TRACKING SDG7

THE ENERGY PROGRESS REPORT

2023

A joint report of the custodian agencies

iea International Energy Agency

IRENA International Renewable Energy Agency

United Nations Statistics Division

THE WORLD BANK IBRD • IDA | WORLD BANK GROUP

World Health Organization

Report designed by: Duina Reyes
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TABLE OF CONTENTS

Acknowledgments 2

EXECUTIVE SUMMARY 6

CHAPTER 1
ACCESS TO ELECTRICITY 32

CHAPTER 2
ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING 66

CHAPTER 3
RENEWABLES 98

CHAPTER 4
ENERGY EFFICIENCY 132

CHAPTER 5
INTERNATIONAL PUBLIC FINANCIAL FLOWS TO DEVELOPING COUNTRIES IN SUPPORT OF CLEAN ENERGY 160

CHAPTER 6
THE OUTLOOK FOR SDG 7 194

CHAPTER 7
TRACKING PROGRESS TOWARD SDG 7 ACROSS TARGETS: INDICATORS AND DATA 222

ACKNOWLEDGMENTS

Partnership

The Energy Progress Report is a product of close collaboration among the five SDG 7 custodian agencies delivered through a specially constituted Steering Group:

- International Energy Agency (IEA)
- International Renewable Energy Agency (IRENA)
- United Nations Statistics Division (UNSD)
- World Bank
- World Health Organization (WHO)

The Steering Group was supported by the SDG 7 Technical Advisory Group, composed as follows.

- African Development Bank (AfDB)
- Clean Cooking Alliance
- Denmark (Ministry of Foreign Affairs)
- ENERGIA
- European Commission
- FIA Foundation
- Food and Agricultural Organization (FAO)
- Germany (Federal Ministry for Economic Cooperation and Development)
- Hivos
- International Institute for Applied Systems Analysis
- International Labour Organization (ILO)
- Islamic Development Bank
- Kenya (Ministry of Energy and Petroleum)
- Latin American Energy Organization (OLADE)
- Norway (Ministry of Foreign Affairs)
- Pakistan (Ministry of Foreign Affairs)
- Renewable Energy Policy Network for the 21st Century (REN 21)

- Sustainable Energy for All (SEforALL)
- TERI School of Advanced Studies
- The Netherlands (Ministry of Foreign Affairs)
- The United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLLS)
- UAE (Ministry of Foreign Affairs)
- United Nations Association of China
- United Nations Children's Fund (UNICEF)
- United Nations Department of Economics and Social Affairs (UN DESA)
- United Nations Development Programme (UNDP)
- United Nations Economic Commission for Africa (UNECA)
- United Nations Economic Commission for Asia and the Pacific (ESCAP)
- United Nations Economic Commission for Latin America and the Caribbean (ECLAC)
- United Nations Economic Commission for Western Asia (ESCWA)
- United Nations Economic Programme for Europe (UNECE)
- United Nations Environment Programme (UNEP)
- United Nations Framework Convention on Climate Change (UNFCCC)
- United Nations Human Settlements Programme (UN-Habitat)
- United Nations Industrial Development Organization (UNIDO)
- United Nations Institute for Training and Research (UNITAR)
- Vienna University of Technology

The financial and technical support of the Energy Sector Management Assistance Program (ESMAP) is gratefully acknowledged. A partnership between the World Bank and 24 entities, ESMAP helps low- and middle-income countries reduce poverty and boost growth through sustainable energy. ESMAP's analytical and advisory services are fully integrated within the World Bank's country financing and policy dialogue in the energy sector.

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- The chapter on renewable energy was prepared by the IEA (Francois Briens, Roberta Quadrelli, Pouya Taghavi, Jeremy Moorhouse, and Yannick Monschauer) and IRENA (Mirjam Reiner, Gerardo Escamilla, Diala Hawila, Hannah Guinto, Faran Rana, and Divyam Nagpal), with substantial contributions from UNSD (Leonardo Souza and Agnieszka Koscielniak).
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- The chapter on financial flows was prepared by the IRENA (Gerardo Escamilla, Mirjam Reiner, Diala Hawila, Faran Rana, and Hannah Guinto).
- The Outlook chapter was prepared by the IEA (Daniel Wetzel, Gianluca Tonolo, Yannick Monschauer, Carlo Starace, and Nouhoun Diarra), with IRENA (Ricardo Gorini, Nicholas Wagner, Mirjam Reiner, Hannah Guinto, and Jinlei Feng).
- The chapter on indicators and data was jointly prepared by the custodian agencies under the coordination of WHO (Josselyn Mothe, Alina Cherkas, and Heather Adair-Rohani).

Data Sources

The report draws on two meta databases of global household surveys—the Global Electrification Database managed by the World Bank and the Global Household Energy Database and related estimates managed by WHO. Energy balance statistics and indicators for renewable energy and energy efficiency were prepared by IEA (Roberta Quadrelli and Pouya Taghavi, with support from Alexandre Bizeul and Juha Koykka) and UNSD (Leonardo Souza, Agnieszka Koscielniak, and Costanza Giovannelli). The indicator on international financial flows to developing countries was prepared by IRENA (Gerardo Escamilla) based on the IRENA Public Investments Database and the OECD/DAC Creditor Reporting System. Data on gross domestic product and value-added were drawn chiefly from the World Development Indicators of the World Bank. Population data are from the United Nations Population Division.

Review and Consultation

The public consultation and peer review process was coordinated by WHO. Comments were provided by Economic Commission for Latin America and the Caribbean (ECLAC), European Union (EU), Sustainable Energy for All (SEforALL), Swedish International Development Cooperation Agency (SIDA), United Nations Industrial Development Organization (UNIDO), United Nations Institute for Training and Research (UNITAR), and United Nations International Children's Emergency Fund (UNICEF). The IEA's internal review process was led by Laura Cozzi with contributions from Yannick Monschauer, Daniel Wetzel, Francois Briens, Pouya Taghavi, Roberta Quadrelli, and Gianluca Tonolo. IRENA's internal review process was led by Rabia Ferroukhi, with contributions from Ute Collier, Divyam Nagpal, Mirjam Reiner, and Gerardo Escamilla. The UNSD's internal review process was led by Leonardo Souza, with contributions from Agnieszka Koscielniak. The World Bank's internal peer review process was led by Demetrios Papathanasiou, with contributions from Gabriela Elizondo Azuela, Dana Rysankova, Sandeep Kohil, Jan Friedrich Kappen, Alisha Noella Pinto, Carlos Andres Guadarrama Gandara, Chiedza Portia Mazaiwana, Christophe de Gouvello, Dolf Jean Gielen, Henrik Rytter Jensen, Johanna Christine Galan, Raluca Georgiana Golumbeanu, Sharmila Bellur, and Tarek Keskes.

Outreach

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EXECUTIVE SUMMARY

Photo: © Unsplash by Aboodi Vesakaran

OVERVIEW

Since its inception in 2018, *Tracking SDG 7: The Energy Progress Report* has become the global reference point for information on the realization of SDG 7. It is produced annually by five of the custodian agencies responsible for tracking global progress toward Sustainable Development Goal 7 (SDG 7), which is to "ensure access to affordable, reliable, sustainable, and modern energy for all." The custodians developing the report are the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the United Nations Statistics Division (UNSD), the World Bank, and the World Health Organization (WHO).

The report offers the international community a global summary of progress on energy access, energy efficiency, renewable energy, clean cooking, and international cooperation to advance SDG 7. It presents updated statistics for each of the indicators and provides policy insights on priority areas and actions needed to spur further progress on SDG 7, as well as related SDGs. Figure ES.1 offers an updated snapshot of the primary indicators for the most recent year.

Despite some progress across the indicators, the current pace is not adequate to achieve any of the 2030 targets. As in previous years, rates of progress vary significantly across regions, with some regions making substantial gains and some slowing their progress or even moving backward. Among the major economic factors impeding the realization of SDG 7 globally are the uncertain macroeconomic outlook, high levels of inflation, currency fluctuations, debt distress in a growing number of countries, lack of financing, supply chain bottlenecks, tighter fiscal circumstances, and soaring prices for materials. The effects of the COVID-19 pandemic and the steady rise in energy prices since summer 2021 are expected to be a further drag on progress, particularly in the most vulnerable countries and those that were already lagging behind.

Although certain policy responses to the global energy crisis appear likely to improve the outlook for renewables and energy efficiency, other necessary policy actions, as well as financial flows, continue to lag. This particularly concerns lacking universal access to electricity and clean cooking in developing economies, with projections indicating that SDG 7 will not be reached by 2030.

This year marks the mid-point of the implementation of the UN 2030 Agenda for Sustainable Development. The picture on progress since the adoption of the Agenda in 2015 is mixed. Target 7.1 on ensuring universal access to affordable, reliable, and modern energy services is off track, with an estimated 675 million people still without access to electricity and 2.3 billion without access to clean cooking in 2021. Current trends suggest that the world's shot on the target will fall very wide of the mark in 2030.

The uptake of renewable energy (target 7.2) has grown since 2010, but efforts must be scaled up to substantially increase the share of renewables in total final energy consumption. Likewise, despite steady progress, the rate of improvement in energy efficiency (target 7.3) is not on track to double by 2030, with the current trend of 1.8 percent falling short of the targeted increase of 2.6 percent each year between 2010-2030. To make up for the lack of progress, improvements would need to accelerate further from now to 2030.

Finally, progress on target 7.a—to increase international public financial flows supporting clean energy in developing countries—began to decline even before the onset of the COVID-19 pandemic, with financial resources more than a third lower since 2020 than the average of the previous decade (2010–19). As financial flows have contracted for the third year in a row, they have become increasingly concentrated in a small number of countries. The decreasing trend in international public financial flows may delay achievement of SDG 7, especially for the least-developed countries (LDCs), landlocked developing countries, and small island developing states.

FIGURE ES.1 • Primary indicators of global progress toward the SDG 7 targets

INDICATOR	2010	LATEST YEAR
7.1.1 Proportion of population with access to electricity	**1.1 billion** people without access to electricity	**675 million** people without access to electricity (2021)
7.1.2 Proportion of population with primary reliance on clean fuels and technology for cooking	**2.9 billion** people without access to clean cooking	**2.3 billion** people without access to clean cooking (2021)
7.2.1 Renewable energy share in total final energy consumption	**16%** share of total final energy consumption from renewables	**19.1%** share of total final energy consumption from renewables (2020)
7.3.1 Energy intensity measured as a ratio of primary energy and GDP	**5.53 MJ/USD** primary energy intensity	**4.63 MJ/USD** primary energy intensity (2020)
7.a.1 International financial flows to developing countries in support of clean energy research and development and renewable energy production, including in hybrid systems	**11.9 USD billion** international financial flows to developing countries in support of clean energy	**10.8 USD billion** international financial flows to developing countries in support of clean energy (2021)

ACCESS TO ELECTRICITY (SDG INDICATOR 7.1.1)

Recent progress is not on track to reach universal access by 2030. Globally, access to electricity grew by an annual average of 0.7 percentage points between 2010 and 2021, **rising from 84 percent of the world's population to 91 percent**. The number of people without electricity almost halved during the period, from **1.1 billion in 2010 to 675 million in 2021**. The pace of annual growth slowed during 2019–21 to 0.6 percentage points.

To bridge the gap, especially for people living in poor and remote regions, the annual rate of growth in access must be 1 percentage point per year from 2021 onward—almost twice the current pace. If no additional efforts and measures are put in place, some 660 million people, mostly in Sub-Saharan Africa, would still be unserved in 2030 (IEA 2022a). Policies for energy access should demonstrate political commitment and maximize the socioeconomic benefits of access, keeping the most vulnerable populations at the forefront of efforts to close the access gap.

CLEAN COOKING SOLUTIONS (SDG INDICATOR 7.1.2)

The global population lacking access to clean cooking fell from **2.9 billion in 2010 to 2.3 billion in 2021**, but the goal of universal access by 2030 remains elusive: some **1.9 billion people would still be without access to clean cooking in 2030**. If current trends continue, almost six out of ten people without access to clean cooking in 2030 would reside in Sub-Saharan Africa.

With the ongoing impact of COVID-19 and soaring energy prices, the IEA estimates that 100 million people who recently transitioned to clean cooking may revert to using traditional biomass (IEA 2022a). Eastern Asia and Latin America and the Caribbean were the only regions to sustain progress in access to clean cooking between 2019 and 2021 (ESMAP 2022). Unless efforts are rapidly scaled up today, polluting cooking fuels and technologies will continue to claim millions of lives each year while perpetuating gender inequity, deforestation, and climate damage. Integrating clean cooking into broader energy planning, improving affordability, and devising better delivery mechanisms are some of the key policy levers to drive clean cooking. If such efforts are paired with sustained financing at an adequate level, the world can get back on track to making clean cooking a reality for all.

RENEWABLE ENERGY (SDG INDICATOR 7.2.1)

Universal access to affordable, reliable, sustainable, and modern energy depends on faster deployment of renewable energy in electricity, heat, and transport. But unless the pace quickens, the share of renewable energy in total final energy consumption (TFEC) will remain sluggish. **In 2020, the share of renewable energy in TFEC stood at just 19.1 percent** (or 12.5 percent if traditional use of biomass is excluded), not much more than the 16 percent a decade earlier.

If the world is to be on track to limit the temperature rise to less than 1.5°C throughout the century, the share of renewables must reach 33–38 percent by 2030 (In the power sector, renewables would need to account for 60-65 percent of electricity generation.). Much greater effort is needed to increase the use of renewables in transport and heating, both directly (through the use of bioenergy, solar thermal and geothermal, and ambient heat) and indirectly (through electrification), while progressing on energy conservation.

Enhancing renewables-based electricity supply in developing countries deserves particular attention. Positively, developing countries saw a record-breaking renewable capacity growth in 2021 (+9.8 percent year-on-year), with cumulative installations reaching 268 watts per capita. Yet this growth is unevenly distributed, and further action is required in the least developed countries.

ENERGY EFFICIENCY (SDG INDICATOR 7.3.1)

SDG target 7.3 calls for doubling the global rate of improvement in energy intensity over the average rate during 1990–2010—which means improving energy intensity by 2.6 percent per year between 2010 and 2030.[1] **Yet progress between 2010 and 2020 averaged only 1.8 percent**. To make up for lost ground, improvement in energy intensity **must now exceed 3.4 percent globally from 2020 to 2030**—twice the rate achieved in the past decade. An even greater improvement would be needed to be on track to limit the end-of-century temperature rise to less than 1.5°C.

The needed improvements will require more aggressive efficiency mandates—including bans on the sale of the most inefficient equipment—and codes requiring that new buildings meet net-zero standards.

INTERNATIONAL PUBLIC FINANCIAL FLOWS (SDG INDICATOR 7.A.1)

International public financial flows in support of clean energy in developing countries began to drop before the onset of the COVID-19 pandemic and continued to fall through 2021. **In 2021, these flows amounted to USD 10.8 billion, an 11 percent drop from 2020**, 35 percent less than the 2010–19 average and only about 40 percent of the 2017 peak of USD 26.4 billion. Commitments remain heavily concentrated in a handful of countries. It is expected that the downward trend in public investments continued in 2022. Data released in 2022 and 2023 will provide a clearer picture of the effects on public financial flows of the energy crisis in Europe sparked by the war in Ukraine.

While there is no quantitative target for this indicator, IEA and IRENA scenarios estimate that staying in line with international climate and energy goals requires annual investments in renewable electricity generation and related infrastructure of USD 1.4–1.7 trillion through 2030. Investments will be needed not only in technologies, but also in policy interventions and international cooperation. Although the private sector finances most renewable energy investments, the public sector remains a critical source of finance, particularly for many developing countries. Overall, redirecting investments from fossil fuels, increasing aid commitments, introducing structural reforms in international public finance, innovating funding mechanisms, and improving the transparency of commitment reporting are all necessary steps.

***

As the path to realizing SDG 7 and related SDGs by 2030 narrows, the SDG 7 custodian agencies also emphasize the need for stronger and more tangible commitments to close the gaps in access to electricity and clean cooking fuels and technologies; the need for a fundamental transformation of the global energy system as a precondition for sustainable development and global energy security; and the importance of international cooperation and financing to deliver on the vast promise of the energy transition.

Continued improvements on data and the tracking of global SDG 7 targets will be critical to ensure evidenced-based decision and policy making. The custodians will further enhance the global dashboard now freely accessible online and continue to refine this annual report, which has strengthened institutional, organizational, and sectoral collaboration.[2] Results emerging from the joint work of the custodians have included joint publications (including analytical guidebooks), capacity-building actions, and coordinated dissemination efforts.

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1 Energy intensity is the ratio of the total energy supply to the annual GDP created—in essence, the energy used per unit of wealth created.

2 The global dashboard is available online here: https://trackingsdg7.esmap.org/

The custodian agencies further urge the international community and policy makers to safeguard the gains made toward achieving SDG 7; to advance structural reforms to overcome obstacles to action on affordable, reliable, sustainable, and modern energy for all; and to maintain a strategic focus on the vulnerable countries needing the most support.

***

The remainder of this summary is devoted to the major SDG 7 target areas: access to electricity, access to clean fuels and technologies for cooking, renewable energy, energy efficiency, and international public financial flows to developing countries in support of clean energy.

ACCESS TO ELECTRICITY

Access to electricity is expected to improve through 2030, after the difficult economic conditions created by the COVID-19 pandemic and the war in Ukraine have stabilized. However, variations across countries will persist, and many countries will not reach universal access by 2030 unless much more is done. Even then, progress may be limited for countries with weak energy access–related institutions and policies. The outlook is better for countries with strong institutional and policy support for access, most of which have already made historic progress in bringing the benefits of electricity to their population.

According to IEA's Net Zero by 2050 Scenario, annual investment of USD 30 billion will be required to achieve universal access to electricity by 2030.

* * *

Globally, access to electricity (SDG 7.1.1) grew on average by 0.7 percentage points each year between 2010 and 2021, rising from 84 percent of the world's population to 91 percent and raising the number of people with an electricity connection by more than a billion. Over the past decade, access improved steadily, reducing the number of people without access from 1.1 billion in 2010 down to 675 million in 2021, despite a growing population. The recent slowdown in growth is leaving the poorest and hardest-to-reach people without access. In 2019–21, the number of people with access increased by 114 million per year, fewer than the 129 million who had access each year between 2010 and 2019.[3]

To reach universal access by 2030, the world will have to scale up annual growth in electrification to 1 percentage point per year from 2021 onward through investments and policy support, instead of the 0.6 percentage point pace recorded between 2019 and 2021. If no additional efforts and measures are put in place, some 660 million people—560 million in Sub-Saharan Africa and 70 million in Developing Asia—will remain unserved in 2030 (IEA 2022a).[4] Because of the continued negative impacts of COVID-19 on the global and national economies, compounded by the war in Ukraine and the related energy crisis, urgent actions must be taken to prevent setbacks in access.

Globally, the number of unserved people fell steadily between 2010 and 2021. However, the trend differs across regions (figure ES.2). Fifty-one countries in the developing world have achieved universal access, 17 of them in Latin America and the Caribbean. Another 95 countries, concentrated in Sub-Saharan Africa, were still short of the target in 2021, despite progress in about one-quarter of them—including half of the 20 countries with the largest access deficits (defined as the population lacking access to electricity). In Sub-Saharan Africa, the number of people without access was roughly the same in 2021 as in 2010.

Most of the decline in the unserved population came in Asia. The number of people without access plummeted in Central and Southern Asia, falling from 414 million in 2010 to 24 million in 2021, with much of the improvement occurring in Bangladesh, India, and other populous countries. The number without access to electricity in Eastern and South-eastern Asia declined from 90 million to 35 million during the same period. In Northern Africa and Western Asia, the unserved population decreased less markedly—falling from 37 million in 2010 to 30 million in 2021.

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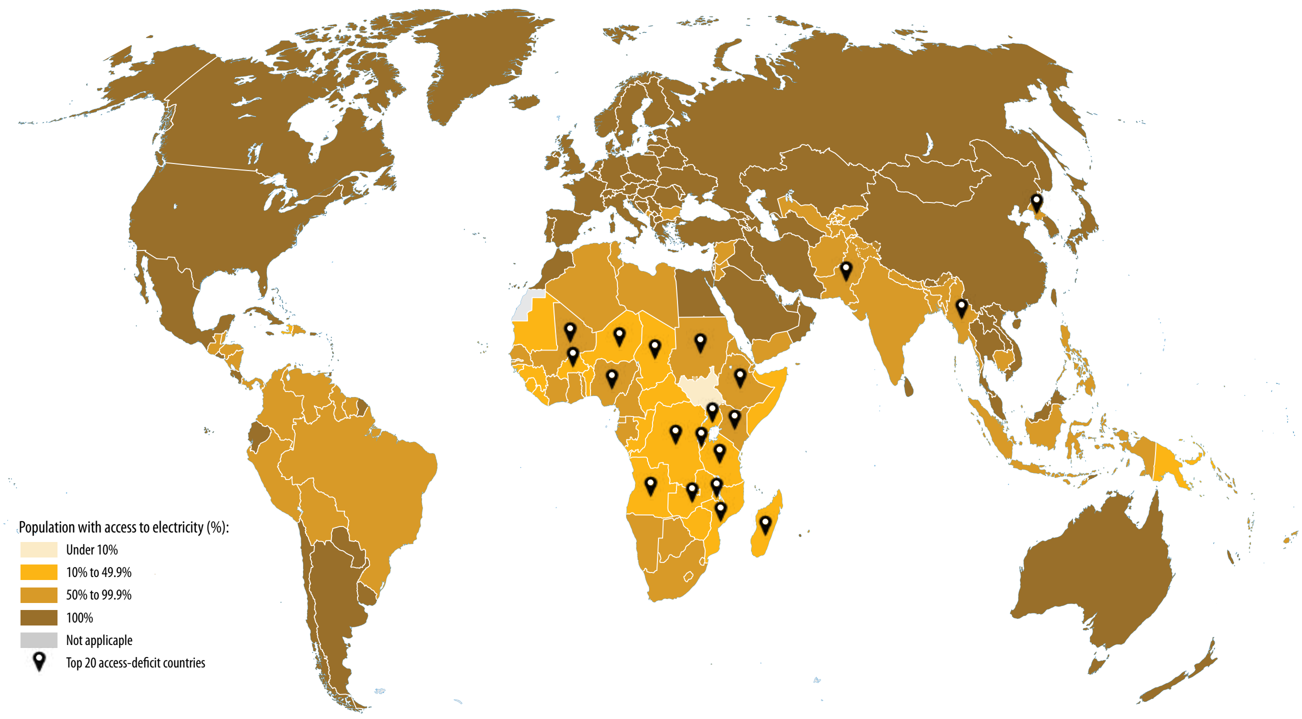
3 The annual change in access is calculated as the difference between the access rate in year 2 and the rate in year 1, divided by the number of years: (Access Rate Year 2 – Access Rate Year 1)/(Year 2 – Year 1).

4 The projected access rate of 92 percent in 2030 was calculated based on the UN population database and IEA World Energy Outlook (2022).

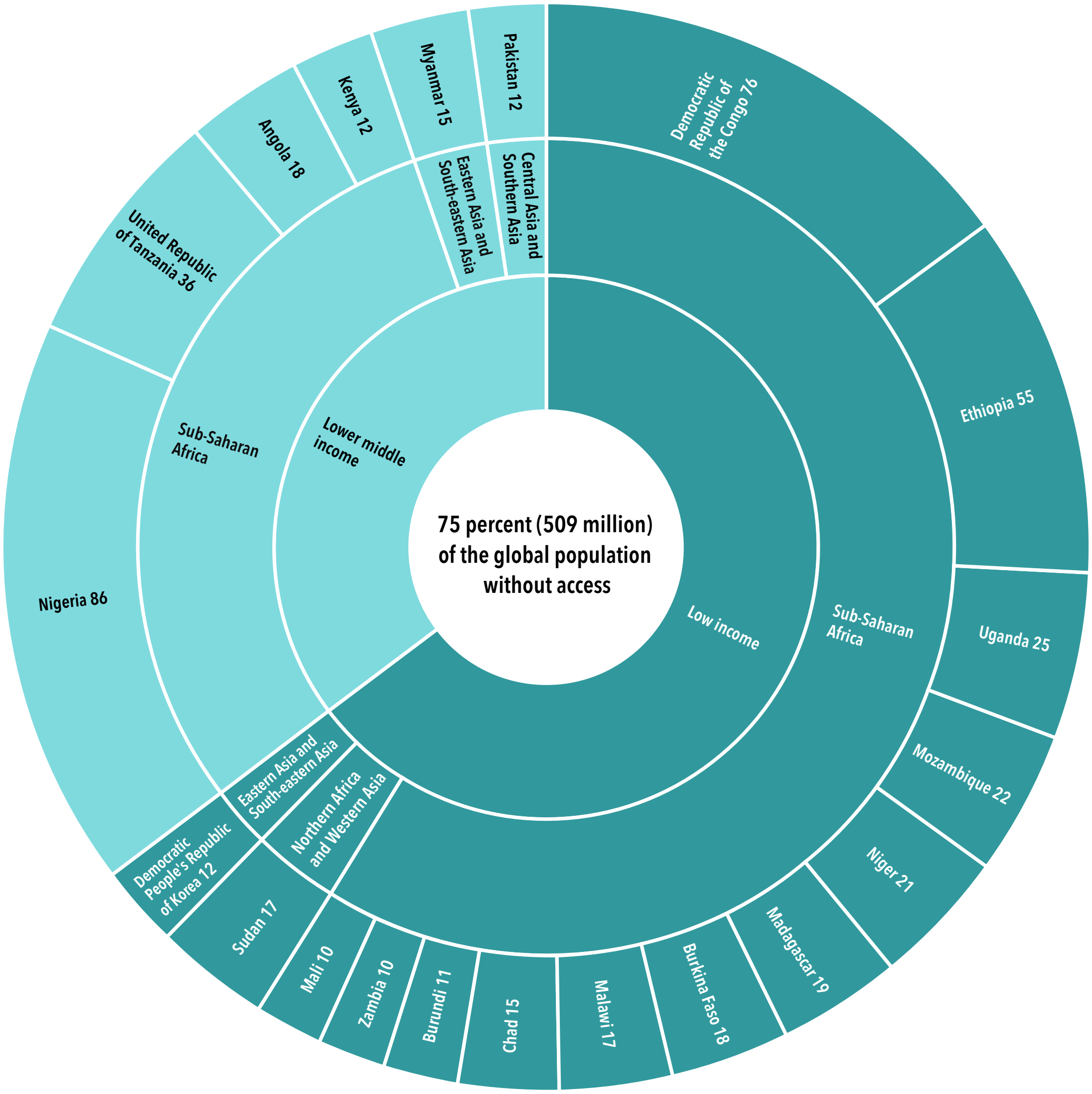
FIGURE ES.2 • Share of global population with access to electricity in 2021



Source: World Bank 2023.
Disclaimer: This map was produced by the Geospatial Operations Support Team of the World Bank based on the Cartography Unit of the World Bank. The boundaries, colors, denominations, and other information shown do not imply any judgment on the part of the custodian agencies concerning the legal status of or sovereignty over any territory or the endorsement or acceptance of such boundaries.

