

# **CO2 Emissions in 2022**



# INTERNATIONAL ENERGY AGENCY

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## Key messages

- **Global energy-related CO<sub>2</sub> emissions grew by 0.9% or 321 Mt in 2022, reaching a new high of over 36.8 Gt.** Following two years of exceptional oscillations in energy use and emissions, caused in part by the Covid-19 pandemic, last year's growth was much slower than 2021's rebound of more than 6%. Emissions from energy combustion increased by 423 Mt, while emissions from industrial processes decreased by 102 Mt.
- In a year marked by energy price shocks, rising inflation, and disruptions to traditional fuel trade flows, **global growth in emissions was lower than feared**, despite gas-to-coal switching in many countries. Increased deployment of clean energy technologies such as renewables, electric vehicles, and heat pumps helped prevent an additional 550 Mt in CO<sub>2</sub> emissions. Industrial production curtailment, particularly in China and Europe, also averted additional emissions.
- **Specific challenges in 2022 contributed to the growth in emissions.** Of the 321 Mt CO<sub>2</sub> increase, 60 Mt CO<sub>2</sub> can be attributed to cooling and heating demand in extreme weather and another 55 Mt CO<sub>2</sub> to nuclear power plants being offline.
- **CO<sub>2</sub> growth in 2022 was well below global GDP growth of 3.2%**, reverting to a decade-long trend of decoupling emissions and economic growth that was broken by 2021's sharp rebound in emissions. Improvements in the CO<sub>2</sub> intensity of energy use were slightly slower than the past decade's average.
- **Emissions from natural gas fell by 1.6% or 118 Mt**, following continued tightening of supply exacerbated by Russia's invasion of Ukraine. Reductions in emissions from gas were particularly pronounced in Europe (-13.5%). The Asia Pacific region also saw unprecedented reductions (-1.8%).
- **Increased emissions from coal more than offset reductions from natural gas.** Amid a wave of gas-to-coal switching during the global energy crisis, CO<sub>2</sub> emissions from coal grew by 1.6% or 243 Mt, far exceeding the last decade's average growth rate, and reaching a new all-time high of almost 15.5 Gt.
- **Emissions from oil grew even more than emissions from coal, rising by 2.5% or 268 Mt to 11.2 Gt.** Around half of the increase came from aviation, as air travel continued to rebound from pandemic lows, nearing 80% of 2019 levels. Tempering this increase, electric vehicles continued to gain momentum in 2022, with over 10 million cars sold, exceeding 14% of global car sales.
- **The biggest sectoral increase in emissions in 2022 came from electricity and heat generation**, whose emissions were up by 1.8% or 261 Mt. In particular, global emissions from coal-fired electricity and heat generation grew by 224 Mt or 2.1%, led by emerging economies in Asia.
- **A strong expansion of renewables limited the rebound in coal power emissions.** Renewables met 90% of last year's global growth in electricity

generation. Solar PV and wind generation each increased by around 275 TWh, a new annual record.

