CHAPTER 6
THE OUTLOOK FOR SDG 7

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Main messages

- **Outlook for progress toward 2030 goals.** Sustainable Development Goal (SDG) 7 is off track. Even so, progress in policy and technology has shown promising results, especially in additions to renewable generation capacity. The years marked by the COVID-19 pandemic and 2022 energy crisis slowed progress, notably in Africa, where advances in energy access were stymied or reversed. However, a preliminary analysis of 2023 and 2024 trends justifies optimism. In addition, several high-profile international agreements are raising attention to all aspects of SDG 7. Among these are the COP28 consensus on tripling renewable power capacity and doubling the rate of energy efficiency, as well as the Clean Cooking Declaration, the Dar es Salaam Declaration, and several energy compacts, all of which are setting new targets and objectives to bolster access to electricity and clean cooking access in Africa, where the access gap is largest today. In aggregate, these efforts could foretell an improving outlook, as the ambitions spelled out in the declarations are backed by concrete measures and investments.
- **Outlook for access to electricity.** Progress on electricity access has been remarkable in recent decades. Since 2000, the world has reduced the number of people without access by 925 million, and 45 countries have reached near universal access to electricity. However, the International Energy Agency (IEA) projects that around 645 million will still lack access in 2030, 85 percent of them in Sub-Saharan Africa. Based on today's policies, around a fifth of the countries presently lacking universal access will close the gap by 2030. Achieving universal electricity access by 2030 requires significant investment and policy support and will rely increasingly on distributed solutions, which have scaled up rapidly in recent years thanks to low-cost solar power and batteries.
- **Outlook for access to clean cooking.** Since 2010 the number of people having no access to clean cooking has dropped by 900 million, predominantly through the use of liquified petroleum gas (LPG). Still, universal access by 2030 remains out of reach under current policies and investments: Some 1.8 billion people will still lack access to clean cooking by the end of the decade. Around 58 percent of those lacking access will be living in Sub-Saharan Africa, 36 percent in Asia, and the 4 percent in Latin America and the Caribbean. Improvements through 2030 will continue to be marked by strong regional disparities, as in past years. The number of people without access to clean cooking in Sub-Saharan Africa is growing and expected to reach 1 billion by 2030, largely because population growth is outstripping gains in access. On the positive side, estimates project a continued decline in the use of polluting fuels and an increase in the use of gaseous fuels and electricity for cooking, but reaching full access to clean cooking will require an annual investment of USD 10 billion through 2030, half for Sub-Saharan Africa alone.
- **Outlook for renewable energy.** Renewable energy is the fastest-growing energy source today. Projections under today's policies show that renewables are set to surpass coal as the predominant electricity source globally in 2025. To meet the call to triple renewables made at COP28, the world would need to reach at least 11,000 gigawatts (GW) of global renewable power capacity by 2030; corresponds to renewables (modern uses) attaining a 32–35 percent share in total final energy consumption (TFEC) by 2030 in IEA and International

Renewable Energy Agency (IRENA) scenarios. Under current plans and policies, the world is expected to make significant progress in renewable power capacity, but an ambition gap of between 3.8 and 4.2 TW remains through 2030.

- **Outlook for energy efficiency.** Energy efficiency has gained important political momentum, driven by rising security concerns, recent energy price spikes, and the target of doubling the improvement rate agreed upon at COP28. Early estimates for 2024 show a modest 1 percent annual improvement in the rate of energy intensity, around half the pace of progress achieved during the 2010–19 period. Achieving the doubling target rate by 2030 would require robust policy action and a significant increase in investment. The rate of improvement would need to be just over 4 percent to achieve the COP28 target toward 2050, according to IEA and IRENA net-zero scenarios, which are roughly aligned with the SDG 7 target.
- **Investment needs.** Achieving the SDG 7 target demands a substantial increase in clean energy investments. IEA and IRENA estimate average annual energy-transition-related investments in the range of USD 4.2–4.5 trillion by 2030.[39] It will be essential to address this investment gap, particularly in developing economies grappling with the high cost of capital.

39 IEA's investment estimate accounts for capital spending on energy supply, infrastructure, end-use, and efficiency required for alignment with a 1.5°C Scenario. IRENA's estimates cover investments in renewable power generation, energy efficiency, and grid and flexibility improvements needed for an energy transition aligned with the 1.5°C Scenario.

Presentation of scenarios

This chapter describes the results of global modeling exercises undertaken to determine whether current policy settings and investments are sufficient to meet the SDG 7 targets and to identify what additional actions might be needed. Scenarios for the targets are taken from IEA's *World Energy Outlook* (IEA 2024a), IRENA's *World Energy Transitions Outlook: 1.5°C Pathway* (IRENA 2024a), and WHO's Business-as-Usual Scenario (see annex 1). The modeling also draws on insights from the IEA's COP28 Tripling Renewable Capacity Pledge (IEA 2024) and IRENA's Delivering on the UAE Consensus (IRENA et al. 2024). The chapter explores scenarios in which energy trends evolve under today's policies as well as more ambitious pathways that deliver on all energy-related SDGs, including substantial reductions in air pollution (SDG target 3.9) and action to combat climate change (SDG 13).

IEA's Stated Policies Scenario explores how energy trends evolve under today's policies, assuming no additional policies are put in place. Under this scenario, bottom-up modeling is conducted that provides a sense of the prevailing direction for the energy sector based on a detailed reading of the latest policy settings in countries around the world. It accounts for energy, climate, and related industrial policies that are in place or that have been announced. The aims of these policies are not automatically assumed to be met; they are incorporated in the scenario only to the extent that they are underpinned by adequate provisions for their implementation. The Net Zero Emissions by 2050 Scenario considers the SDG 7 goals for 2030 and net-zero energy sector emissions for 2050 as targets to determine what would be needed to achieve desired outcomes. Under the Net Zero Emissions by 2050 Scenario, by 2030, modern renewables reach a 30 percent share of total final energy consumption (TFEC), and average annual energy efficiency improvements in global energy intensity attain a level in the neighborhood of 4 percent over 2024–30. In this scenario, energy sector emissions reach net zero by 2050, aligned with broader scenarios consistent with limiting the end-of-century global temperature increase to 1.5°C over preindustrial levels.

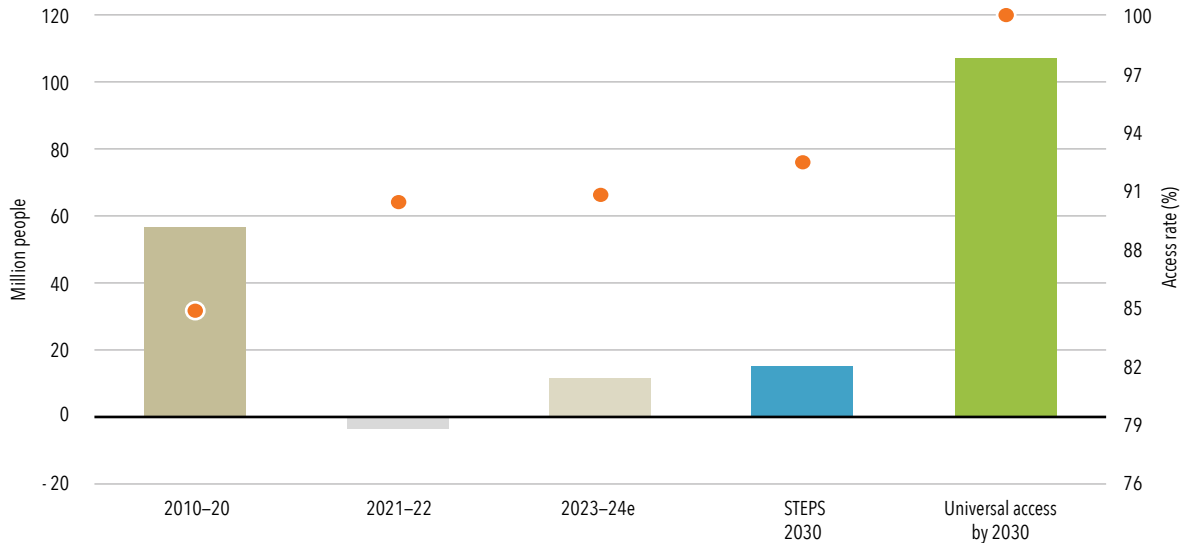
IRENA's Planned Energy Scenario offers a perspective on future energy system developments based on government energy plans, targets, and policies. The 1.5°C Scenario outlines a pathway that aligns the global energy transition with the goal of limiting the global temperature rise to 1.5°C above preindustrial levels by the end of the 21st century. This scenario is driven by key technological and policy measures, including the rapid expansion of renewables-based power, direct renewable energy use, improvements in energy efficiency, widespread electrification of end-use sectors, deployment of clean hydrogen and its derivatives, and the integration of carbon removal solutions such as carbon capture and storage (CCS) and bioenergy with CCS. These measures would result in a net-zero carbon energy system by midcentury.

