

*Global Outlook*

## Emissions

Providing reliable, affordable energy to support prosperity and enhance living standards is coupled with the need to do so in ways that reduce impacts on the environment, including the risks of climate change.

**Report***Aug. 28, 2023*

Billions of people need reliable, affordable energy every day. At the same time, that energy use is contributing to CO<sub>2</sub> emissions. Progress on society's energy and climate objectives requires practical approaches and new technology solutions.

Solutions require the cooperation and collaboration of governments, academia, the business community, and consumers around the world.



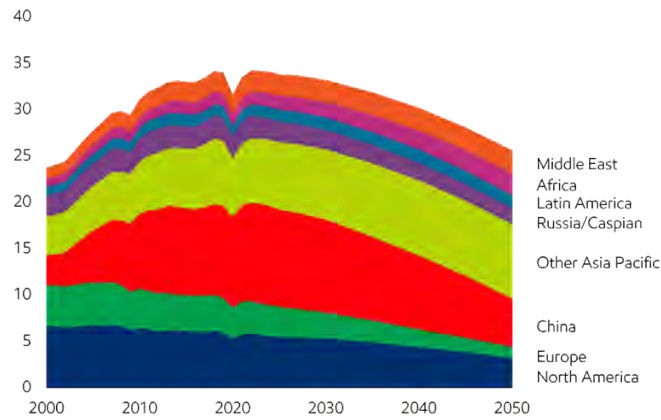
Governments play an important role in developing and enacting policies that seek to address climate change risks in the most practical and cost-effective way.

Policies that promote innovation can expand the available options society has for providing access to energy while reducing impacts on the environment. Additionally, policies that harness the flexibility of free markets and competition can quickly scale the best solutions for each sector within a country.

Effective policy frameworks will be critical to reduce global greenhouse gas emissions and meet society's need for reliable and affordable energy.

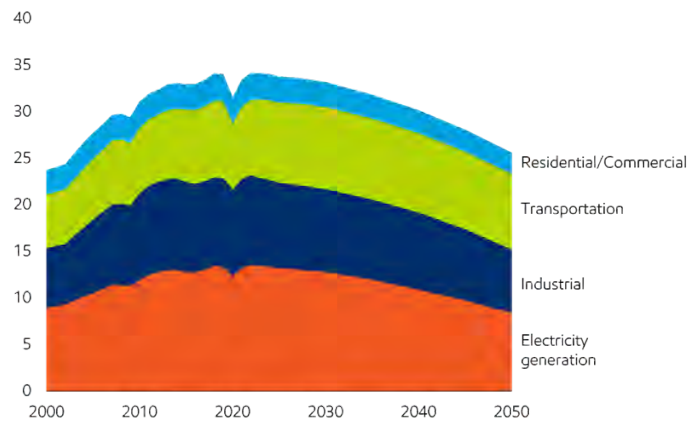
### Energy-related CO<sub>2</sub> emissions peak

Billion tonnes



### All sectors contributing to restrain CO<sub>2</sub> emissions growth

Global energy-related CO<sub>2</sub> emissions - Billion tonnes



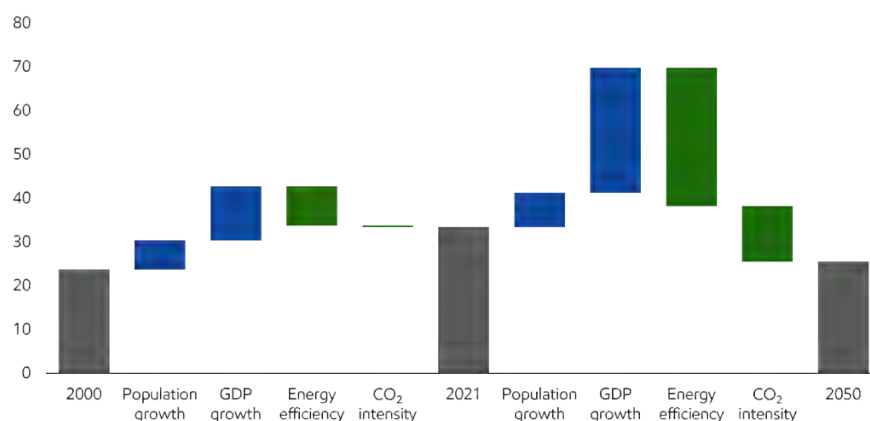
- Policy choices, consumer preferences and technology play a role in balancing energy supply and demand and the effects on emissions.
- From 2000 to 2021, the economic expansion in Asia Pacific saw CO<sub>2</sub> emissions substantially rise, only partially offset by reductions in Europe and North America.
- Global annual energy-related CO<sub>2</sub> emissions are likely to peak this decade, as countries try to reduce the emissions intensity of their economies.
- A shift to less carbon-intensive sources of electricity (for example, renewables, nuclear and natural gas) will reduce the CO<sub>2</sub> intensity of delivered electricity in