In 2021, the 20 countries with the largest access deficits accounted for 75 percent of the world's people lacking electricity access (figure ES.3). The countries with the largest numbers without access were Nigeria (86 million), the Democratic Republic of Congo (76 million), and Ethiopia (55 million). In 2021, these top three countries are the same as in the previous edition of this report. India and South Sudan dropped out of the top 20, and Zambia and Mali joined it. Increases in electrification did not keep up with population growth in the Democratic Republic of Congo between 2019 and 2021. As a result, the access deficit there increased by about 2 million people. In contrast, the number of people without access in Nigeria and Ethiopia decreased by 2 million each year between 2019 and 2021, although those countries are still in the top 3 in terms of unserved population. During the same period, as in Ethiopia, Kenya increased its access rate by more than 3 percentage points, and its unserved population declined by about 2 million a year.

FIGURE ES.3 • The 20 countries with the largest access deficits in 2021 by region and income levels



Source: World Bank 2023.

Differences are also seen in urban versus rural access to electricity. In 2021, 98 percent of those living in urban areas of the world had access to electricity, contrasted with just 85 percent in rural areas. Between 2019 and 2021, however, the pace of electrification was rapid in rural areas, where the number of people with access grew by 33 million a year, significantly outpacing population growth. This trend was driven by Central and Southern Asia. In Sub-Saharan Africa, by contrast, rural electrification progress lagged behind population growth, with more than 80 percent of the 524 million people in rural areas living without access to electricity in 2021. Meanwhile, annual growth in the number of connected rural dwellers slowed in Eastern and South-eastern Asia, a result of a steady decline in the overall rural population. In Northern Africa and Western Asia, expansion of rural access kept pace with population growth.

Narrowing the gap between rural and urban access requires a better understanding of electricity end uses and greater mobilization of public financing to make electricity more affordable and electricity infrastructure more resilient.

Compared with the global average, the LDCs saw a relatively rapid increase in electrification, connecting about 32 million people a year in 2019–21 and bringing the rate of access up 3 percentage points from 53 percent in 2019 to 56 percent in 2021, still leaving 481 million LDC residents without access. A gap of more than 30 percentage points persists in access rates between LDCs and the global average. In countries marked by fragility, conflict, and violence, access increased from 55 percent to 58 percent, leaving 421 million people still unserved in 2021.[5]

At the current pace of electrification, most people without access by 2030 will live in LDCs and countries affected by fragility, conflict, and violence. Dedicated financial and regulatory support should be strengthened to increase electrification in these settings.

Stand-alone off-grid solutions hold potential for closing the access gap in remote and rural areas of Sub-Saharan Africa, where weak utility creditworthiness and other challenges, such as the absence of infrastructure and low population densities, have impeded progress in grid electrification (ESMAP 2022a).

In the face of the COVID-19 pandemic, mini-grid systems continued to expand access between 2019 and 2021 through support from policy makers, private investors, and end users (IRENA 2022). The number of people connected to mini-grids powered by solar, hydro, and biogas technologies reached 11 million in 2021.[6] Solar mini-grids, which served about a third of those connected, have become the least-cost way of bringing reliable electricity to communities living far from the grid or experiencing regular power cuts (ESMAP 2022b). Even so, the number with access to stand-alone off-grid solar solutions dropped from 107 million in 2019 to 101 million in 2021.[7] To close the access gap by 2030, however, off-grid renewable electrification will have to be scaled up rapidly through dedicated policies and strong financial schemes.

Specific policies to expand infrastructure, upgrade technology, and achieve modern and sustainable energy service targets under a given regulatory framework vary by country, but all countries need to establish an enabling environment that de-risks investments, supports innovation, promotes transparency and accountability, and offers benefits to local economies. Technological innovation and digitalization offer the prospect of reducing costs, providing efficiencies across the value chain, and improving accountability (thus encouraging the required investment and spurring large cross-sectoral effects). Public financing will continue to play an important role in ensuring affordable access for all and supporting the development of enabling environments through investments in skills and capacity building, planning, and market linkages for productive uses of electricity.

5 The list of countries affected by violent conflict is based on the World Bank classification. The list is updated annually and this report refers to the list published in July 2022: https://thedocs.worldbank.org/en/doc/69b1d088e3c48ebe2cdf451e30284f04-0090082022/original/FCSList-FY23.pdf

6 According to ESMAP (2022b), 48 million people were connected to around 21,500 mini-grids powered by solar photovoltaic (PV), followed by hydro and fossil fuels in 2021.

7 The figure of 101 million people with current access is calculated based on sales from GOGLA and its affiliates, which include GOGLA members, companies with Verasol-certified products, and companies working with the Low Energy Inclusive Appliances program.

ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

The world is not on track to achieve universal access to clean cooking by 2030. Even though an estimated 71 percent of the global population had access to clean cooking fuels and technologies in 2021—an increase of 2 percentage points since 2020 and 14 points since 2000[8]—2.3 billion of the world's people still use polluting fuels and technologies for their cooking. This continues to put household members, particularly women and children, at greater risk of chronic diseases, while also contributing to climate change, perpetuating gender inequity, and compromising actions for sustainable development. Efforts to accelerate the achievement of universal access to clean cooking by 2030 are urgently needed. Sustained development aid and financing in low- and middle-income countries will be necessary to ensure universal access to clean cooking fuels and technologies, alongside a long-term transition from LPG to electricity that will require substantial investments in infrastructure and changes in cooking practices.

* * *

On a global scale, the number of people with access to clean cooking has risen consistently over the last two decades. The total number of people lacking access to clean cooking—a measure of the number exposed to the damaging health and socioeconomic effects of polluting fuels and technologies—began to fall substantially only after 2010, dropping from its historic level of around 3 billion people in that year to 2.3 billion people in 2021.

The health consequences of household air pollution are stark and tragic. The use of inefficient stoves paired with solid fuels and kerosene releases air pollution that puts household members, particularly women and children, at greater risk of chronic disease. According to WHO (2022), 3.2 million deaths are attributable to household air pollution created through the use of polluting fuels and technologies for cooking, including 240,000 pneumonia deaths in children under the age of five (WHO 2021). Failure to reach the target of universal access to clean cooking fuels and technologies will continue to claim millions of lives each year. The lack of access to clean fuels and modern energy systems for cooking has impacts beyond health, preventing many from living life to the fullest. The drudgery posed by reliance on inefficient stoves and fuels (which must often be foraged) falls disproportionately on women and children, particularly girls.

Improvement in the global access rate has been driven by progress in the most populous low- and middle-income countries. Rapid progress in China, India, Indonesia, Brazil, and Pakistan, where the combined access rate rose from 49 percent in 2010 to 77 percent in 2021, stands in sharp contrast to the minimal progress in other countries (48 percent in 2010 to 52 percent in 2021). Large regional variability exists (figure ES.4), as good progress in the largest countries may obscure the lack of progress in a great many smaller countries. India alone accounts for the largest share of the access deficit, with 505 million people lacking access, followed by China at 296 million.

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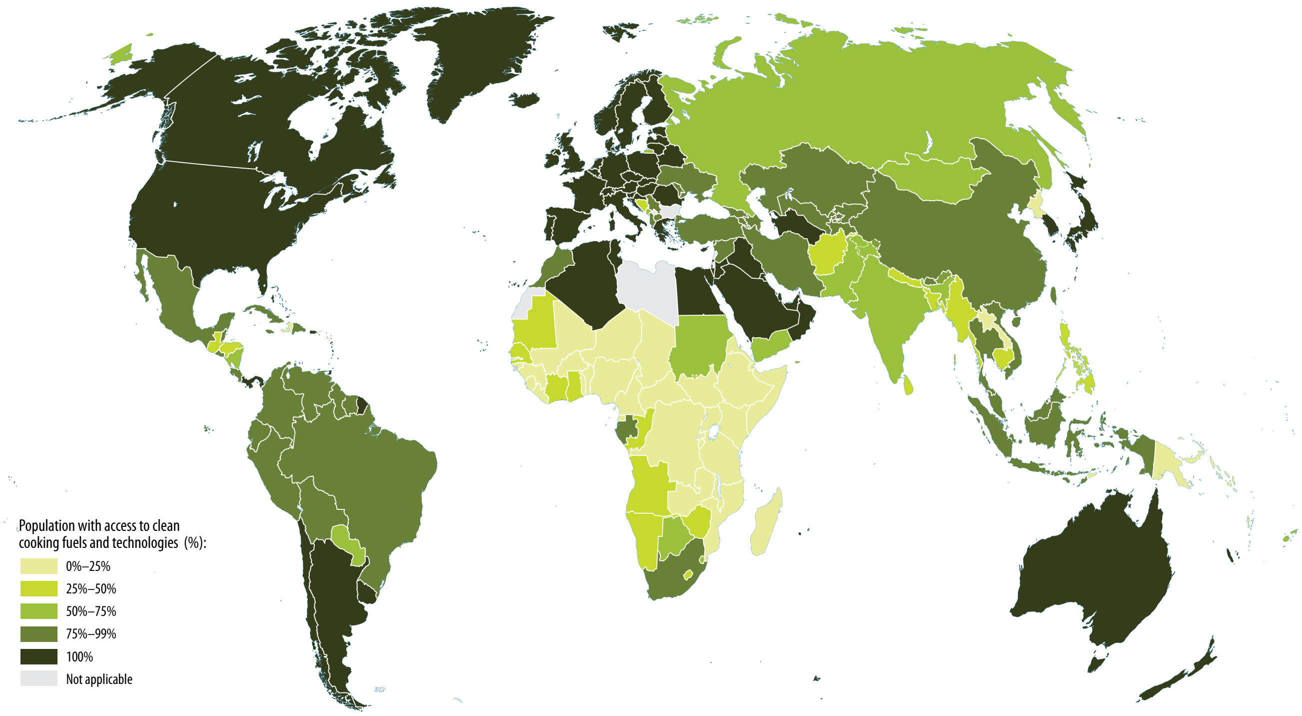
8 Clean fuels and technologies include stoves powered by electricity, liquefied petroleum gas (LPG), natural gas, biogas, solar, and alcohol. Clean fuels and technologies are as defined by the normative technical recommendations in the WHO Guidelines for Indoor Air Quality: Household Fuel Combustion (WHO 2014).

FIGURE ES.4 • Share of population with access to clean cooking fuels and technologies, 2021 (percent)



Source: WHO 2023; Stoner and others 2021.
Disclaimer: This map was produced by the Geospatial Operations Support Team of the World Bank based on the Cartography Unit of the World Bank. The boundaries, colors, denominations, and other information shown do not imply any judgment on the part of the custodian agencies concerning the legal status of or sovereignty over any territory or the endorsement or acceptance of such boundaries.

In 2000, four in ten people lacking access to clean cooking lived in Central Asia and Southern Asia; another four in Eastern Asia and South-eastern Asia; and two in Sub-Saharan Africa. By 2021, four in ten people without access lived in Sub-Saharan Africa, as the access deficit shrank in the two Asian regions and grew sharply in Sub-Saharan Africa. If current trends continue, almost six in ten people without access will reside in Sub-Saharan Africa by 2030. The number of people without access in that region is growing at a rate of almost 20 million people per year as gains in access fail to keep pace with population growth. The growing access deficit in Sub-Saharan Africa could undermine increasing trends in global access.

Large urban-rural discrepancies in access to clean cooking fuels and technologies are found worldwide. Urban areas enjoy greater access to clean cooking than rural areas, but the gap is narrowing. The percentage of people with access in urban areas rose only slightly in the past decade—from 82 percent in 2010 to 86 percent in 2021, owing to a higher baseline. Over the same period, the percentage with access in rural areas rose from 31 percent to 51 percent. Between 2000 and 2010, the difference in access to clean cooking between urban and rural areas stood at around 50 percentage points. By 2021 the gap had fallen to 35 percentage points; it is expected to narrow to 23 percentage points in 2030 if current trends continue.

There is an ongoing shift in the fuel mix. Unprocessed biomass, once the most commonly used fuel in low- and middle-income countries, was overtaken by gas in around 2010 with the rapid growth of LPG programs in India, Indonesia, and Peru, among other countries. However, in rural areas, biomass was still the principal cooking fuel of 49 percent of people (1.5 billion) in 2021, more than any other type of fuel. Use of unprocessed biomass may be decreasing in both urban and rural areas, but primary reliance on charcoal persists and is increasing in some areas, particularly urban areas of Sub-Saharan Africa, where it was used by 30 percent of people or 140 million people in 2021.

In rural areas (and overall), the share of people who use gas as their primary fuel is rising more quickly than those who use electricity, whereas the use of electricity is rising more quickly in urban areas. Among low- and middle-income countries, the use of electricity is highest in Eastern and South-eastern Asia, at 24 percent.

Given current trends, the pledge made at the UN's 2021 High-level Dialogue on Energy to ensure that an additional 1 billion people would gain access to clean cooking solutions by 2025 will not be reached.[9] Only 39 of the 128 countries still lacking universal access to clean cooking have set clean cooking targets, and less than half of those aim to achieve universal access by 2030 (IEA 2022a). Current policy ambitions are therefore far from the targets of SDG 7.

Focusing on the near term, the number of people with access to clean cooking is expected to increase by only 510 million people from 2021 to 2025. The expected access deficit is largely concentrated in Sub-Saharan Africa, where almost 60 percent of the population is projected to still lack access to clean cooking in 2030. Because of the ongoing impact of the COVID-19 pandemic and soaring energy prices, 100 million people who recently transitioned to clean cooking are expected to revert to using cheaper traditional biomass (IEA 2022a). Between 2019 and 2021, Eastern Asia and Latin America and the Caribbean were the only regions to sustain progress in access to clean cooking (ESMAP 2022a).

Considering the significant benefits of clean cooking for the health of people and the planet, it should be at the top of the sustainable development agenda. Without immediate and sustained political action, the world will arrive at 2030 with 1.9 billion people still using polluting stove and fuel combinations for most of their cooking, harming the environment, impeding economic development, and compromising human health, particularly among women and children. Scaling up clean cooking still faces supply-side challenges, including a lack of resources and infrastructure, while, on the demand side, cost remains a deterrent and behavioral inertia persists. However, there are known solutions, and a growing number of countries are exploiting them. The time is ripe to take action to keep the universal target in reach.

9 Pledge made during the High-level Dialogue on Energy in 2021, as part of the Global Roadmap for Accelerated SDG 7 Action in Support of the 2030 Agenda for Sustainable Development and the Paris Agreement on Climate Change (United Nations 2021).

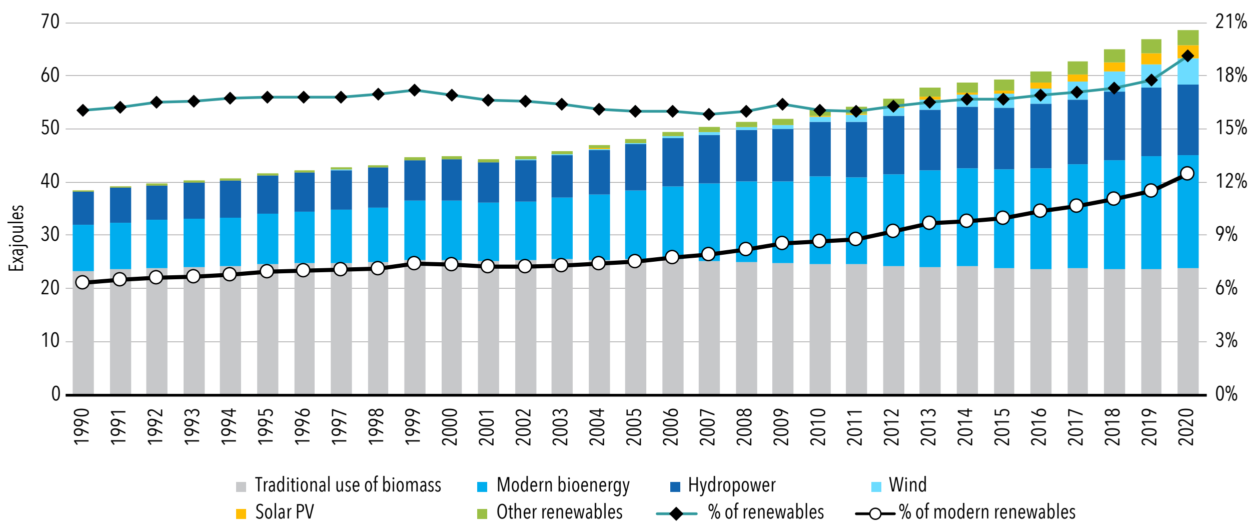
RENEWABLE ENERGY

SDG target 7.2 for 2030 is "increasing substantially the share of renewable energy in the global energy mix." In 2020, the TFEC declined by 4.7 percent year-on-year as the COVID-19 pandemic and policy responses disrupted social and economic activities worldwide. In this context of declining energy demand, renewable energy consumption, including traditional use of biomass, continued to progress at a modest pace, growing 2.6 percent year-on-year globally, and increasing its share of TFEC to 19.1 percent. Yet the current trend is neither in line with the ambition of the target nor with internationally agreed climate objectives, and the uptake of renewable energy must be accelerated.

* * *

The share of renewable sources in TFEC has remained relatively steady globally over the past three decades, with a slow upward trend in recent years (+3 percentage points over the past ten years), owing mostly to the accelerated deployment of renewable electricity technologies. In 2020, to slow the spread of the pandemic, governments across the world imposed restrictions on most social and economic activities, curtailing transport, industrial production and services, and causing a significant dip in energy demand. At the same time, global renewable energy consumption expanded to 68.6 exajoules (EJ) in 2020, pushing the share of renewables in TFEC to 19.1 percent, up from 17.7 percent in 2019 (figure ES.5).

FIGURE ES.5 • Renewable energy consumption and share in total final energy consumption, by technology, 1990-2020



Source: IEA (2022c), UNSD (2022).

Ensuring access to affordable, reliable, sustainable and modern energy for all implies a substantial increase in the share of renewable energy sources not only in the generation of electricity, but also in transport and heat.[10]

10 In 2020, the three categories accounted for 22 percent, 29 percent, and 49 percent of TFEC, respectively.

The share of renewables in final consumption is greatest for **electricity**, rising from 26.2 percent in 2019 to 28.3 percent in 2020. Renewable electricity accounts for a third of global renewable energy consumption, including traditional uses of biomass, and half of modern uses. It also accounts for about 90 percent of the year-on-year increase in the share of renewables in the energy mix, driven by continuous expansion of capacity in wind and solar PV.

Heat is the largest energy end-use worldwide, accounting for half of global final energy consumption (175 EJ). The sector remains heavily dependent on fossil fuels, which meet more than three-quarters of global heat demand. Renewable sources accounted for just 24 percent of the energy used for heat, and more than half of that is represented by traditional uses of biomass, which increased 1 percent in 2020 in response to higher prices for modern forms of renewable energy. Despite its dominant share in final energy consumption, the heat sector has received limited policy attention and support until very recently.

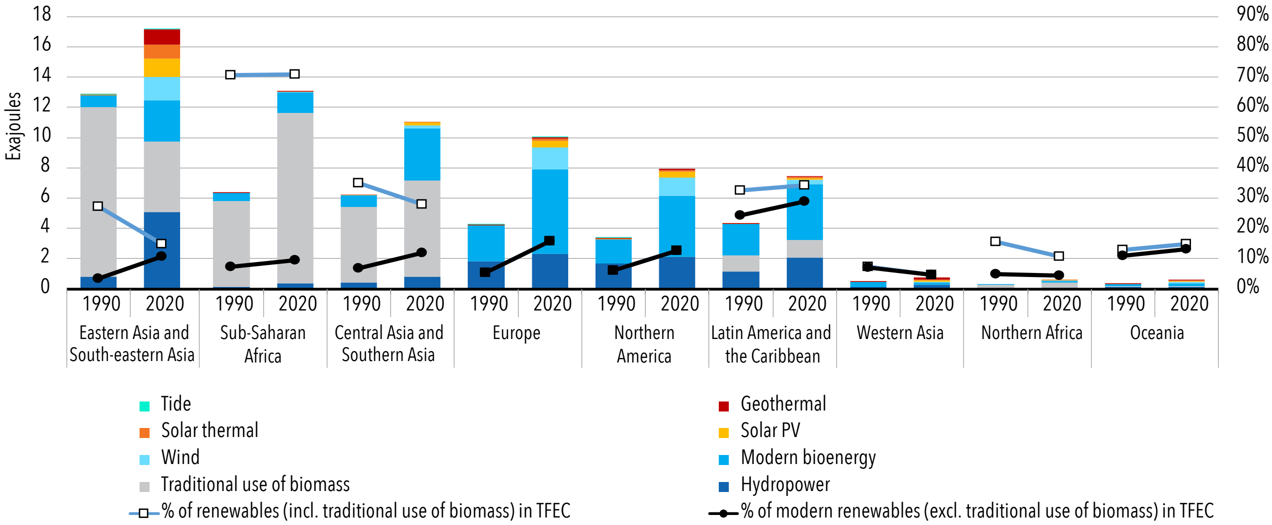
The **transport** sector is the end-use sector with the lowest renewable energy penetration, at only 4 percent of final energy consumption in 2020 and only 9 percent of worldwide consumption of modern forms of renewable energy. Liquid biofuels represented 90 percent of the renewable energy consumed for transport, with most of the remainder coming from renewable electricity for vehicles and trains, which expanded by 0.02 EJ year-on-year in 2020. A fraction of this growth is attributable to the growing number of electric vehicles on the road—from 7.1 million in 2019 to 11.3 million in 2020, while the electricity that powers these vehicles comes increasingly from renewable sources.

The **agri-food** sector also has substantial linkages with renewable energy. About 30 percent of the world's energy is consumed within agri-food systems, from production to food consumption.[11] The majority of that energy is fossil fuel–based (IRENA and FAO 2022). A joint approach to the renewable energy transition and the transformation of agri-food systems is necessary to meet their demand for electricity, heating, cooling, processing, and transport while advancing the SDGs and the Paris Agreement on Climate Change (IRENA and FAO 2022).

There are strong **regional disparities** in the share of renewables in the energy mix (figure ES.6). In 2020, almost half of the global year-on-year increase in modern renewable energy consumption came from Eastern Asia, owing primarily to the deployment of wind, hydropower and solar PV. Europe accounted for more than a quarter of the year-on-year growth in modern renewable energy use, due to favorable conditions for hydropower and the expansion of wind and solar PV capacity. The share of renewables in TFEC grew fastest in Latin America and in Europe (respectively +2.8 and +1.5 percentage points in 2020), supported in both cases by significant declines in TFEC (-7.7 percent and -5.5 percent, respectively—the largest declines after Northern America). Modern use of bioenergy declined 8 percent year-on-year in North America, owing partly to reduced consumption by the pulp and paper industry and in the residential heating sector due to a mild winter in 2019–2020. While traditional use of biomass continued to decline in Eastern and South-eastern Asia, this was offset by increasing consumption in Sub-Saharan Africa, partly driven by population growth.

11 The energy used in agri-food systems includes direct energy for primary production as well as shares of the energy demands for fertilizer manufacturing, food processing, storage, and other inputs.

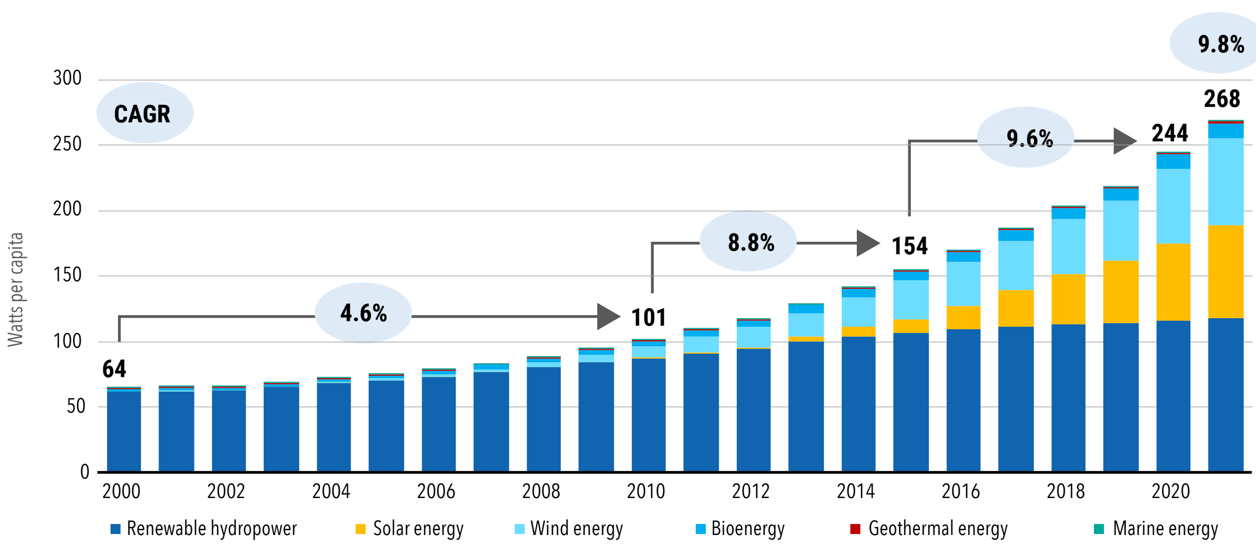
FIGURE ES.6 • Renewable energy consumption and share in total final energy consumption, by region, 1990 and 2020



Source: IEA (2022c), UNSD (2022).

Progress on SDG indicator 7.b.1, which tracks renewables-based generating capacity in developing countries, has been on the rise since 2007, when the share of renewables-based capacity stood at 24.8 percent. In 2021, that share reached a record high of 38 percent, with 268 watts per capita of cumulative renewable capacity installed (figure ES.7), close to the world average of 38.3 percent. Additions of renewables-based capacity in developing countries peaked in 2020, with 186 GW added, before contracting to 174 GW in 2021.

Figure ES.7 • Growth in renewable energy-generating capacity per capita by technology across regions, 2010–21



Source: IRENA (2022a).
Note: CAGR = compound annual growth rate.

