

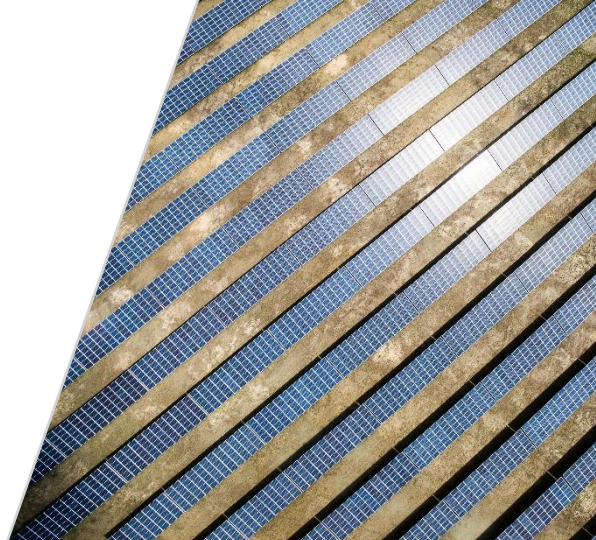
# Power Transition Trends 2022

Coal power spikes, but progress on renewables  
brings hope

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**Bloomberg**NEF  
Philanthropies



# Executive summary

The world recorded an unprecedented spike in coal generation in 2021 as countries turned to existing fleets of fossil-fueled power plants to meet fast-growing power demand and keep the lights on amid droughts and higher natural gas prices. However, renewable technologies also had a banner year, both in terms of contributions to global generation and new capacity added.

What occurs over the balance of this decade stands to be decisive in determining whether the world achieves a net-zero emissions path and policy mechanisms to address today's energy challenges will influence how that future unfolds. This annual report examines trends in global generation, capacity and emissions. It aims to illustrate to policy makers, investors and other key stakeholders, ahead of COP27, the state of the power sector globally through year-end 2021. It is based on data collected by BloombergNEF analysts on six continents from primary sources in 136 countries and markets, along with aggregated data from the rest of the world. Key findings include:

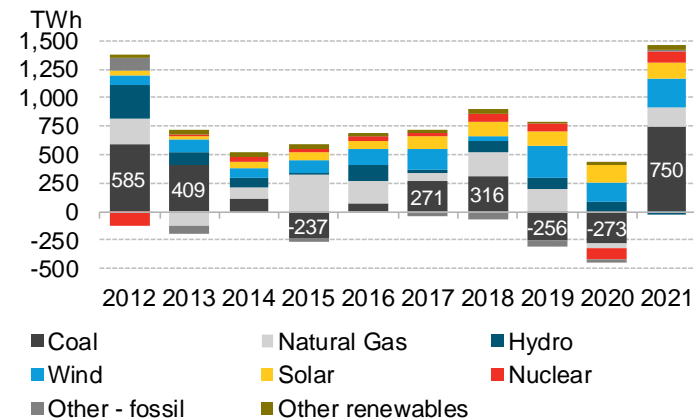
- The world saw an unprecedented spike in global coal generation 2020-2021, with an 8.5% jump in power production from the technology. Greater coal use boosted power sector CO<sub>2</sub> emissions 7% in 2021 from the year prior.
- Three factors contributed to the coal surge: rebounding top-line electricity demand thanks to economic recovery, lower hydro generation due to droughts around the world and higher natural gas prices. Half of the countries that pledged at the COP26 talks to phase out coal recorded growth in coal generation in 2021.

**5.6%** Growth in global power production in 2020-2021

**8.5%** Spike in coal generation in 2020-2021

**75%** Wind and solar's share of 2021 capacity additions

## Global annual generation change by technology



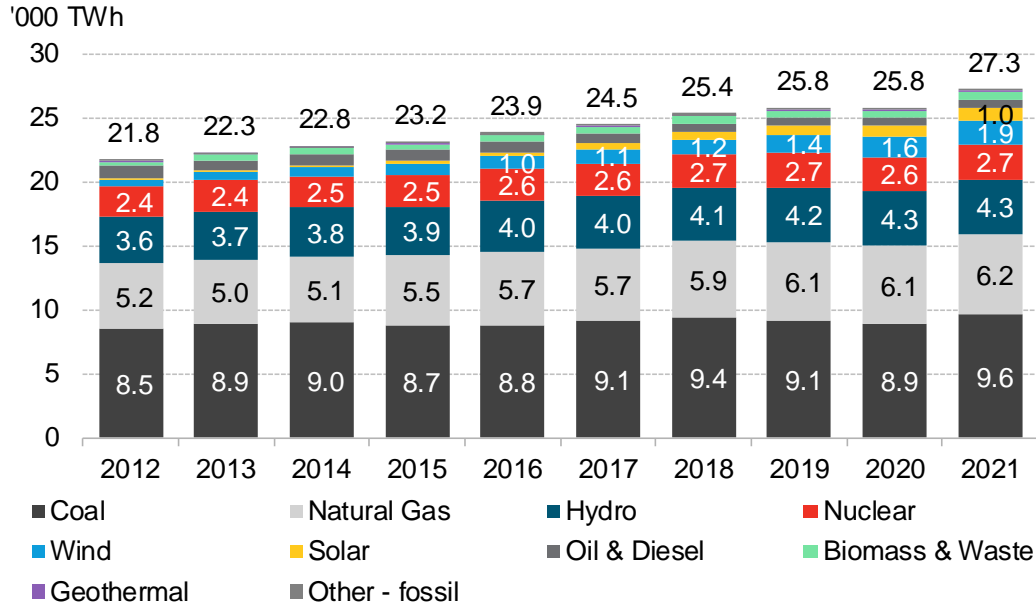
Source: BloombergNEF

# Executive summary (2)

- Led by Asia, total global power production jumped 5.6% in 2021 as economies bounced back from the impacts of Covid-19. Power generation spiked to 27,300TWh from 25,800TWh to set a new high following three years of stable electricity demand.
- Solar achieved a new milestone in 2021, clearing 1,000TWh of generation for the first time, while wind neared 2,000TWh. Together, the technologies accounted for 10.5% of all power produced worldwide. In all, zero-carbon generation totaled over 10,000TWh to meet nearly 40% of global power demand.
- Wind and solar accounted for three quarters of the 364GW of new capacity installed in 2021. Solar alone was half of all capacity added and solar annual build was 25% higher in 2021 than in 2020. Meanwhile, net growth in coal capacity was at its lowest in at least 15 years. In all, fossil fuels accounted for only 14% of total capacity added in the year.
- More countries than ever are opting to build renewable energy. In 2021, over three quarters of the world's nations surveyed installed more clean power (including hydro) on a capacity basis than any other technology. Solar was the technology of choice in nearly half of the world's nations. Hydro followed with 15%, down from 20% a decade earlier.
- Solar is also quickly spreading to new markets though deployment at scale remains somewhat concentrated. In 2021, the number of countries that installed at least 1MW of solar capacity reached a new high of 112 markets – 7.5 times the number of markets that added coal. This is up from 101 markets in 2020 and just 55 in 2012.
- 53 economies added some wind capacity in 2021, up from 44 in 2020. Still, clean energy deployment at scale remains concentrated. Ten markets accounted for 85% of solar capacity added. A separate 10 were where 89% of 2021 wind got built.
- Total global power-generating capacity has nearly doubled over 15 years and reached a new high at 7.9TW in 2021. The Asia-Pacific region has led the capacity boom with 191% growth 2006-2021. Coal continues to account for over a quarter of the global installed capacity.

# Global power generation rebounded in 2021

## Global annual generation by technology



Source: BloombergNEF

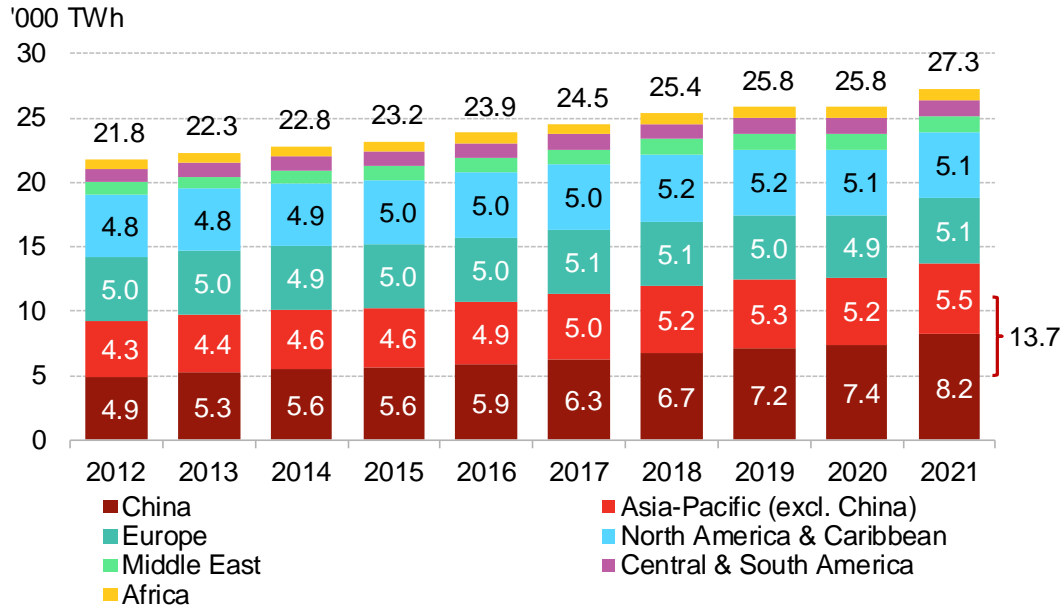
Total global power production jumped 5.6% in 2021 as economies rebounded from the worst of the Covid-19 pandemic. Generation spiked from 25,800 terawatt-hours (TWh) in 2020 to 27,300TWh in 2021. This marked a new high and came on the heels of three years of flat electricity demand.

