2. Energy demand

2.1 Primary energy consumption

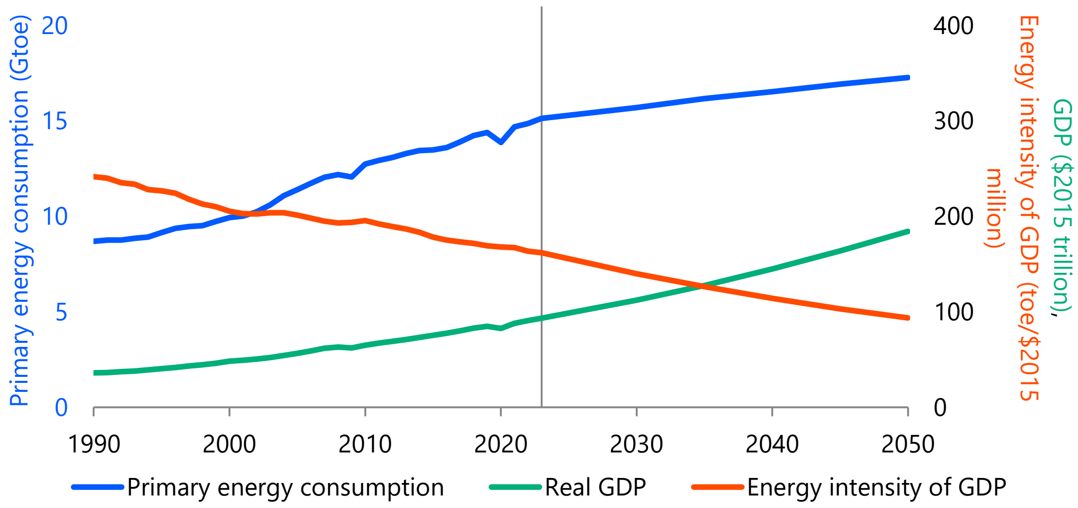
Whilst improvements in energy consumption per unit of GDP are being made from the perspective of climate change countermeasures and energy security, the volume continues to increase.

Even in 2025, the effects of climate change have been evident, with extreme wildfires in California in January, extreme heat waves in India and Pakistan since April, and the worst wildfires on record across Europe, covering an area of over 1 million hectares in the summer. To mitigate the impacts of climate change, each country has set greenhouse gas (GHG) emission reduction targets, and at the 29th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP29), held in Baku, Azerbaijan in November 2024, it was planned to conduct a follow-up, from 2025 until COP33, on the results of the Global Stocktake, which assessed global progress on GHG reductions and was completed at COP28. However, some developing economies claimed that there was no need for monitoring or follow up, while major advanced economies and small island nations called for confirmation of the implementation status of the agreement. This led to a sharp confrontation between the two sides, and further discussions were postponed. In 2025, US President Donald Trump directed the withdrawal of the United States from the Paris Agreement and related international climate commitments, with the withdrawal scheduled to take effect in January 2026, one year after notification. The framework for the 2050 net-zero target is losing momentum, with major banks withdrawing from the Net Zero Banking Alliance (NZBA), an international coalition aiming for decarbonisation, following pressure from some US Republican lawmakers. The European Union (EU) has also been proceeding with an ambitious proposal to reduce emissions by 90% compared with 1990 levels by 2040, but there are moves to allow the use of credits from afforestation and renewable energy deployment outside the European Union to achieve national targets, as well as to delay a final decision due to opposition from member states.

Furthermore, amid heightened tensions in the Middle East, Iran proposed a blockade of the Strait of Hormuz in June 2025. In August, escalating hostilities in Ukraine led to Ukrainian attacks on Russia's Druzhba crude oil pipeline facilities. Additionally, large-scale power outages occurred in Spain and Portugal in May. These developments have heightened concerns regarding energy supply stability and price stabilisation. On the energy demand side, there are growing uncertainties, including potential increased electricity consumption associated with digital transformation driven by generative artificial intelligence (AI) and other technologies. Consequently, while acknowledging diverse energy transition pathways, countries are strengthening policies to promote economic growth and a stable supply through enhanced energy efficiency and reduced fossil fuel dependence via clean technologies.

Global primary energy intensity per gross domestic product (GDP) from 2023 to 2050 will decline faster than from 1990 to 2022 as countries around the world promote higher energy efficiency and energy conservation in the context of economic, climate change and energy security actions (Figure 2-1). Although COP28 set a target to double the annual rates of energy efficiency improvement from 2% to 4% until 2030, the actual improvement is expected to reach only 2.1% annually from 2023 to 2030, decline to 2.0% by 2035 and remain at 2.0% up to 2050. As global GDP will grow faster than improvements in energy intensity, primary energy consumption will continue to rise. Energy consumption growth, which was 1.7% per year from 1990 to 2023, will slow to 0.5% per year from 2023 to 2035 due to continued progress in energy conservation and will remain at the same annual pace through 2050. As a result, global energy consumption will increase by 9% relative to 2023 levels by 2035, reaching 16 164 million tonnes of oil equivalent (Mtoe) and by 16% by 2050, to 17 298 Mtoe. It will be difficult to satisfy the new demand simply by increasing the supply of non-fossil fuels such as nuclear and renewable energies. Therefore, countries must enhance energy efficiency further to reduce global fossil fuel consumption with an eye towards the goals set at COP28.

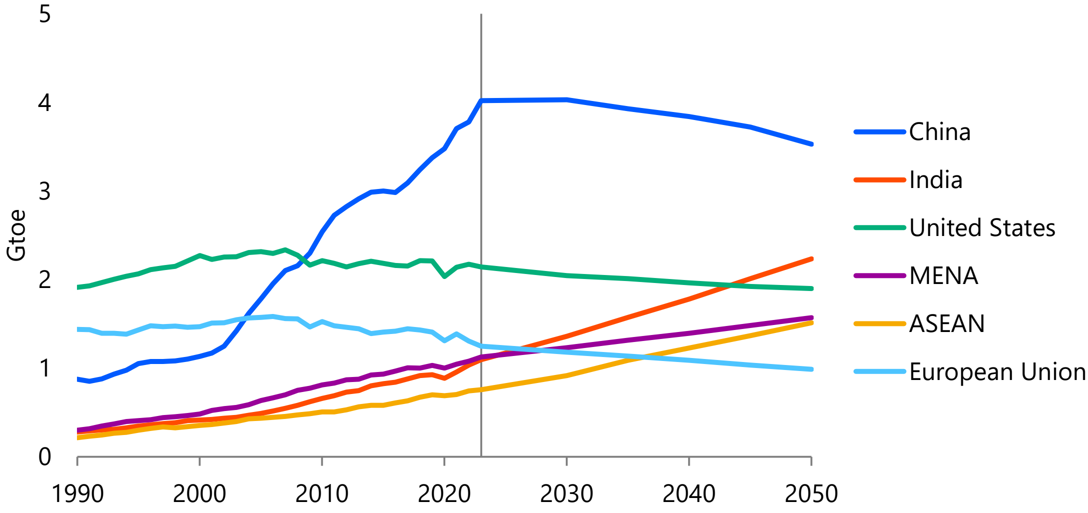
Figure 2-1 | Global primary energy consumption, real GDP and energy intensity of GDP [Reference Scenario]



By region, primary energy consumption in China, which has driven the global increase since 2000, will peak in the early 2030s and begin to decline due to slower economic growth as well as progress in energy efficiency, such as a shift towards services industries and the penetration of electric vehicles (EVs). Meanwhile, primary energy consumption in India, the Association of Southeast Asian Nations (ASEAN) and the Middle East and North Africa (MENA) will continue to increase in line with their rapid economic expansion, despite some progress in energy efficiency. The increase in these three countries/regions will account for 97% of the increase in the world's consumption from 2023 to 2035 and 110% from 2023 to 2050, pushing up global energy consumption, with their share growing from 20% in 2023 to 25% in 2035 and 31% in 2050 (Figure 2-2). Therefore, beyond the need to accelerate energy consumption reductions in Advanced Economies and China, the ability of India, ASEAN and MENA to moderate their energy consumption will determine global consumption trends and ultimately the success of climate change and energy security measures.

India, ASEAN and MENA, respectively, will increase their primary energy consumption by 2.7%, 1.2% and 2.6% per annum from 2023 to 2050 and account for 13%, 9% and 9% of global energy consumption in 2050. This is because their GDP will continue to grow at high annual rates of 5.7%, 4.1% and 3.0% through 2050. From the perspective of curbing global energy consumption, decoupling economic growth from energy consumption in these countries/regions represents a critical global challenge.

Figure 2-2 | Primary energy consumption in selected countries/regions [Reference Scenario]



Advanced Economies, including the United States, the European Union and Japan, as well as China, must continue reducing their energy consumption in light of climate change and energy security concerns. However, in the United States, President Trump has suspended funding allocations under the Inflation Reduction Act and revoked environmental executive orders issued under the previous Biden administration, such as the target for electric vehicles to account for 50% of annual new car sales by 2030. In the European Union, regulations for automotive manufacturers continue to be relaxed through the postponement of targets and increased flexibility, treating the 2025 carbon dioxide (CO_2) emission standards as a three-year average from 2025 to 2027, reflecting the difficulty of achieving them. China's 14th Five-Year Plan, announced in 2021, set a goal of reducing CO_2 emissions per GDP by 18% between 2021 and 2025 compared with 2020 levels, but by 2023, emissions had increased from the previous year, resulting in only a 2% reduction relative to 2020. The United States, Europe, Japan, and China will account for 40% and 21% of global GDP in 2035 and 35% and 23% in 2050, respectively, and will continue to hold large shares of energy consumption, at 22% and 24% in 2035 and 18% and 20% in 2050. To restrain global energy consumption in support of climate change and energy security measures, these economies should accelerate their reduction of energy consumption while contributing to stable global economic growth through sustained consumption and investment.

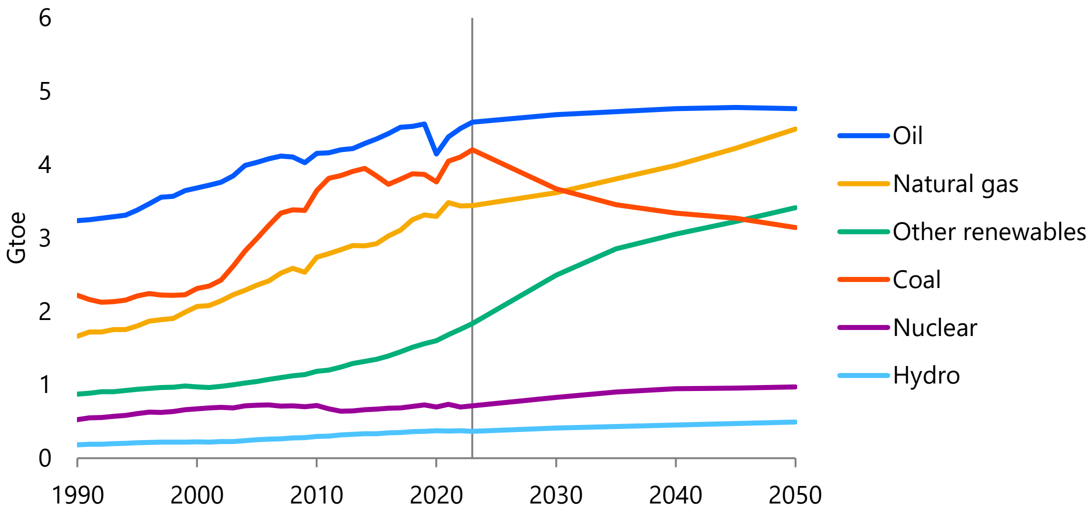
Further reducing global energy consumption will require enhanced international cooperation between advanced economies and emerging and developing economies, as well as among emerging and developing economies, alongside strengthened national policies. Advanced economies such as the United States, Europe and Japan must facilitate efficient technology transfer and support emerging and developing economies to achieve economic growth while limiting energy consumption by utilising Article 6 of the Paris Agreement, adhering to the new joint numerical targets on climate finance agreed at COP29, and addressing energy security concerns, particularly regarding fossil fuel supply instability.

