# 5. Carbon dioxide emissions

## 5.1 Current trends: Correcting the course of climate change measures and strengthening the competitiveness of Europe and the United States

In recent years, global efforts to combat climate change and reduce carbon dioxide emissions have reached a turning point. In particular, the announcement by the second Donald Trump administration, which took office in January 2025, to withdraw from the Paris Agreement, has triggered a backlash against US climate change policies. This sudden change in policy not only shook the domestic policy foundations but also seriously impacted the international cooperative system, casting uncertainty over policy decisions in various countries and the future direction of markets. Therefore, this section will focus on the current situation in the United States since the inauguration of the second Trump administration, as well as policy trends in the United States and Europe, and developments in climate change countermeasures.

On 20 January 2025, Mr Trump took office as president and signed an executive order that included withdrawing from the Paris Agreement[21]. The order covered five items, including: 1/ unleashing US energy; 2/ declaring a national energy emergency; and 3/ placing the United States first in international environmental agreements. One consequence of signing this executive order is that the United States, which had been contributing approximately $11 billion[22] annually to the United Nations Framework Convention on Climate Change (UNFCCC), will cease these contributions. Furthermore, the US withdrawal has made it even more difficult to provide developing countries with at least $300 billion a year in climate finance (public and private) by 2035 as funding for global warming countermeasures, as agreed at the 29th Conference of the Parties to the UNFCCC (COP29).

Within the United States, since the inauguration of the second Trump administration, the Environmental Protection Agency announced on 12 March that it would ease 31 regulations to advance President Trump's first executive order. This deregulation includes a reconsideration of power plant regulations, a reconsideration of motor vehicle regulations, and a reconsideration of the 2009 endangerment finding and regulations and actions that rely on that finding. Mr Trump also signed the executive order 'Protecting American Energy From State Overreach' on 8 April. The document declared that 'state overreach in energy regulation would undermine the economy and national security of the United States' and called for suspending enforcement of domestic emissions trading systems and carbon taxes (the so-called Superfund Act). Following this signing, the U.S. Department of Justice set a 7 July deadline for filing lawsuits against states participating in these initiatives, but no lawsuits have been filed.

In July, the Inflation Reduction Act (IRA)/Infrastructure Investment and Jobs Act (IIJA) tax credit funding suspension (including the suspension of wind and solar photovoltaic tax credits) was enacted. In addition, the bill rescinded the 2009 Endangerment Finding, which found that greenhouse gas (GHG) emissions have adverse effects on health and welfare, and proposed the repeal of automobile GHG emission standards. The government also plans to propose the

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[21] The White House, "Putting America First In International Environmental Agreements", 20 January 2025. https://www.whitehouse.gov/presidential-actions/2025/01/putting-america-first-in-international-environmental-agreements/

[22] U.S. Department of State, "COP 29 Update: U.S. International Public Climate Finance", 18 November 2024. https://2021-2025.state.gov/cop-29-update-u-s-international-public-climate-finance/

complete abolition of GHG emission criteria, on the grounds that GHGs from thermal power plants do not contribute to air pollution.

**Table 5-1 | Major energy and environment-related policies of the United States and the European Union**

| | United States | European Union |
|---|---|---|
| September 2024 | | Publication of Draghi Report (highlighting lack of investment, high energy costs and strategic dependency as key issues) |
| January 2025 | Mr Trump took office as the 47th President of the United States.<br>Direction to review energy regulations and speed up and licensing procedures.<br>National energy emergency declared<br>Withdrawal from and review of international environmental agreements (the Paris Agreement, etc.) directed. | Indication of the path to improving Europe's competitiveness presented |
| February 2025 | | Investments that boost both clean manufacturing and competitiveness.<br>Simplification proposed for the Corporate Sustainability Reporting Directive (CSRD), the Corporate Sustainability Due Diligence Directive (CSDDD) and the Carbon Border Adjustment Mechanism (CBAM) (Omnibus Simplification). |
| March 2025 | Review of the legal basis for GHG regulations commenced | |
| April 2025 | Judicial decisions on state carbon pricing and emissions trading systems (ETS) supported | |
| May 2025 | | Amendments adopted to postpone compliance with vehicle GHG emission criteria until 2027 |
| July 2025 | Reduction of renewable energy tax credits and support for fossil fuels (One Big Beautiful Bill Act passed).<br>Proposal to abolish Endangerment Finding + Proposal to abolish automobile GHG emission regulations. | |

