Rhodium Group

Energy & Climate

Global Greenhouse Gas Emissions: 1990-2023 and Preliminary 2024 Estimates

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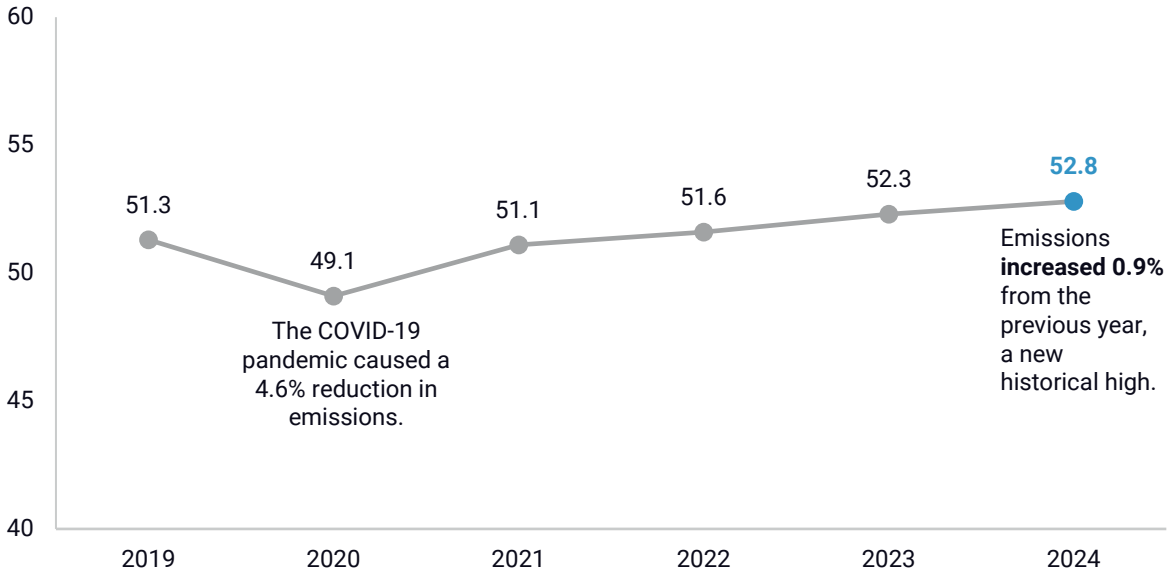
Each year, Rhodium Group provides updated estimates of global and national greenhouse gas emissions, encompassing all primary gases and key economic sectors. This dataset enables consistent tracking of emissions trends across countries and over time, providing an independent view of how the world's emissions are evolving in relation to global climate goals. In the latest update, we find that global greenhouse gas emissions reached a new historical high in 2024, increasing 0.9% from the previous year and rising from 52.3 to 52.8 gigatons of CO_2 equivalent. This new peak continues the gradual increase observed since the pandemic and underscores the persistent challenge of achieving sustained declines amid uneven progress in energy transitions across regions.

FIGURE 1

Preliminary global GHG emissions estimates for 2024

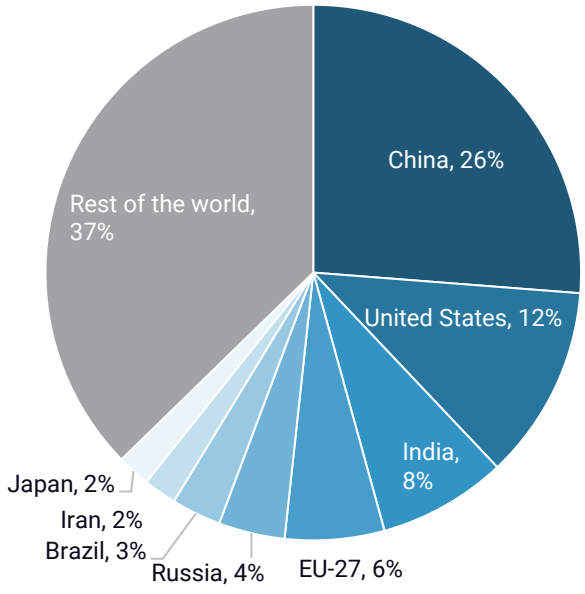
Billion metric tons of CO_2e



Source: Rhodium Group

In 2024, global greenhouse gas emissions continued to be dominated by a small group of major economies (Figure 2). China accounted for roughly 26% of the global total, followed by the United States (12%), India (8%), and the EU-27 (6%). Russia, Brazil, and Japan each contributed between 2-4%, while Iran re-emerged among the top emitters, accounting for about 2% of global emissions—reflecting higher oil production and exports following the gradual easing of restrictions imposed in 2015. Altogether, these economies accounted for nearly two-thirds of global emissions in 2024, underscoring the concentration of emissions among a select few countries.