Fossil fuel consumption continues to expand, with natural gas seeing particularly strong growth, continues to expand amid growing concerns about climate change and energy security.

In addition to the global trend towards carbon neutrality, Russia's invasion of Ukraine has heightened concerns about the stable supply of fossil fuels, particularly in Europe. As part of climate change mitigation efforts, COP28 established ambitious targets to triple global renewable energy installed capacity by 2030 compared with 2022 levels and triple global nuclear power generation installed capacity by 2050 compared with 2020 levels.

However, under current plans, nuclear will only reach 1.4 times the 2020 level by 2050 on a primary energy basis. Although renewables will sustain the growth observed during the 2020s, they will increase by only 1.4 times between 2022 and 2030. Growth will further slow after 2030 due to land availability and grid integration constraints, resulting in a 1.5-fold increase by 2035 and 1.8-fold by 2050 (Figure 2-3). Additionally, the adoption of hydrogen and ammonia will remain limited, as demand is not yet sufficient to justify their high costs.

Figure 2-3 | Global primary energy consumption [Reference Scenario]



Fossil fuel consumption declined significantly in 2020, partly due to the economic downturn and voluntary home confinement (or lockdowns) amid the COVID-19 pandemic. However, consumption rebounded as economies recovered from the pandemic, with coal and oil reaching a record high in 2023. Until 2030, overall fossil fuel consumption will decrease, as a significant reduction in coal offsets increases in oil and natural gas. After 2030, due to a larger increase in natural gas, fossil fuel consumption will resume growth, rising by 1.4% by 2050 compared with 2023 levels. Although the supply concerns have heightened due to Russia's invasion of Ukraine, natural gas, which emits the least carbon among fossil fuels, will be the most actively utilised fossil fuel to support climate change mitigation. Natural gas consumption will grow at an average annual rate of 1.0% through 2050, reaching 1.3 times its 2023 level, primarily driven by demand in the power generation sector. Oil will increase until the mid-2040s due to greater movement of people and goods and expanded use of petrochemical feedstocks. It will then begin to decrease slightly as the penetration of electrified vehicles increases and fuel efficiency improves in the road sector. This marks a departure from the IEEJ Outlook 2025, which projected that oil consumption on a calorie basis would continue to increase throughout the projection period. However, it is essential to recognize that consumption levels in 2050 will remain comparable to current levels and may even exceed them on a volume basis (p.28). Whilst coal will increase in India and ASEAN, where electricity demand is expanding, due to its low cost, it will generally decline due to climate change mitigation measures, mainly in Advanced Economies, and air pollution, mainly in China. Coal will decline at an annual rate of 1.1% by 2050 and will be lower than that of renewable energy sources excluding hydro in the late 2040s.

While non-fossil energy sources will increase, overall energy demand will grow even faster. As a result, non-fossil sources alone will not be sufficient to meet total energy demand over the next three decades. Through 2050, it will remain realistic for the world, especially Emerging and Developing Economies whose energy consumption is increasing, to use both fossil fuels and non-fossil energy (Figure 2-4).

Figure 2-4 | Primary energy consumption changes [2023–2050, Reference Scenario]

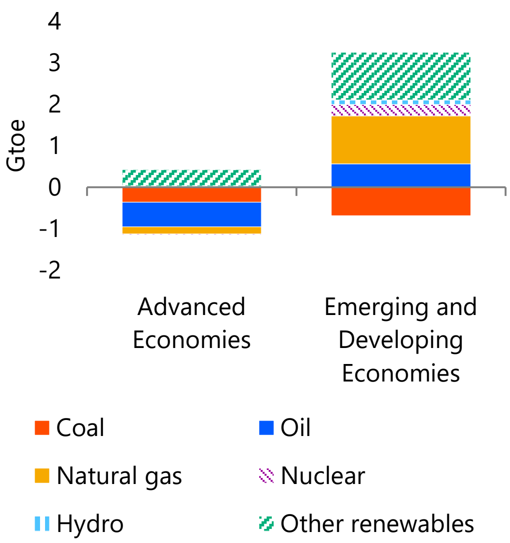
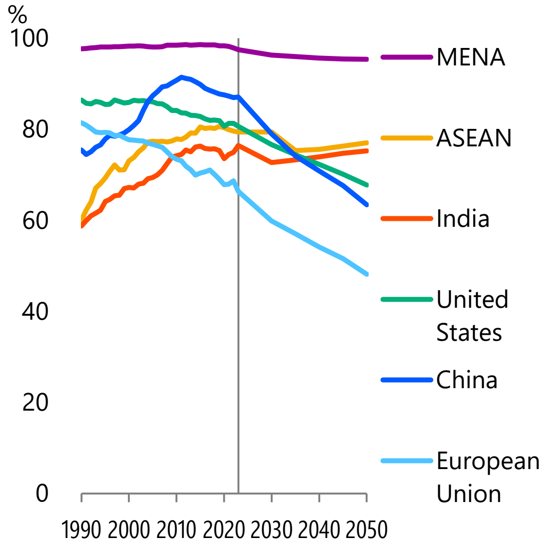


Figure 2-5 | Dependence on fossil fuels in selected economies/regions [Reference Scenario]



Dependence rates on fossil fuels will decrease from 81% in 2023 to 72% by 2050. The United States, the European Union and Japan will see their dependence rates decline from 81%, 66% and 85% in 2023 to 68%, 48% and 64% in 2050, respectively, as the adoption of non-fossil energy sources advances amid declining total energy consumption (Figure 2-5). Meanwhile, Emerging and Developing Economies excluding China will see their dependence rates remain high. Fossil fuel dependence rates in India, ASEAN and MENA will remain high at 75%, 77% and 95%, respectively, due to increasing total energy consumption, with fossil fuels continuing to meet much of this rising demand.

Energy consumption reduction and decarbonisation will not be easy in any sector.

Among sectors, industry will experience the highest energy consumption growth, primarily in Emerging and Developing Economies, followed by the transport sector, the buildings sector and the other transformation sector, with similar increases (Figure 2-6). In the industry sector, production in secondary industries, such as machinery, will expand significantly in Emerging and Developing Economies. The transport sector will see increased consumption by motor vehicles as incomes rise in Emerging and Developing Economies, while consumption by air and sea transport will also grow substantially due to increased passenger movement and international trade. Energy consumption growth in the buildings sector will also be significant. In India, ASEAN and MENA, the continued development of tertiary industries, including global call centres and improved household access to energy will drive demand growth. Rising living standards in these economies will further push up energy consumption in the buildings sector. Given these factors, it will be challenging for these economies to curb energy demand while maintaining economic growth. Furthermore, some point out that data centres are driving up electricity demand globally, including in Advanced Economies.

Figure 2-6 | Contributions to global primary energy consumption changes [Reference Scenario]

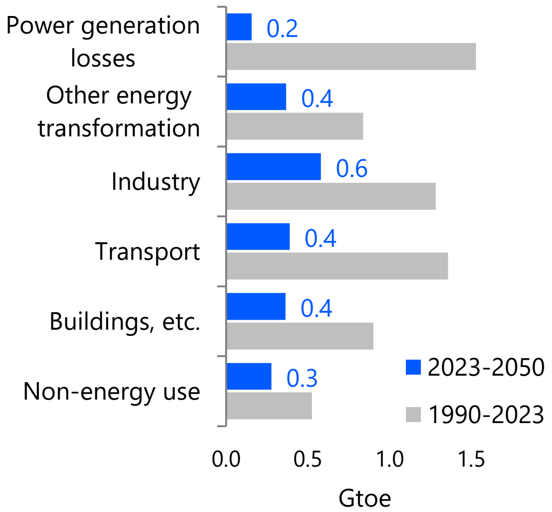
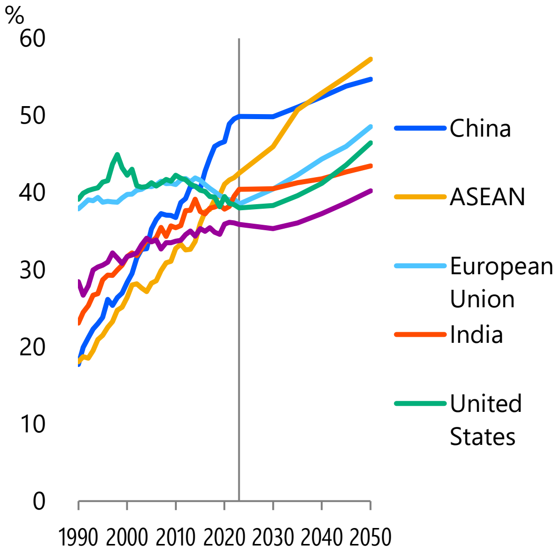


Figure 2-7 | Electrification rates on the supply side in selected economies/regions [Reference Scenario]

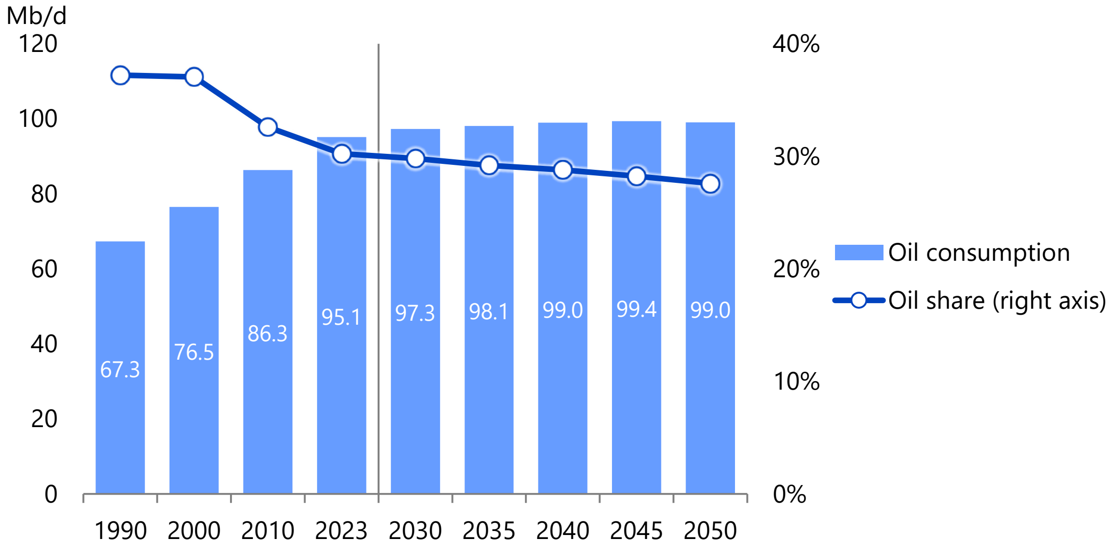


Energy consumption (losses) in the power generation sector will increase due to higher electricity generation resulting from rising electrification rates, although improvements in fossil fuel-fired power generation efficiency and a shift towards non-fossil power sources, which are assumed to have 100% efficiency (no losses), will partly offset this increase (Figure 2-7). As incomes rise and infrastructure development progresses in currently unelectrified regions, electricity consumption in Emerging and Developing Economies will continue to increase due to its convenience and widespread adoption. Furthermore, electricity demand will continue to grow, not only in Emerging and Developing Economies, but also in Advanced Economies, where digitalisation is increasing energy needs. Although the share of non-fossil energy sources is expected to grow, they will likely be insufficient to fully meet the rising electricity demand.