2050 by about 65% compared to 2021.

- Efficiency gains and growing use of less carbon-intensive energy will help reduce industrial CO<sub>2</sub> emissions relative to GDP by about 65% over the Outlook period.
- Transportation represents about 25% of CO<sub>2</sub> emissions today, and this share is likely to grow modestly by 2050, driven by expanding commercial transportation activity.
- Global light-duty vehicle CO<sub>2</sub> emissions are expected to peak in the mid-2020s before falling by 35% by 2050, as conventional vehicles continue to become more efficient and electric cars gain significant share.

## Restraining global energy-related CO<sub>2</sub> emissions

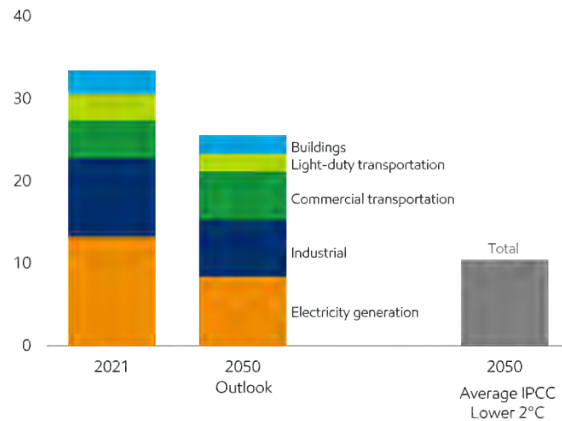
Billion tonnes



- The primary driver of increasing global CO<sub>2</sub> emissions between 2000 and 2021 was economic growth, as global GDP expanded about 80%.
- Improving energy efficiency (energy use per unit of GDP) helped slow the growth in emissions, while global CO<sub>2</sub> intensity of energy use remained fairly constant, with increased coal use in some non-OECD countries offsetting emission reductions in the OECD countries.
- As the world's economy more than doubles by 2050, technology will be essential to mitigate emissions. The Outlook projects a sustained improvement of CO<sub>2</sub> intensity (more solar, wind, nuclear, coal to gas switch, carbon capture and storage) in addition to accelerated efficiency gains.
- By 2050, efficiency and emissions intensity reduction are expected to contribute to a ~65% decline in the carbon intensity of the global economy.

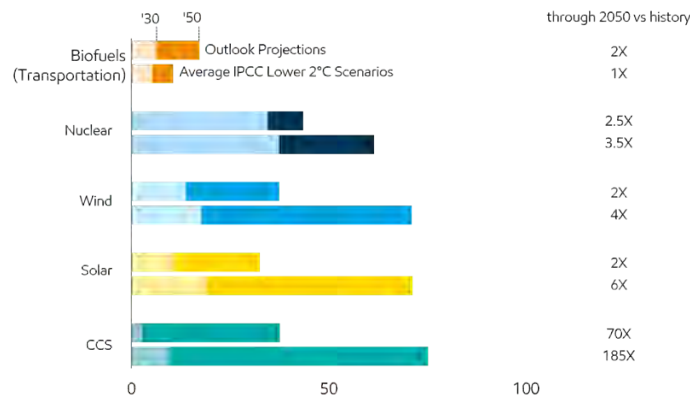
## More change required to reach 2°C scenarios

