CHAPTER 3
RENEWABLES

Photo: © Masdar Official

Main messages

- **Global trend.** In 2022, renewables represented 17.9 percent of the world's total final energy consumption (TFEC), including traditional uses of biomass, and 13 percent excluding them. TFEC, which had doubled in the preceding 15 years, continued to increase despite the disruption caused by the COVID-19 pandemic and the ensuing energy crisis. Renewables' share of TFEC remained relatively steady over the previous three decades, increasing slowly over 2012–22 (+2.8 percentage points), despite their increased use in electricity generation. The electricity sector continues to lead in the growth of renewables' share, while progress in transport and heat remains limited.
- **Target for 2030.** Ensuring access to affordable, reliable, sustainable, and modern energy for all requires swifter expansion of renewable energy's use in generating electricity and heat, and for transport. Target 7.2 of Sustainable Development Goal (SDG) 7 calls for a substantial increase of the share of renewable energy in the global energy mix by 2030. The main indicator used to assess progress is the share of renewable energy in TFEC. While no quantitative milestone has been set, current trends indicate that progress is not sufficient to meet the SDG target or other international climate and development objectives. Significant action to expand the adoption of renewable energy and boost energy efficiency is needed, especially in heat and transport.
- **Recent trends.** Global renewables-based power capacity is growing faster than at any time in the past three decades, with 585 GW of renewable capacity added in 2024. Under current policies and market conditions, global power capacity is expected to increase another 2.7 times, by 2030. But even this expansion is not sufficient to triple global renewables' capacity by 2030—an objective endorsed by the Parties to the UNFCCC at the United Nations Climate Change Conference (COP28) in 2023.
- **Electricity.** The use of renewables-based electricity grew almost 8 percent from 2021 to 2022, and by 56 percent from 2015. As of 2022, almost 30 percent of all energy consumed to generate electricity was renewable—the largest share among all end uses of renewables. Renewables-based electricity, in turn, represented more than a third of global renewable energy consumption and half of modern uses of renewable energy. Continuous new capacity additions—mainly in wind and solar photovoltaics (PV), for which the combined generation more than tripled in 2022 relative to 2015—is rapidly increasing renewables' share in electricity. Hydropower remains the predominant source of renewables-based electricity in the world, meeting 15 percent of global demand.
- **Heat.** In 2022, renewable sources accounted for about 21 percent of the world's use of energy for heat. Notably, almost half of this renewables-based heat took the form of the traditional use of biomass (19 exajoules [EJ]), of which more than 90 percent was concentrated in Sub-Saharan Africa and Asia. The share of modern renewable energy use in global heat consumption increased marginally. The share was just 11 percent in 2022, only 2.1 percentage points higher than a decade earlier. This is in large part because of the simultaneous increase in global annual heat demand, despite the 2022 energy crisis.

- **Transport.** Final energy consumption for transport grew 4 percent (+4 EJ) in 2022, while remaining below 2019 levels. The share of renewable energy in transport TFEC rose to 4 percent in 2022, up from 3.1 percent in 2015. Biofuels, primarily crop-based ethanol and biodiesel, continued to dominate renewable energy use in transport, growing 5 percent year-on-year in 2022. Remarkably, the amount of renewables-based electricity used in vehicles and trains almost doubled from 2015—due to higher electric vehicle (EV) sales and a greater share of renewables in electricity for transport.
- **Regional highlights.** The widespread use of traditional biomass for heating and cooking in Sub-Saharan Africa places it first among the regions where renewables constitute the largest share of energy supply. When considering only modern uses of renewable energy, the share of renewables in TFEC was the highest in Latin America and the Caribbean, reflecting hydropower generation and the consumption of bioenergy in industrial processes and biofuels for transport. In 2022, almost half of the global year-on-year increase in modern uses of renewable energy came in Eastern Asia, essentially China, where wind and solar PV dominated growth, followed by Northern America and Latin America and the Caribbean.
- **Top 20 energy-consuming countries.** The share of renewable energy in TFEC varies widely across countries. Among the top 20 energy-consuming countries, Brazil and Canada continued to have the largest shares of modern uses of renewables in 2022 (respectively, 45 percent and 24 percent of TFEC), due to their considerable reliance on hydropower for electricity, biofuels for transport, and biomass for extracting heat, specifically, in industry. Also in that year, Korea and Türkiye recorded the largest year-on-year increase in the share of modern uses of renewables (+16 and +15 percent, respectively),[11] followed by China and Germany (+9 percent). China alone accounted for more than a fifth of global modern uses of renewable energy. Between 2010 and 2022, the United Kingdom, Germany, and China led in the growth of the share of modern uses of renewables in TFEC (+10, +8, and +8 percentage points, respectively), followed by India, Indonesia, and France (with shares increasing between +5 and +6 percentage points). This growth was mostly possible thanks to the development of wind and solar PV, as well as a significant decrease in TFEC in the United Kingdom, Germany, and France in 2010–22, and a significant shift from traditional to modern uses of biomass in China, Indonesia, and India.
- **Indicator for installed renewable energy generating capacity in developing countries.** Installed renewables-based capacity reached an all-time high in 2023, both globally at 478 watts per capita and in developing countries at 341 watts per capita. Yet significant disparities among countries and regions remain, with developed countries having 3.4 times more renewable power per capita than developing countries. Oceania and Northern America and Europe lead in installed renewables-based capacity per capita, with over 1,100 watts installed, while Sub-Saharan Africa remains critically behind, at only 40 watts per capita. While least-developed countries (40 watts per capita), landlocked developing countries (105 watts per capita), and small island developing states (110 watts per capita) have gradually added renewables-based capacity, deployment remains well below levels in both developing countries and the world overall. Given the energy access gaps in many of these countries as well as persistent inequality between developed and developing countries, continued efforts are needed to overcome these inequities, to reach target 7.b, "expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries."

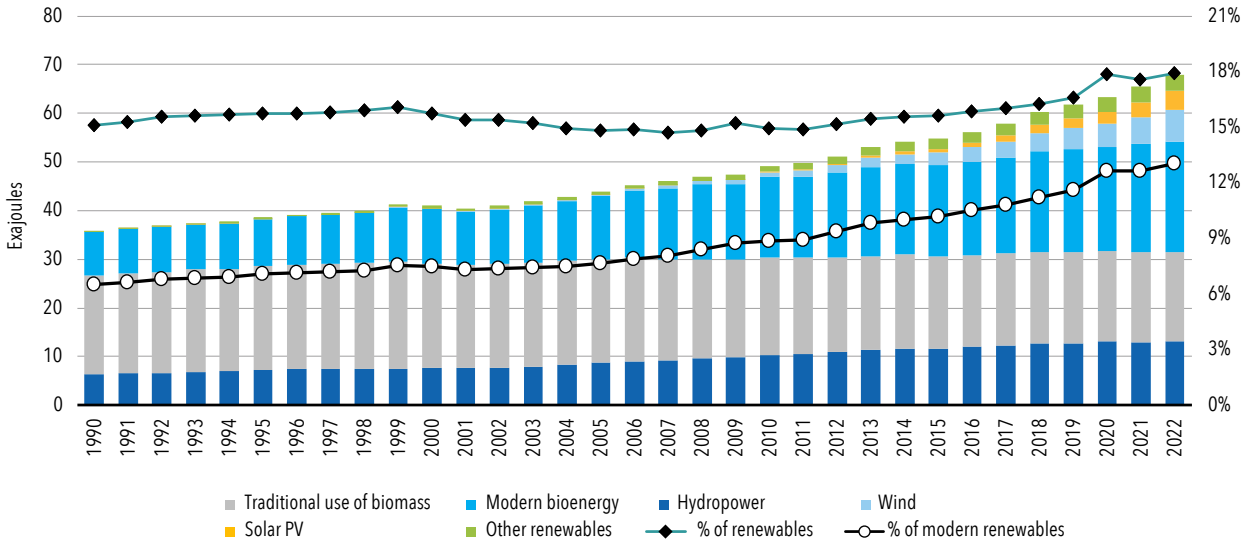
11 The Kingdom of Saudi Arabia more than doubled its share of modern uses of renewables on a year-on-year basis. The share remains marginal, however (0.15 percent in 2022).

Are we on track?

Globally, renewables have maintained a relatively steady share of TFEC over the past three decades; their share grew slowly in the most recent decade (+2.8 percentage points), despite their accelerated deployment in electricity generation.[12]

Global final energy consumption grew 1.8 percent year-on-year in 2022, but this increase was not as significant as the rebound (5 percent) following the worldwide COVID-induced disruptions in 2021. Global renewable energy consumption, including traditional uses of biomass,[13] reached 67.8 EJ in 2022, bringing renewables' share of global TFEC to 17.9 percent. This share was slightly higher than the 17.6 percent[14] of the year before but at the same level as observed in 2020 (figure 3.1).

FIGURE 3.1 • RENEWABLE ENERGY CONSUMPTION AND SHARE OF TFEC BY TECHNOLOGY–MODERN AND TOTAL RENEWABLES, 1990–2022



Source: International Energy Agency and United Nations Statistics Division.

Note: EJ = exajoule; PV = photovoltaic; TFEC = total final energy consumption.

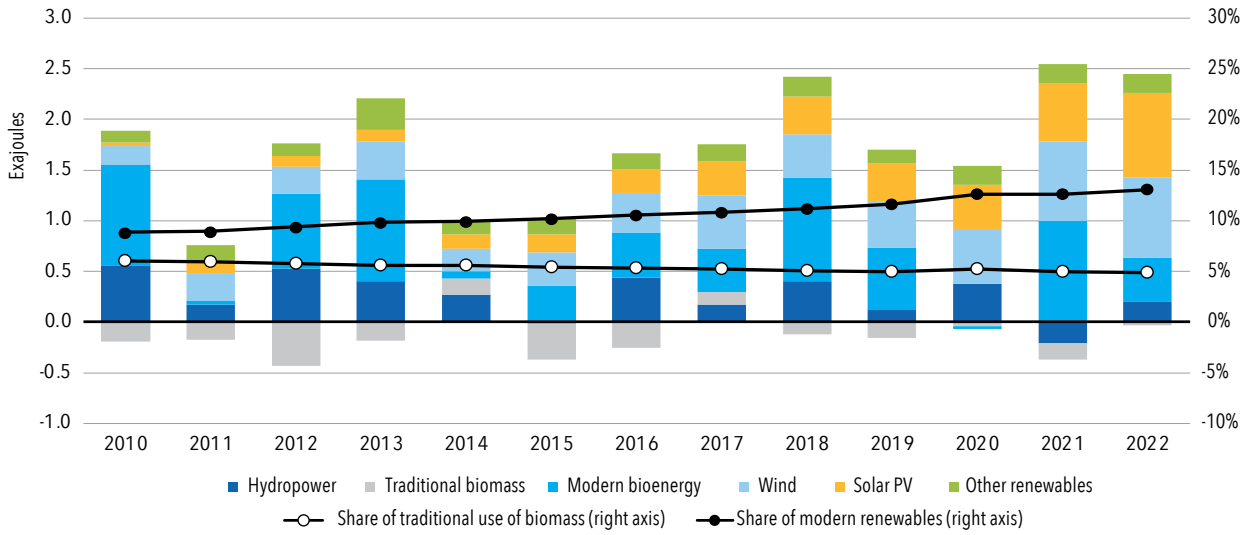
12 If not referenced otherwise, all data in this chapter come from the IEA World Energy Balances database (IEA 2024a), UNSD Energy Balances 2022 (UNSD 2024a), Energy Statistics Database 2022 (UNSD 2024b), and IRENA Renewable capacity statistics 2025 (IRENA 2025).