But the positive global and regional trends hide the fact that the countries most in need of support are being left behind, even within the broader category of developing countries. Closing the gap in the deployment of renewables-based generating capacity will require tailored policies and investments to ensure that the energy transition is just and sustainable in the long term. More needs to be done to meet the SDG target 7.b: to "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 landlocked developing countries, in accordance with their respective programmes of support."

The ambitious deployment of renewables-based generating capacity across regions is crucial to avoid locking in unsustainable and polluting energy choices and investing scarce fiscal resources in assets that are likely to become stranded. Long-term commitments to renewable energy from policy makers—supported by well-designed targets, comprehensive plans, and timelines for the short, medium, and long term—are needed to set clear directions around which stakeholders can plan their activities. The more detailed, specific, and credible the target, the more it can catalyze public and private investments and support. Renewable energy targets also need to be ambitious enough to break free of historical trends and align renewable energy deployment with international climate ambitions. The targets then need to be implemented through a range of instruments, including regulations, fiscal incentives, and behavioral measures. These policies to support the ramp-up of renewable energy must be underpinned by structural changes, as countries endeavor to transform entire energy systems through the use of sustainable sources of energy to power economies and improve lives and livelihoods.

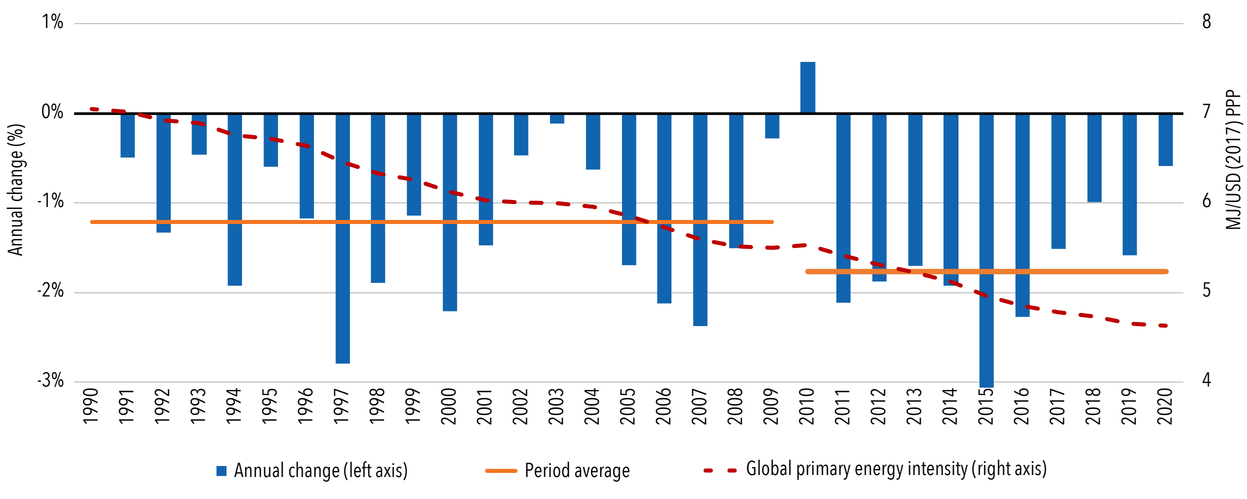
ENERGY EFFICIENCY

Progress on energy efficiency is measured by tracking the year-on-year percentage change in "energy intensity"— the energy used per unit of economic output. Initially, the United Nations recommended an annual improvement rate of 2.6 percent between 2010 and 2030 to achieve the target, but global progress has been slower than that in all years except 2015.[12] For 2020, in fact, the annual improvement in energy intensity was just 0.6 percent, the lowest figure since 2010, mainly affected by the COVID-19 pandemic restrictions. The poor showing to date means that global energy intensity must now improve from 2020 to 2030 at an annual rate of no less than 3.4 percent (up 0.2 percent from last year's recommendation) to reach SDG target 7.3 and 4.2 percent to reach the International Energy Agency's (IEA's) Net Zero Emissions by 2050 Scenario (IEA 2021a).

* * *

Globally, energy intensity has improved gradually since 1990 (figure ES.8). But it improved only 0.6 percent in 2020, to 4.63 MJ/USD (2017 PPP [purchasing power parity]), in the context of the COVID-19 crisis, as GDP and total energy supply fell by 3.2 and 3.8 percent, respectively (IEA 2021b). The COVID-19 crisis worsened an already undesirable trend, with the 2020 result well below the average annual growth of 1.2 percent recorded during 1990-2010, and 1.8 percent achieved between 2010 and 2020. Historical GDP and energy intensity data suggest that large declines in GDP, such as those occurring in 2020, tend to be followed by declines in future energy intensity improvement rates (IEA 2020a).

Figure ES.8 • Global primary energy intensity and its annual change, 1990–2020



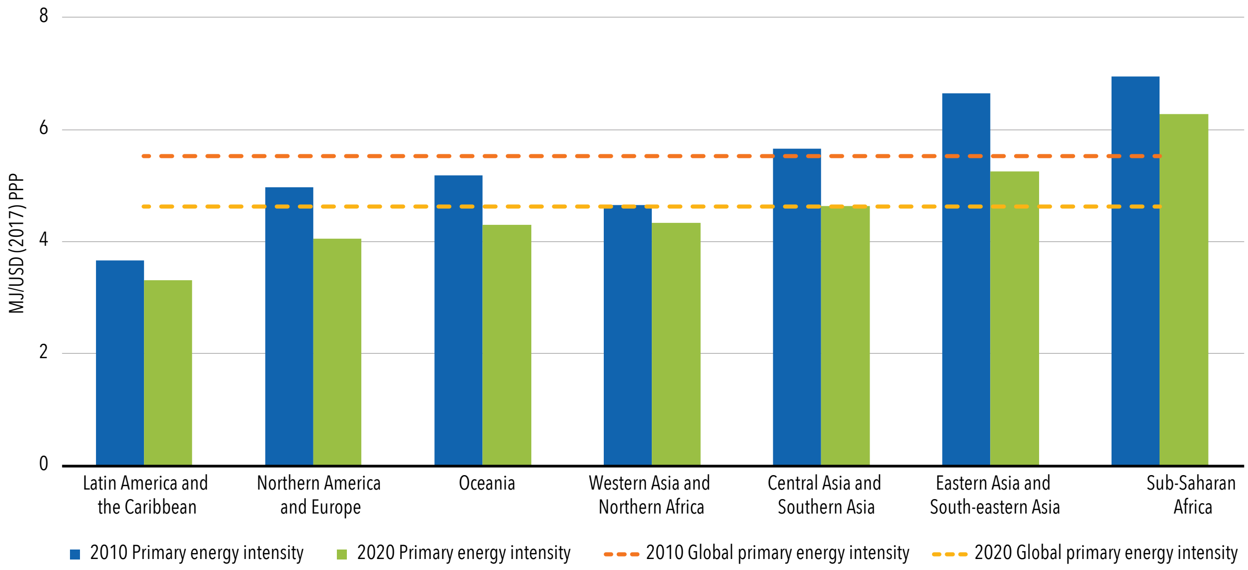
Source: IEA, UNSD, and World Bank. The energy data for the figures in this section come from a joint data set built by the International Energy Agency (https://www.iea.org/data-and-statistics/) and the United Nations Statistics Division (https://unstats.un.org/unsd/energystats/). GDP data are sourced from the World Bank's World Development Indicators database (http://datatopics.worldbank.org/world-development-indicators/).
MJ = megajoule; PPP = purchasing power parity.

At the regional level, Latin America and the Caribbean, Western Asia and Northern Africa, and Sub-Saharan Africa recorded the smallest average gains in energy intensity improvement over the period 2010–20 (1 percent per year

12 The 2.6 percent rate was calculated based on a goal of doubling the global rate of improvement in energy intensity between 2010 and 2030 over the average rate achieved during 1990–2010.

or less). However, trends differed across these regions. In Latin America and the Caribbean, total energy supply decreased slightly, and GDP growth was among the lowest worldwide. The region also consumes the least energy in the world, at 3.3 MJ/USD (2017 PPP) (figure ES.9). On the other hand, total energy supply and GDP in Western Asia and Northern Africa, and in Sub-Saharan Africa, grew at rates higher than the global average.[13] Three regions—Eastern Asia and South-eastern Asia, Latin America and the Caribbean, Western Asia and Northern Africa—saw energy efficiency improvements double in 2010–20 compared with 1990-2010.

FIGURE ES.9 • Primary energy intensity at a regional level, 2010 and 2020



Source: IEA, UN, and World Bank (see note to figure ES.8).
MJ = megajoule; PPP = purchasing power parity.

Improving energy intensity in the top 20 energy-consuming countries is central to meeting SDG target 7.3, in view of the fact that they account for approximately three-quarters of global GDP and energy consumption. Over the period 2010–20, 14 of the 20 achieved faster improvements in energy intensity than in the previous decade, although only five (China, the United Kingdom, Indonesia, Japan, and Germany) exceeded the level of 2.6 percent originally thought to be sufficient to achieve SDG 7.3. In addition, intensity improvement doubled in six countries in 2010–20 compared with 1990–2010; these are Mexico, France, Indonesia, Japan, Türkiye, and Italy. That these groups of high achievers include both developed economies and major developing economies shows that all countries can double their energy efficiency improvement rates, despite differences in their starting improvement levels.

In the context of end-use trends, a variety of metrics can be used to examine energy intensity across key sectors, such as industry, transport, buildings, and agriculture.[14] Over the period 2010–20, energy intensity improved at an accelerated rate across all sectors, except residential buildings (figure ES.10).

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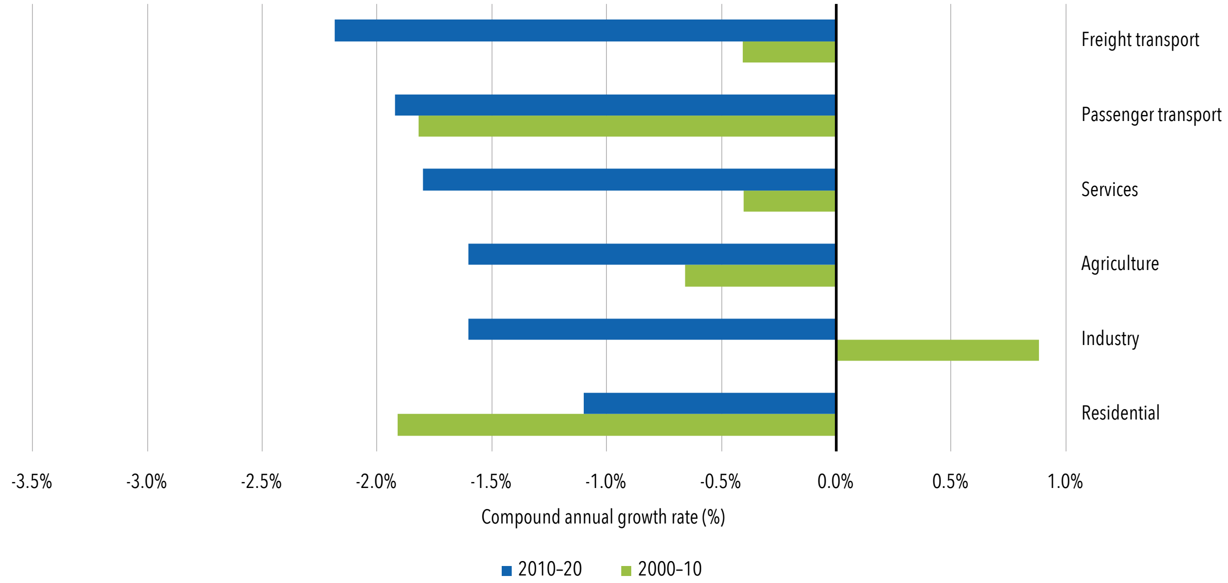
13 Sub-Saharan Africa is highly energy intensive, at 6.3 MJ/USD (2017 PPP). The figure for Western Asia and Northern Africa was 4.3 MJ/USD (2017 PPP).

14 The measures for energy intensity used for individual sectors (e.g., in figure ES.10) differ from those applied to global primary energy intensity. Energy intensity for freight transport, for example, is defined as final energy use per metric ton-kilometer. For passenger transport, it is final energy use per passenger-kilometer. For residential use, it is final energy use per square meter of floor area. In the service, industry, and agriculture sectors, energy intensity is defined as final energy use per unit of gross value-added (USD 2017 PPP). In the longer term, it would be desirable to develop more refined sectoral and end-use-level indicators to examine energy intensity by industry (e.g., cement, steel) or end use (e.g., heating, cooling). Doing so will not be possible without more disaggregated data and statistical collaboration with relevant energy-consuming sectors.

Figure ES.10 • Compound annual growth rate of energy intensity by sector, 2000–10 and 2010–20



Sources: IEA, UNSD, and World Bank (see note to figure ES.8).
Note: The measures for energy intensity used here for individual sectors differ from those applied to global primary energy intensity (see footnote 12).

Chemicals, nonmetallic minerals, and metals lowered their energy intensity at an annual average rate of 1–2 percent over 2010–20; less-intensive manufacturing did so by 2–4 percent per year over the same period (IEA 2022b). Energy intensity fell the fastest in freight transport, at 2.2 percent annually, a drop much steeper than the 0.4 percent annual decrease observed between 2000 and 2010. In the services sector, energy intensity improved by 1.8 percent annually between 2010 and 2020. It also improved significantly for agriculture—from 0.7 percent a year in 2000–10 to 1.6 percent between 2010 and 2020 due to the sector's economic output outpacing growth in energy demand. A backward trend was observed in the residential sector, which accounts for nearly a third of global energy consumption. Energy intensity improvements in the sector fell from 1.9 percent in the first decade of the new century to 1.1 percent annually between 2010 and 2020.

The technology and resources needed to double energy efficiency by 2030 are all available, including digitalization, which is already reshaping the energy landscape and facilitating progress toward improved energy efficiency. Wide-scale data collection, analysis, and application can help direct energy efficiency measures to where they can have the greatest impact. More refined sectoral and end-use-level indicators would make it possible to examine energy intensity by industry (e.g., cement, steel) or end use (e.g., heating, cooling). But developing those indicators will not be possible without more disaggregated data and statistical collaboration with energy-consuming sectors.

For the time being, the slow pace of improvement in energy efficiency is a major missed opportunity for the global community. Making energy efficiency a priority in policies and investments over the coming years can help achieve SDG target 7.3, promote economic development, improve health and well-being, and ensure universal access to clean energy.

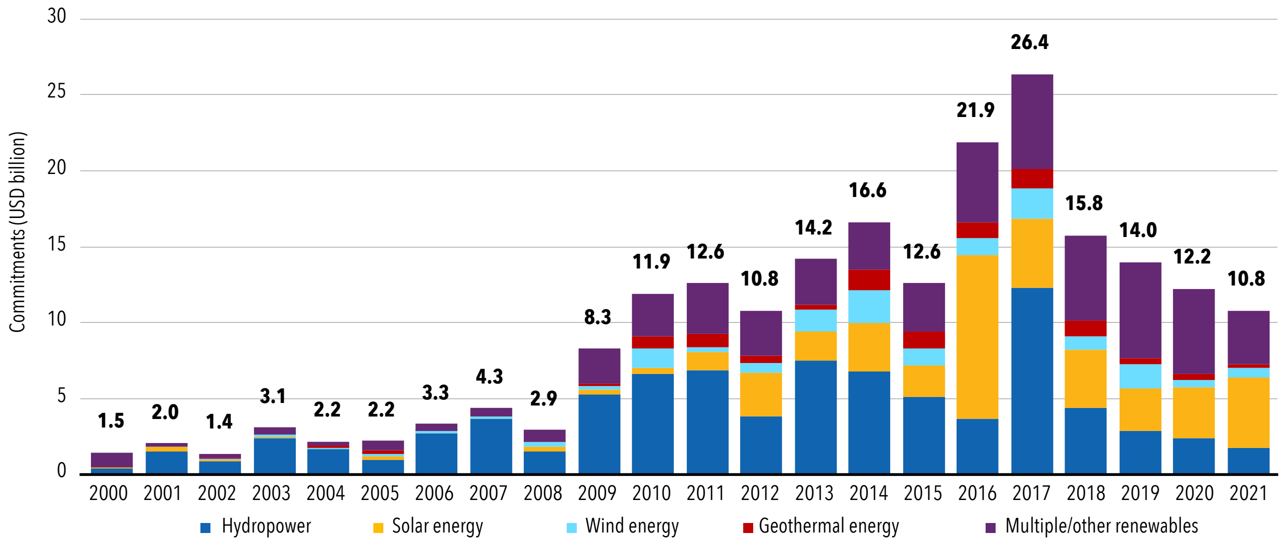
INTERNATIONAL PUBLIC FINANCIAL FLOWS TO DEVELOPING COUNTRIES IN SUPPORT OF CLEAN ENERGY

International public financial flows supporting clean energy in developing countries began dropping before the COVID-19 pandemic and continued through 2021. While there is no quantitative target for such flows under indicator 7.a.1, their dwindling may delay achievement of SDG 7, especially for LDCs, landlocked developing countries, and small island developing states. International public flows must increase substantially and be targeted at countries most in need of financial aid.[15]

* * *

The volume of public international financial flows to developing countries in support of clean energy research and development and renewable energy production (together referred to as renewables) decreased over 2020–2021. In 2021, these flows totaled USD 10.8 billion, down 11 percent from 2020 (figure ES.11). The 2021 figure was equal to that of 2012 and among the lowest levels recorded over the past 10 years. It is 35 percent lower than the average of USD 16.7 billion for 2010–19 and only 40 percent of the 2017 peak of USD 26.4 billion.

FIGURE ES.11 • Annual international public financial flows toward renewables in developing countries, by technology, 2000-21

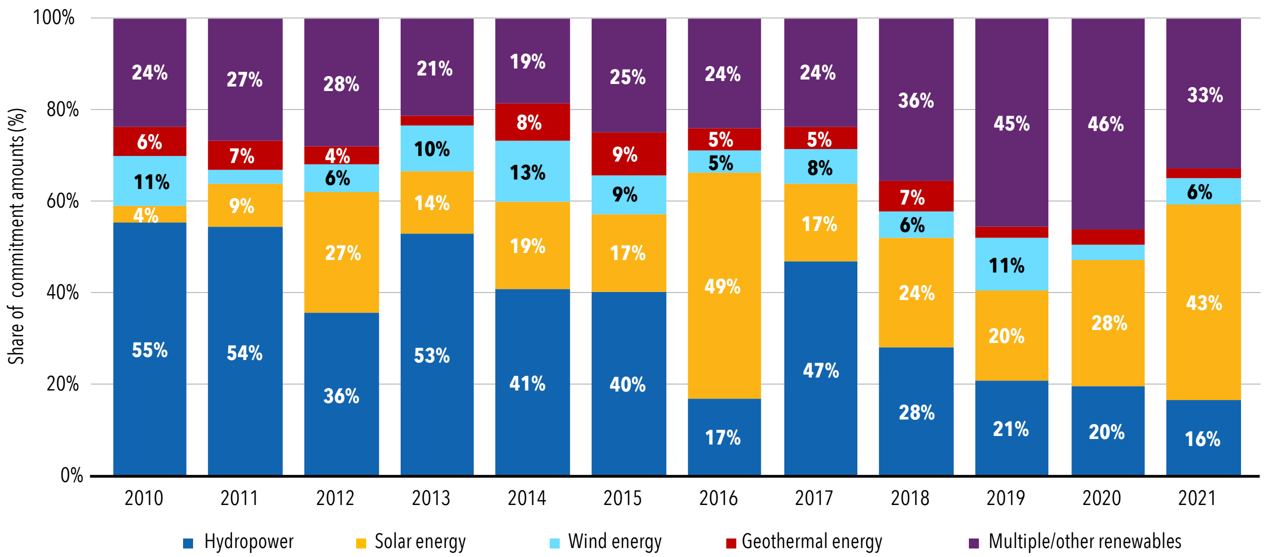


Source: IRENA and OECD 2023.
Note: Multiple/other renewables include commitments whose descriptions are unclear in the financial databases; commitments that target more than one technology with no details specifying the financial breakdown for each; bioenergy commitments, which are almost negligible; multipurpose financial instruments such as green bonds and investment funds; and commitments targeting a broad range of technologies. Examples of the latter include renewable energy and electrification programs, technical assistance, energy efficiency programs, and other infrastructure supporting renewable energy.

15 International public financial flows include official development assistance and other official flows that are transferred internationally to other countries. Referred to as flows, commitments, or financing in this summary, they are reported when committed, not when disbursed. Sixty-eight institutions or donors made commitments through 236 agencies during the years between 2000 and 21. Unless stated otherwise, all commitment amounts are expressed in US dollars in 2020 constant prices and exchange rates. Constant amounts are adjusted for changes in the inflation rate in the country in which the commitment was made, as well as changes in exchange rates between the provider's currency and the US dollar over the same period.

Figure ES.12 reveals that commitments continued to shift from hydropower to solar energy in 2021. Solar attracted the largest share of flows (43 percent), followed by multiple/other renewables (33 percent) and hydropower (16 percent); wind and geothermal energy received less than 10 percent of total flows. Since 2018, an increasing share of commitments has fallen into the multiple/other renewables category, which includes energy funds, green bonds, and other government-led programs to support renewables, energy efficiency, and electricity access. This category is growing in importance, as interest grows in funding mechanisms that target multiple energy technologies at once.

FIGURE ES.12 • Share of annual public flows by technology, 2010-21



Source: IRENA and OECD 2023.

Note: Multiple/other renewables are defined in the note to figure ES.11.

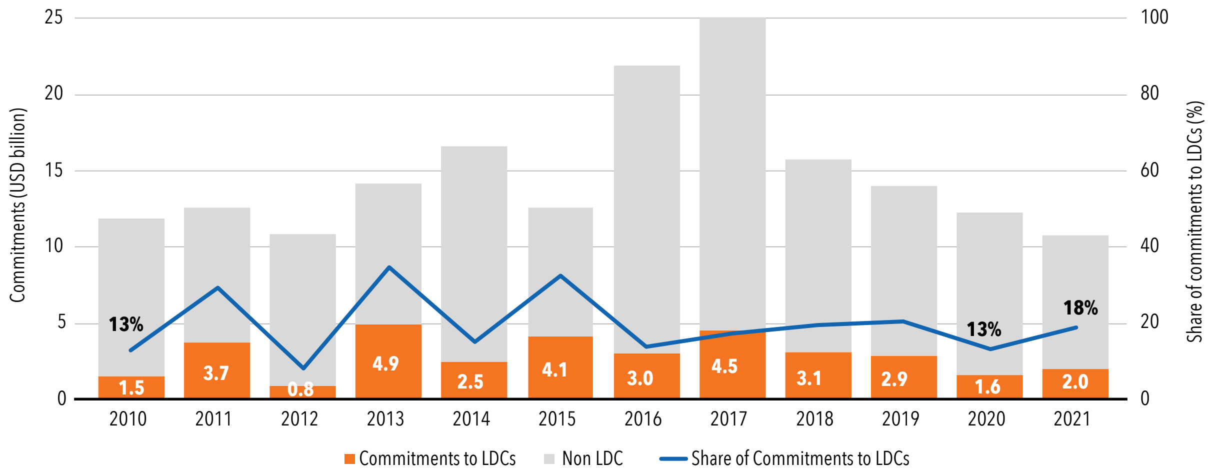
While international public flows decreased overall, several regions saw increases in 2021. Flows to Northern America and Europe rose 81 percent (USD 180 million); flows to Sub-Saharan Africa rose 45 percent (USD 1,213 million); flows to Eastern Asia and South-eastern Asia rose 23 percent (USD 251 million); and flows to "unspecified countries" rose 4 percent (USD 21 million).[16] Meanwhile, flows to other regions declined: Latin America and the Caribbean experienced the largest drop in international public finance, with a decrease of 62 percent (USD 2,295 million; Western Asia and Northern Africa fell by about 59 percent (USD 582 million); Oceania fell 42 percent (USD 9 million); and Central Asia and Southern Asia fell 8 percent (USD 232 million).

Although the distribution of flows has widened over the years, international public financial flows remain highly concentrated among a small group of countries, with 23 countries receiving 80 percent of all commitments in 2020. In 2021, the number of countries receiving most of the commitments was even smaller, with only 19 countries receiving the bulk of flows. For 2020–2021, India was the top recipient of for the past two years (USD 2.9 billion, with 66 percent for solar energy); followed by Pakistan (USD 1.7 billion, with 82 percent for hydropower); Brazil (USD 1.4 billion for infrastructure); and Mexico (almost USD 900 million, mainly for solar energy and modernizing hydropower plants).

16 "Northern America and Europe" is included as a region for the first time this year. It captures flows to eight countries in Europe (Albania, Belarus, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia, Moldova, Serbia, and Ukraine). No data were included for Northern America. The region is nevertheless referred to as Northern America and Europe, following the United Nations' M49 regional classification. "Unspecified countries" refers to commitments to multiple countries or commitments not directed to a specific region. Regional bonds and funds and umbrella loans for multiple projects usually fall into this category.

Historically, the world's 46 LDCs have received a small share of international public flows, as illustrated in figure ES.13. Flows to LDCs decreased in the past two years, dropping to USD 1.6 billion in 2020 and USD 2 billion in 2021.

FIGURE ES.13 • International public financial flows to LDCs and non-LDCs for renewables, 2010-21



Source: IRENA and OECD 2023.
Note: LDCs = least developed countries.

Given the importance of off-grid renewable energy solutions in closing the energy access gap, it is encouraging that flows for these solutions reached a record USD 558 million in 2021 (IRENA and CPI 2023). Although these investments still represent a small portion of the overall financing of energy access and renewables, they are a crucial, and cost-effective, part of the effort to close the access deficit.

In 2021, the combined public and private flows to renewable energy reached an estimated USD 430 billion (IRENA and CPI 2023). Even so, the current level of investment falls far short of the investments required to limit the rise in the average global temperature to 1.5°C by the end of the century while closing the energy gap and advancing development imperatives. To meet the 1.5°C goal, at least USD 1.3 trillion a year in current prices must be directed to renewable power and the direct use of renewables between 2021 and 2030, and at least USD 2 trillion a year is needed for broader power sector investments, including power grids and flexibility (IRENA 2022; IEA 2022a).

Redirecting investments from fossil fuels, increasing official development assistance, innovating funding mechanisms, harmonizing the reporting of commitments, and introducing structural reforms in international public finance will also be necessary steps to elicit greater volumes of international public financial flows and to make the most of them. Taking these steps will require strong political will and collaboration among global stakeholders. Happily, momentum is building for reform, as evidenced by the Bridgetown Initiative headed by Barbados (UN 2023).