Energy-related emissions - CO<sub>2</sub> billion tonnes



## Example lower-carbon solutions trends

World - Quadrillion Btu



- The Global Outlook projects energy-related CO<sub>2</sub> emissions in 2050 almost 25% below 2021. The average of the IPCC Lower 2°C scenarios would require a reduction of about 70%.
- More electrification and renewables can address only part of the problem. Additional lower-emission solutions are required under Lower 2°C scenarios. For all these lower-emission solutions, a clear acceleration in deployment is required. The largest rate of acceleration needed, up to 185 times the recently observed rate of deployment, is in carbon capture and storage.
- The Outlook assumes continued progress in costs of technology and policy support in its projection of lower-emission solutions deployment. Monitoring the

role of deployment of these solutions provides useful signposts on the pace of the transition..

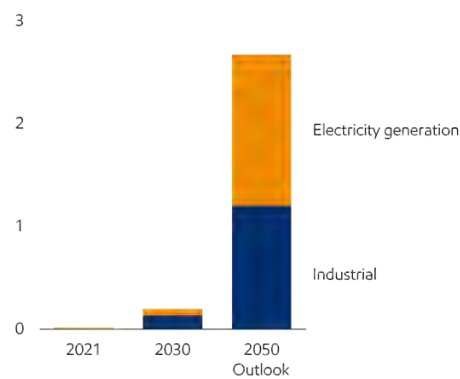
## Low carbon solutions

Having a suite of lower-carbon technologies for hard-to-decarbonize sectors is important. They have a critical role to play in the energy transition, with multiple options required to meet differing needs. Biofuels, Hydrogen-based fuels and carbon capture and storage are three key lower-carbon solutions needed in addition to Wind and Solar. Pace of deployment for each of these technologies will be driven by policy support, technology improvements and supporting infrastructure development.

---

## Carbon capture and storage

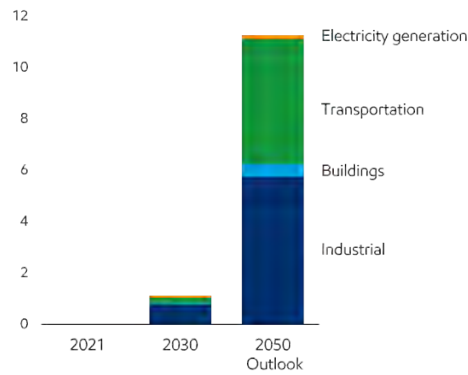
Billion tonnes per year



- Carbon capture and storage is the process of capturing CO<sub>2</sub> emission at the source and injecting them into deep underground geologic formations for safe, secure and permanent storage.
- Carbon capture and storage on its own, or in combination with hydrogen production, is among the few proven technologies that could enable CO<sub>2</sub> emissions from high-emitting and hard to decarbonize sectors such as power generation and heavy industries, including manufacturing, refining and petrochemicals.

## Hydrogen-based fuel use

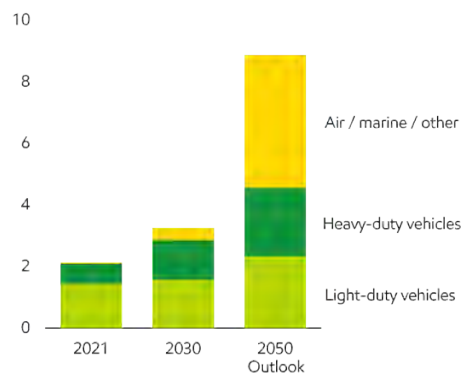
Quadrillion Btu



- Low-carbon hydrogen will be a key enabler replacing traditional furnace fuel to decarbonize the industrial sector.
- Hydrogen and hydrogen-based fuels like ammonia are also expected to make inroads into commercial transportation as technology improves to lower costs and policy develops to support the needed infrastructure development.

## Biofuels growth in transportation

Million of oil-equivalent barrels per day



- Along with electrification, biofuels is expected to play an important role in decarbonization of the transportation space, growing by over four-fold from 2021 to 2050.
- For aviation in particular, biofuels is expected to be the primary transition fuel as other options such as battery-electric are not as viable as they are with road transportation.