13 The term "traditional uses of biomass" refers to the use of local solid biofuels (wood, charcoal, agricultural residues, and animal dung), burned using basic techniques, for example, traditional open cookstoves and fireplaces. The low conversion efficiency of such solutions can generate adverse environmental effects, including indoor pollution, which poses health hazards. Because of their informal and noncommercial nature, it is difficult to estimate the energy consumed in such practices, which remain widespread in households in parts of the developing world. For the purposes of this report, "traditional uses of biomass" refers to the residential consumption of primary solid biofuels and charcoal in countries outside the Organisation for Economic Co-operation and Development (OECD). Although biomass is also used with low efficiency in OECD countries (e.g., in fireplaces burning split logs), it is reported here under modern use. Modern bioenergy, along with solar PV, solar thermal, geothermal, wind, hydropower, and tidal energy, is one of the "modern renewable" sources analyzed in this report.

14 The 2021 share of renewables in TFEC has been revised downward from 18.7 percent (as stated in last year's report) to 17.6 percent. This is because solid biofuels consumption in 2021 in the residential sector was revised downward for Nigeria, South Africa, and Zimbabwe in the 2024 edition of the IEA World Energy Balances database, due to the adoption of a more accurate bottom-up methodology for estimating consumption per capita. Residential solid biofuel consumption in 2021 was also revised downward for China, to reflect trends in population with a primary reliance on biomass for cooking, as reported by the World Health Organization. The figures for Ethiopia and Indonesia underwent similar downward adjustments based on the latest official statistics.

From 2021 to 2022, growth in renewable energy use came predominantly from solar PV, wind, and modern uses of bioenergy, followed by hydropower and geothermal and solar thermal, whereas traditional uses of biomass declined slightly (figure 3.2). The shares of solar PV and wind power in TFEC grew about 27 percent and 14 percent year-on-year, respectively, and together were responsible for three-quarters of the increase in renewables-based electricity.

FIGURE 3.2 • GROWTH IN RENEWABLE ENERGY CONSUMPTION BY TECHNOLOGY AND THE SHARES OF MODERN USES OF RENEWABLE ENERGY AND TRADITIONAL USES OF BIOMASS IN TFEC, 2010–22

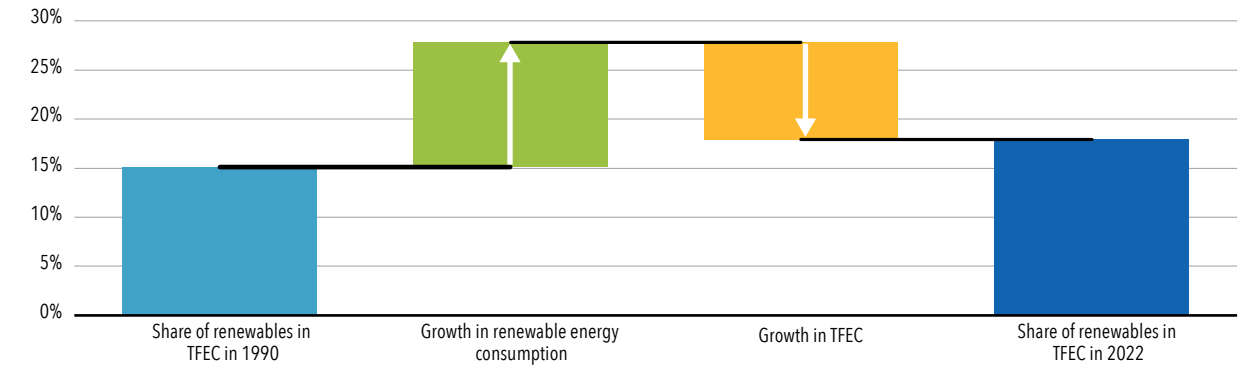


Source: International Energy Agency and United Nations Statistics Division.

Note: EJ = exajoule; PV = photovoltaic.

From 1990 to 2022, global renewable energy consumption grew 89 percent while TFEC grew 60 percent. As a result, the share of renewable energy in TFEC remained relatively steady (figure 3.3). Two trends coexisted in that period: The share of modern uses of renewables (excluding traditional uses of biomass) in TFEC progressively increased, from 6.5 percent in 1990 to more than 13 percent in 2022, with the strongest growth in the electricity sector. Meanwhile, the share of traditional uses of biomass declined, from 8.6 percent to less than 5 percent.

FIGURE 3.3 • IMPACT OF TFEC GROWTH ON THE GROWING SHARE OF RENEWABLES IN TFEC GLOBALLY, 1990–2022



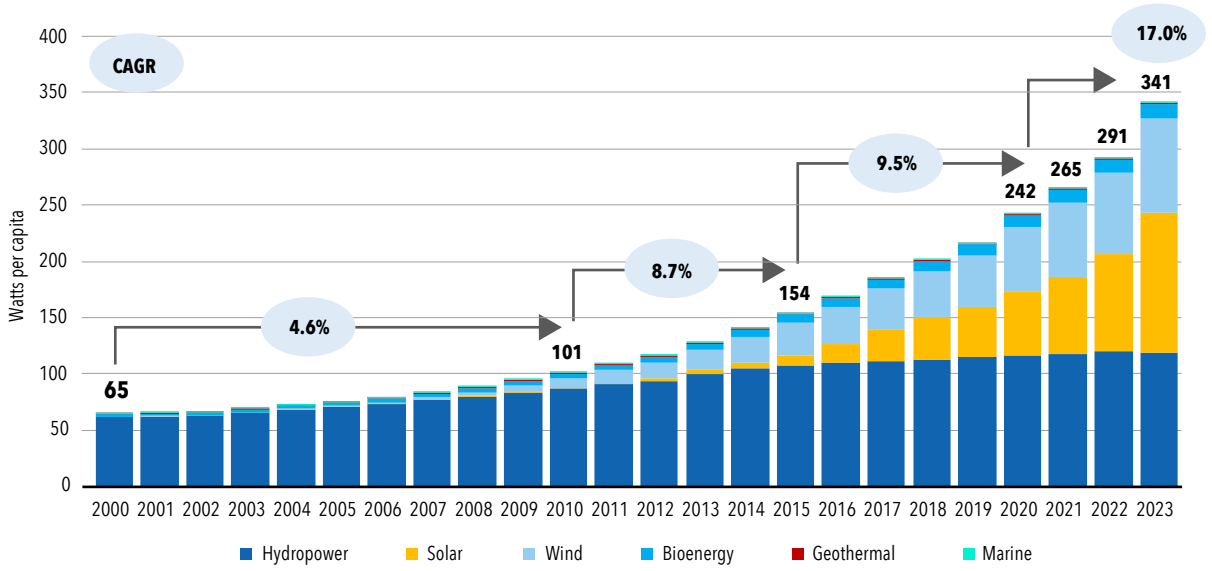
Source: International Energy Agency and United Nations Statistics Division.

Note: TFEC = total final energy consumption.

In 2012–22, modern uses of bioenergy accounted for almost one-third (+5.3 EJ) of the increase in modern uses of renewable energy—the largest absolute increase among renewable sources, although closely followed by wind (+4.9 EJ). Solar PV and wind grew at an average of about 29 percent and 15 percent, respectively—the fastest growth, despite starting from a smaller base. Overall, bioenergy, including traditional uses of biomass, remained the largest source of renewable energy, representing almost 11 percent of the global final energy consumption and almost two-thirds of the renewable portion in 2022, followed by hydropower, wind, and solar PV.

Renewable energy generating capacity continues to grow globally, reaching 478 watts per capita in 2023. Notable disparities remain between countries, with 1,162 watts installed in developed countries compared with 341 watts in developing countries. Hydropower, solar, and wind technologies continue to drive the expansion of renewables in developing countries (see figure 3.4 and table 3.1). These figures reflect progress toward SDG target 7.b—"expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing states, and land-locked developing countries." Progress is tracked through Indicator 7.b.1, which measures the installed renewable energy generating capacity per capita—the metric presented here.

FIGURE 3.4 • INSTALLED RENEWABLES-BASED CAPACITY PER CAPITA FOR DEVELOPING COUNTRIES (2000–23) AND CAGR IN SELECTED YEARS



Source: International Renewable Energy Agency.

Note: CAGR = compound annual growth rate.

Globally, renewable energy capacity per capita more than doubled (from 215 watts per capita) between 2013 and 2023 (table 3.1). This sustained growth reflects a compound annual growth rate (CAGR) of 9.4 percent over five years, accelerating from a CAGR of 8.1 percent in 2012. The last decade's highest annual increase in renewable energy capacity per capita in global terms was in 2023 (13 percent). A record high CAGR, of 11.1 percent, was also observed in developing countries over the same period.

Developing countries—including China, Brazil, and India—are leading the charge in global renewable energy generating capacity per capita.[15] Their year-on-year growth of 17 percent in 2023, and a five-year CAGR of 11.1 percent, outpaced developed countries' annual growth and 5-year CAGR. This growth is driven by public policies and investments that have enabled lower technology costs (IRENA 2024a), as global policies and strategies increasingly prioritize renewable energy (IRENA et al. 2024).

TABLE 3.1 • GLOBAL INSTALLED RENEWABLE ENERGY GENERATING CAPACITY PER CAPITA, ANNUAL GROWTH, AND 5-YEAR CAGR, 2010–23

	GLOBAL			DEVELOPED			DEVELOPING		
Year	Renewables per capita (watts)	Annual growth (%)	5-year CAGR (%)	Renewables per capita (watts)	Annual growth (%)	5-year CAGR (%)	Renewables per capita (watts)	Annual growth (%)	5-year CAGR (%)
2010	174	6.3	5.0	499	6.5	4.7	101	7.0	6.1
2011	187	7.2	5.8	537	7.7	5.7	109	7.5	6.7
2012	200	7.1	6.4	580	7.9	6.5	116	7.1	7.0
2013	215	7.2	6.8	610	5.3	6.7	128	9.9	7.8
2014	230	7.2	7.0	644	5.5	6.6	140	9.6	8.2
2015	248	7.8	7.3	687	6.7	6.6	154	9.5	8.7
2016	267	7.5	7.3	728	5.9	6.3	168	9.6	9.2
2017	286	7.2	7.4	764	5.0	5.7	185	9.8	9.7
2018	305	6.8	7.3	803	5.1	5.6	201	8.8	9.5
2019	326	6.8	7.2	857	6.7	5.9	216	7.4	9.0
2020	358	9.6	7.6	920	7.4	6.0	242	11.9	9.5
2021	388	8.4	7.8	991	7.6	6.4	265	9.6	9.5
2022	423	9.1	8.1	1,074	8.5	7.1	292	10.0	9.5
2023	478	13.0	9.4	1,162	8.1	7.7	341	17.0	11.1

Source: International Renewable Energy Agency.

Note: CAGR = compound annual growth rate.

Despite sustained progress in renewable energy deployment, the levels achieved remain insufficient. Developing countries are struggling to meet growing energy demand, foster sustainable development, and reduce energy poverty. Notable disparities in renewable energy-generating capacity per capita exist also within developing countries (as discussed in more detail in the next section), further underscoring the need for support to reach target 7.b, "expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries."

