5.1 Introduction

The chapter examines selected regions and countries which together account for nearly 90% of global GDP, population and energy demand. It highlights the specific issues and dynamics that affect them, taking account of their very different specific circumstances and ambitions. Starting points for the analysis vary widely and depend on a host of factors that include population, urbanisation, per capita income, economic structure, availability of natural resources and geography. Each section includes some common elements that describe the overarching trajectories for energy and emissions, key findings and the main factors that help to explain them. Each section also provides insights on one or two topical issues that highlight distinctive aspects of the projections. Table 5.1 highlights key indicators for the selected countries and regions.

Table 5.1 ▷ Key economic and energy indicators by region/country, 2022

	Population (million)	Total energy supply (EJ)	Electricity demand (kWh per capita)	Cars per thousand people	CO_2 emissions (Gt)	CO_2 emissions (t per capita)
United States	336	94	12 133	682	4.7	14
Latin America and the Caribbean	658	37	2 253	137	1.7	3
European Union	449	56	5 521	557	2.7	6
Africa	1 425	36	508	25	1.4	1
Middle East	265	36	4 190	175	2.1	8
Eurasia	238	42	5 051	193	2.4	10
China	1 420	160	5 612	201	12.1	9
India	1 417	42	926	31	2.6	2
Japan and Korea	177	29	8 703	490	1.7	9
Southeast Asia	679	30	1 592	63	1.7	3

Note: EJ = exajoules; kWh = kilowatt-hours; Gt = gigatonnes; t = tonnes.

Notes to key energy and emissions trends across regions

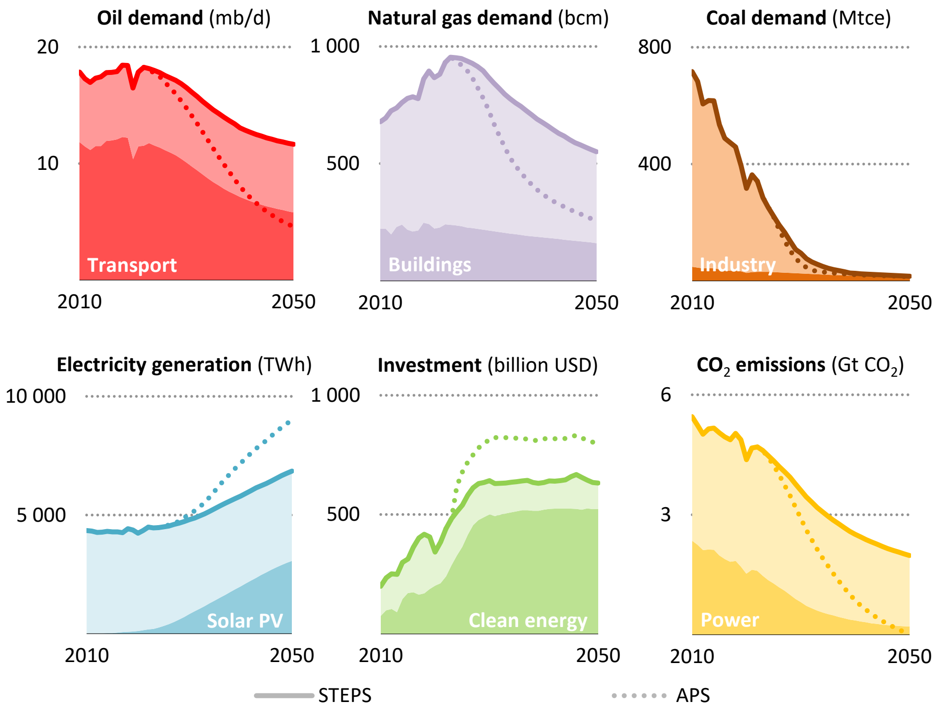
Each section in this chapter has a key trends figure that shows trajectories for oil, natural gas and coal primary energy demand, electricity supply, investment and carbon dioxide (CO_2) emissions. In all figures, the STEPS outlook for a particular sector or technology is shown more prominently in a darker colour, with the lighter area representing the remaining contribution of other sectors or technologies. Investment data are presented in real terms in year-2022 US dollars (USD) converted at market exchange rates.

CO_2 emissions refer to net energy-related carbon dioxide emissions. Common units and acronyms used in the figures include: mb/d = million barrels per day; Mt = million tonnes; Mtce = million tonnes of coal equivalent; bcm = billion cubic metres; GW = gigawatts; GWh = gigawatt-hours; TWh = terawatt-hours; EJ = exajoules; Gt CO_2 = gigatonnes of carbon dioxide; PV = photovoltaics.