Oil consumption will peak in the late 2040s, while its share of primary energy consumption will decline gradually.

Global oil consumption, which stood at 95.1 million barrels per day (Mb/d) in 2023, will increase gradually, peaking in the mid-2040s before accounting for 99.0 Mb/d in 2050 (Figure 2-8). The oil share of primary energy consumption will continue to decline slightly from 30% in 2023 to 28% by 2050. This rate of decline will remain comparable to that observed between 2010 and 2023. Oil will remain the world’s most widely used energy source through 2050.

Figure 2-8 | Global oil consumption and its share of primary energy consumption [Reference Scenario]



In Advanced Economies, oil consumption has already peaked (Figure 2-9). Since reaching its peak in 2005, oil consumption has declined at an annual rate of 1.2%, but from 2023 to 2050, the decline will accelerate at an annual rate of 1.5%. The main factor driving this decline in Advanced Economies is the reduction in automobile fuel consumption, supported by fuel efficiency improvements and the adoption of electrified vehicles, including hybrid vehicles. By contrast, oil consumption in India, ASEAN and MENA will steadily increase at an annual rate of 1.5% from 2023 to 2050. The oil consumption of these economies will grow mainly in the transport, non-energy use and buildings sectors.

Figure 2-9 | Oil consumption in selected economies/regions [Reference Scenario]

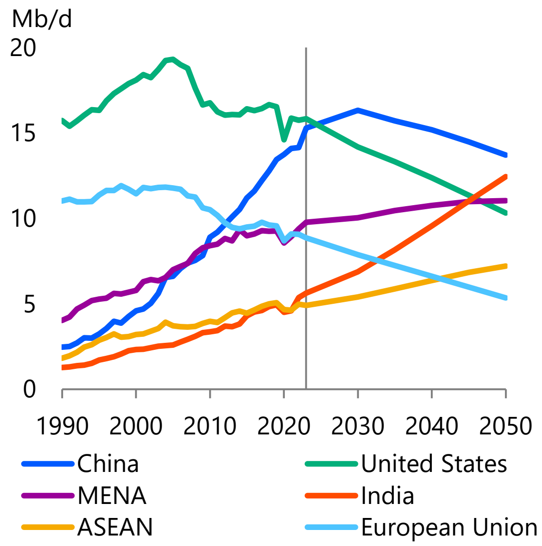
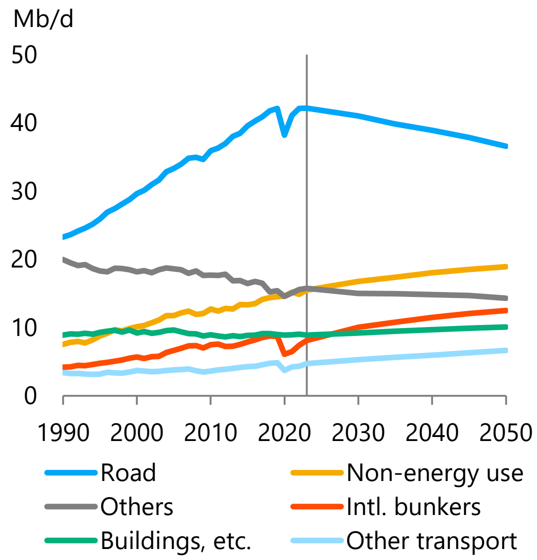


Figure 2-10 | Global oil consumption [Reference Scenario]



By sector, oil consumption in the road sector, which has the largest share, will peak in the 2020s and then decline, as the effects of fuel efficiency improvements and the expansion of electrified vehicles outweigh the impact of increasing vehicle ownership (Figure 2-10). Meanwhile, oil consumption in the other transport sector, including international bunkers, domestic aviation and domestic navigation, is difficult to replace through means such as electrification. Rising trade and passenger mobility will drive growth in this area.

In India, ASEAN and MENA, oil consumption for automobiles will rise from 8.8 Mb/d in 2023 to 13.7 Mb/d in 2050. Vehicle ownership in these countries/regions will increase by 3.4-fold from current levels, supported by rising incomes and improvements in transport infrastructure, such as roads and bridges. To curb oil consumption, it will be necessary to actively promote a transition to electric vehicles and others. In Emerging and Developing Economies, the initial cost of electric vehicles may remain higher compared with conventional cars even in 2050, restricting sales to high-income consumers unless strong climate policies and financial incentives are implemented.

Oil consumption in the non-energy use sector, primarily for petrochemicals, will increase by 2.3 Mb/d from 2023 to 2050 in India, ASEAN and MENA, accounting for 68% of global growth in the sector. While global demand for plastics and other petrochemical products is strong, oil-producing countries hope to foster their petrochemical industries as part of their industrial diversification. This means that both supply-side and demand-side factors will drive oil consumption growth in this sector. To suppress consumption in the sector, regulations on plastics consumption will need to be toughened. However, even from the perspective of addressing plastic waste issues, the reality is that establishing an international prevention treaty, as called for by the United Nations Environment Assembly in 2022, remains as difficult as climate change measures, with the 2025 intergovernmental negotiations failing to reach agreement.

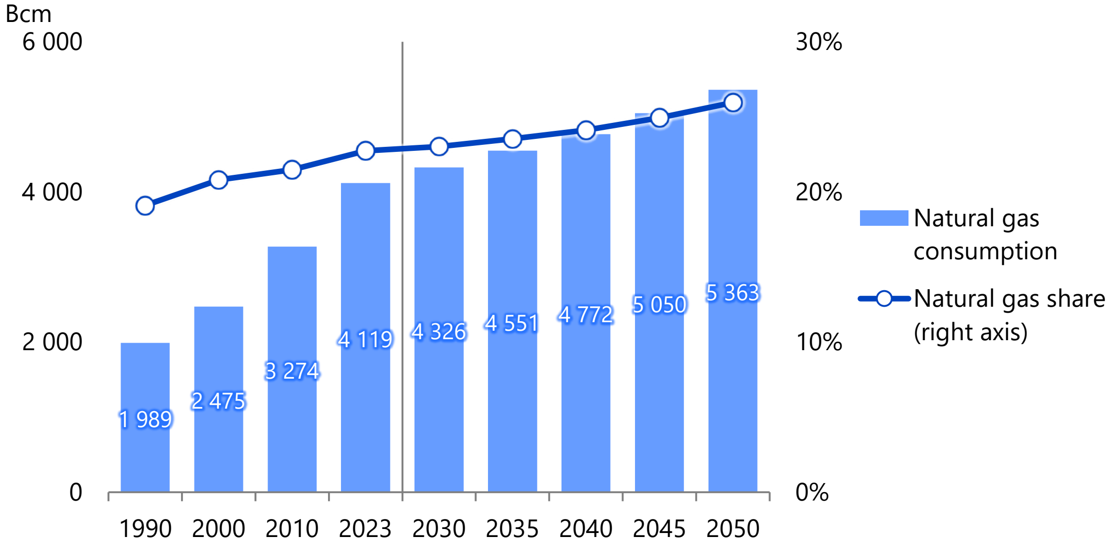
Oil consumption in the buildings sector of India, ASEAN and MENA will increase by 1.5 Mb/d from 2023 to 2050, accounting for 119% of the net global increase in this sector. As incomes rise, consumers in these countries/regions will shift from coal and solid biomass to oil, which is a relatively cleaner alternative in terms of health impacts. It should also be noted that in Sub-Saharan countries other than South Africa, oil consumption by the buildings sector will increase by 0.5 Mb/d during the same period. In those countries, the high initial investment required to switch to and operate electricity or city gas for water heating and cooking leads consumers to choose liquefied petroleum gas for that purpose.

China’s oil consumption is expected to increase mainly in the non-energy use sector, peaking at 16.3 Mb/d around 2030, before declining to 13.7 Mb/d in 2050 due to a decline in the road sector driven by the increase in electric vehicles. Accelerating the reduction of oil consumption in China will be critical to achieving deeper global reductions in oil use.

Demand for natural gas for power generation continues to grow in India, ASEAN and MENA.

Natural gas consumption will see the largest increase of all energy sources through 2050. Global consumption will grow at an annual rate of 1.0%, rising from 4 119 billion cubic metres (Bcm) in 2023 to 5 363 Bcm in 2050 (Figure 2-11). As a result, natural gas will expand its share of primary energy consumption from 23% in 2023 to 26% in 2050, making it the second most consumed energy source after oil. As the European Union reduces its dependence on Russian natural gas and increases imports from other regions, particularly liquefied natural gas (LNG), the question of how to limit global natural gas demand growth remains critical.

Figure 2-11 | Global natural gas consumption and its share of primary energy consumption [Reference Scenario]



India, ASEAN and MENA will account for 77% of the total global increase in natural gas consumption, adding a combined 1 245 Bcm between 2023 and 2050 (Figure 2-12). By 2050, natural gas consumption will reach 215 Bcm in India, 1 134 Bcm in ASEAN and 590 Bcm in MENA. The Middle East is expected to increase domestic natural gas consumption while continuing to prioritise cost-competitive oil exports to generate foreign currency. India and ASEAN will expand natural gas consumption primarily for the power generation sector to meet their rising electricity demand. China will see an increase of 42 Bcm by 2050, driven primarily in the power generation sector, although its level will fall below ASEAN levels in the 2040s. In contrast, the European Union will accelerate its transition away from natural gas, reducing its consumption by 131 Bcm by 2050, falling below India's level.

By sector, natural gas consumption in the buildings sector will decline due to increasing electrification and energy efficiency improvements (Figure 2-13). In contrast, consumption in Emerging and Developing Economies, including China, will rise, particularly in the power generation and industry sectors. In the power generation sector, natural gas demand will remain largely stable until 2030 due to the expansion of renewables and other energy sources. After 2030, demand is expected to rise again as the deployment of alternative power sources fails to keep pace with growing electricity needs. Natural gas consumption for power generation in Emerging and Developing Economies will increase at an annual rate of 2.7% from 2023 to 2050, accounting for 109% of global growth in the sector. This trend is driven by natural gas's lower CO_2 emissions compared with other fossil fuels, its relatively high flexibility in adjusting supply in response to fluctuations in demand, and its ability to support large-scale power generation at lower integration costs than renewables.

