging.

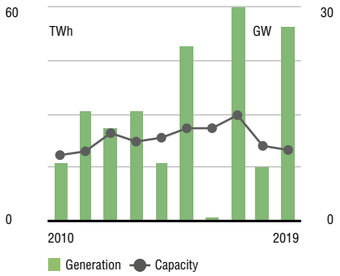
Electricity Demand Change



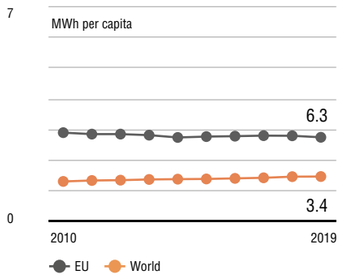
Fossil & Fossil-Free Generation Change



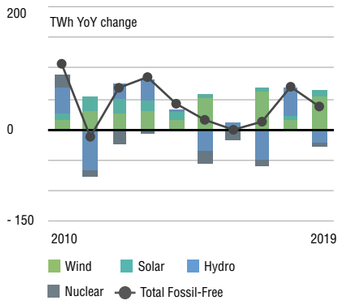
Wind Generation & Capacity Change



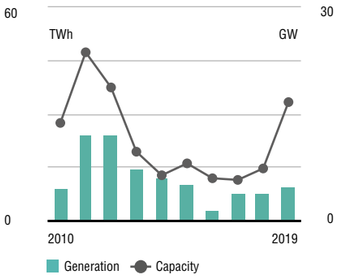
Electricity Demand per Capita



Fossil-Free Generation Change



Solar Generation & Capacity Change



→ Coal generation collapsed

The EU saw a record 24% fall in coal-fired generation in 2019. Coal now stands at half its 2007 peak, and makes up only 14% of the electricity mix. In 2019, coal's fall is attributable to the rise in wind and solar, switching from coal to gas driven by increases in the EU carbon price, and a small fall in electricity demand.

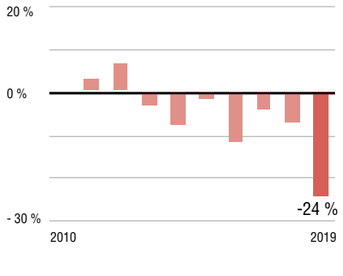
→ Gas generation increased by 12%

The one-off switch in economics resulted in a 73TWh rise in gas generation, which was a big contribution to coal's fall.

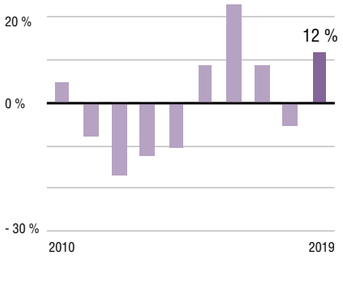
→ CO_2 emissions collapsed because of the fall in coal

EU power sector emissions fell by 13% in 2019, the largest fall this century. The carbon intensity of EU electricity is collapsing rapidly, and is now 42% below the global average.

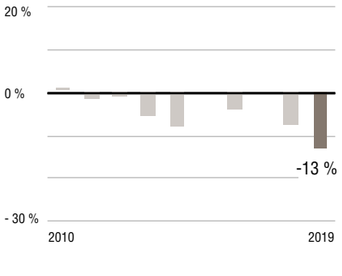
Coal Generation Change



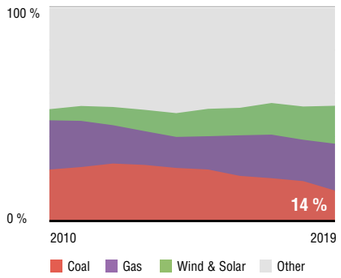
Gas Generation Change



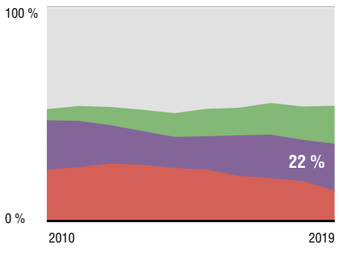
CO_2 Emissions Change



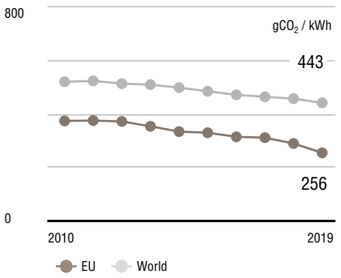
Coal in the Electricity Mix



Gas in the Electricity Mix



CO_2 Intensity Of Electricity



India

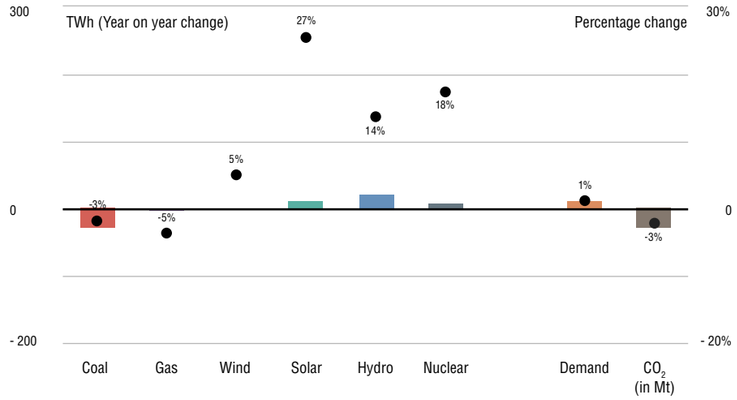
Key Messages

- *Coal generation fell for the first time on record, posting a decline of 3%.* As a result, power sector CO2 emissions also fell by 3%.
- *Low GDP growth, a bumper hydro year and a nuclear pick-up enabled the fall in coal.* Therefore, the fall in coal is likely to be a one-off for now. Wind and solar did also play a role in coal's falls, and this will become much more important in time.
- *Solar generation saw strong growth, although not-so for wind generation.* New solar capacity installed did set a record, with 12GW installed in 2019.

What happened in 2019?

India saw a surprising 3% fall in coal generation because electricity demand unexpectedly shrank in the second half of 2019 due to weak economic growth. A record monsoon season led to a 14% growth in hydro generation, which helped reduce coal. A relatively small 8GW of new coal plants were built in 2019, although there is a further 29GW in the pipeline that could be built. Solar capacity installations accelerated considerably. This increased solar generation by 27%, but wind generation increased only 5%.

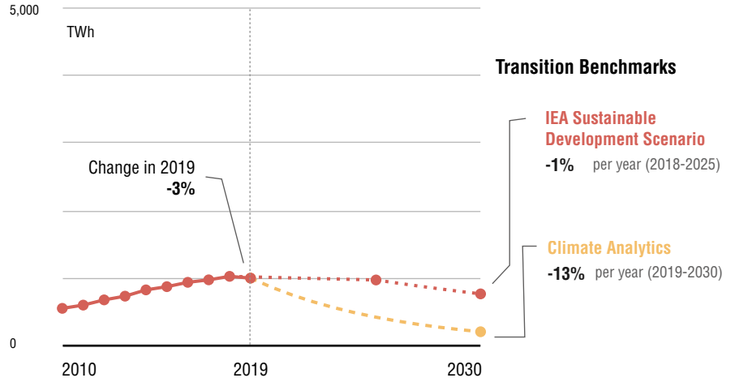
2019 Changes



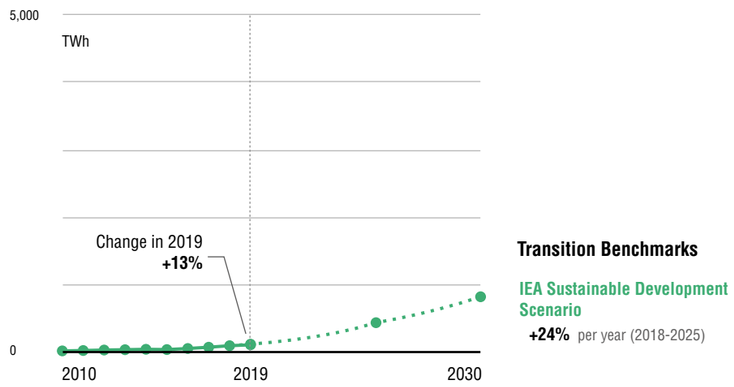
Is the transition happening fast enough?

India has good intentions. India has ambitious plans to deploy new wind and solar. However, it's also building new coal plants. The 3% fall in coal generation in 2019 was a good sign, but it's likely a one-off for now. Coal generation needs to be falling every year. Wind and solar generation grew at 13% in 2019, but from India's low base that's not fast enough - wind and solar generation must quadruple by 2025 to reach the IEA SDS. This requires compound growth rate of 24%.

Coal generation with future scenarios



Wind + solar generation with future scenarios



India

Electricity demand growth paused

Indian electricity demand grew by only 0.8% in 2019 compared to an average annual increase of 7% per year from 2010 to 2018. This was due to low GDP growth of 4.8%, the lowest since 2008. However, with electricity demand per person at less than one-third of the global average, subdued demand growth is likely to be a temporary phenomenon.

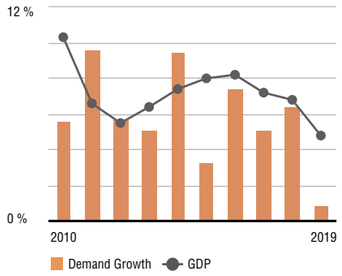
Fossil-free generation boosted by record solar additions and monsoon

Hydro generation was boosted by the strongest monsoons in 25 years. Nuclear generation also showed an increase.

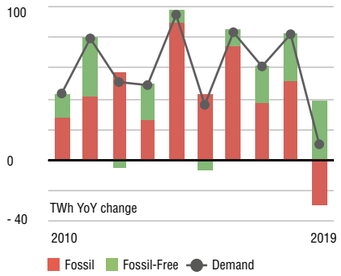
Solar capacity additions increased to a record 12 GW

New solar capacity hit a new record at 12 GW, solar provided 3.4% of all electricity in 2019. India opened the world's largest solar farm in 2019. The growth in wind was less impressive. Wind generation grew at the lowest rate since 2015, and new wind installations fell for the second year running.

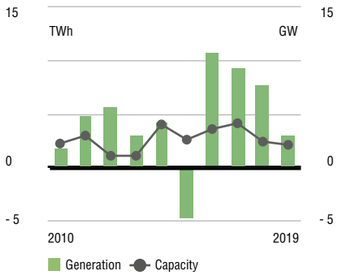
Electricity Demand Change



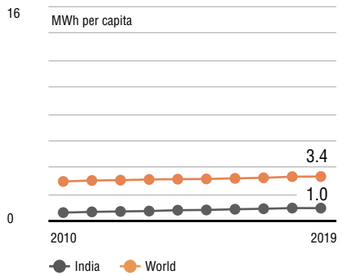
Fossil & Fossil-Free Generation Change



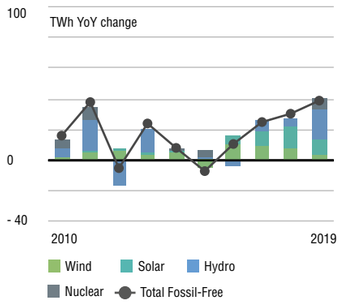
Wind Generation & Capacity Change



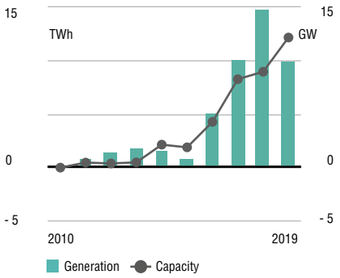
Electricity Demand per Capita



Fossil-Free Generation Change



Solar Generation & Capacity Change



Coal shows a surprise fall

Coal generation fell for the first time since at least 1990 when the IEA's reporting began. The fall was likely a one-off for now, caused by the combination of a large reduction in demand growth, and weather-driven increase in hydro generation. Wind and solar also played a role. Coal-fired generation fell 3%. However, coal still contributes 72% to the Indian electricity mix, and India is still building new coal plants. In 2019, GEM data shows there was 8 GW of new coal capacity brought online, with almost no old coal plants closed.

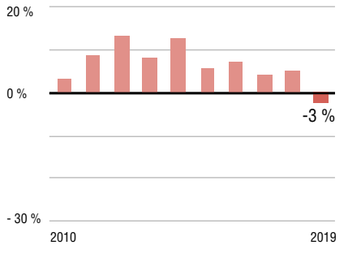
Gas generation also fell in 2019

It fell 5%. However, the change is relatively unimportant as gas only provides a small (3%) part of India's generation.

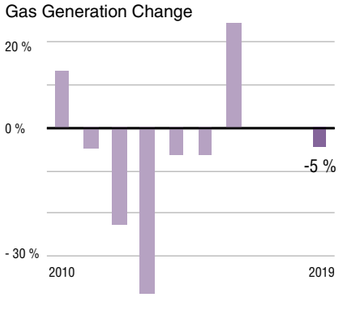
CO_2 emissions fell in line with coal generation

The carbon intensity of India's electricity generation fell by 4% in 2019, but remains much more carbon-intensive than the global average.

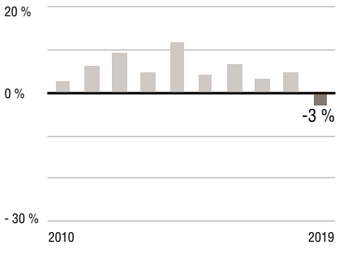
Coal Generation Change



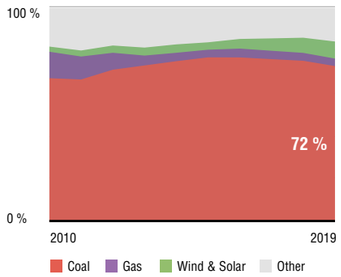
Gas Generation Change



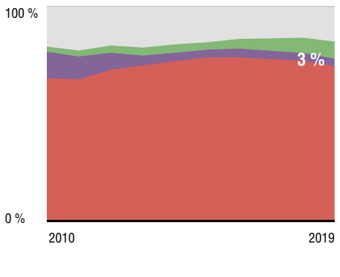
CO_2 Emissions Change



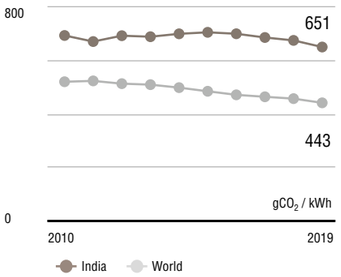
Coal in the Electricity Mix



Gas in the Electricity Mix



CO_2 Intensity Of Electricity



Rest of the World

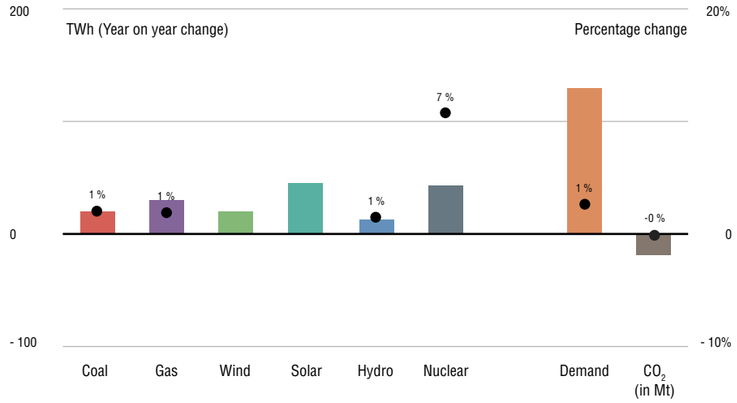
Key Messages

- *Solar growth accelerated, especially Japan, South Korea, Australia and Vietnam.* But wind is setting no growth records.
- *Electricity demand growth slowed.* Falls in OECD demand mask continued increases in developing nations, notably in Vietnam and Indonesia.
- *Coal generation increased slightly, by 1%.* Nuclear restarts led to a fall in coal generation in Japan and South Korea, but that was undermined by a rise in coal in Indonesia, Vietnam and Pakistan.
- *Gas generation also increased slightly, by 1%.* There was strong growth in Saudi Arabia, Mexico and Iran. It was tempered by a big fall in Turkish gas generation on higher hydro generation.