Such sceptical movements regarding climate change in the United States are affecting all areas of markets, policy and diplomacy outside the country. Particularly notable were the gains made by right-wing and centre-right parties in elections across various countries, as well as the increase in policies prioritising the international competitiveness of domestic industries.

Meanwhile, on 9 January 2025, the European Union announced its Competitiveness Compass[23], outlining three priority areas, including decarbonising the EU economy, and five cross-cutting support policies, including deregulation. It pledged to simplify regulations and support clean industries to address the stagnation of innovation and hollowing out of manufacturing within the region. Furthermore, on 26 February, the European Union proposed the 'Omnibus Package'[24] to simplify the Corporate Sustainability Reporting Directive (CSRD), the Corporate Sustainability Due Diligence Directive (CSDDD), and the Carbon Border Adjustment Mechanism (CBAM). The package aims to reduce the compliance burden on businesses, such as European Sustainability Reporting Standards (ESRS) disclosure and supply chain audits, by reducing the number of target businesses. This is intended to enhance the Union's international competitiveness and is seen as a response to investment competition with the United States and China. Additionally, on 27 May, the European Union announced the relaxation of automobile exhaust gas regulations (changing the target value achievement from a single year in 2025 to an average over the period from 2025 to 2027)[25].

Examples of specific policies and documents calling for strengthening competitiveness in the European Union include the Clean Industrial Deal[26] and the Draghi Report[27]. The Clean Industrial Deal is a comprehensive package announced by the European Commission on 26 February to make decarbonisation an engine for 'industrial competitiveness'. It aims to address high energy costs and global competition by simultaneously advancing industry electrification and the renewable energy transition while reducing costs. The main pillars include: 1/ an affordable energy action plan (developing power grids and promoting electrification); 2/ creating demand for clean products (introducing sustainability and European resilience standards into procurement rules); 3/ mobilising funds (channelling more than €100 billion through an industrial decarbonisation bank and innovation fund); 4/ resource circulation and joint procurement of critical minerals; 5/ skills development; and 6/ simplifying regulations. The background to these developments is the Draghi Report, published in September 2024, in which former European Central Bank (ECB) President Mario Draghi summarised 'The Future of European Competitiveness' at the request of the European Commission. Taking into account the future transition costs of energy-intensive industries, the report analyses factors such as lack of investment in growth, persistently high energy prices, and lack of competitiveness. Thus, within the European Union as well, the need to enhance competitiveness across multiple fronts is being asserted, and these phenomena—which can be seen as actions based on such assertions—represent a gradual shift away from the previous overemphasis on climate change countermeasures.

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23 European Commission, "Competitiveness compass", https://commission.europa.eu/topics/eu-competitiveness/competitiveness-compass_en. Retrieved 20 August 2025

24 European Commission, "Commission simplifies rules on sustainability and EU investments, delivering over €6 billion in administrative relief", 6 February 2025

25 European Union, "$CO_2$ emissions in cars: Council gives final approval to additional flexibility for carmakers", https://www.consilium.europa.eu/en/press/press-releases/2025/05/27/co2-emissions-in-cars-council-gives-final-approval-to-additional-flexibility-for-carmakers/pdf/, 27 May 2025

26 European Commission, "Clean Industrial Deal", https://commission.europa.eu/topics/eu-competitiveness/clean-industrial-deal_en, Retrieved 8 August 2025