Figure 2-12 | Natural gas consumption in selected economies/regions [Reference Scenario]

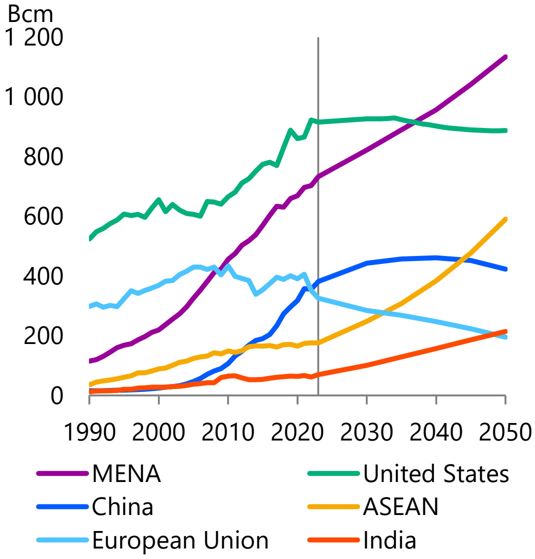
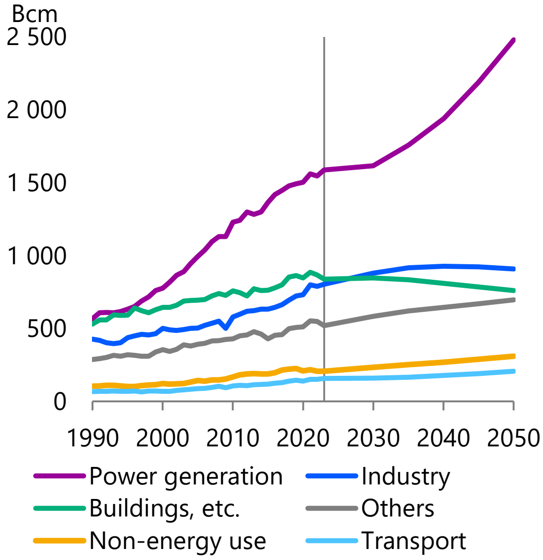


Figure 2-13 | Global natural gas consumption [Reference Scenario]



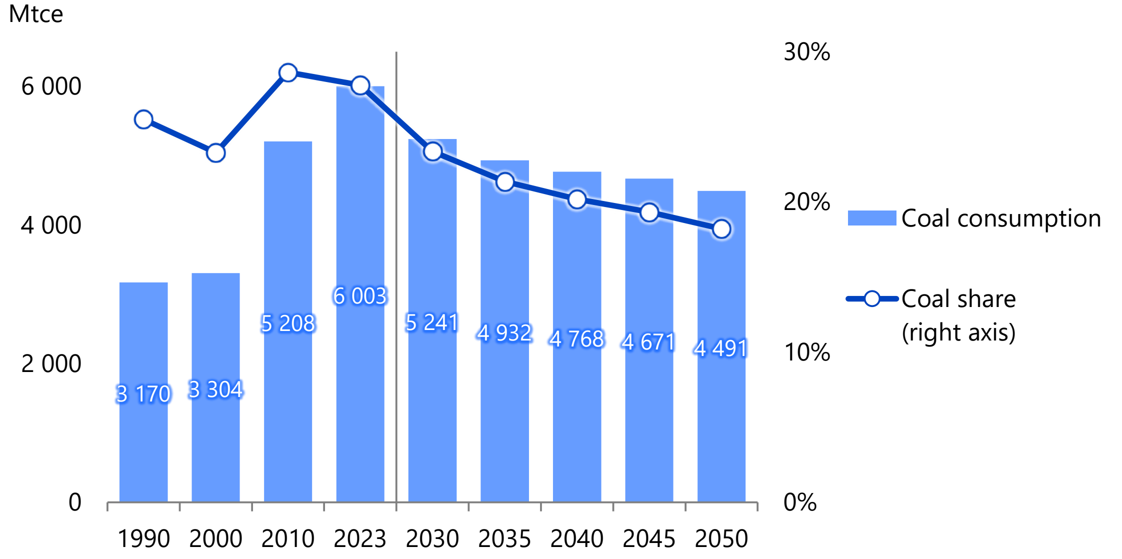
In the industry sector, natural gas consumption in Advanced Economies will decline, while demand in Emerging and Developing Economies will grow at an annual rate of 1.0%, contributing 149% of net global growth. Many industries will shift from oil and coal to natural gas due to its economic and environmental advantages. In the buildings sector, natural gas consumption is expected to decline due to increasing electrification and energy efficiency measures. China will be the primary driver of demand growth as it rapidly transitions from solid fuels such as coal and fuelwood to natural gas to improve air quality and public health.

As India, ASEAN, MENA and China drive the growth in natural gas consumption, they should adopt and widely implement high-efficiency technologies. For example, the power generation sector should fully utilise natural gas-fired combined cycle plants to optimise energy use and reduce consumption.

Coal consumption will peak in the 2020s due to environmental measures.

Global coal consumption, which stood at 6 003 million tonnes of coal equivalent (Mtce) in 2023, will decline at an annual rate of 1.1% due to the impact of environmental policies (Figure 2-14). Coal's share of primary energy consumption will decrease from 28% in 2023 to 18% in 2050. It will cede its position as the second-largest energy source to natural gas in the early 2030s, following oil, and will fall below renewables excluding hydro by the late 2040s.

Figure 2-14 | Global coal consumption and its share of primary energy consumption [Reference Scenario]



In 2023, China accounted for 58% of global coal consumption, while India and ASEAN together made up 17%. The United States, Europe and Japan collectively accounted for 10%. By 2050, coal consumption in China and these three Advanced Economies will decline to 39% and 5% of the global total, respectively, while India and ASEAN will see their combined share rise to 39%, matching China's level (Figure 2-15).

Figure 2-15 | Coal consumption in selected economies/regions [Reference Scenario]

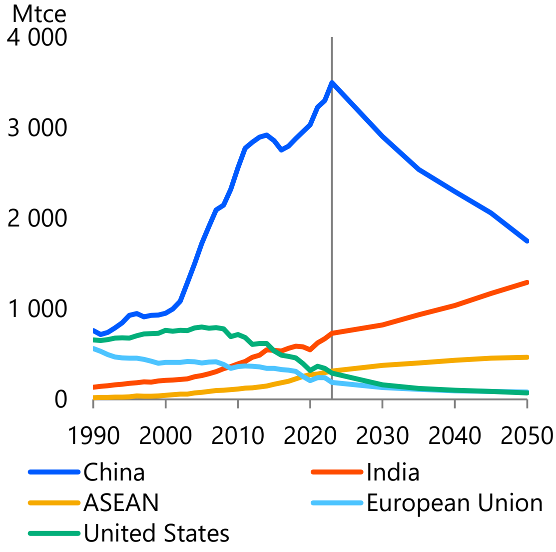
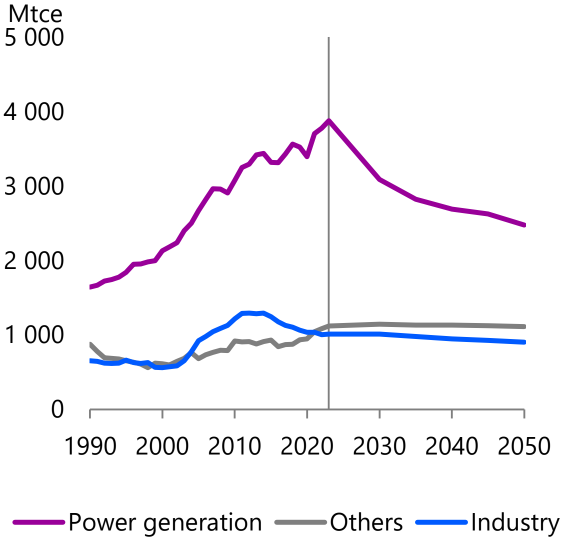


Figure 2-16 | Global coal consumption [Reference Scenario]



In China, coal consumption for industry has been declining since peaking in 2012, while that for power generation will decrease after peaking in the early 2020s due to measures against climate change and air pollution, which will result in a 50% overall decline in coal consumption by 2050. Coal consumption in the United States, Europe and Japan will continue falling in both the power generation and industry sectors, posting a 65% drop by 2050. In contrast, coal consumption in

India and ASEAN will continue to grow. By 2050, coal use for power generation will increase 1.6 times in India and 1.4 times in ASEAN. Industrial coal consumption will expand even more, rising by 2.0 times in India and 1.5 times in ASEAN. Note that MENA consumes limited coal due to the large number of oil- and gas-producing countries.

With growing pressure to address climate change, coal consumption has come under increasing scrutiny worldwide. At the 2024 meeting of environment ministers from the Group of Seven (G7), member countries agreed to phase out coal-fired power plants that lack emission reduction measures by 2035. In Europe, stricter regulations have raised the economic burden on coal-fired power plants while further tightening limits on CO_2 and mercury emissions. As such, restrictions on coal use are being strengthened in both the power generation and industry sectors. Meanwhile, in the United States, the Trump administration is promoting the use of coal to revitalise the domestic coal industry from the perspective of 'energy dominance'. While governments and financial institutions in Advanced Economies have been actively promoting coal divestment, an increasing number of financial institutions have been changing their policies since the Trump administration took office. Furthermore, many Emerging and Developing Asian Economies, including India and ASEAN, continue to rely on coal as an affordable domestic energy source to support energy self-sufficiency. These countries do not impose particularly strict restrictions on coal consumption. To curb coal consumption, Advanced Economies must accelerate their phase-out efforts, while China, India and ASEAN should prioritise switching from coal to natural gas and to hydrogen and ammonia, for both power generation and industrial use.

Non-fossil energy use, such as solar photovoltaics and wind, will increase, but their share of primary energy consumption will be limited.

As more countries pursue carbon neutrality, expectations for the expansion of non-fossil energy sources continue to rise. In conjunction with COP28, participating nations declared that they would triple the world's renewable power generation capacity by 2030. Separately, another declaration was issued to triple the world's nuclear power generation capacity by 2050 compared with 2020 levels.

Non-fossil energy consumption for power generation centred on nuclear and hydro will grow 2.2 times, rising from 1 753 Mtoe in 2023 to 3 864 Mtoe in 2050 (Figure 2-17).

The most rapid growth will come from solar photovoltaics, wind and other renewable sources, which will expand 4.9 times over the same period. In contrast, nuclear and hydro will see slower growth due to policy constraints, environmental concerns and social considerations. Consequently, the share of nuclear and hydro in non-fossil energy for power generation will decline from 62% in 2023 to 38% in 2050.

Meanwhile, non-fossil energy consumption for heating will remain largely reliant on traditional solid biomass, such as fuelwood and manure, which are widely used in rural areas of Emerging and Developing Economies. From 957 Mtoe in 2023, non-fossil energy consumption for heating will decrease to 696 Mtoe by 2050 (Figure 2-18). Its consumption will decline as rural residents switch to modern energy sources in line with improvements in their income and living standards. Liquid biofuel for transport and heating, along with biogas, will grow 1.7 times by 2050, though they will still make up only 23% of total non-fossil energy consumption for heating.-

Non-fossil energy consumption will dramatically increase towards 2050. However, its share of total primary energy consumption will not increase as significantly, since overall energy demand will continue to rise. The share will only increase from 19% in 2023 to 28% in 2050.