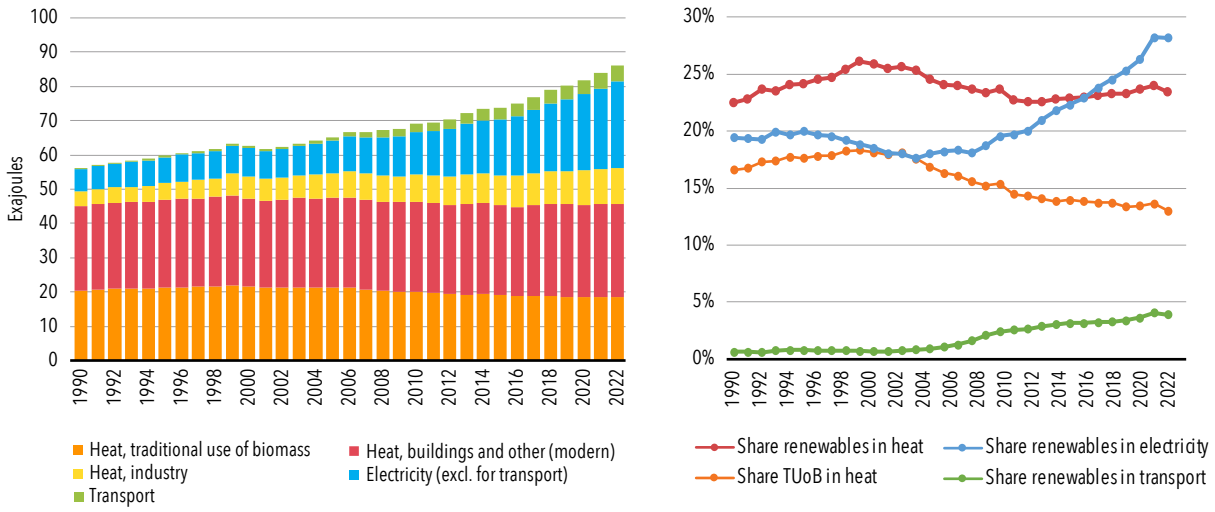
15 The full list of developed and developing countries can be found in Annex 1.

Looking beyond the main indicators

Ensuring access to affordable, reliable, sustainable, and modern energy for all implies a substantial increase in the share of renewable energy in all three main end-use categories, heat, transport, and electricity, which made up 46, 31, and 23 percent, respectively, of TFEC in 2022 (figure 3.5).

Electricity has seen the largest and the most dynamic increase in renewables' share in final consumption. Renewables' share in electricity grew from 23 percent in 2015 to almost 30 percent in 2022. In the **heating** subsector, renewable sources represented about 21 percent of energy used; almost half of this corresponded to traditional uses of biomass, which decreased 0.2 percent in 2022. Including the use of renewables-based electricity, the **transport** sector accounts for only 9 percent of global modern uses of renewable energy. It is the end-use sector with the lowest penetration of renewable energy, which represented only 4 percent of the sector's final energy consumption in 2022.

FIGURE 3.5 • RENEWABLE ENERGY CONSUMPTION AND SHARE BY END USE, 1990–2022



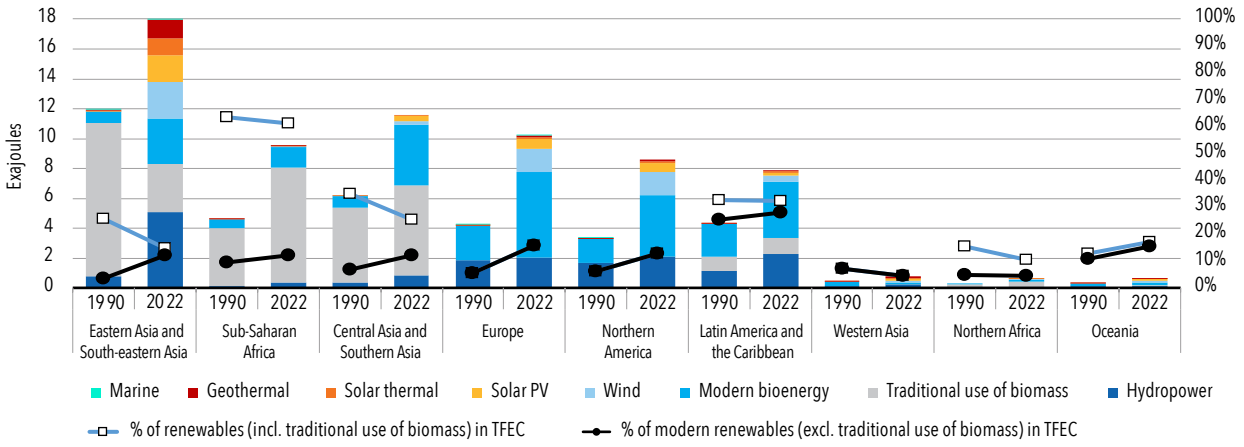
Source: International Energy Agency and United Nations Statistics Division.

Note: Electricity used for transport is included under transport. EJ = exajoule; TUoB = traditional uses of biomass.

Regional trends

Progress across regions varies widely. For instance, while renewable energy constitutes about two-thirds of TFEC in Sub-Saharan Africa, modern uses of renewables, excluding traditional uses of biomass, represent only 12 percent of TFEC in the region (figure 3.6). The share of modern uses of renewable energy is the largest in Latin America and the Caribbean (28 percent of TFEC in 2022), due mostly to the consumption of bioenergy for industrial processes (especially in the sugar and ethanol industry), biofuels for transport, and sizeable hydropower generation.

FIGURE 3.6 • RENEWABLE ENERGY CONSUMPTION AND SHARE IN TFEC BY REGION, 1990 AND 2022



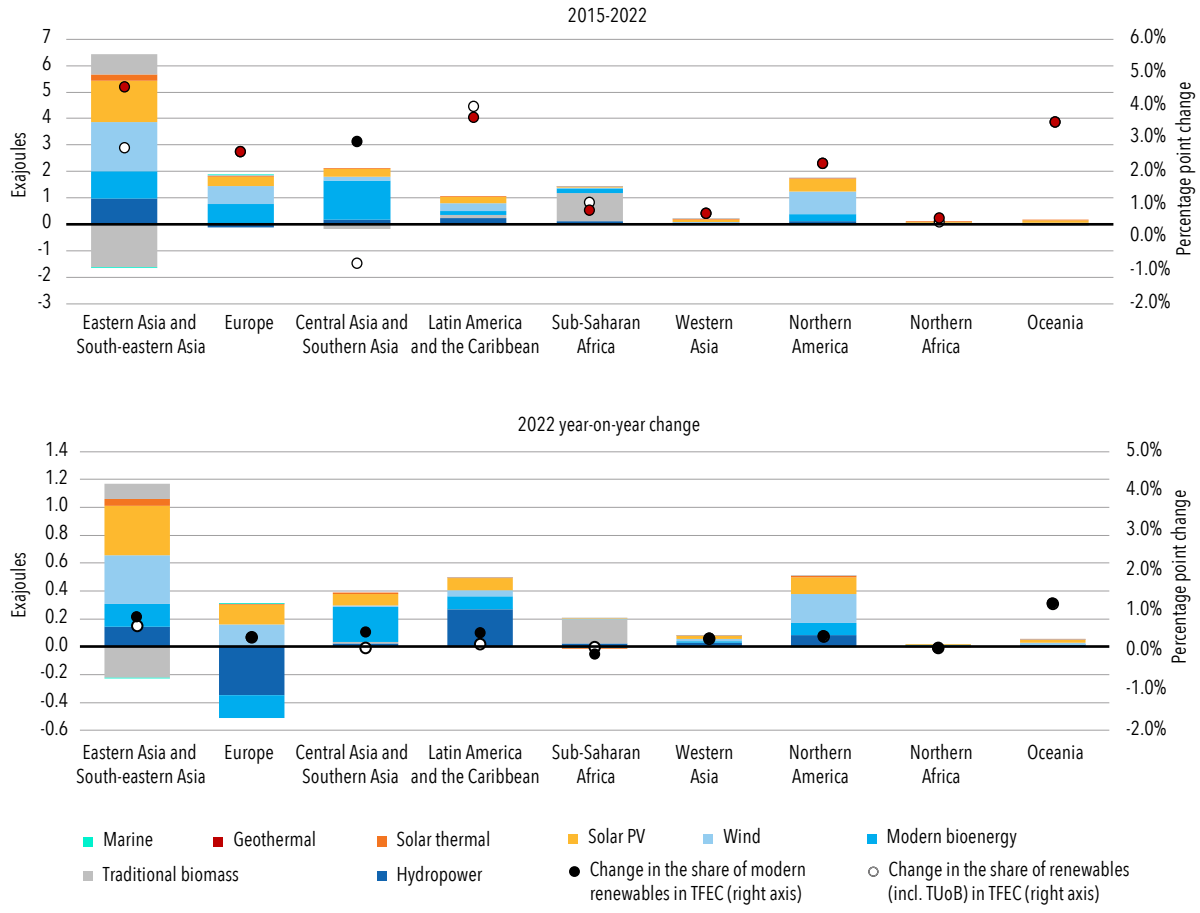
Source: International Energy Agency and United Nations Statistics Division.

Note: "Traditional uses of biomass" refers to the residential consumption of primary solid biofuels and charcoal in countries outside the OECD. Although biomass is used with low efficiency in OECD countries as well, such use is reported here under "modern bioenergy."

In 2022, significant additions of wind and solar PV, and, to a lesser extent, geothermal capacity, in Eastern Asia and South-eastern Asia led the region to represent almost half of the global year-on-year increase in modern uses of renewable energy, while traditional uses of biomass continued to decline significantly (figure 3.7). Europe ranked second for solar PV and wind capacity additions in 2022 (IEA 2022a).

After a strong rebound in 2021, TFEC increased only moderately in 2022 (+1.8 percent year-on-year). Nonetheless, this made the use of renewable energy more noticeable as a share of TFEC. Renewables' share in TFEC grew for all regions, led by Oceania and Eastern and South-eastern Asia (respectively, +1.2 and +0.6 percentage points in 2022 year-on-year). Growth in modern uses of bioenergy was the largest in Central Asia and Southern Asia (+0.3 percentage points year-on-year). Globally, traditional uses of biomass declined slightly; while they increased in Sub-Saharan Africa, this growth was offset by decreased consumption in Eastern and South-eastern Asia.

FIGURE 3.7 • CHANGE IN RENEWABLE ENERGY CONSUMPTION AND RENEWABLES' SHARE IN TFEC BY REGION, 2015–22, AND YEAR-ON-YEAR CHANGE, 2022



Source: International Energy Agency and United Nations Statistics Division.

Note: "Traditional uses of biomass" refers to the residential consumption of primary solid biofuels and charcoal in countries outside the OECD. Although biomass is used with low efficiency in OECD countries as well, such use is reported under "modern bioenergy."

At the national level, the share of renewable sources in energy consumption varies widely depending on resource availability, policy support, and the total energy demand resulting from consumption patterns and energy efficiency performance. After a strong rebound in 2021, TFEC grew moderately in 2022, in line with previous years. Only 11 of the top 20 energy-consuming countries recorded a higher TFEC in 2022 than in 2021.[16] In the remaining nine countries, TFEC decreased,[17] most likely due to energy conservation measures amid the energy crisis.