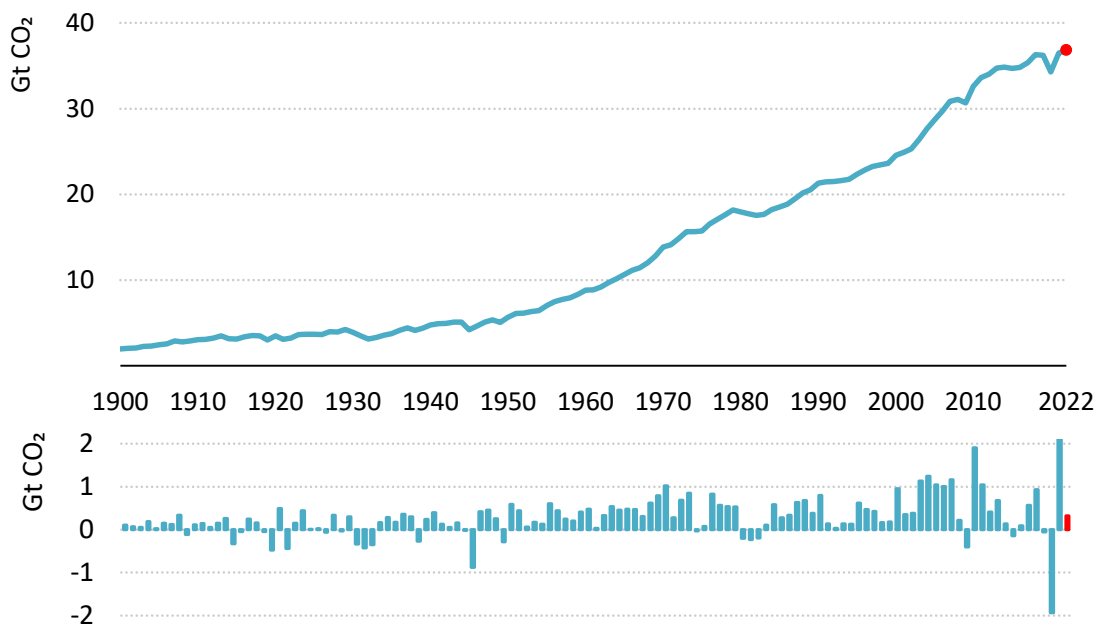
- **Emissions from industry declined by 1.7% to 9.2 Gt last year.** While several regions saw manufacturing curtailments, the global decline was largely driven by a 161 Mt CO<sub>2</sub> decrease in China's industry emissions, reflecting a 10% decline in cement production and a 2% decline in steel making.
- **China's emissions were relatively flat in 2022, declining by 23 Mt or 0.2%.** Growing emissions from combustion were offset by declines from industrial processes. Weaker economic growth, declining construction activity, and strict Covid-19 measures led to reductions in industrial and transport emissions. Power sector emissions growth slowed compared with the average of the past decade but still reached 2.6%.
- **The European Union saw a 2.5% or 70 Mt reduction in CO<sub>2</sub> emissions** despite oil and gas market disruptions, hydro shortfalls due to drought, and numerous nuclear plants going offline. Buildings sector emissions fell markedly, helped by a mild winter. Although power sector emissions increased by 3.4%, coal use was not as high as anticipated. For the first time, electricity generation from wind and solar PV combined exceeded that of gas or nuclear.
- **US emissions grew by 0.8% or 36 Mt. The buildings sector saw the highest emissions growth, driven by extreme temperatures.** The main emissions reductions came from electricity and heat generation, thanks to unprecedented increases in solar PV and wind, as well as coal-to-gas switching. While many other countries reduced their natural gas use, the United States saw an increase of 89 Mt in CO<sub>2</sub> emissions from gas, as it was called upon to meet peak electricity demand during summer heat waves.
- **Emissions from Asia's emerging market and developing economies, excluding China, grew more than those from any other region in 2022,** increasing by 4.2% or 206 Mt CO<sub>2</sub>. Over half of the region's increase in emissions came from coal-fired power generation.
- This report is the first in the **IEA's new series, the [Global Energy Transitions Stocktake](#).** The new tracker consolidates the IEA's latest analysis in one place, making it freely accessible in support of the first Global Stocktake in the lead-up to COP 28.

## Energy-related CO<sub>2</sub> emissions grew by 0.9% to over 36.8 Gt in 2022

Global carbon dioxide (CO<sub>2</sub>) emissions from energy combustion and industrial processes<sup>1</sup> grew 0.9% or 321 Mt in 2022 to a new all-time high of 36.8 Gt. This estimate is based on the IEA's detailed region-by-region and fuel-by-fuel analysis, incorporating the latest official national statistics and publicly available data on energy use, economic indicators, and weather.

Last year's increase follows two years of exceptional oscillations in energy-related emissions. Emissions shrank by more than 5% in 2020, as the Covid-19 pandemic cut energy demand. In 2021, emissions rebounded past pre-pandemic levels, growing more than 6% in tandem with economic stimulus and the roll-out of vaccines.