TRACKING PROGRESS ACROSS TARGETS: INDICATORS AND DATA

Monitoring progress toward the SDG 7 goals depends on a robust framework of indicators backed by statistical data. Since this effort began back in 2013, improvements in reporting, advances in countries' statistical capacities, and enhanced models have raised the quality, reliability, and consistency of data. The custodian agencies and international community have spurred efforts to further improve data collection, analysis, and reporting. The definition of 232 initial indicators (since expanded to 248) was an important step (UNSTATS n.d.). These indicators have resulted in a common language and framework, aligning the efforts of governments, civil society, and the private sector toward shared goals.

These statistical tools and methods make it possible to track national, regional, and global progress based on collaboration between national statistical offices and international and regional organizations using optimized and standardized data-collection resources. For example, household surveys can be designed to support tracking across SDG 7 targets and even other SDG targets, such as health, air pollution, and quality of life.

Nonetheless, examination of each SDG 7 indicator reveals the need for additional information. The custodian agencies emphasize the need to strengthen resources for enhanced national data collection within current and planned international programs on energy transitions. Domestic statistical capacities, too, must be reinforced. To this end, the World Bank and the WHO have prepared a guidebook to integrate energy access questions into existing national household surveys (World Bank and WHO 2021). The custodial agencies responsible for this report also host webinars for statistical agencies, produce statistical guidance and reports on data collection, and regularly consult with national statistical offices about the estimates they provide. Continuing efforts by the World Bank, WHO, and other custodians to mainstream energy access questions into national household surveys are an important form of support for those offices.

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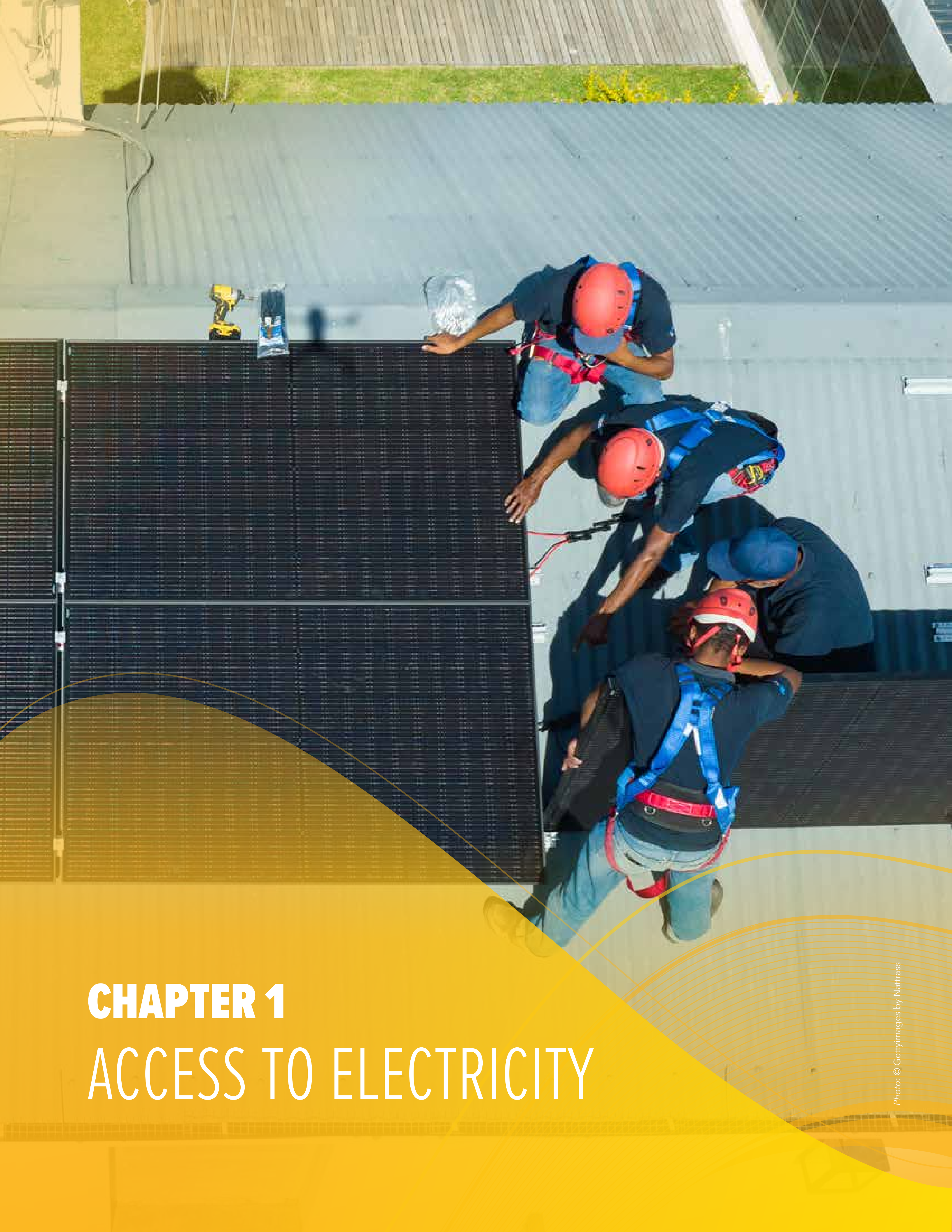

CHAPTER 1
ACCESS TO ELECTRICITY

Photo: © Gettyimages by Nattrass

Main Messages

- **Global trend.** Globally, access to electricity grew every year between 2010 and 2021, rising from 84 percent of the world's population to 91 percent, raising the number of people with access by more than a billion. The number without electricity dropped by almost half, from about 1.1 billion in 2010 to 675 million in 2021. The pace of annual growth in access has slowed since 2019, however. Several factors may account for the slowdown, including the COVID-19 pandemic. The current pace is not fast enough to reach the last mile.
- **Target for 2030.** To reach universal access by 2030, the world will have to drastically increase efforts toward the target by scaling up investments and policy support. To bridge the gap, the annual rate of growth in access must be 1 percentage point per year from 2021 onward—almost twice the current pace of 0.6 percentage points in 2019–21. If no additional measures are taken, about 660 million people will still be unserved in 2030 (IEA 2022). Some 75 million people were estimated to have lost the ability to pay for extended electricity services because of the pandemic and the energy crisis associated with the conflict in Ukraine (IEA 2022).
- **Regional highlights.** Access to electricity remains a major barrier to socioeconomic development in Sub-Saharan Africa, where more than 80 percent of the global population lacking access to electricity lived in 2021. Despite steady progress in the access rate over the past decade, the number of people without access in the region remained stagnant because of population growth, leaving 567 million without access in 2021. In contrast, Central and Southern Asia, Latin America and the Caribbean, and Eastern and South-eastern Asia are on track to universal access, with access rates of more than 98 percent. Of these, Central and Southern Asia made the fastest progress in electrification between 2019 and 2021. Northern Africa and Western Asia showed consistent progress—94 percent of the population in the region enjoyed access in 2021. The access rate in Oceania has remained at around 81 percent since 2010.
- **Urban-rural divide.** Electrification grew more rapidly in rural areas, where the bulk of the population without access lives, than in urban areas. But because the access rate in rural areas improved from a very low level, the gap between rural and urban areas remains large. In 2021, roughly 8 of every 10 people without access were living in rural communities, most of them in Sub-Saharan Africa. To narrow the access gap between urban and rural areas, a better understanding of electricity end uses and a greater mobilization of public financing are needed to address affordability challenges and make electricity infrastructure more resilient. Moreover, both grid and off-grid electrification options should be deployed to ensure a rapid expansion of service to rural areas. Geographic information systems (GIS) should be considered to identify areas in dire need of policy support and investment.
- **Top 20 access-deficit countries.** As of 2021, the 20 countries with the largest access deficits accounted for 75 percent of the global population without access. The countries with the largest number of people without access were Nigeria (86 million), the Democratic Republic of the Congo (76 million), and Ethiopia (55 million). In 2019–21, electrification progress in the Democratic Republic of the Congo trailed population growth; as a result, the number of unserved people in the country increased. On the contrary, the progress of electrification outpaced population growth in Nigeria and Ethiopia. Among access-deficit countries, Kenya and Ethiopia showed the most rapid improvement, extending electrification by more than 3 percentage points each year between 2019 and 2021.

- **Decentralized renewable energy.** The number of people served by renewable mini-grids powered by solar, hydro, and biogas technologies was 11 million globally in 2021 (IRENA 2022).[17] Solar mini-grids, a viable option for last-mile communities, accounted for one-third of connections in 2021. Around 101 million people had access to stand-alone off-grid solar solutions in 2021, a decrease from 107 million in 2019 owing to a significant drop in sales during the COVID-19 pandemic (GOGLA 2022).[18] Off-grid renewable energy solutions continue to play a key role in expanding electricity access in many countries in Sub-Saharan Africa.
- **Interlinkages with other Sustainable Development Goals (SDGs).** Universal access to electricity is not a stand-alone target. Particularly in low-income countries, electrification can help increase educational attainment, improve healthcare, increase food security, and create business opportunities and jobs. It is therefore imperative, when planning measures to accelerate electricity access, to consider interlinkages with other SDGs, notably SDG 1 (poverty), SDG 3 (health), SDG 4 (education), SDG 5 (gender equality), and SDG 17 (climate action). To maximize the chances of success, policy makers should work to build a legal and institutional environment that is conducive to strong utilities, that attracts new mini-grid and off-grid business models (to help close the affordability gap), that mobilizes adequate amounts public and private sector financing, and that focuses on poor and fragile regions where progress has been slow.

17 According to ESMAP (2022b), 48 million people were connected to about 21,500 mini-grids in 2021, mostly first- and second-generation systems. Approximately half of installed mini-grids are powered by solar photovoltaic (PV), followed by hydro and fossil fuels. Meanwhile, the IRENA figure includes access under Tier 1 (access through a small PV mini-grid) or Tier 2 or better (access through a large PV mini-grid or non-PV mini-grid).

18 The data are a subset of the market—that is, a proxy for higher-quality products that are quality-certified and/or associated with GOGLA members. The number of off-grid users is probably much larger. For example, OGS Market Trend Reports (Lighting Global/ESMAP et al. 2022) estimates nearly half a billion. This topic is explored in more detail in the chapter.

Are We on Track?

In 2021, 91 percent of the global population enjoyed access to electricity (figure 1.1).[19] Over the past decade, access improved steadily, reducing the number of unelectrified people from 1.1 billion in 2010 to 675 million in 2021, despite a growing population. But the COVID-19 pandemic and associated energy crisis are estimated to have caused 75 million people to have lost the ability to pay for an extended bundle of electricity services (IEA 2022).[20] Against the backdrop of challenging macroeconomic conditions induced by the COVID-19 pandemic and geopolitical developments, and absent urgent action by national governments and the international community, the share of the global population projected to have access to electricity by 2030 will be 92 percent, leaving some 660 million people unserved, of whom approximately 85 percent will be in Sub-Saharan Africa.[21]

Figure 1.1 • Percentage of population with access to electricity

Source: World Bank 2023; IEA 2022.

The pace of growth in electricity access has been slow in recent years, the main result being to leave the poorest and hardest-to-reach people without access. In 2019–21, the number of people with access increased by 114 million per year, fewer than the 129 million per year observed between 2010 and 2019. Overall, access grew 0.7 percentage points per year between 2010 and 2019, declining to 0.6 percentage points a year between 2019 and 2021 (figure 1.2).[22] To reach universal access by 2030, the annual rate of growth in electricity access will have to be 1 percentage point per year from 2021 onward. The acceleration must be concentrated in Sub-Saharan Africa, with progress of more than 5 percentage points a year on average over the next nine years. Given the continued impacts of COVID-19 on the global and national economies, which have been compounded by the war in Ukraine and the related energy crisis, urgent actions must be taken to maintain energy access as a key priority and prevent setbacks.

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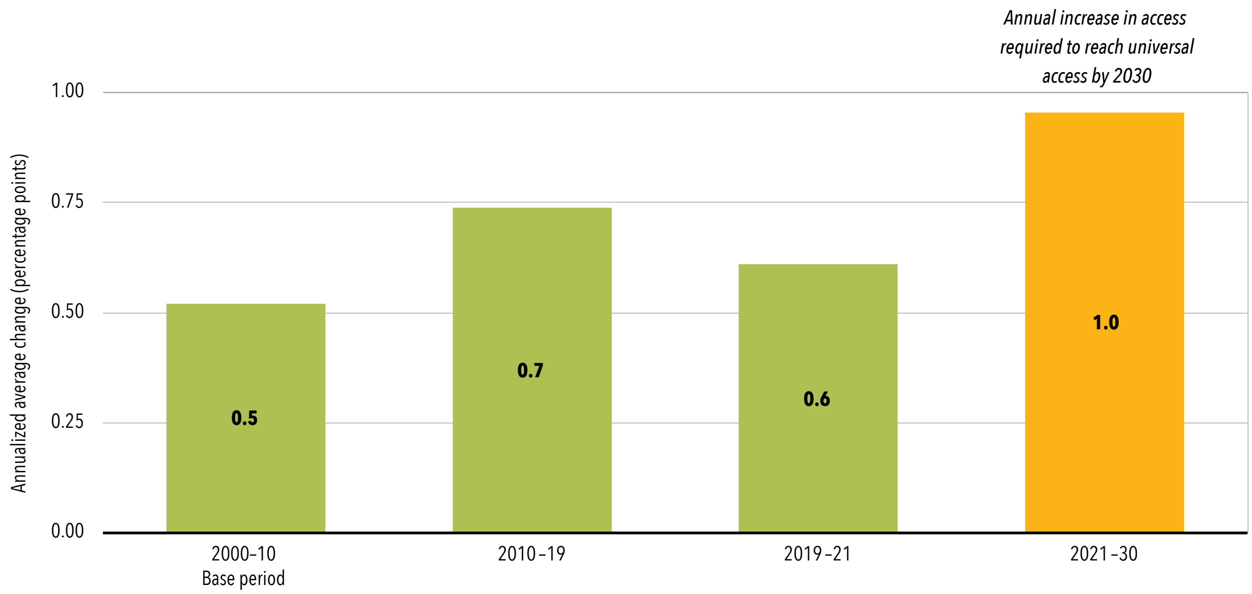
19 The rate of access to electricity generally means either having or not having an electricity connection.

20 An extended bundle of electricity services includes four lightbulbs operating for four hours per day, a fan for six hours per day, a radio or television for four hours per day, and a refrigerator.

21 The projected access rate of 92 percent in 2030 was calculated based on UN population data and IEA (2022).

22 The annual change in access is calculated as the difference between the access rate in year 2 and the rate in year 1, divided by the number of years: (Access Rate Year 2 – Access Rate Year 1)/(Year 2 – Year 1)

Figure 1.2 • Average annual increase in access to electricity, 2000–21

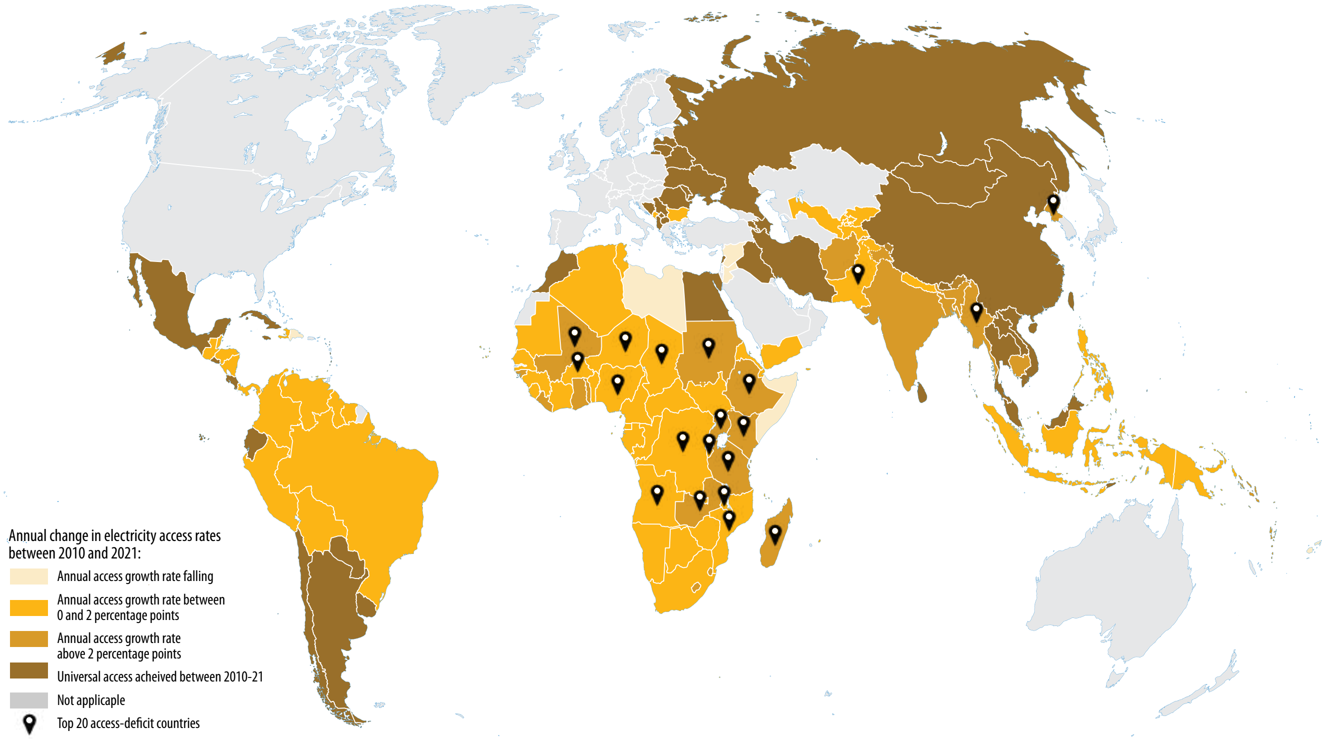


Source: World Bank 2023.

Since 2010, 51 countries have achieved universal access, 17 of them in Latin America and the Caribbean (figure 1.3). Another 95 countries, concentrated in Sub-Saharan Africa, were still short of the target in 2021. About one-quarter of these countries—which includes half of the 20 countries with the largest access deficits[23]—advanced their electrification access by more than 2 percentage points each year, whereas declining annual access growth appeared in some of the remaining three-quarters of the countries. To reverse these trends, governments and international organizations should prioritize information-based electrification planning, mobilize capital, and deploy implementation programs, focusing particularly on countries and areas with very low access rates and those that have made only limited progress in recent years.

23 In this chapter, the access deficit is defined as the population lacking access to electricity.

Figure 1.3 • Annual change in electricity access rates in access-deficit countries, 2010–21



Source: World Bank 2023.

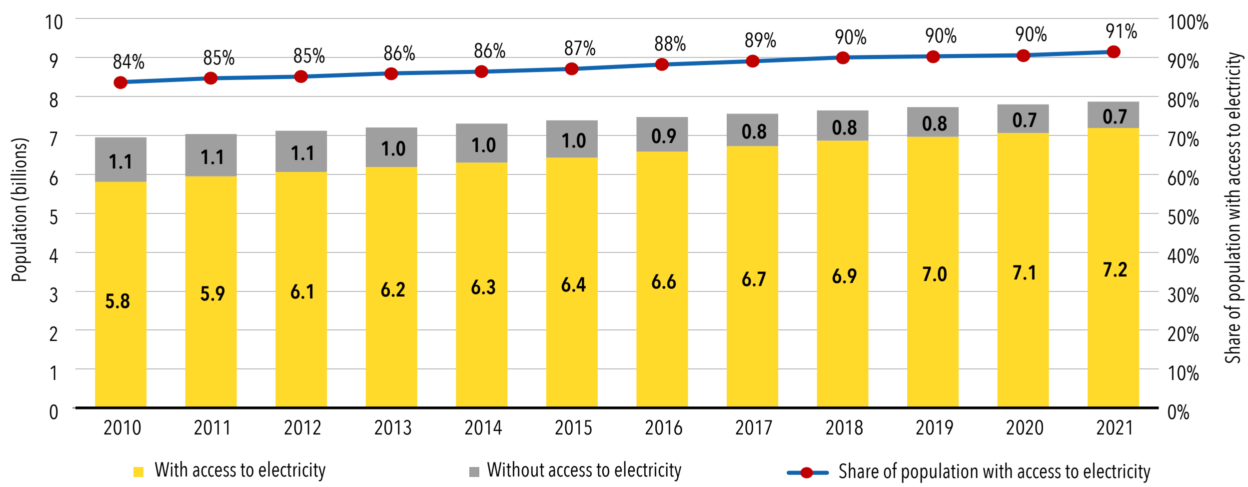
Disclaimer: This map was produced by the Geospatial Operations Support Team of the World Bank based on the Cartography Unit of the World Bank. The boundaries, colors, denominations, and other information shown do not imply any judgment on the part of the custodian agencies concerning the legal status of or sovereignty over any territory or the endorsement or acceptance of such boundaries.

Looking Beyond the Main Indicators

ELECTRICITY ACCESS AND POPULATION GROWTH

Between 2010 and 2021, the global rate of access to electricity increased from 84 percent to 91 percent (figure 1.4). Over the past decade, the increase in the number of people with access to electricity outpaced population growth. However, compared with the annual growth of 0.7 percentage points seen between 2010 and 2021, progress dipped to 0.6 percentage points in 2019–21. The dip is not surprising: the home stretch usually involves connecting people living in the most remote and poorest areas.

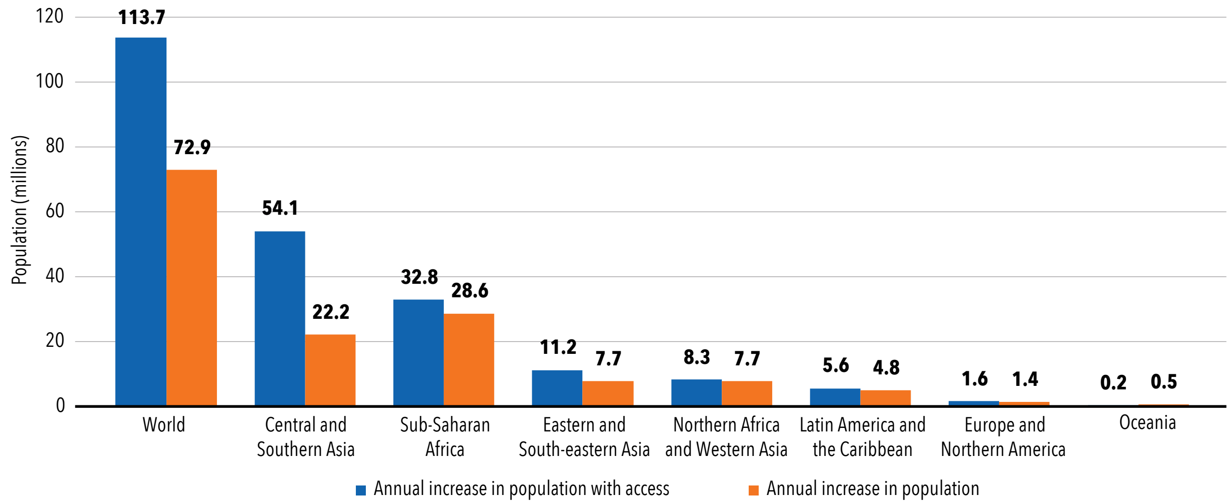
Figure 1.4 • Global electricity access and population growth, 2010–21



Source: World Bank 2023.

In 2019–21, the population with access to electricity increased by 114 million a year on average, while the world's population grew by 73 million, helping to close the electrification gap (figure 1.5). Electrification efforts in most regions outperformed or kept pace with population growth. Most of the annual increase in access came from Central and Southern Asia, where 54 million people a year gained access between 2019 and 2021, outstripping the population increase of 22 million. Southern Asia showed the fast growth in electricity access thanks to growing economies and urbanization. In Sub-Saharan Africa, electrification largely kept up with population growth in 2019–21. However, although the trend resulted in a marginal decrease in the number of people without access, the region still has the largest access deficits in the world. Because small national power systems predominate in the region, regional cooperation among national electricity companies and regional electricity markets are important to manage prices and ensure security of electricity supply (ESMAP 2022a).

Figure 1.5 • Annual increase in total population and in population with access to electricity between 2019 and 2021

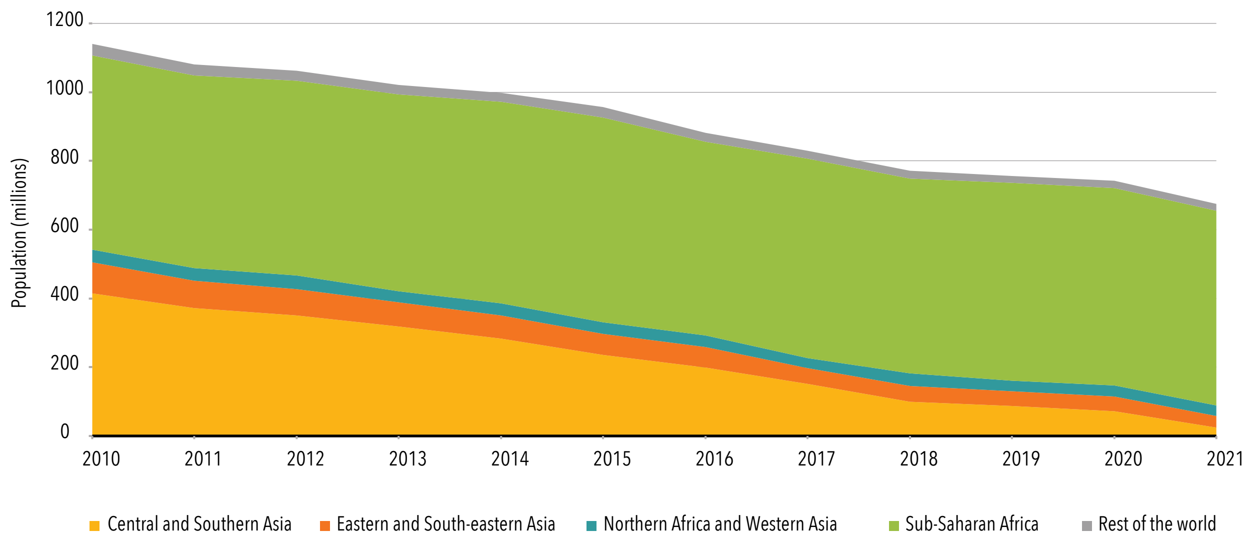


Source: World Bank 2023.