5.2 United States

5.2.1 Key energy and emissions trends

Figure 5.1 ▷ Key trends in the United States, 2010-2050



IEA. CC BY 4.0.

The United States has mobilised unprecedented levels of government support to boost clean energy and reduce greenhouse gas (GHG) emissions (Table 5.2). The principal legislative vehicles are the Bipartisan Infrastructure Investment and Jobs Act of 2021, which invests around USD 190 billion for clean energy and mass transit, and the US Inflation Reduction Act of 2022, which provides an estimated USD 370 billion in funding to promote energy security and combat climate change. In the STEPS, these and other initiatives result in a reduction of nearly 40% in CO_2 emissions by 2030, relative to the 2005 level (Figure 5.1).

The largest impact of the increased government support is in the power sector, followed by transport and industry. In the STEPS, CO_2 emissions in 2030 in the power sector are 50% lower than today. This is largely the result of tax credits that accelerate the deployment of solar photovoltaics (PV) and wind. The reduction in emissions also reflects support for lifetime extensions of nuclear power plants, as well as batteries and carbon capture, utilisation and storage (CCUS) technology. In the transport sector, tax credits for electric cars and investment in charging infrastructure lead to annual sales of electric cars rising from 1 million in 2022 and 1.6 million in 2023 to close to 8 million in 2030, by which they account for 50% of new car registrations. Technologies that aid emissions reductions in hard-to-abate industrial sectors, such as CCUS and low-emissions hydrogen, are eligible for substantial tax credits, which can lay the foundation for strong growth in the years ahead. By attracting private capital, these incentives collectively support a doubling in clean energy investment in the United States by 2030 over 2022 levels. There is also a notable increase in cross-cutting investment in technology innovation.

These investments further accelerate reductions in demand for coal, which faces increasingly strong competition from renewables and natural gas. In the STEPS, coal demand falls by almost three-quarters by 2030 relative to the current level, largely thanks to solar PV and wind increasing their share of electricity generation. Natural gas demand is higher than the level in 2022 for several years, but peaks in the mid-2020s and then begins to decline, mostly as a result of lower demand in the power and buildings sectors. Oil demand falls by nearly 2 million barrels per day (mb/d) by 2030 from around 18 mb/d today, largely due to rising electric vehicle (EV) sales and fuel economy improvements.

Table 5.2 ▹ Key policy initiatives in the United States

Policy	Description
Inflation Reduction Act	• Commits nearly USD 370 billion for energy security and climate change.
Bipartisan Infrastructure Investment and Jobs Act	• Commits around USD 550 billion in total federal investment, including around USD 190 billion for clean energy and mass transit infrastructure.
Methane Emissions Reduction Action Plan	• Focuses on cutting methane emissions from the largest sources, including oil and natural gas production, landfills and the agricultural sector.
Updated Nationally Determined Contribution	• Aiming to reduce GHG emissions by 50-52% by 2030 from 2005 levels. • National target to reach net zero GHG emissions by 2050.
State-level clean electricity targets	• 100% carbon-free electricity or energy targets by 2050 in 22 states plus Puerto Rico and Washington DC.
Fuel economy standards	• Requirements to improve by 8% per year for light-duty vehicles for model years 2024-2025 and by 10% for model year 2026 relative to 2021 levels.
Zero emissions vehicles (ZEV) targets	• California ZEV mandate for cars beginning in 2026 and rising to 100% of sales in 2035 (Advanced Clean Cars II). Other states have adopted this mandate. • California regulations to boost the deployment of medium- and heavy-duty ZEVs (Advanced Clean Trucks). Other states followed the same example.

Exports of oil and gas from the United States are set to pick up in the coming years, in part because of lower export volumes from Russia (notably for natural gas). In the STEPS, the United States maintains its status as the world's largest natural gas exporter through to 2030. Liquefied natural gas (LNG) exports from the United States increase by 75% from 2022 levels to reach 185 billion cubic metres (bcm) by 2030, of which 95 bcm is transported to the European Union. Efforts to reduce methane emissions, along with efficiency and fuel switching policies, increase the availability and value proposition of US oil and gas exports.