Under WHO's Business-as-Usual Scenario, no new policies or interventions are implemented or take place. Current trends are extrapolated into the future until countries approach 100 percent access to clean fuels and technologies. As such, the scenario provides a neutral baseline for assessing the effects of various interventions.

The outlook for access to electricity

The latest data indicate that the number of people without access to electricity declined by more than 18 million from 2022 to 2023. This follows a period of stagnation and setbacks in expanding electricity access, a period in which population growth exceeded new connections in many countries. Preliminary data collected by the IEA for 2024 suggest that improvements are set to continue this year, as the number of people without access to electricity is expected to decline by a similar amount as in 2023. Today, around 85 countries lack universal access: Under today's policy trajectory, 20 of these countries will achieve the target by 2030, only nine in Sub-Saharan Africa. Under IEA's Stated Policies Scenario, 645 million people—roughly 8 percent of the global population—will remain without electricity access by 2030, 85 percent of them in Sub-Saharan Africa, where around 40 countries without universal access to electricity have official targets, yet only about half of those targets are as ambitious as SDG target 7.1. Achieving targets requires adequate policies, holistic electrification plans (including centralized and decentralized solutions), and resourced implementing institutions. Targets and electrification plans alone though, often do not directly translate into actual progress on the ground when not accompanied by comprehensive enabling frameworks (figure 6.1).

FIGURE 6.1 • REDUCTION IN POPULATION WITHOUT ACCESS TO ELECTRICITY ANNUALLY AND ACCESS RATES, HISTORICALLY AND IN 2030 UNDER IEA SCENARIOS



Source: IEA 2024a.

e = estimate; STEPS = Stated Policies Scenario.

Most developing countries in Asia remain on track to reach near-universal access by 2030; less than 2 percent of the region's population remains without electricity access in 2030. Reaching the target of universal access would require substantially faster progress in Afghanistan, Mongolia, and Pakistan, however. In Central and South America, only the most remote populations will remain without electricity access by 2030. Haiti, one of the poorest countries in the world, is the sole exception, with a large share of its population expected to remain without access in 2030.

Sub-Saharan Africa is home to 80 percent of all people lacking electricity access today, a figure that remains unchanged by 2030 under today's trends, with the region still accounting for 546 million people without access by the end of the decade.

Robust electrification plans supported by sufficient financing can help achieve universal electricity access by 2030. Sub-Saharan African countries (including Côte d'Ivoire, the Gambia, Kenya, and Rwanda) have achieved or surpassed target levels in the past. But 22 other Sub-Saharan African countries representing more than half of the region's unelectrified population (including Chad, the Democratic Republic of Congo, Madagascar, Malawi, Mozambique, and Niger) have been witnessing a rise in the number of people without access. Several new policies were implemented in 2024 in countries with electricity gaps, notably in Africa within the context of Mission 300 (see also chapter 1). These new policies are adding positive momentum to the latest projections, although many countries that endorsed the Dar es Salaam Energy Declaration have not yet announced new policies to reinforce their latest targets (Africa Energy Summit 2025).

Efforts must be stepped up, especially in least-developed countries, which might benefit from special support measures, including the Democratic Republic of Congo, Niger, Sudan, the United Republic of Tanzania, Uganda, and Ethiopia, which together are home to half of the region's population projected to lack access in 2030. Of the 20 countries with the largest access gap, 18 are in Sub-Saharan Africa, 13 of which are facing situations of fragility, conflict, and violence. These countries host significant numbers of displaced people, adding an extra layer of complexity in providing appropriate electrification options to temporary settlements.

Achieving universal electricity access by 2030 would require some 120 million people to gain access each year, requiring annual investments of USD 45 billion through 2030, based on the IEA's least-cost assessment. These investments include electricity generation, electricity networks, and decentralized solutions. International support, including in the form of concessional finance, plays a major role, especially as public finance remains strained after a series of global crises. This is particularly true in the least-developed countries. Opening the electricity sector to private sector participation and using concessional support to de-risk their investments can help accelerate progress, especially in contexts where energy markets are relatively well established and a pipeline of bankable projects exists (see also chapter 5). Changes in policy will also play a central role. Many successful electrification campaigns have a strong focus on electrifying health facilities, schools, and productive uses (including agricultural enterprises) alongside households' needs.

Success will depend on the right regulatory provisions for decentralized solutions, improved tracking and monitoring, improved geospatial data to help private sector players better target communities, development of a pipeline of bankable projects, and adequate public finance, including grants from international donors and philanthropies.

Decentralized systems are also set to play a growing role in closing the access gap, especially in Africa. Lower costs, higher quality, and more adequate business models have helped these technologies reach more remote communities that lay beyond the near-term plans for grid expansion. While in developing Asia, grid connections play the largest role in extending new access, in Sub-Saharan Africa they provide only 43 percent of new connections by 2030, according to IEA's latest country-by-country geospatial analysis to identify the least-cost feasible pathway toward providing connections to unelectrified populations. Conversely, 30 percent of new connections are to be provided through mini-grids. The remainder would be stand-alone systems, mostly solar home systems.

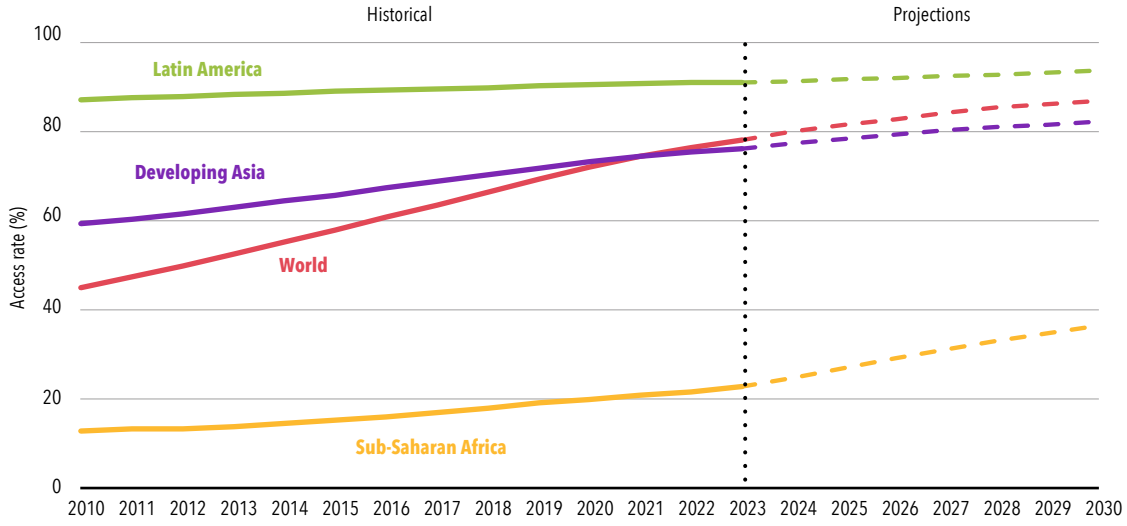
Affordability remains a key issue. About a third of the Sub-Saharan African population presently lacking access to electricity cannot afford basic energy services without additional financial incentives. Accordingly, small solar home systems are a rapidly growing market and could quickly provide basic electricity services to households before full access solutions reach these households. Based on IEA estimates, if the one-third of households where other options are unaffordable were to gain access first via small solar lighting systems the cost would be USD 5 billion annually by 2030. This spending would defer total investment costs of roughly USD 12–13 billion annually between now and 2030, which would need to be allocated to upgrading electricity connections beyond 2030 to bring these households to basic levels of access.

The outlook for access to clean cooking fuels and technologies

The policies in place today are insufficient to achieve universal access to clean cooking. If current trends continue, both IEA and WHO estimate that 22 percent of the world's population—or around 1.8 billion people—will still lack access to clean cooking by 2030 (figures 6.2 and 6.3). Significant progress has been made in Asia, where more than a billion people have gained access since 2010. In Sub-Saharan Africa, on the other hand, almost the same number of people as today are expected to be without access to clean cooking fuels and technologies at the end of the decade (IEA 2024a). WHO estimates that more than three-quarters of them—or close to a billion people—are expected to be relying on polluting fuels and technologies in 2030 in Sub-Saharan Africa (WHO 2025) (figure 6.3). Many African countries are not expected to achieve universal access even into the 2050s. Countries facing fragility, conflict, and violence have demonstrated particularly slow rates of progress. Achieving universal access will require delivering access to more 300 million people each year through 2030—half of them in Sub-Saharan Africa. Some African countries are implementing clean cooking plans, yet more often than not they lack the resources to support them. Today, less than 20 percent of clean cooking plans are backed by clear financing schemes (IEA 2024a).