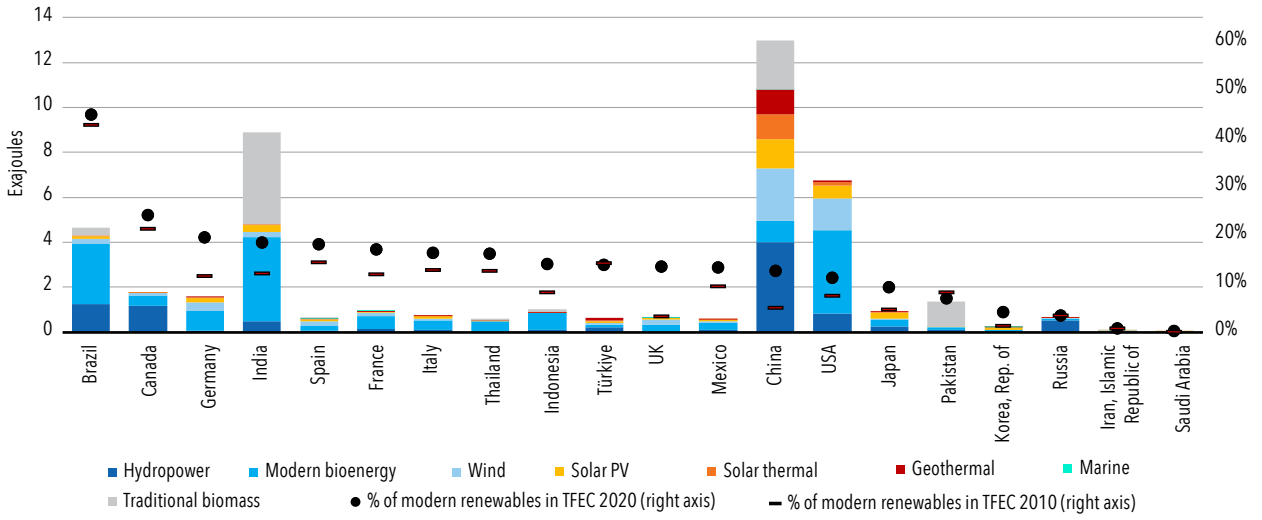
16 Countries that saw an increase in TFEC include Brazil, Canada, China, India, Indonesia, the Islamic Republic of Iran, Mexico, Pakistan, Saudi Arabia, Thailand, and the United States.

17 Countries that saw a decrease in TFEC include France, Germany, Italy, Japan, Korea, the Russian Federation, Spain, Türkiye, and the United Kingdom.

In 2022, year-on-year growth in modern uses of renewables was the largest in the Republic of Korea (+16 percent), followed by Türkiye (+15 percent).[18] Brazil and Canada continued to lead the top 20 energy-consuming countries in the share of modern uses of renewables in 2022 (45 and 24 percent of TFEC, respectively), owing to their considerable reliance on hydropower for electricity, biofuels for transport, and biomass for extracting heat, specifically in industry. China alone accounted for over a fifth of the global modern uses of renewable energy, despite its TFEC having a less than 13 percent share of modern renewables.

Between 2010 and 2022, the United Kingdom, Germany, and China achieved the largest increases in the share of modern uses of renewables in TFEC (+10, +8, and +8 percentage points, respectively), followed by India, Indonesia, and France (with shares increasing between +5 and +6 percentage points). This growth was mostly possible thanks to the development of wind and solar PV, as well as a significant decrease in TFEC in the United Kingdom, Germany, and France between 2010 and 2022 and a significant shift from traditional to modern uses of biomass in China, India, and Indonesia (figure 3.8).

FIGURE 3.8 • RENEWABLE ENERGY CONSUMPTION, 2022, AND SHARE OF MODERN USES OF RENEWABLES IN TFEC, 2010 AND 2022, FOR THE TOP 20 ENERGY-CONSUMING COUNTRIES



Source: International Energy Agency and United Nations Statistics Division.

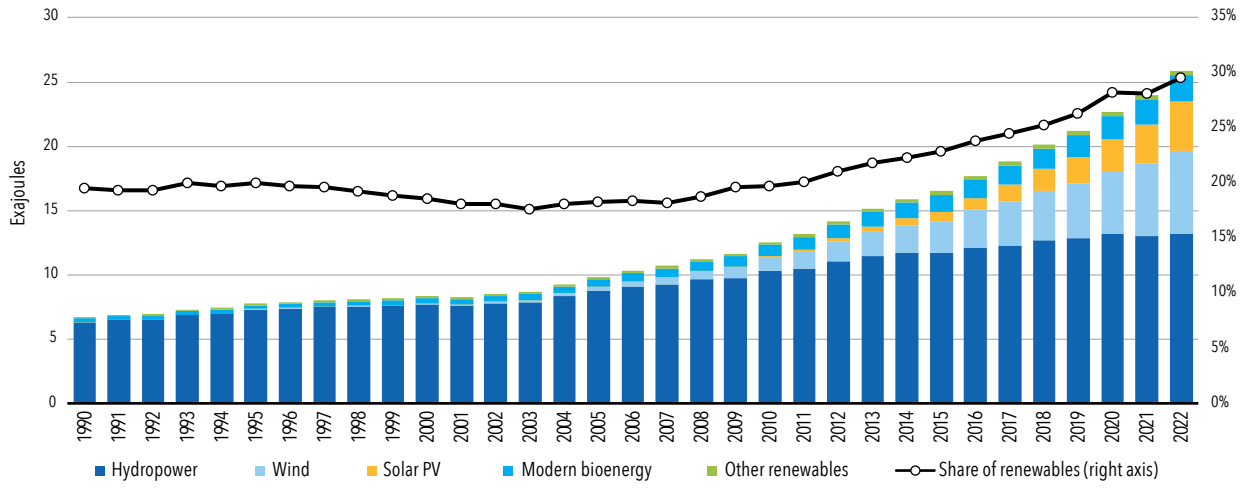
Note: "Traditional uses of biomass" refers to the residential consumption of primary solid biofuels and charcoal in countries outside the OECD. Although biomass is used with low efficiency in OECD countries as well, such use is reported under "modern bioenergy."

18 It should be noted that Saudi Arabia more than doubled its share of modern uses of renewables on a year-on-year basis. The share remains rather marginal, however (0.15 percent in 2022).

Electricity

Electricity accounted for 23 percent of TFEC globally in 2022. It is the fastest-growing end use: electricity consumption almost doubled over the past 22 years and grew 37 percent since 2010.[19] Although global annual electricity consumption increased slightly, by 3 percent, to 86 EJ in 2022, global renewables-based electricity consumption grew almost 8 percent (+1.8 EJ) year-on-year in 2022. The share of renewables in electricity generation increased to almost 30 percent in 2022—the greatest share among all end uses (figure 3.9).

FIGURE 3.9 • GLOBAL RENEWABLES-BASED ELECTRICITY CONSUMPTION BY TECHNOLOGY, 1990–2022



Source: International Energy Agency and United Nations Statistics Division.

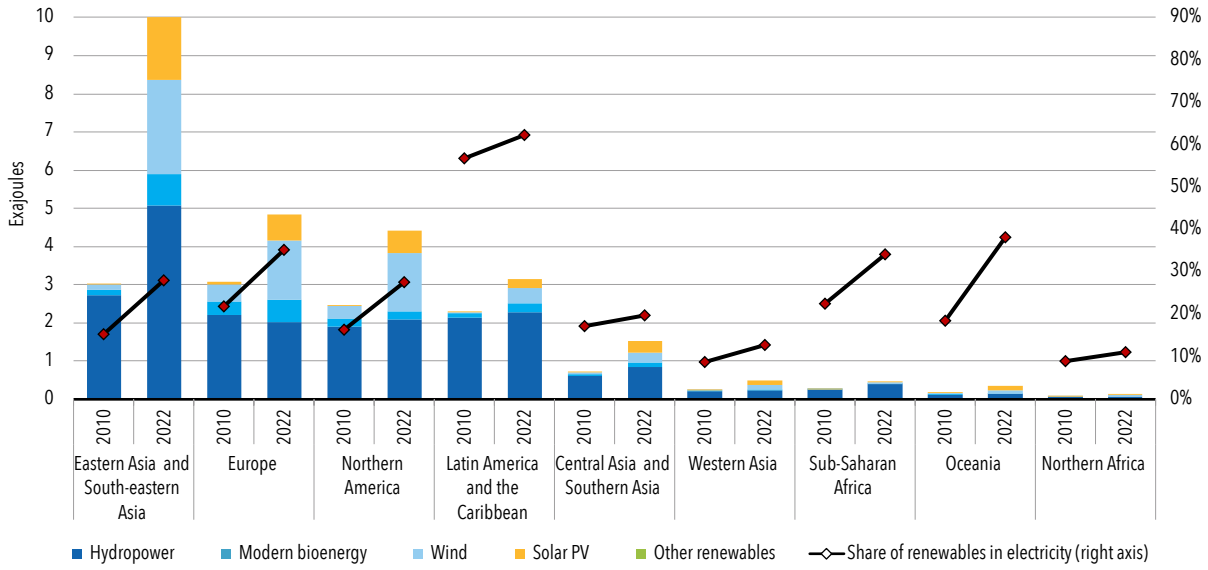
PV = photovoltaic.

In 2022, wind and solar PV made the largest contributions to the annual increase in renewables-based electricity consumption, with hydropower and electricity from combustible bioenergy and other technologies (geothermal, concentrating solar power, marine energy) contributing the remaining growth. Hydropower remained the largest source of renewables-based electricity globally and for each region, representing in many cases more than half of renewables-based electricity consumption in 2022. After extreme drought conditions in 2021, hydroelectricity consumption grew 1.5 percent year-on-year in 2022, rebounding to the levels seen in 2020.

Eastern Asia and South-eastern Asia recorded the largest absolute year-on-year increase of renewables in electricity consumption in 2022. Almost half of the growth in global renewables-based electricity consumption came from this region, chiefly in China, followed by Indonesia and Japan. This growth was led by rapid developments of wind and solar PV. The share of renewable sources in electricity consumption was the largest in Latin America and the Caribbean, where hydropower alone accounted for almost half of electricity consumption in 2022. Oceania and Europe ranked second and third, respectively, for their shares of renewable sources in electricity consumption, followed by Sub-Saharan Africa. Rapidly declining costs and policy support contributed to wind and solar PV together representing almost 70 percent of the increase in global renewables-based electricity consumption from 2010 (figure 3.10).

19 Among the most important factors driving this trend is the rapidly growing use of electricity for space cooling. Air conditioners and electric cooling fans accounted for about 10 percent of global electricity consumption in 2018 (IEA 2018).

FIGURE 3.10 • RENEWABLES-BASED ELECTRICITY CONSUMPTION AND RENEWABLES' SHARE IN ELECTRICITY BY REGION, 2010 AND 2022

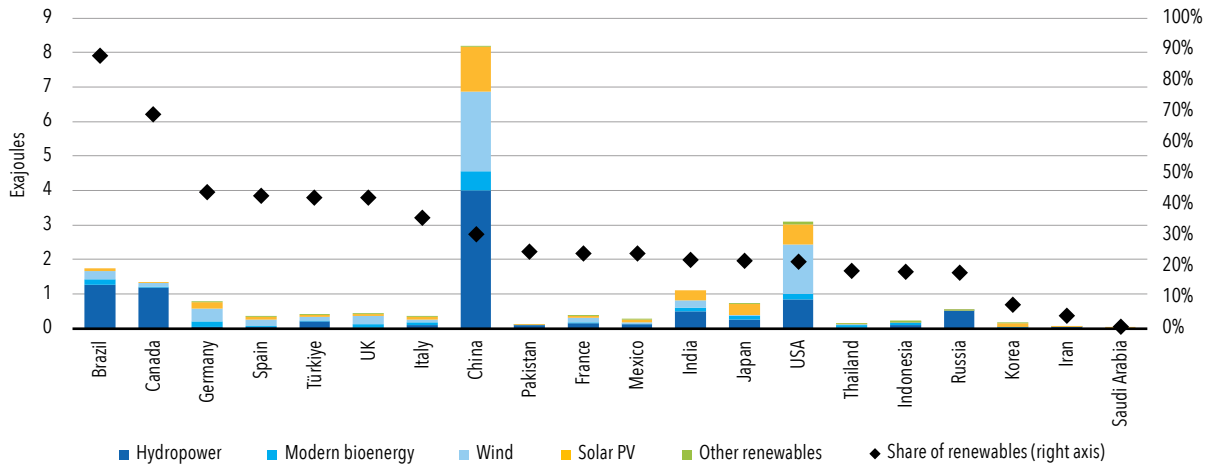


Source: International Energy Agency and United Nations Statistics Division.