What happened in 2019?

Electricity demand rose by 1.4%, its lowest rate in a decade. Fossil-free sources met most of this increase, although both coal and gas also needed to rise slightly to meet increased electricity demand. Solar generation increased by 33% (+46TWh), with strong contributions from Japan, South Korea, Vietnam and Australia. Wind generation grew by 11% (+21TWh) with good additions from Brazil, Argentina and Mexico.

2019 Changes

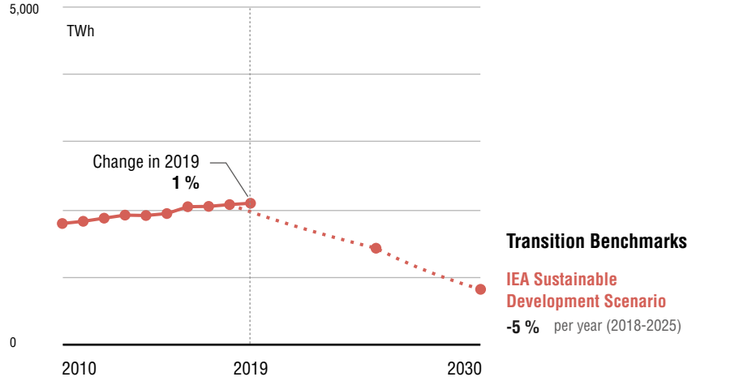


Is the transition happening fast enough?

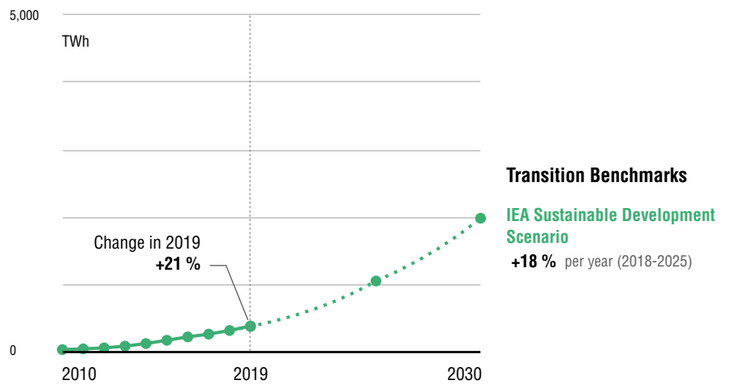
No. Coal generation is still rising, and it needs to be falling. Many countries are doing well, but few are doing well enough.

The biggest coal generators need to take the most urgent action. OECD countries, notably Japan, South Korea and Australia need to have mostly phased-out coal by 2030. Non-OECD countries, notably Russia, South Africa and Indonesia need to have mostly phased out coal by 2040. None of these countries are taking sufficient action to make sure that happens.

Coal generation with future scenarios



Wind + solar generation with future scenarios



Rest of World

Electricity demand rises slowly

Demand rose at 1.4%, its lowest level since 2009. Falls in OECD demand mask continued increases in developing nations, notably in Vietnam and Indonesia. At 2.4 MWh, the average demand per capita is made up of a very wide range of consumption levels. These range from more than 15 MWh in Canada and some Middle Eastern nations to less than 0.2 MWh in many African countries.

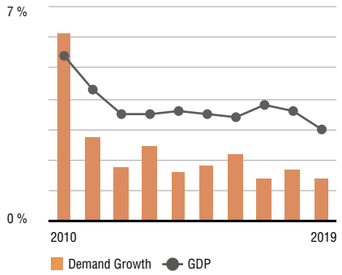
Fossil-free generation rises on solar growth and nuclear restarts

Nuclear generation increased as reactors returned in Japan and South Korea.

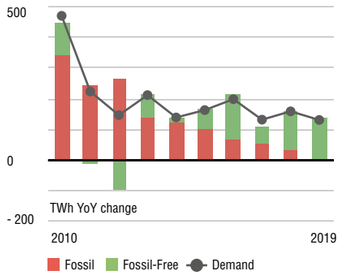
Solar generation growth accelerated markedly in 2019, but wind generation lags behind

Solar generation increased by 33% (+46TWh) as a record level of new solar capacity was installed. There were strong additions from Japan, South Korea, Vietnam and Australia. Vietnam solar capacity increased from 0.1 GW to 5.5 GW in 2019 alone. Wind generation grew 11% (+21TWh) with good additions from Brazil, Argentina and Mexico. However, wind generation grew at only half that of solar generation.

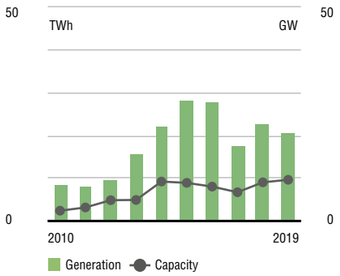
Electricity Demand Change



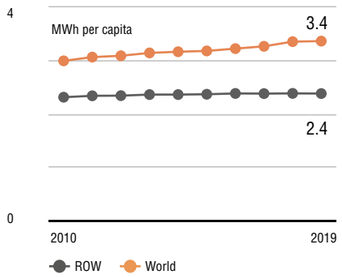
Fossil & Fossil-Free Generation Change



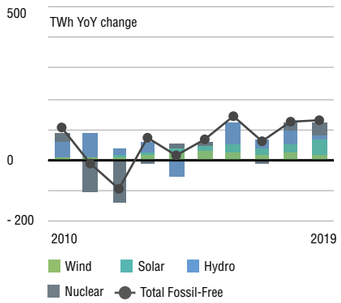
Wind Generation & Capacity Change



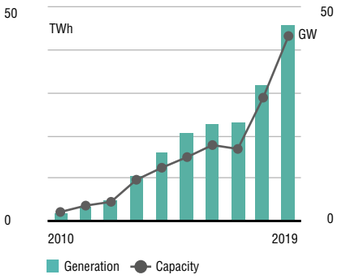
Electricity Demand per Capita



Fossil-Free Generation Change



Solar Generation & Capacity Change



Coal grew slightly by 1%

Coal generation fell in Japan (-4%, -11 TWh), South Korea (-5%, -12 TWh) and South Africa (-4%, -9 TWh), and were offset by rises in Indonesia (+11%, 16 TWh), Vietnam (+34%, 25 TWh) and Pakistan (+95%, +16 TWh).

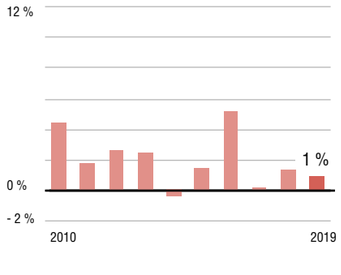
Gas generation rose by 1%

Gas generation rose by 1%. There were significant increases in Saudi Arabia (+11%, 24 TWh), Mexico (+9%, 17 TWh), and Iran (+8%, +20 TWh). These rises were tempered by a large fall in gas generation in Turkey (-39%, 34 TWh), where there was a large increase in hydro generation.

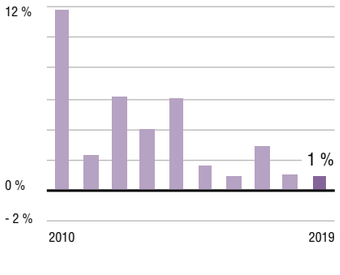
CO2 emissions fell slightly, by 0.5%

Although coal and gas generation rose very slightly, oil generation falling especially in Iran and Pakistan actually led to a very slight fall in rest of the world CO2 emissions overall.

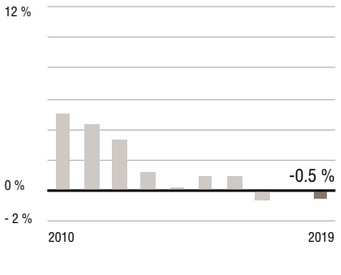
Coal Generation Change



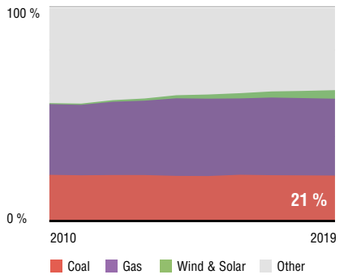
Gas Generation Change



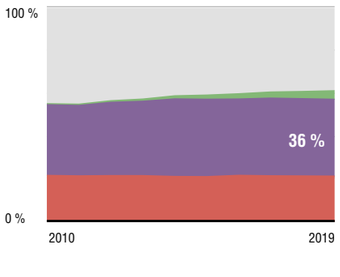
CO_2 Emissions Change



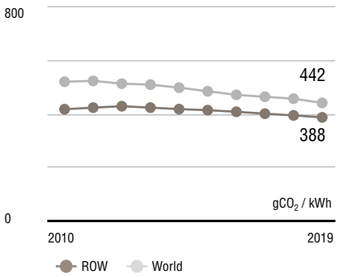
Coal in the Electricity Mix



Gas in the Electricity Mix



CO_2 Intensity Of Electricity



Strictly embargoed until 00.01GMT on 9th March

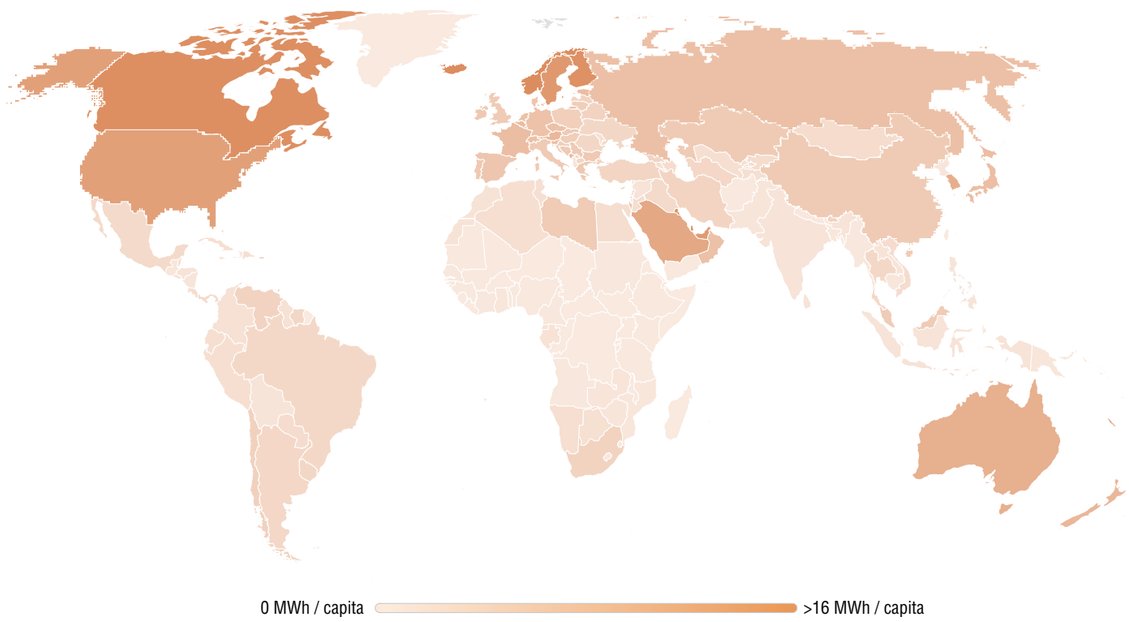
Generation and Demand

Electricity Demand

Key Messages

- *Electricity demand growth slowed to 1.4%, the slowest increase since the 2009 recession.* This was due to low GDP growth of 3%, and also because of the weather - especially milder winter months in the US and EU.
- *Chinese electricity demand rose at over three times the global average.* Its demand per capita is now higher than in the UK.
- *Slower electricity demand growth is critical to reducing coal generation.* This will require robust energy efficiency measures to moderate demand pressures from the decarbonisation of transport, industry and heat.

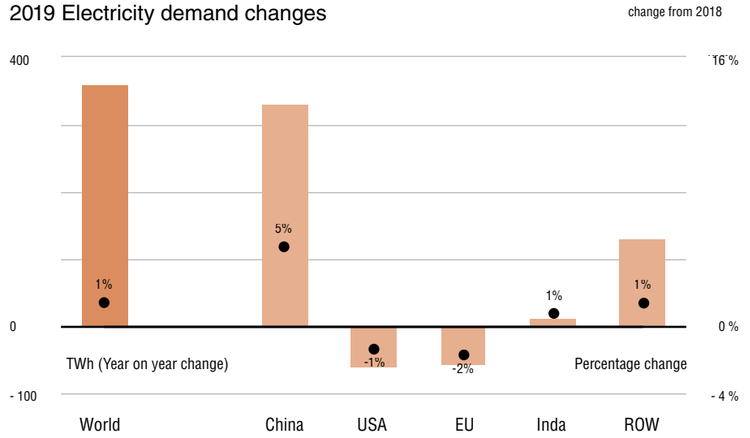
Electricity demand per capita in 2019



What happened in 2019?

Electricity demand growth slowed to 1.4%, the slowest increase since the 2009 recession. This was due to low GDP growth of 3%, and also because of the weather - especially milder winter months in the US and EU. Almost all the growth came from China. Chinese electricity demand rose at over three times the global average, and demand per capita is now higher than in the UK. Electricity demand was weak elsewhere. Demand even fell in the US, EU, India, Japan, Canada and South Korea.

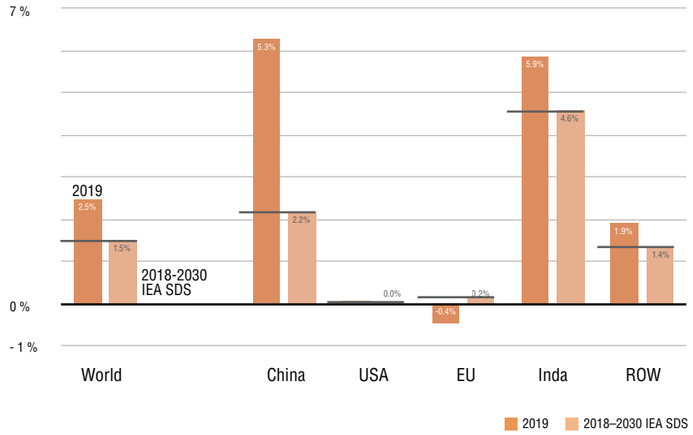
2019 Electricity demand changes



Is the transition happening fast enough?

It's not yet clear. Electricity demand growth in the coming decade will need to slow to about half the rate of the previous decade. Global electricity demand rose on average 2.5% per year from 2010 to 2019, and the IEA SDS shows just a 1.5% per year increase is needed until 2030. The biggest difference is China. Chinese electricity demand growth will need to slow to 2% this decade, compared to the 6% growth seen in the previous decade. China has already begun its journey to electrify transport. Robust energy efficiency measures will be critical to prevent electricity demand spiralling upward as extra electricity will be needed for the electrification of transport, industry and heat.