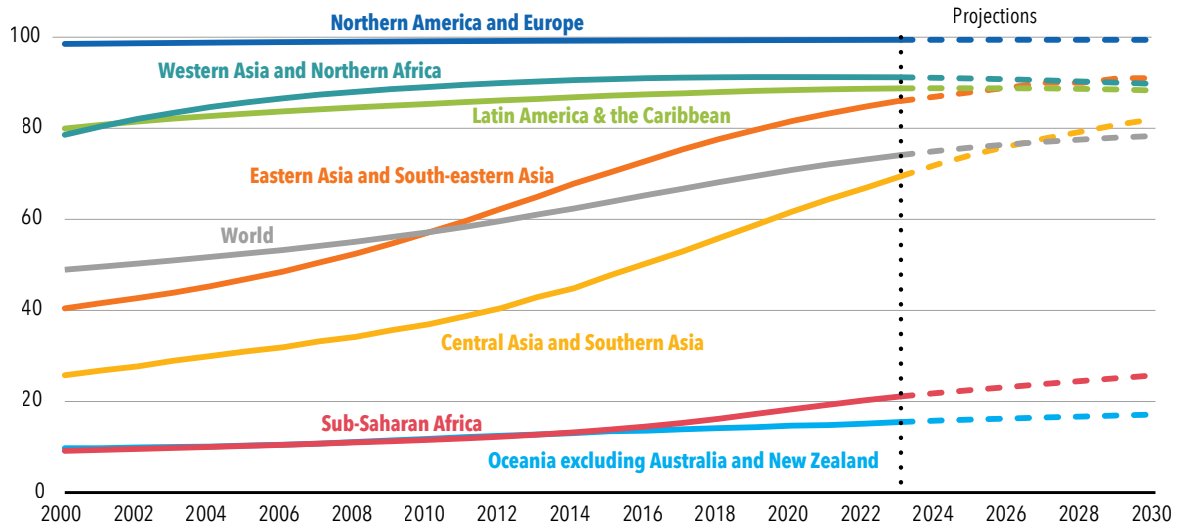
Other regions also display disturbing access trends. Under WHO's Business-as-Usual Scenario, an estimated 88 percent of those living in Oceania outside Australia and New Zealand (or 12 million people) will not have access to clean cooking fuels and technologies in 2030 (figure 6.3). For Central Asia and Southern Asia the corresponding figures are 18 percent (more than 400 million people).

FIGURE 6.2 • HISTORICAL AND PROJECTED CLEAN COOKING ACCESS RATE BY REGION, AND IN IEA'S STATED POLICIES SCENARIO, 2010–30



Source: IEA 2024a.

FIGURE 6.3 • HISTORICAL AND PROJECTED CLEAN COOKING ACCESS RATE BY REGION UNDER WHO'S BUSINESS-AS-USUAL SCENARIO, 2000–30



Source: WHO 2025.

Note: Australia and New Zealand are excluded as both the historical and projected access rates are 100 percent.

If current trends continue through 2030, WHO projects that 60 percent and 8 percent of the population in low- and middle-income countries will primarily use gas and electricity, respectively, for cooking. At the same time, 19 percent are expected to still be relying on unprocessed biomass, 5 percent on charcoal, and close to 2 percent on kerosene and coal. The overall growth in clean cooking will be largely driven by the increased adoption of gaseous fuels.

A scenario in line with universal access would cut the use of solid biomass by 50 percent. The resulting mix of cooking solutions in emerging markets and developing economies by 2030 would have more than half of the population cooking predominantly with natural gas or LPG, 25 percent with electricity, and the remainder with modern bioenergy. In such a scenario, LPG plays a leading role in providing new access, followed by improved cookstoves, and then electricity. In some regions, new infrastructure would be needed, particularly in Sub-Saharan Africa. Achieving universal access by 2030 would imply demand for LPG grows threefold by 2030 according to IEA assessments (IEA 2023a), requiring an expansion of distribution services and an increase in cylinders and refilling stations. In the same scenario, electric cooking would increase demand for electricity by 16 percent by 2030 in Sub-Saharan Africa. While most improved cookstoves alone do not provide the full benefits of cooking with electricity, gas, LPG, or bioethanol, they do represent an important transition for households without the economic means to afford stoves using purchased fuels—and where modest affordability support from governments is unlikely to be enough. Evidence shows that cooking on an efficient improved cookstoves (ISO tier 3 and above) reduces biomass use compared with a traditional stove by 20–75 percent, with most commercial improved cookstoves yielding efficiencies at the higher end.

Achieving universal clean cooking access could cut greenhouse gas emissions by 1.5 gigatons of CO_2 equivalent ($GtCO_2eq$) owing to reduced biomass combustion and less deforestation, a figure comparable to the current annual emissions from aviation and shipping combined (IEA 2024a). This reduction stands alongside major health and social benefits. Reducing household air pollution improves health outcomes and lessens the need for daily fuelwood collection—typically a substantial burden on women and children—freeing up time for education, work, or leisure.

Required capital investments in clean cooking technologies and infrastructure through 2030 total USD 10 billion annually (IEA 2024a)—a substantial increase from current investment levels (USD 2.5 billion). For these investments to materialize, policy guidelines and institutional frameworks must be put in place to incorporate clean cooking into energy planning strategies, thereby attracting private funding and making optimal use of public funding.

Last year, the Summit for Clean Cooking in Africa mobilized a record USD 2.2 billion in additional commitments and precipitated a number of new targets and policies on clean cooking (IEA 2024b). The results of the summit have created positive momentum. Bridging the access gap in clean cooking will depend on a coordinated combination of national action, international collaboration, and private investment to lower the cost of clean cooking through innovation in clean fuels and technologies. Climate finance, particularly carbon finance, if properly managed, can be pivotal in making clean cooking more accessible and affordable, especially for the most underserved communities.

The outlook for renewable energy

SDG target 7.2 calls for a substantial increase in the share of renewable energy in the energy mix. Although it does not specify a quantitative objective, various long-term scenarios for a net-zero energy system by 2050 require a tripling of the installed capacity of renewables-based power by 2030. The tripling is reflected in the historic COP28 agreement, which calls for at least 11,000 GW of renewable power by 2030 (UNFCCC 2023a), in line with IEA's Net Zero Emissions by 2050 Scenario and IRENA's 1.5°C Scenario. Under current plans and policies, the world is likely to make significant progress—but a shortfall of 3.8–4.2 TW from the 11,000 GW target would remain.

The outlook for renewables under IEA's Stated Policies Scenario and IRENA's Planned Energy Scenario remains positive in all regions despite the impact of recent crises on supply chains and prices. This positive outlook is supported by targeted policies and falling technology costs. Under IEA's Stated Policies Scenario, the share of all renewables (including traditional uses of biomass) in TFEC is projected to rise from 17 percent in 2023 to 23 percent in 2030, and the share of modern renewables, which excludes traditional use of biomass, is projected to increase from 13 percent in 2023 to 19 percent in 2030. Under IRENA's Planned Energy Scenario, the overall share of modern uses of renewables in TFEC would grow to 23 percent in 2030. Achieving the 11,000 GW level of renewable energy capacity would mean bringing the share of renewables in TFEC to around 32–35 percent.

Greater ambition—and matching policy action—remain key. These will include strategic long-term planning, modernization and expansion of transition infrastructure, development of enabling regulatory frameworks, market design reforms optimized for high penetration of renewable energy sources, and the strengthening of the institutional capacities and human resource capabilities essential for accelerating deployment.

Bridging the gap: Insights from IEA's Stated Policies Scenario and Net Zero Emissions by 2050 Scenario

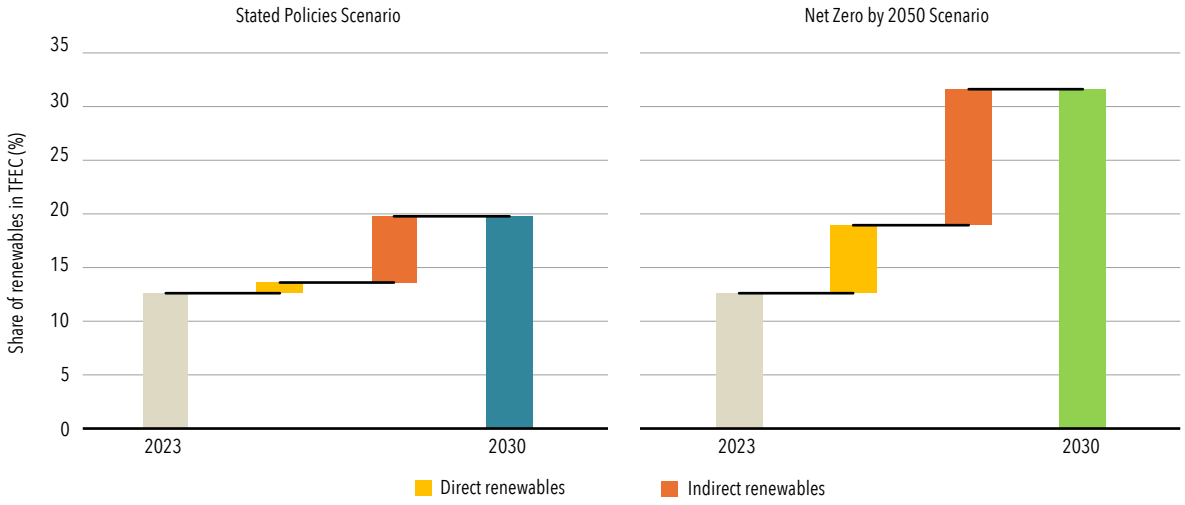
Renewables in the power sector continue to be the fastest-growing energy source worldwide. Annual capacity additions for renewables in 2023–30 are projected to triple over the trends seen in 2015–22, with solar photovoltaic (PV) and wind spearheading the expansion. The projected rate falls short of the COP28 goal to triple existing capacity by 2030, but not by much: Renewable capacity is expected to account for 80 percent of the progress needed by the end of the decade under today's policies—that is, under the Stated Policies Scenario (IEA 2024a).