THE ACCESS DEFICITS ACROSS REGIONS AND MORE

Globally, the number of unserved people fell every year between 2010 and 2021 (figure 1.6). However, the trend is different across regions. Most of the decline came in Asia, while the pace was sluggish in Sub-Saharan Africa, where the number of people without access in 2021 was roughly the same as in 2010. The number of people without access plummeted in Central and Southern Asia, falling from 414 million in 2010 to 24 million in 2021, largely due to a decline in the number of the unserved in populous countries, such as Bangladesh and India in Southern Asia. The number of people without access to electricity in Eastern and South-eastern Asia declined from 90 million to 35 million from 2010 to 2021. In Northern Africa and Western Asia, the access deficit decreased slowly: from 37 million in 2010 to 30 million in 2021.

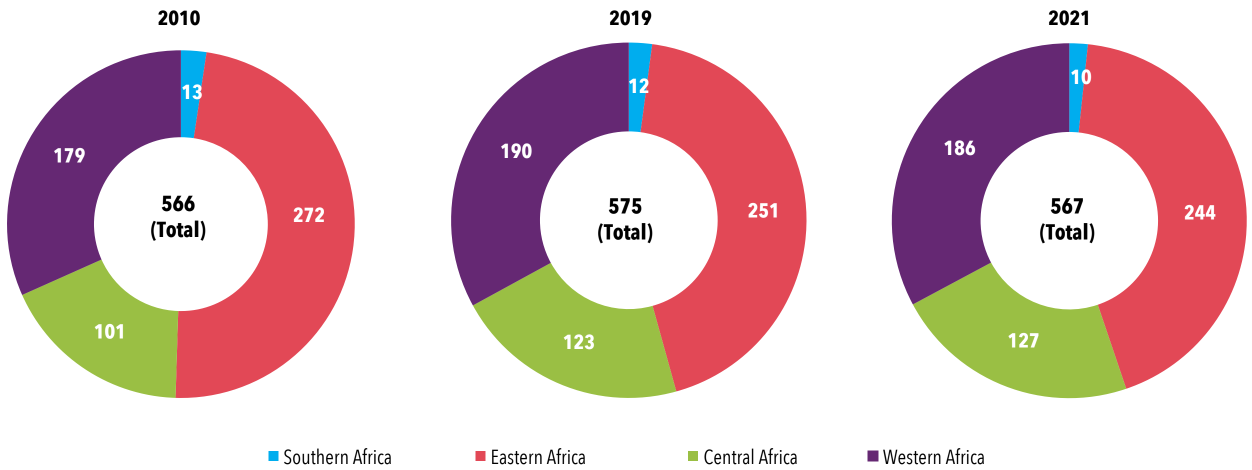
Figure 1.6 • Number of people without access to electricity, in selected regions, 2010–21 (millions of people)



Source: World Bank 2023.

In contrast, the access deficit has remained large in Sub-Saharan Africa, where about half of the regional population still lacked access in 2021. As a result, more than 80 percent of the world's unserved lived in Sub-Saharan Africa in 2021. The pattern of the access deficits in the region is far from uniform. In Central and Western Africa, population growth outpaced improvements in electrification in 2010–21, increasing the access deficit (figure 1.7). Meanwhile, the access deficit has fallen steadily in Eastern and Southern Africa. But poor reliability of electricity services is as serious a problem in Africa as low rates of access and per capita consumption. Few utilities measures service quality. Therefore, there is an urgent need for meaningful monitoring and reporting of reliability statistics at the end-user level.

Figure 1.7 • Number of people in Sub-Saharan Africa without access to electricity, by subregion, 2010, 2019, and 2021 (millions of people)

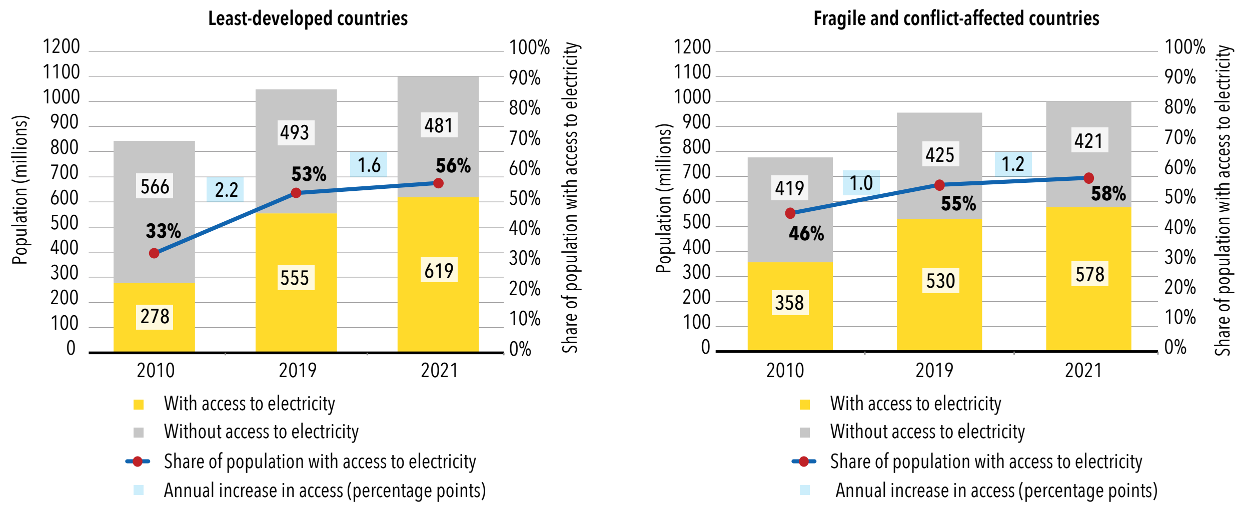


Source: World Bank 2023.

Compared with the global average, LDCs saw a relatively rapid increase in electrification, connecting about 32 million people a year in 2019–21 and bringing the rate of access up 3 percentage points, from 53 percent in 2019 to 56 percent in 2021 (figure 1.8). Nevertheless, a wide gap of more than 30 percentage points in access rates between LDCs and the global average persists, leaving 481 million LDC residents without access. In countries marked by fragility, conflict, and violence (FCV), access increased from 55 percent to 58 percent, leaving 421 million people still unserved in 2021.[24] At the current pace of electrification, most people without electricity access by 2030 will live in LDCs and FCVs. Dedicated financial and regulatory support should be strengthened to increase electrification in these settings.

24 The list of countries affected by violent conflict is based on the World Bank classification. The list is updated annually. This report refers to the list published in July 2022: https://thedocs.worldbank.org/en/doc/69b1d088e3c48ebe2cdf451e30284f04-0090082022/original/FCSList-FY23.pdf

Figure 1.8 • Increases in global access to electricity in least-developed and conflict-affected countries, 2010, 2019, and 2021

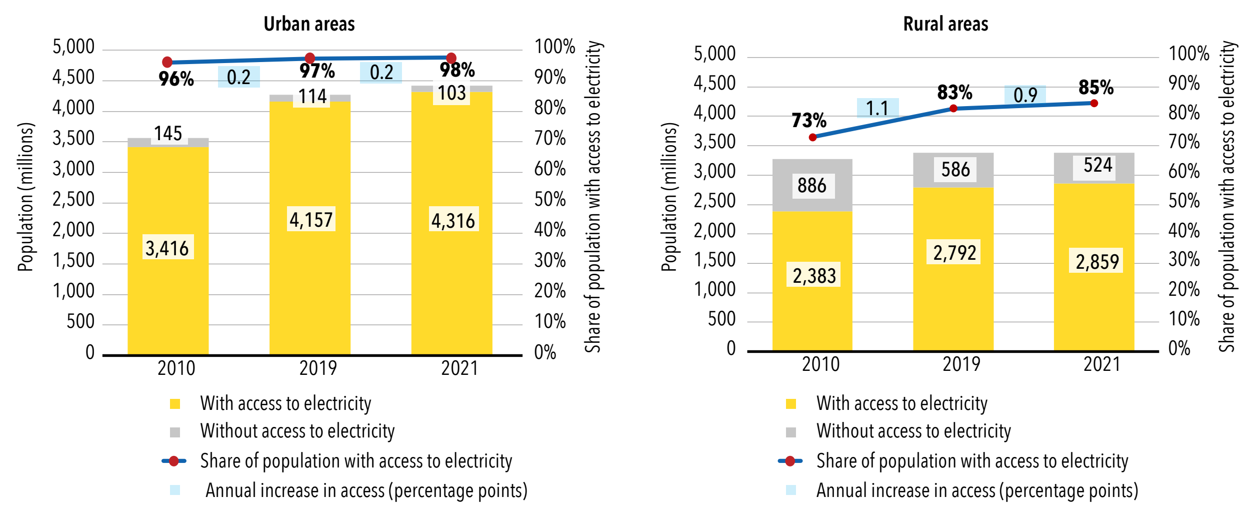


Source: World Bank 2023.

THE URBAN-RURAL DIVIDE

The discrepancy between access rates in urban and rural areas has been narrowing. In 2019–21, the pace of electrification was rapid in rural areas, outpacing population growth. In urban areas, by contrast, it flattened, partly because most urban areas had already achieved higher access. Also, rapid urbanization coupled with population growth has increased energy consumption and offset access gains. Even so, electrification rates in rural areas still trail far behind those in urban areas. In 2021, the share of the world's population with access to electricity was 85 percent in rural areas and 98 percent in urban areas (figure 1.9). Narrowing the gap between rural and urban access requires a better understanding of electricity end uses and greater mobilization of public and private financing to make electricity more affordable and electricity infrastructure more resilient. Grid and off-grid electrification options should be deployed to ensure a rapid expansion of service in rural areas. In addition, GIS techniques must be more widely applied to identify rural areas in dire need of policy support and investment.

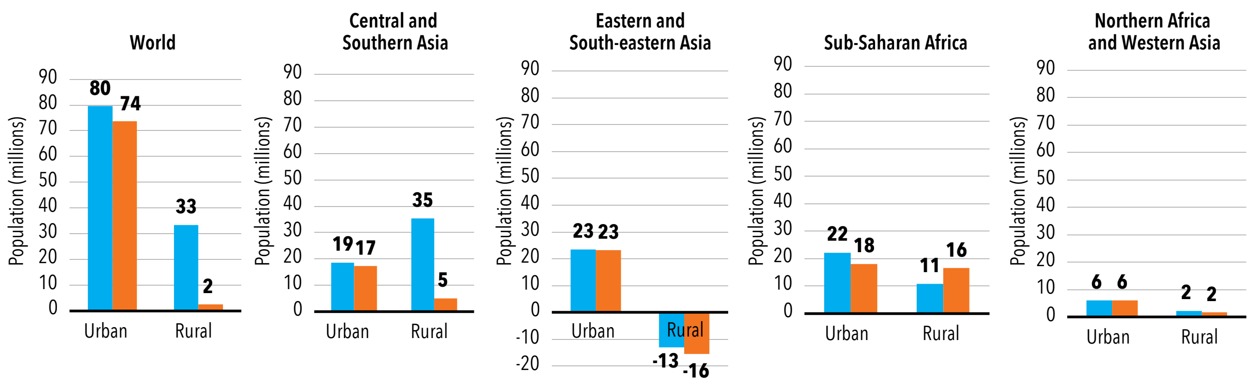
Figure 1.9 • Increases in global access to electricity in urban and rural areas, 2010, 2019, and 2021



Source: World Bank 2023.

During this period, the number of people with access to electricity grew by 33 million a year in rural areas, significantly outpacing population growth (figure 1.10). This trend was driven by Central and Southern Asia. In contrast, rural electrification progress lagged behind population growth in Sub-Saharan Africa. More than 80 percent of the 524 million rural dwellers without access in 2021 were in Sub-Saharan Africa. In the same period, annual growth in the number of rural residents served slowed in Eastern and South-eastern Asia, as the rural population shrank. In Northern Africa and Western Asia, electrification progress in rural areas kept pace with population growth. In urban areas, 80 million people a year gained access to electricity over the period. Owing to rapid urbanization and population growth, however, more than half of Sub-Saharan Africa's urban population lived in informal settlements, where reliable access to electricity is much lower than in other urban areas (UN 2022).[25]

Figure 1.10 • Annual increase in total population and population with access to electricity in urban and rural areas, globally and by region, 2019–21

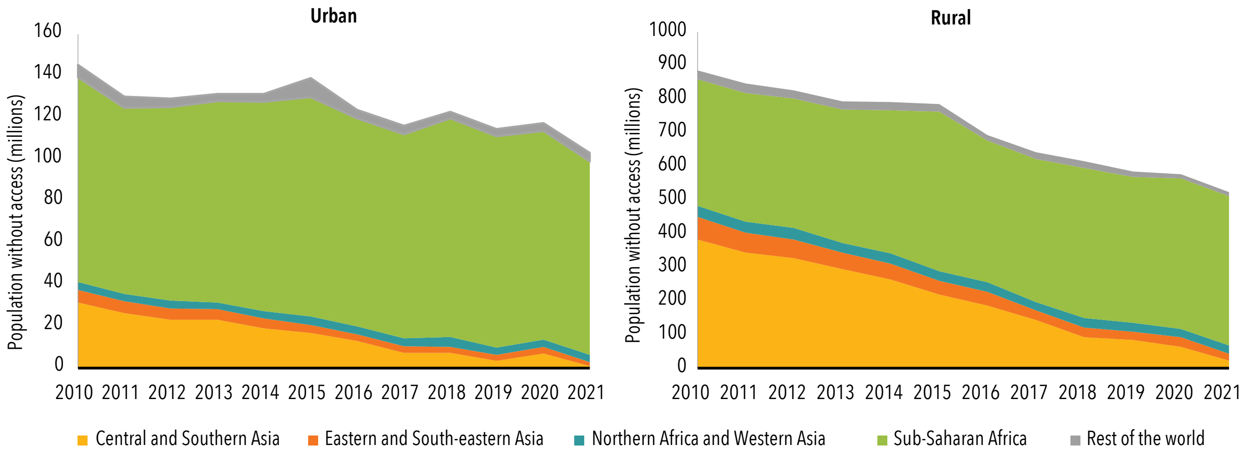


Source: World Bank 2023.

Between 2010 and 2021, the number of unserved people in Central and Southern Asia plunged from 31 million to about 1 million people in urban areas and from 383 million to 23 million in rural areas. In Eastern and South-eastern Asia, the number of people without access in urban and rural areas dropped to a third of the access deficits in 2010, falling to 2 million and 21 million, respectively. In Northern Africa and Western Asia, the urban access deficit remained almost the same, while the number of rural population without access decreased from 33 million to 25 million. In Sub-Saharan Africa, the access deficit declined to 93 million in urban settings but increased to 444 million in rural areas, with an annual increase of 6 million (figure 1.11). Central Africa, in particular, led the substantial increase in the region's rural access deficit over the period. Eastern Africa accounted for about half of the rural population without access in Sub-Saharan Africa in 2021.

25 According to the metadata for SDG indicator 11.1.1 ("proportion of urban living in slums, informal settlements or inadequate housing") informal settlements are recognized as synonymous with slums, with a particular focus on the formal status of land, structure, and services. They are defined by three main criteria, including (1) inhabitants whose claim to land or housing is insecure, (2) neighborhoods that lack (or are cut off from) formal basic services; and (3) housing that does not comply with current planning and building regulations.

Figure 1.11 • Access deficits in urban and rural areas, globally and in selected regions, 2010–21



Source: World Bank 2023.

ELECTRIFICATION USING DECENTRALIZED RENEWABLE ENERGY

Tracking progress in access to electricity produced using decentralized renewables depends on a complex mix of elements, of which market structure and the multiplicity of players in value chains are two. This section reviews trends in mini-grids and stand-alone off-grid solar solutions reported by the International Renewable Energy Agency (IRENA) and the Global Off-Grid Lighting Association (GOGLA) respectively.[26]

Stand-alone off-grid solutions are promising for closing the access gap in remote and rural areas of Sub-Saharan Africa, where weak utility creditworthiness and other challenges (such as the absence of infrastructure and low population densities) have impeded progress in grid electrification in rural and remote areas (ESMAP 2022a). However, to close the access gap by 2030, off-grid renewable electrification should be rapidly scaled up through dedicated policies and strong public and private financial schemes.

In the context of the challenges of the COVID-19 pandemic, mini-grid supply continued to expand access between 2019 and 2021 through support from policy makers, private investors, and end users (IRENA 2022). The number of people connected to mini-grids powered by solar, hydro, and biogas technologies reached 11 million in 2021 (figure 1.12).[27] In particular, solar Tier 2+ mini-grids have shown fast growth in recent years. Solar mini-grids served about a third of the connected and have become the least-cost way of bringing reliable electricity to communities living far from the grid or experiencing regular power outages (ESMAP 2022b). Among the 20 countries with the highest rates of access to mini-grid supply, about half were in Sub-Saharan Africa. Seychelles and Nepal served more than 5 percent of their population through mini-grids.

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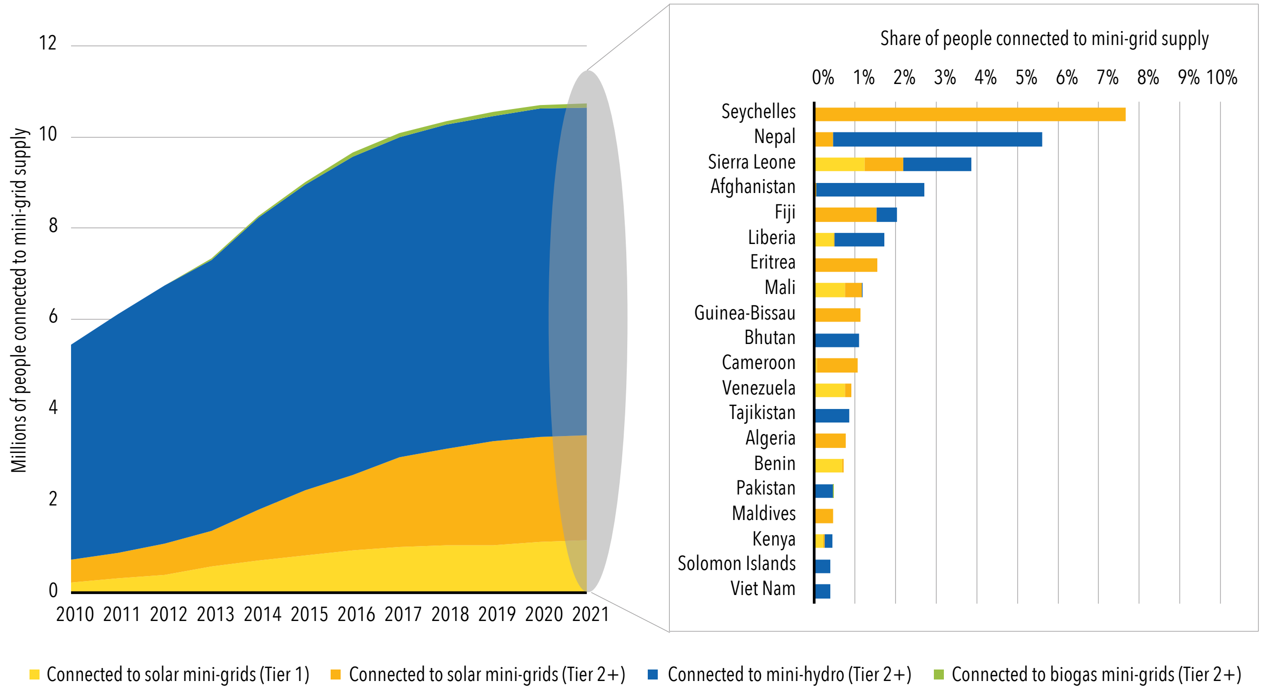
26 IRENA assesses Tier 1 (small PV mini-grid access) and Tier 2 access or better (large PV mini-grid access and non-PV mini-grids). GOGLA assesses access to electricity from off-grid solar products, including portable lanterns, multi-light systems, and solar home systems.

27 According to the ESMAP's market outlook and handbook "2022 mini grids for half a billion people", 48 million people were connected to about 21,500 mini grids. Most of these systems are first- and second-generation mini-grids, and approximately half of installed mini-grids are powered by solar, with hydro and fossil fuels.

Figure 1.12 • Increase in number of people with access to mini-grid supply (Tier 1+) in 2010–21 and 20 countries with the highest rates of access to mini-grid supply in 2021



Source: IRENA 2022.

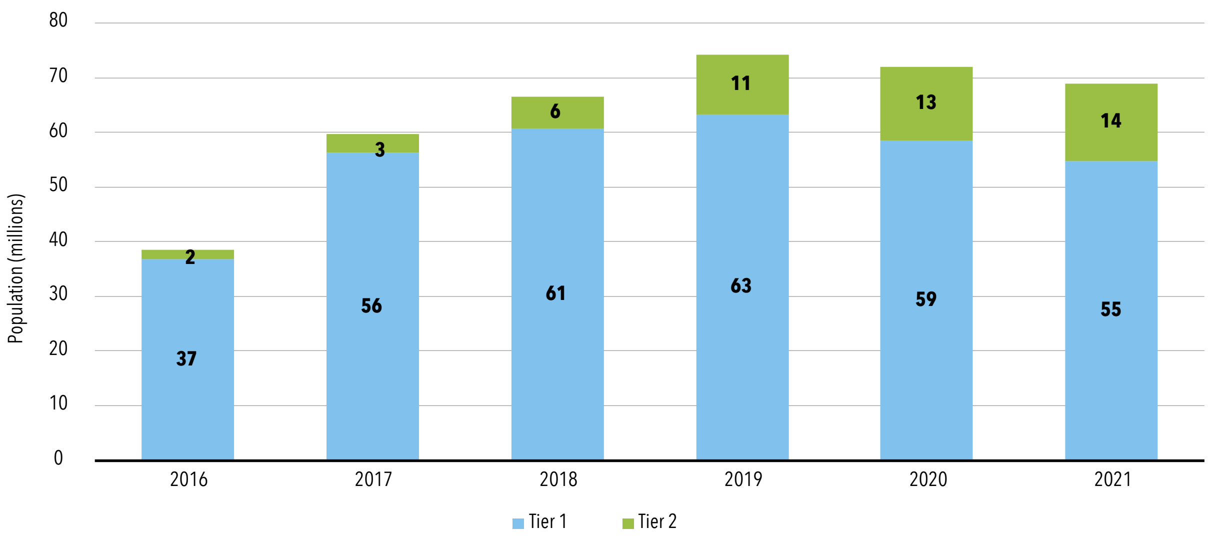
Note: More information on the Tier classification can be found in the last section of this chapter.

The number of people with access to stand-alone off-grid solar solutions dropped from 107 million in 2019 to 101 million in 2021, as the sector was hit by the COVID-19 pandemic (GOGLA 2022).[28] The decrease in sales in 2020 was significant compared with 2019 sales, which represented a peak. The countries with the largest number of people connected to off-grid solar products were Kenya (23 million), India (15 million), and Ethiopia (7 million). Between 2019 and 2021, access to Tier 2 solutions grew consistently from 11 million to 14 million, whereas Tier 1 access decreased from 63 million to 55 million (figure 1.13).[29] Since 2021, the sector has begun to recover from the COVID crisis, with a 10 percent increase in sales of solar energy kits and a 7 percent increase in market turnover. Still, significant efforts are required to recover the pre-COVID level and reach universal access by 2030 (box 1.1).

28 The figure of 101 million is calculated based on sales by GOGLA and its affiliates, which include GOGLA members, companies with Verasol-certified products, and companies working with the Low Energy Inclusive Appliances (LEIA) program. For these reasons, the impact figure captures only a percentage of the customers reached with off-grid solar technologies. ESMAP reports 490 million off-grid solar users (Lighting Global/ESMAP et al. 2022), but the quality of many of the systems is unknown.

29 Tier 1 and Tier 2 do not add up exactly to the total of 101 million people with access to quality-verified off-grid solar products because calculation of the total reflects the "partial" or "full" household aspects of Tier 1 based on the estimator created by SEforALL. For example, when some products, such as solar lanterns or multi-light kits, do not create full Tier 1 access, stacking of several products is considered in the current total of people with access.

Figure 1.13 • People connected to off-grid solar products by access tier, 2016–21



Source: GOGLA 2022.

Note: Tier classification is defined as Tier 1 (partial Tier 1 or full Tier 1 based on the system size and capacity of each product) and Tier 2 and above (at least 20 Wp, coupled with high-efficiency appliances or above 50 Wp even using conventional appliances). More information can be found in the Methodology section of this chapter.

Box 1.1 • Energy access beyond the pandemic: Findings from the Off-Grid Solar Market Trends Report

The 2022 Off-Grid Solar Market Trends Report was produced by Lighting Global/ESMAP, GOGLA, Efficiency for Access, and Open Capital Advisors. This box explores the key findings from the report.

In a trajectory to achieve universal access to electricity by 2030, the recent findings of the report indicate that off-grid solar technologies are expected to be the most cost-effective and feasible solution for 55 percent of new household connections over the next five years. While the economic disruptions induced by the COVID-19 pandemic led to a decline of 22 percent in the sales of off-grid solar products during 2019–20, the sector has since demonstrated resilience and nascent recovery, though sales remain below pre-COVID levels. The number of people accessing solar energy kits grew from 420 million people in 2019 to more than 490 million by the end of 2021, with more people gaining the higher Tier 2 level of access.[a]

Pay As You Go (PAYG), a business model that allows customers to pay for their system in smaller increments over several months, can help by lowering the up-front cost of owning a solar home system, but this may be insufficient to close the affordability gap. According to the report, even if PAYG were universally available, an estimated 177–277 million people currently without access would be unable to afford a Tier 1 system because of higher prices and lower income, in part as a result of the economic repercussions of the current energy crisis in the wake of the pandemic.

Businesses in the sector create hundreds of thousands of jobs, more than half of which are created in rural areas within the off-grid solar industry, boosting incomes in regions with relatively few employment opportunities. Many jobs are filled by members of the burgeoning youth population, whose opportunities are particularly limited.

Governments, investors, and development partners are increasingly recognizing the potential of off-grid solar solutions to power public institutions, including rural schools and health clinics. In addition, off-grid solar lighting systems and packages designed to encourage productive uses of electricity are powering more than 10 million micro- and small enterprises around the world. There is also a substantial opportunity to leverage solar energy for productive uses in the agriculture sector. Expanding access to technologies like solar water pumping or solar-powered cold storage holds the promise to quickly improve the livelihoods of some 22 million smallholder farmers across Sub-Saharan Africa and India.

According to the report, in order to achieve SDG 7, 1.1 billion people around the world will have to be served with off-grid solar products at Tier 1 and above by 2030. This would include (i) 186 million customers of weak grids who will need off-grid solar systems as a backup; (ii) 493 million current off-grid solar users who are expected to continue replacing and upgrading their systems; and (iii) 464 million people connecting to off-grid solar for the first time.