Coal led the growth with an 8.5% jump from 2020-2021. Total global coal generation reached its highest level ever in 2021 at 9,600TWh. Over two thirds of markets with some coal capacity installed (52 around the world) saw coal generation grow 2020-2021. By comparison, from 2019-2020 coal usage rose in just 27 markets.

Global solar generation reached 1,000TWh for the first time, while wind neared 2,000TWh. All zero-carbon sources of generation (renewables, hydro and nuclear) totaled over 10,000TWh, or nearly 40% of global power production. Generation from natural gas and nuclear rose 3% and 4%, respectively, while hydro power's contribution slid by 0.7%.

# Asia drove the generation growth

## Global annual generation by region or country



The Asia-Pacific region led the spike in global electricity production with a 9% 2020-21 jump. Thanks to a strong economic rebound, China saw generation rise 10.5% to 8,200TWh. This marked its largest single year-on-year jump in a decade.

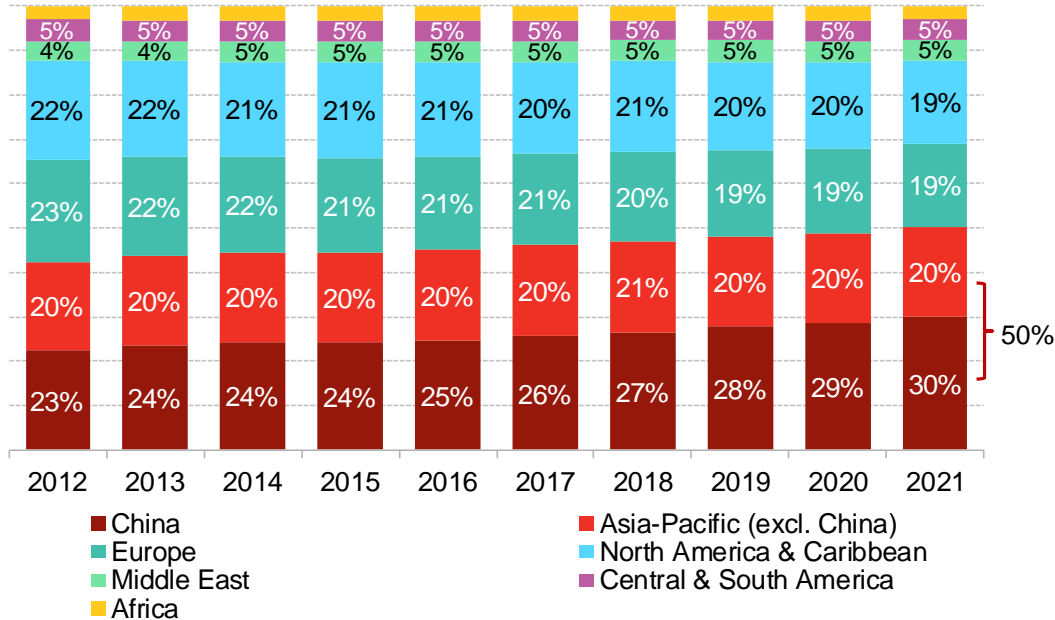
Power production in Asia-Pacific markets (excluding China) is now greater than in Europe or North America & Caribbean. These economies account for the largest growth in power production over 10 years and jumped 6% 2020-2021 to 5,500TWh. The uptake was led mainly by India, South Korea, Malaysia, Japan and Indonesia, which together represented 73% of Asia's ex-China total generation growth.

Central & South America and Europe saw generation grow 5.6% and 4.3%, respectively. Meanwhile in North America & Caribbean and Africa, power demand has remained roughly flat.

Source: BloombergNEF

# Asia accounts for half of global electricity demand

Share of annual generation by region or country



Demand for electricity from the Asia-Pacific region has risen swiftly over the past decade and the continent now accounts for half of global generation. China alone accounts for 30% of the global power generation.

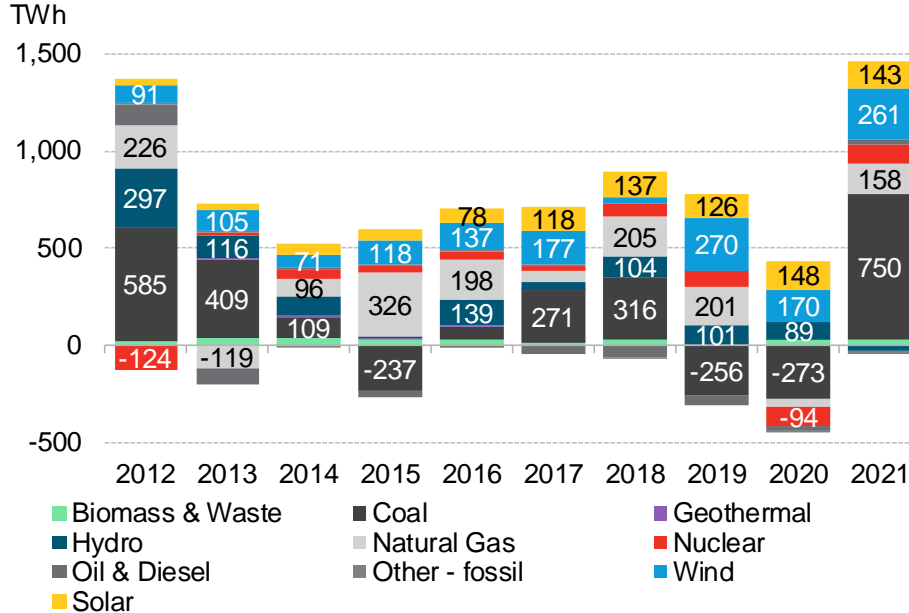
Demand in North America and Europe has declined over a decade and touched new lows in 2021. North America and Europe accounted for 19% each of the world's electricity production in 2021, down from 23% and 22%, respectively in 2020.

The Middle East, Central & South America and Africa have broadly held their shares of global generation, as the rate of growth in demand in these nations has generally matched the global growth rate. The Mideast and Central & South America account for 5% of global electricity generation each, while Africa represents 3%.

Source: BloombergNEF

# Coal accounted for the majority of additional generation in 2021

## Global annual generation change



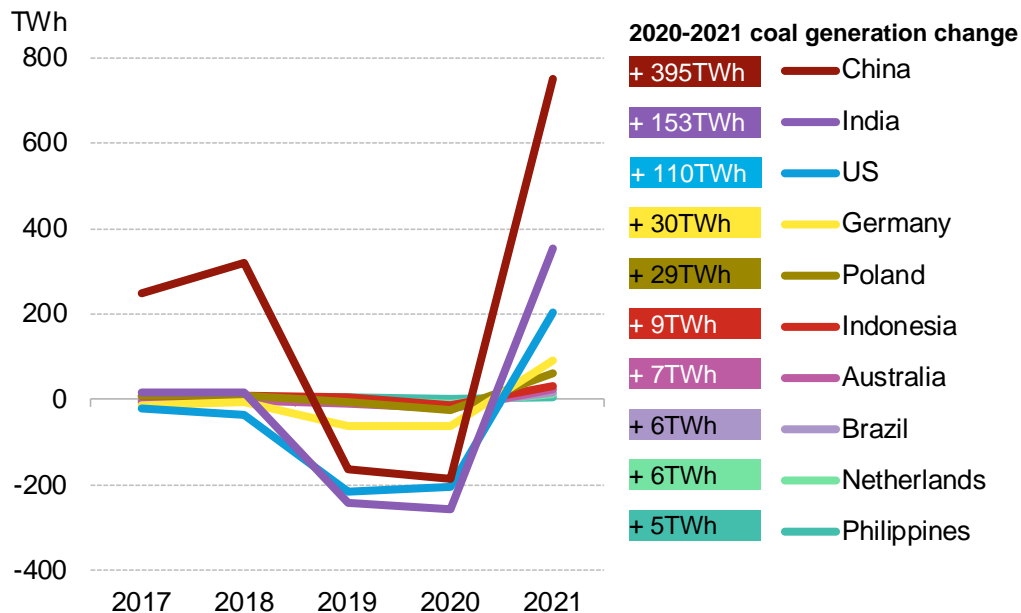
For the first time since 2013, coal-fired power plants were the top contributor to top-line power generation growth. Following two years of decline, coal generation jumped 750TWh in 2021 and accounted for over half of all net additional power generation. Three factors explained the surge: fast-growing post-pandemic electricity demand overall, depressed hydro generation due to droughts and higher natural gas prices.