FIGURE 2
2024 net GHG emissions from the world's largest emitters
Percent share of global total



Source: Rhodium Group

Based on our preliminary estimates of energy CO_2 in 2024, economic growth did not result in significant changes in emissions among the world's largest economies (Figure 3). In several countries, economic expansion was accompanied by increases in energy-related CO_2, while in others, emissions continued to decline despite growth. India and China stand out: both recorded solid GDP growth of 7% and 2.8%, alongside corresponding increases in energy CO_2 emissions of 4.6% and 1%, respectively. Russia also saw emissions rise in line with economic recovery, while Brazil, the United States, Japan, and the EU-27 maintained or deepened declines in energy CO_2 even as GDP expanded modestly. Taken together, these trends indicate that the relationship between economic growth and emissions remains uneven across major economies.

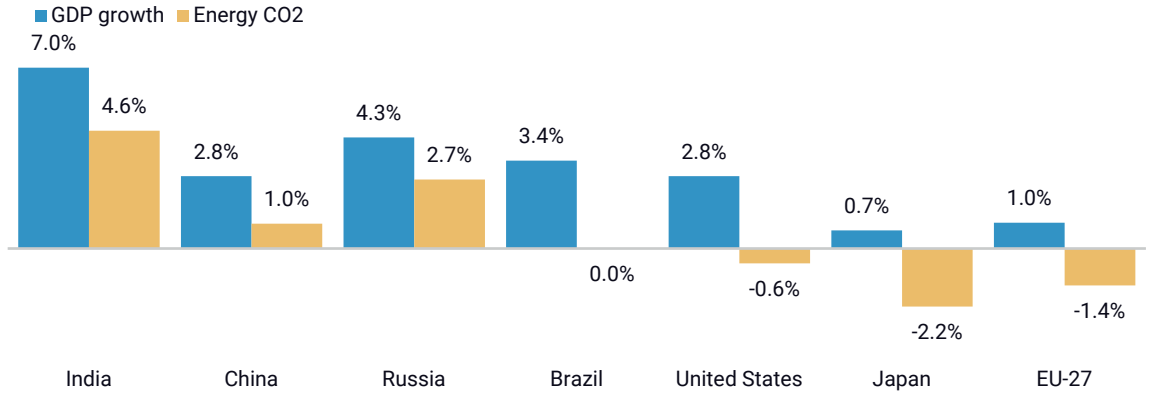
Changes in CO_2 emissions from energy among major economies were relatively small in 2024 compared with the previous two years (Figure 4). Across major economies, emissions increased or declined only slightly. Russia was a notable outlier, with emissions rising 2.7% after remaining nearly flat in 2023. This reflects a partial rebound in Russia's energy sector, supported by a 7.6% increase in natural gas production and higher LNG exports. In China,

emissions growth slowed as weaker industrial activity and rapid additions of solar and wind reduced coal generation. In contrast, the United States, the EU, and Japan saw emissions continue to decline—due in part to lower coal generation and milder winter conditions that curbed heating demand—though at a slower pace than in 2023. India saw higher fossil fuel use in 2024, driven by increased coal and gas demand, whereas Brazil experienced a decline as wind, solar, and hydropower met a larger share of electricity needs. Overall, the limited changes across major economies resulted in a slight overall increase in global energy CO_2 emissions in 2024, bringing emissions up to a new record high, highlighting the difficulty of driving meaningful declines.

FIGURE 3

2024 change in gross domestic product and energy CO_2 emissions for the top emitters