Figure 2-17 | Global non-fossil energy consumption for power generation [Reference Scenario]

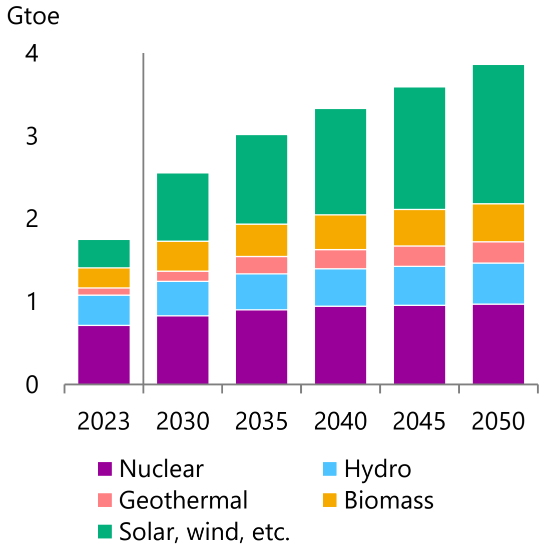
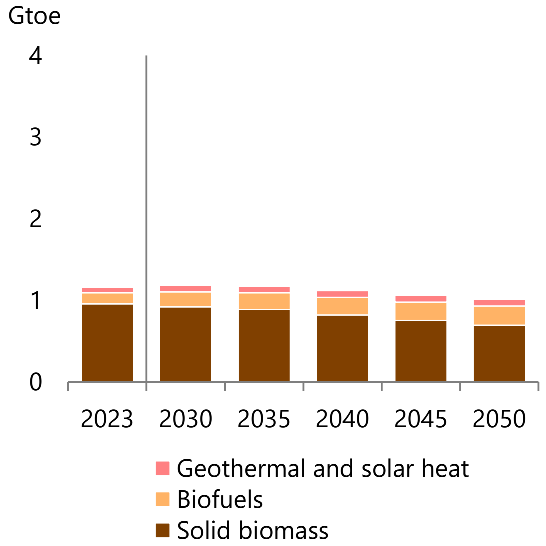


Figure 2-18 | Global non-fossil energy consumption for heating [Reference Scenario]



The centre of Asian energy consumption growth will shift from China to India and ASEAN.

Asia will account for 54% of global energy consumption growth as its share of the global economy increases from 35% in 2023 to 44% in 2050 in real terms (Figure 2-19). China, India and ASEAN will be the primary drivers of this global economic expansion. While these economies share some similarities in energy consumption trends, they also exhibit distinct differences. Energy consumption in China will peak in the late 2020s, whereas in India and ASEAN, it will continue to rise (Figure 2-20). These differences stem from variations in economic and population growth.

Figure 2-19 | Asian primary energy consumption [Reference Scenario]

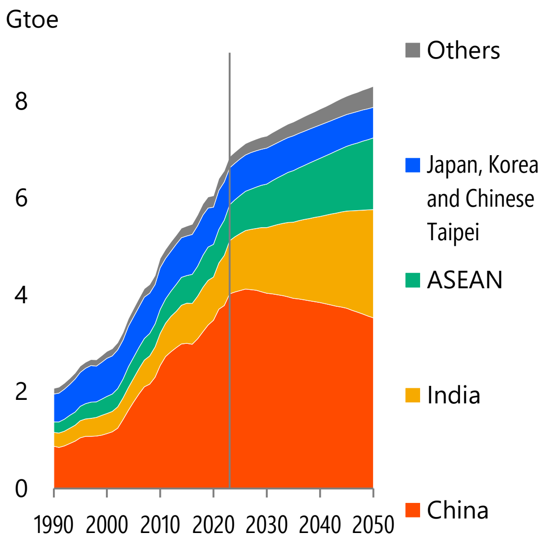
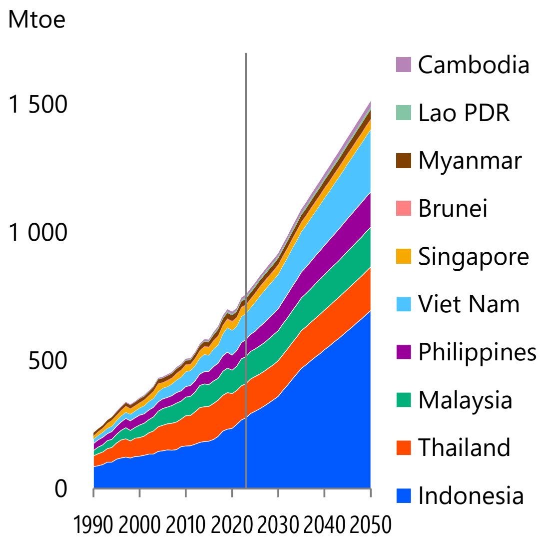


Figure 2-20 | ASEAN's primary energy consumption [Reference Scenario]



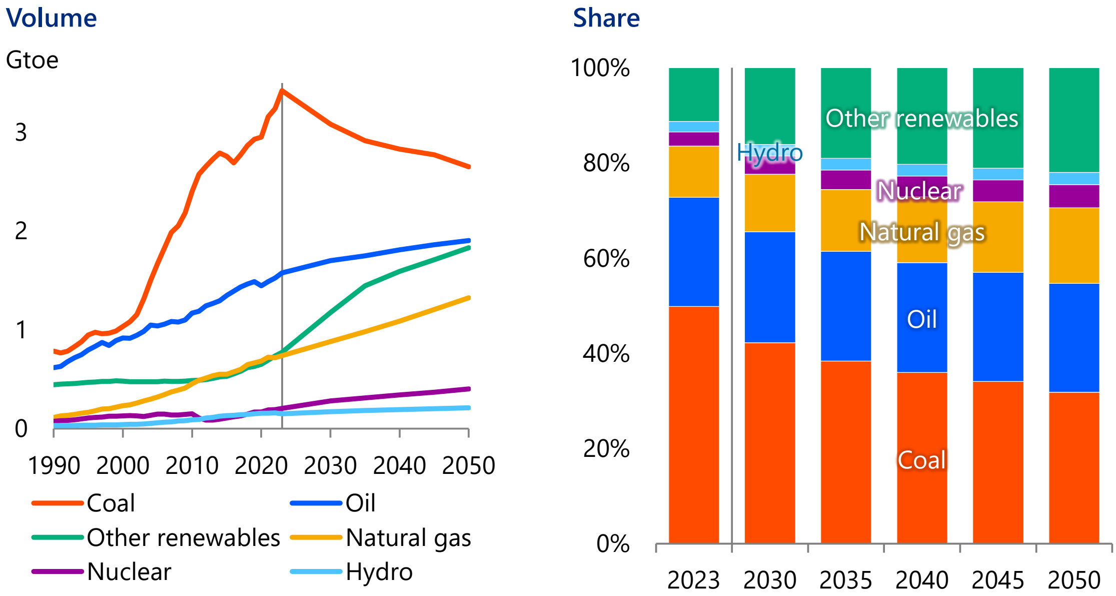
China's economy expanded 16.9-fold, from 1 trillion dollars in 1990 to $17.6 trillion in 2023 and will grow another 2.4-fold to $42 trillion by 2050. In the meantime, its population grew from 1.14 billion in 1990 to a peak of 1.41 billion in 2021 but will decline to below the 1999 level of 1.25 billion by 2050. Under the 14th Five-Year Plan (2021–2025), China has positioned the transition to a green economy as a key growth strategy. From the early 2020s, energy consumption will decline even as economic growth continues, similar to trends observed in advanced economies, driven primarily by energy conservation efforts in industry. After increasing at an average annual rate of 4.7% from 1990 to 2023, China's energy consumption is projected to decline at an annual rate of 0.5% from 2023 to 2050. By 2050, energy consumption will fall below 2023 levels, despite real GDP per capita exceeding $33 000. This marks China's transition to a mature economy, increasingly focused on carbon neutrality. China's share of Asian energy consumption rose from 42% in 1990 to 59% in 2023 but will decline to 42% by 2050.

India's economy expanded 7.0-fold, from $500 billion in 1990 to $3.3 trillion in 2023 and will grow 4.5-fold to $15 trillion in 2050. Its population rose from 860 million in 1990 to 1.44 billion in 2023, surpassing that of China. It will continue growing to reach 1.68 billion by 2050. Consequently, real GDP per capita will rise from $500 in 1990 to $9 000 in 2050, improving incomes and living standards. Although India has committed to achieving carbon neutrality by 2070, its energy consumption will continue growing at an annual rate of 2.7% from 2023 to 2050. As a result, climate change mitigation and energy security measures will become increasingly critical. India's share of Asian energy consumption will surge from 14% in 1990 and 16% in 2023 to 27% by 2050.

ASEAN's economy, valued at $740 billion in 1990, grew to $3.4 trillion in 2023 and will reach $10.1 trillion by 2050. Its population will expand from 440 million in 1990 to 770 million by 2050. As a result, real GDP per capita, which stood at $1 700 in 1990 and $4 900 in 2023, will rise to $13 000 by 2050, further improving income levels. ASEAN's energy consumption will continue to rise at an annual rate of 2.6% from 2023 to 2050, with Asia's share expanding from 11% in 2023 to 18% by 2050. Of that increase in consumption, 60% will be accounted for by Indonesia, which has declared its intention to achieve carbon neutrality by 2060. Within ASEAN, countries that have previously been fossil fuel exporters are facing declining supply capacity due to increased consumption and resource depletion, making energy security measures as important as climate change countermeasures.

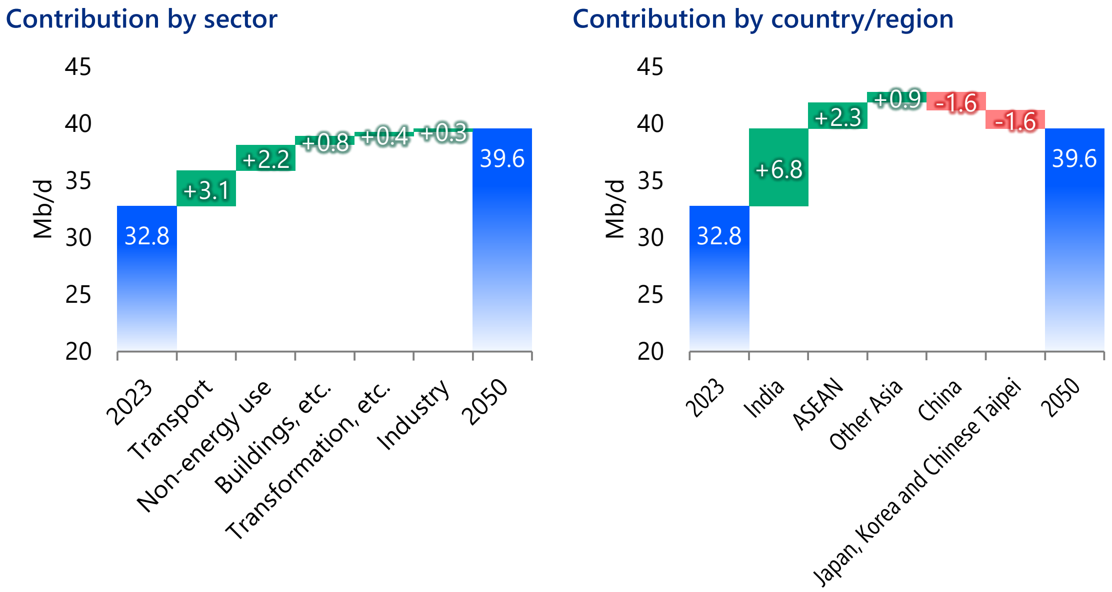
Even by 2050, while energy consumption in India and ASEAN will still be increasing, Asia will remain reliant on fossil fuels. Although this dependency will decrease from 84% in 2023, it will still account for 70% of its energy mix (Figure 2-21). Oil and natural gas consumption will continue to grow, driven primarily by demand from the transport and power generation sectors. Reducing Asia's dependence on fossil fuels will be essential for ensuring global energy stability and meeting climate goals.