By 2025, renewables are expected to surpass coal as the predominant source of electricity generation. Solar PV leads as the renewable electricity source, meeting nearly half of the growth in electricity demand from 2023 to 2030 under today's policy trends, followed by wind, at around 35 percent. Hydropower continues to be the largest low-emission electricity source globally through 2030, providing flexibility and supporting other essential power system services. This, combined with the electrification of end uses, should enable the share of renewables-based electricity in TFEC to rise above 10 percent by 2030, up from 6 percent in 2023. This figure includes increased use of electricity in transport owing to greater penetration of electric vehicles.

The pace of renewables' growth in transport, industry, and buildings is projected to double between 2024 and 2030 in the Net Zero by 2050 Scenario compared with the previous seven-year period. Combined with growing electrification, renewables' share in transport rises to nearly 17 percent (IEA 2024c). For transport, renewable electricity will account for half of this growth, led by adoption of electric vehicles followed by biofuels, with small contributions from biogases, hydrogen, and e-fuels. Direct use of renewables, principally biofuels, constitutes 11 percent of fuel for road transport, on average. Nevertheless, renewables' share in transport increases by only two percentage points, to 6 percent in 2030. For heat, consumption of renewables expands more than 50 percent, driven by renewable electricity use for heating in non-energy-intensive industries and buildings, followed by bioenergy (IEA 2024c).

The use of renewables increases twice as rapidly under the Net Zero Emissions by 2050 Scenario as under the Stated Policies Scenario (IEA 2023b). Under the more ambitious Net Zero Emissions by 2050 Scenario, modern uses of renewables would represent around a third of TFEC in 2030 (figure 6.4).

FIGURE 6.4 • RENEWABLES' SHARE IN TOTAL FINAL ENERGY CONSUMPTION IN 2023 AND UNDER IEA SCENARIOS BY 2030



Source: IEA 2024c.

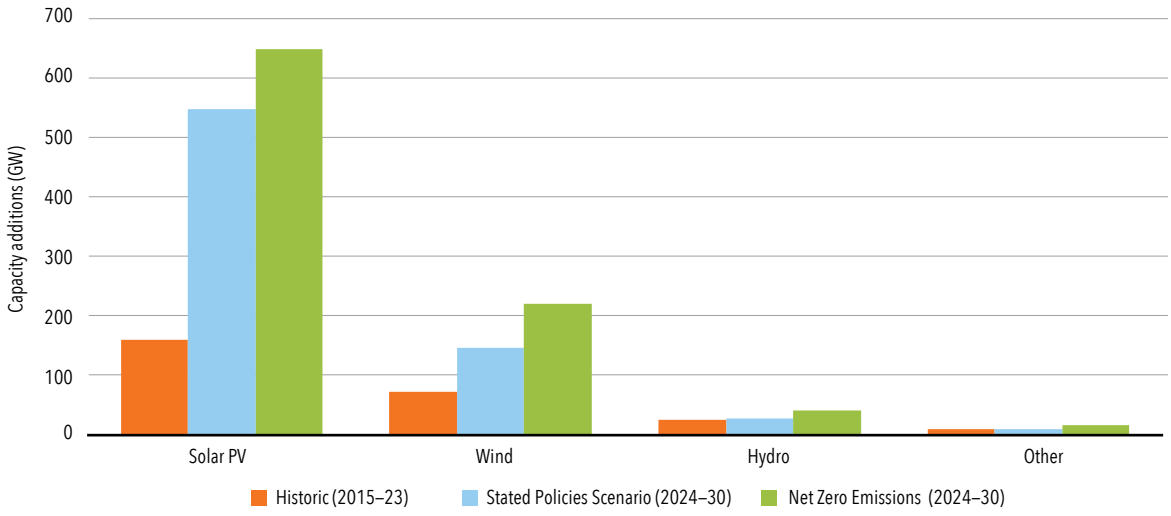
Under IEA's Net Zero Emissions by 2050 Scenario, increased electrification of end uses is a primary means to boost renewables' share in TFEC. Under this scenario, electricity's share in the final energy demand rises to over 30 percent by 2030, compared with about 12 today. This growth is driven primarily by the electrification of transport and heat.

Renewable energy is used for heating in various applications, including space and water heating, cooking, and industrial processes. This heat can come directly from sources like bioenergy, solar thermal, or geothermal energy, or indirectly through electricity and district heating generated from renewables. Transitioning to direct renewable heat—such as solar thermal water heating, biomass, and low-carbon gases—can help decrease reliance on fossil fuels. In 2023, renewables represented 12 percent of the total energy consumed for heating worldwide. By 2030, this share would increase to around 30 percent under the Net Zero Emissions by 2050 Scenario.

The share of traditional uses of biomass falls to 3 percent of TFEC by 2030 under the Stated Policies Scenario. Under the Net Zero Emissions by 2050 Scenario, traditional uses of biomass are phased out completely by 2030, being replaced with more modern and efficient fuels and technologies.

The fastest increase in the share of renewables under the Net Zero Emissions by 2050 Scenario occurs in electricity generation—reaching about 60 percent from the current level by 2030, or a 16 percentage point increase over that in the Stated Policies Scenario. Globally, renewables-based electricity generation increases 12 percent annually under the Net Zero Emissions by 2050 Scenario, to approximately 22,520 terawatt-hours by 2030. This is supported by unprecedented solar PV and wind capacity additions, reaching, respectively, 640 GW and 220 GW a year on average over 2024–30 (figure 6.5). Annual investment in renewables-based power triples over the decade, topping USD 1.2 trillion a year by 2030. This is supported by additional spending on expanding and modernizing electricity networks and battery storage and improving the operational flexibility of existing assets to better integrate renewables.

FIGURE 6.5 • AVERAGE ANNUAL CAPACITY ADDITIONS OF RENEWABLE POWER GENERATION, BY TECHNOLOGY, UNDER IEA SCENARIOS



Source: IEA 2024a.
GW = gigawatt; PV = photovoltaics.

Energy policy, socioeconomic factors, and natural resource availability shape the growth of renewables differently across regions. In developing economies, renewable electricity generation is projected to account for more than 80 percent of growth by 2030 under the Stated Policies Scenario. Under the same scenario, the share of renewables in electricity generation by 2030 varies widely, from 15 percent in the Middle East and 17 percent in Northern Africa to around 80 percent in Central and South America, where hydropower dominates. In the Net Zero Emissions by 2050 Scenario, renewables play an expanding role in all regions, reaching or surpassing 50 percent of total electricity generation in many areas by 2030.

Under the Net Zero Emissions by 2050 Scenario, the supply of low-emission hydrogen increases from 0.3 million metric tons (Mt) today to 90 million in 2030. The share of low-emission hydrogen in TFEC reaches 10 percent. Achieving net-zero emissions by 2050 also requires carbon capture technologies. Under the Net Zero Emissions by 2050 Scenario, in 2030, just above 1.2 GtCO2 is captured via carbon capture, utilization, and storage and by CO2 removal technologies that do not include nature-based measures.

Accelerating the energy transition: Insights from IRENA's 1.5°C Scenario and Delivering on the UAE Consensus

The target to triple renewable power capacity is an essential element for achieving SDG 7 and climate action under SDG 13. Advancing the energy transition at the required pace and scale would require that the electricity sector be decarbonized completely by midcentury, making the years to 2030 crucial. While a diverse selection of technologies is essential to fully decarbonize the energy system by 2050, the urgency of the 2030 goal narrows the options available. Only renewable power and energy efficiency measures can be scaled up quickly enough to meet this approaching milestone. To ensure long-term success, however, this accelerated deployment must be complemented by continuous innovation and faster deployment across a much broader suite of technologies.