Percentage change relative to the previous year

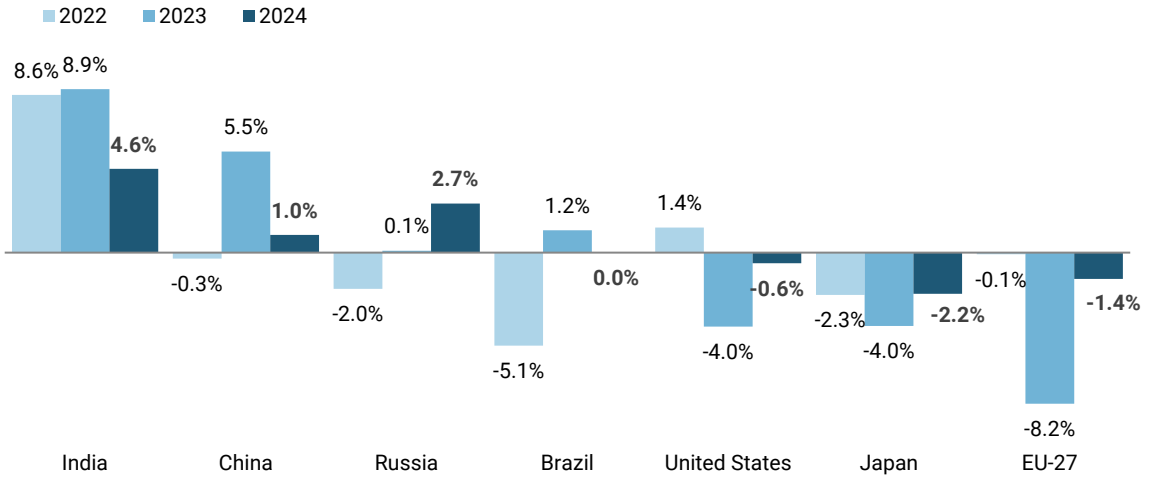


Source: Rhodium Group and World Bank

FIGURE 4

Change in annual energy CO_2 emissions for the top-emitting economies

Percentage change relative to the previous year

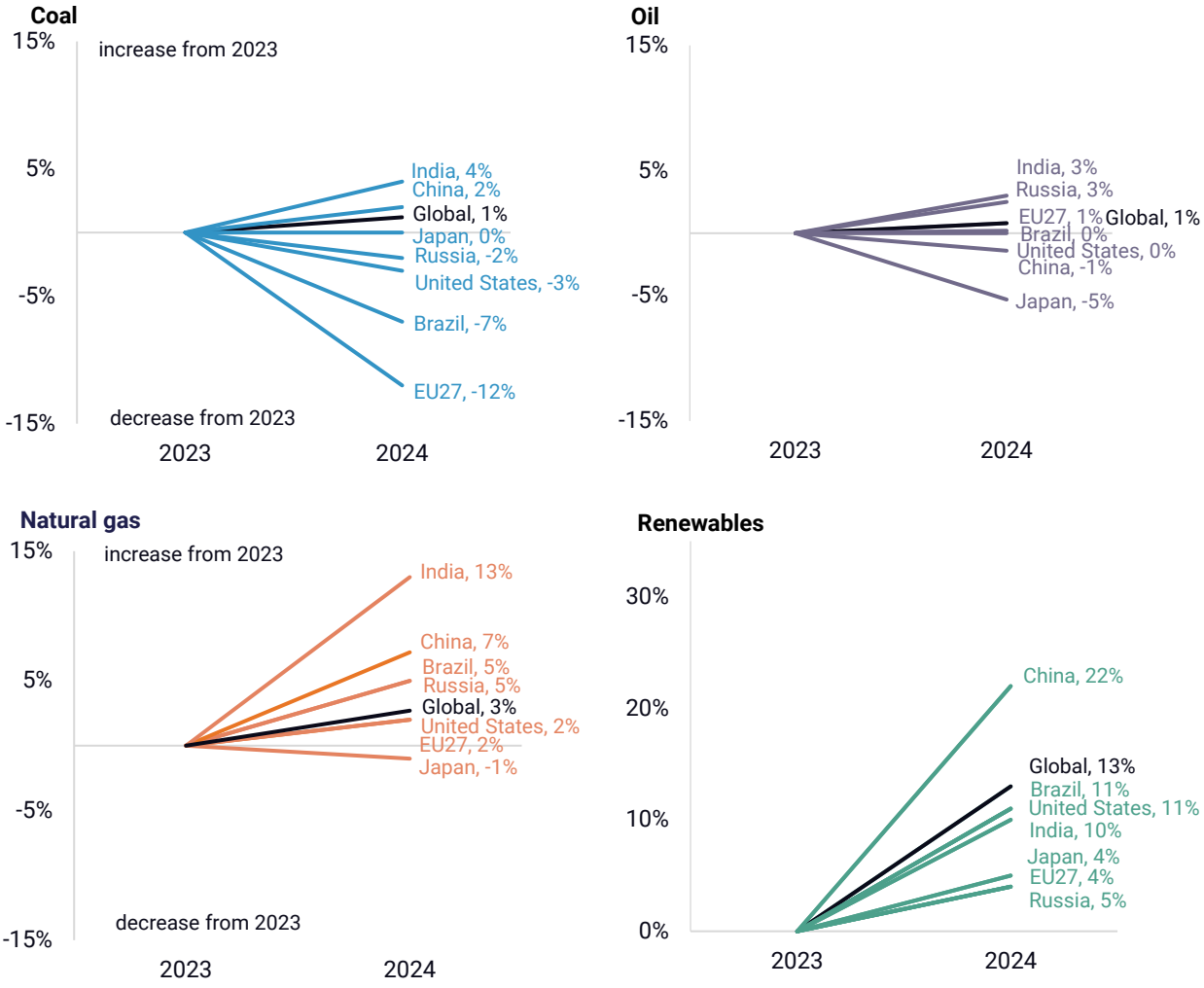


Source: Rhodium Group

Global fossil fuel consumption patterns in 2024 help explain the change in energy-related CO_2 emissions compared with the previous year. Global coal and oil use increased by about 1%, while natural gas consumption rose 3% and renewable energy use increased by

nearly 13% (Figure 5). This reflects weakening coal demand growth in many advanced economies, record renewable power generation, rising natural gas use in industry and power, and a shift from gasoline- to electric-powered cars.

FIGURE 5
Coal, oil, natural gas, and renewable energy consumption
Percentage change relative to the previous year (indexed to 2023)



Source: Rhodium Group

Year-on-year changes in coal consumption were a mixed bag, but represented a moderation of growth or continued decline across all major economies. In the EU, wind and solar supplied nearly half of total power demand, helping push coal consumption to a new record low. In China, coal