**Figure 1: Global CO<sub>2</sub> emissions from energy combustion and industrial processes and their annual change, 1900-2022**



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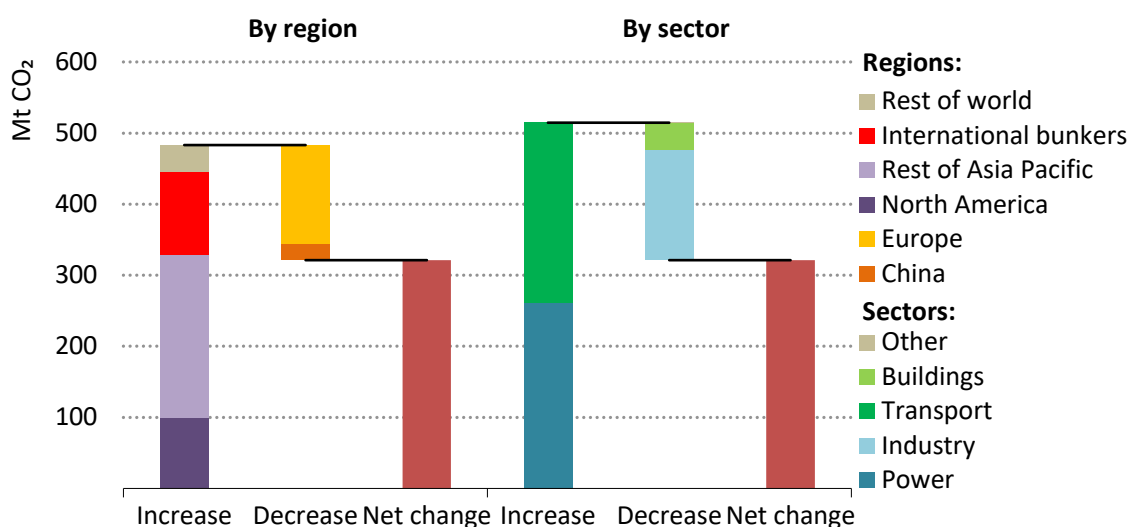
CO<sub>2</sub> emissions from energy combustion grew by around 1.3% or 423 Mt in 2022, while CO<sub>2</sub> emissions from industrial processes declined by 102 Mt. Emissions growth in 2022 was below global GDP growth (+3.2%), reverting to a decades-long trend of decoupling emissions and economic growth that was broken in 2021.

<sup>1</sup> All subsequent mentions of CO<sub>2</sub> emissions refer to CO<sub>2</sub> emissions from energy combustion and industrial processes, unless otherwise specified. Further details about methodology are at the end of the report.

Meanwhile, improvements in CO<sub>2</sub> intensity of energy use were slightly slower than the past decade's (2012-2021) annual average.

There were divergent trends between regions and sectors. CO<sub>2</sub> emissions grew in North America and Asia (excluding People's Republic of China ["China" hereafter]), outweighing reductions from Europe and China. At a global level, CO<sub>2</sub> emissions from power and transport (including international bunkers) grew by 261 Mt and 254 Mt, respectively, more than offsetting reductions from industry and buildings.

**Figure 2: Change in CO<sub>2</sub> emissions by region and by sector, 2021-2022**



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Note: Transport includes international bunkers.