IRENA's 1.5°C Scenario details six key categories of performance indicators, including scaling up renewable energy's share in TFEC and electricity generation to 35 and 68 percent by 2030, with a corresponding increase in the share of energy consumed in the form of electricity to 30 percent.[40]

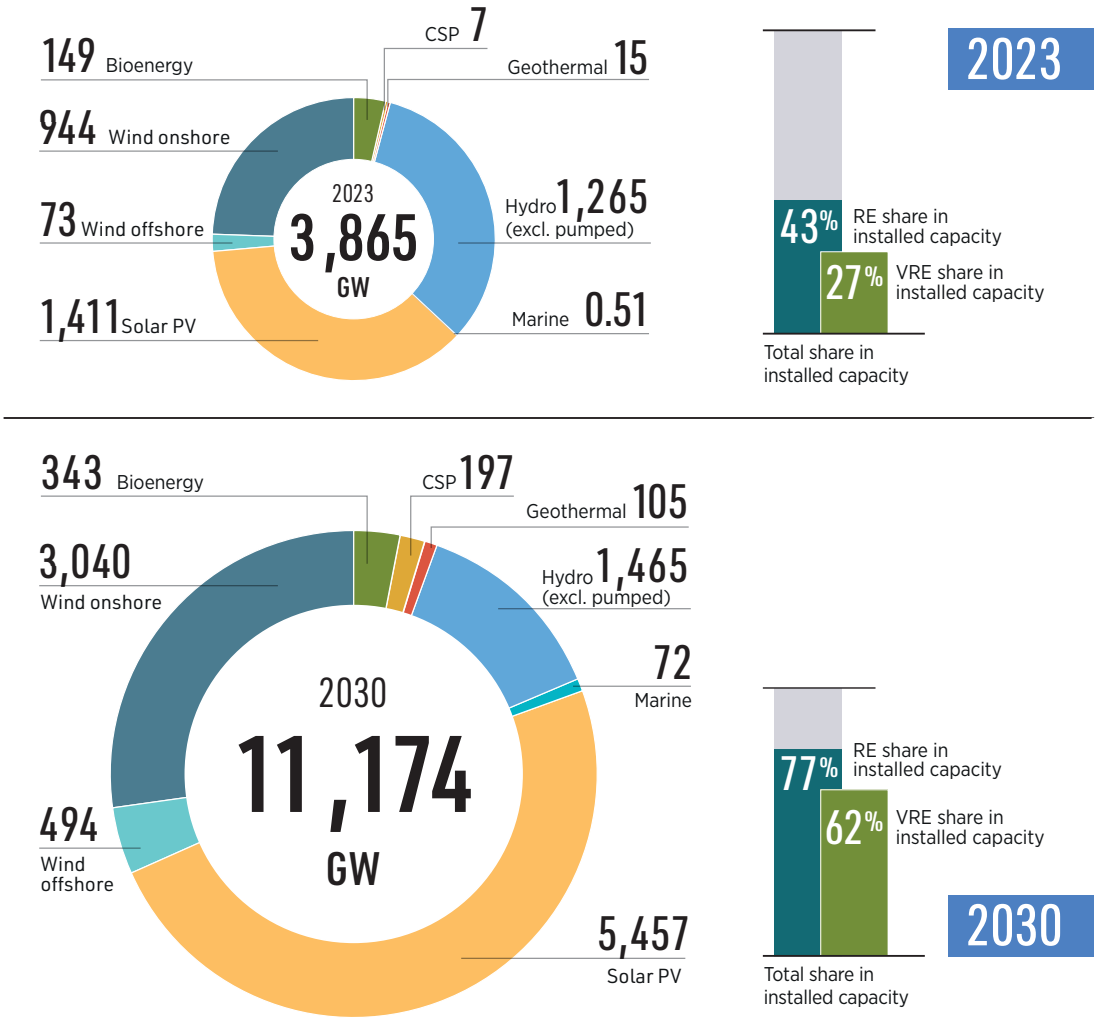
Tripling global renewables-based power capacity by 2030 is technically feasible and economically viable, but doing so will require commitment, policy support, and investment at scale. Since 2015, newly installed renewables-based power capacity has consistently outpaced new fossil fuel and nuclear power installations combined, reaching an estimated 473 GW in 2023 and 585 GW in 2024 (IRENA 2024b, 2025). By contrast, new capacity additions of onshore and offshore wind, hydropower, geothermal, bioenergy, concentrated solar power, and marine energy in 2023 lagged behind the requirements of IRENA's 1.5°C pathway. The significant acceleration in solar PV deployment—with 346.9 GW added in 2023 (73 percent higher than in 2022)—indicates that solar PV is the only renewable technology that is on track to grow annual additions each year to reach its target of 5.5 TW of capacity required by 2030 (figure 6.6). Notably, rapid electrification of heating and transport applications, alongside increased green hydrogen production, would significantly boost the demand for electricity under IRENA's 1.5°C Scenario.

To reach the goal of tripling renewable energy capacity, the world needs to add an average of 1,044 GW annually, which corresponds to a compound annual growth rate of 16.4 percent through 2030 (figure 6.7). This would require installed capacity to rise from 3.9 TW to 11.2 TW from 2024 to 2030, an increase of 7.3 TW in fewer than seven years.

Existing national plans and targets would amount to only half of the annual growth in renewable power capacity needed. Plans would deliver 3.5 TW (48 percent) of the required capacity expansion. This would bring global installed capacity to 7.4 TW by 2030, 3.8 TW (34 percent), well short of the tripling target.

40 The average annual primary energy intensity improvement rate would need to increase to 4 percent between 2023 and 2030, doubling the rate observed in 2022. The production of clean hydrogen would need to increase to 125 Mt by 2030. Finally, some investment in CO_2 removal technologies would also be required, namely, in the hard-to-abate sectors, such as heavy industry.

FIGURE 6.6 • GLOBAL INSTALLED RENEWABLES-BASED POWER CAPACITY IN 2023 AND 2030 UNDER IRENA'S 1.5°C SCENARIO

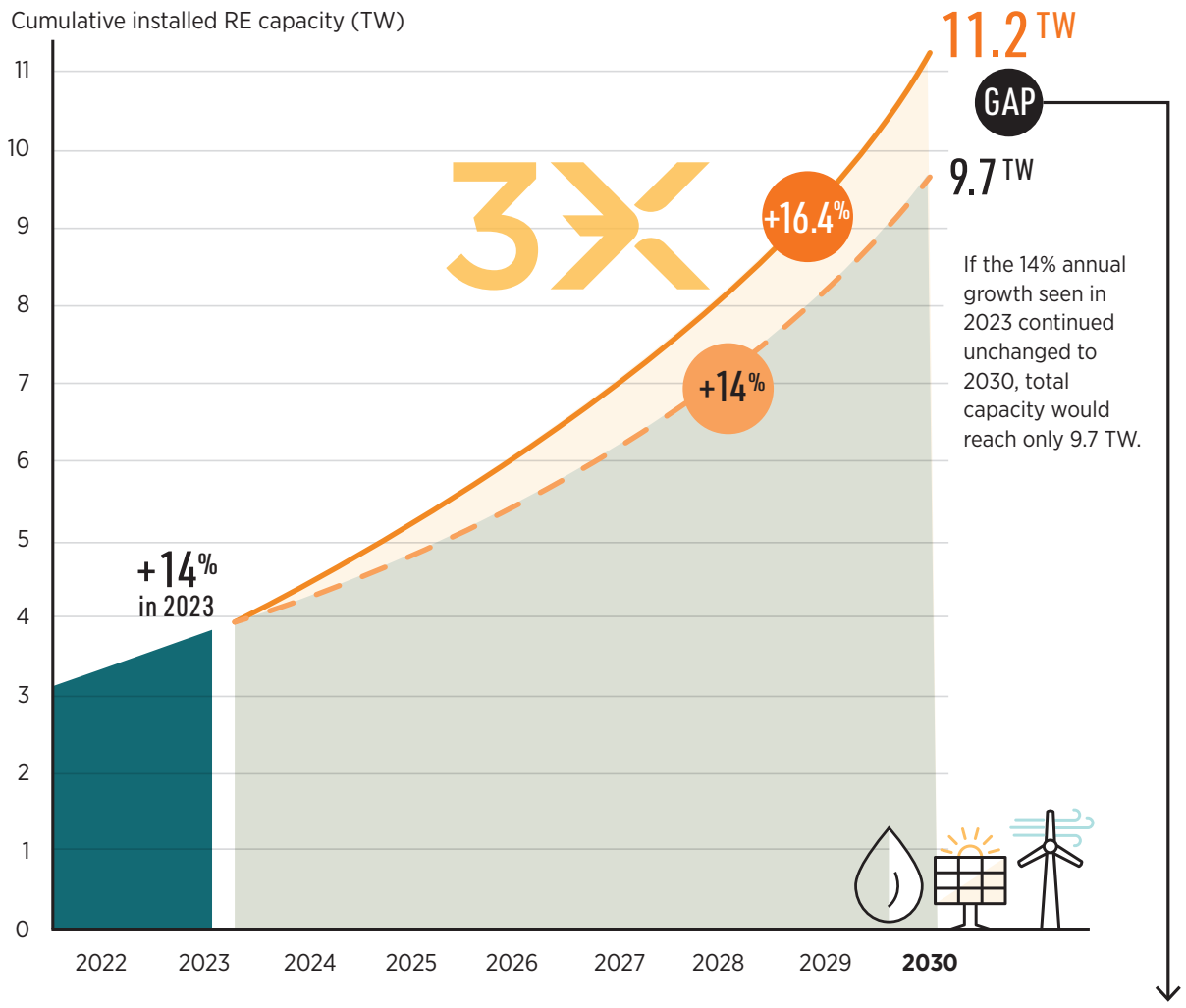


Source: IRENA et al. 2024.