Figure 2-21 | Asian primary energy consumption [Reference Scenario]



Asia's oil consumption growth will slow from an annual rate of 2.9% between 1990 and 2023 to 0.7% from 2023 to 2050. The transport sector will drive 46% of this growth by 2050, while the non-energy use sector and the buildings sector will contribute 33% and 11%, respectively (Figure 2-22). By region, India will account for 100% and ASEAN for 34%. The share of India and ASEAN combined exceeds 100% because Japan, Korea and China will cut consumption. To curb oil demand, India and ASEAN must prioritise fuel efficiency improvements in the automobile sector, including vehicle electrification. Given that Asia will account for 175% of global oil consumption growth, developments in the region will significantly impact global oil trends.

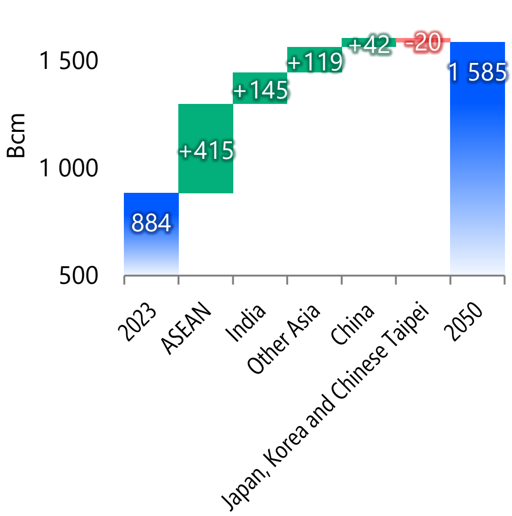
Figure 2-22 | Asian oil consumption [Reference Scenario]

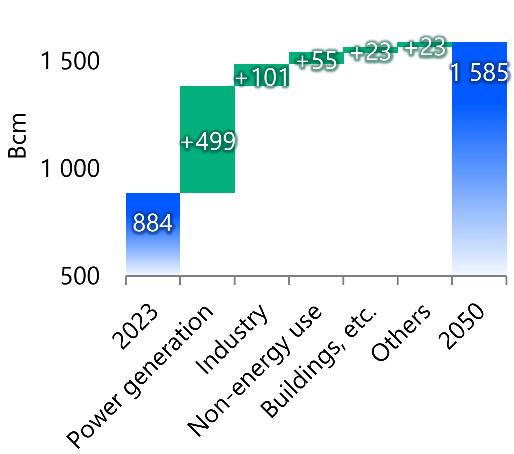


To ensure stable oil supplies while addressing environmental concerns, Asian economies must accelerate the transition to alternative energy sources and enhance oil consumption efficiency.

Asia's natural gas consumption grew at an annual rate of 5.8% between 1990 and 2023 but will slow to 2.2% per year from 2023 to 2050. Of this growth by 2050, the power generation sector will account for 71%, the industry sector for 14% and the non-energy use sector for 8% (Figure 2-23). ASEAN will contribute 59% of the increase, followed by India at 21% and China at 6%. To curb natural gas consumption, China, India and ASEAN will need to improve efficiency, reduce electricity transmission and distribution losses and promote hydrogen co-firing in power generation. Additionally, enhancing insulation and efficiency measures in the buildings sector will be crucial. As Asia's natural gas consumption growth will account for 56% of global growth, limiting demand in these countries/regions will have a direct impact on global natural gas trends.

Figure 2-23 | Asian natural gas consumption [Reference Scenario]





Although natural gas emits less CO_2 than oil and coal, it is still a fossil fuel that emits CO_2 when combusted. Therefore, it is essential for emerging and developing economies to maximise efficiency in natural gas use. This can be achieved by improving skills in equipment operation and maintenance, encouraging the mandatory adoption of natural gas-fired combined cycle systems and hydrogen co-firing in the power generation sector.

LNG imports will play a critical role in meeting Asia's natural gas demand. The region's LNG consumption is expected to rise from 279 million tonnes in 2024 to a 1.4-fold increase reaching 379 Mt in 2035 and further to 591 Mt in 2050, a 2.1-fold increase. Japan and Korea were among the earliest and largest LNG importers, but in 2021 and 2023, China surpassed Japan to become the world's largest LNG importer. In 2024, Japan, Korea and Chinese Taipei combined accounted for 49% of Asia's LNG imports, while China, India, ASEAN and South Asia together accounted for 51%. By 2050, this distribution will shift significantly, with the former group's share falling to 21% and the latter's rising to 79%. Consequently, India, ASEAN and China will play increasingly important roles in securing a stable LNG supply for the region.

Unlike oil or natural gas consumption, coal consumption in Asia will peak in the 2020s before beginning a long-term decline, driven primarily by reductions in coal-fired power generation.

Between 1990 and 2023, coal consumption grew rapidly at an annual rate of 4.6%, but it will decline at an annual rate of 1.0% from 2023 to 2050. Concerns over climate change and air pollution have led to growing global criticism of coal-fired power plants. Across Asia, the adoption of renewable energy is advancing, leading to a decline in coal consumption for power generation. However, coal will remain Asia's dominant energy source in 2050, accounting for 32% of the region's total energy mix. India and Indonesia, among others, will continue expanding coal-fired power generation to meet rising electricity demand. Asian economies must strive to reduce environmental burdens while advancing the effective utilisation of Asia's abundant coal resources. To achieve this, they must avoid constructing new or expanding inefficient coal-fired power plants, and instead pursue the introduction of carbon capture, utilisation and storage (CCUS) involving advanced economies, alongside ammonia co-firing.

Although Asia's non-fossil energy consumption remains lower in volume than oil or natural gas consumption, it will grow at an annual rate of 2.9% from 2023 to 2050. Renewables, excluding traditional biomass, will account for 96% of the region's non-fossil energy consumption growth between 2023 and 2050, followed by nuclear at 15%, while traditional biomass use will decline by 11%. China will account for 54% of the growth in renewable energy consumption (excluding traditional biomass), ASEAN 15% and India 25%. In nuclear, China will account for 62% of the increase, while ASEAN and India will contribute 9% and 24%, respectively. Asia's share of global non-fossil energy consumption will rise by 11 percentage points from 2023 levels, reaching 50% in 2050.

In 2020, China announced its goal of achieving carbon neutrality by 2060, setting a policy to curb fuels with higher CO_2 intensity, such as oil and coal, while promoting the use of natural gas and non-fossil energy sources through 2050. Additionally, China has been advancing industrial policies focused on renewable energy, battery storage and electric vehicles, strengthening its global position in decarbonisation technologies. However, given China's substantial fossil fuel consumption, significant improvements in energy efficiency and decarbonisation efforts will be required. Meanwhile, India, which will drive most of Asia's incremental energy consumption through 2050, has pledged to achieve carbon neutrality by 2070. Many ASEAN nations, including Indonesia, have also committed to carbon neutrality. Under its 'Make in India' initiative, India is promoting domestic solar photovoltaic power generation and the adoption of EVs. In ASEAN, Indonesia has integrated energy conservation and green industry development into its medium-term national development plan. To accelerate energy efficiency and decarbonisation, Asia must take a proactive approach, leveraging continued and enhanced technical and financial assistance from Japan, Korea, China and other economies. These commitments by China, India and ASEAN to address climate change will also contribute to the stability of energy supplies, including LNG.

2.2 Final energy consumption

Global final energy consumption in 2050 will increase 1.2-fold from 2023.

In the Reference Scenario, global final energy consumption will increase 1.2-fold, from 10 249 million tonnes of oil equivalent (Mtoe) in 2023 to 11 857 Mtoe in 2050, representing an average annual growth of 0.5%. The following key trends will define this change in global final consumption between 2023 and 2050.

First, India, the Association of Southeast Asian Nations (ASEAN) and the Middle East and North Africa (MENA) will be the primary drivers of global final energy consumption growth through 2050. As a result, any major developments affecting energy demand in these countries/regions will significantly influence global consumption trends. Therefore, particular attention should be paid to the factors that cause fluctuations in final energy consumption in these countries/regions. Those fluctuating factors include economic growth, the details and strengths of their energy-related policies, the technological development and diffusion of energy-using equipment.

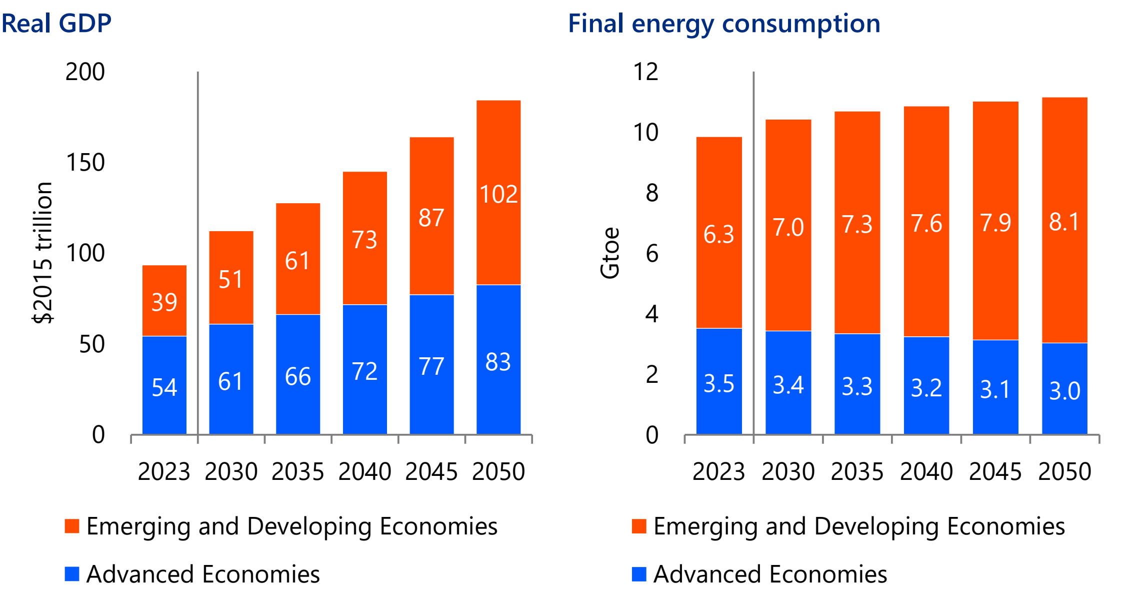
Second, all major energy sources will continue to play a role in global final energy consumption in 2050. While coal consumption will decline from the late 2020s and renewable energy consumption will decline from the 2030s, neither will reach an absolute minimum by 2050. While climate change is a critical global issue, if climate policies and investment strategies aimed at addressing it become overly biased towards specific energy sources, there is a risk of disrupting the overall energy supply-demand balance in the medium to long term. Therefore, it is essential to establish a market where each energy source can be supplied stably in response to demand, while taking into account trends in demand changes and the impact of climate change.