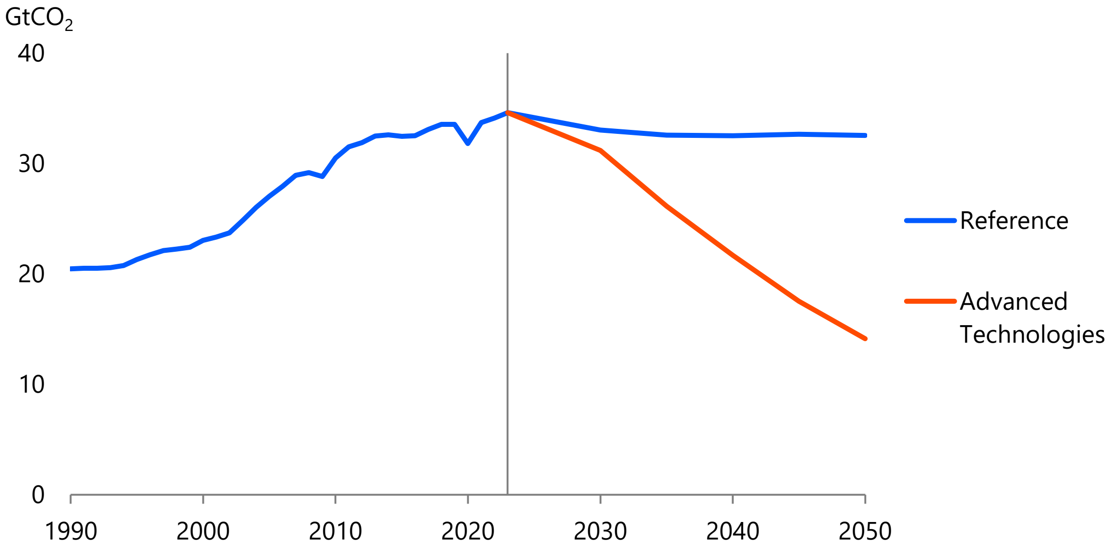
27 European Commission, "The Draghi report on EU competitiveness", https://commission.europa.eu/topics/eu-competitiveness/draghi-report_en, Retrieved 8 August 2025

Compared with the past, climate change measures have clearly shown a softening trend since around the start of the second Trump administration. On the other hand, renewable energies, particularly solar photovoltaics and wind, will likely see increased adoption in line with market principles as power generation costs fall.

## 5.2 Outlook for emissions

Figure 5-1 shows the world's carbon dioxide ($CO_2$) emissions[28]. In the Reference Scenario, emissions will peak in the mid-2020s, followed by a continuous decline towards 2035. However, the rate of decline will slow from 2035 onwards and remain roughly flat until 2050. On the other hand, in the Advanced Technologies Scenario, emission reductions will proceed smoothly towards 2050. Comparing $CO_2$ emissions between the two scenarios, the Advanced Technologies Scenario shows a significant reduction of 22% in 2035, 35% in 2040, and 57% in 2050 compared with the Reference Scenario. Meanwhile, according to the Intergovernmental Panel on Climate Change (IPCC)'s Sixth Assessment Report (AR6), to achieve the 1.5°C target, greenhouse gas (GHG) emissions need to be reduced by 43% by 2030 compared with 2019 levels, 60% by 2035, and 69% by 2040. However, the reductions under the Advanced Technologies Scenario will be only 7% in 2030, 22% in 2035, 35% in 2040 and 58% in 2050. This comparison reveals a significant gap with the 1.5°C target, highlighting that current measures alone are far from sufficient and that additional actions are essential. In addition, the latest assessment shows that the carbon budget has shrunk significantly since AR6, making the 1.5°C target unrealistic and necessitating a more realistic target of 2°C. This point is discussed in Section 9.2