Note: Bioenergy includes biogas, biomass waste, and solid biomass.

CSP = concentrated solar power; GW = gigawatt; PV = photovoltaic; VRE = variable renewable energy; RE = renewable energy; hydropower data excludes pumped hydro.

FIGURE 6.7 • CLOSING THE GAP TO REACH TRIPLING RENEWABLE POWER CAPACITY BY 2030 UNDER IRENA'S 1.5°C SCENARIO



Renewable power targets in NDCs =

5.4 TW

total global installed renewable power capacity in 2030

Renewable power targets in national plans and policies =

7.4 TW

total global installed renewable power capacity in 2030

1.5°C Scenario =

11.2 TW

total global installed renewable power capacity in 2030

Source: IRENA et al. 2024.

The levels of ambition stated in the Nationally Determined Contributions set by nations in connection with their participation in the SDGs are even lower, according to IRENA's quantification of renewable power targets found in the NDCs. Stated targets for new renewable capacity additions translate to 1.5 TW in new capacity, bringing the total global installed renewable power capacity to just 5.4 TW. These findings underscore both the need for aligning national policies with NDCs, as well as the broader imperative of enhancing global ambition.

The achievement of the Paris Agreement's 1.5°C climate target is at significant risk owing to insufficient progress in the energy sector. While some advancements have been made, the deployment of renewables, energy efficiency improvements, and electrification efforts remain far below the levels required to align with the Paris Agreement. Urgent, accelerated action is needed, particularly leading up to 2030, to scale up renewable energy deployment, phase out fossil fuels, and enhance energy system resilience.

The outlook for energy efficiency

At COP28 in late 2023, nearly 200 countries reached an agreement to collectively double the global average annual rate of energy efficiency improvements by 2030. This marked the strongest governmental acknowledgment of energy efficiency's crucial role in the clean energy transition. One year later, however, progress in efficiency had yet to accelerate, highlighting the need for stronger policy implementation.

Initially, SDG target 7.3 called for doubling the global rate of improvement in energy efficiency to 2.6 percent between 2010 and 2030 over the 1990–2010 baseline. Given that the improvement was less than 2 percent in the following decade (2010–22), an annual rate of at least 4 percent from 2023 until 2030 became necessary to achieve the same target. That target was expressed in the COP28 Global Renewable and Energy Efficiency Pledge.

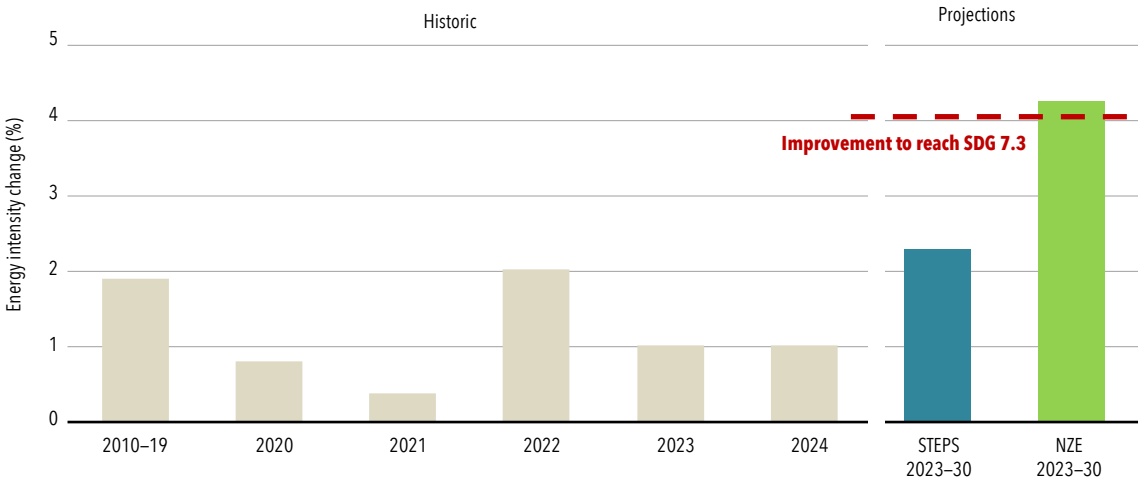
Energy efficiency improvements can be achieved through structural shifts and technological advancements, particularly electrification and the deployment of renewable energy. Key measures include increasing the adoption of electric heat pumps and electric vehicles, scaling up building retrofits, optimizing industrial energy consumption through efficient electric motors, and advancing circular economy practices. These measures would not only reduce overall energy demand while enhancing system flexibility, but also facilitate decarbonization by shifting consumption toward clean electricity sources.

In 2024, governments representing more than 70 percent of global energy demand introduced new or updated efficiency policies, which is one of the main reasons for positive progress in the Stated Policies Scenario. The European Union strengthened regulations to achieve a zero-emission building stock by 2050, including measures to encourage retrofitting. China enhanced appliance standards and set more ambitious national efficiency targets, while the United States tightened fuel economy standards for heavy-duty vehicles, although these are now being re-evaluated. Kenya revised its building energy code to mandate efficiency requirements for new construction. Over the past year, governments allocated approximately USD 60 billion for building efficiency and USD 45 billion for low-emission vehicles, bringing total efficiency-related funding over the last five years to more than USD 1 trillion (IEA 2024d).

Regrettably, global progress on energy efficiency—measured by the rate of change in primary energy intensity—will likely show only minimal improvement (1 percent) in 2024, well below the average rate over the 2010–23 period. While progress accelerated in some countries in response to the global energy crisis following the war in Ukraine, overall improvements have slowed. While recent years produced large regional differences, the disparities shrank in 2024: Intensity improvements in advanced economies have slowed, while progress in many emerging and developing

economies held steady or increased slightly (figure 6.8). China led global improvement over the previous decade (2010–19) with an annual average improvement in energy intensity of 3.8 percent, but the pace since then has slowed, with a 1 percent deterioration in 2023 and a modest improvement of 1.5 percent in 2024. The European Union saw historic improvements in 2022 and 2023 in the wake of Russia's reduced gas flows to the European Union, but progress is likely to slow to 0.5 percent in 2024, while the United States is estimated to see progress fall from 3.5 percent in 2023 to 2.5 percent in 2024 (IEA 2024d)

FIGURE 6.8 • HISTORICAL AND PROJECTED IMPROVEMENT IN GLOBAL ENERGY INTENSITY BY SCENARIO, 2010–30



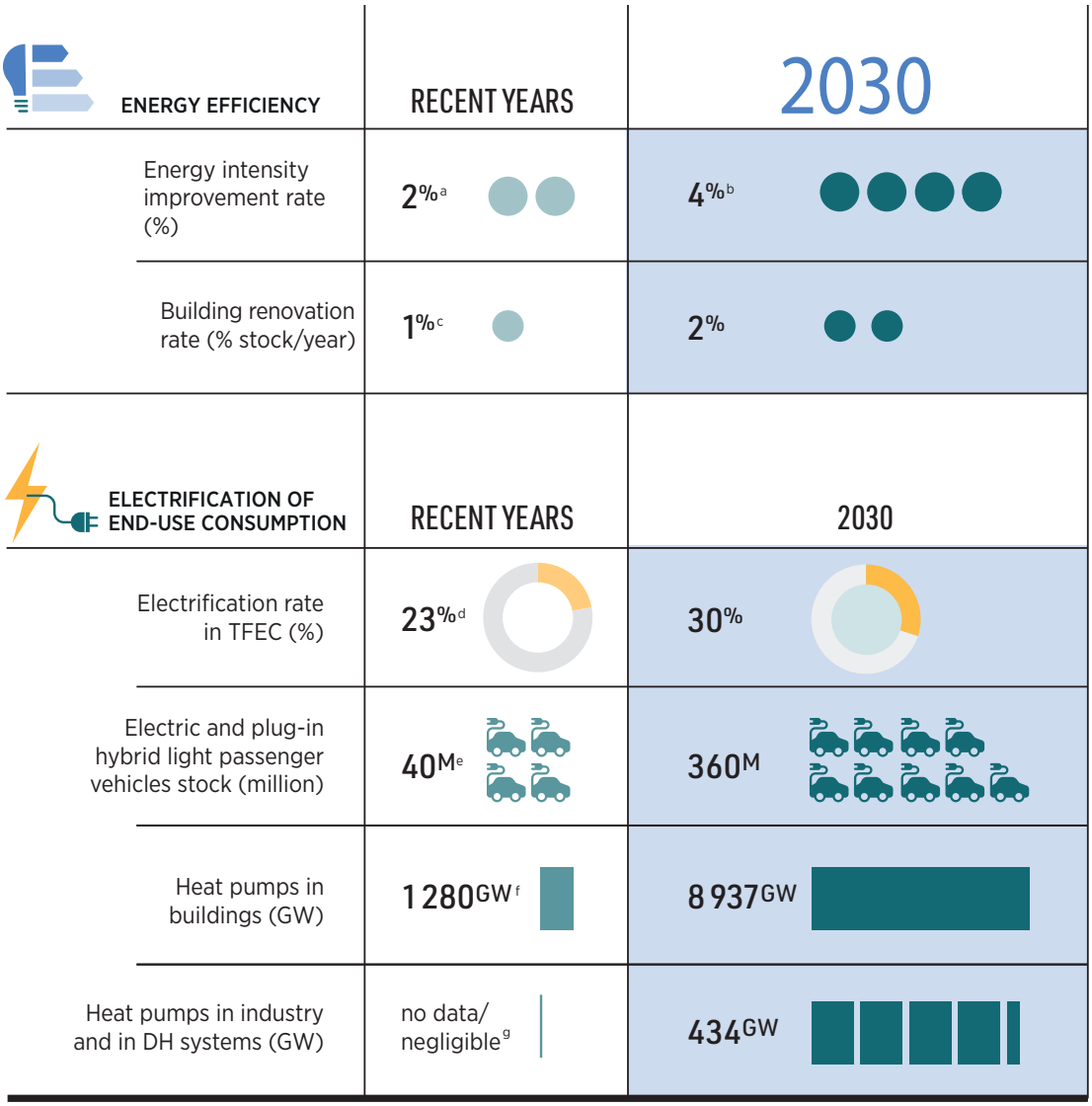
Source: IEA 2024d.