Average annual electricity demand changes by region

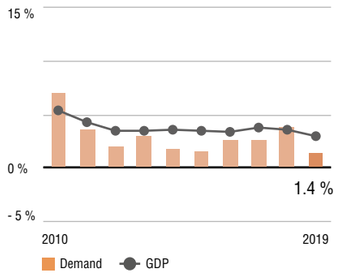


Electricity Demand

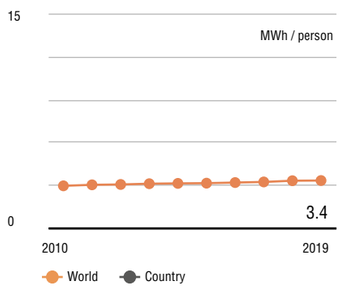
World
Electricity demand growth slowed

Electricity demand rose by 1.4%, the slowest increase since the 2009 recession. This was due to low GDP growth of 3%, and also because of the weather - especially milder winter months in the US and EU.

Electricity Demand Change



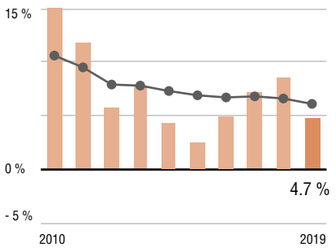
Electricity Demand Change per Capita



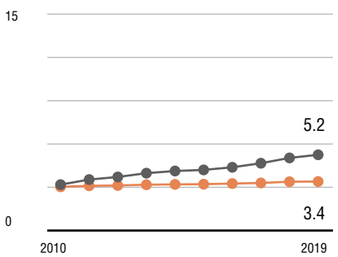
China
Electricity demand continued to soar

Electricity demand rose by 4.7% in 2019, more than three times the global average of 1.4%. The large rise was despite China's slowest GDP growth in 30 years, and follows on the back of a huge 8% rise in 2018. Electricity demand per capita is now 53% above the global average. At 5.2 MWh, per capita demand now exceeds the level in the UK, but remains less than half the level in the US.

Electricity Demand Change



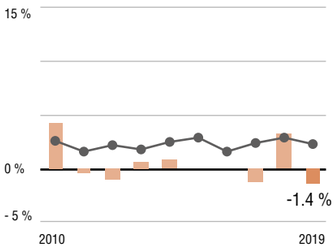
Electricity Demand Change per Capita



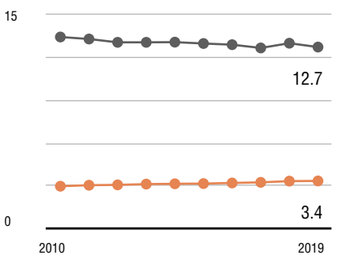
United States
Electricity demand fell due to a mild winter

Electricity demand fell 1.4%, correcting for a large rise in 2018. Weather was the biggest driver: 2019 winter months were warm, correcting for a colder 2018. Industrial demand declined at 5% as economic growth slowed. US electricity demand per capita is one of the highest in the world. The average US citizen uses almost four times more electricity than the global average, and more than twice the European or Chinese per capita

Electricity Demand Change



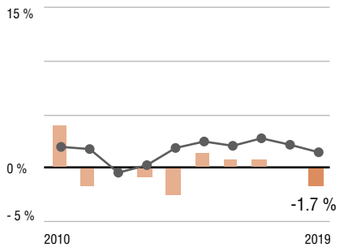
Electricity Demand Change per Capita



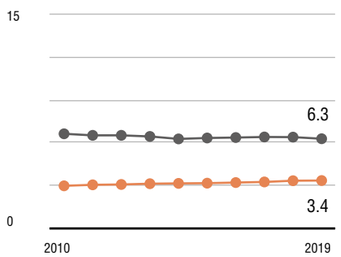
European Union
Electricity demand fell due to a mild winter

Electricity demand fell 1.7% in 2019, falling in most countries, because of warm winter months. Electricity demand per person is still almost double the world average but the gap is narrowing as world consumption rises. Anticipated rises in electricity demand from electric cars and electrification of heat and industry are not yet showing.

Electricity Demand Change



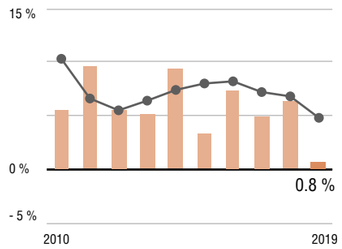
Electricity Demand Change per Capita



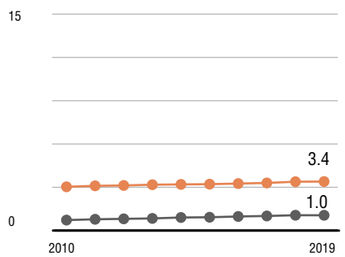
India
Electricity demand growth paused

Indian electricity demand grew by only 0.8% in 2019 compared to an average annual increase of 7% per year from 2010 to 2018. This was due to low GDP growth of 4.8%, the lowest since 2008. However, with electricity demand per person at less than one-third of the global average, subdued demand growth is likely to be a temporary phenomenon.

Electricity Demand Change



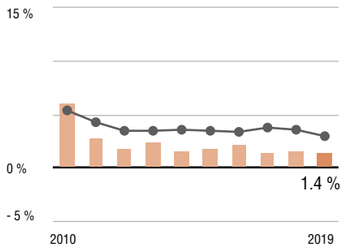
Electricity Demand Change per Capita



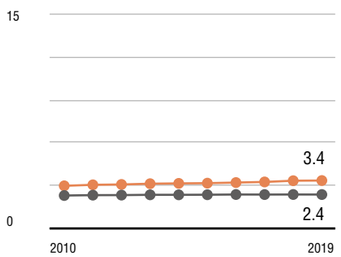
Rest of World
Electricity demand rises slowly

Demand rose at 1.4%, its lowest level since 2009. Falls in OECD demand mask continued increases in developing nations, notably in Vietnam and Indonesia. At 2.4 MWh, the average demand per capita is made up of a very wide range of consumption levels. These range from more than 15 MWh in Canada and some Middle Eastern nations to less than 0.2 MWh in many African countries.

Electricity Demand Change



Electricity Demand Change per Capita

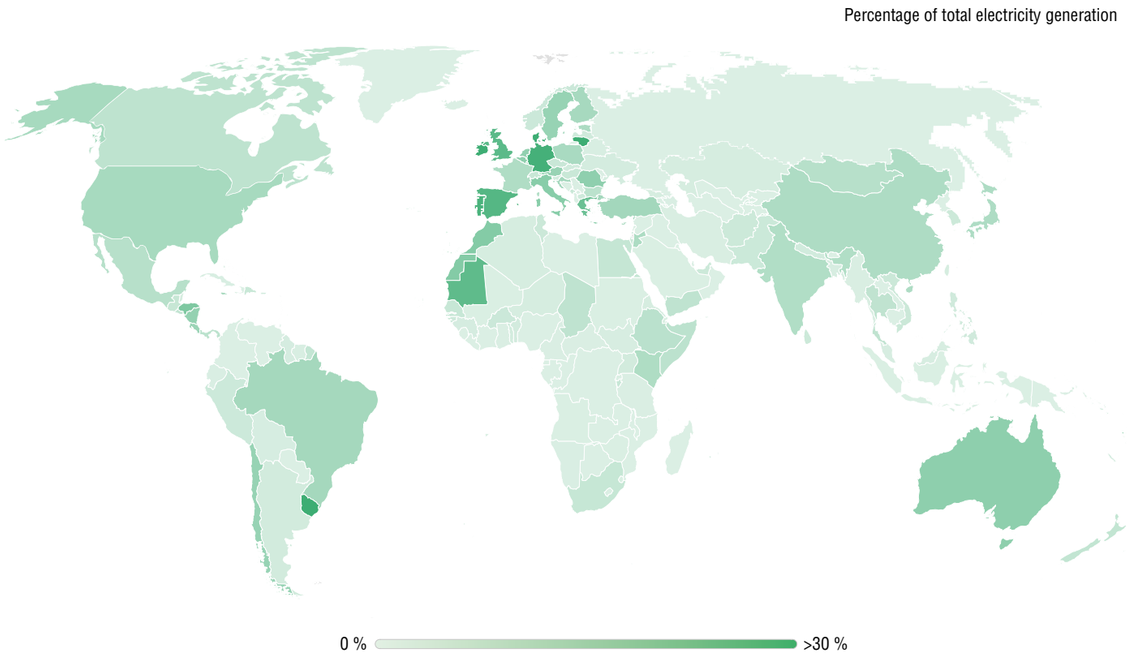


Fossil-Free Generation

Key Messages

- *Wind and solar generation grew by 15% (+270 TWh) in 2019.* The wind and solar generation rise of 270 TWh was the second biggest on record, but the growth rate is slowing - the 15% growth rate was the lowest this century. Of the four key regions, China showed the fastest growth of 16% (+86 TWh) and the US the slowest with 11% (+41 TWh); India and EU both recorded 13% growth rates (+13 TWh and +64 TWh respectively).
- *Hydro and nuclear generation rose, but unlike wind and solar, there is no big pick-up in deployment.* Nuclear plants restarted in Japan and South Korea. Whilst new nuclear plants in China rose, it built less new hydro capacity than the last few years.
- *The compound growth needed for wind and solar over the next years will be very challenging to achieve.* Record low wind and solar prices in 2019 give hope that compound growth rates could be maintained if governments step up.

Wind and solar generation, as a percentage of national electricity production



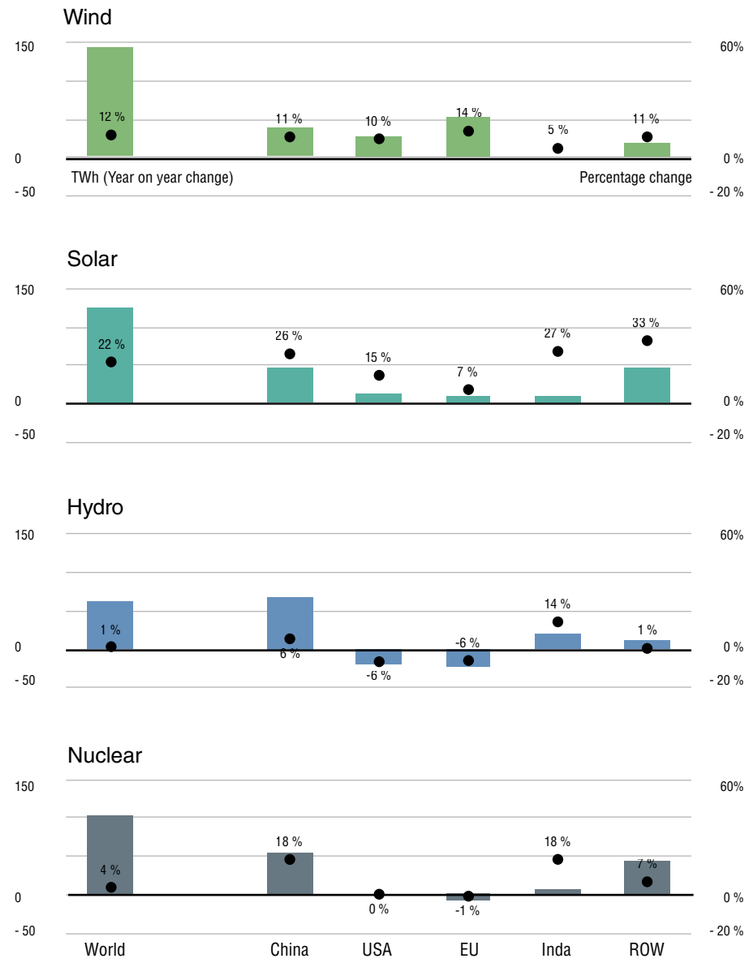
What happened in 2019?

Wind generation increased by 12%. Three-quarters of the rise was from just 7 countries: China, US, Germany, UK, France, Sweden and Brazil.

Solar generation increased by 22%. China saw the biggest generation increase but a capacity slowdown means it will be lower next year.

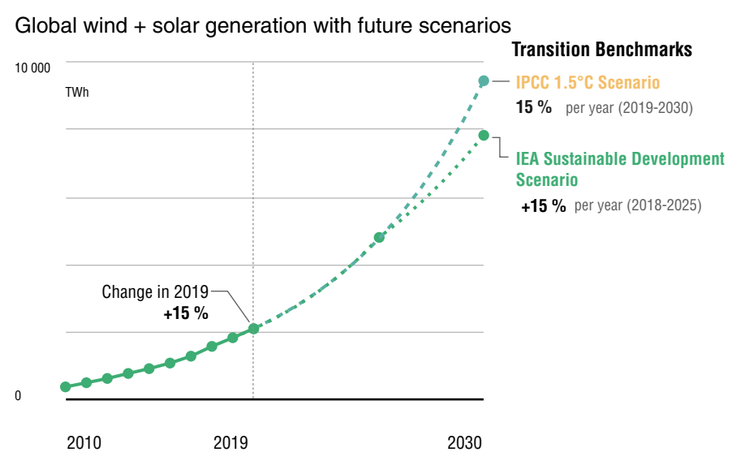
Hydro generation only increased by 1%. China, the main country building new hydro, built much less. Wet conditions in China and India offset a drier EU and US.

Nuclear generation rose 4%, the most this century. This was due to new plants in China and restarts in South Korea and Japan.



Is the transition happening fast enough?

It's not yet clear. Wind and solar generation increased by 15% in 2019. Huge compound growth is needed to more than double wind and solar generation by just 2025. It's not yet clear governments are ready to facilitate this. However, record low prices for wind and solar give hope that deployment rates can be sustained in countries with record deployment, and increased elsewhere.



Fossil-Free Generation

Strictly embargoed until 00.01GMT on 9th March

→ World

Fossil-free generation growth keeps pace with weak electricity demand

Nuclear generation rose at the fastest rate this century, because of restarts in Japan and South Korea, and also new capacity installed in China. Hydro generation rose, but mostly due to wet conditions in China and India. In China, where most new hydro is being built, hydro capacity was up only 4 GW, compared to 16 GW average this decade.

→ China

Fossil-free generation added less than the growth in electricity demand

Fossil-free generation grew by 10% (+227 TWh), which was less than the 329 TWh growth in electricity demand, necessitating a rise in fossil generation of 102 TWh to meet extra demand. Hydro generation increased 69 TWh, driven more by heavy rains rather than new capacity - hydro capacity was up only 4 GW, compared to 16 GW average this decade. Nuclear generation increased 54 TWh as 4 GW more capacity came online.

→ United States

Fossil-free generation barely grew because of weak wind and solar growth

Nuclear generation was unchanged, and hydro generation fell, after a wet year in 2018.

→ European Union

Fossil-free generation increase driven by wind

Hydro and nuclear generation fell slightly, with drier conditions affecting hydro, and outages at French and UK nuclear plants.

→ India

Fossil-free generation boosted by record solar additions and monsoon

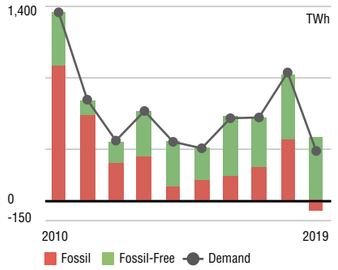
Hydro generation was boosted by the strongest monsoons in 25 years.

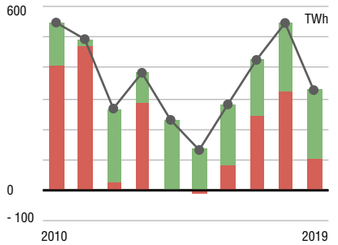
→ Rest of World

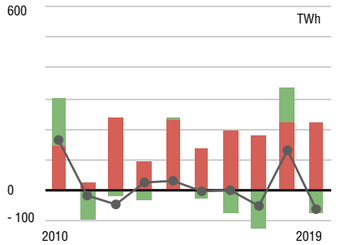
Fossil-free generation rises on solar growth and nuclear restarts

Nuclear generation increased as reactors returned in Japan and South Korea.