The updated Nationally Determined Contribution (NDC) of the United States shows a substantial increase in ambition to 2030 in line with its pledge to reach net zero emissions by

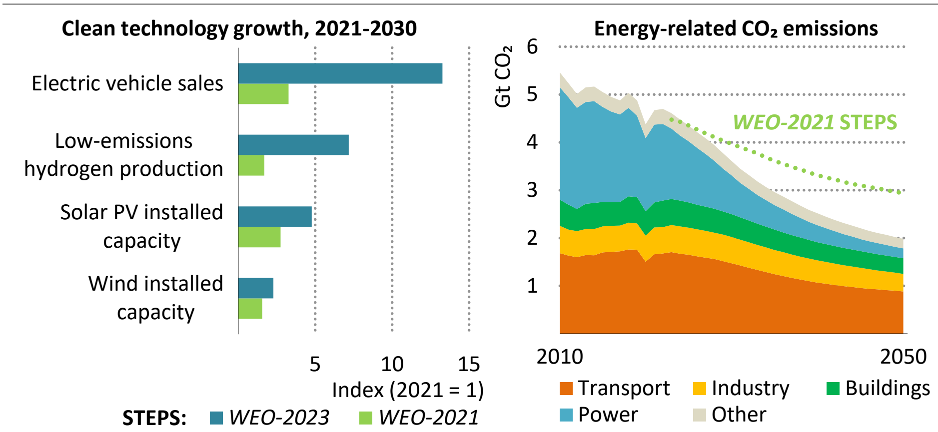
2050. Its commitment to reduce GHG emissions by 50-52% in 2030 from 2005 levels requires continuing efforts to accelerate deployment of renewables and other low-emissions technologies. Scaling up batteries and other forms of storage will also be important, as well as action to modernise, digitalise and expand grids in a timely manner.

5.2.2 How much have the US Inflation Reduction Act and other recent policies changed the picture for clean energy transitions?

The Inflation Reduction Act, the Bipartisan Infrastructure Investment and Jobs Act and other recent policies have reshaped the US energy outlook. Targeting a broad set of technologies across many sectors, the incentives now available are making clean energy investment more attractive, prompting faster deployment of clean energy technologies and the development of new clean energy manufacturing capacities in the United States. Our updated assessment in the STEPS clearly demonstrates the significant impact of these policies when compared to the outlook prior to these policies in the Stated Policies Scenario from the *World Energy Outlook-2021* (*hereinafter referenced as WEO-2021* STEPS) (IEA, 2021).

Clean energy deployment and CO_2 emissions

Figure 5.2 ▷ Clean energy technology growth and energy-related CO_2 emissions in the United States in the STEPS

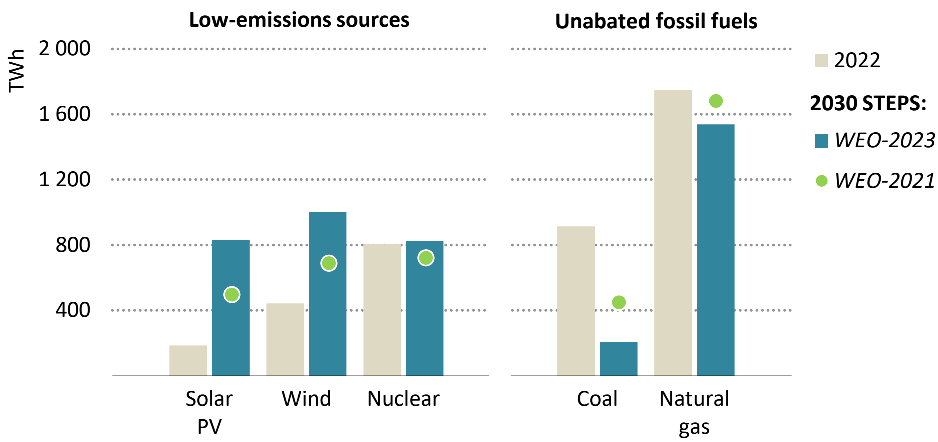


The Inflation Reduction Act spurs clean energy technology deployment and accelerates the pace of CO_2 emissions reductions

The Inflation Reduction Act and other recent policies have significantly improved the outlook for a host of clean energy technologies. Electric vehicle sales in 2030 are projected in this *World Energy Outlook* (*WEO-2023*) STEPS to be 13-times the 2021 level, compared with just a threefold increase in *WEO-2021* STEPS (Figure 5.2). Carbon capture projects completed by 2030 in the STEPS, including those under construction, are set to capture three-times the volume of CO_2 emissions as in 2021, double the increase projected prior to the Inflation

Reduction Act, while low-emissions hydrogen is now expected to gain much more than the modest foothold projected in the *WEO-2021*. Wind and solar PV have also benefited significantly from the support now available for clean energy technologies. As a result of these changes, energy-related CO_2 emissions decline to 3.6 gigatonnes (Gt) by 2030 in the STEPS, 10% below the level in 2030 projected in the *WEO-2021* STEPS. The power sector accounts for most of the difference, followed by transport and industry, but all sectors make a contribution. The accelerated progress made by 2030 also paves the way for more rapid progress in succeeding years: emissions in 2050 are now projected to be one-third below the level expected before the Inflation Reduction Act came into force.