**Figure 5-1 | Global $CO_2$ emissions**

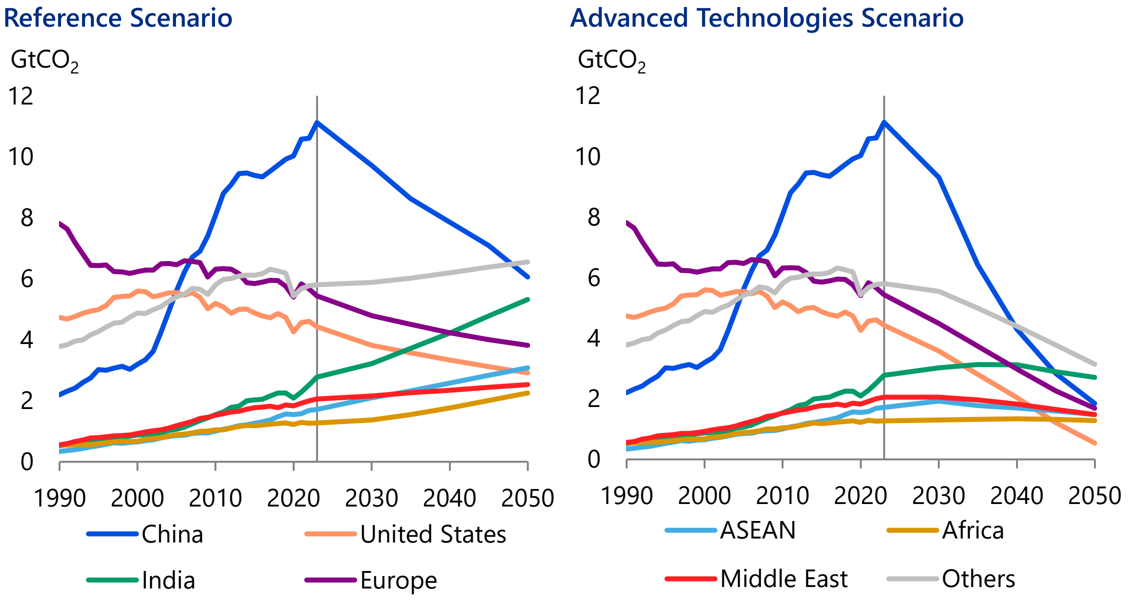



In 2023, China accounted for 32% of $CO_2$ emissions and the United States for 13%, with these two countries accounting for roughly half of global emissions. Looking at future emissions by region, emissions in the Reference Scenario will continue to decline in China, the United States and Europe (Figure 5-2). Emissions will continue to increase in India, the Association of Southeast

[28] Energy-related $CO_2$ emissions minus removals by direct air capture and carbon storage (DACCS). The same applies throughout this chapter.

Asian Nations (ASEAN), Africa and the Middle East, while in the Advanced Technologies Scenario, emissions will decrease in all eight countries/regions.