The following provides insights on final energy consumption changes in the Reference Scenario by economy group, region, sector and energy source between 2023 and 2050.

By economy group: Emerging and Developing Economies will drive global consumption growth.

The increase in global final energy consumption from 2023 to 2050 will be driven primarily by Emerging and Developing Economies (Figure 2-24). While final energy consumption in Advanced Economies will decline over the same period, steady growth in Emerging and Developing Economies will more than offset this reduction, leading to an overall increase in global final energy consumption through 2050.

Figure 2-24 | Real GDP and final energy consumption [Reference Scenario]



In Emerging and Developing Economies, final energy consumption is projected to reach 8 123 Mtoe in 2050, a 1.3-fold increase from 2023 (0.9% per year), driven by economic growth and population increase. These economies will follow a growth trajectory in the medium to long term. Improvements in energy efficiency and the expansion of service sectors will slow the rate of increase in final energy consumption. Final energy consumption growth will be significantly lower than real gross domestic product (GDP) growth (3.6% per annum).

In contrast, Advanced Economies will see final energy consumption decline to 3 039 Mtoe by 2050, a 10% reduction from 2023 levels. Even in those economies, real GDP will grow from 2023 to 2050 (1.6% per annum). However, in contrast to the upward trend in real GDP, final energy consumption will continue its downward trend, decreasing at an annual rate of 0.5%. This decline follows a trend that has been evident since the late 2000s, driven by accelerated energy conservation efforts and a structural shift towards service-based economies. As a result, the final energy consumption elasticity against GDP[4] in Advanced Economies will shift from 0.20 between 1990 and 2023 to −0.35 between 2023 and 2050[5].

Improving energy efficiency remains a key strategy for decarbonisation. Both advanced economies and emerging and developing economies will need to implement measures to enhance energy efficiency across all final energy consumption sectors.

By region: India, ASEAN and MENA will drive future final energy consumption growth.

Between 2023 and 2050, final energy consumption growth will be driven primarily by India, ASEAN and MENA (Figure 2-25 and Figure 2-26). Together, these countries/regions will account for more than 70% of the global increase in final energy consumption during this period.

Figure 2-25 | Global final energy consumption and contribution by country/region [Reference Scenario, 2023–2050]

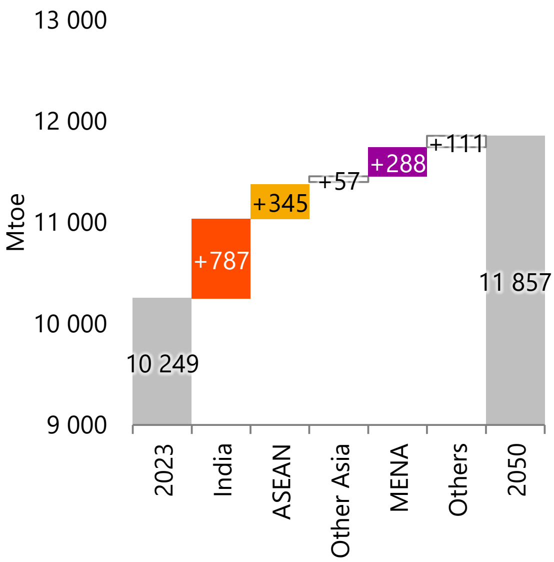
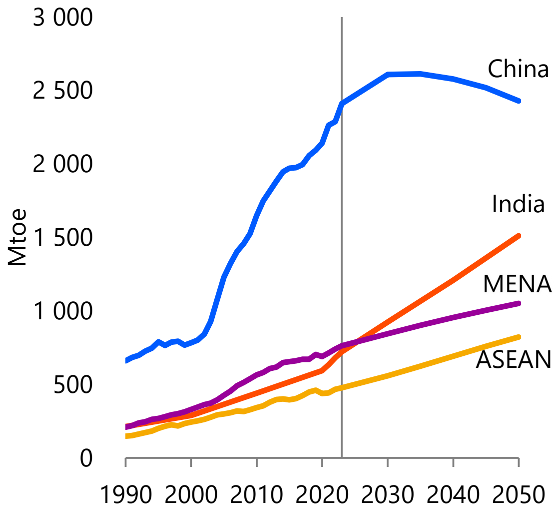


Figure 2-26 | Final energy consumption in China, India, MENA and ASEAN [Reference Scenario]



As a result of the strong demand growth in India and ASEAN, Asia's share of global final energy consumption will widen from 42% in 2023 to 46% in 2050. In the future, Asia will become an even more significant energy consumption centre.

India, which became the world's most populous country in 2022, will see its population exceed 1.6 billion and approach 1.7 billion by 2050. With GDP growing at an annual rate of 5.7% between 2023 and 2050, driven by urbanisation and other factors, India's GDP per capita will increase 3.9-

[4] Final energy consumption elasticity against GDP = final energy consumption growth rate ÷ real GDP growth rate.
[5] Nevertheless, higher economic growth does not necessarily mean less energy consumption.

fold. Backed by population and GDP growth, India's final energy consumption will grow 2.1-fold (2.8% per year) from 724 Mtoe in 2023 to 1 511 Mtoe in 2050. India alone will account for 60% of Asia's incremental final energy consumption, underscoring its rising significance not only within Asia but also globally. India's share of global final energy consumption will expand from 7.1% in 2023 to 12.7% in 2050, highlighting its growing influence on global energy demand.

In ASEAN, final energy consumption will grow at an annual rate of 2.0%, increasing from 477 Mtoe in 2023 to 822 Mtoe in 2050, largely driven by Indonesia and Viet Nam. Of the total 345 Mtoe increase in ASEAN's final energy consumption, Indonesia will contribute 142 Mtoe and Viet Nam 80 Mtoe. This growth reflects both countries' rising populations and expanding economies. In 2023, Indonesia and Viet Nam had populations of 281 million (the largest in ASEAN) and 100 million (the third largest), respectively, with continued growth expected. Between 2023 and 2050, GDP per capita will increase 2.9-fold in Indonesia and 3.6-fold in Viet Nam. Against this backdrop, Indonesia's final energy consumption will surpass that of Japan by the late 2030s.

China's final energy consumption will increase modestly, from 2 410 Mtoe in 2023 to 2 430 Mtoe in 2050. While China will remain the world's largest final energy consumer during this period, its energy demand will begin to decline after the 2030s. This pattern will differ from the constant uptrend in India and ASEAN. A key factor behind China's stabilisation and eventual decline in final energy consumption is the industry sector. The energy-intensive steel and cement industries, in particular, will see significant reductions in energy demand. The impact of efforts to eliminate excess capacity has already begun to materialise, with cement production peaking in the mid-2010s and crude steel production peaking in 2020 before shifting to a downward trend.

Final energy consumption in MENA will increase at an annual rate of 1.4% from 764 Mtoe in 2023 to 1 052 Mtoe in 2050 mainly in Iran, North Africa and Saudi Arabia. They will account for most of the region's total growth of 288 Mtoe. Specifically, Iran's final energy consumption will rise by 62 Mtoe, North Africa's by 86 Mtoe and Saudi Arabia's by 58 Mtoe. Population growth in these economies—at an annual rate of 0.9%—will outpace that of India and ASEAN, while GDP per capita will increase 2.0-fold in North Africa, 1.6-fold in Iran and 1.4-fold in Saudi Arabia.

By sector: Emerging and Developing Economies will drive consumption growth in each sector.

Between 2023 and 2050, global final energy consumption will increase across all sectors, driven primarily by Emerging and Developing Economies. In contrast, final energy consumption in Advanced Economies will decline in all sectors except for the non-energy use sector (Figure 2-27).

In the transport sector, final energy consumption will grow at an annual rate of 0.5%, rising from 2 936 Mtoe in 2023 to 3 324 Mtoe in 2050, supported by growth in the road sector of Emerging and Developing Economies. The increase will reach 388 Mtoe, capturing 24% of the overall global rise in final energy consumption. Economic growth in these economies will lead to a significant expansion of automobile ownership over the same period (Figure 2-28). Consequently, final energy consumption in the transport sector of Emerging and Developing Economies will grow at an annual rate of 1.1%. In contrast, Advanced Economies will see an increase in electricity consumption due to the policy-driven adoption of electric vehicles. However, oil consumption in the road sector will decline significantly due to improvements in fuel efficiency and a reduction in internal combustion vehicle ownership. As a result, final energy consumption in the transport sector of Advanced Economies will decline at an annual rate of 1.5%.

Figure 2-27 | Final energy consumption in Advanced Economies, and Emerging and Developing Economies [Reference Scenario]