To achieve this goal, an estimated USD 23.3 billion in public and private funding will be required. Based on historical sales and investment trends, however, the off-grid sector is projected to raise only USD 7.8 billion in investments between now and 2030. Moreover, current funding is highly concentrated in mature markets; only a fraction of private investment is directed toward nascent and emerging markets, where the vast majority of unconnected households are located. To unlock the sector's full potential, bridge the affordability gap, and make products accessible to households in hard-to-reach areas, increases in both public and private funding will be needed.

Source: Lighting Global/ESMAP and others (2022).

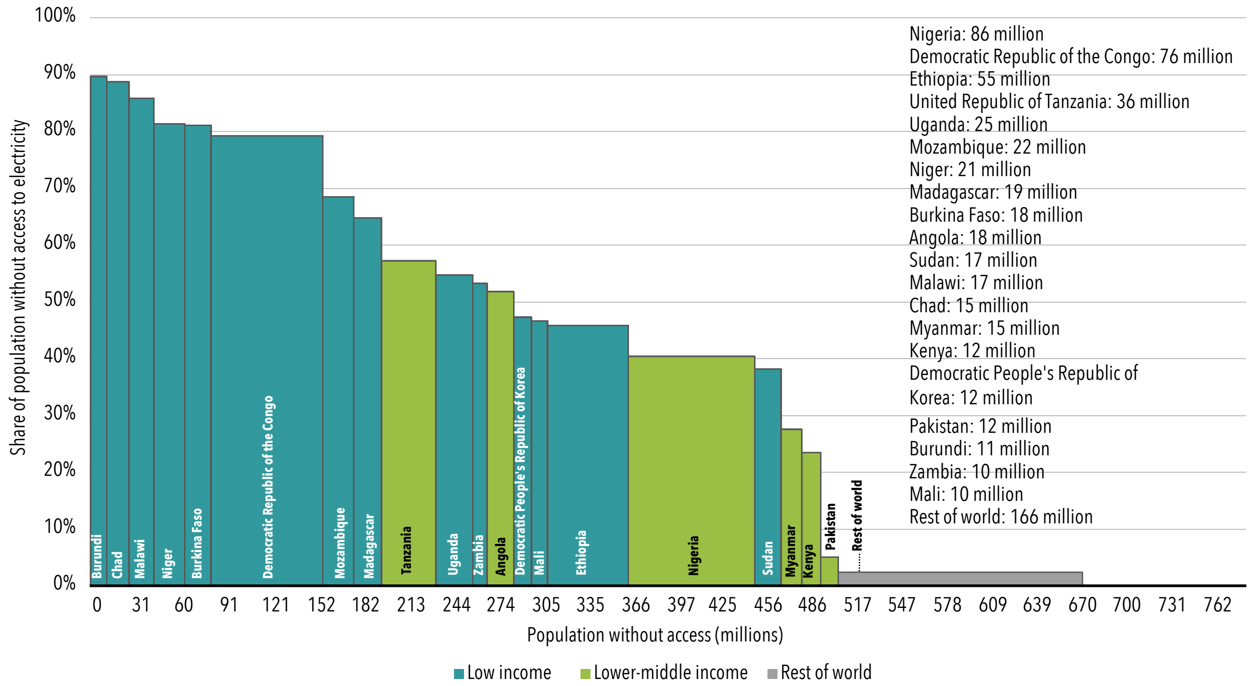
a The estimate of 490 million with access is based on sales of the broader industry, not just sales of GOGLA affiliates. The estimate includes sales of component-based solutions.

COUNTRY TRENDS

In 2021, the 20 countries with the largest access deficits accounted for 75 percent of the world's people lacking access to electricity. The countries with the largest numbers without access were Nigeria (86 million), the Democratic Republic of the Congo (76 million), and Ethiopia (55 million) (figure 1.14). In 2021, the top three countries were the same as in the previous edition of this report. India and South Sudan dropped out of the top 20, and Zambia and Mali joined it.

Increases in electrification did not keep up with population growth in the Democratic Republic of the Congo between 2019 and 2021. As a result, the access deficit increased by about 2 million people annually. In contrast, the number of people without access in Nigeria and Ethiopia fell by 2 million each year between 2019 and 2021, although those countries are still among the top 3 in terms of unserved population. During the same period, Kenya and Ethiopia increased their access rates by more than 3 percentage points. Consequently, as in Ethiopia, the number of unserved people declined by about 2 million a year in Kenya in 2019–21.

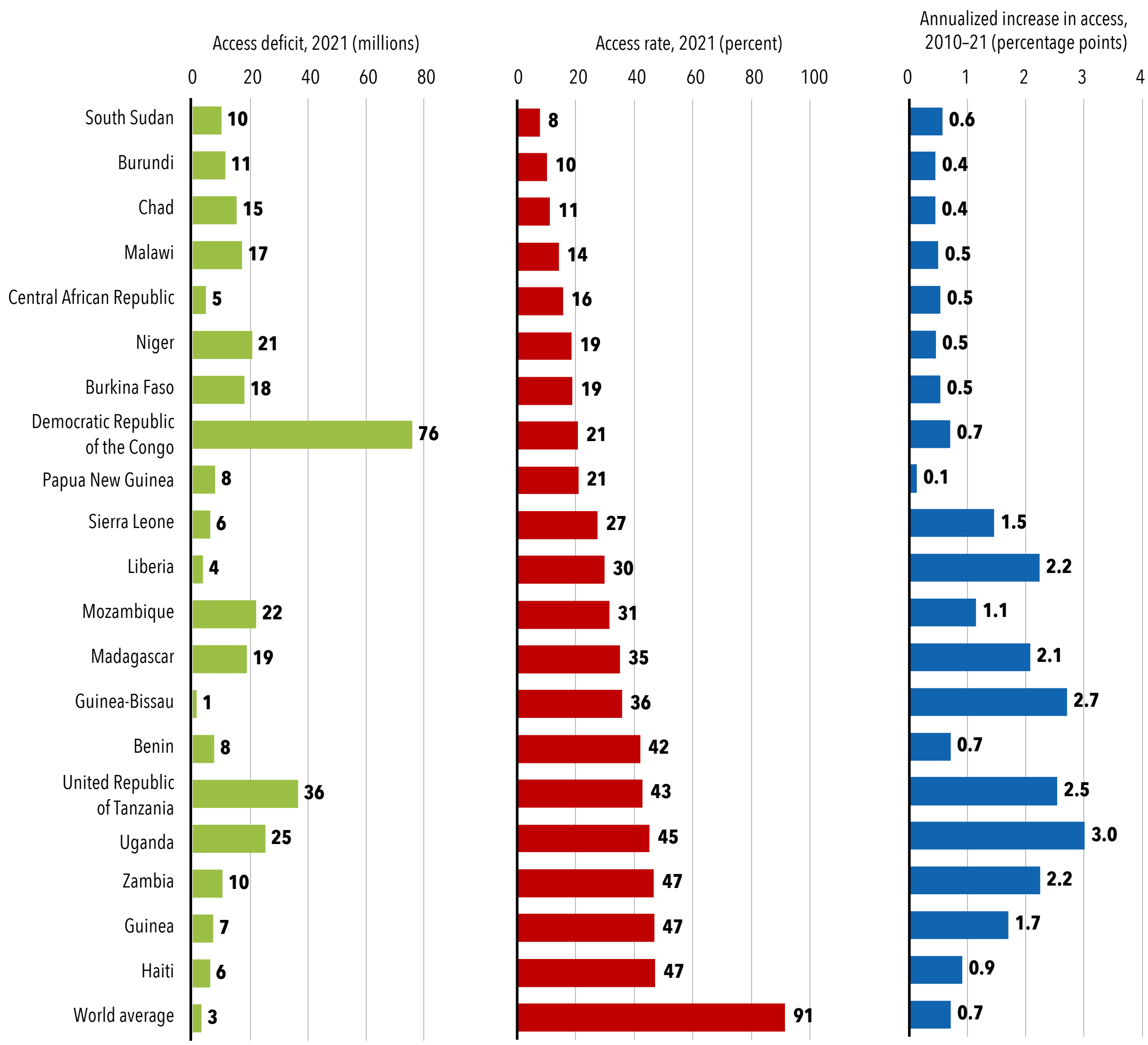
Figure 1.14 • Share and absolute size of population without access to electricity in the top 20 access-deficit countries and the rest of the world, 2021



Source: World Bank 2023.

The lowest access rates were in Burundi (10 percent) and South Sudan (8 percent) (figure 1.15), where the pace of electrification was slow over the past decade. The electricity infrastructure in South Sudan has been underdeveloped due to decades of conflict and insecurity. Burundi had the large access gap between urban (63 percent) and rural areas (2 percent); thus, the country should prioritize rural electrification to help the poor and the most vulnerable communities improve their livelihoods. In contrast, Guinea-Bissau, Tanzania, and Uganda expanded electrification by approximately 3 percentage points a year between 2010 and 2021, although overall access rates remained low.

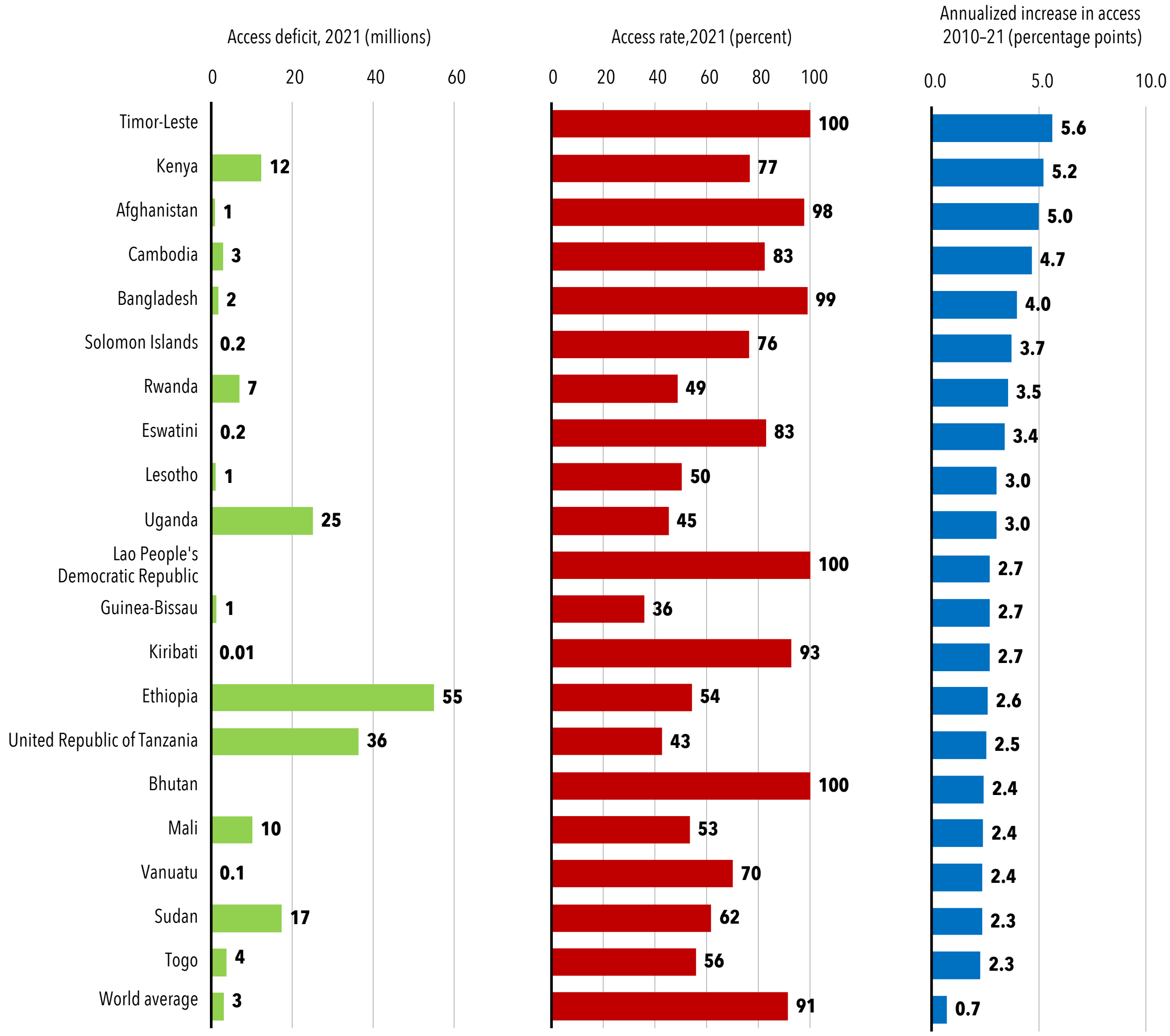
Figure 1.15 • Access to electricity in countries with the lowest rates of electrification, 2021



Source: World Bank 2023.

Timor-Leste and Kenya increased their access rates fast—by around 5 percentage points a year since 2010—thanks to notable improvements in rural electrification. These countries have built strong access strategies tailored to their country contexts (figure 1.16). For example, Kenya developed regulatory and policy frameworks for grid and off-grid solar expansion and extended them into several underserved countries in partnership with the private sector (ESMAP 2022a). Despite the fast-growing trends, the countries should continuously take action to address a concerning challenge of improving the reliability and quality of electricity access.

Figure 1.16 • Access to electricity in countries with the largest increases in access, 2010–21



Source: World Bank 2023.

Policy Insights: The Interlinkages Between SDG 7 and Other SDGs

Policies for energy access should demonstrate political commitment and maximize the socioeconomic benefits of access, keeping the most vulnerable populations at the forefront of efforts to close the access gap. Annual investment of USD 30 billion is required to achieve universal access to electricity by 2030, according to IEA's Net Zero by 2050 Scenario (IEA 2022). Expanding blended finance and establishing partnerships of humanitarian, development, government, and private actors through impact investing and risk-mitigation instruments can attract new capital, increase funding from existing investors, and improve the terms of both equity and debt financing (Prasad and others 2022; Gibson and others 2022).

Governments should strive to improve the legal and institutional environment so as to improve the financial viability of utilities to expand on-grid access and attract private sector investments in clean energy generation. A supportive climate and the right policies would also serve to expand mini-grid and off-grid electrification to meet energy access goals. In the early stages of electrification, for example, PAYG energy service providers that provide lease-to-own, usage-based payment services have benefited in some countries from low-cost public financing. Arranging public-private partnerships and project finance with long repayment periods and flexible payment schedules, especially when interest rates are high, would provide a major boost to utilities, mini-grid operators, off-grid companies, and other energy service providers (ESMAP 2022b).

Coordination efforts should focus on strengthening and supporting partnerships between local and regional stakeholders, the goal being to improve local conditions and lead to more sustainable and robust regional effects. Collaboration among regulators, utilities, mini-grid operators, off-grid companies, community leaders, and nongovernmental organizations allows stakeholders to share experiences; pool resources, knowledge, and capacity building; and set shared standards. Such collaboration can improve the security of supply, the broader diffusion of technological innovation, and the sustainability of new business models, ultimately leading to harmonization of standards and practices and more affordable energy services (African Development Bank 2022).

Affordable, reliable, modern energy is a prerequisite for the attainment of other SDGs. At the same time, it competes for attention with other SDGs. This section explores how energy access is interlinked with several SDGs, notably SDG 1 (zero poverty); SDG 3 (good health and well-being); SDG 4 (high-quality education); SDG 5 (gender equality); SDG 8 (decent work and economic growth); SDG 9 (industry, innovation, and infrastructure), and SDG 13 (climate action). Improvements to energy access take place within the framework of the 2015 Paris Agreement on climate change, which commits the world to holding the long-term mean global temperature to no more than 2°C above pre-industrial levels and reaching net-zero emissions by 2050.

INCREASING ACCESS TO CLIMATE-RESILIENT ENERGY: INTERLINKAGES BETWEEN SDG 7 AND SDG 13 (CLIMATE ACTION)

Expanding access to affordable, clean energy and meeting climate change obligations are interdependent. Achieving these two goals is challenging, however, especially for the least-developed countries, which must build cleaner and more resilient energy systems as a prerequisite to meet international climate change pledges. To manage the trade-offs, policy makers must develop practical climate adaptation strategies and plans for energy infrastructure that are connected to diverse climate justice considerations. The participation of public and private investors will be needed to support initiatives in pursuit of both goals.

Electricity expansion through mini-grids or stand-alone systems could help developing countries to address electricity access challenges in a climate-friendly manner and sustain livelihoods. Like other types of infrastructure, however, modern electrical capacity (grid, off-grid, and mini-grid) is vulnerable to climate change to varying extents (IEA 2021). These vulnerabilities imperil the gains in access to affordable, reliable, modern energy achieved over the past decades (WMO 2022). Adapting to climate change can also increase demand for energy (Ruijven, de Cian, and Wing 2019). Satisfying that demand with renewable energy will require tight integration of renewables in the adaptation agenda (IRENA 2021).

In the quest for affordable and clean energy access, therefore, integrated-least cost planning is important to meet consumers' needs for reliable and efficient energy services. Governments can and should build an enabling environment to attract and manage private capital into clean on-grid electrification, while simultaneously leveraging public funds to encourage private sector investment in decentralized electricity access. Integrating climate change considerations into national access policies, strategies, and planning supports the concurrent goal of strengthening resilience and adaptive capacity to climate-related hazards and natural disasters. Accounting for the detrimental effects of climate change on energy access—by, for instance, making infrastructure more resilient, diversifying energy sources, and developing adequate insurance mechanisms—can help communities, utilities, and countries enable adaptation action (United Nations Climate Change Secretariat 2017).

Acquiring high-resolution climate, energy system, and socioeconomic data remains a challenge, especially in Africa, as does developing the capacity of private and public stakeholders to apply the data to energy access and business planning, financing, and related policy making (UN 2021a). Local, national, and regional stakeholders must improve their ability to acquire data, manage it (including by addressing data privacy, ownership and sharing between entities), and to use it to expand climate-resilient energy access.

INCREASING ACCESS TO ENERGY AT SCHOOLS AND HEALTH FACILITIES: INTERLINKAGES BETWEEN SDG 7 AND SDGS 4 (HIGH-QUALITY EDUCATION) AND 3 (GOOD HEALTH AND WELL-BEING)

Increasing access to high-quality education is crucial for reducing poverty. Access to energy facilitates lighting, heating, cooling, cooking, and access to informational and communication technologies, all of which can improve learning (UN 2019, 2021). Modern and dependable access to energy in schools can attract new teachers and increase teacher retention, facilitate school administration, and increase access to teaching resources and classroom materials. Access to electricity at home can free students of the time-consuming task of collecting fuel; improve health and education outcomes; and allow students to study after dark, thereby increasing attendance, performance, literacy, and school completion rates.

The COVID-19 pandemic exposed the shortcomings of a lack of energy and internet in schools and homes, which prevented millions of children from continuing or accessing education, adversely affecting their learning and putting them at risk of not returning (UNESCO 2020). In 2020, only 47 percent of lower-secondary schools in Sub-Saharan Africa had access to electricity; globally, less than half the population had access to the internet (UNESCO 2022). In 2021, rates of electricity access in primary schools were as low as 4 percent in Chad, 9 percent in Nepal, and 10 percent in Niger (UNESCO 2022).

Technology should be harnessed to address educational challenges through out-of-the-box programs, as some countries are already doing. In Sierra Leone, for example, SMS Dictionary allows students with access to electricity but not the internet to charge their phones and learn new words (Sengeh 2022). Radio instruction—first rolled out during the 2014 Ebola crisis—helped keep children in schools during the COVID-19 pandemic (Behsudi 2021). Sierra Leone is also using tablets—which can be charged with the same mini-grid and off-grid solutions that provide power to cell-phones—to track budgets, grades, and other administrative priorities (Ministry of Basic and Secondary Education of Sierra Leone 2022).

Accelerating financing for affordable mini-grid and stand-alone systems, including battery storage technologies, is an important step toward providing education that has implications for many other SDGs. Using innovative solutions to increase energy access in schools should be part of an integrated strategy to make education accessible and inclusive for all, including previously marginalized groups, such as pregnant students, rural students, and persons with disabilities. In turn, investment in education will be needed to equip the next generation of tech leaders with the necessary skills to perform this work. Green skills and other facets of energy education are important in preparing a generation of young people to complete the energy transition.

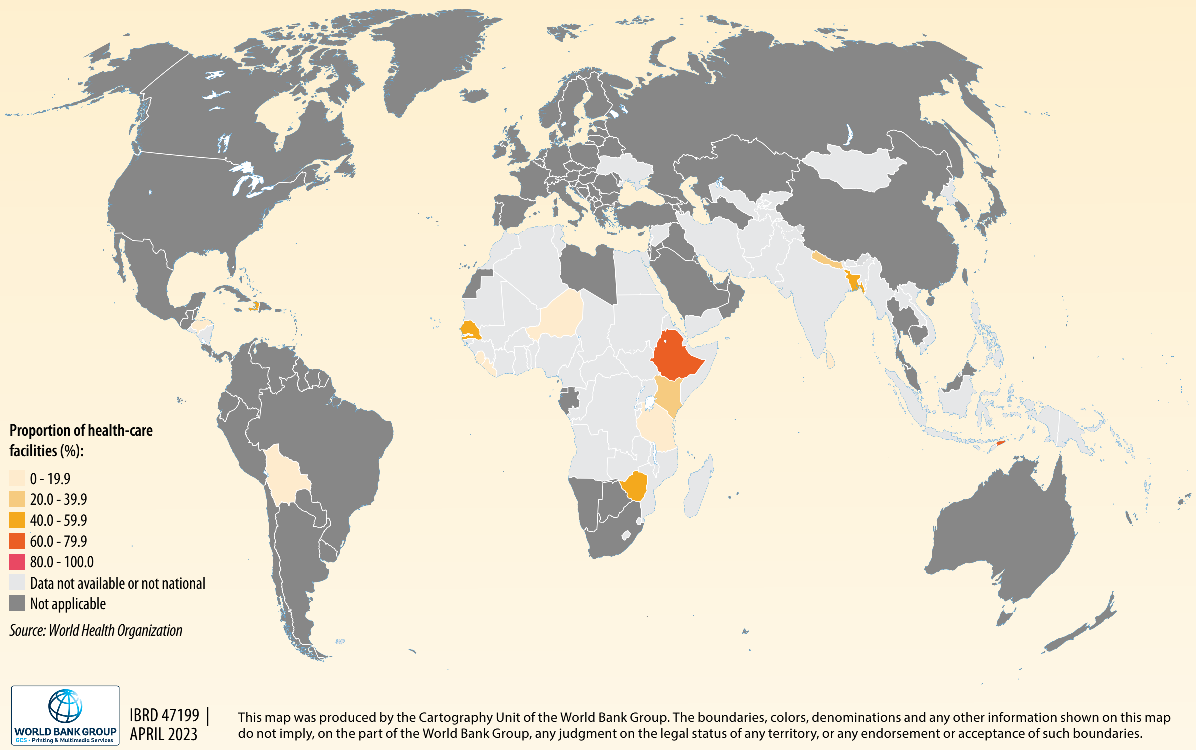
Reliable electricity is also needed to power life-saving medical and emergency operations. Unreliable supplies compromise medical equipment and instruments, water for sanitization, cold chain immunization systems, and other fundamental amenities. A recent study presented data on electrification of health care facilities and key priority actions for governments and development partners (box 1.2).

Box 1.2 • Accelerating access to electricity by health-care facilities

Reliable electricity access is crucial for effective delivery of health care. In 2023, the World Health Organization, the World Bank, the International Renewable Energy Agency, and Sustainable Energy for All published Energizing Health: Accelerating Electricity Access in Health-Care Facilities. The report discusses the overlaps between these two crucial SDGs, as summarized here.

Electricity access is essential to powering basic services in health-care facilities—among them lighting, clean water supply, childbirth and neo-natal care, immunization, storage, and power for medical equipment. Unfortunately, this aspect of health infrastructure is often neglected, leading to inadequate access to electricity, especially in low- and lower-middle-income countries (figure B1.2.1).

Figure B1.2.1 • Percentage of health-care facilities reporting unreliable electricity access in national surveys, 2015–22



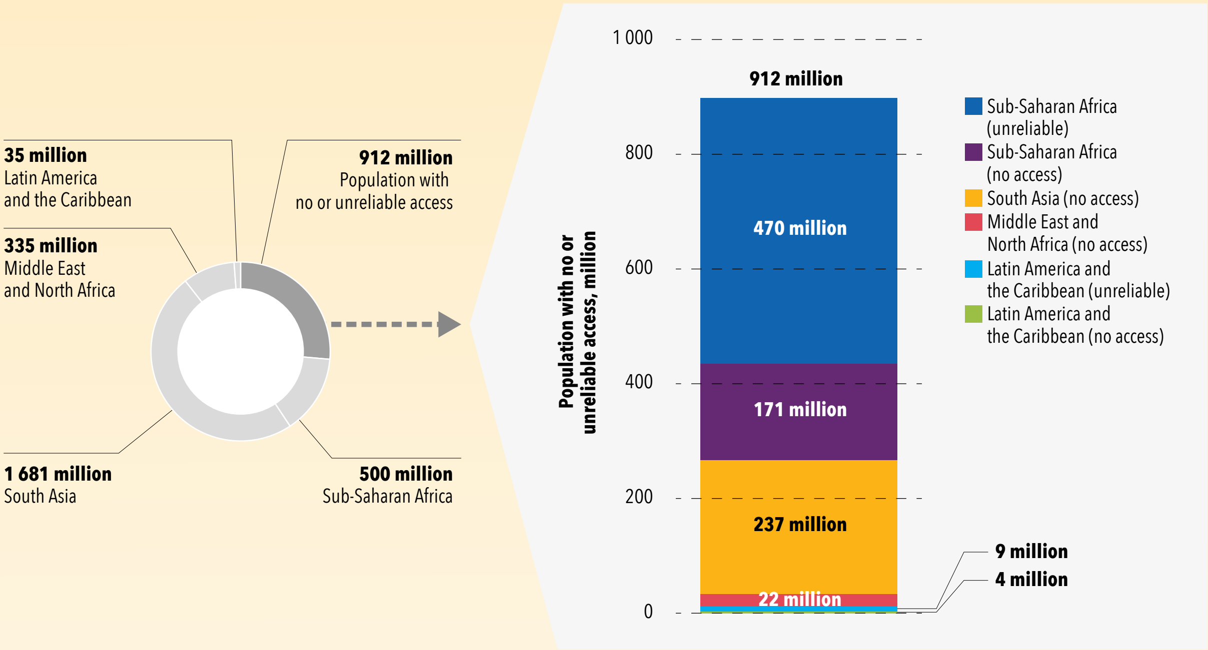
Source: World Health Organization 2023.