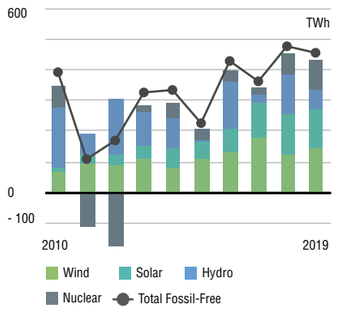
Fossil + Fossil-Free Change

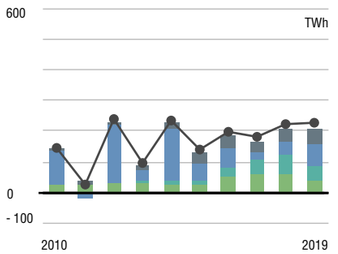


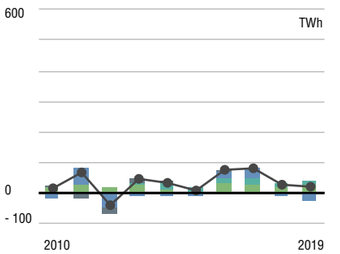




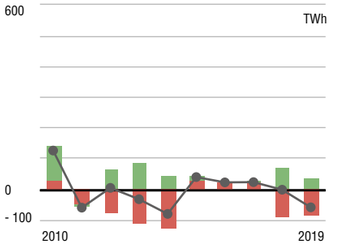
Fossil-Free Change

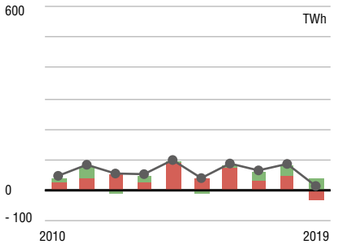


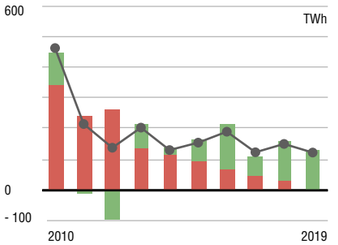




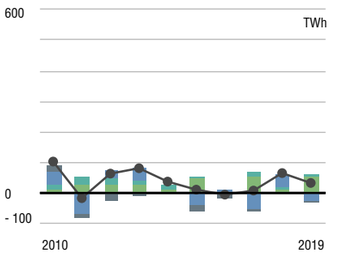
Fossil + Fossil-Free Change

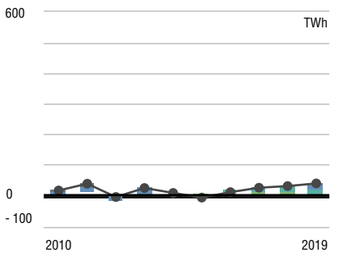


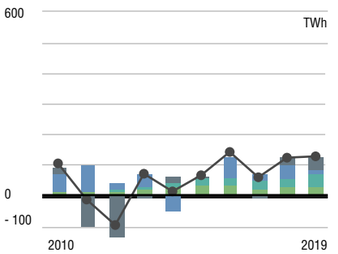




Fossil-Free Change







Wind & Solar Generation

→ World

Wind and solar generation growth slowed to 15% (+270 TWh)

The wind and solar generation rise of 270 TWh was the second biggest on record, but the growth rate slowed - the 15% growth rate was the lowest this century. Of the four key regions, China showed the fastest growth of 16% (+86 TWh) and the US the slowest with 11% (+41 TWh); India and EU both recorded 13% growth rates (+13 TWh and +64 TWh respectively). Five further countries added 40 TWh between them, mostly solar: Japan, Brazil, Mexico, Australia and Vietnam.

→ China

Wind and solar generation growth slowed to 16% (+86 TWh)

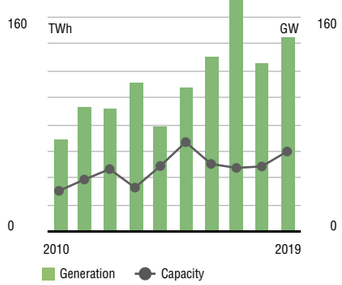
Growth of 86 TWh (40 TWh of wind and 46 TWh of solar) was the lowest growth since 2016. But the growth rate of 16% was the lowest this century. New wind installations were 26GW, below the 34GW installed in 2015. New solar installations were 30GW, below the 53GW installed in 2017.

→ United States

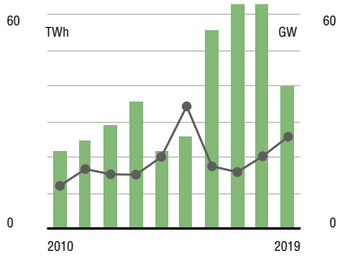
Wind and solar generation grew at only 11% (+41 TWh)

This is the lowest of any major region: China grew at 16% (+86 TWh) India 13% (+13 TWh) and EU 13% (+64 TWh). Wind and solar generation increased by 41 TWh (+27 TWh of wind, 14 TWh of solar). Neither solar nor wind set new records for new installations: 9GW of solar was installed, below the 11GW record in 2016, and 9GW of wind was installed, below the 13GW record in 2012.

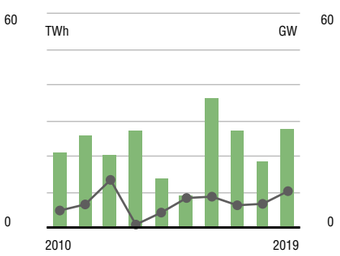
Electricity Demand Change



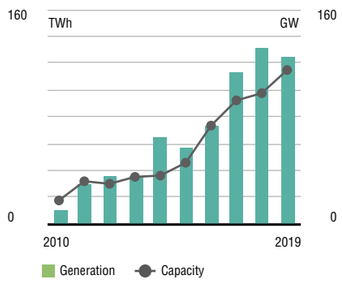
Electricity Demand Change



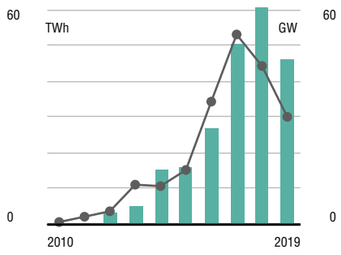
Electricity Demand Change



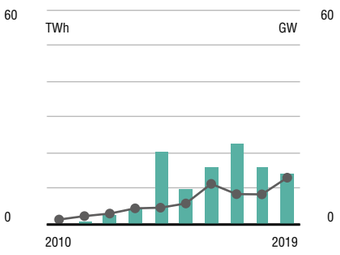
Electricity Demand Change per Capita



Electricity Demand Change per Capita



Electricity Demand Change per Capita



→ European Union

Wind and solar generation increased in 2019 by 13% (64 TWh)

Wind generation saw a large increase, helped by new offshore installations. However, German onshore wind slowed on new planning laws. Solar generation showed a strong rise, with capacity additions doubling over 2018. Spain leapt to become the largest solar installer in the EU. The growth of wind and solar continues to be concentrated in western Europe, with eastern European countries lagging.

→ India

Solar capacity additions increased to a record 12 GW

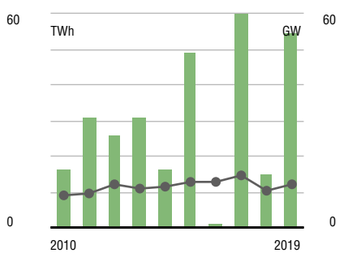
New solar capacity hit a new record at 12 GW, solar provided 3.4% of all electricity in 2019. India opened the world's largest solar farm in 2019. The growth in wind was less impressive. Wind generation grew at the lowest rate since 2015, and new wind installations fell for the second year running.

→ Rest of World

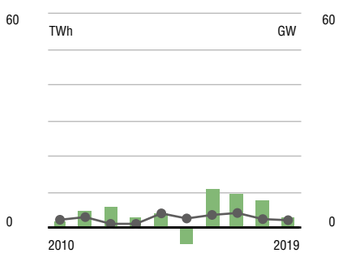
Solar generation growth accelerated markedly in 2019, but wind generation lags behind.

Solar generation increased by 33% (+46TWh) as a record level of new solar capacity was installed. There were strong additions from Japan, South Korea, Vietnam and Australia. Vietnam solar capacity increased from 0.1 GW to 5.5 GW in 2019 alone.Wind grew 11% (+21TWh) with good additions from Brazil, Argentina and Mexico. However, wind generation grew at only half that of solar generation.

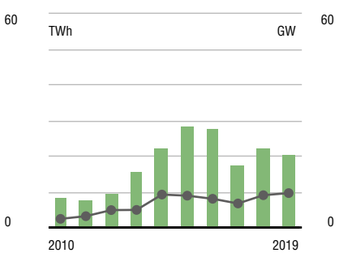
Electricity Demand Change



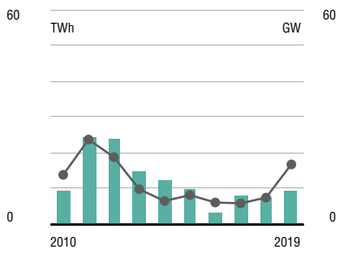
Electricity Demand Change



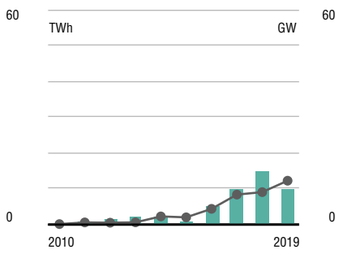
Electricity Demand Change



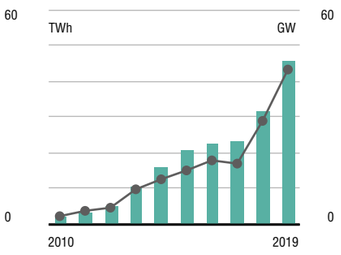
Electricity Demand Change per Capita



Electricity Demand Change per Capita



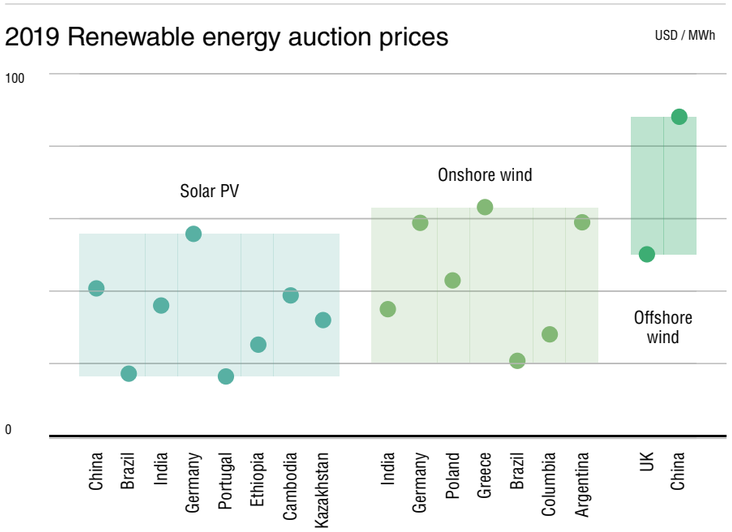
Electricity Demand Change per Capita



Wind and Solar progress in 2019

Latest Prices

Solar: Solar auctions have delivered record low prices in 2019. The lowest prices were established in Portugal at 16.5 USD/MWh and in Brazil, 17.3 USD/MWh. In January 2020, these records had already been surpassed by an auction in Qatar where the final price was 16 USD/MWh.

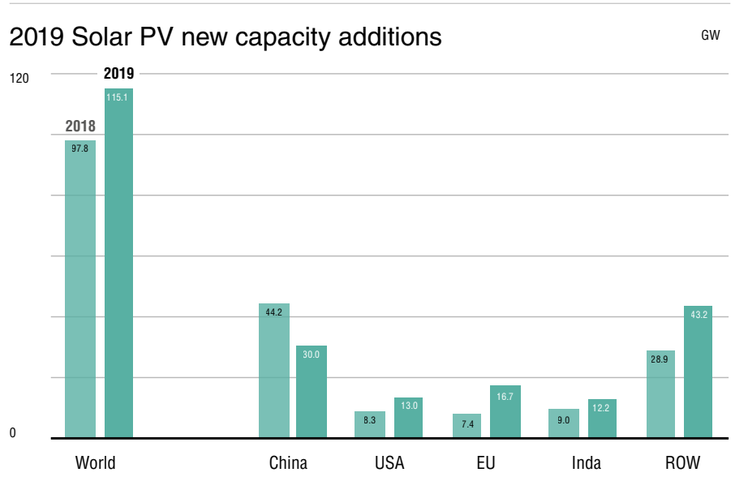


Onshore wind: The lowest price for onshore wind in 2019 was 21 USD/MWh in an auction held in Brazil. The second-lowest price was 28 USD/MWh in Colombia. Projects in Greece were awarded for a price of 63 USD/MWh. India also awarded a record low onshore wind price of 35 USD/MWh.

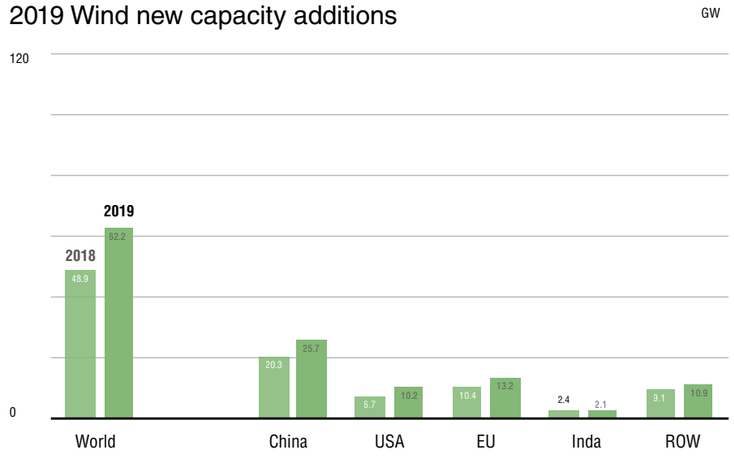
Offshore wind: A zero-subsidy offshore wind project was awarded in 2019 in the Netherlands. In the United Kingdom, auctions have delivered new record low prices for offshore wind at 50 USD/MWh while in China the lowest offshore wind price was 88 USD/MWh. The vast majority of prices of renewable energy project stemming from auctions were below generation costs of fossil fuel alternatives estimated by IRENA to be 49 USD/MWh to 174 USD/MWh. .

New Capacity

Solar: Solar capacity installed in 2019 was around 115 GW, 18% more than the previous year. USA, India and the European Union have seen increases of 56%, 36% and 96% respectively in 2019 compensating for the decline in installations in China. Rest of World countries have increased their installations by 56%.



Wind: Preliminary estimates for wind capacity installed in 2019 are around 62 GW, 27% more than in 2018 but less than the 67 GW added in 2015. As such, growth has started to accelerate from the flat three years before. The European Union, Rest of World, China and USA have seen growth rates of 27%, 19%, 27% and 53% respectively, while India has seen a 12% decline.