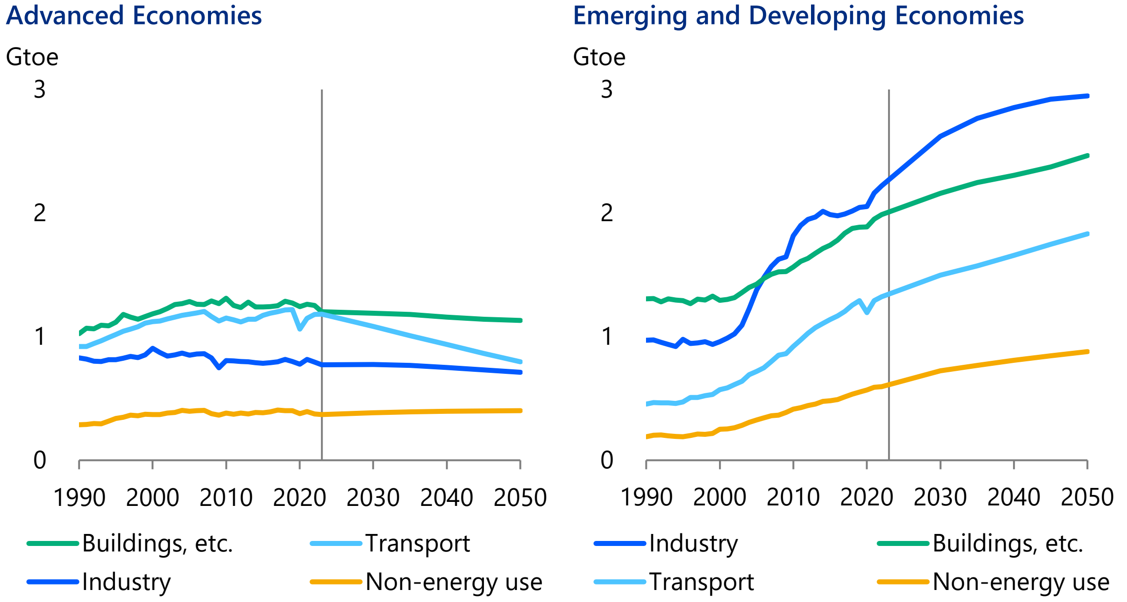
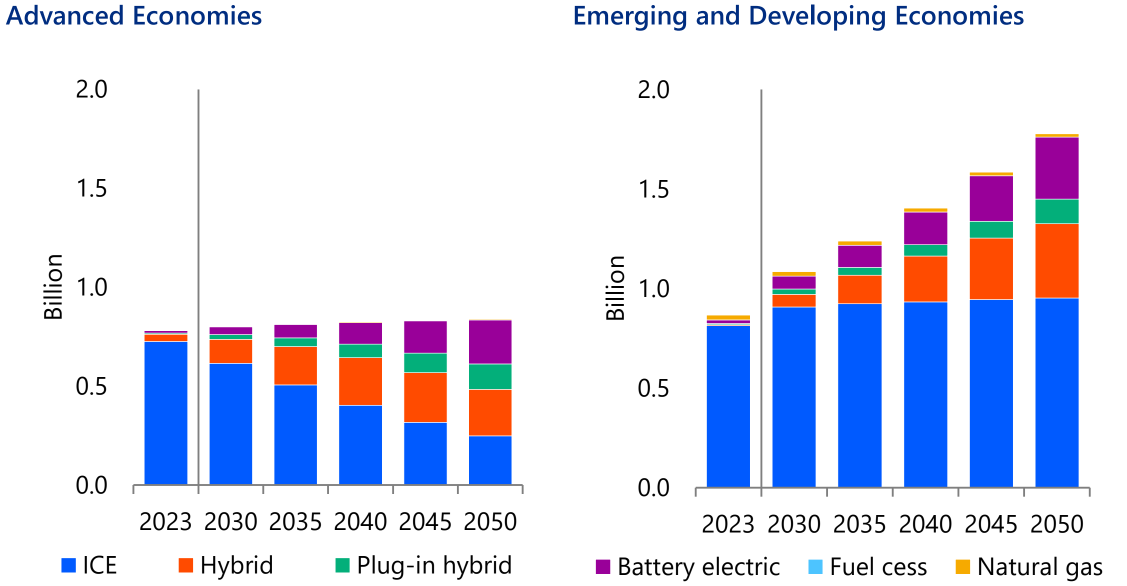


Figure 2-28 | Automobile ownership [Reference Scenario]



In the industry sector, final energy consumption will grow at an annual rate of 0.6%, increasing from 3 080 Mtoe in 2023 to 3 659 Mtoe in 2050. This growth will be driven primarily by increased electricity and natural gas consumption in manufacturing industries of Emerging and Developing Economies. The sector's total consumption growth will reach 580 Mtoe, accounting for 36% of the overall rise in final energy consumption. In general, however, there is a strong incentive in the industry sector, including manufacturing, to reduce the energy consumption of businesses to enhance the cost competitiveness of products. As a result, the growth in final energy consumption in the global industry sector will be slower than the 2.3% annual growth in the value added of the global secondary sector from 2023 to 2050.

In the buildings sector, final energy consumption will grow at an annual rate of 0.4%, increasing from 3 232 Mtoe in 2023 to 3 595 Mtoe in 2050. The growth will be driven by increased consumption of electricity, city gas and petroleum products in the commercial and residential sectors of Emerging and Developing Economies. However, as Advanced Economies increasingly adopt electricity-consuming appliances, the consumption of city gas and petroleum products in the commercial and residential sectors will trend downward worldwide. The total increase in final energy consumption in the buildings sector will reach 363 Mtoe, representing 23% of the overall rise in final energy consumption. As living standards improve in Emerging and Developing Economies, access to modern energy and energy-efficient appliances will increase. In Africa, the share of traditional biomass (fuelwood and manure) in the buildings sector's energy consumption will decline from 73% in 2023 to 32% in 2050, while in Asia, where the share has already fallen to 18%, it will further decline to 5%.

In the non-energy use sector, final energy consumption is expected to grow at an annual rate of 0.9%, increasing from 1 002 Mtoe in 2023 to 1 279 Mtoe in 2050, mainly due to rising oil and natural gas consumption in Emerging and Developing Economies. The sector's total consumption growth will amount to 277 Mtoe, accounting for 17% of the overall rise in final energy consumption. In Emerging and Developing Economies, demand for petrochemical products, including plastics, will increase as living standards improve. In Advanced Economies, consumption will rise slightly between 2023 and 2050. In North America, the petrochemical industry's non-energy use will increase due to the expansion of shale gas production, which enables cost-effective procurement of feedstocks. While plastics are convenient, their massive consumption has caused international issues such as resources and waste constraints, marine plastic waste and impacts on climate change. In response to these issues, plastics made from biomass instead of fossil fuels will be gradually introduced.

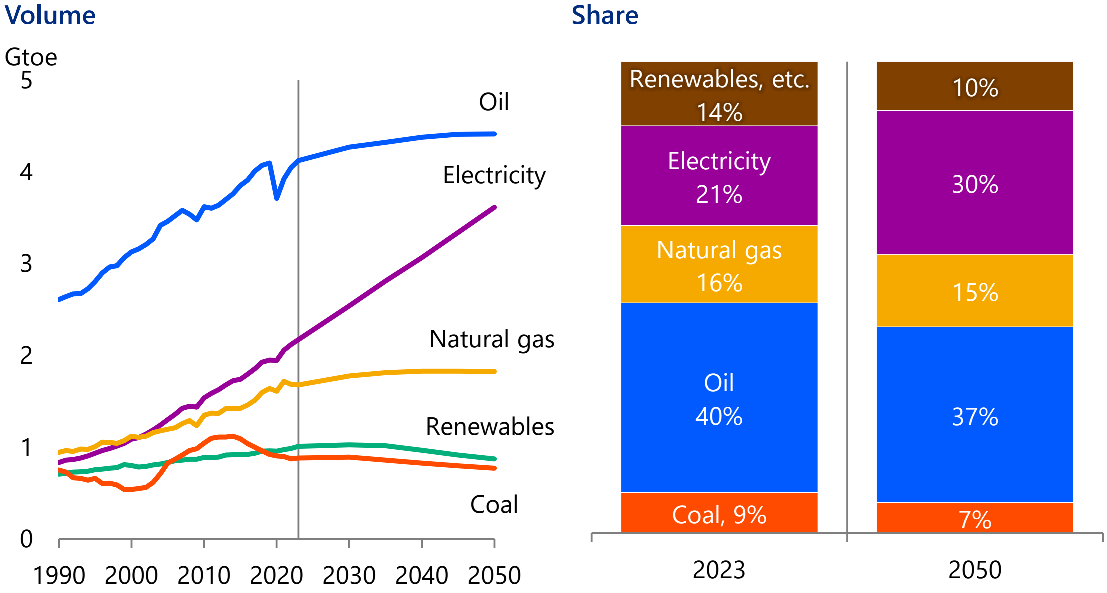
By energy source: Demand for all energy sources will remain.

Changes in global final energy consumption from 2023 to 2050 can be categorised into two trends: energy sources with an increasing share and those with a declining share (Figure 2-29).

While electricity's share of global final energy consumption will rise, the shares of oil, coal, natural gas and other renewables (dominated by the direct use of biomass) will decrease. Despite this shift, demand for coal and renewables and especially natural gas will remain significant in 2050. Fossil fuels (coal, oil and natural gas) will see their combined share of global final energy consumption fall from 65% in 2023 to 59% in 2050, yet they will continue to represent more than half of total consumption.

Final oil consumption will increase at a rate of 0.3% per year from 4 122 Mtoe in 2023 to 4 413 Mtoe in 2050, led by growth in the transport sector including the road sector in Emerging and Developing Economies. While the decline in Advanced Economies is expected to be 525 Mtoe, the increase in Emerging and Developing Economies will be 595 Mtoe. In Asia, where motorisation is accelerating, including in India and ASEAN, oil consumption in the road sector will increase by 151 Mtoe. The non-energy use sector will post the second-highest growth in oil consumption, following transport. In this sector, oil consumption will expand in Asia and the Middle East, where abundant local resources support petrochemical industry development.

Figure 2-29 | Global final energy consumption (by energy source) [Reference Scenario]



Final electricity consumption will grow at an annual rate of 1.9%, increasing from 2 171 Mtoe in 2023 to 3 615 Mtoe in 2050. This growth will be driven by increased electricity use in the buildings and industry sectors. Electricity is the only energy source that will post consumption growth also in Advanced Economies. While the primary drivers of global electricity demand growth will be China, India and ASEAN, the consumption will increase also in North America and Europe. Generally, as people's incomes rise, electricity is preferred for its convenience. Additionally, the increasing penetration of digitalisation will expand the use of electricity-consuming devices and machinery. Electricity's share of global final energy consumption will rise from 21% in 2023 to 30% in 2050. As economies and societies become more reliant on electricity, the consequences of supply disruptions will grow. While decarbonising power sources is a significant issue, it is also important to ensure a stable supply system of electricity from the viewpoint of energy security.

Final natural gas consumption will grow at an annual rate of 0.3%, rising from 1 680 Mtoe in 2023 to 1 827 Mtoe in 2050. Growth will be concentrated in the industry and non-energy use sectors of Emerging and Developing Economies. In India, ASEAN and MENA, where manufacturing industries are expanding, demand for natural gas will increase, particularly for processing and assembly industries. In the non-energy use sector, India and ASEAN, with their growing demand for chemicals, and the Middle East, which is seeking to expand its petrochemical industry using natural gas, will drive the growth of global natural gas consumption.

Final coal consumption will decline at an annual rate of 0.5%, falling from 882 Mtoe in 2023 to 772 Mtoe in 2050, due primarily to reductions in China's industry and buildings sectors. As mentioned in the regional perspective, China's coal-intensive steel and cement manufacturing industries will contract in the medium to long term. By 2050, coal consumption in China's industry sector will be less than half of its 2023 level. In addition, China has pledged its '3060 Goal', which aims to reach peak carbon dioxide (CO_2) emissions by 2030 and become carbon neutral by 2060. Based on this goal, China plans to reduce coal consumption from 2025. This will accelerate the shift to electricity in the industry sector and to natural gas and electricity in the buildings sector.

Final renewable energy consumption will decline at an annual rate of 0.5%, decreasing from 1 009 Mtoe in 2023 to 875 Mtoe in 2050. This decline will be primarily driven by the ongoing energy transition in Emerging and Developing Economies in Asia and Africa. One area of renewable energy in final consumption gaining attention is liquid biofuels for use in automobiles and aircraft. However, traditional biomass, including fuelwood and manure used in Emerging and Developing Economies, accounted for the largest share at 68% in 2023, followed by 14% for fuelwood mainly for space heating in Europe and North America, 13% for liquid biofuels and 4% for others. As mentioned in the perspective by sector, the use of modern energy is gradually replacing the use of traditional biomass in Emerging and Developing Economies in Asia and Africa. As a result, global final consumption of renewables will gradually decline from the 2030s.