**Figure 5-2 | $CO_2$ emissions**

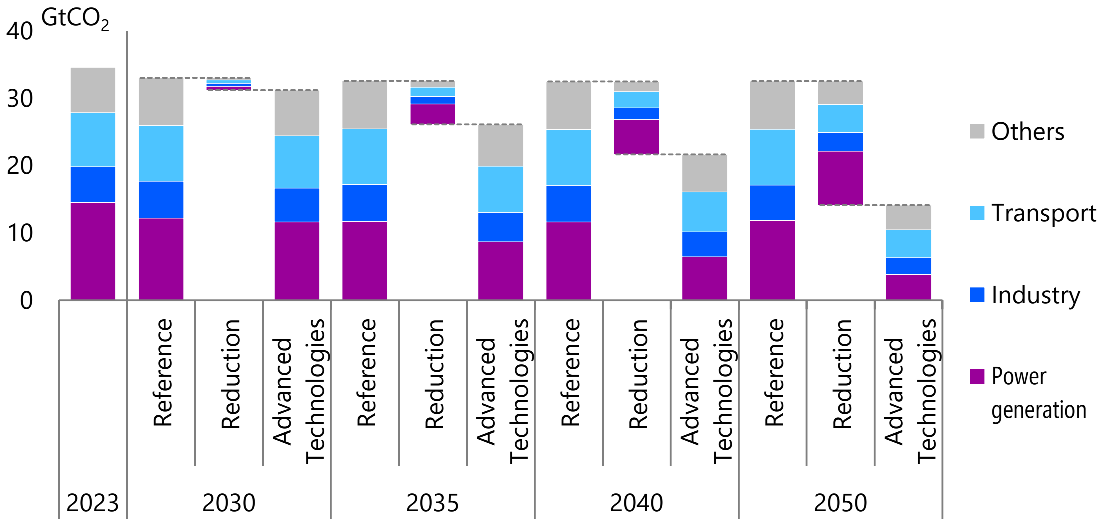



In the Advanced Technologies Scenario for 2050, the largest reduction from the Reference Scenario will be achieved by the United States (82% reduction), followed by China (70% reduction). These outstanding reductions by the two countries, as shown in Figure 3-12, will be attributable to the marked decrease in carbon emissions intensity in the power generation sector due to the expanded introduction of solar photovoltaics and wind. Emissions reductions in ASEAN and India will be around 50% compared with the Reference Scenario, while reductions in Africa and the Middle East will remain in the low 40% range. As stated above, while overall carbon emissions intensity in China and the United States is relatively low, intensity levels in the power generation sector remain high in ASEAN, India, the Middle East and Africa. This is attributable to significant increases in gross domestic product (GDP) in ASEAN and India, coupled with persistently high energy consumption per unit of GDP (indicating that economic growth and environmental impacts will not be decoupled).

In the Advanced Technologies Scenario, India's emissions decline only slowly from 2040 to 2050, and at this rate, it will be difficult for the Indian government to achieve its target of net zero by 2070. Therefore, policies and investments that contribute to emissions reduction, along with the promotion of clean power sources, are required.

The sectoral share of global $CO_2$ emissions in 2023 was approximately 42% for power generation, 15% for industry, and 23% for transport (Figure 5-3). In the Reference Scenario, $CO_2$ emissions from the power generation, industry, and transport sectors will decline only marginally between 2023 and 2030. From 2030 onwards, each sector will experience a slight decrease or stagnation, followed by no significant change in emission shares in 2050. On the other hand, in the Advanced Technologies Scenario, emissions from the power generation sector will decrease year by year, falling sharply to 26% by 2050 compared with 2023. Similarly, emissions from the industry and transport sectors will continue to decline, with the former reducing emissions by 46% and the latter by 52% in 2050 compared with 2023.

**Figure 5-3 | Global $CO_2$ emissions**




Note: Removals through the direct air capture and storage (DACCS) and bioenergy with carbon capture and storage (BECCS) are excluded from Other and Power Generation, respectively.

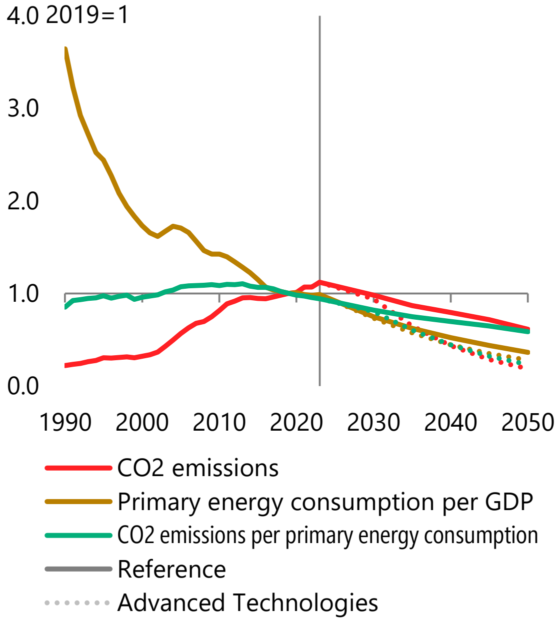
In the decomposition of factors affecting $CO_2$ emissions, two key indicators are considered: the reduction in $CO_2$ emissions per unit of primary energy consumption ($CO_2$ emissions/primary energy consumption) and the reduction in primary energy consumption per unit of GDP (primary energy consumption/GDP). Taking these factors into account, China, ASEAN, India, and the United States, where future $CO_2$ emissions are projected to fluctuate significantly, are analysed. Figure 5-4 to Figure 5-7 show the breakdown of $CO_2$ emissions, primary energy consumption per unit of GDP, $CO_2$ emissions per unit of primary energy consumption and $CO_2$ emission reductions by sector.