Another coal generation spike is possible in 2022 as European nations seek short-term solutions to compensate for droughts and extremely high gas prices. Germany has this year reactivated 4.8GW of fossil fuel power plants, including 3.2GW of coal-fired capacity. Another 5.5GW of coal is expected online by year-end, along with 4GW of nuclear capacity. Other European countries are expected to follow similar paths.

Source: BloombergNEF

# China, India and the US led the coal generation spike

Annual coal generation change in top markets for coal electricity growth



Source: BloombergNEF

China, India and the US led the spike in coal power production. These markets saw coal generation jump 9%, 16% and 14%, respectively 2020-2021.

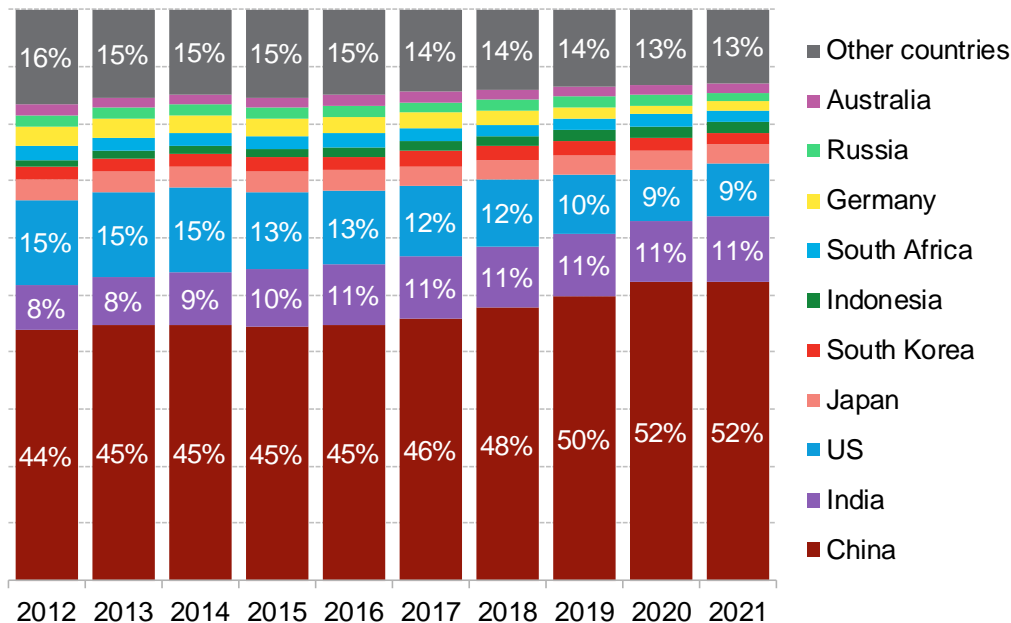
Coal's rebound in 2021 came after much-celebrated declines in previous years. The US, Germany, Netherlands and Italy are among countries where coal electricity has been trending down since at least 2017.

Half of the countries that pledged to phase out coal at COP26 recorded growth in coal generation in 2021. In November 2021, over 40 countries committed to retire coal capacity and nearly all world nations pledged to phase down unabated coal plants. Still, many countries trended in the opposite direction in 2021.



# Over 85% of coal generation occurs in just 10 countries

## Top countries for coal generation



Ten countries accounted for 87% of the total coal power produced globally in 2021. This was virtually unchanged from 2020. China, India and the US accounted together for 63%. Japan and South Korea completed the top five, with 3% and 2% of the total, respectively.

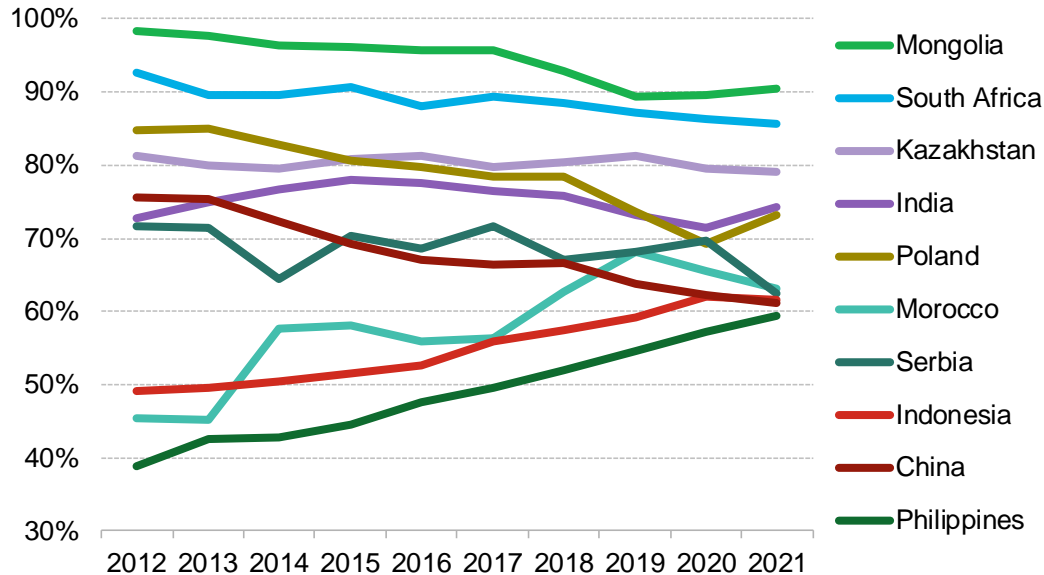
China has been the top coal generator for at least the last 15 years and in 2021 was responsible for 52% of coal generation, up from 44% in 2012. Its coal power production has consistently increased since 2015 and recorded a 9% jump 2020-2021.

India was the second biggest coal generator and was responsible for 11% of the total, or 1,100TWh with the US right after with 9%, or 904TWh. Unlike all others in the top 10, the US has cut its coal generation share since the beginning of the decade. In 2012, the US was 15% of coal generation; in 2021, it was 9%.

Source: BloombergNEF

# Many markets continue to rely heavily on coal

## Leading nations' coal penetration rates



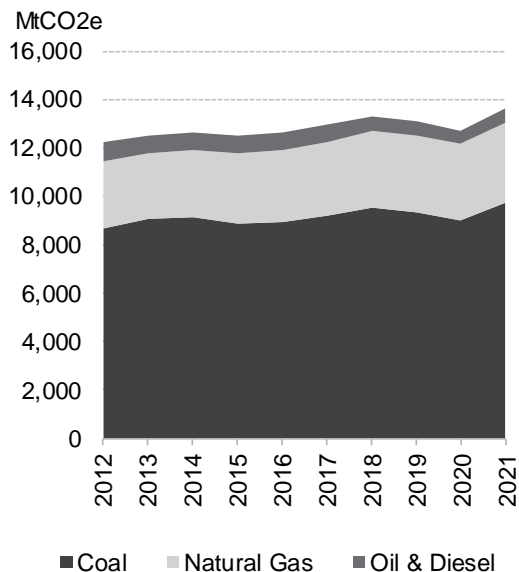
Ten countries rely on coal to meet at 60% of their power demand. Mongolia leads, with over 90% of its electricity coming from coal, followed by South Africa with 86%. In both nations, growth in wind and solar use has slowly helped reduce coal's share. Kazakhstan, India and Poland follow with 79%, 74% and 73%, respectively.

The Philippines and Indonesia has seen their reliance on coal rise most over the past decade. In both nations, coal has been nearly the only source meeting fast-growing demand. Renewables have seen limited progress by comparison. Philippines' coal reliance spiked from 39% in 2012 to 59% in 2021. In Indonesia, it jumped 49% to 61% over the same period.

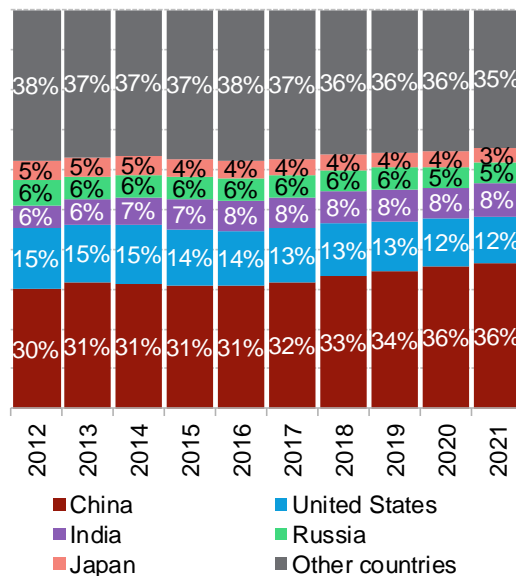
Source: BloombergNEF

# Higher coal generation boosted power sector emissions 7%

## Global power sector emissions by technology



## Global power sector emissions by country



Power sector CO2 emissions rose 7% in 2021 from the year prior to set a new record. This was mainly due to the jump in year-on-year coal generation. Emissions from coal-fired power plants rose 8% in 2021 from the prior year. Natural gas emissions also increased 4% compared to 2020. This marked the biggest year-on-year rise in gas-related emissions since 2014-2015.