PV = photovoltaic.

Trends in renewables' share in electricity consumption vary among the top 20 energy-consuming countries, from about 1 percent to nearly 90 percent. Brazil and Canada are by far the leaders, due to large hydropower capacities (figure 3.11). Wind and solar PV, that is, nondispatchable renewables, together are the largest sources of renewables-based electricity in India, the United States, Germany, France, Italy, Japan, Spain, Mexico, the United Kingdom of Great Britain and Northern Ireland, the Republic of Korea, and Saudi Arabia, and they supply more than three-fifths of the total renewable electricity consumption in these countries. Between 2021 and 2022, China contributed about 43 percent of the global annual increase in renewables-based electricity consumption, more than 90 percent of it from wind and solar PV.

FIGURE 3.11 • RENEWABLES-BASED ELECTRICITY CONSUMPTION IN THE TOP 20 ENERGY-CONSUMING COUNTRIES, BY SOURCE AND COUNTRY, 2022



Source: International Energy Agency and United Nations Statistics Division.

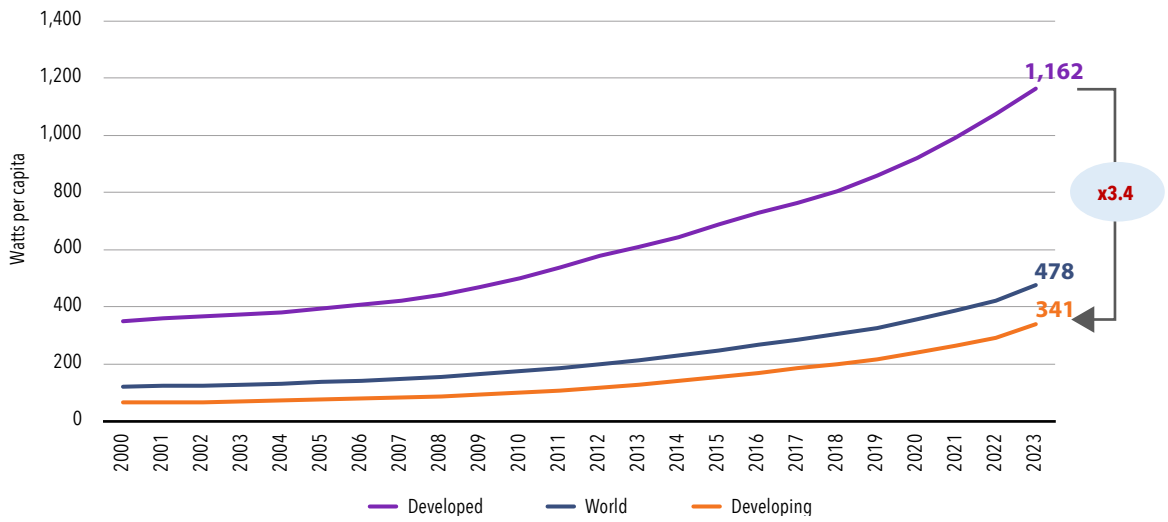
PV = photovoltaic.

Installed renewable energy generating capacity per capita

Despite substantial progress in indicator 7.b.1, developed and developing regions still show significant disparities. Developed countries had 1,162 watts of renewable energy capacity per capita in 2023, while the average person in a developing country was limited to only 341 watts. This means that people in developing countries met their energy needs using less than a third of the renewables-based power available to the average person in a developed country (figure 3.12). If Brazil, China, and India are excluded from the developing country category, the category average drops to only 126 watts per capita for 2023, showing the outsized impact of some of the larger countries owing to the uneven distribution of renewable energy capacity.

While the disparity has narrowed in the past 10 years (in 2013, developed countries had 4.8 times more renewable energy capacity per capita), developed countries still possess 3.4 times more renewable energy capacity per capita. Renewable energy must be deployed at a faster pace in developing countries to accomplish SDG 7 and fulfill the overall SDG agenda by the end of the decade, especially given their critical role in helping ensure universal access for all (see chapter 1).

FIGURE 3.12 • ANNUAL GROWTH OF RENEWABLE ENERGY GENERATING CAPACITY PER CAPITA IN DEVELOPING AND DEVELOPED COUNTRIES, AND THE WORLD, 2000–23

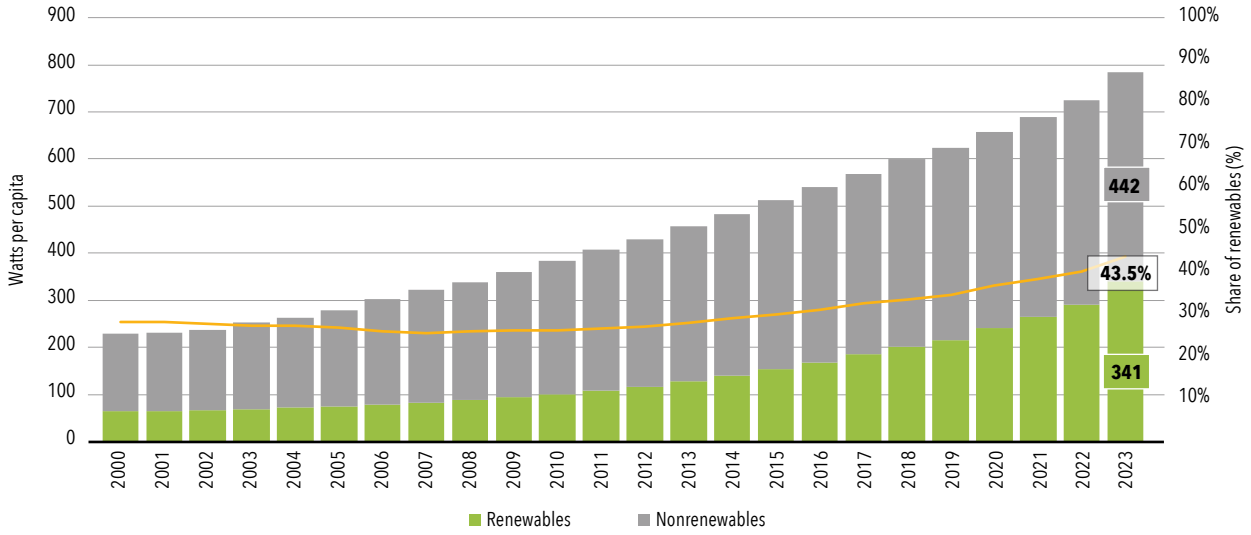


Source: International Renewable Energy Agency.

Developing countries have steadily increased their renewable shares in the past two decades, peaking at 43.5 percent of total energy generating capacity in 2023. But nonrenewable sources continue to dominate (figure 3.13). While many regions are exploring renewable energy technologies, particularly solar, as least-cost options for new power generation, unique challenges, in particular financial and capacity constraints (as also discussed in chapter 5), hinder renewables' deployment in developing countries (IRENA 2023a).

In 2023, developing countries had less renewable energy capacity installed per capita than in developed countries by a factor of 3.4, but a higher share of renewables in total installed capacity (43.5 percent, compared with 42.3 percent). This higher share of installed capacity, despite lower absolute levels, reflects progress and suggests an opportunity to continue leapfrogging carbon-intensive development pathways in favor of more sustainable energy systems (IRENA 2023b).

FIGURE 3.13 • ANNUAL GROWTH OF RENEWABLE ENERGY GENERATING CAPACITY IN DEVELOPING COUNTRIES, AND SHARE OF RENEWABLES, 2000–23



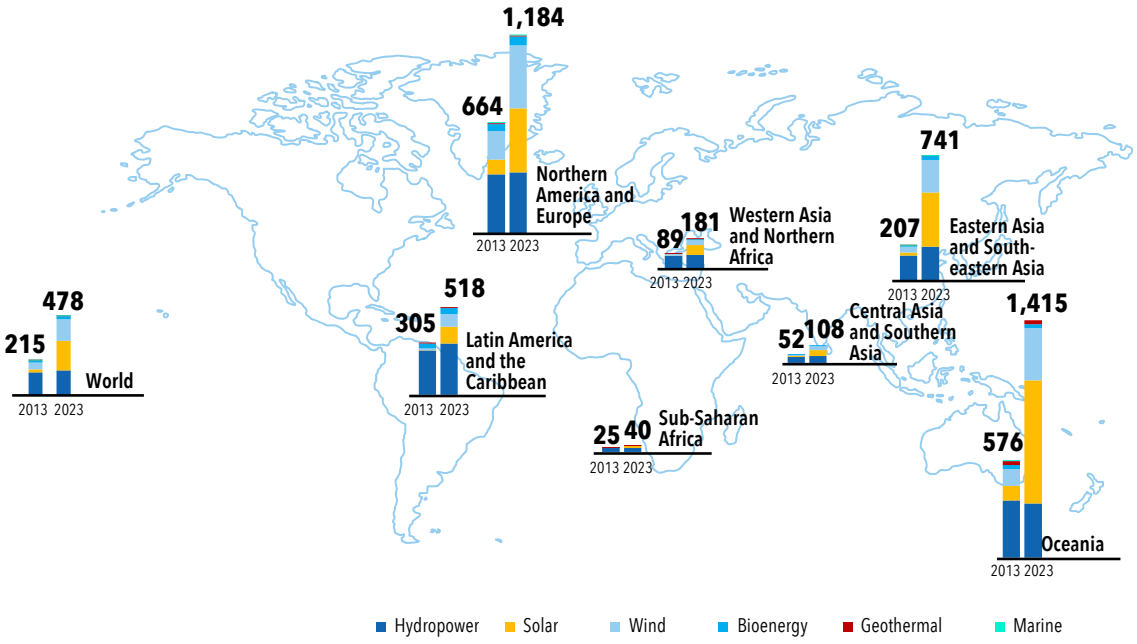
Source: International Renewable Energy Agency.

The largest growth of renewable energy generating capacity per capita in the past decade occurred in Eastern and South-eastern Asia, mainly driven by solar power, followed by hydropower and wind (figure 3.14). The region's installed renewable energy generating capacity per capita, which grew at a CAGR of 13.6 percent over the past decade, more than tripled in 2013–23, from 207 watts to 741 watts. Meanwhile, Oceania, Central and Southern Asia, and Western Asia and Northern Africa each more than doubled their installed renewable energy per capita in the same period. The lowest growth rates are attributed to Northern America and Europe, Latin America, and Sub-Saharan Africa, in that order.