Fossil Generation

Key Messages

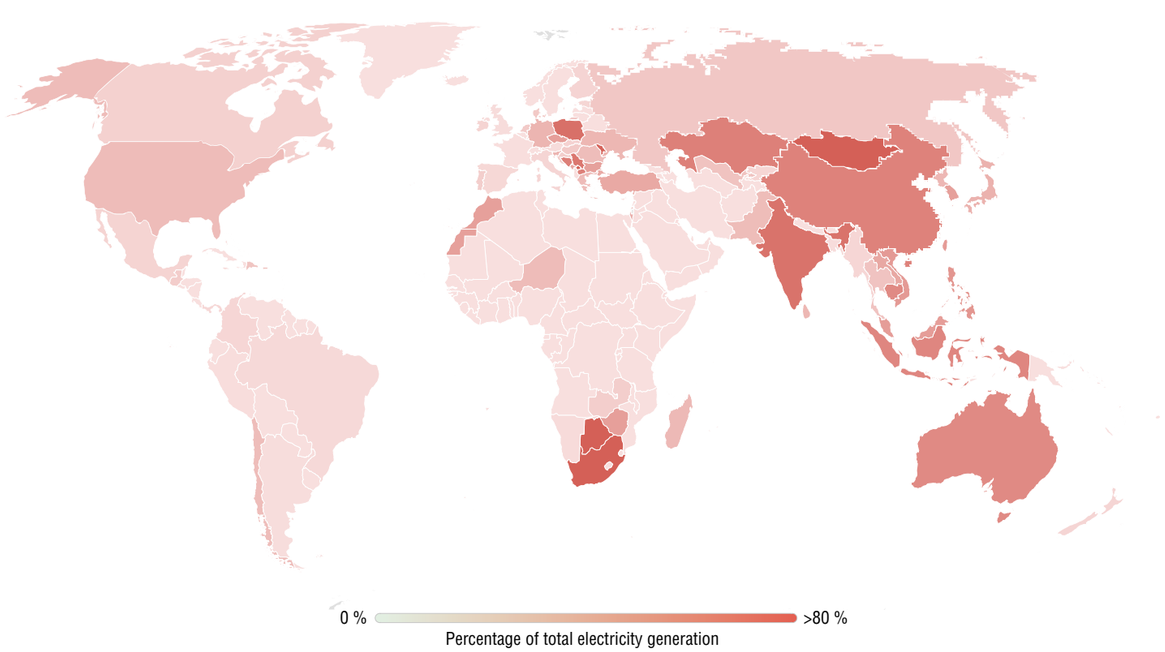
→ Coal generation fell a record 3%, but falling coal is not yet the "new normal". Coal fell because electricity demand growth slowed, wind and solar generation rose, gas replaced coal in the US and the EU, hydro increased, new nuclear plants were added and nuclear plants restarted in South Korea and Japan. Some of these factors were one-off factors that are unlikely to be reproduced.

→ China in 2019, for the first time, was responsible for more than half of the world's coal generation. Since 2015, when the Paris Climate Agreement was signed, China's coal generation has risen by 17%, whereas coal generation in the rest of the world has fallen by 9%.

→ Global power sector CO_2 emissions fell by a record 2%. CO_2 emissions would have fallen faster if fossil-free generation had totally replaced coal, rather than a pick-up in coal-gas switching. The climate impact of methane leaks from the extra gas generation is not included in our calculations.

→ Given the one-off nature of some of the reasons for the fall in power sector CO_2 emissions in 2019, there is not sufficient evidence to suggest emissions will fall fast enough to limit climate change to 1.5 degrees.

Coal generation as a percentage of national electricity production



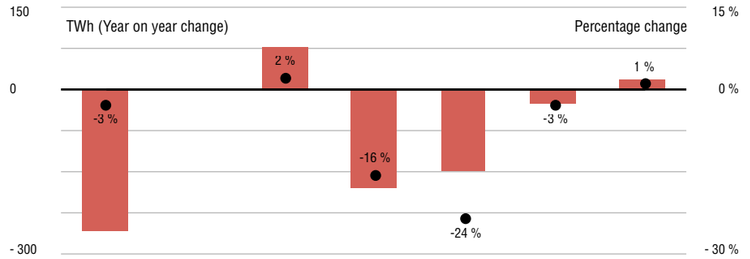
What happened in 2019?

Coal generation fell 3%. Coal collapsed in the EU and the US. Overall fall due to a rise in wind and solar generation, slow electricity demand growth, gas replacing coal in the US and the EU, new nuclear plants (China and India) and restarts (in South Korea and Japan). Coal increased in China.

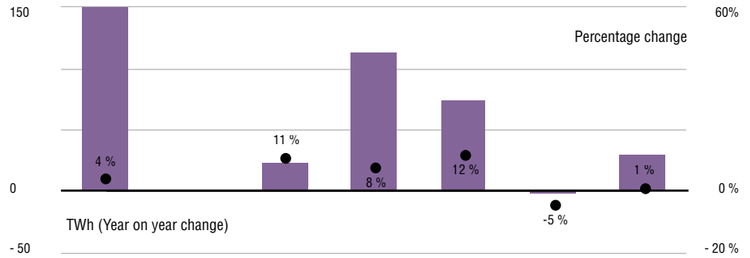
Gas generation rose 4%. Gas use rose in the US and EU, part of the reason for coal collapsing. Gas use rose in China, Saudi Arabia, Mexico and Iran. Only 3 countries saw a big fall in gas: Japan, South Korea and Turkey.

CO_2 emissions fell 2%. The coal collapse in the EU and US meant CO_2 emissions fell faster than the increase in China's CO_2.

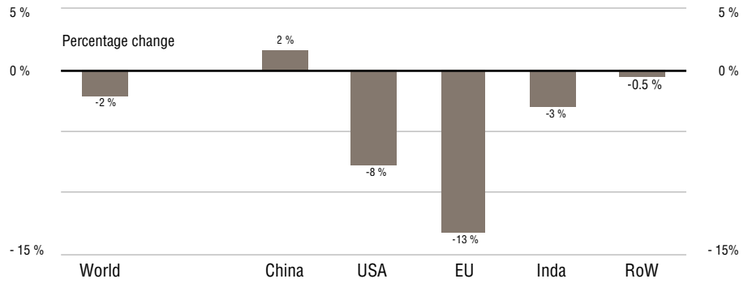
2019 coal generation changes by region



2019 gas generation changes by region



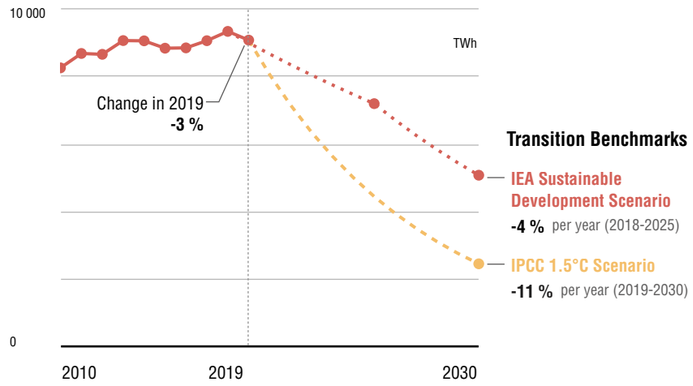
2019 CO_2 emissions changes by region



Is the transition happening fast enough?

No. Despite the 3% fall in coal generation, it's not clear yet that falling coal generation is the "new normal". Coal generation will need to fall at 11% per year every year until 2030, to meet the IPCC's medial level of the 1.5C compatible scenarios. Even the less-ambitious IEA Sustainable Development scenario needs drops of 4% per year.

Global coal generation with future scenarios



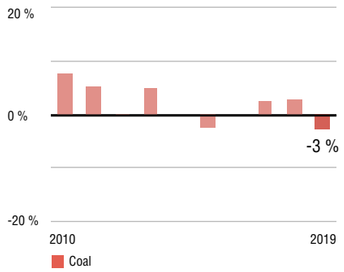
Coal generation

→ World

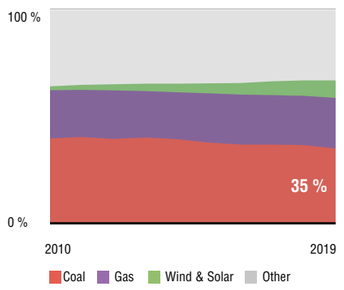
Coal generation fell a record 3%

Coal fell 3% (-259 TWh), as coal collapsed in the EU and the US, but rose in China. This is because wind and solar generation rose, electricity demand increased by the least in a decade, gas replaced coal in the US and the EU, and nuclear plants restarted in South Korea and Japan. New coal-fired generation capacity continues to rise, driven primarily by new additions in China.

Coal generation change



Generation Mix

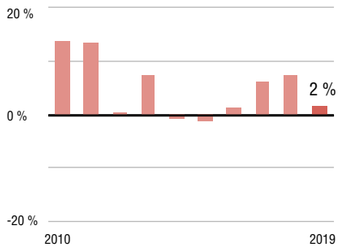


→ China

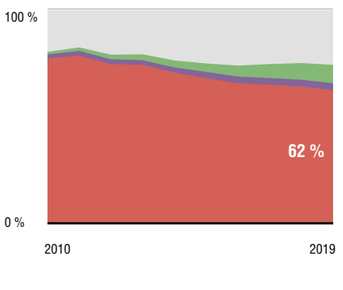
Coal rose to half of the world's coal generation

Coal-fired generation rose 2% in 2019. Since 2015, China's coal generation has risen by 17%, compared to a fall of 9% in the rest of the world. For the first time, China is now responsible for over 50% of global coal generation.At 62%, coal's relative share of the electricity mix is falling, but only because total electricity demand has increased even more dramatically. This hides the absolute rise in coal generation which has doubled in 12 years.

Coal generation change



Generation Mix

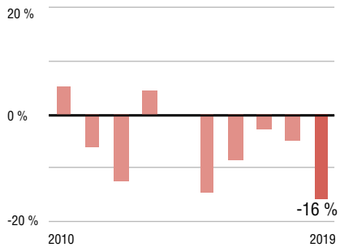


→ United States

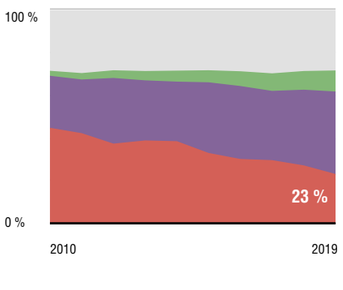
Coal generation collapsed - and was replaced largely with gas generation

Coal generation fell by 16% (180 TWh), to 24% of total generation. This was due to a 113 TWh increase in gas generation, a 58 TWh fall in electricity demand, and a 41 TWh rise in wind and solar. This fall is the largest on record, and the fifth year of consecutive falls. It brings US coal generation to half its 2007 level, and the lowest since 1975.

Coal generation change



Generation Mix

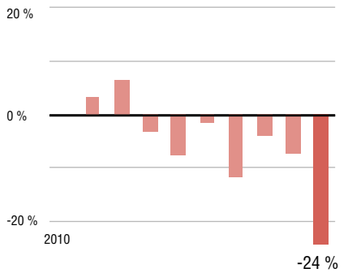


→ European Union

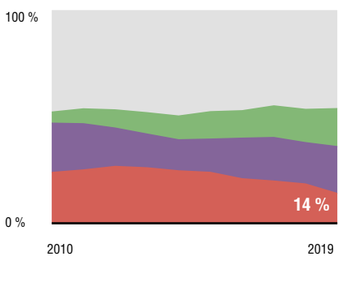
Coal generation collapsed

The EU saw a record 24% fall in coal-fired generation in 2019. Coal now stands at half its 2007 peak, and makes up only 14% of the electricity mix. In 2019, coal's fall is attributable to the rise in wind and solar, switching from coal to gas driven by increases in the EU carbon price, and a small fall in electricity demand.

Coal generation change



Generation Mix

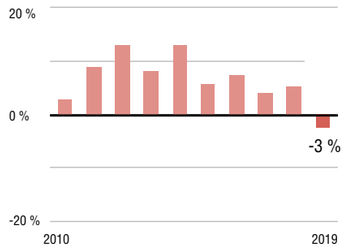


→ India

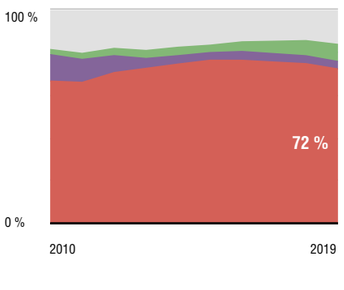
Coal shows a surprise fall

Coal generation fell for the first time since at least 1990 when the IEA's reporting began. The fall was likely a one-off for now, caused by the combination of a large reduction in demand growth, and weather-driven increase in hydro generation. Wind and solar also played a role. Coal-fired generation fell 3%. However, coal still contributes 72% to the Indian electricity mix, and India is still building new coal plants. In 2019, GEM data shows there was 8 GW of new coal capacity brought online, with almost no old coal plants closed.

Coal generation change



Generation Mix

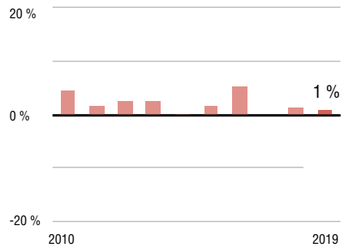


→ Rest of World

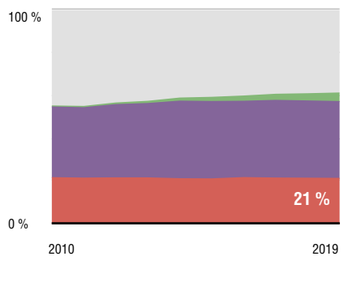
Coal grew slightly by 1%

Coal generation fell in Japan (-4%, -11 TWh), South Korea (-5%, -12 TWh) and South Africa (-4%, -9 TWh), and were offset by rises in Indonesia (+11%, 16 TWh), Vietnam (+34%, 25 TWh) and Pakistan (+95%, +16 TWh).

Coal generation change



Fossil-Free Change

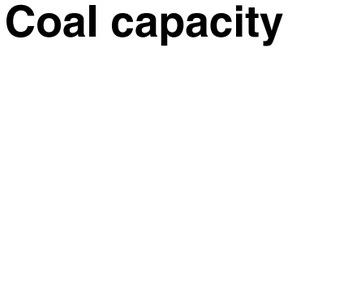


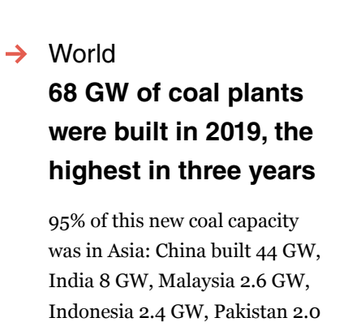
Coal capacity

→ World

68 GW of coal plants were built in 2019, the highest in three years

95% of this new coal capacity was in Asia: China built 44 GW, India 8 GW, Malaysia 2.6 GW, Indonesia 2.4 GW, Pakistan 2.0 GW, Japan 1.3 GW and Philippines 1.2 GW. There were very few closures outside the US and the EU.

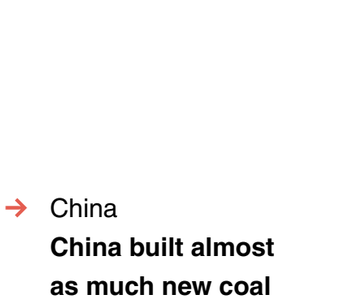


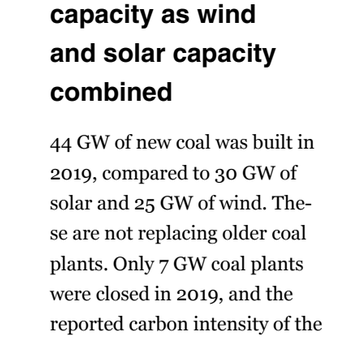


→ China

China built almost as much new coal capacity as wind and solar capacity combined

44 GW of new coal was built in 2019, compared to 30 GW of solar and 25 GW of wind. These are not replacing older coal plants. Only 7 GW coal plants were closed in 2019, and the reported carbon intensity of the Chinese coal fleet improved just 0.3%, the lowest improvement since reporting began in 2006.