China's $CO_2$ emissions will peak in the mid-2020s in both the Reference Scenario and the Advanced Technologies Scenario, before continuing to decline. $CO_2$ emissions per unit of primary energy consumption reached their peak in 2013 and have been on a downward trend since then. One of the reasons for this decline was the introduction of renewable energies. As shown in Table A25, as of 2013, renewables accounted for only a small portion of China's power generation mix, with coal-fired power generation accounting for the majority. However, the introduction of renewables continued to expand, increasing their share by 2023.

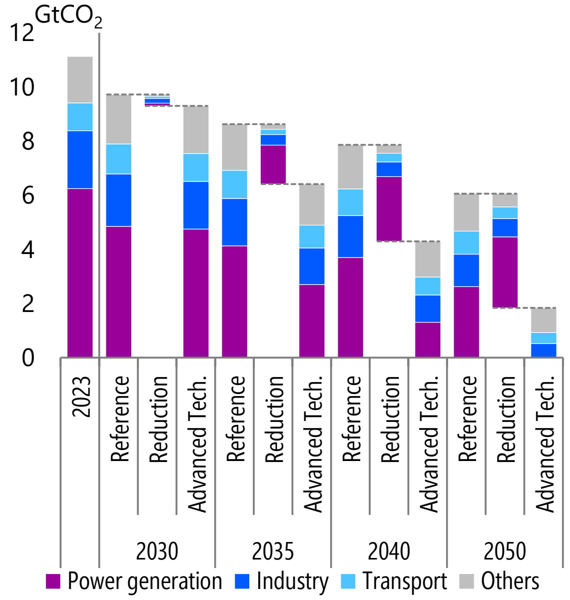
Even after 2023, the introduction of solar photovoltaics and wind continues. In the Advanced Technologies Scenario, in particular, solar photovoltaics and wind will account for approximately 70% of total electricity generated in 2050, a proportion that is extremely high even by international standards. Looking at $CO_2$ emissions by sector, those from the power generation sector will decrease year-on-year in both the Reference Scenario and the Advanced Technologies Scenario. In addition, primary energy consumption per unit of GDP has been declining every year since 1990, with the exception of certain periods. The downward trend will continue from 2023 onwards, with emissions by 2050 projected to be 64% lower than 2019 levels in the Reference Scenario and 72% lower in the Advanced Technologies Scenario.