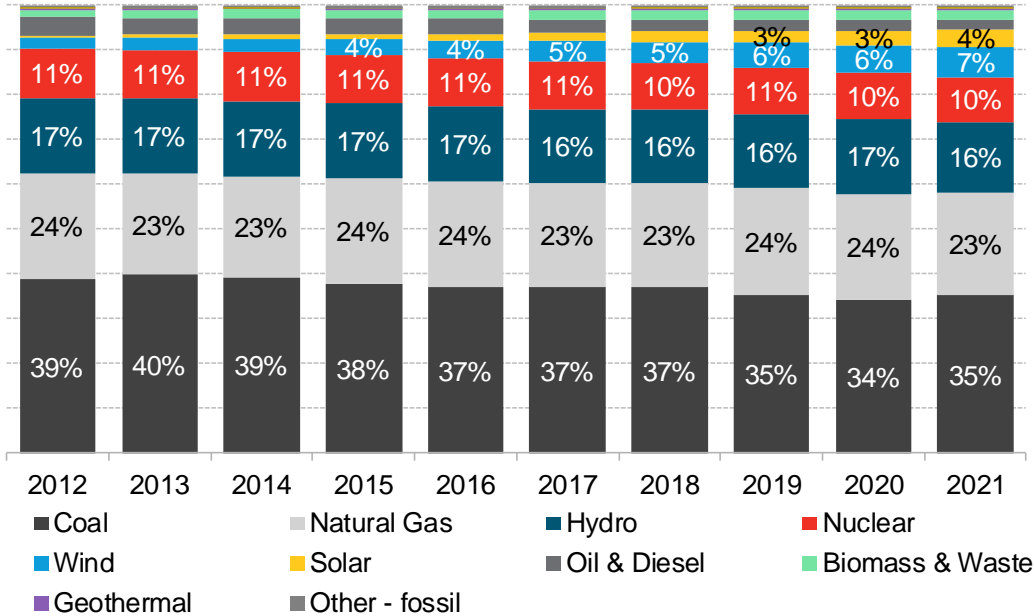
Due to high coal generation, China, the US and India are responsible for 57% of global power sector emissions. Russia and Japan follow far behind with 5% and 3%, respectively.

While emissions remained flat or slid slightly 2019-2020 in absolute terms in most nations, in China they rose 1% in 2020 and 9% in 2021. Since 2015, the country has consistently raised its share of total global power sector emissions. In six years, China's power-sector emissions have soared 28% over the last six years.

Source: BloombergNEF and NEO 2020

# Wind and solar surpassed 10% of global generation for the first time

## Share of global generation by technology



With nearly 3,000TWh of power produced in 2021, wind and solar accounted for a combined 10.5% of 2021 generation. Wind's contribution rose to 6.8%, up from just 0.7% a decade ago, while solar reached 3.7% up from virtually nothing in 2012. Non-hydro renewables (wind, solar, geothermal and biomass) reached 13% of total generation, compared to 5% at the beginning of this decade.

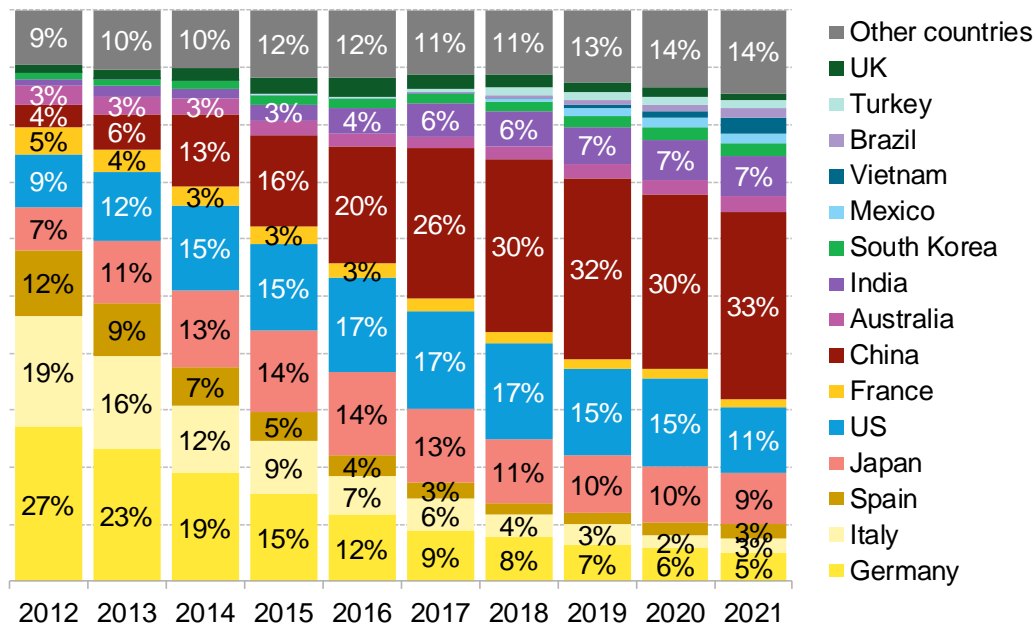
Zero-carbon technologies accounted for 39% of total generation in 2021. Hydro and nuclear were 16% and 10% respectively in 2021, but the participation of these technologies in grids has just fluctuated over the decade.

Fossil fuels remain the world's main power source and accounted for 61% of 2021 global generation. Coal remained the top technology in 2021 at 35%. Natural gas followed with a 23% contribution.

Source: BloombergNEF

# Solar is concentrated in a small number of markets, but others are growing

## Leading nations' shares of global solar generation



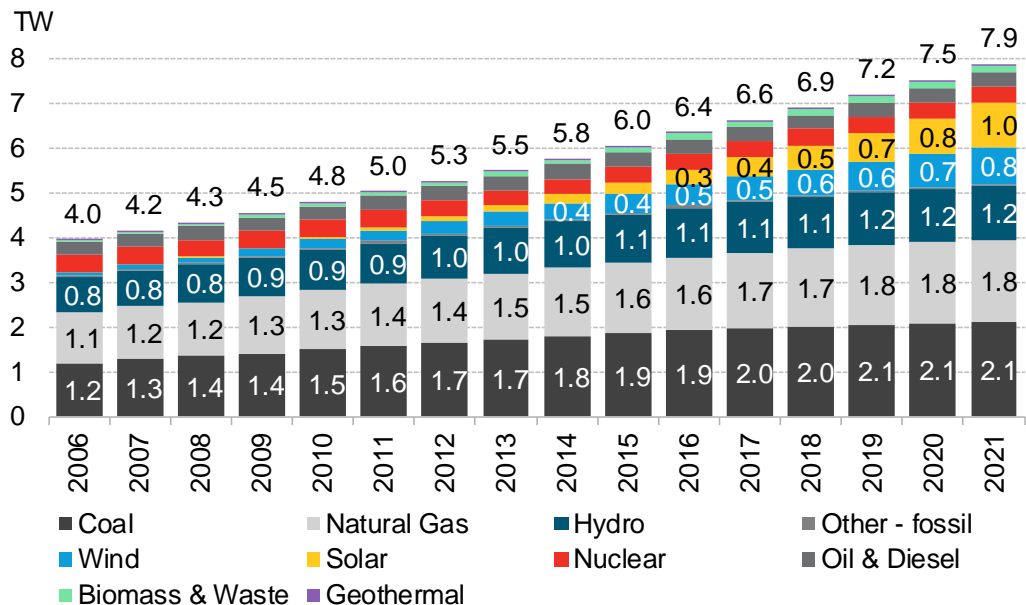
While solar generation remains concentrated in a relatively small group of countries, new leaders have emerged over the decade. In 2012, most solar power production was concentrated in developed nations, but over the decade it has gained momentum in a growing and diverse number of nations. In 2012, only 33 countries had solar generation above 20GWh. By 2021, this had more than tripled to 118 countries.

A third of global solar generation occurred in China in 2021. The US, Japan and India followed with 11%, 9% and 7%, respectively. Vietnam, Mexico and Brazil are other emerging markets that have seen solar generation grow over past few years. Together, they accounted for 6% of 2021 global solar generation.

Source: BloombergNEF

# Total installed capacity has nearly doubled in 15 years

## Global installed capacity by technology



Global installed power-generating capacity reached a new high in 2021 of 7.9TW, nearly double the 4TW installed 15 years ago. From 2020 to 2021, capacity grew 4.8%, the biggest increase since 2015-2016.