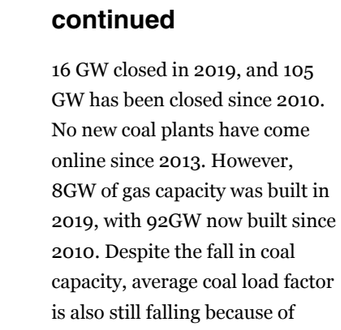




→ United States

Coal capacity closures continued

16 GW closed in 2019, and 105 GW has been closed since 2010. No new coal plants have come online since 2013. However, 8GW of gas capacity was built in 2019, with 92GW now built since 2010. Despite the fall in coal capacity, average coal load factor is also still falling because of the collapse in coal generation, dropping below 50% for the first time.



→ European Union

Coal load factor collapsed in 2019

The fall in coal generation 2019 was much faster than the fall in capacity, which pulled the average load factor down to a record 37%. 7 GW of coal plants closed in 2019, and 66 GW have retired since 2010. In 2019, Germany, Greece and Hungary committed to phasing out coal, bringing the total to 15 EU countries, ensuring closures continue apace.
.

→ India

India built 8 GW of new coal plants in 2019

India brought 8 GW of coal plants online in 2019, and closed only 1GW. Average coal load factor fell in 2019 because both coal generation fell and coal capacity increased. It now stands at a record low of 57%.

→ Rest of World

New coal-fired plants continued to be built in 2019 in Asian countries

Almost 90% of the 15 GW was in Asian countries. Malaysia built 2.6 GW, Indonesia 2.4 GW, Pakistan 2.0 GW, Japan 1.3 GW and Philippines 1.2 GW. Only 22 GW of coal plants have closed since 2010.

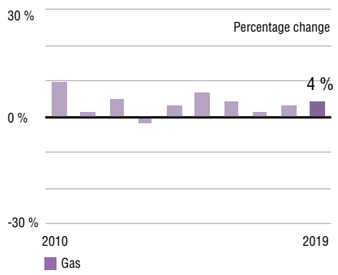
Coal capacity data has been taken from Global Energy Monitor's 'Global Coal Plant Tracker' update of Jan-20. It provides data on net capacity as well as annual additions and retirements. Coal load factors were taken from national sources where available (China, United States, India), and calculated for remaining regions (EU, Rest of World) using the ratio of annual coal-fired generation to annual coal capacity.

Gas generation

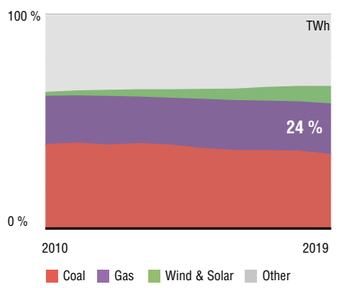
→ World
Gas generation rose 4%

This happend mostly as a result of gas generation replacing coal in the EU and US.

Gas Generation Change



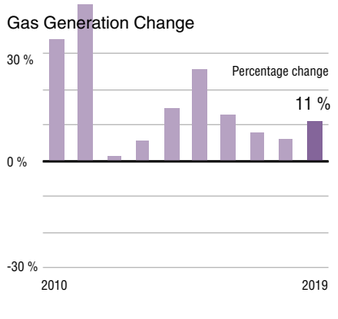
Generation Mix



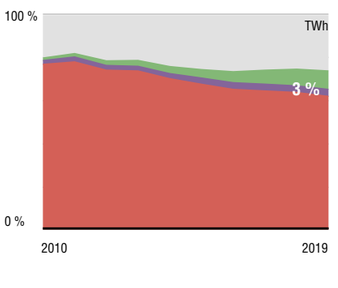
→ China
Gas rose from a low base

Gas-fired generation rose by 11% in 2019, increasing to 3% of the electricity mix. 6 GW of new gas capacity was built in 2019.

Gas Generation Change



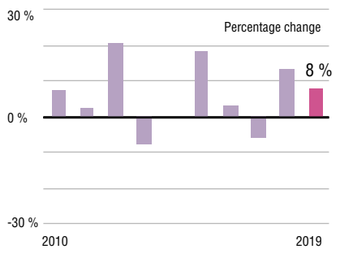
Generation Mix



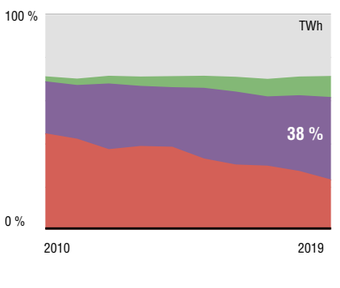
→ United States
Gas generation continued to soar

It rose by 7%, and now stands at 38% of the electricity mix. New gas capacity continues to be built apace, with 7 GW more in 2019, cumulatively adding over 100 GW last decade.

Gas Generation Change



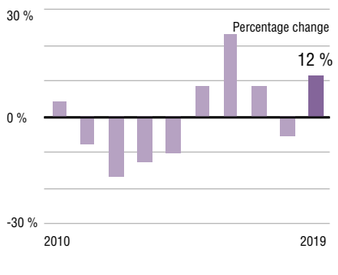
Generation Mix



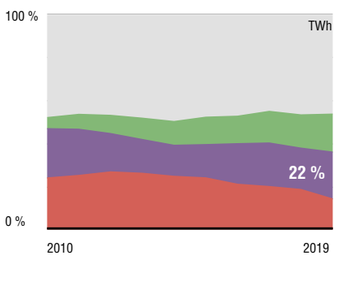
→ European Union
Gas generation increased by 12%

The one-off switch in economics resulted in a 73TWh rise in gas generation, which was a big contribution to coal's fall.

Gas Generation Change



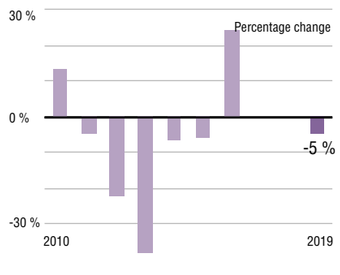
Generation Mix



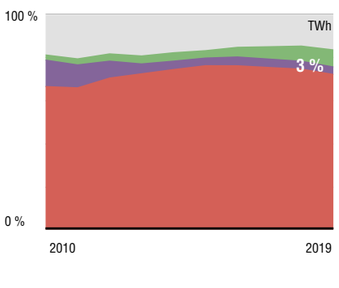
→ India
Gas generation fell in 2019 by 5%

However, the change is relatively unimportant as gas only provides a small (3%) part of India's generation.

Gas Generation Change



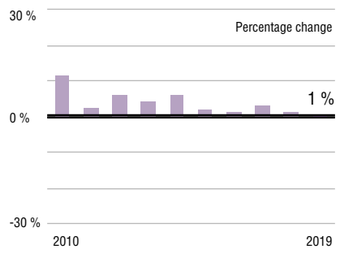
Generation Mix



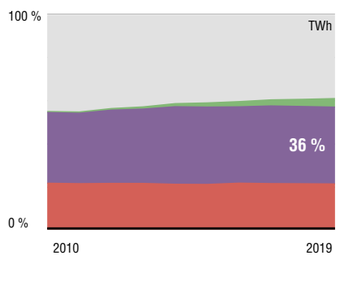
→ Rest of World
Gas grew slightly by 1%

Gas generation rose by 1%. There were significant increases in Saudi Arabia (+11%, 24 TWh), Mexico (+9%, 17 TWh), and Iran (+8%, +20 TWh). These rises were tempered by a large fall in gas generation in Turkey (-39%, 34 TWh), where there was a large increase in hydro generation.

Fossil + Fossil-Free Change



Generation Mix



Power sector CO2 emissions

→ World

CO_2 emissions fell 2%, as the fall in coal generation was partly offset by the rise in gas generation

This doesn't take into account the climate impact of methane leaks from the additional gas generation. The carbon intensity of electricity fell by 3% over the year. At 442 gCO2/kWh, it is now 15% lower than the start of this decade, as fossil-free generation has grown faster than fossil.

→ China

CO_2 emissions rose 1.6% with coal and gas generation

Despite huge investment in new coal plants, the reported carbon intensity of the Chinese coal fleet improved just 0.3% in 2019, the lowest improvement since reporting began in 2006. China's carbon intensity of electricity of 576 gCO2/kWh is 30% above the global average. The high efficiency of its coal fleet only goes so far in limiting the impact of the high coal generation in China.

→ United States

CO_2 emissions fell by 8%, coal's fall was tempered by the rise in gas emissions.

When you include methane leaks from gas generation the fall in US greenhouse gas emissions is reduced. The carbon intensity of US electricity continued to fall, and is slightly below the global average. However, because the average US citizen uses so much electricity, the absolute CO2 emissions per person is over three times higher than the global average in the power sector.

→ European Union

CO_2 emissions collapsed because of the fall in coal

EU power sector emissions fell by 13% in 2019, the largest fall this century. The carbon intensity of EU electricity is collapsing rapidly, and is now 42% below the global average.

→ India

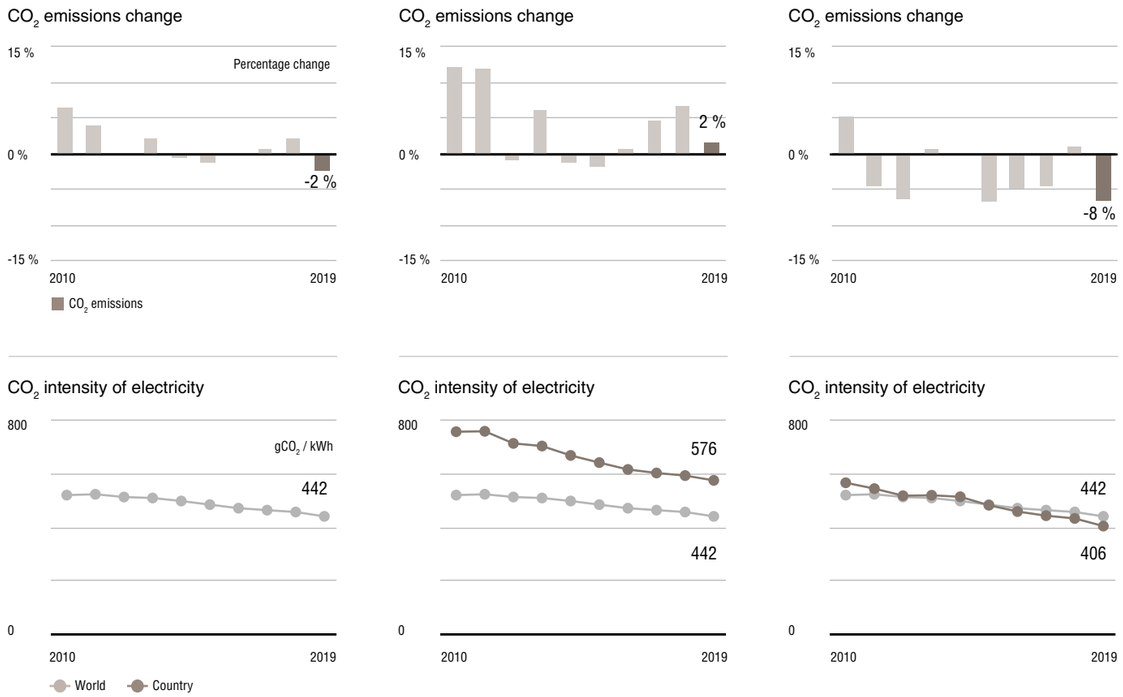
CO_2 emissions fell in line with coal generation

The carbon intensity of India's electricity generation fell by 4% in 2019, but remains much more carbon-intensive than the global average.

→ Rest of World

CO_2 emissions fell slightly, by 0.5%

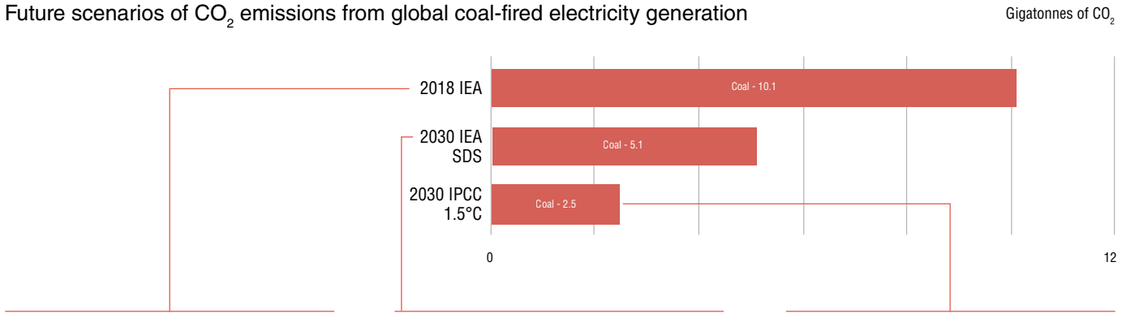
Although coal and gas generation rose very slightly, oil generation falling especially in Iran and Pakistan actually led to a very slight fall in rest of the world CO2 emissions overall.



Future Scenarios

IPCC and IEA modelling both show that immediate and aggressive action to cut coal generation is critical to limiting climate change.

Future scenarios of CO_2 emissions from global coal-fired electricity generation



Coal power plants emitted 10.1GT of CO2 in 2018. This is equal to 30% of all the CO2 emissions from all fossil fuels in 2018, according to the IEA.

The IEA's Sustainable Development Scenario (IEA SDS) shows that coal power emissions must halve by 2030.

Emissions must reduce from 10.1 gigatonnes to 5.1 GT to be on target for the Paris Climate Agreement. Falling coal power generation alone delivers 61% of the required global reductions in fossil fuel emissions to 2030

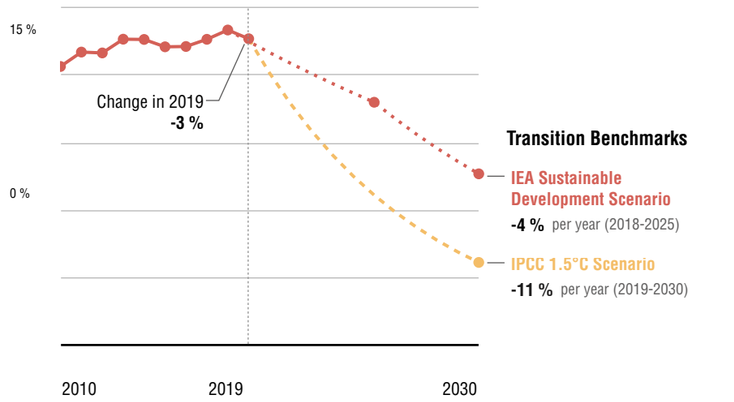
The IPCC's "Special Report on Global Warming of 1.5°C" (IPCC 1.5) implies coal power emissions must fall even faster, by 75% by 2030.

Their modelling implies a fall to 2.5GT, the median value in their below 1.5C and 1.5°C with low-overshoot pathways. We back-calculated the 2.5 GT from their coal electricity generation of 8.83 exajoules, which equals 2453 TWh. We assume there is no significant carbon capture in the IPCC scenario; if there is then the falls in CO2 would be even higher than this.

The IPCC 1.5 shows much bigger coal generation falls than the IEA SDS.