NZE = Net Zero Emissions by 2050 Scenario; SDG = Sustainable Development Goal; STEPS = Stated Policies Scenario.

Renovating existing building stock is another critical component of global energy efficiency efforts, given that buildings account for a substantial share of energy consumption. However, current renovation rates remain at approximately 1 percent per year—far below the level required to meet climate targets. While there is growing momentum in retrofitting buildings with energy-efficient technologies, a significant acceleration is necessary to achieve the required reductions in energy consumption by 2030 (IRENA et al. 2024). The same is true of other end-use sectors (figure 6.9).

Accelerated electrification is a key efficiency improvement strategy, involving the adoption of more energy efficient technologies such as electric heat pumps and electric vehicles. These technologies consume less energy than fossil fuel-based sources while also contributing to emissions reductions. As electricity grids increasingly integrate renewable energy sources, the efficiency and decarbonization benefits of electrification will become even more pronounced. Progress in transport electrification during 2023 marked significant strides but remains insufficient to meet the targets set in IRENA's 1.5°C Scenario. By 2030, the global electrification rate in total final energy consumption for transport would need to reach nearly 7 percent, with road transport offering the greatest potential for growth. The current stock of battery electric vehicles and plug-in hybrid electric vehicles would need to grow ninefold to reach 360 million by 2030, a trajectory far above current growth rates (IRENA 2024c). In the heating sector, the continued adoption of heat pumps will be essential for energy-efficient decarbonization (IRENA et al. 2024). While progress has been made across end-use sectors it remains insufficient, as discussed in chapter 4.

FIGURE 6.9 • PROGRESS TOWARD AND GAPS IN GLOBAL ENERGY EFFICIENCY AND ELECTRIFICATION OF END USES BY 2030



Source: IRENA and others 2024, plus other works cited in notes below.

Notes DH = district heating; GW = gigawatt; M = million; TFEC = total final energy consumption

a. Energy intensity improvement achieved in 2022

b. Average annual improvement rate required between 2023 and 2030

c. Estimated percentage of renovated buildings in the global stock in 2021

d. 2022 value, IEA World Energy Statistics and Balances (IEA 2024g)

e. 2023 value (IEA 2024h)

f. 2023 value estimated from (IEA 2021, https://www.iea.org/reports/clean-energy-market-monitor-march-2024)

g. No database of industrial heat pumps is available today (Schlosser and others 2020). Industrial heat pumps are assumed to represent a negligible share of the total final energy consumption in industrial process heat supply (Agora Energiewende 2023).

If energy efficiency improvements are to double, there is a need for robust government policy packages incorporating information, regulations, and incentives—and a tripling of global investments. For example, almost half of newly built floor area around the world is not yet covered by efficiency requirements, and the regulations in place vary significantly by country in scope and stringency. Similarly, just three out of five industrial electric motors in use globally are covered by minimum energy performance standards (IEA 2024d).

In a pathway aligned with the doubling of efficiency agreed at COP28, between now and 2030, cars would become 5 percent more efficient each year, largely through electrification and a switch to smaller vehicles. In industry, annual energy productivity would increase by 2.3 percent per year, and electricity would account for 30 percent of energy use by 2030. The retrofit rates for buildings would more than double to 2.5 percent per year, generating energy savings large enough to power all buildings in China and India. Appliances including air conditioners and refrigerators would require 30–40 percent less energy, and consumers would make active behavioral changes, for example, limiting home heating to 19–20°C (IEA 2024d).

While achieving this rate of improvement will be challenging, it is not unprecedented. Of the vast majority of the 150 countries for which data are available since 2012, energy intensity improved by 4 percent or more at least once and by more than half at least three times (IEA 2024ed). The challenge for governments will be to sustain this level of improvement for the rest of the decade. Fortunately, many of the necessary policies and technologies are already in place. In most sectors, governments can make rapid progress toward doubling by building upon existing policies and accelerating the deployment of technologies already available. The minimum energy performance standards of many governments are already at or very close to the levels set forth under the Net Zero Emissions by 2050 Scenario. Implementing and enforcing these standards across sectors would aid in the collective effort of doubling progress in energy efficiency.

Investments needed to achieve SDG 7

Between 2015 and 2021, annual clean energy investments averaged over USD 1 trillion (in 2022 dollars) (IEA 2024f). Global clean energy investments, encompassing renewables-based power, renewables-based fuel, energy efficiency, end-use electrification, and resilient grids, rose by more than 5 percent in 2023. Yet, investments in renewables also remain unevenly distributed, with 84 percent of investments flowing to China, the European Union, and the United States. Sub-Saharan Africa, where 565 million people still lack access to electricity, received 40 times less than the per capita world average for transition-related investment (IRENA and OECD 2024). While international public flows to developing countries in support of clean energy rebounded to USD 21.6 billion in 2023, they remain below the 2016 peak of USD 28.4 billion and fall far short of the energy needs of developing countries, especially least developed countries. (For more, see chapter 5.)

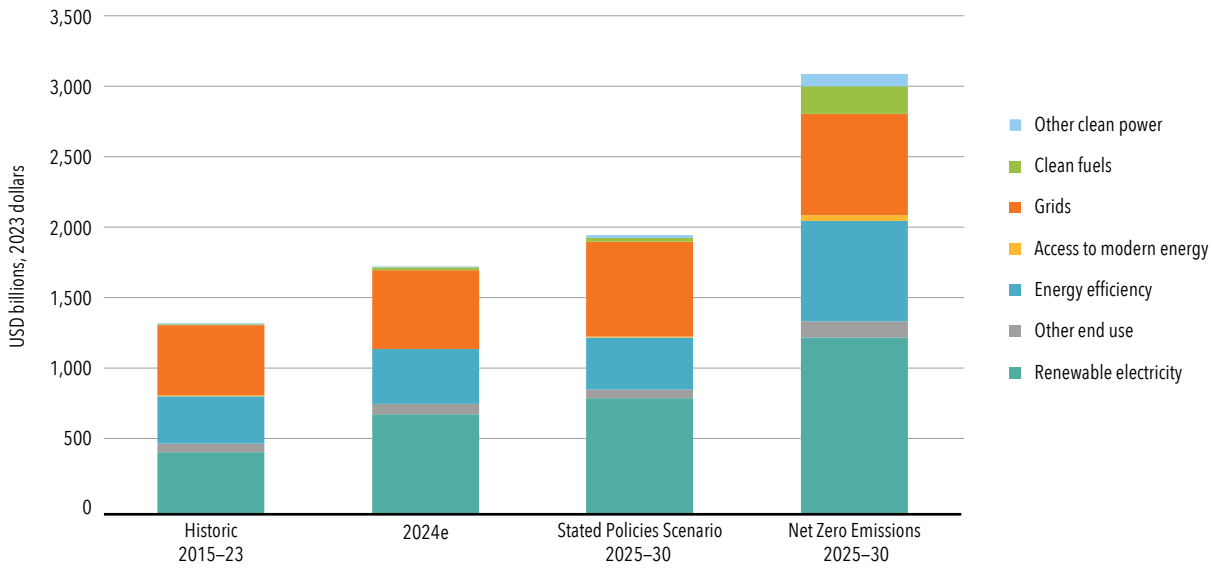
Both IEA and IRENA emphasize the pressing need to escalate investments in the energy transition across the globe. According to IEA's Net Zero Emissions by 2050 Scenario, an average annual investment of USD 4 trillion in the energy sector is required over 2023–30, whereas energy investments under the Stated Policies Scenario average more than USD 3 trillion in the same period (figure 6.8).