consumption grew only moderately as rapid additions of solar and wind capacity met much of the increase in electricity demand. In India, coal demand rose substantially, though the pace was tempered by growing renewable generation.

Oil use grew modestly or fell in most major economies. India recorded one of the largest increases globally, driven by rising consumption of gasoline and diesel from the transport sector. Oil demand fell in China, driven by soaring EV adoption, even as oil demand for

petrochemicals and industry rose. Oil consumption in the US, the EU, and Japan remained broadly flat or declined in 2024.

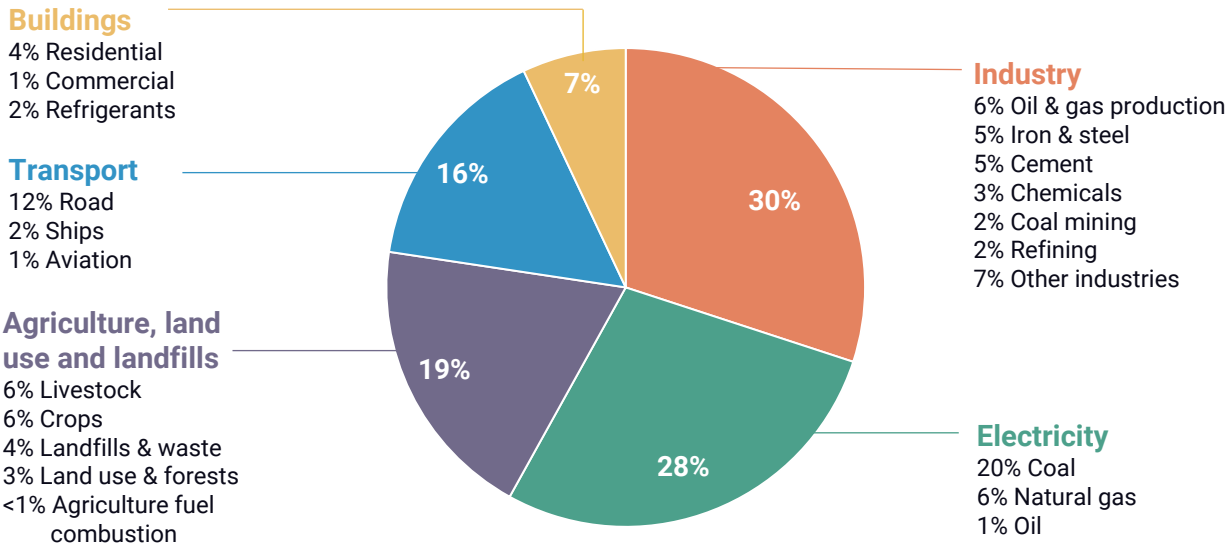
Natural gas use increased in 2024 in all major economies apart from Japan, where the restarting of nuclear reactors has eaten into natural gas-powered electricity generation. Growth elsewhere was supported by lower prices and higher demand in both the power and industrial sectors.

Renewable energy consumption continued to grow rapidly across major economies, supplying nearly 38% of the growth in total energy supply. But despite this strong growth in renewable energy, total energy consumption outpaced the shift away from fossil fuels, resulting in a rise in global emissions.