The IEA SDS is less ambitious than the IPCC, because (a) it assumes 1.65 degrees, not 1.5 degrees, and (b) and it relies on net negative emissions after 2050 where the IPCC median scenario does not. Please refer to the IEA's blog "What would it take to limit the global temperature rise to 1.5°C?" for more details.

Global coal generation with future scenarios



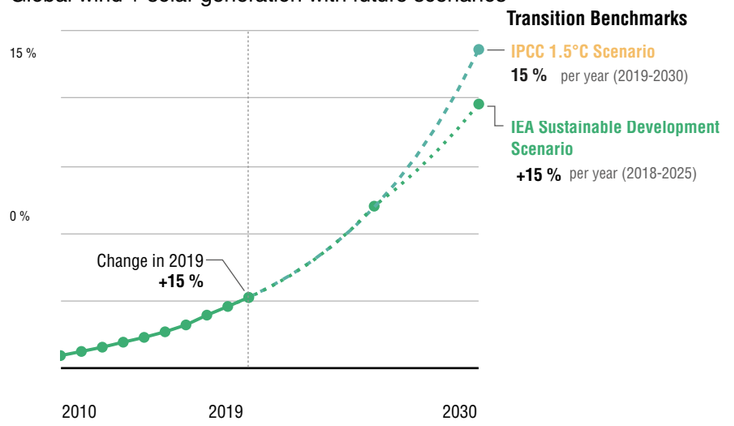
A four-fold increase in wind and solar generation is needed by 2030 to replace the coal generation, according to the IEA SDS.

The median value of their below 1.5C and 1.5C with low-overshoot scenarios is 34.02 exajoules of wind and solar generation in 2030 is equal to 9450 TWh.

How did we split this by region?

The IEA SDS already outputs generation by region, however the IPCC 1.5 does not. For wind and solar, we do not give a regional breakdown for IPCC. For coal generation, we do give a regional breakdown of IPCC 1.5, sourced from Climate Analytics. In their report "Global and regional coal phase-out requirements of the Paris Agreement: Insights from the IPCC Special Report on 1.5°C", they showed that OECD countries must reduce coal generation by 86%, and non-OECD Asia must reduce by 63%, relative to 2010. We applied the 86% to the US and EU, and the 63% to China and India.

Global wind + solar generation with future scenarios



Data

Strictly embargoed until 00.01GMT on 9th March

Data Method

This report provides data that aggregates 2019 generation for 85% of the world's electricity production.

Strictly embargoed until 00.01GMT on 9th March

For the following countries, we have taken data from national sources:

- China - China Electricity Council (CEC) 21st January
- United States - Energy Information Administration (EIA) 26th February
- India - Central Electricity Authority (CEA) 31st January
- European Union - via Ember's 'European Power Sector Review' 5th February

For all other countries, we have used the EIA's 'International data browser' to obtain historical data. Accessed on 5th February 2020.

And for 2019, we used national datasets for the following additional countries:

- Brazil - ONS data, 30th January 2020
- Canada - Stats Canada data, 28th January 2020
- Japan - ENECHO data, 28th January 2020
- South Korea - KEPCO data, 22nd January 2020
- Turkey - Teias data, 28th January 2020
- Vietnam - EVN data, 15th November 2019
- Argentina - Cammesa data, 28th January 2020
- Chile - CEN data, 23rd January 2020
- South Africa - ESKOM data, 6th February 2020
- Philippines - NGCP data, 16th January 2020
- Mexico - CRE data, 16th January 2020
- Taiwan - Taipower data (via Electricity-Map), 6th January 2020
- Australia -AEMO data, 10th February 2020
- Pakistan - NEPRA data, 22nd January 2020
- Russia - Minenergo data, 30th January 2020

China
CEC Data

Year	Demand	Net imports	Total Generation	Coal	Gas	Other Fossil	Nuclear	Hydro	Wind	Solar	Biomass and Waste	Other Renewables	Units	CO2 Emissions	Units
2000	1310.347	-8.754	1319.101	1034.310	20.408	25.234	15.903	220.190	0.615	0.020	2.421	0.000	TWh	1103.823	Mt CO2
2001	1455.331	-8.600	1463.931	1120.040	22.099	27.326	16.597	274.658	0.749	0.024	2.438	0.000	TWh	1185.659	Mt CO2
2002	1625.733	-8.404	1634.137	1264.724	24.954	30.856	25.166	285.094	0.873	0.040	2.430	0.000	TWh	1328.027	Mt CO2
2003	1851.248	-7.364	1858.612	1467.811	28.961	35.811	41.661	280.844	1.039	0.063	2.422	0.000	TWh	1528.953	Mt CO2
2004	2154.904	-6.076	2160.980	1684.862	33.244	41.106	47.946	350.009	1.332	0.068	2.414	0.000	TWh	1740.905	Mt CO2
2005	2415.246	-6.183	2421.429	1890.024	37.292	46.111	50.332	393.047	2.028	0.074	2.406	0.115	TWh	1937.376	Mt CO2
2006	2773.729	-6.882	2780.611	2207.128	43.548	53.848	54.844	414.769	3.868	0.084	2.396	0.126	TWh	2244.450	Mt CO2
2007	3216.757	-10.315	3227.072	2571.080	50.729	62.727	62.863	471.354	5.710	0.105	2.387	0.116	TWh	2593.808	Mt CO2
2008	3418.549	-12.802	3431.351	2651.489	52.316	64.689	69.219	565.548	13.079	0.152	14.715	0.144	TWh	2653.724	Mt CO2
2009	3670.199	-11.380	3681.579	2866.547	56.559	76.616	70.050	571.682	27.615	0.392	11.965	0.153	TWh	2846.079	Mt CO2
2010	4214.164	-13.514	4227.678	3260.754	75.740	63.997	74.742	686.736	49.400	0.100	16.109	0.100	TWh	3199.912	Mt CO2
2011	4717.755	-12.745	4730.500	3696.100	108.800	72.200	87.200	668.100	74.100	0.600	23.200	0.200	TWh	3582.029	Mt CO2
2012	4975.701	-10.779	4986.480	3713.100	110.300	70.500	98.300	855.600	103.000	3.600	31.600	0.480	TWh	3559.730	Mt CO2
2013	5360.949	-11.231	5372.180	3980.500	116.400	86.400	111.500	892.100	138.300	8.400	38.300	0.280	TWh	3782.488	Mt CO2
2014	5593.091	-11.409	5604.500	3951.000	133.300	97.000	133.200	1060.100	159.800	23.500	46.100	0.500	TWh	3749.601	Mt CO2
2015	5727.556	-12.444	5740.000	3897.700	166.900	112.200	171.400	1112.700	185.600	39.500	53.900	0.100	TWh	3686.787	Mt CO2
2016	6010.078	-12.722	6022.800	3945.700	188.300	127.900	213.200	1174.800	240.900	66.500	65.400	0.100	TWh	3714.408	Mt CO2
2017	6436.840	-11.860	6448.700	4178.200	203.200	125.000	248.100	1193.100	303.400	116.600	81.000	0.100	TWh	3892.428	Mt CO2
2018	6984.340	-11.860	6996.200	4482.900	215.500	132.900	294.400	1232.900	366.000	177.500	94.000	0.100	TWh	4155.075	Mt CO2
2019	7313.340	-11.860	7325.200	4560.000	238.669	134.572	348.700	1301.900	405.700	223.800	111.758	0.100	TWh	4220.260	Mt CO2

CEC

Central Electricity Council (CEC) data has been used wherever possible, as a timely source of official national generation data for China. Biomass and Waste includes Biomass power and waste incineration CEC data. Other fossils generation is equivalent to CEC total thermal generation minus Coal, Gas and Biomass and Waste generation. This mapping implicitly includes CEC 'Waste heat, pressure, and gas' generation data within Other Fossil - it is possible that other statistical reviews categorize this as coal generation. CEC coal generation data does not include generation for industry self-use - BP and IEA likely estimate this, resulting in larger values.

EIA

Where possible EIA international data has been used to complete historical generation if CEC data was unavailable.

Gap Filling

Any gaps in historical fossil generation data were filled using thermal generation data from the National Bureau of Statistics (NBS), disaggregated according to Coal, Gas and Other Fossil's share of total thermal generation in 2009 CEC data.

Estimates

Gas generation has been estimated to increase by 2.4 % in 2019. Biomass and Waste generation for 2019 has been estimated using the growth rate published by the National Energy Administration (NEA). Data from 2017 has been carried forward for both Net Imports and Other Renewables.

Strictly embargoed until 00.01GMT on 9th March

United States
EIA Data

Year	Demand	Net imports	Total generation	Coal	Gas	Other Fossil	Nuclear	Hydro	Wind	Solar	Biomass and Waste	Other Renewables	Units	CO2 Emissions	Units
2000	3835.868	33.763	3802.105	1966.265	614.993	116.015	753.893	270.034	5.593	0.493	60.726	14.093	TWh	2398.948	Mt CO2
2001	3758.671	22.027	3736.644	1903.956	648.169	136.787	768.826	208.138	6.737	0.543	49.748	13.741	TWh	2364.801	Mt CO2
2002	3879.435	20.983	3858.452	1933.130	702.468	108.094	780.064	255.586	10.354	0.555	53.709	14.491	TWh	2372.113	Mt CO2
2003	3889.605	6.420	3883.185	1973.737	665.508	133.450	763.733	267.271	11.187	0.534	53.341	14.424	TWh	2410.772	Mt CO2
2004	3981.867	11.312	3970.555	1978.301	725.352	135.377	788.528	259.929	14.144	0.575	53.537	14.811	TWh	2441.974	Mt CO2
2005	4080.201	24.778	4055.423	2012.873	774.424	135.046	781.986	263.763	17.811	0.550	54.277	14.692	TWh	2500.984	Mt CO2
2006	4083.122	18.420	4064.702	1990.511	830.618	77.141	787.219	282.689	26.589	0.508	54.861	14.568	TWh	2434.025	Mt CO2
2007	4187.997	31.252	4156.745	2016.456	910.043	77.970	806.425	240.614	34.450	0.612	55.539	14.637	TWh	2496.839	Mt CO2
2008	4152.209	32.821	4119.388	1985.801	894.687	58.046	806.208	248.543	55.363	0.864	55.034	14.840	TWh	2438.027	Mt CO2
2009	3984.384	34.053	3950.331	1755.904	931.611	50.865	798.855	268.818	73.886	0.891	54.493	15.009	TWh	2219.473	Mt CO2
2010	4151.037	25.977	4125.060	1847.290	999.010	49.916	806.968	254.702	94.652	1.212	56.089	15.219	TWh	2339.768	Mt CO2
2011	4137.392	37.251	4100.141	1733.430	1025.255	44.336	790.204	312.934	120.177	1.818	56.671	15.316	TWh	2236.262	Mt CO2
2012	4095.026	47.261	4047.765	1514.043	1237.792	36.977	769.331	271.290	140.822	4.327	57.622	15.562	TWh	2100.316	Mt CO2
2013	4123.840	57.876	4065.964	1581.115	1137.688	40.752	789.016	263.884	167.840	9.036	60.858	15.775	TWh	2116.592	Mt CO2
2014	4158.051	53.212	4104.839	1581.710	1138.631	43.693	797.166	253.193	181.655	28.924	63.989	15.877	TWh	2113.876	Mt CO2
2015	4158.411	66.671	4091.740	1352.398	1346.599	42.277	797.178	243.989	190.719	39.032	63.632	15.918	TWh	1978.089	Mt CO2
2016	4161.989	66.502	4095.487	1239.149	1391.114	37.959	805.694	261.126	226.993	54.866	62.760	15.826	TWh	1883.885	Mt CO2
2017	4114.575	56.314	4058.261	1205.835	1308.884	34.486	804.950	293.839	254.303	77.276	62.762	15.927	TWh	1803.970	Mt CO2
2018	4251.822	44.469	4207.353	1146.393	1480.204	37.267	807.078	285.819	274.952	96.147	62.765	16.728	TWh	1824.286	Mt CO2
2019	4185.445	37.538	4147.907	976.188	1583.518	31.772	807.893	267.417	299.540	107.123	58.296	16.160	TWh	1690.459	Mt CO2

EIA

Energy Information Administration (EIA) data has been used for all years. Solar includes 'Utility scale' and 'Small scale' solar, and Other Fossil includes 'Petroleum Liquids', 'Petroleum Coke', and 'Other' generation.

India
CEA Data

Year	Demand	Net imports	Total generation	Coal	Gas	Other Fossil	Nuclear	Hydro	Wind	Solar	Biomass and Waste	Other Renewables	Units	CO2 Emissions	Units
2000	487.475	1.345	486.130	349.615	43.139	2.560	14.060	73.717	1.684	0.007	1.347	0.000	TWh	384.744	Mt CO2
2001	509.569	1.268	508.301	365.794	44.887	2.352	18.235	72.960	2.241	0.012	1.820	0.000	TWh	398.556	Mt CO2
2002	520.984	1.345	519.639	382.288	44.863	2.452	17.760	67.735	2.687	0.014	1.840	0.000	TWh	411.941	Mt CO2
2003	552.213	1.690	550.523	395.521	50.438	2.729	16.370	79.994	3.590	0.017	1.863	0.000	TWh	424.718	Mt CO2
2004	588.435	1.695	586.740	414.813	58.393	2.482	15.044	89.607	4.490	0.019	1.893	0.000	TWh	443.667	Mt CO2
2005	616.687	1.554	615.133	428.681	60.530	2.227	17.745	97.404	6.603	0.019	1.923	0.000	TWh	454.584	Mt CO2
2006	663.123	2.741	660.382	456.036	61.326	2.125	17.828	112.411	8.690	0.019	1.949	0.000	TWh	478.122	Mt CO2
2007	698.670	4.940	693.730	469.363	67.057	3.241	17.832	122.407	11.796	0.059	1.976	0.000	TWh	490.955	Mt CO2
2008	730.969	5.511	725.458	494.160	73.217	4.523	15.231	115.006	13.701	0.063	9.557	0.000	TWh	515.047	Mt CO2
2009	786.131	5.301	780.830	534.172	89.609	4.220	16.816	106.188	17.804	0.075	11.947	0.000	TWh	556.047	Mt CO2
2010	829.574	5.548	824.026	550.459	101.516	3.144	23.082	111.378	19.660	0.113	14.673	0.000	TWh	571.485	Mt CO2
2011	908.947	5.118	903.829	598.444	96.592	1.949	32.224	131.633	24.530	0.827	17.631	0.000	TWh	606.419	Mt CO2
2012	959.858	4.640	955.218	675.941	75.184	2.356	33.140	115.655	30.120	2.290	20.533	0.000	TWh	661.712	Mt CO2
2013	1008.777	3.947	1004.830	730.956	46.185	1.949	33.465	131.616	33.170	4.140	23.349	0.000	TWh	692.301	Mt CO2
2014	1103.582	0.575	1103.007	824.173	43.185	1.840	34.747	130.328	37.340	5.850	25.545	0.000	TWh	771.836	Mt CO2
2015	1139.645	0.094	1139.551	871.914	40.515	0.383	38.153	132.260	32.741	6.566	16.743	0.275	TWh	803.765	Mt CO2
2016	1223.033	-1.093	1224.126	936.233	50.212	0.315	37.884	128.611	43.453	11.556	15.655	0.208	TWh	856.853	Mt CO2
2017	1284.147	-1.592	1285.739	972.939	50.256	0.249	38.438	135.865	52.629	21.545	13.478	0.340	TWh	882.073	Mt CO2
2018	1366.240	-1.592	1367.832	1024.706	50.257	0.213	38.120	141.331	60.311	36.331	16.148	0.414	TWh	923.612	Mt CO2
2019	1376.578	-1.592	1378.170	998.538	47.980	0.104	45.163	161.741	63.309	46.273	14.680	0.383	TWh	896.599	Mt CO2

CEA

Central Electricity Authority (CEA) data has been used wherever possible. CEA data does not include generation from auto-producers, leading to differences with other sources, particularly for fossil generation.