**Figure 5-4 | Primary energy consumption per GDP and emission reductions in China**

**$CO_2$ emissions**



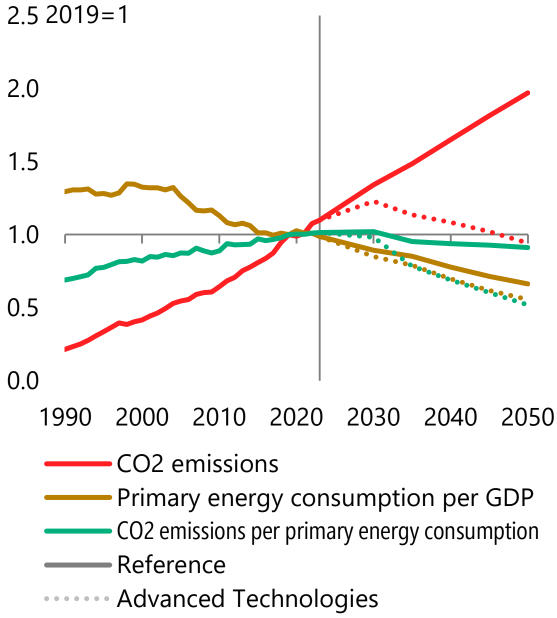

**$CO_2$ emission reductions by sector**



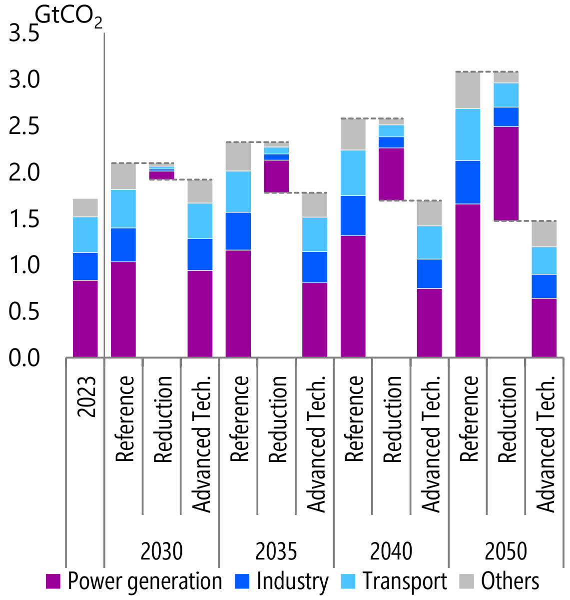

In ASEAN, $CO_2$ emissions keep increasing along with economic growth and will continue to grow due to strong growth in the future. In the Reference Scenario, $CO_2$ emissions will increase year by year towards 2050, while in the Advanced Technologies Scenario, they will peak around 2030. During the same period (2030), $CO_2$ emissions per unit of primary energy consumption will reverse their previous stagnant trend and begin to decline. Furthermore, primary energy consumption per unit of GDP, which was almost stagnant until 2004, began to decline, followed by a year-on-year decrease from 2023 onwards. On the other hand, in terms of $CO_2$ emissions by sector in 2050, they will double in the power generation sector compared with 2023 levels, increase 1.5 times in the industry sector, and increase approximately 1.5 times in the transport sector. In the Advanced Technologies Scenario, emissions will fall by 20% in the power generation sector, by 14% in the industry sector, and by 20% in the transport sector. Thus, to reduce $CO_2$ emissions during economic growth, both primary energy consumption per unit of GDP and $CO_2$ emissions per unit of primary energy consumption must be lowered, presenting significant hurdles on the path towards decarbonisation and carbon neutrality.