Wind and solar grew fastest. Solar PV capacity jumped 23% 2020-2021 to 973GW in 2021. That is more than nine times the 103GW that was online in 2012 and 139 times the 7GW that was installed in 2006. Global wind capacity jumped 12% 2020-2021 to 833GW. Total wind capacity installed has nearly tripled in a decade.

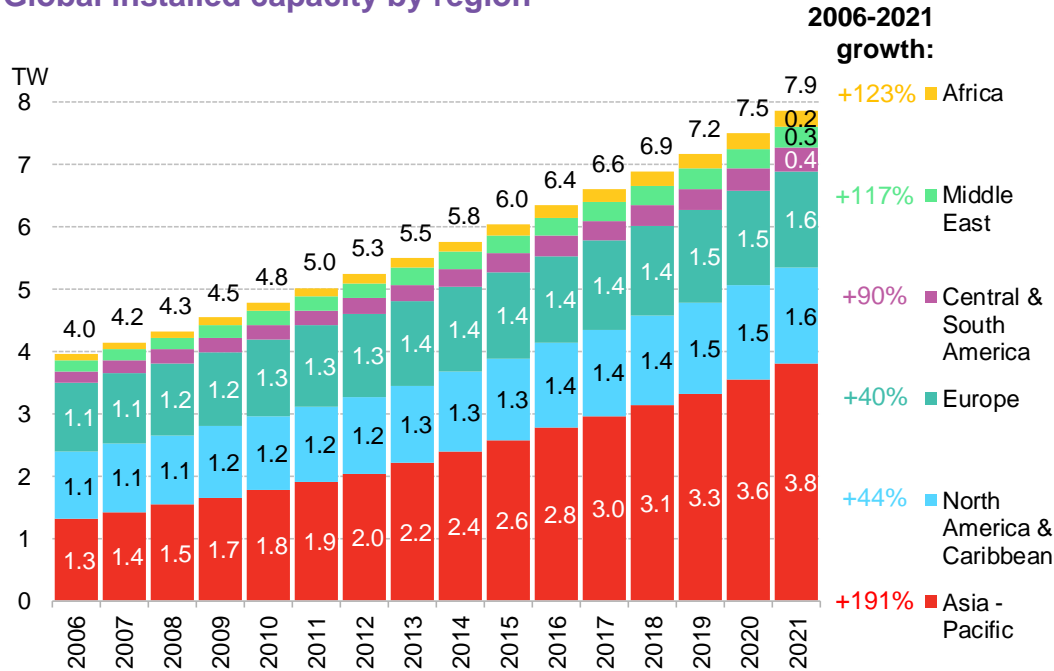
We expect wind and solar to account for over a quarter global capacity by the end of 2022. Together, these technologies were 23% of global capacity as of year-end 2021. Zero-carbon technologies reached 45% of global capacity, up from just 11% in 2012.

Coal still accounts for the largest individual share of global capacity. Coal capacity online continues to rise even as its share on percentage basis declines.

Source: BloombergNEF

# Asia and Africa's capacity has grown fastest in the past 15 years

## Global installed capacity by region



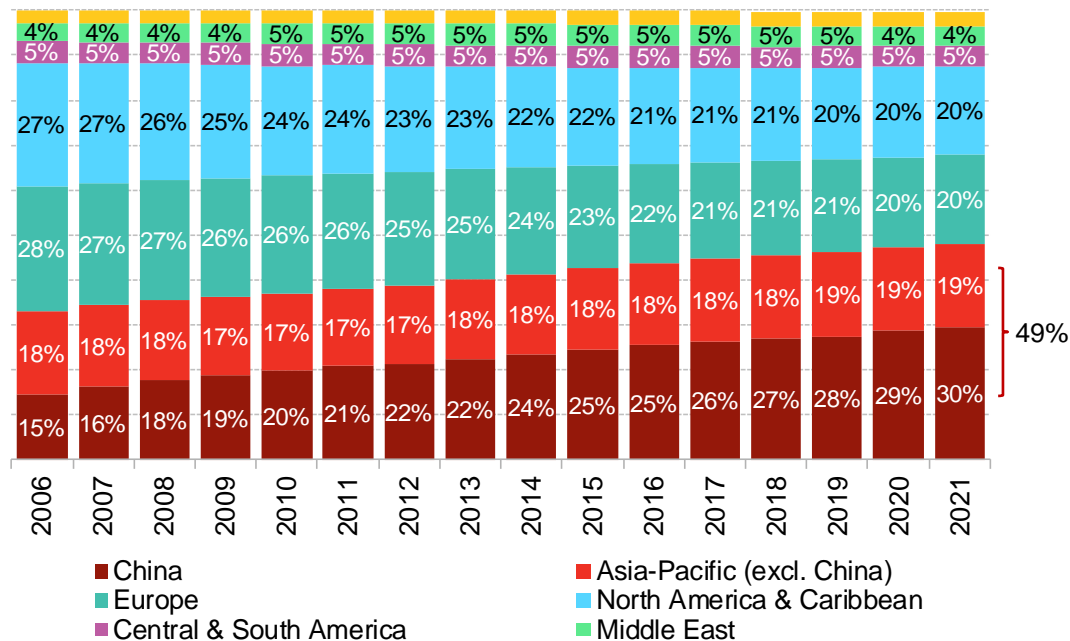
The Asia-Pacific's power-generating capacity has nearly tripled in a decade and a half. In absolute numbers, APAC's total installed capacity jumped from 1.3TW in 2006 to 3.8TW in 2021. Laos, Cambodia and Vietnam all recorded impressive expansions of their power matrices, with growth rates ranging from 528% to over 1,100% since 2006. Africa followed with a 123% jump over the period. In 2021, the continent reached 249GW of capacity, up from 111GW in 2006, Angola, Ethiopia and Rwanda are among the African nations that saw their installed capacity grow most over the period.

Europe and North America were the regions that have grown least since 2006. These regions saw their power matrices grow by just 40% and 44%, respectively.

Source: BloombergNEF

# Asia is home to nearly half of global installed capacity

Share of global installed capacity by region or country



2021 reaffirmed the Asia-Pacific region's role in the global power mix and the region now is home to 49% of global installed capacity. As of year-end 2021, APAC totaled 3.8TW installed, with China accounting alone for 30% of the total global. The country's capacity has more than doubled over a decade, from 1.1TW in 2012 to 2.3TW in 2021.

Apart from Asia, all other regions broadly held their shares 2020-2021 with Europe and North America remaining the second largest regions for installed capacity, accounting for 20% each. However, these were also the only two regions to see their shares of capacity drop sharply since 2006, when each accounted for 27% of global capacity.

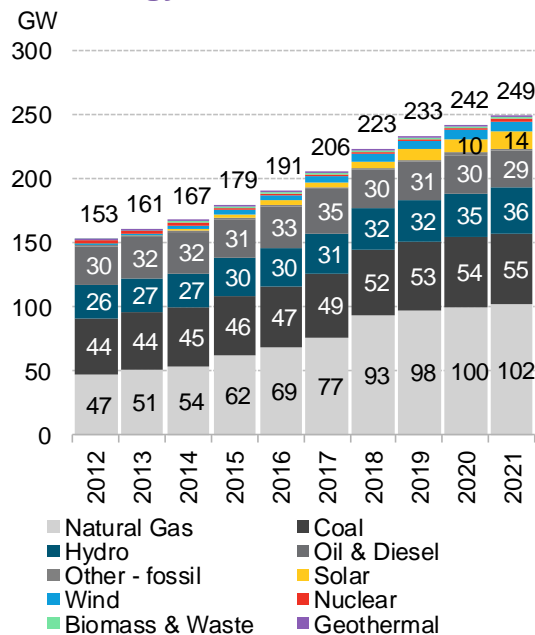
Despite being home to 16% of the world's population, Africa has just 3% of installed global capacity. This share has remained stable over the past 15 years.