The bulk of the investment required to meet the SDG 7 targets under the Net Zero Emissions by 2050 Scenario is allocated to renewables-based electricity generation (including batteries) and end-use efficiency; the investment amounts to USD 1,016 billion and USD 566 billion per year, respectively (again, in 2022 dollars). However, additional average annual spending of USD_{2022} 494 billion on expanding and modernizing electricity networks is essential to support investments in renewables-based power. Grid investments have not kept pace with generation, especially in emerging markets and developing economies, posing a potential barrier to clean energy transitions.

Under IEA's Net Zero Emissions by 2050 Scenario, achieving universal energy access in developing economies necessitates average annual investments of USD 55 billion by 2030. Two-thirds of this investment is required in Sub-Saharan Africa.

Even though these investments represent only 10 percent of annual spending in the upstream oil and gas sector, reaching these spending levels for access remains challenging owing to the small-scale nature of projects and the affordability challenges faced by end users. International support through development aid and from multilateral development banks will be crucial in mobilizing investment and mitigating the risks associated with access and other energy investments in emerging markets and developing economies.

FIGURE 6.10 • AVERAGE ANNUAL INVESTMENT IN SELECTED TECHNOLOGIES UNDER IEA SCENARIOS, 2015–30



Source: IEA 2024a.

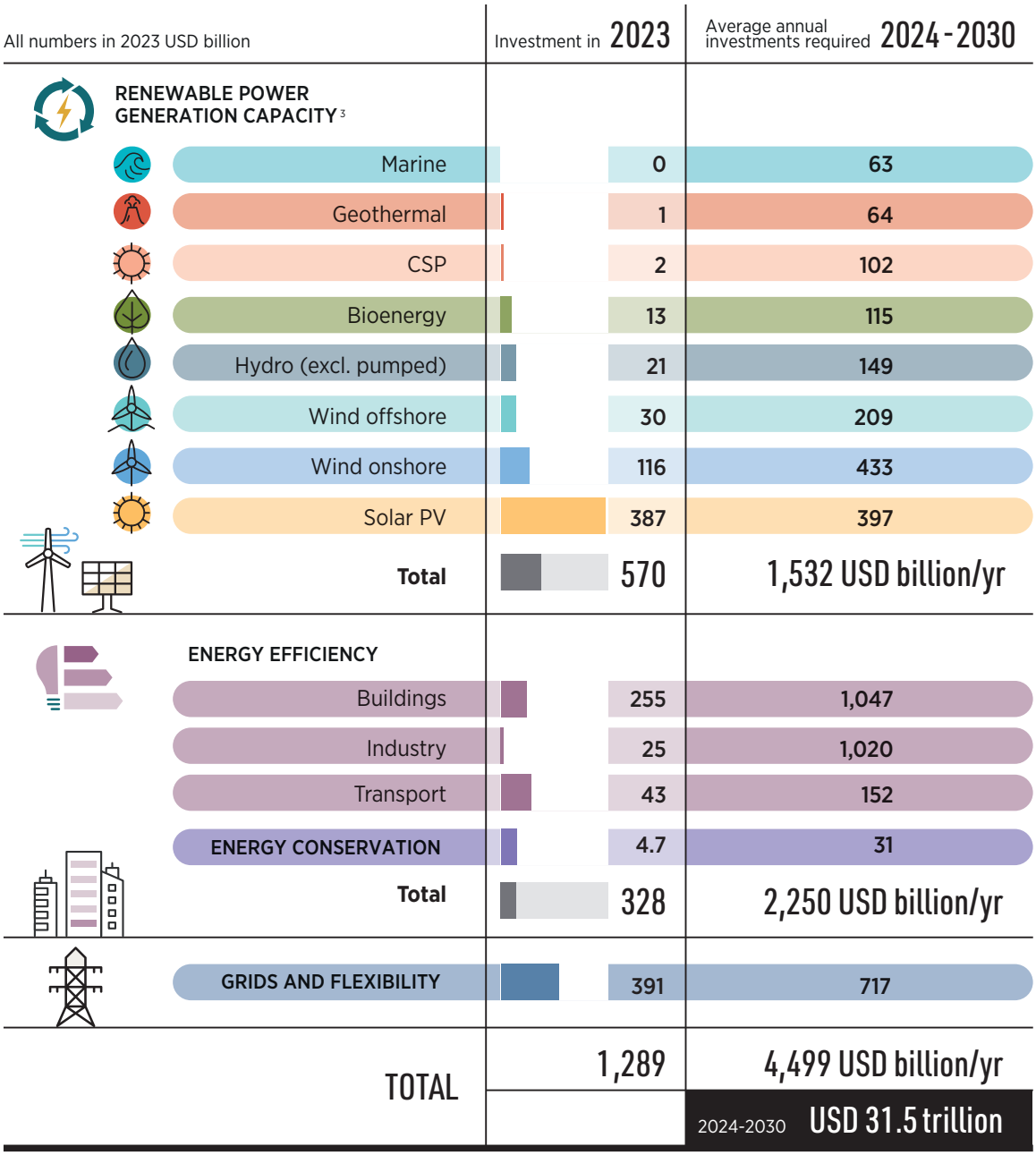
Under IRENA's 1.5°C Scenario, USD 31.5 trillion in cumulative investment in renewables, grids, flexibility measures, energy efficiency, and conservation would be required by 2030 to meet the renewable power capacity and energy efficiency targets of the UAE Consensus (UNFCCC 2023b). While annual investments in renewable power capacity reached a record high of USD 570 billion in 2023, they fall far short of the average USD 1.5 trillion needed each year between 2024 and 2030.

Given current progress, IRENA estimates that annual investments for solar PV are on track to meet the goal to triple global renewable power capacity. In contrast, annual investments in other technologies such as wind, hydropower, bioenergy, CSP, and geothermal are still falling short. And investments in power grid networks and other flexibility measures (especially energy storage) are urgently needed in parallel with the expansion of renewable power capacity.

An estimated average of USD 717 billion per year is needed in grids and flexibility between 2024 and 2030, nearly double the investment made in 2023 (figure 6.11).

To double energy efficiency, IRENA's 1.5°C Scenario estimates that current investments (USD 323 billion in 2023) will need to increase almost sevenfold. This would translate into USD 2.2 trillion across buildings, transport, and industry each year between 2024 and 2030.

FIGURE 6.11 • INVESTMENTS REQUIRED TO TRIPLE RENEWABLE POWER CAPACITY AND DOUBLE ENERGY EFFICIENCY BY 2030 COMPARED WITH 2023 PROGRESS



Source: IRENA et al. 2024. PV = photovoltaic; CSP = concentrated solar power; yr = year.

Conclusion

While progress has been made toward the achievement of SDG 7—which aims for universal access to affordable, reliable, sustainable, and modern energy by 2030—significant challenges remain across all targets. Innovations in technology and policy have expanded access to electricity and clean cooking, especially in Asia. However, regional disparities persist, with slow progress and insufficient support for Sub-Saharan Africa being of particular concern. Existing solutions, including mini-grids and solar home systems, can help support electricity access in hard-to-reach areas. But enhanced international cooperation, a broad range of financing mechanisms tailored to country circumstances, and adaptable and inclusive policy frameworks designed to optimize public spending and attract private investment are needed to power sustainable development. Comprehensive electrification strategies that also consider productive uses are essential to tackle the full spectrum of challenges and to ensure no one is left behind.

Scaling up renewable energy and improving energy efficiency are essential not only to meet SDG 7 but also to address the broader environmental and socioeconomic challenges reflected in the broader SDG agenda. Achieving these goals demands a fundamental shift in energy production, distribution, and consumption, supported by increased investments and enabling policies. Policy makers can play a crucial role in fostering sustainable energy transitions by creating favorable conditions for the adoption of renewable energy and improvements in energy efficiency, all toward the end of facilitating investment and ensuring that marginalized communities are able to benefit from the energy transition. Empowering people, including youth, with the skills and knowledge to engage in the energy sector fosters a forward-looking mindset that is crucial for achieving long-term progress.

Advancing a sustainable energy future requires collaboration among governments, the private sector, international organizations, and civil society. This collective effort should focus on mobilizing and channeling financing, making clean energy technologies more affordable, and ensuring equitable distribution of benefits and burdens associated with the energy transition. The energy and development needs of people must be at the center of efforts to build a sustainable energy future. Scaling up efforts with a holistic approach can bridge energy access gaps and move the globe toward a sustainable future and inclusive energy future for all.