## Greater deployment of clean energy technologies helped prevent further emissions growth amid crises

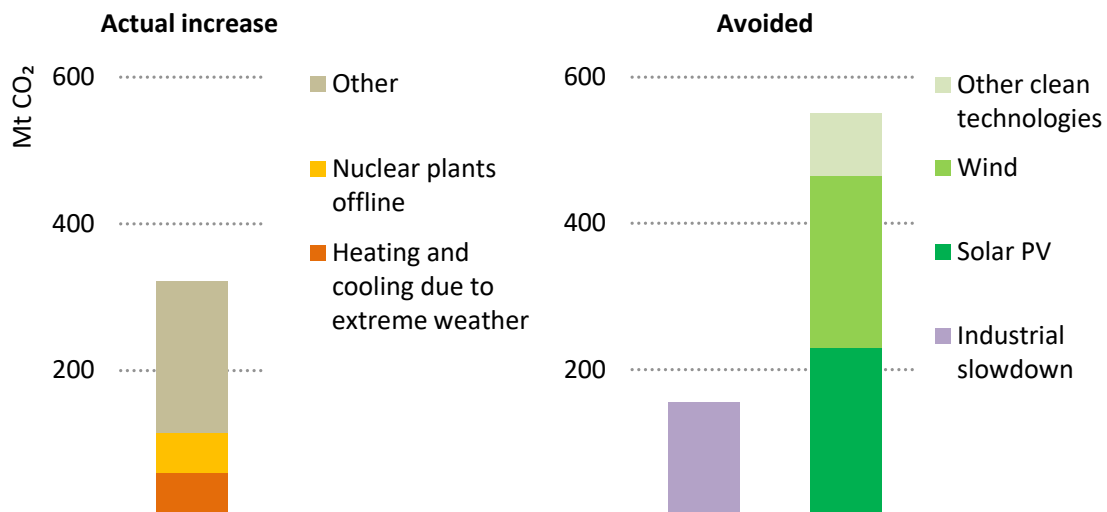
In an exceptionally turbulent year with Russia's invasion of Ukraine, energy price shocks, rising inflation, and major disruptions to traditional fuel trade flows, global growth in emissions was lower than anticipated.

Impressive growth of solar PV and wind generation helped prevent around 465 Mt CO<sub>2</sub> in power sector emissions. Other clean energy technologies, including other renewables, electric vehicles, and heat pumps, helped prevent an additional roughly 85 Mt CO<sub>2</sub>. Without this increased growth in clean energy deployment, the annual increase in energy-related emissions would have been almost triple. Emissions reductions also resulted from economic slowdowns, including

155 Mt CO<sub>2</sub> from decreases in energy-intensive industrial production, mainly in China, the European Union, Japan, Korea and North America.

Specific challenges in 2022 also contributed to the global increase in emissions. Of the overall increase of 321 Mt CO<sub>2</sub>, extreme temperatures contributed 60 Mt from heating and cooling for buildings. The decline in nuclear power generation, due to both maintenance and continued phase-outs, led to another 55 Mt CO<sub>2</sub>.

**Figure 3: Change in global CO<sub>2</sub> emissions by driver, 2021-2022**



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Notes: Solar PV and wind refer to the annual growth in generation. Other clean technologies is the annual growth in use of other renewables, electric vehicles, and heat pumps. In this figure, industry includes iron and steel, chemicals, non-metallic minerals, and non-ferrous metals.

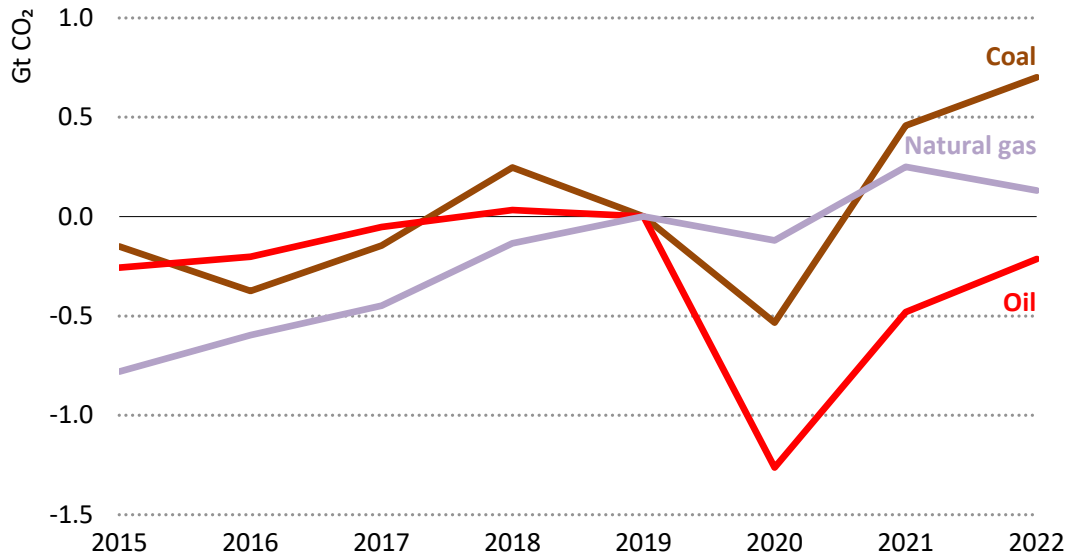
## Reductions in emissions from natural gas were more than replaced by emissions from coal

Emissions from natural gas decreased by 1.6% or 118 Mt in 2022, as an already tight gas supply was exacerbated by Russia's invasion of Ukraine and the widespread trade disruptions that followed.