Source: BloombergNEF



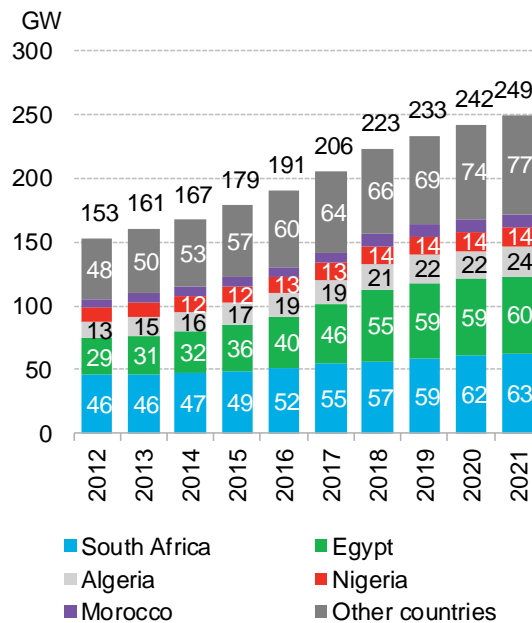
# Fossil fuels predominate in Africa but are concentrated in five countries

## Africa installed capacity by technology



Source: BloombergNEF

## Africa installed capacity by market



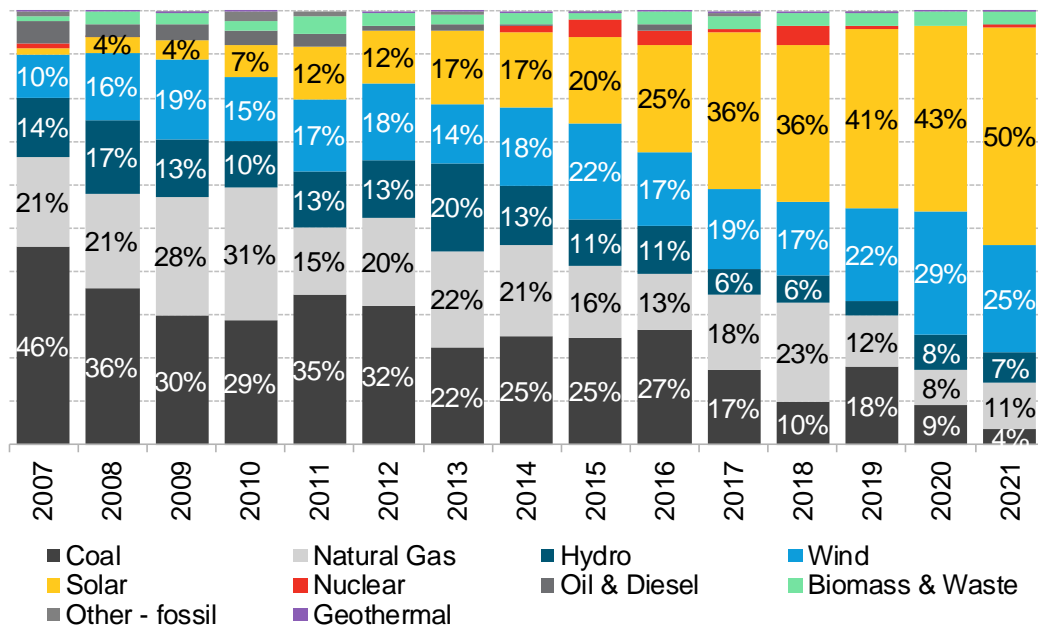
Fossil fuels dominate Africa's power matrix with natural gas accounting for 41% capacity installed, followed by coal with 22%. Renewables (including large hydro) have consistently grown over the decade and now account for 23% of the continent's total capacity. Solar jumped from just 0.3GW in 2012 to 14GW in 2021, while wind grew from 1.2GW to 8GW over the period.

Africa's total installed capacity is heavily concentrated in five countries, which are also home to five of the six highest electrification rates on the continent. South Africa, Egypt, Algeria, Nigeria and Morocco account for 69% of the region's power matrix at 172GW.

Solar has the potential to close Africa's electrification rate gap as around three quarters of the Sub-Saharan Africa (SSA) population still lacks access to reliable electricity. BNEF's 2020 New Energy Outlook projects that solar in SSA could reach 55GW in 2030 and over 400GW in 2050. However, to allow PV to flourish, financial and regulatory barriers must be addressed.

# Solar was half of all capacity installed in 2021

## Share of global capacity additions by technology



New power-generating capacity added globally set a new record in 2021 at 364GW. This was up 7% from 339GW in 2020, and up 41% from 257GW added in 2012.

Solar was 50% of all capacity added, followed by wind at 25%. PV additions in 2021 were 25.5% larger than those in 2020. Wind saw a 7.5% decline compared to the year prior.

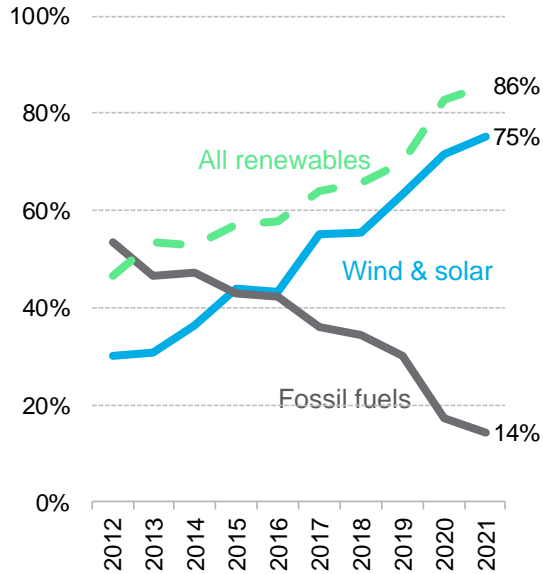
Renewables (including hydro) comprised 85% of total capacity additions. This was up from just 46% in 2012.

Coal's contribution to year-on-year growth was lowest at 4%. Natural gas accounted for 11% of new capacity in 2021, up from 8% in 2020.

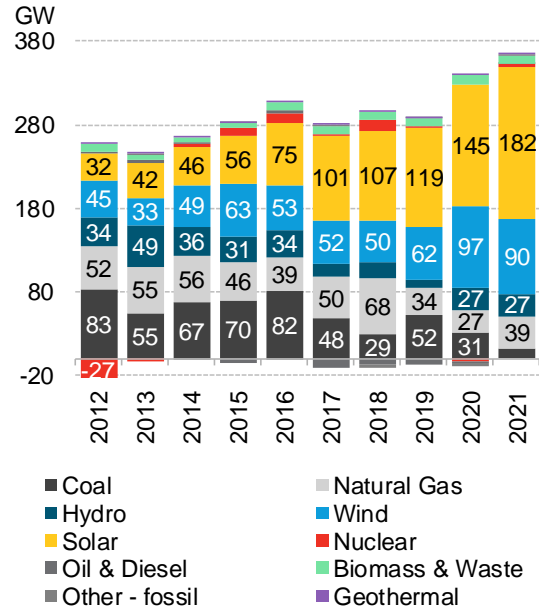
Source: BloombergNEF. Note: Share of global capacity additions excluding retirements.

# Wind and solar were three quarters of all capacity added globally in 2021

Global share of net capacity additions



Global year-on-year capacity change



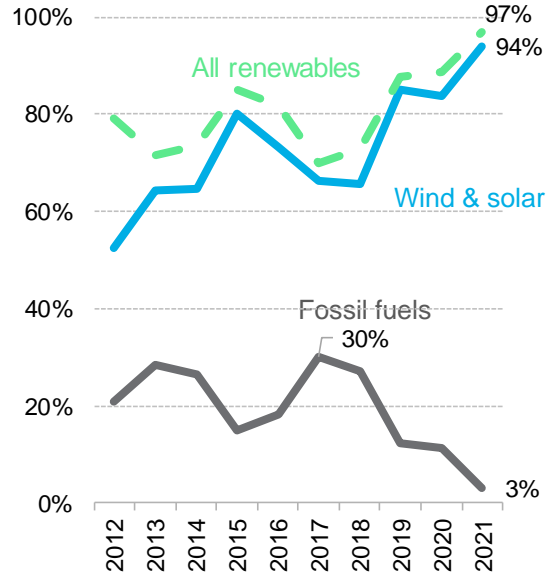
Together, wind and solar accounted for 75% of capacity added globally in 2021. Net additions of these technologies totaled 272GW, up from 77GW in 2012 when they were 30% of the total. Steep drops in costs have spurred the massive growth of these technologies. Wind and solar are now the cheapest sources of new bulk power generation in countries that make up two-thirds of world population and three-quarters of global GDP.

Fossil fuels' net capacity additions as a share of all new build slumped to their lowest level ever in 2021 at 14%. Coal led the decline. It slid to 13GW added compared to 82GW in 2012 and 52MW in 2019. Natural gas was the top fossil fuel added in 2021, accounting for 11% of total build, up 41% from 2020.

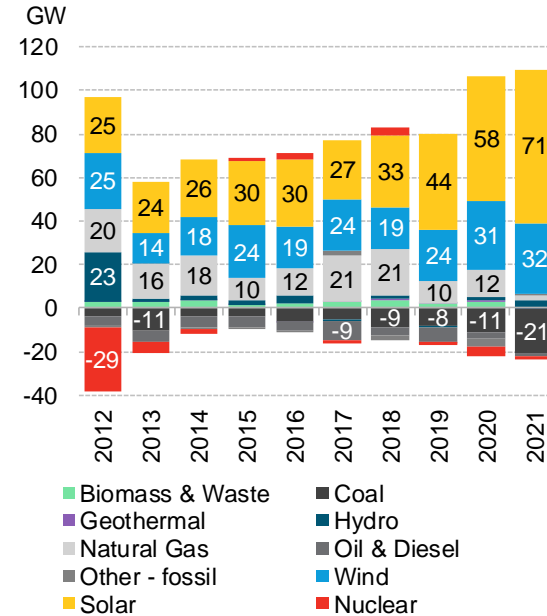
Source: BloombergNEF

# 2021 was a record for coal retirements in developed markets

## Developed markets' share of net capacity additions



## Developed markets' year-on-year capacity change



Developed countries shuttered 21GW of coal capacity in 2021, the most ever in a single year.