Note: This figure is extracted from the report Energizing Health: Accelerating Electricity Access in Health-Care Facilities.

In low- and lower-middle-income countries of South Asia and Sub-Saharan Africa, approximately 12 percent and 15 percent of health-care facilities, respectively, have no access to electricity. Only half of Sub-Saharan Africa's hospitals have reliable access. These data translate to some 25,000 health facilities with no power and 68,000 with unreliable power. Overall, it is estimated that the health-care facilities of nearly 1 billion people in low- and lower-middle-income countries lack reliable access to electricity (figure B1.2.2). The urban-rural divide is sharp. For example, less than 5 percent of rural facilities in Senegal have reliable access, compared with almost 55 percent of urban facilities.

The World Bank's analysis shows that 64 percent of health-care facilities in 63 low- and middle-income countries require immediate intervention, and USD 4.9 billion is urgently needed to bring these facilities up to a minimal level of reliable electrification. Further comprehensive energy needs assessments in health services are crucially needed.

Figure B1.2.2 • Estimated population served by health-care facilities with no electricity access or with unreliable electricity, disaggregated by region



Source: World Health Organization 2023.
Note: This figure is extracted from the report Energizing Health: Accelerating Electricity Access in Health-Care Facilities.

Decentralized renewable energy solutions, such as solar photovoltaics, are cost-effective, clean, and rapidly deployable, making them a good solution for electrifying health-care facilities without waiting for arrival of the grid. Powering health-care facilities through renewables also helps build climate resilience.

Building the capacity of local stakeholders, local skills, and local markets around the needs of energy in health is essential. The "install and forget" approach to electrification must be transformed into "install and maintain," with accountability mechanisms and long-term operation and maintenance, waste management, and replacement of batteries and spare parts all included in budget planning.

Both the lack of electricity and unreliable supply are major barriers to wider health-care coverage. Reliable electrification must be considered a priority because health is a public good and a human right. To make good on that right, technical assistance, development financing, and investments from governments, donors, and development partners must be increased through cooperation that avoids duplicate efforts and integrates specialized health knowledge, medical devices and appliances, and energy systems at the country level.

Source: WHO 2023.

INCREASING ACCESS TO ENERGY WHILE LEAVING NO ONE BEHIND: INTERLINKAGES BETWEEN SDG 7, SDG 5 (GENDER EQUALITY), AND FRAGILITY, CONFLICT, AND VIOLENCE

Access to electricity is strongly associated with women's economic empowerment and gender equality, just as gender-sensitive electrification policies and regulations are more likely to succeed. A gender-sensitive approach to electrification, with women involved in policy making, could help increase women's participation in business activities in the energy sector, despite social and other barriers, while also driving more inclusive solutions for electricity access. In Sub-Saharan Africa, several countries have adopted gender-responsive energy policy frameworks for electrification expansion (ESMAP 2022a). Because gender-disaggregated data and information are limited, strengthening gender-inclusive energy policies and promoting women's entrepreneurship will depend on stronger efforts by policy makers and practitioners to develop gender statistics.

Fragility and energy poverty are closely interlinked. Instability and conflict inhibit the development of infrastructure and investment for electrification, and the electricity access gap exacerbates existing vulnerabilities. People living in FCV settings or along the "last mile" face special barriers to energy supply and higher access costs.[30] Forcibly displaced persons often experience minimal access to electricity, and when they do, they must often use sources of electricity that are costly, inefficient, unsafe, and harmful to the environment. Logistical and technical challenges make it difficult to provide energy access in displacement settings, increasing project risks and diminishing potential returns (World Bank 2022).

Camps and settlements for forcibly displaced persons are among the areas that are hardest to reach with electricity because their residents are poor, the settings are often remote, and the high upfront capital costs of energy are typically hard to justify for settlements that are intended to be temporary. As a result, most water systems, health-care facilities, and schools serving forcibly displaced persons and their host communities lack access to reliable and modern energy. Solarization efforts are ongoing in 46 percent of water pumping stations in displacement settings, 37 percent of health-care facilities, and 13 percent of schools; most of the remainder still depend on unreliable, fossil fuel–powered energy, or have no power at all (UNHCR 2022). Investing in solar and other renewable solutions in these areas is paramount to advancing progress on SDG 7.

To sustainably address the vulnerabilities of forcibly displaced persons and their impacts on local communities, energy access projects in displacement settings typically need to be addressed differently from standard development initiatives (World Bank 2022). Evidenced-based least-cost programs—including programs supporting the deployment of mini-grid and off-grid technologies—should recognize vulnerable populations, rather than emergency aid programs, as the primary agents of decision-making, keeping people at the center of attention. Improvements might include linking energy access to program incentives, integrating vulnerable populations in funding windows, and supporting technologies and skill development that address the particular access challenges of vulnerable populations.

Focusing energy access efforts and financing on people suffering from fragility, conflict, and violence (before or after displacement) and on women and girls has been shown to have multiplier effects on poverty reduction, educational attainment, inequality, and the attainment of other SDGs (UNHCR 2020). National access and infrastructure plans, regulatory frameworks, and efforts to strengthen the enabling environment around access should integrate these populations into the broader energy access strategy in an inclusive, effective, and sustainable manner (UNHCR n.d.).

30 A staggering 90 percent of displaced people lack access to sustainable, reliable, affordable energy. This lack of access affects all areas of life in refugee camps, including education, health care, hygiene, and safety (UNHCR 2022). This figure reflects only displaced people living in camps, rather than other settings.

INCREASING ACCESS TO ENERGY BY STIMULATING MARKETS AND IMPROVING REGULATORY FRAMEWORKS: INTERLINKAGES BETWEEN SDG 7 AND SDG 8 (DECENT WORK AND ECONOMIC GROWTH) AND SDG 9 (INDUSTRY, INNOVATION, AND INFRASTRUCTURE)

COVID-19 brought new challenges to the advancement of all SDGs; it also created opportunities to recalibrate spending, re-focused attention on new priorities, and highlighted possible connections among the goals (Shulla 2021). In September 2021, for the first time in 40 years, the UN secretary-general convened the High-Level Dialogue on Energy, this time with the objective of promoting an accelerated implementation of SDG 7, other targets of the 2030 Agenda for Sustainable Development, and the Paris Agreement (UN 2021). The Dialogue issued recommendations to make universal access to electricity a political, economic, and environmental priority, aligned with an inclusive COVID-19 recovery, by (i) reinforcing enabling policy and regulatory frameworks and (ii) catalyzing, harnessing, and redirecting energy-access financing as needed to deliver universal energy access by 2030 (UN n.d).

Many developing economies are hobbled by scarce financing, inadequate risk mitigation resources, financially nonviable utilities, low capacity in critical agencies, and the absence of local financial institutions with access-related expertise—all of which compromise the bankability of access projects. Specific policies to expand infrastructure, upgrade technology, and achieve modern and sustainable energy service targets under a given regulatory framework are country dependent, but all countries need to establish conditions that support new and innovative ways to promote transparency, ensure accountability, and de-risk investments. The vitality of small and medium-size enterprises, in particular, depends on closing the gap between commitments and disbursements, reducing inefficient subsidies, and identifying predictable, practicable methods of leveraging public resources.

Regulatory and policy frameworks for electricity access should be designed to support innovations in energy technology and to leverage financing—both for the ultimate purpose of providing affordable and reliable electricity and maximizing economic growth. The World Bank's Regulatory Indicators for Sustainable Energy (RISE) measure the policy and regulatory environment for public and private investment in the realm of sustainable energy. The most recent RISE survey results (ESMAP 2022a) provide performance scores on access to electricity in the aftermath of the COVID-19 pandemic (box 1.3).

Good regulatory and policy frameworks will encourage productive uses of electricity, which generate income and employment in local communities and thus help fight poverty. Integrated access planning, with special attention to the expansion of mini-grid and off-grid systems, is a precondition for such frameworks. In addition to promoting productive uses at the local level, regulatory and policy frameworks informed by integrated planning can meet the energy demands of industry (especially small and medium-sized enterprises), attract private investment in the energy sector, and multiply the effects of the sector on the rest of the economy. For example, an ongoing effort to mainstream mini-grid tariff settlement tools and methodologies across African regulators could broaden deployment of mini-grids across the region, buoying economic activities that depend on access to modern and reliable energy (African Forum for Utility Regulators 2021). To exploit the interlinkages with SDGs 8 and 9 the policy and regulatory environment for energy access must integrate incentives for cross-sectoral collaboration.

Supporting technological innovation and digitalization could reduce costs, provide efficiencies across the value chain, and improve collection and accountability, encouraging investments that widen opportunities to close the energy access gap while having large cross-sectoral effects. Two examples: Technology platforms that connect developers with investors and suppliers in large-scale mini-grid tenders can bring mini-grid projects to fruition (ESMAP 2022b). And using machine learning and artificial intelligence for load management, planning, and upkeep can minimize costs and free resources to expand and improve grid and other energy services. Governments should consider the deployment of digital technologies and the interoperability of components when strengthening and updating national institutional networks and legal frameworks that guide standards and regulations for energy products and services.

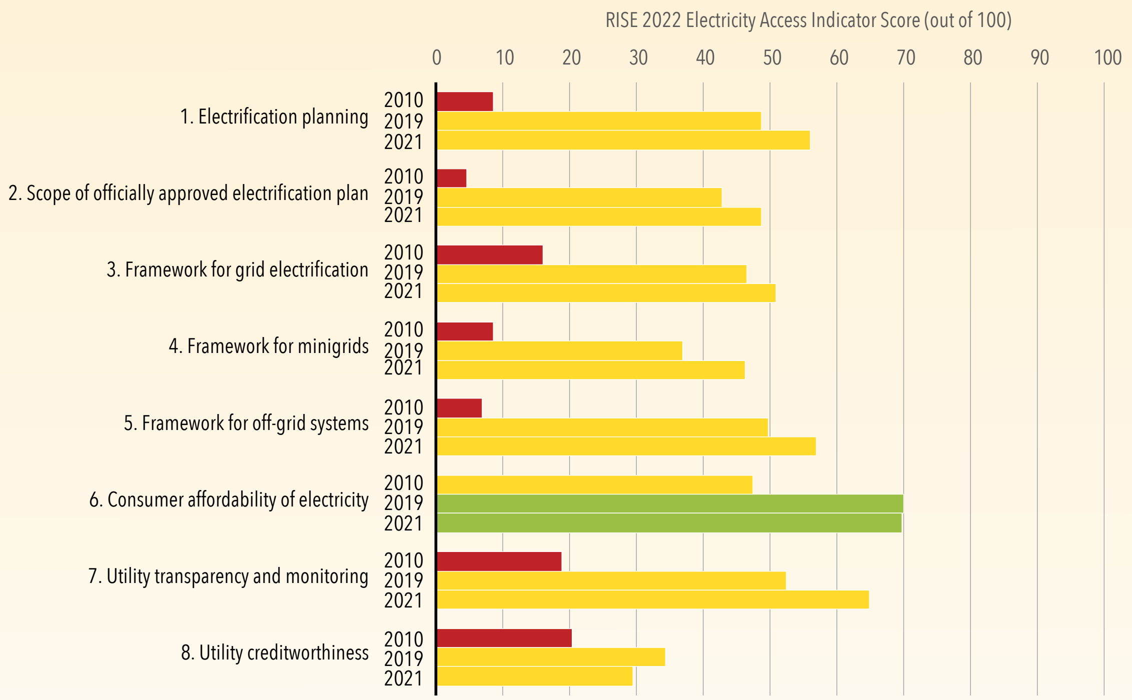
Box 1.3 • Progress on the energy access pillar of the Regulatory Indicators for Sustainable Energy (RISE) 2022

The Regulatory Indicators for Sustainable Energy (RISE), compiled by the Energy Sector Management Assistance Program (ESMAP), tracks electricity access policies across 54 access-deficit countries. RISE uses "traffic light" colors to represent the lower, middle, and upper third of access scores, normalized to a theoretical minimum of 0 and a maximum of 100.

The latest RISE results (ESMAP 2022a) show that although the global economy slowed in 2019–21, many governments continued to advance in their access-related regulations. In 2021, a quarter of the access-deficit countries entered the green zone in their overall access scores, and about half were in the yellow zone. The results are based on eight indicators that capture a comprehensive picture of regulatory incentives for mini-grids and off-grid systems, including approaches to targeting low-income households (figure B1.3.1). The steady overall improvement was primarily due to changes in the following indicators: electrification planning, frameworks for mini-grids and off-grid systems, and utility transparency and monitoring (Indicators 1, 4, 5, and 7). Nigeria and Ethiopia, two of the largest access-deficit countries (along with the Democratic Republic of the Congo), made notable progress in policy and regulatory measures and reached the green zone in their overall electricity access scores.

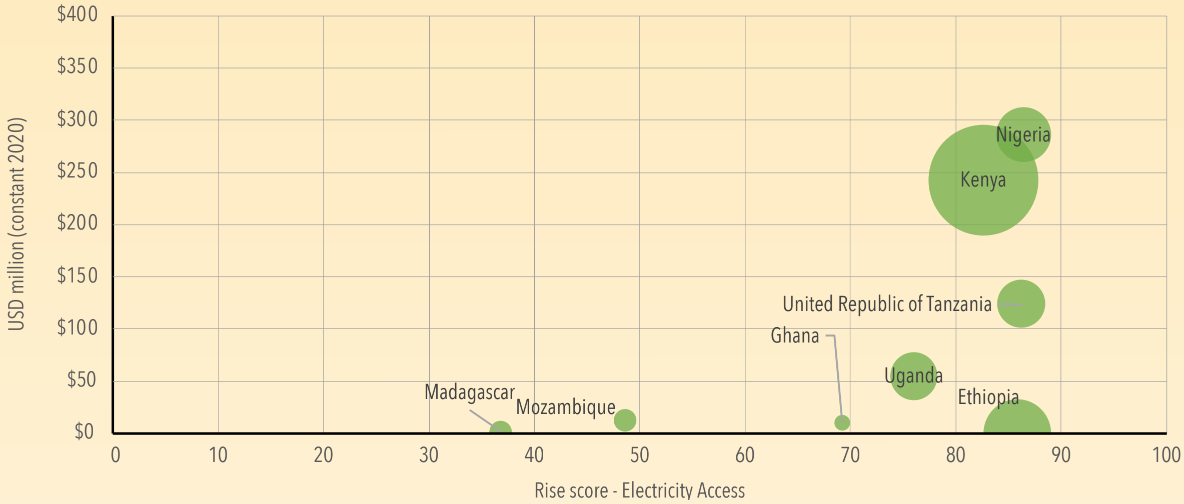
Further analysis illustrates the strong correlation between RISE scores and investment mobilization at the national level (IRENA 2023) (figure B1.3.2).

Figure B1.3.1 • Electricity access: Progress by RISE indicators, 2010, 2019, and 2021



Source: ESMAP 2022a.
Note: Among the indicators, utility creditworthiness (Indicator 8) reflects only results calculated from the financial statements of distribution utilities, whereas the consumer affordability score (Indicator 6) considers both quantitative findings and policies. The other indicators measure only policy frameworks or plans.

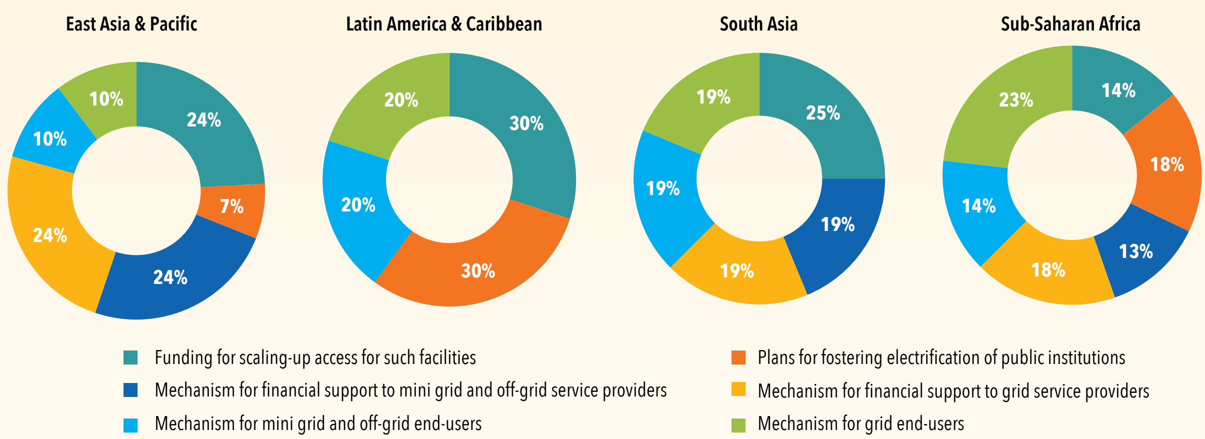
Figure B1.3.2 • Investment with respect to RISE scores and populations served by off-grid renewables in access-deficit countries in Sub-Saharan Africa, 2010–21



Source: IRENA 2023.
Note: Bubble size represents the population (households) served by off-grid renewable energy. Most off-grid renewable investment in Nigeria is for commercial and industrial purposes; that investment is not reflected in the graph.

The 2022 edition of the RISE indicators includes a stand-alone "COVID-19 module" that monitors electricity access policies and mechanisms for end users, suppliers, and public institutions during the pandemic. Financial support for electricity consumption through grid, mini-grid, and off-grid systems was observed across all regions, but Sub-Saharan Africa experienced the strongest support response (figure B1.3.3). Additionally, although the pandemic left some in Sub-Saharan Africa unable to pay for basic electricity services, consumer affordability increased at the regional level in 2021 according to the consumer affordability indicator of the RISE survey. Latin America and the Caribbean experienced the same change (ESMAP 2022a).

Figure B1.3.3 • The RISE COVID-19 module: Share of countries with supportive mechanisms, plans, and funding for access to electricity after the outbreak of the pandemic



Source: ESMAP 2022a.

Methodological Notes

The subsections that follow expand on several methodological matters raised or implied in the text.

THE WORLD BANK'S GLOBAL ELECTRIFICATION DATABASE

The World Bank's Global Electrification Database compiles nationally representative household survey data and census data for the period 1990–2021. It incorporates data from the Socio-Economic Database for Latin America and the Caribbean, the Middle East and North Africa Poverty Database, and the Europe and Central Asia Poverty Database, all of which are based on similar surveys. The database relies on the Bank's Multi-Tier Framework, which classifies access along a tiered spectrum, from Tier 0 (no access) to Tier 5 (the highest level of access). At the time of this analysis, the database contained 1,375 surveys from 149 countries in 1990–2021.

A multilevel, nonparametric model is applied to extrapolate data for missing years (described below). The modeling approach originally developed by the World Health Organization (WHO) to estimate clean fuel usage was adapted to project electricity access and fill in missing data points.[31] Where data were available, access estimates were weighted by population. Multilevel, nonparametric modeling takes into account the hierarchical structure of data (country and regional levels), using the regional classification of the United Nations.

The model was applied in all countries with at least one data point. In order to use as much real data as possible, results based on survey data were reported in their original form for all years available. The statistical model was used to fill in data for years in which data were missing and to conduct global and regional analyses. In the absence of survey data for a given year, information from regional trends was used. The difference between real data points and estimated values is clearly identified in the database. Countries classified as high-income are assumed to have electrification rates of 100 percent for the years the countries belong to the category.

For 1990–2010, the statistical model was generally based on insufficient data points or outdated household surveys. To avoid having electrification trends in this period overshadow efforts since 2010, the model was run twice, once with survey data and assumptions for 1990–2021 (for model estimates for 1990–2021) and once with survey data and assumptions for 2010–21 (for model estimates for 2010–21). The first run extrapolates electrification trends for 1990–2021, given the available data points. The second considers only real data collected since 2010 and estimates the historical evolution in the most recent years. The outputs from the two model runs were then combined to generate a final value for access to electricity. If survey data were available, the original observation remained in the final database. Otherwise, the larger value generated by the model runs was chosen as the final data point.

Under the WHO methodology adapted for the purpose of assessing access, regional trends affect the estimation of yearly values in countries with missing data points in certain years. Depending on the regional trend and how many years have passed since the last available year of data for a certain country, the model can interpolate unrealistic access rates of 100 percent. To avoid reporting unrealistic rates, the country's latest survey data are extended. In this version of the report, this was done in Afghanistan, Nepal, and Nigeria.

31 The model draws on the modeling of solid fuel use for household cooking presented in Bonjour and others (2013).

COMPARISON BETWEEN DEMAND-SIDE DATA AND SUPPLY-SIDE DATA

While the World Bank's Global Electrification Database collects data mainly from household surveys and censuses, the IEA's Energy Access Database draws from government reports of household electrification (usually based on connections reported by utilities). IEA considers a household to have access if it receives enough electricity to power a basic bundle of energy services.

The two approaches sometimes yield different estimates. Estimates based on household surveys are moderately higher than estimates based on energy sector data because they capture a wider range of phenomena, including off-grid access, "informal" connections (connections not made by or known to the utility), and self-supply systems.

Comparison of the two datasets in the previous edition of this report (updated in this edition) highlights their respective strengths. Household surveys, which are typically conducted by national statistical agencies, offer two advantages for measuring electrification. First, thanks to efforts to harmonize questionnaire designs, electrification questions are largely standardized across country surveys. Although not all surveys reveal detailed information on the forms of access, questionnaire designs capture emerging phenomena, such as off-grid solar access. Second, data from surveys convey user-centric perspectives on electrification. Survey data capture all forms of electricity access, painting a more complete picture of access than may be possible from data supplied by service providers. But greater investment in data collection and capacity building is needed to generate a comprehensive and accurate survey-based understanding of electricity access.

Government data on electrification reported by national ministries of energy are supply-side data on utility connections. They offer two principal advantages over national surveys. First, administrative data are often available on an annual basis and may therefore be more up to date than surveys, which are conducted every two to three years. (Moreover, since 2010, only about 20 percent of countries have published or updated their electricity data at intervals of two to three years in time for global data collection.) Second, administrative data are not subject to the challenges that can arise when conducting field surveys. Household surveys (particularly those implemented in remote and rural areas) may suffer from sampling errors that may lead to underestimation of the access deficit.

MEASURING ACCESS TO ELECTRICITY PROVIDED THROUGH OFF-GRID SOLAR SOURCES

The rates and levels of access to off-grid solar energy shared in this chapter are based on data shared by affiliates in the bi-annual data collection undertaken by GOGLA, Lighting Global, and Efficiency for Access.

Eligible off-grid solar lighting products included in the affiliate data collection are defined as systems that include a solar panel, a battery, and at least one light point. Every six months, affiliate companies fill out a questionnaire on their product sales by country, system type/size, and business model; they also share product specifications and capacities. Although companies are ultimately responsible for the accuracy of the self-reported data submitted, the data are checked for quality by an independent consultancy (Berenschot), as well as by GOGLA, Lighting Global, and the Energy Savings Trust.

Manufacturers and distributors of off-grid solar products report their sales, but the results shared in public reports cover only products sold by manufacturers of off-grid solar products. This is to avoid double counting sales reported by both manufacturers and distributors. The product sales reported by manufacturers include both business-to-business transactions (e.g., sales to distributors, governments, and nongovernmental organizations) as well direct business sales to customers. The latest Market Trends Report (Lighting Global/ESMAP and others 2022) estimates that sales of

GOGLA affiliate companies represent 28 percent of the total off-grid solar market, although estimates of percentages by country, as well as by system size and business model, vary significantly.

In addition to using standardized impact metrics[32] created by the GOGLA Impact Working Group, additional steps are taken to calculate tiers of energy access:

Tier 1. To estimate Tier 1 energy access, a "SEforALL factor" is applied to the sales numbers.[33] That factor estimates the service-level impact of smaller technologies. This tool reviews the system size and capacity of each product and estimates whether it has helped to unlock either partial or full Tier 1 access. It then calculates the total number of people who have achieved either partial or full Tier 1 access.

Tier 2. Products that have a capacity of more than 50 watts peak, or that are more than 20 watts peak and come packaged with a television, are deemed to provide Tier 2 energy access. This approach is designed to align product specifications or energy service with the requirements for Tier 2 access of the Multi-Tier Framework. Products that have enabled a household to achieve Tier 2 access are not included in the final Tier 1 estimates.

MEASURING ACCESS TO ELECTRICITY PROVIDED THROUGH MINI-GRID SOURCES

IRENA collects off-grid capacity and generation data from a variety of sources. These include IRENA questionnaires; national and international databases; and unofficial sources, such as project reports, news articles, academic studies, and websites. For some countries, IRENA also estimates off-grid solar PV capacity, based on solar panel import statistics obtained from the United Nations' COMTRADE Database.

The agency's 2022 decentralized energy database contains global data on off-grid renewable energy in Africa, Asia, South America, Central America and the Caribbean, and Oceania. Its database covers off-grid renewable power capacity (in megawatts), biogas production (in cubic meters), and energy access (in numbers of inhabitants). This chapter uses energy access data estimated for people with access to hydropower, solar mini-grids (Tiers 1 and 2), and biogas.

IRENA publishes off-grid statistics by the end of December each year. Details on the methodology used in this report are set forth in IRENA (2018).

32 The Global Impact Metrics are available online here: https://www.gogla.org/impact/gogla-impact-metrics.

33 Where a product provides partial Tier 1 access a methodology devised by SEforALL can be applied to calculate how several products can be combined to reach Tier 1 equivalency. The methodology was designed to account for "energy stacking" and so to prevent Tier 1 access from being underrepresented in calculations.