Industry and power remain the highest-emitting sectors

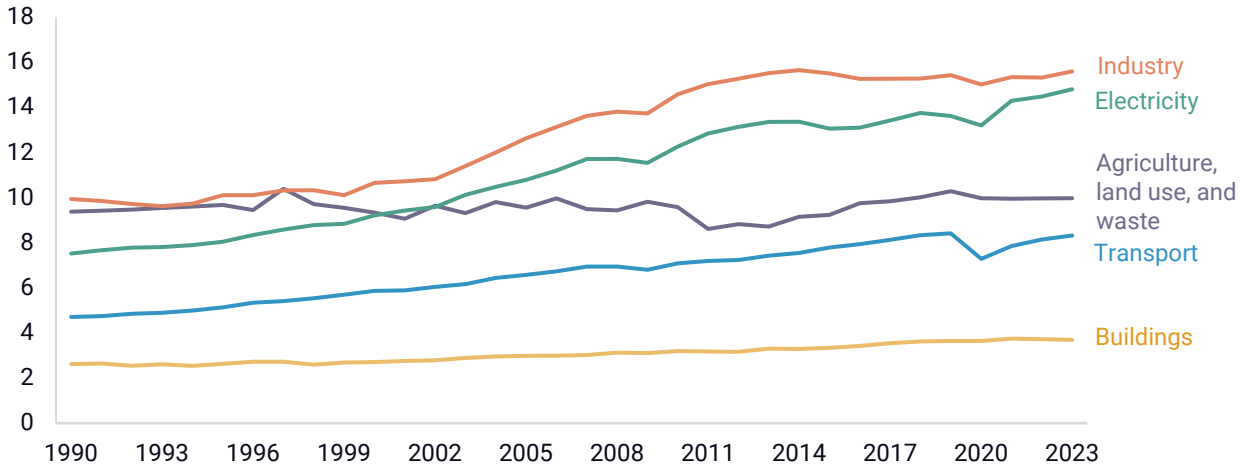
Sector-level data through 2023 provides a long-term view of how emissions sources have evolved across the major sectors of the global economy. The industrial and power sectors remained the most significant contributors, together accounting for nearly 60% of total greenhouse gas emissions (Figure 6). Agriculture, land use, and waste contributed 19% and transport made up 16%, while emissions from buildings remained comparatively small at 7%. Over time, emissions from industry, power, and transport have continued to rise, while emissions increases in the buildings sector have been more gradual (Figure 7). These historical patterns highlight the concentration of global emissions in electricity, industrial, and transport systems, underscoring the importance of structural changes in these sectors to achieve sustained reductions in total emissions.

FIGURE 6
Global emissions by sector
Percent share of 2023 net GHG emissions



Source: Rhodium Group

FIGURE 7
Global GHG emissions by sector for 1990-2023
Billion metric tons of CO_2e



Source: Rhodium Group

Methodology

The data described here are available on Rhodium's ClimateDeck data platform. ClimateDeck provides GHG emissions and energy data for all 190+ countries and all 50 US states, with tools that allow users to filter by region, GHG, sector and sub-sector, as well as socioeconomic indicators (e.g., emissions per capita and per GDP) and full inventory tables for each country.

These estimates reflect several methodological updates that enhance the accuracy and consistency of our historical emissions data. Specifically, we have adopted the Global Warming Potentials (GWP) for non-CO_2 gases from the IPCC's Fifth Assessment Report (AR5), in alignment with UNFCCC reporting guidelines. Additionally, we transitioned to third-party datasets for Agriculture, Forestry, and Other Land Use (AFOLU) and energy CO_2 emissions to ensure methodological consistency across countries. As a result, our data may not fully align with self-reported UNFCCC inventory data, which can vary by country.

This year, we revised historical industrial emissions to include fuel consumption used in hydrogen production and non-CO_2 emissions from refining processes. By accounting for these previously unreported emissions sources, our estimates now provide a more comprehensive view of the industrial sector's contribution to historical emissions, with slight increases in certain years to reflect these additions.

In deriving our global and country-specific GHG emissions estimates, we incorporate data from IEA's energy consumption flows and BP's 2024 Statistical Review for fossil fuel CO_2. For AFOLU and waste emissions, our primary data source is FAOSTAT, with projections from IIASA's GLOBIOM 2021 included in our preliminary estimates for 2023. These estimates do not account for emissions from forest fires. For all other non-CO_2 gases, we use Annex I inventories and EPA's Global Non-CO_2 data.

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