Fossil fuels' net additions in developed countries collapsed in 2021, totaling just 3% of new build capacity compared to 30% as recently as 2017. Natural gas accounted for just 3GW, compared to 12GW in 2020.

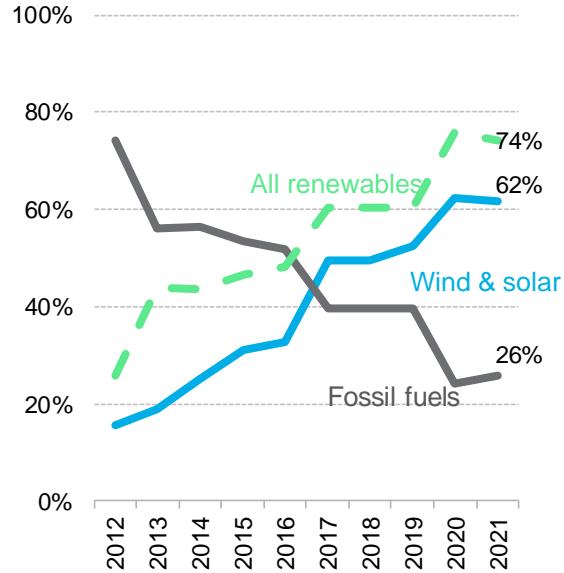
Developed nations could see coal retirements slow in 2022. As European nations have struggled with droughts and gas supply cuts from Russia, coal has become a short-term crutch to meet energy needs. As result, many nations have delayed coal phase-out plans and even restarted capacity that had been mothballed.

Across all technologies, a record 86GW of new capacity was added in wealthy nations in 2021. Wind accounted for the second most added technology at 32GW. Renewables, including hydro, totaled 106GW.

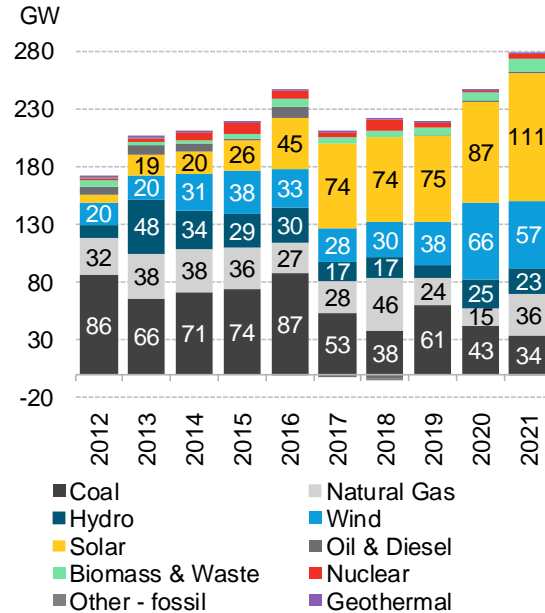
Source: BloombergNEF

# Coal and gas were a quarter of capacity additions in developing markets

Developing markets' share of net capacity additions



Developing markets' year-on-year capacity change



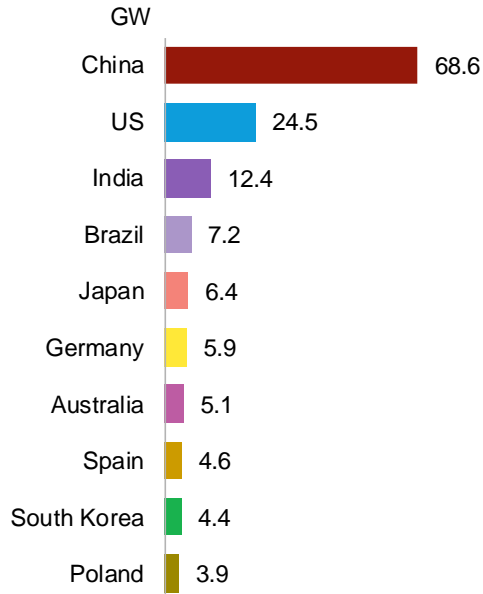
Developing markets added 70GW of fossil fuel capacity to their grids in 2021. At 34GW, coal additions dropped to their lowest level ever, but remained significant. Net additions from natural gas bounced back to 36GW in 2021, up from 15GW the year prior.

With solar and wind taking the lead, developing markets have added more capacity than ever. These nations saw a 13% growth in net additions in one year to 278GW in 2021. Solar set a new record at 111GW, 27% more than in 2020. Wind followed with 57GW added in 2021.

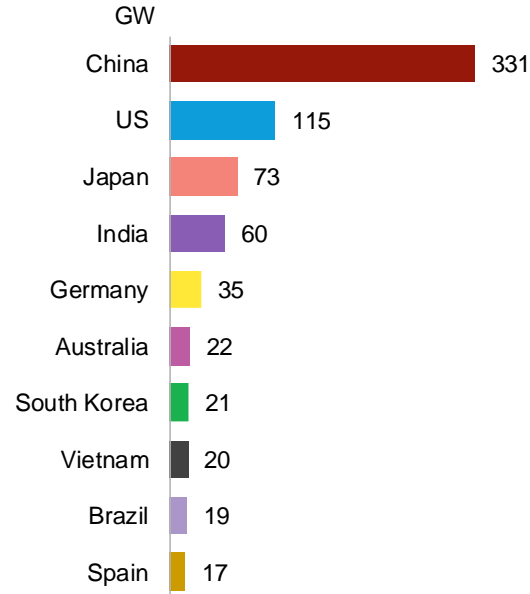
Source: BloombergNEF

# Solar growth is concentrated in a limited number of markets

Top 10 countries for solar capacity additions, 2021



Top 10 markets for solar capacity additions, 2012-2021



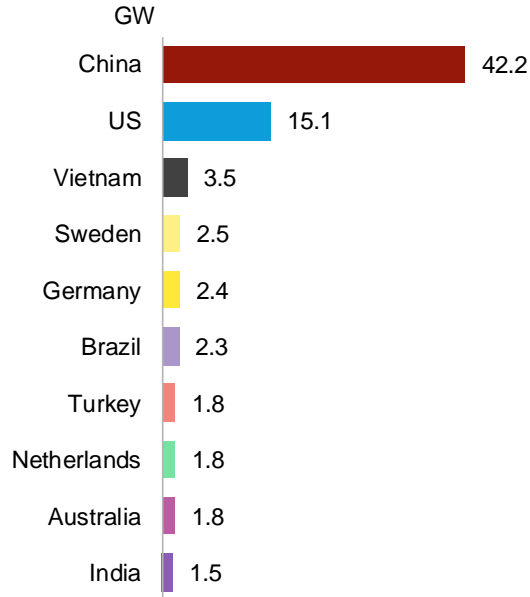
Ten countries were responsible for 85% of all solar capacity added in 2021 and 80% of all capacity added over 2012-2021. China, the US and India led both in 2021 and over the past decade. The three nations alone were 57% of global capacity added 2012-2021.

New solar markets are emerging quickly as enabling policy frameworks improve. Brazil and Vietnam are developing nations where solar has boomed in recent years. Brazil's net metering policy brought 10GW of distributed PV capacity online from 2019 through 2021. Vietnam's feed-in tariff led to nearly 20GW of new utility-scale and small-scale solar.

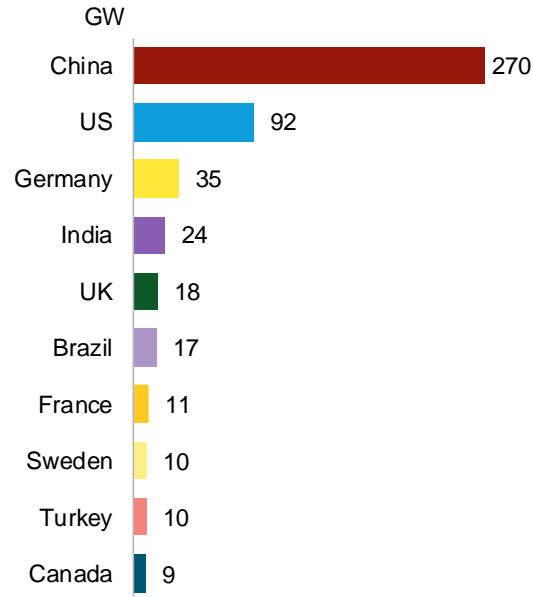
Source: BloombergNEF. Note: Graphs show net capacity additions.