Notably, Oceania has the highest ratio of renewables-based power to population, at 1,415 watts per capita, followed by Northern America and Europe, at 1,184 watts per capita, while the lowest is in Sub-Saharan Africa, at just 40 watts per capita. While growth was slower in Northern America and Europe, this is due in part to the fact that the region already possessed substantial renewable energy capacity in 2013, as well as the fact that further expanding renewables requires upgrading or replacing existing infrastructure rather than simply adding new capacity. New renewable installations in these regions have therefore been more incremental than in regions with lower starting capacity. In fact, with 664 watts per capita as of 2013, Northern America and Europe already had more renewable power per person 10 years ago than the average person did in 2023 in Latin America and the Caribbean, Western Asia and Northern Africa, Central and Southern Asia, and Sub-Saharan Africa. Yet there is still much scope for renewables' share of electricity supply to grow in Northern America and Europe.

A critical front in the global push toward achieving SDG 7 is Sub-Saharan Africa, which is at risk of being left behind in the global energy transition. Limited progress in installed renewable energy generating capacity per capita, from 25 watts in 2013 to only 40 watts in 2023, reflects ongoing struggles in achieving universal energy access and supporting sustainable development as population growth continues to outpace energy demand.

FIGURE 3.14 • GROWTH IN RENEWABLE ENERGY GENERATING CAPACITY PER CAPITA BY TECHNOLOGY ACROSS REGIONS, 2010–23



Source: International Renewable Energy Agency.

CAGR = compound annual growth rate.

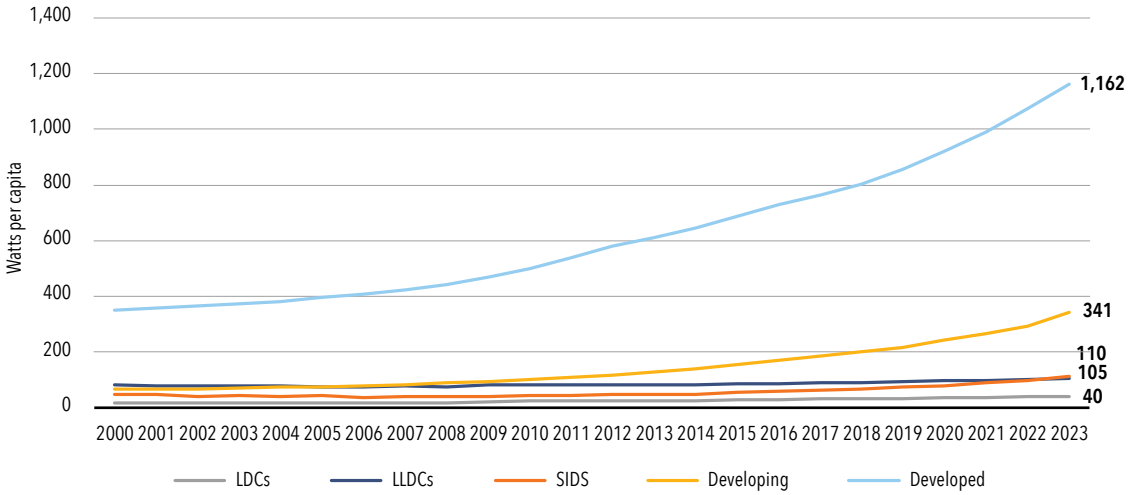
Disclaimer: This map is provided for illustration purposes only. Boundaries and names shown on this map do not imply any endorsement or acceptance by IRENA.

Target 7.b[20] emphasizes the specific needs of least-developed countries (LDCs), small island developing states (SIDS), and landlocked developing countries (LLDCs) by 2030. Figure 3.15 illustrates the status of renewable energy generating capacity per capita for this subset of developing countries. For all three groups, capacity is below that of developing countries as a whole (341 watts per capita), with 110 watts per capita for SIDSs, 105 watts per capita for LLDCs, and only 40 watts per capita for LDCs.

The sluggish growth of renewables in these country groups contrasts sharply with both the wider developing category and, even more so, with developed regions. It reflects systemic issues—including limited access to financing, inadequate infrastructure, and insufficient revenues—that hinder large-scale deployment of renewables. Dedicated efforts are thus needed to ensure that the 106 countries comprising the LLDCs, LDCs, and SIDS—home to 1.8 billion—are not left behind in the energy transition.

20 This target aims by 2030 to expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular LDCs, SIDS, and LLDCs,, in accordance with their respective programmes of support."

FIGURE 3.15 • RENEWABLE ENERGY GENERATING CAPACITY PER CAPITA BY COUNTRY GROUP, 2000–23



Source: International Renewable Energy Agency.

SIDS = small island developing state; LDC = least-developed country; LLDC = landlocked developing country.

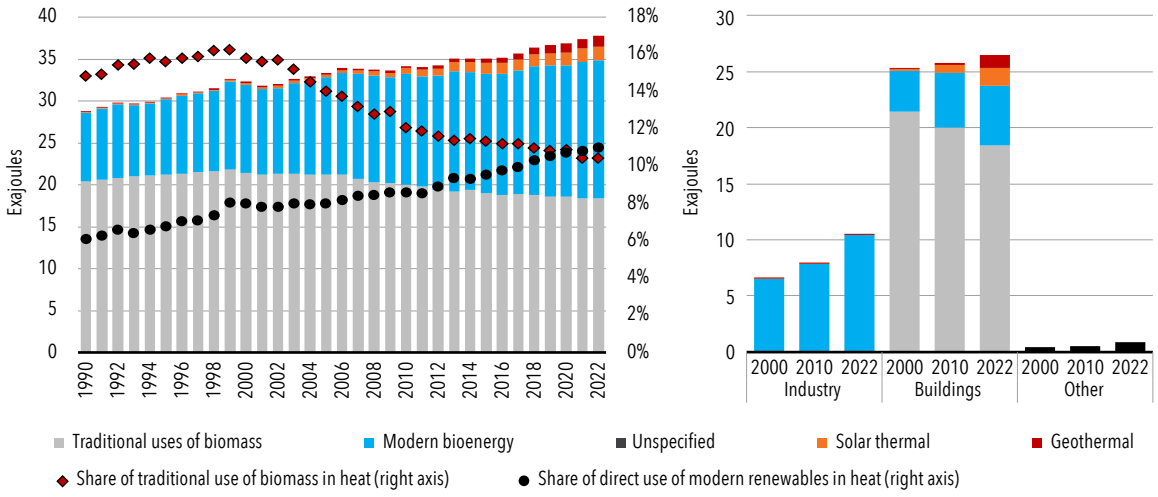
Heat

Heat is the largest energy end use worldwide, accounting for almost half of global TFEC (176 EJ). Worldwide, the total energy consumption for heat in 2022 was roughly the same as that in 2021. The global heat sector relies heavily on fossil fuels, meeting more than three-quarters of heat demand through coal, gas, and oil. Traditional uses of biomass for heat declined slightly, by 0.2 percent, in 2022 year-on-year, accounting for over 10 percent (18 EJ) of the global energy consumption for heat. Excluding traditional uses of biomass, as well as ambient heat harnessed by heat pumps[21] (on which data are limited), direct modern uses of renewables for heat increased 1.8 percent year-on-year to exceed 19 EJ in 2022. This represented 11 percent of the total energy consumed for heat, only 2.7 percentage points higher than in 2010 (figure 3.16).

Despite its dominant share in TFEC, the heating sector has received limited policy attention and support, until recently (IEA 2022a), with the development of renewable-heat-focused policies that include energy security considerations. Greater ambition and stronger policy support are needed to progress toward SDG target 7.1 ("ensure universal access to affordable, reliable and modern energy services"—for instance, for cooking and space and water heating) and SDG target 7.2 ("increase substantially the share of renewable energy in the global energy mix"). Strong improvements in energy efficiency, conservation, and material efficiency—especially for energy-intensive materials such as cement and steel, which come from hard-to-decarbonize sectors—must be combined with rapid deployment of renewable heat technologies to transition away from fossil fuels and inefficient and unsustainable uses of biomass.

21 The rapid spread of heat pumps over the past decade is making ambient heat an increasingly important heat source, although its prevalence globally is difficult to estimate because data are unavailable for some markets. Because of the lack of data, this report does not account for it, although ambient heat (in excess of any electricity used to run the pumps) can be credited as a renewable source, and electric heat pumps are expected to play a key role in the decarbonization of the heating sector.

FIGURE 3.16 • RENEWABLE HEAT CONSUMPTION BY SOURCE AND SECTOR, 1990–2022



Source: International Energy Agency and United Nations Statistics Division.

Note: Indirect consumption of renewable heat through renewables-based electricity is not represented in this figure.

Bioenergy accounts for about 85 percent (16.4 EJ) of direct[22] modern use of renewables for heat globally. It accounts for about one-tenth (IEA 2021) of the energy consumed for industrial heat and one-twentieth of the energy consumed for heat in the buildings sector (IEA 2024b). Industry accounts for over two-thirds of modern uses of bioenergy, mostly in subsectors producing biomass residues on site, such as wood, pulp, and paper industries, as well as the sugar and ethanol industries. In 2022, industrial consumption of modern uses of bioenergy for heat grew 3 percent year-on-year—mostly due to increasing use in Brazil's and India's sugar and ethanol industries—but decreased 2.8 percent in the buildings sector.

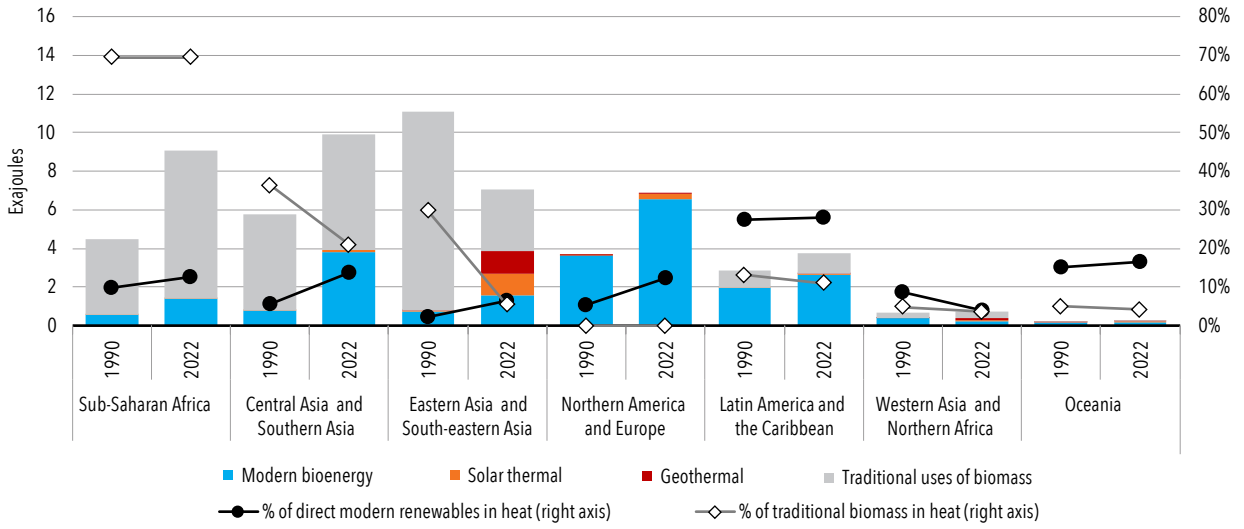
Global **solar thermal** heat consumption increased 5 percent between 2021 and 2022; it accounted for 8 percent (1.62 EJ) of modern uses of renewables for heat, yet met less than 1 percent of total final heat demand. New solar thermal installations in 2023 fell 7 percent, due to challenges in China's real estate market, as reduced rates of construction limited the demand for solar thermal systems. However, year-on-year growth occurred in the United Kingdom (+66 percent), India (+27 percent), Greece (+10 percent), Mexico (+5 percent), and Brazil (+3 percent).