Figure 5.3 ▹ Electricity generation from selected sources in the United States in the STEPS, 2022 and 2030



The Inflation Reduction Act accelerates deployment of solar PV and wind, supports nuclear lifetime extensions and leads to an 80% reduction in unabated coal power by 2030

In the power sector, the boost provided by the Inflation Reduction Act for both existing and new low-emissions sources of electricity accelerates the transition away from coal-fired generation and reduces CO_2 emissions. If all the conditions are met to receive the maximum available tax credits for solar and wind, then the levelised cost to consumers of new solar PV and wind in the United States is expected to be lower than anywhere else in the world. These incentives are attracting private investors. By 2030, solar PV output surpasses 800 terawatt-hours (TWh) in the STEPS (two-thirds above the level projected in *WEO-2021* STEPS) and wind reaches 1 000 TWh (almost 50% above the level in the *WEO-2021* STEPS) (Figure 5.3). Tax credits in the Inflation Reduction Act also support lifetime extensions of nuclear power plants, which are one of the cheapest sources of low-emissions electricity. As a result of these various incentives, unabated coal-fired power falls by about 80% in the STEPS, compared with about 50% in the *WEO-2021* STEPS. Unabated natural gas-fired generation also declines by more than projected prior to the Inflation Reduction Act.

Clean energy manufacturing

In recent years, clean energy manufacturing has been insufficient to meet domestic needs in the United States. For example, in 2022, the domestic content of wind turbine blades and hubs was about half and only one-third of solar PV modules were produced domestically. While imports of clean energy components will continue, and would benefit from more supply diversity, the Inflation Reduction Act provides significant incentives to boost domestic clean energy manufacturing in the interests of maximising the domestic benefits of the transition to clean energy and of national security. These incentives have resulted in a number of announcements from companies looking to develop new clean energy manufacturing capabilities in the United States, including plans for the production of hydrogen, batteries, solar PV and wind turbines (Table 5.3). The United States has witnessed a surge in announcements of large manufacturing facilities over the past year. Gigafactory capacity, expected to remain operational until 2030, increased from 750 gigawatt-hours (GWh) in July 2022 to 1.2 TWh by September 2023, due in large part to the support in the Inflation Reduction Act (Benchmark Minerals Intelligence, 2023).

Table 5.3 ▻ New announcements for clean energy technology manufacturing in the United States

Technology	Description
Hydrogen production	• Aim to reach over 5.5 Mt of hydrogen by 2030 (mainly coupled with CCUS). • Top-five projects account for around half of the capacity target. The largest project would produce 1 Mt of hydrogen per year and be online in 2028.
Batteries	• Aim for production capacity of 1.2 TWh by 2030, about 12-times the current level. • Top-five projects account for one-third of the capacity target. Tesla alone has announced 260 GWh production capacity by 2030.
Solar PV	• Exceeding 40 GW production capacity for solar modules by 2030, up from 7 GW today.
Wind	• 1.5 GW production capacity of offshore nacelles by the end of this decade.

Sources: IEA analysis based on BNEF (2023a, 2023b), Wood Mackenzie (2023), SPV Market Research (2023) and Benchmark Minerals Intelligence (2023).

An increase in manufacturing capacities will help the United States to create more resilient supply chains for clean energy technologies, though these will inevitably take time to develop. Around USD 150 billion in planned investment has been announced so far for key technologies, including batteries, EVs, charging infrastructure, offshore wind, and solar (US Department of Energy, 2023). With these investments, the United States is likely to be able to meet all or most of its domestic needs for hydrogen electrolysers, EV and stationary battery deployment by 2030. However, even with a sixfold increase in solar PV module manufacturing, the United States would still only produce about 10% of what is needed for 2030 deployment in the STEPS. The figure for wind is even lower, and there have been few announcements so far about planned increases in domestic manufacturing capacity for wind power components. Ensuring resilient and diverse international supply chains is therefore going to remain important as clean energy deployment ramps up.