# 89% of wind capacity is located in 10 countries

Top 10 countries for wind capacity additions, 2021



Top 10 markets for wind capacity additions, 2012-2021



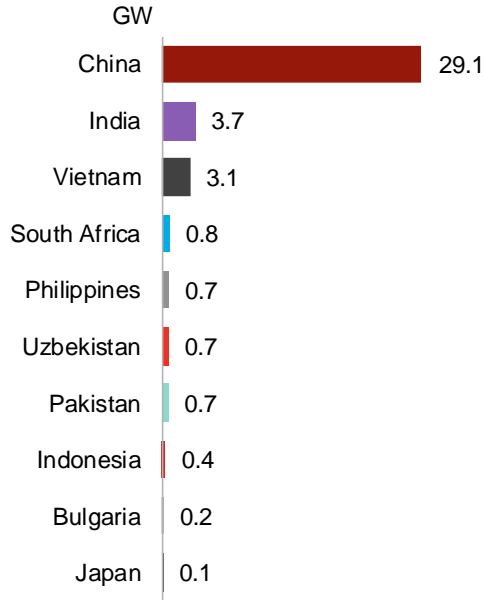
Wind installations are concentrated in a relatively small number of nations, with the top ten countries accounting for 89% of the global capacity additions in 2021. China alone represented 47% of all wind build in 2021 and 40% of global cumulative wind installed capacity as year-end 2021.

The US, the second biggest market for wind, accounted for 17% of the total added in 2021. It installed 15GW last year, 8% less than in 2020. Vietnam followed with 3.5GW in 2021, representing 4% of all wind capacity added in the year.

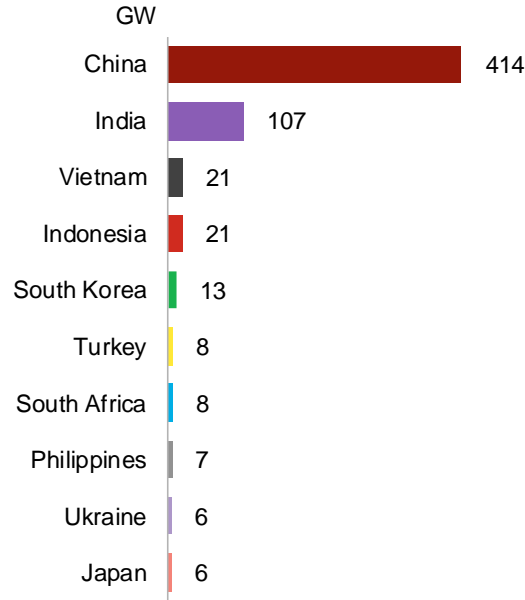
Source: BloombergNEF. Note: Graphs show net capacity additions.

# Asia markets dominate coal additions

Top 10 countries for coal capacity additions, 2021



Top 10 countries for coal capacity additions, 2012-2021



China and India continue to lead in the building of new coal-fired power generating capacity. The two countries accounted for 83% of new coal additions in 2021.

China alone added 414GW of coal 2012-2021, or 62% of the total global, while India installed 107GW over the same period. Despite the high numbers, both nations are slowing their coal build. China's 2021 additions represented less than half of what the country installed at the beginning of the decade and dropped 18% from what it installed in 2020.

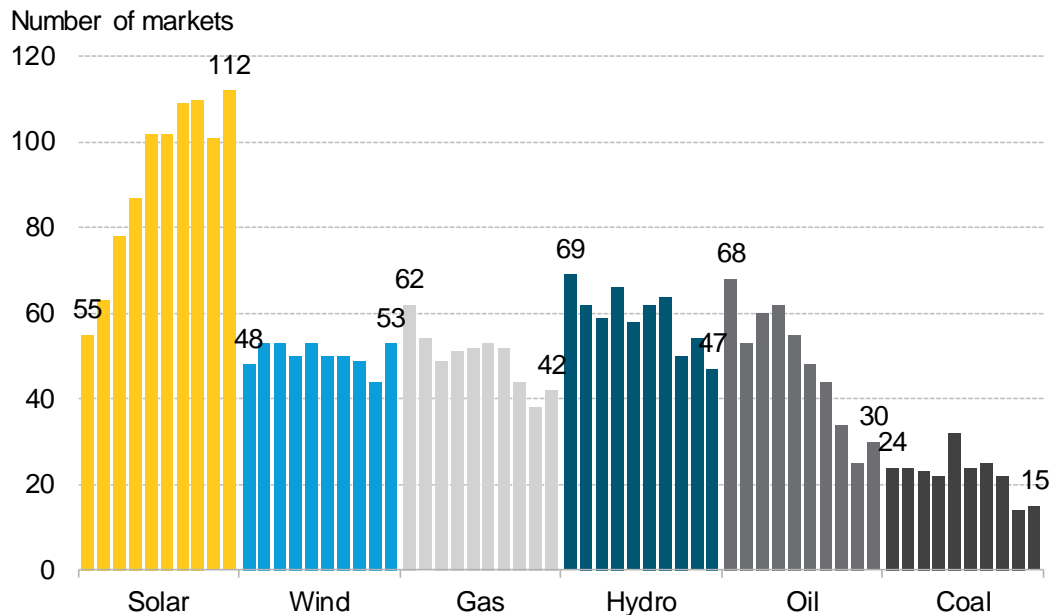
Six other Asian markets are among top 10 countries for coal additions in 2021, representing 14% of the total. Vietnam, Philippines, Uzbekistan, Pakistan, Indonesia and Japan added together 5.7GW last year.

Source: BloombergNEF. Note: Graphs show net capacity additions.



# Solar is quickly spreading to new markets

## Countries with >1MW installed per year, 2012-2021



Source: BloombergNEF

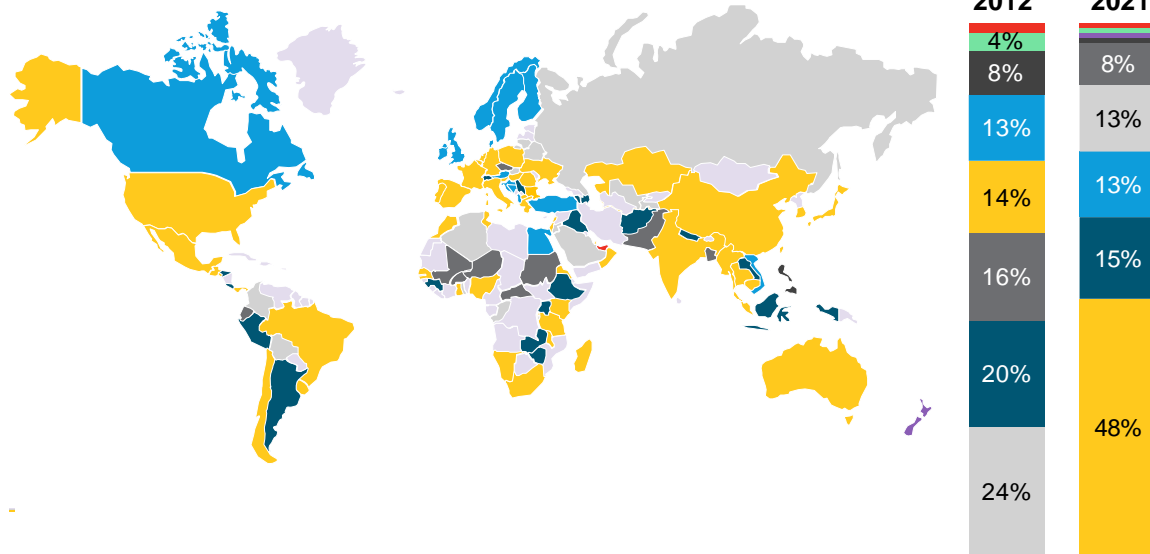
In 2021, 112 countries installed at least 1MW of solar capacity – a new high. That is up 11% from the 101 nations in 2020 and more than double the 55 countries in 2012. The modular nature of PV, along with steep equipment price declines over a decade explain the technology's proliferation.

Wind also established a new record and is now the second most popular technology. 53 markets added some capacity of the technology in 2021, up from 44 in 2020.

More countries added oil, gas and coal capacity in 2021 than in 2020. Gas was the fossil fuel technology installed in the greatest number of countries (42), followed by oil (24) and coal (15).

# Renewables were the top choice in three quarters of the world's markets

## Most popular new power-generating technology installed, 2021



■ Solar ■ Wind ■ Hydro ■ Geothermal ■ Biomass ■ Coal ■ Gas ■ Oil ■ Nuclear ■ No additions available

Source: BloombergNEF. Note: Map colored by which technology was most installed in 2021 alone. Depicts the percentage of nations that installed the most MW of each technology. It is based on country-level data for 136 countries but excludes countries that have not recorded any capacity additions. Solar includes small-scale PV.

More countries than ever are making renewable energy technologies their top choice. In 2021, 78% of the world's nations installed more clean power (including hydro) than fossil-fueled power. That is up from 50% in 2012.

Solar was the technology of choice in nearly half the world's nations. In 2021, 48% of countries surveyed made solar their top choice. Hydro followed with 15%, down from 20% a decade earlier.

In 2012, 49% of the world's nations added more fossil fuel technologies than any other power source. By 2021, that had fallen to 21%. Only one country made coal its top choice in 2021: the Philippines.

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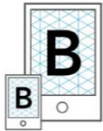
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