Global **geothermal** heat consumption grew 9.3 percent in 2022. It was driven almost exclusively by China and represented over 6.5 percent (1.3 EJ) of modern uses of renewables for heat. About 60 percent of geothermal heat is harnessed by ground source heat pumps worldwide (Lund and Toth 2021). The large majority of applications are in the buildings sector, with bathing, swimming, and space heating (primarily via district heating) being the most prevalent end uses globally. China accounts for over four-fifths of the global geothermal heat consumption, followed by Türkiye and the United States, which together account for almost one-tenth.

22 For the purposes of this report, the "heating" subsector encompasses all energy not used as electricity or for transport, even those energy uses that are not for heating purposes (e.g., diesel oil in a water pump). If we see heat strictly as an end use, renewables also contribute to heat supply indirectly through renewables-based electricity used for heating and district heat networks. If we account for these indirect uses, and exclude ambient heat harnessed by air source heat pumps, then renewables-based electricity makes the second-largest contribution to modern end use of renewables-based heat after bioenergy, and the fastest-growing one. Renewables-based electricity used for heating accounted for almost half of the increase in total (direct and indirect) modern use of renewable energy used for heat in 2018; this was due to the combination of increasing renewables penetration in power and heat electrification using electric heat pumps and boilers. The buildings sector is responsible for the majority of electricity consumption for heat.

Traditional uses of biomass are primarily concentrated in Sub-Saharan Africa and Asia (figure 3.17), with—in descending order—India, China, Ethiopia, the Democratic Republic of the Congo, Nigeria, and the United Republic of Tanzania together accounting for two-thirds of global consumption. Despite a slightly declining trend since 2006, traditional uses of biomass in 2022 were still at a level similar to that of 1990 at a global scale. Trends differed across regions and countries in 2012–22, with significant declines in Eastern Asia, especially in China, as well as in Indonesia and Viet Nam, partly compensated by strong population-driven increases in Sub-Saharan Africa (especially in Nigeria, Ethiopia, Uganda, and the Democratic Republic of the Congo).

FIGURE 3.17 • RENEWABLES CONSUMPTION IN HEAT BY REGION, 1990 AND 2022



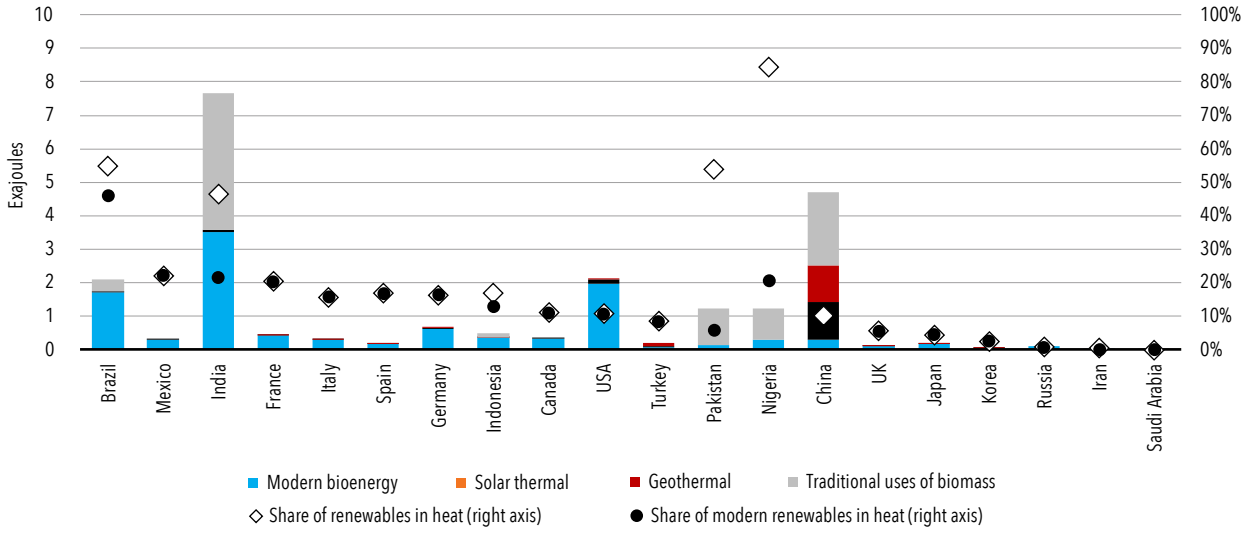
Source: International Energy Agency and United Nations Statistics Division.

Note: The statistical framework adopted for this figure does not account for the use of renewables-based electricity for heating. "Traditional uses of biomass" refers to the residential consumption of primary solid biofuels and charcoal in countries outside the OECD. Although biomass is used with low efficiency in OECD countries as well, such use is reported under "modern bioenergy."

EJ = exajoule.

China and India together represented over 70 percent of the global increase in modern use of renewable energy for heat in 2010–22. Together with the United States and Brazil, they represented 43 percent of the global heat demand and accounted for half of modern use of renewable heat globally in 2022 (figure 3.18). This is due to the significant consumption of bioenergy in the pulp and paper industry and for residential heating in the United States; extensive use of bagasse in Brazil's and India's sugar and ethanol industry; and notable deployment of solar thermal water heaters and geothermal heat in China. Europe accounts for another quarter of the global modern use of renewable heat, owing to the use of residential wood and pellet stoves and boilers (e.g., in France, Germany, and Italy) and of biomass in district heating (e.g., Nordic and Baltic countries, Germany, France, and Austria). Although not detailed in this report, renewable heat consumption was indirectly driven by the growing consumption of renewables-based electricity through electric heaters and heat pumps (accounted for in the electricity sector), as well as the use of heat pumps to harness ambient heat (not quantified in this report) in China, the United States, and the European Union (IEA 2024b).

FIGURE 3.18 • RENEWABLE HEAT CONSUMPTION AND THE SHARE OF RENEWABLES IN TOTAL HEAT CONSUMPTION, BY COUNTRY, FOR THE TOP 20 ENERGY-CONSUMING COUNTRIES, 2022



Source: International Energy Agency and United Nations Statistics Division.

Note: "Traditional uses of biomass" refers to the residential consumption of primary solid biofuels and charcoal in countries outside the OECD. Although biomass is used with low efficiency in OECD countries as well, such use is reported under "modern bioenergy." Indirect consumption of renewable energy through electricity for heat is not included in this figure.

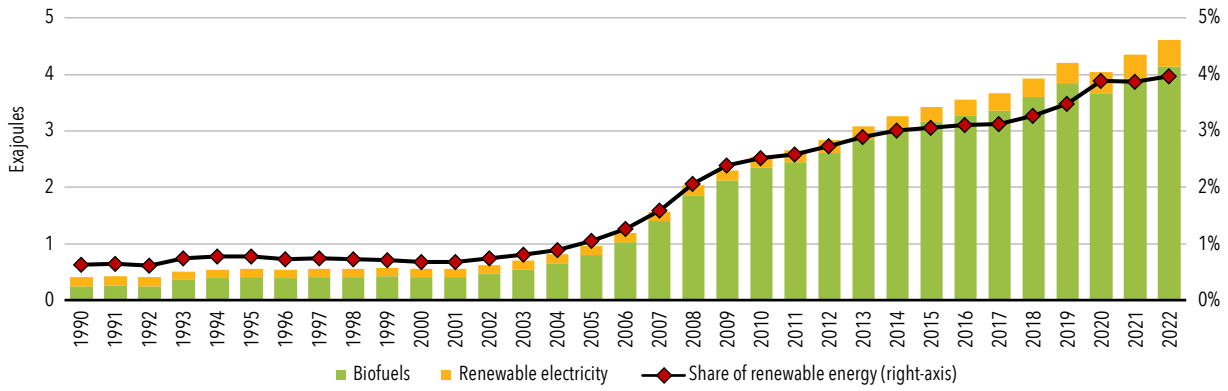
Transport

The share of renewable energy in transport TFEC rose to 3.9 percent in 2022, up from 3 percent in 2015. Global TFEC for transport increased 4 percent (+5 EJ) between 2021 and 2022. Biofuels, representing nearly 90 percent of the renewable energy consumed for transport, continued to dominate; their share grew 5 percent year-on-year in 2022 (+0.22 EJ), despite their overall share in transport TFEC remaining steady, at 3.5 percent. The shares of bio gasoline and other liquid biofuels (mostly bioethanol) grew 3 percent in 2022, over 2021. By comparison, in 2022, the shares of biodiesel and renewable diesel grew well beyond the levels seen in 2021. The combined demand for these fuels in 2022 was 6 percent more than in 2021.

Liquid biofuels, mainly crop-based ethanol and biodiesel blended with fossil transport fuels, represented nearly 90 percent of the renewable energy consumed for transport; most of the remainder came from renewables-based electricity used in vehicles and trains, which grew 14.5 percent from 2021.

This growth is partly due to an expanding EV fleet. The number of EVs on the road rose from 10.2 million in 2020 to 16.5 million in 2021 and then to more than 26.3 million in 2022 (IEA 2024c). The electricity powering these vehicles has increasingly come from renewable sources, with renewables' share of total electricity used in transport climbing from 20 percent in 2010 to 29.6 percent in 2022 (figure 3.19).

FIGURE 3.19 • GLOBAL SHARE OF RENEWABLE FUELS IN TRANSPORT AND TOTALS FOR RENEWABLES-BASED ELECTRICITY AND BIOFUELS, 1990–2022



Source: International Energy Agency and United Nations Statistics Division.

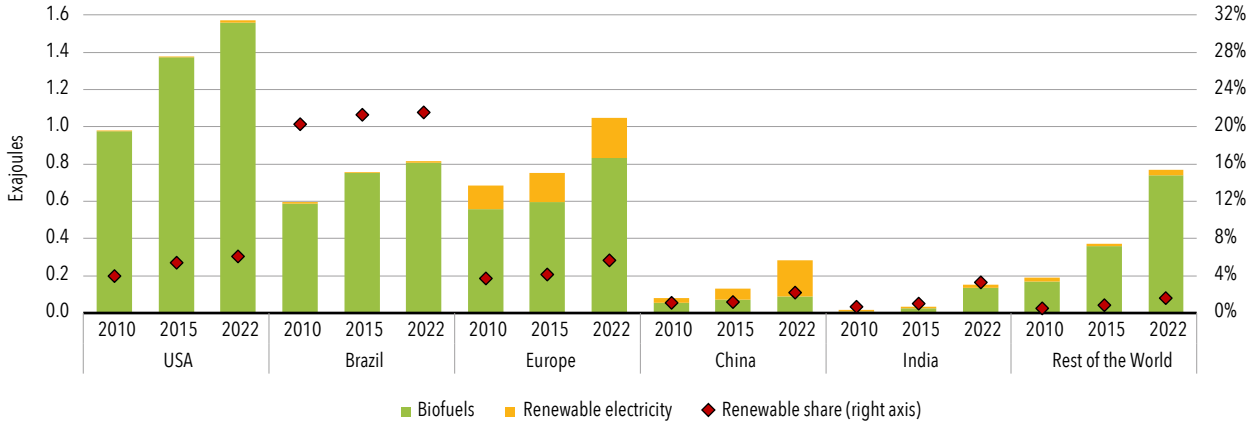
RES = renewable energy sources.