### Figure 5-5 | Primary energy consumption per GDP and emission reductions in ASEAN

**$CO_2$ emissions**



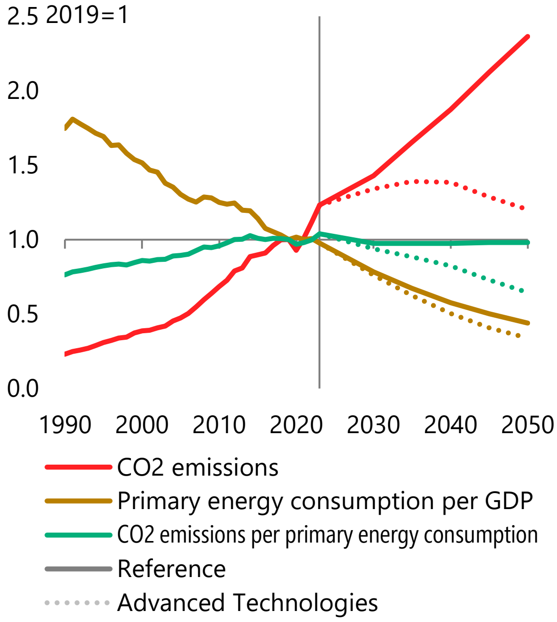

**$CO_2$ emission reductions by sector**



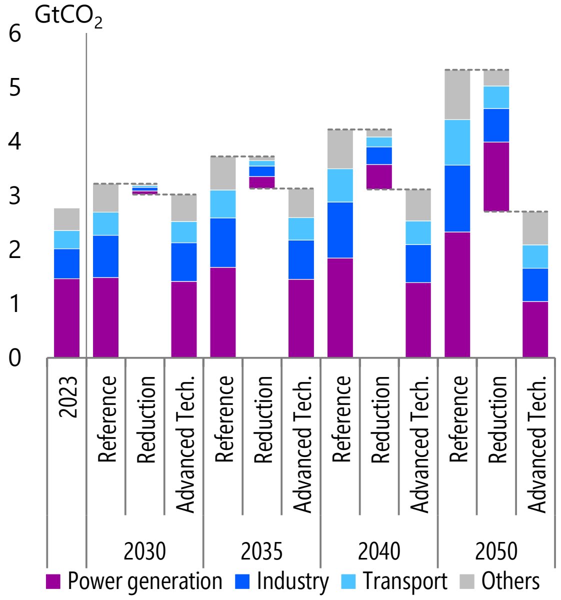

India will follow a path very similar to that of ASEAN, although the scale of its emissions may differ. However, even in the Advanced Technologies Scenario, $CO_2$ emissions will peak in 2040, and given that $CO_2$ emissions in 2050 are roughly equivalent to those in 2023, achieving a decarbonised society is becoming increasingly challenging.

### Figure 5-6 | Primary energy consumption per GDP and emission reductions in India

**$CO_2$ emissions**




**$CO_2$ emission reductions by sector**



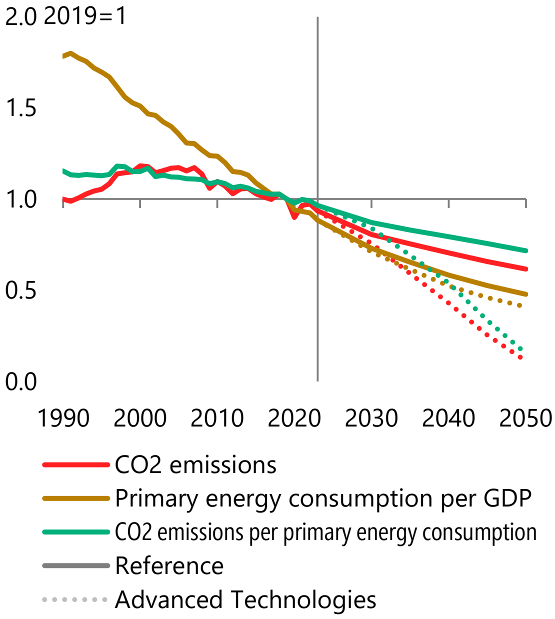
In the United States, $CO_2$ emissions, which already peaked in the 2000s, will decline in the long term under both the Reference Scenario and the Advanced Technologies Scenario. However, it is necessary to closely monitor the situation as the pace of decline may slow depending on future policy trends. On the other hand, $CO_2$ emissions per unit of primary energy consumption and primary energy consumption per unit of GDP show a broadly decreasing trend under both scenarios. In 2050, $CO_2$ emissions from the transport and power generation sectors will decline by 42% compared with 2023 levels in the Reference Scenario, while they will decrease by 81% in the transport sector and by 99% in the power generation sector in the Advanced Technologies Scenario. Unlike China, India and ASEAN, the United States has a large transport sector, which accounts for a substantial share of its $CO_2$ emissions. However, as mentioned above, in the Advanced Technologies Scenario, significant decarbonisation is also achieved in the transport sector, necessitating technology transfer to other countries.

In the Advanced Technologies Scenario, as stated above, China and the United States will have made significant reductions in emissions from their current levels by 2050, while the reduction rates of ASEAN and India will fall short of those of China and the United States. Comparing these two groups, it is notable that China and the United States will achieve near-zero emissions from the power generation sector. At the same time, $CO_2$ emissions per unit of primary energy consumption will decline substantially. As shown in Table A25, Table A26, Table A30 and Table A38,

China and the United States will significantly expand the introduction of renewable energies and power sources with carbon capture and storage (CCS) (including bioenergy with CCS [BECCS]). In other words, promoting the transfer of these technologies to developing countries such as ASEAN and India is essential for decarbonising the entire world.

**Figure 5-7 | Primary energy consumption per GDP and emission reductions in the United States**

**$CO_2$ emissions**




**$CO_2$ emission reductions by sector**