EIA

Energy Information Administration (EIA) International data has been used to complete historical generation if CEA data was unavailable.

Gap Filling

Any gaps in historical fossil generation data were filled using BP Statistical Review data*, scaled to fit CEA data by the ratio between CEA and BP data for the relevant fuel type in 2005.

Estimates

Net imports values for 2018 and 2019 were carried forward from 2017 due to a lack of available data.

*Data from BP statistical review 2018, accessed on 22/10/2019.

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European Union
Ember Data

Year	Demand	Net imports	Total generation	Coal	Gas	Other Fossil	Nuclear	Hydro	Wind	Solar	Biomass and Waste	Other Renewables	Units	CO2 Emissions	Units
2000	3032.710	23.022	3009.688	920.290	479.581	214.618	944.993	386.882	22.223	0.114	40.987		TWh	1354.254	Mt CO2
2001	3094.482	7.033	3087.448	924.367	496.225	208.416	978.986	408.476	26.704	0.182	44.092		TWh	1356.816	Mt CO2
2002	3128.981	15.523	3113.458	938.633	525.058	220.043	990.196	353.121	36.319	0.269	49.819		TWh	1393.264	Mt CO2
2003	3205.314	0.096	3205.218	987.346	569.509	208.030	995.860	341.685	44.218	0.419	58.152		TWh	1447.161	Mt CO2
2004	3271.118	-4.328	3275.447	967.192	618.818	188.772	1008.437	362.760	58.951	0.695	69.823		TWh	1426.536	Mt CO2
2005	3312.249	15.676	3296.573	943.518	668.776	184.929	997.699	348.397	70.453	1.467	81.334		TWh	1417.993	Mt CO2
2006	3347.824	7.970	3339.854	965.021	684.364	172.767	989.877	351.131	82.322	2.500	91.872		TWh	1431.536	Mt CO2
2007	3368.017	15.818	3352.199	964.813	740.478	154.376	935.277	347.831	104.388	3.789	101.246		TWh	1434.274	Mt CO2
2008	3380.668	23.076	3357.592	881.434	790.608	145.497	937.215	364.108	119.546	7.454	111.730		TWh	1360.681	Mt CO2
2009	3214.816	20.144	3194.672	806.614	732.879	125.394	894.010	366.601	133.064	14.124	121.988		TWh	1239.002	Mt CO2
2010	3343.545	7.560	3335.985	808.823	765.486	124.623	916.610	408.009	149.373	23.264	139.796		TWh	1251.703	Mt CO2
2011	3286.687	7.189	3279.498	833.681	705.268	115.158	906.749	341.314	180.068	47.531	149.730		TWh	1235.329	Mt CO2
2012	3294.182	18.650	3275.532	886.420	584.905	110.703	882.366	367.666	206.103	71.530	165.840		TWh	1222.394	Mt CO2
2013	3264.746	12.611	3252.136	859.176	511.445	102.421	876.830	404.160	236.822	86.113	175.169		TWh	1155.154	Mt CO2
2014	3187.590	15.498	3172.092	793.159	458.349	99.320	876.298	407.380	253.171	98.220	186.196		TWh	1063.956	Mt CO2
2015	3230.104	14.430	3215.674	781.004	498.048	99.432	857.020	372.100	301.958	108.383	197.729		TWh	1065.085	Mt CO2
2016	3255.398	18.390	3237.008	689.835	611.516	98.697	839.685	380.990	302.859	111.427	201.999		TWh	1022.731	Mt CO2
2017	3281.467	10.199	3271.268	661.868	663.763	95.721	829.719	331.313	362.412	119.393	207.079		TWh	1023.313	Mt CO2
2018	3282.524	27.496	3255.028	614.354	626.670	94.264	826.980	375.202	377.204	127.062	213.291		TWh	947.382	Mt CO2

Ember

Each year Sandbag/Ember publishes data on European power sector generation, which has been used in this report. This dataset is predominantly made using Eurostat data from 2000 to 2017. 2018 and 2019 data has been calculated by obtaining annual changes in generation from ENTSO-E's transparency platform as well as national sources.

Rest of World
EIA international data

Year	Demand	Net imports	Total generation	Coal	Gas	Other Fossil	Nuclear	Hydro	Wind	Solar	Biomass and Waste	Other Renewables	Units	CO2 Emissions	Units
2000	6,105.58	-53.07	6,158.65	1,331.38	1,534.13	741.89	768.22	1,678.50	1.22	0.45	49.96	52.82	TWh	2,721	Mt CO2
2001	6,203.60	-25.50	6,229.10	1,389.63	1,630.90	707.21	783.63	1,607.11	1.94	0.59	55.00	53.07	TWh	2,771	Mt CO2
2002	6,404.92	-23.18	6,428.09	1,430.90	1,737.93	710.83	781.01	1,651.74	2.54	0.82	59.25	53.06	TWh	2,838	Mt CO2
2003	6,587.81	-1.03	6,588.85	1,494.44	1,851.99	709.88	750.40	1,659.13	4.13	1.08	62.75	55.04	TWh	2,930	Mt CO2
2004	6,870.90	-1.25	6,872.15	1,517.00	1,972.81	711.51	808.14	1,735.10	5.23	1.37	64.97	56.00	TWh	2,978	Mt CO2
2005	7,089.18	-34.93	7,124.11	1,586.01	2,031.48	730.53	829.51	1,806.83	7.13	1.72	73.59	57.28	TWh	3,068	Mt CO2
2006	7,384.10	-18.98	7,403.08	1,654.43	2,163.12	724.74	864.98	1,847.27	10.36	2.08	76.96	59.13	TWh	3,168	Mt CO2
2007	7,670.62	-37.45	7,708.06	1,744.64	2,321.44	767.10	838.37	1,875.58	14.23	2.42	82.62	61.66	TWh	3,340	Mt CO2
2008	7,756.75	-47.19	7,803.93	1,760.19	2,406.56	766.49	822.08	1,887.66	16.92	2.92	79.06	62.04	TWh	3,371	Mt CO2
2009	7,730.72	-42.42	7,773.14	1,715.93	2,421.74	729.47	832.61	1,896.54	24.38	3.92	82.21	66.32	TWh	3,279	Mt CO2
2010	8,201.23	-22.60	8,223.83	1,793.04	2,708.06	709.69	860.03	1,947.93	32.58	5.84	98.53	68.14	TWh	3,444	Mt CO2
2011	8,424.91	-29.28	8,454.18	1,825.43	2,773.09	852.96	754.48	2,027.61	40.35	9.31	102.52	68.43	TWh	3,591	Mt CO2
2012	8,571.56	-51.63	8,623.19	1,872.14	2,942.53	899.03	614.80	2,051.74	50.05	14.11	109.78	68.98	TWh	3,708	Mt CO2
2013	8,783.55	-52.01	8,835.57	1,917.32	3,060.04	875.25	603.54	2,087.32	65.58	24.82	130.42	71.27	TWh	3,753	Mt CO2
2014	8,922.61	-49.21	8,971.82	1,911.52	3,241.87	819.55	621.61	2,031.48	87.67	40.64	142.48	74.99	TWh	3,761	Mt CO2
2015	9,085.81	-52.75	9,138.56	1,940.33	3,293.27	837.80	632.36	2,031.43	115.78	61.39	149.75	76.44	TWh	3,795	Mt CO2
2016	9,284.57	-67.39	9,351.96	2,041.69	3,325.19	774.22	631.81	2,104.52	143.48	84.17	168.76	78.13	TWh	3,828	Mt CO2
2017	9,416.45	-46.60	9,463.04	2,046.61	3,422.94	720.57	622.81	2,128.78	161.03	107.37	172.16	80.78	TWh	3,806	Mt CO2
2018	9,575.47	-44.18	9,619.65	2,073.37	3,460.92	686.62	647.79	2,171.18	183.35	138.88	174.21	83.34	TWh	3,807	Mt CO2
2019	9,706.46	-47.77	9,754.23	2,093.21	3,490.94	640.81	691.77	2,184.72	203.85	184.69	178.37	85.86	TWh	3,789	Mt CO2

EIA

Energy Information Administration (EIA) International Data Browser data has been used where possible. The EIA provides data for 193 countries excluding the US, China, India, and EU member states. These countries make up the ‚Rest of World' category, and their generation and CO2 data is aggregated in the table above. Other renewables includes 'Tide and wave' and 'Geothermal' generation.

Fossil fuel disaggregation

EIA international fossil fuel generation data is not split by fuel type. In order to disaggregate this data, it was necessary to estimate the respective ratios of coal, gas and other fossil generation. These ratios were taken from BP's 'Statistical Review of World Energy'* where available (21 countries), and estimated using the ratio of installed capacities for each fuel type from the WRI global power plant database** for all other countries.

*Data from BP statistical review 2018, accessed on 22/10/2019.
** Data from WRI global power plant database accessed on 9/1/2020.

National data for 2019

2019 values in the table below

Country	Demand	Net imports	Total Generation	Coal	Gas	other fossil	Nuclear	Hydro	Solar	Wind	other renewables	Biomass and waste		CO2 Emissions	Units
Brazil	11.982	0.000	11.982	0.338	0.723	0.178	0.453	0.357	2.443	7.490		0.000	TWh	2,721	Mt CO2
Canada	-3.396	0.000	-3.396	0.714	0.707	0.045	0.696	-6.589	0.440	0.807	-0.216	0.000	TWh	2,771	Mt CO2
Japan	-13.953	0.000	-13.953	-10.928	-22.754	-6.759	25.991	-8.862	7.781	0.445	1.132	0.000	TWh	2,838	Mt CO2
South Korea	-13.271	0.000	-13.271	-12.045	-8.230	-6.936	11.754	1.518	3.692	0.201	-0.823	-2.402	TWh	2,930	Mt CO2
Turkey	2.364	0.608	1.756	-0.122	-33.636	1.631		28.570	2.568	1.550	0.719	0.473	TWh	2,978	Mt CO2
Taiwan	-3.201	0.000	-3.201	-3.996	-1.904	-4.221	4.335	1.395	0.788	0.403		0.000	TWh	3,068	Mt CO2
Vietnam	17.968	0.058	17.910	24.707	2.830	2.467		-15.245	3.475			0.000	TWh	3,168	Mt CO2
Philippines	4.994	0.000	4.994	5.313	1.364	0.937		-1.907	0.012	-0.180	-0.540	-0.003	TWh	3,340	Mt CO2
Argentina	-9.261	-0.482	-8.779	-0.172	-7.164	-0.584	1.467	-4.795	0.102	1.559		0.807	TWh	3,371	Mt CO2
Thailand	9.234	2.089	7.145	0.205	-3.982	-0.056		5.224	-0.006	0.532	0.000	5.227	TWh	3,279	Mt CO2
Chile	0.063	0.037	0.026	-0.580	2.414	-0.219		-2.392	0.770	0.693	-0.004	-0.656	TWh	3,444	Mt CO2
South Africa	-2.032	0.000	-2.032	-8.672	2.493	0.000	3.044	0.000	0.436	0.124	0.000	0.000	TWh	3,591	Mt CO2
Mexico	9.042	-0.014	9.055	-3.222	17.175	-3.032	-4.279	-4.589	4.344	2.623	-0.051	0.086	TWh	3,708	Mt CO2
Australia	-7.059	0.000	-7.059	-6.535	2.285	0.000	0.000	-2.845	0.057	-0.015	0.000	-0.006	TWh	3,753	Mt CO2
Russia	4.814	-0.059	4.873	0.776	2.279	0.069	0.853	0.881	0.000	0.001	0.002	0.013	TWh	3,761	Mt CO2

Estimates

The EIA publishes complete data to 2017. For 2018, data is incomplete for some countries, notably renewables generation data in smaller countries. The following methods were used to obtain a complete dataset for 2018 and 2019:

2018

- For countries with significant wind and solar capacity added in 2018, wind and solar generation data was estimated by multiplying the 2018 net wind/solar capacity by a fleet capacity factor for each country.
- For all other missing data, it was assumed that any generation change was negligible, and so 2017 data was copied forward.

2019

- National data was used where available to calculate annual % increase by fuel. This % increase was applied to 2018 EIA data to give 2019 forecast values. This method was applied to 15 countries, accounting for 61% of rest of world generation.
- Where national data was unavailable, the 3-year average EIA generation increase was applied to 2018 values. This method was applied to 177 countries, accounting for 15% of global generation
- For countries with significant wind and solar capacity added in 2019, wind and solar generation data was estimated by multiplying the 2019 net wind/solar capacity by a fleet capacity factor for each country.

CO_2 methodology

China

The CEC state the efficiency of the Chinese coal fleet annually back to 2006. This is converted into a carbon intensity (assuming 1 tonne of coal produces 2.86 tonnes of CO2), and multiplied by generation data to obtain CO2 emissions from coal. From 2000 to 2006, a 0.8% increase in efficiency has been assumed, in line with the improvements of the last decade. Other fossil generation is assumed to be largely based around coal generation, as this is how other statistical agencies decide to classify it, so the same carbon intensity was assumed as for coal. There is no data on Chinese gas plant efficiencies, so the average of the US and EU carbon intensity of Gas generation has been assumed.

United States

Energy Information Administration (EIA) International Data Browser data has been used where possible. The EIA provides data for 193 countries excluding the US, China, India, and EU member states. These countries make up the ‚Rest of World' category, and their generation and CO2 data is aggregated in the table above. Other renewables includes 'Tide and wave' and 'Geothermal' generation.

India

The CEA does not publish any data on carbon intensity or power sector emissions. The carbon intensity of the China coal fleet has been assumed for India's coal and other fossil generation, and has been used to calculate CO2 emissions for each fuel type. In order to calculate CO2 emissions from gas generation, the average of the US and EU carbon intensity for gas generation in each year has been assumed.

European Union

From 2010 to 2018 CO2 emissions are taken from the EU Emissions Trading Log for Coal, Gas, and Other Fossil generation. Prior to 2010, CO2 emissions are calculated using the carbon intensity from 2010, assuming a slight improvement each year in line with improvement over the last decade. For 2019, the carbon intensity for 2018 is assumed for each fuel type and multiplied by generation data to obtain an estimate for CO2 emissions.

Miscellaneous

The carbon intensity of the Chinese coal fleet has been assumed in order to calculate emissions from coal generation. For gas generation, the average carbon intensity of the US and EU gas fleet has been assumed. Other fossil generation is predominantly from oil, so a typical carbon intensity of 800gCO2/MWh has been assumed.

Capacity data

Wind and solar

IRENA

Wind and Solar capacity data has been taken from IRENA for the years 2010-2018 for all countries.

Ember

For 2019, Ember has built up 2019 Wind and Solar capacity by using a combination of national data and media reports. Capacity estimates were compiled using CEC data for China, CEA data for India, EIA data for United States, WindEurope and Solar Power Europe for European Union and various media reports for Rest of World countries.

Coal

Global Energy Monitor

Coal capacity data has been taken from Global Energy Monitor's 'Global Coal Plant Tracker' update of Jan-20. It provides data on net capacity as well as annual additions and retirements.

Contributors to this report

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Dave has been an electricity analyst since 2000. He worked for 13 years at the utility E.ON on European markets, and for the last 6 years at Ember, specialising in coal power. He has been the lead author for all previous six editions of Ember's "Europe's Power Sector Review".

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Other contributors:

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