Emissions reductions were particularly pronounced in Europe, where they fell by 13.5%, with the strongest year-on-year reductions coming in the last months of the year. European gas prices reached record highs in 2022 following a sharp decline in Russian gas flows. However, a mild start to winter helped reduce household heating demand. In the Asia Pacific, LNG spot prices also spiked, and natural gas emissions declined by 1.8%, the largest year-on-year decline ever seen in the region. By contrast, natural gas demand remained robust in the United States and Canada, where emissions from gas increased by 5.8%.

Coal emissions grew 243 Mt to a new all-time high of almost 15.5 Gt. This 1.6% increase was faster than the 0.4% annual average growth over the past decade.

**Figure 4: Change in global CO<sub>2</sub> emissions by fuel, relative to 2019 levels, 2015-2022**



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## Oil emissions grew the most last year

Emissions from oil grew by 2.5% (or 268 Mt) to 11.2 Gt in 2022. Around half of the year-on-year increase came from aviation as air travel continued its recovery from pandemic lows. The rebound to pre-pandemic emissions levels was faster in advanced economies, where last year's aviation emissions reached 85% of 2019 levels, compared with 73% in emerging market and developing economies.

Total transport emissions increased by 2.1% (or 137 Mt), also driven by growth in advanced economies. Nonetheless, emissions would have been higher without the accelerating deployment of low-carbon vehicles. Electric car sales surpassed 10 million in 2022, making up over 14% of global sales. If all new electric cars on the road had been typical diesel or gasoline cars, global emissions last year would have been another 13 Mt higher.



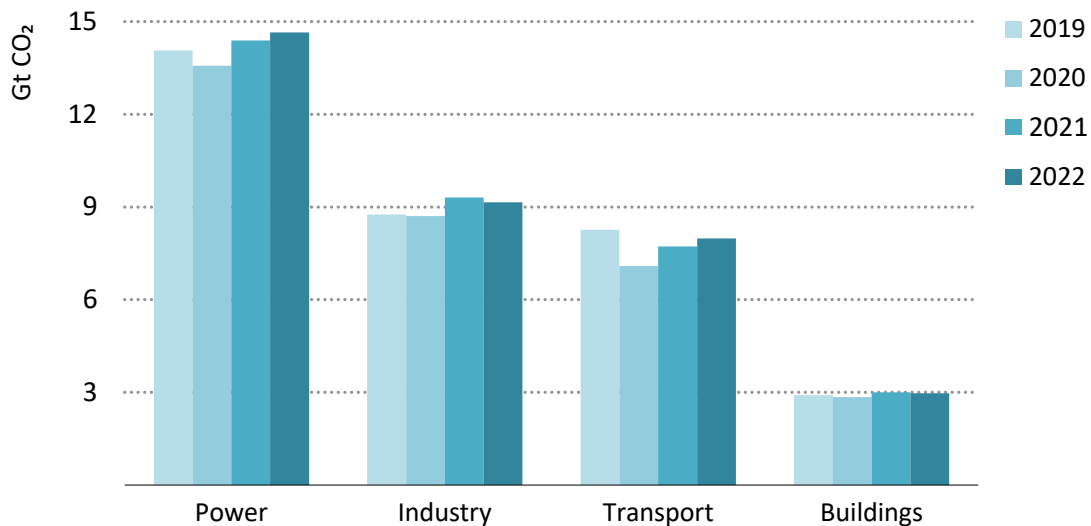
## Despite promising growth in renewables, power sector emissions had the largest sectoral growth

The largest absolute sectoral increase in emissions in 2022 was from electricity and heat generation. Electricity and heat sector emissions increased by 1.8% (or 261 Mt), reaching an all-time high of 14.6 Gt. Gas-to-coal switching in many regions was the main driver of this growth: CO<sub>2</sub> from coal-fired power generation grew by 2.1%, led by increases in Asian emerging market and developing economies. Natural gas emissions in the power sector remained close to 2021 levels, propped up most significantly by an increase in the United States.