Over 2010–22, renewable energy in transport grew nearly 60 percent, but its share of TFEC increased only 1.5 percentage points. The growth is mainly due to country-level policies to expand biofuels, while increased use of renewable electricity (through electrification of transport, and increased renewable energy generation, among other things) has played a smaller, but growing, role. Despite many successes at the country level, supportive policies have only slightly outpaced growing fossil fuel demand, resulting in a modest overall increase in share.

While the United States, Brazil, and Europe account for nearly three-quarters of the renewable energy used in transport, other countries and regions are also increasing their shares (figure 3.20). In the United States and Brazil, biofuels (mainly ethanol and biodiesel) represent 99 percent of the renewable energy used in transport. In Europe, renewables-based electricity represents 20 percent of the renewable energy used in transport. China's use of renewable energy in transport more than doubled between 2015 and 2022; renewable electricity consumption for transport grew two times over this period. By 2022, renewable electricity represented over three-quarters of all renewable energy used in China's transport. This was due to increasing shares of renewables in power generation and efforts to electrify transportation. Biofuels received limited policy support, however. Also, by 2022, EV sales in China had more than doubled, reaching 5.9 million (IEA 2024c). Together, China and Europe represented nearly 85 percent of global electric car sales in 2022. In India, biofuel support policies tripled renewable energy use in transport between 2015 and 2022.

Increasing renewables' share in transport will require multiple policies, including to boost biofuels (while ensuring that feedstock meets stringent sustainability criteria), to electrify transport, and to increase renewable electricity generation; as well as to promote active mobility, support transit efficiency (by design), and phase out fossil fuels for transport. Such policies must be steadily strengthened where they exist and introduced where they do not.

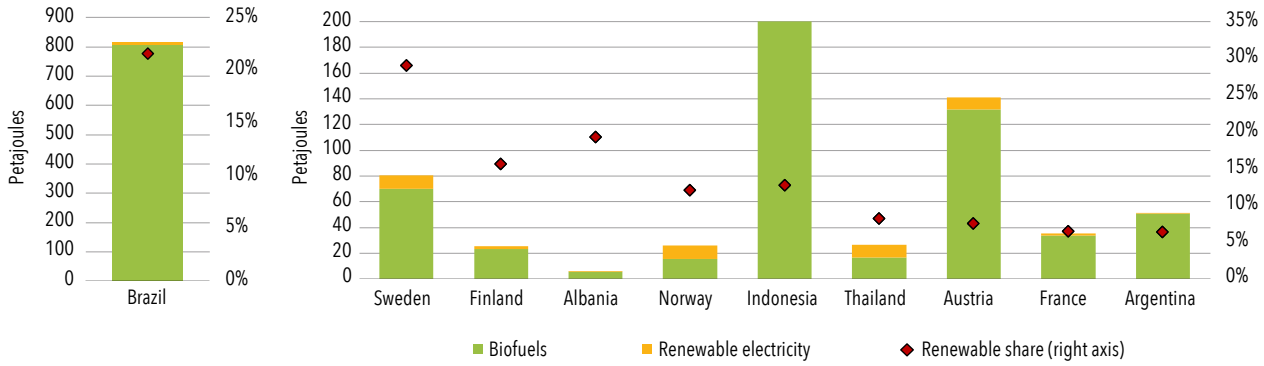
FIGURE 3.20 • RENEWABLE ENERGY SHARE AND TOTAL RENEWABLE ENERGY IN TRANSPORT ACROSS SELECTED COUNTRIES AND REGIONS, 2010, 2015, AND 2022



Source: International Energy Agency and United Nations Statistics Division.

The United States, Brazil, Europe, China, and India account for nearly 85 percent of the renewable energy used for transport, thanks to policy support for biofuels and electrification. In 2022, renewables' shares in transport TFEC were the highest in Brazil, Sweden, Finland, Albania, Norway, and Indonesia—all above 10 percent (figure 3.21).

FIGURE 3.21 • TOP 10 COUNTRIES BY SHARE OF RENEWABLE ENERGY IN TRANSPORT, 2022



Source: International Energy Agency and United Nations Statistics Division.

Policy insights

Since the adoption of SDG 7 in 2015, the share of renewable energy sources in TFEC, including traditional uses of biomass, increased modestly, from 16.7 to 17.9 percent in 2022. The increase remained modest despite record additions of renewable energy over the same period. In 2024 alone, an unprecedented 585 gigawatts of renewable power capacity were added, accounting for over 90 percent of the total power expansion globally (IRENA 2025). Global renewables-based power capacity is expected to grow by a factor of 2.7 in 2030, surpassing countries' current ambitions by nearly 25 percent (IEA 2024b, 2024d). Yet significant disparities remain in the installed renewable capacity of developing versus developed countries. The consensus reached at the climate summit COP28 in 2023 in the UAE to triple global renewable power capacity, double energy efficiency, and transition away from fossil fuels can help shift the needle on increasing renewables' share in the global energy mix—and support infrastructure expansion and technology upgrades for delivering modern and sustainable energy services to all, with adequate policy support and financing.

Renewable energy solutions remain a key enabler of the broader SDG agenda. As global policy makers consider progress toward SDG 8 on employment and economic growth, SDG 5 on gender equality, and SDG 3 on good health and well-being during the 2025 High-Level Political Forum, the recommendations below also emphasize the interlinkages and need for holistic policy making across these areas. The renewable component of SDG 7 is central to this effort since it addresses inequities in energy access and clean cooking (see chapters 1 and 2), while unlocking opportunities that drive progress across health, gender equality, job creation, and other SDGs.

Sustained action is needed to drive the uptake of renewable energy solutions in line with climate and development goals, including the goal to triple global renewables power capacity by 2030. Assessments by the International Renewable Energy Agency and International Energy Agency show that current ambitions are insufficient to meet the tripling goal, with an ambition gap of between 3.8 terawatts (TW) and 4.2 TW by 2030 (as discussed in more detail in the chapter 6). Last year's edition of this report referenced several essential policy measures—effective target setting, long-term planning, and policy support—for accomplishing SDG 7, as well as the tripling goal. Enabling policy and regulatory frameworks remains crucial. Market incentives, including carbon pricing mechanisms, that consider the externalities of fossil fuel use and well-designed procurement schemes should be put in place. Organizational structures of the power sector should be tailored to national contexts, such as institutional structure and the availability of renewable energy resources; those structures must ensure flexibility, reliability, and sustainability. Digital solutions, including advances in artificial intelligence, are offering new opportunities for how sustainable energy is produced, consumed, and financed. Overall, policies and public funds must drive investments in new transmission and distribution infrastructure. Across these measures, the socioeconomic impacts of different policies need to be considered to ensure that benefits and burdens are equitably distributed, both across and within countries, considering in particular the needs of vulnerable populations (IEA 2024b; IRENA 2024b).

Global efforts need to be scaled up to address the uneven deployment of renewable energy, specifically supporting LDCs, SIDSs, and LLDCs, which are at risk of being left behind. Sub-Saharan Africa as a region and LDCs as a group had respectively only 40 watts of renewable energy generating capacity per capita in 2023. Average capacity per capita across LLDCs and SIDSs was 10 times less than the global average. This is far from sufficient to support socioeconomic development in these regions, which are characterized by widespread energy poverty and inequities both within and across countries. Tripling as a global goal on its own does not ensure that equitable renewables deployment will occur in contexts where renewables can help close the energy access gap, support community development and productive uses, and foster sustainable industrialization. Tailored action spanning a

wide range of policy interventions—including in technology and knowledge exchange, capacity building, and access to adequate financing (see also chapter 5)—is needed to enable equitable energy access and the ability to escape the cycles of poverty and exploitation that stifle economic development.

Integrated policy making is required to leverage SDG 7 to support SDG 8, which seeks to "promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all." Renewable energy offers employment opportunities for individuals with a range of skills along the value chain (IRENA 2024b). Rapid deployment of renewable energy is already translating into a growing workforce: 16.2 million in 2023 (IRENA and ILO, 2024). In the wider energy sector, clean energy remains the primary engine of job growth, while employment in fossil fuels grew 3 percent in 2023, driven by growth in the oil and gas sector (IEA 2024e).

Stimulating demand for renewable energy requires clear long-term targets and plans, with support from holistic policies, including industrial policies, as well as affordable financing, to promote renewable energy deployment and the development of domestic value chains. This in turn can help create jobs in procurement and manufacturing, installation, operation and maintenance, as well as end-of-life management (IRENA 2024b). However, most emerging and developing economies face structural barriers to creating new clean energy jobs, especially in manufacturing, because they struggle to attract clean energy investments, lack a robust existing manufacturing base, have a limited skill pool, and have inadequate infrastructure (IEA 2024e).

Job opportunities and the related policy priorities also depend on the context. For rural areas, where new electricity connections are expected to occur mostly through decentralized renewable energy, the electrification agenda must intentionally include productive uses of energy. Integrating productive uses of renewable energy in planning and design will ensure income-generating activities that advance sustainable development. Realizing this requires developing policy and regulatory frameworks conducive to cross-sectoral planning (e.g., between energy and agriculture sectors), tailoring delivery and financing models to rural markets' needs, promoting quality-certified appliances that are efficient and affordable for rural enterprises, and building the capacity of and training key actors involved in productive uses of energy (IRENA 2022a).

Continued attention is needed to ensure that the new jobs created are decent. Employment quality in the renewable energy sector varies widely, reflecting existing national standards and their implementation, the specific nature of the jobs, and unionization rates. Generally, labor standards tend to be higher in industries with formalized structures than in emerging and informal sectors. Improving job quality entails action beyond the energy sector, including in areas such as minimum wage legislation, collective bargaining rights, workplace safety regulation, and social protection, including unemployment and health insurance (IRENA and ILO 2022).

In turn, accomplishing SDG 7 also requires prioritizing inclusive workforce development and just transition policies. Skill shortages are already slowing down the energy transition. In this regard, proactive policy making and close coordination among different actors, including governments, educational institutions, trade unions, and the private sector, is crucial. There is also a need to gather more data on emerging jobs and skills, create new certifications, improve technical and vocational education and training opportunities, and integrate renewable energy into educational curricula. In some countries, targeting workers in related professions can also help ease the skilling needs (IEA 2023; IRENA 2024c; OECD 2024). Adult learning and support for fossil fuel workers and marginalized groups are vital for a just energy transition. This is especially true in the coal sector, which is in structural decline; fewer than 15 percent of the sector's workers were covered by coal-specific just transition policies as of 2023 (IEA 2024e).

Gender equality needs to be mainstreamed across international, national, and local energy policy making and decision-making. Access to affordable energy plays a critical role in women's economic and social empowerment, and supports greater health and well-being, as well as education. As the global community gathers at the 2025 High-

Level Political Forum, it will be important to commit to gender-inclusive policies that specifically address the energy needs of and health impacts on women and girls. This includes eliciting their voices through consultations, place in parens ensuring their active participation at all levels of planning and policy making, and ensuring adequate financing.

Importantly, fostering women's participation can expand the talent pool, reducing the skill gap (IRENA 2024d). Women represent 28 percent of the renewable workforce overall, with higher representation in solar PV (32 percent) but a stark underrepresentation in wind (14 percent) (IRENA 2019, 2020, 2022b). While this exceeds their 16 percent share in the energy sector overall (IEA 2022c), it falls far short of the aspiration for gender parity and fails to harness women's potential to contribute to accomplishing SDG 7. As discussed in chapter 1 (box 1.4), women have also emerged as leaders in accelerating the deployment of decentralized renewable energy solutions. Despite obstacles, they have increasingly been catalysts for change as entrepreneurs and innovators (IRENA 2024d).