Global electricity demand increased by 2.7%, and overall carbon intensity of the electricity generation declined by 2.0%, resuming a nine-year trend that had been broken in 2021.

The resumed decline in carbon intensity resulted from the fast deployment of renewables across all regions, with renewables meeting 90% of global growth in electricity demand. Solar PV and wind generation each increased by around 275 TWh, helping to avoid around 465 Mt in power sector emissions. Although several countries registered severe droughts in 2022, global hydro generation grew by 52 TWh from 2021's levels, which were low because of water shortages in many regions.

**Figure 5: Global CO<sub>2</sub> emissions by sector, 2019-2022**



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Note: Transport includes international bunkers.

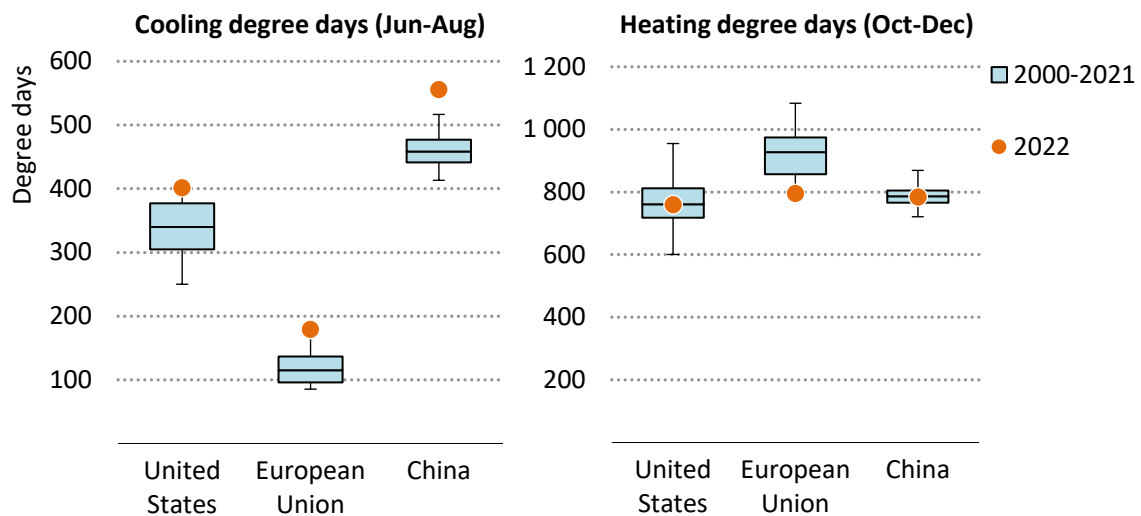
## Reliance on coal- and gas-fired power in extreme weather drove up emissions across regions

Emissions were pushed up by reliance on fossil fuel power plants to meet excess cooling demand during extreme summer heat, with cooling degree days across several regions in 2022 exceeding typical levels or even the maximum seen between 2000 and 2021. In the United States, the share of natural gas in the power fuel mix surpassed 40% in July and August. Coal power generation in China increased in August by [around 15% year-on-year](#) to exceed 500 TWh. In both countries, emissions levels for the first half of the year were lower than in 2021, before summer heat waves reversed the trend.

Europe saw the second warmest start to winter in the last 30 years, and as a result, emissions from buildings were lower than anticipated.

For the full year, cooling and heating demand from extreme weather pushed up global emissions by around 60 Mt CO<sub>2</sub>, around two-thirds of which came from additional cooling needs, and the remaining third from heating needs. This accounted for almost one-fifth of the total global increase in CO<sub>2</sub> emissions.

**Figure 6: Cooling degree days in summer months and heating degree days in winter months for selected countries/regions, 2000-2022**



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Notes: Cooling degree days illustrate how hot average daily temperatures were and are measured relative to 21 °C. Heating degree days illustrate how cold average daily temperatures were and are measured relative to 18 °C.