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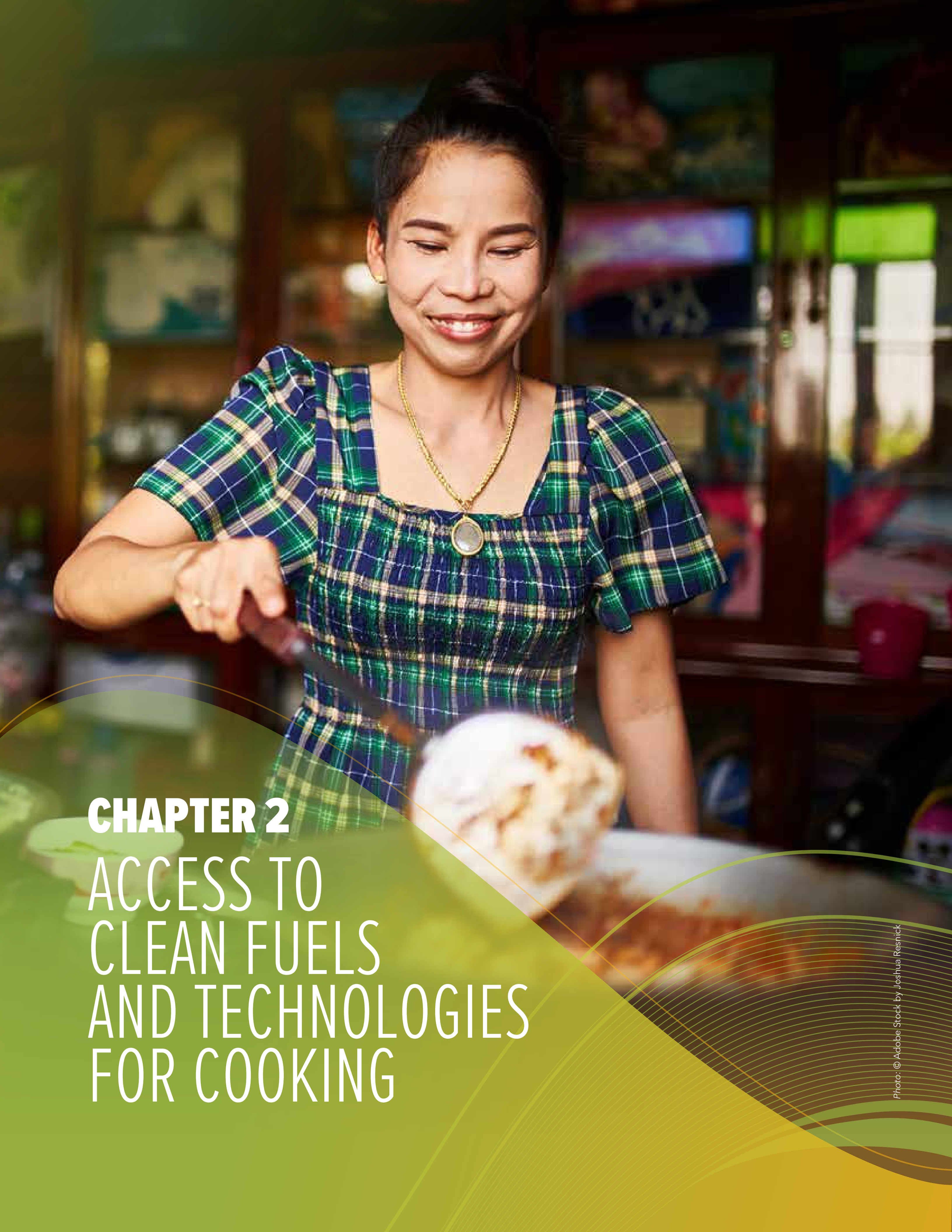

CHAPTER 2
ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

Photo: © Adobe Stock by Joshua Resnick

Main Messages

- **Global trend.** In 2021, 71 percent (67–75) of the global population had access to clean cooking fuels and technologies, an increase of 14 points since 2010.[34] Despite the progress, some 2.3 billion people (2.0–2.6) still use polluting fuels and technologies for most of their cooking.
- **Target for 2030.** Efforts to accelerate the achievement of universal access to clean cooking by 2030 are urgently needed. Current trends suggest that only 77 (73-80) percent of the world's people are expected to have access to clean cooking fuels and technologies by 2030, leaving some 1.9 billion continuing to rely on traditional and inefficient stoves paired with solid fuels (wood, charcoal, coal, crop waste) and kerosene for cooking. Looking beyond 2030 and accounting for population growth, the current business-as-usual trajectory shows that, by 2050, 2.3 billion people in 91 low- and middle-income countries will still lack access to clean cooking. Among the 91 are 45 out of the 47 countries of Sub-Saharan Africa. If current trends continue, around 6 out of 10 people without clean cooking access will reside in Sub-Saharan Africa in 2030, with little or no improvement expected by 2050.
- **Regional highlights.** The access deficit has decreased consistently in Eastern Asia and South-eastern Asia since 2000, and in Central Asia and Southern Asia since 2010. However, in Sub-Saharan Africa, there has been a clear upward trend in the deficit, as access to clean cooking has failed to keep pace with growing populations. There, it has more than doubled since 1990 and has increased by 60 percent since 2000, reaching a total of 0.9 billion people (0.9–1.0) in 2021. Without new policies or urgent interventions, the access deficit in Sub-Saharan Africa is on course to reach 1.1 billion people in 2030, with no signs of slowing thereafter.
- **Urban-rural divide.** Urban areas continue to have greater access to clean cooking than rural areas, but the divide is narrowing over time. Over the last 10 years, access accelerated in rural areas and decelerated in urban areas. The percentage of people with access in urban areas rose only slightly from 82 percent (78–84) in 2010 to 86 percent (83–89) in 2021. Meanwhile, over the same period, the percentage in rural areas rose from 31 percent (27–35) to 51 percent (46–56), five times the improvement seen in urban areas over the same period. If the urban trends continue to decelerate, the percentage of the population with access to clean cooking in urban areas is on course to stall and possibly to begin dropping as soon as 2025.
- **The 20 countries with the largest access deficits.** The 20 countries with the largest access deficits accounted for 78 percent of the global population lacking access to clean cooking, including 10 countries in Sub-Saharan Africa, where more than 600 million people still lacked access to clean cooking fuels and technologies in 2021. In 16 of the 20 countries, less than half of the population had access to clean cooking fuels and technologies. Moreover, in seven (all in Sub-Saharan Africa), less than 10 percent of the population had access.

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34 Throughout the chapter, parenthetical figures appearing after estimates are 95 percent uncertainty intervals, as defined in the methodology section at the end of the chapter. Clean fuels and technologies include stoves powered by electricity, liquefied petroleum gas (LPG), natural gas, biogas, solar, and alcohol. Clean fuels and technologies are as defined by the normative technical recommendations in the WHO Guidelines for Indoor Air Quality: Household Fuel Combustion (WHO 2014).

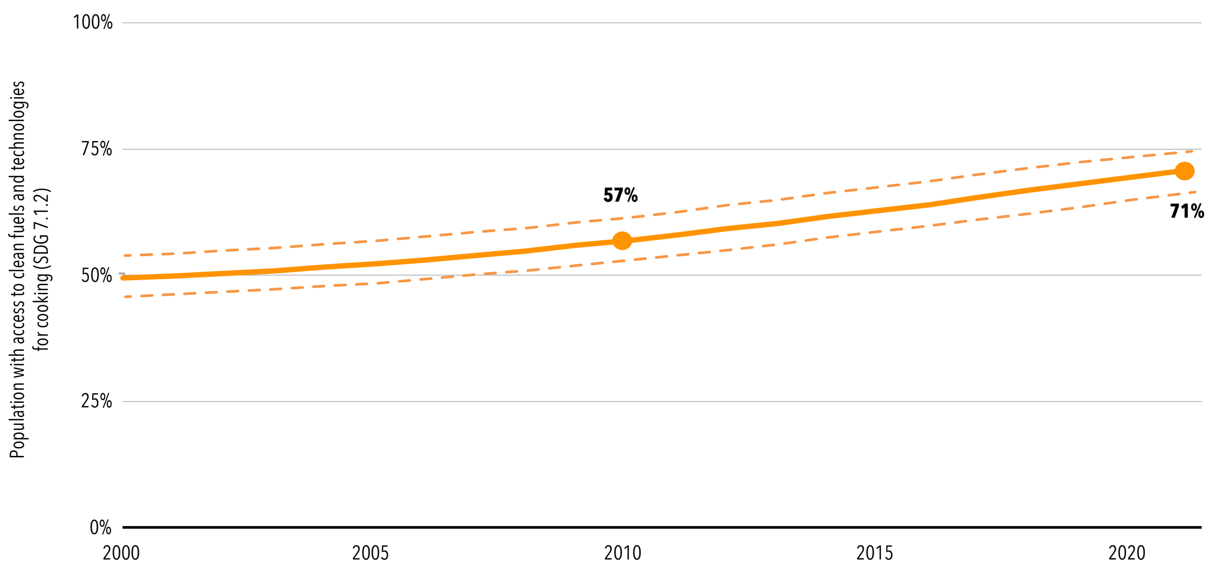
- **The 20 countries with the lowest access rates.** Almost all of the 20 countries with the lowest rates of access to clean cooking, with the exception of Rwanda, have shown little or no progress in increasing their access rates between 2017 and 2021 (with an increase of less than 0.4 percentage points). Nineteen of these countries are in Africa and are among the least-developed countries, with Haiti the only non-African country among them.
- **Global and regional fuel trends.** In low- and middle-income countries in 2021, gaseous fuels (liquefied petroleum gas [LPG], natural gas, biogas) were used by 55 percent (49–60) of people (3.6 billion) as their main energy source for cooking. Unprocessed biomass (wood, crop waste, dung) was the main fuel of 29 percent (24–34) of people (1.9 billion); electricity, of 10 percent (7–14) of people (660 million); and charcoal, of 4 percent (3–4) of people (240 million). Only 1 percent of people still used coal and kerosene as their main fuels in 2021.
- **Clean cooking as a cost-effective measure to tackle climate change.** Clean cooking can and should be an integral part of strategies for achieving the targets specified in Nationally Determined Contributions (NDCs) under the Paris Agreement on climate change and advancing toward the goal of net zero emissions by 2050 and achieving Sustainable Development Goals 7, 9, and 13. New evidence on the climate, health, and social benefits of transitioning to clean cooking strengthens the argument for universal clean cooking as a way to accelerate the energy transition.
- **Energy compacts driving policy action and commitments for clean cooking.** Energy compacts that lead to national clean cooking strategies and commitments are an important vehicle for countries to accelerate the transition to clean cooking. Numerous state and non-state actors, such as companies, regional and local governments, and nongovernmental organizations have joined in the commitment to accelerate access to clean cooking. If realized, national targets to accelerate access to clean cooking, as spelled out in NDCs and energy compacts, have the potential to improve human health, livelihoods, the climate, and the natural environment at large. Promoting the use of a range of cleaner cooking fuel options such as electricity, LPG, ethanol, and biogas should thus be upheld as an important implementable action for countries to use to advance development outcomes, preserve nature, and mitigate and adapt to the effects of climate change.

Are We on Track?

The world is not on track to achieve universal access to clean cooking by 2030. In 2021, only 71 percent (67–75) of the global population had access to clean cooking fuels and technologies, the latter comprising stoves powered by electricity, LPG, natural gas, biogas, solar energy, and alcohol. However, this leaves 2.3 billion people (2.0–2.6) still relying primarily on polluting fuels and technologies, such as simple stoves paired with charcoal, coal, crop waste, dung, kerosene, or wood.[35]

There has been some progress in the global access rate over the past two decades, as seen in figure 2.1. Yet if current trends continue, only an estimated 77 percent (73–80) of the global population will have access to clean cooking fuels and technologies by 2030, falling far short of the 2030 target of universal access and leaving 1.9 billion people to suffer the damaging effects of polluting cooking fuels and technologies on human health, livelihoods and the environment.

Figure 2.1 • Percentage of the global population with access to clean cooking fuels and technologies, 2000–21

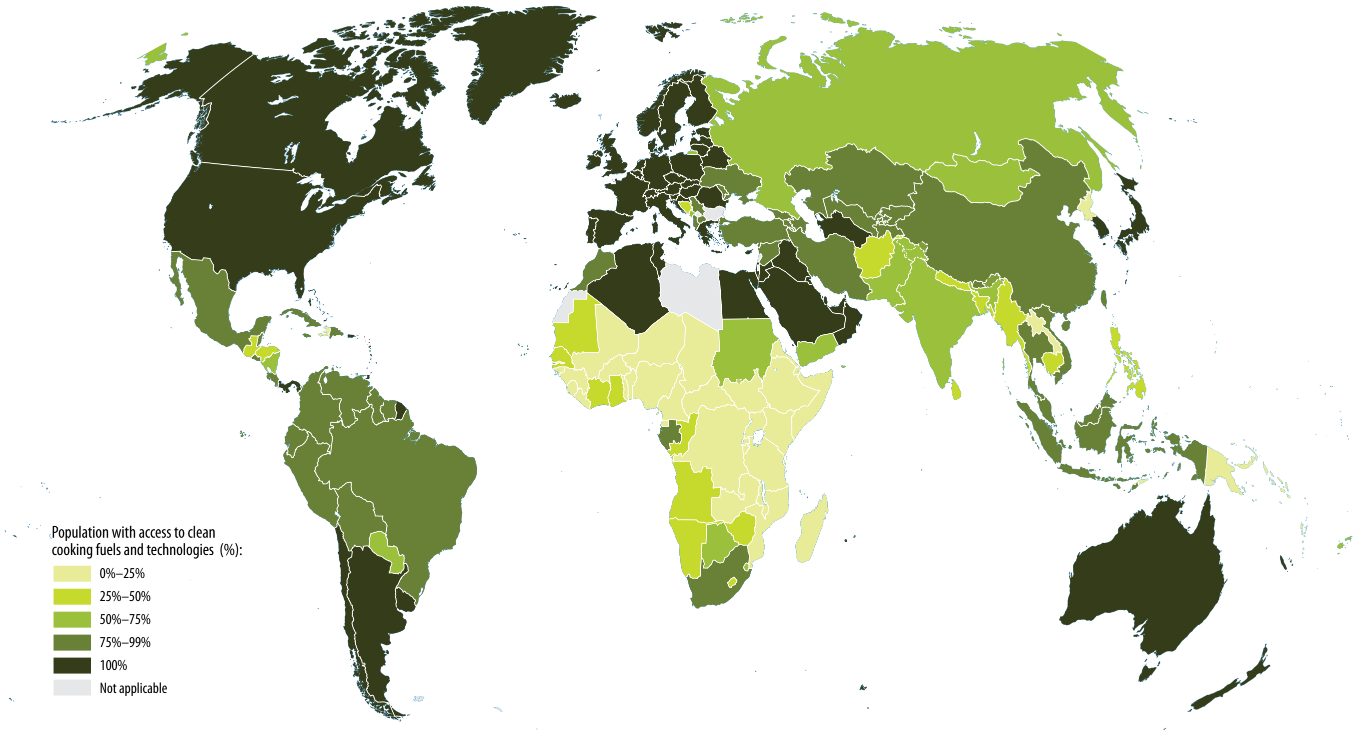


Source: WHO 2023.
Note: Dashed lines are 95% uncertainty intervals.

Globally, the number of people without access to clean cooking continues to decrease each year. However, large regional variability exists (figures 2.2 and 2.3). In fact, the number of people without access in Sub-Saharan Africa is growing at a rate of almost 20 million people per year as gains in the share of people with access fail to keep pace with population growth, to the detriment of the almost 1 billion people already suffering the negative effects of polluting cooking in the region. The growing access deficit in Sub-Saharan Africa, if not reversed, could dampen or undermine current increasing trends in global access.

35 Because of the data-driven nature of the analysis and limitations in the data, this chapter examines cooking fuel rather than cookstove and fuel combinations. The methodology section at the end of the chapter provides additional details. Population estimates are from 2021. Population data from the 2018 revision of World Urbanization Prospects were used to derive the population-weighted regional and global aggregates. Low- and middle-income countries without data were excluded from all aggregate calculations; high-income countries were excluded from aggregate calculation for specific fuels.

Figure 2.2 • Share of population with access to clean cooking fuels and technologies, 2021 (percent)

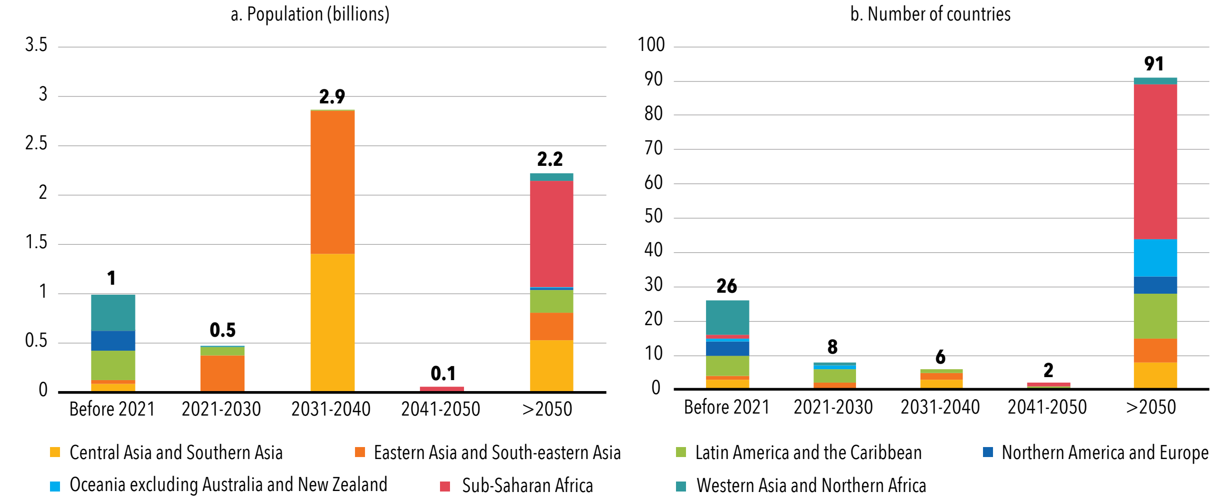


Source: WHO 2023.
Disclaimer: This map was produced by the Geospatial Operations Support Team of the World Bank based on the Cartography Unit of the World Bank. The boundaries, colors, denominations, and other information shown do not imply any judgment on the part of the custodian agencies concerning the legal status of or sovereignty over any territory or the endorsement or acceptance of such boundaries.

Without much stronger efforts, the great majority of low- and middle-income countries will miss the 2030 universal access target and beyond (figure 2.3). Eight countries with a total population of 500 million in 2021 are expected to achieve universal access[36] in the period 2021–30. A further six countries with a combined population of 2.9 billion are on track to transition to universal clean cooking between 2031 and 2040. However, just two countries are on track to cross this threshold between 2041 and 2050. Most alarmingly, 80 countries with a total population of 2 billion are not expected to reach even 90 percent clean cooking coverage by 2050.

36 Due to the inherent uncertainty in input survey data and modelled estimates, for SDG 7.1.2 monitoring, countries are assumed to have universal access if modelled estimates indicate that 95 percent or more primarily rely on clean fuels and technology for cooking.

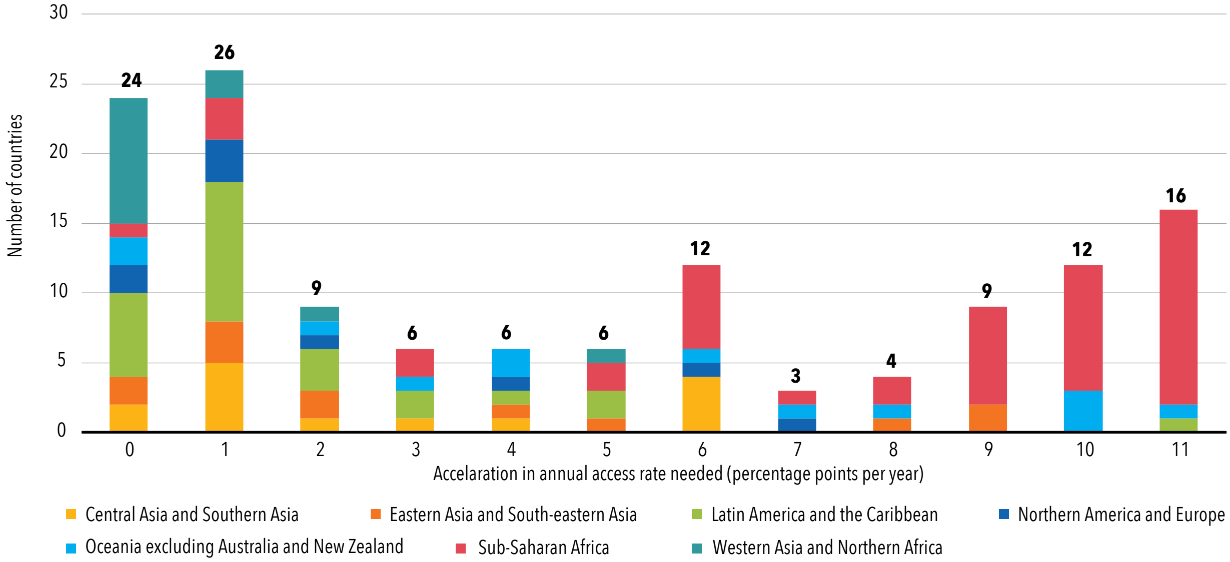
Figure 2.3 • Total population and number of LMICs expected to achieve universal access to clean cooking, based on current trends by region



Source: WHO 2023.

An acceleration of progress is therefore urgently needed if the world is to achieve universal access by 2030. In 41 countries, predominantly in Sub-Saharan Africa, additional increases of 8–11 percentage points per year above the current trends are needed to reach 100 percent access from 2021 to 2030 (figure 2.4). Furthermore, without an additional 1–3 percentage point increase in access per year, 82 countries will not reach universal access to clean cooking by 2050, with 45 of these countries in Sub-Saharan Africa.

Figure 2.4 • Additional annual rate of increase in access to clean cooking from 2021 to 2030 in access-deficit countries needed to universal clean cooking by 2030



Source: WHO 2023.
Note: Additional increases are rounded to the nearest percentage point.

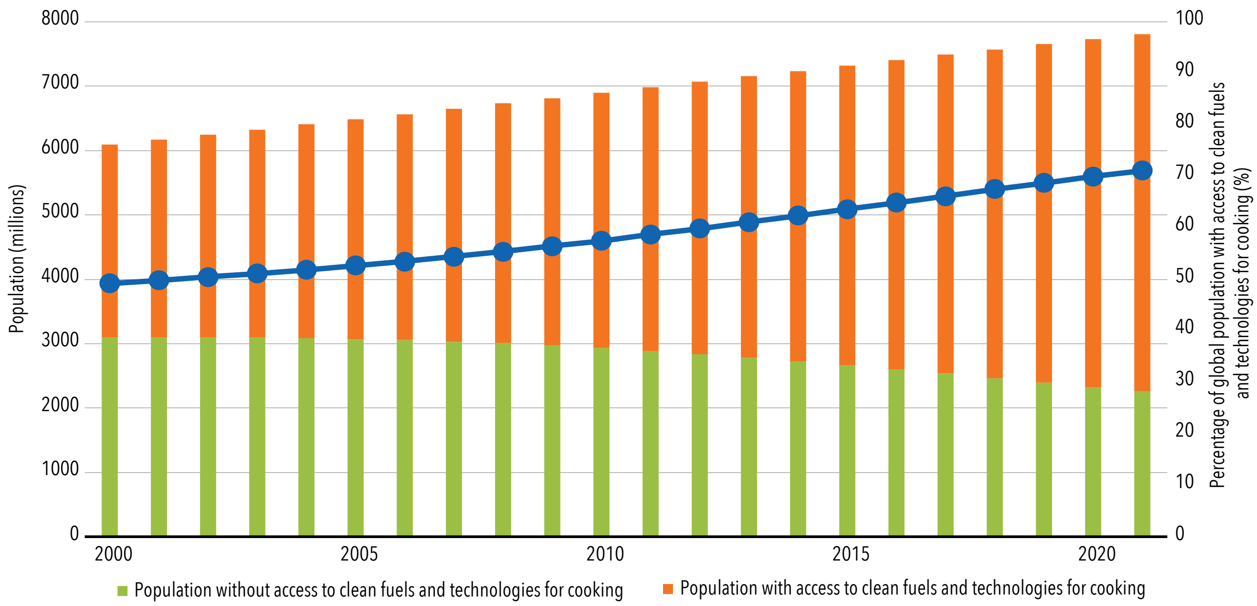
With current trends, the number of people with access to clean cooking will increase by 510 million people from 2021 to 2025. This demonstrates the considerable and urgent need to scale up action to ensure an additional 1 billion people obtain access to clean cooking solutions by 2025, as pledged by the Global Roadmap for Accelerated SDG7 Action in Support of the 2030 Agenda for Sustainable Development and in effort to achieve the Paris Agreement on Climate Change.

Looking Beyond the Main Indicators

ACCESS AND POPULATION

The global rate of access to clean fuels and technologies for cooking reached 71 percent (67–75) in 2021. Figure 2.5 shows a gradual increase in the access rate over the past two decades, with a total increase of around 22 percentage points since 2000.

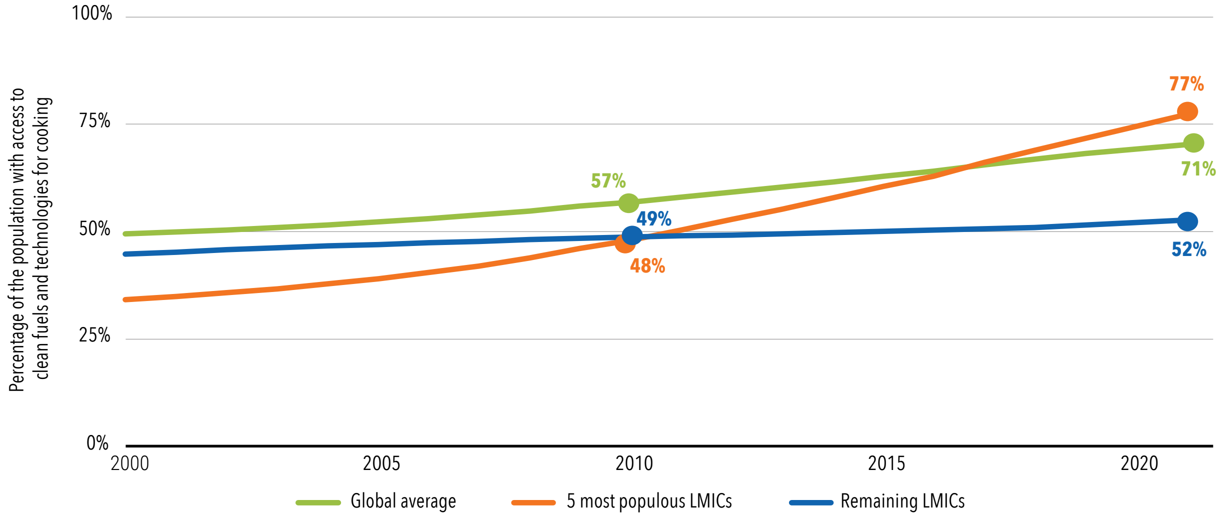
Figure 2.5 • Change in the absolute number of people (left axis, bars) and percentage of the global population (right axis, line) with access to clean cooking, 2000–21



Source: WHO 2023.

Improvement in the global access rate has been predominantly driven by progress in the most populous low- and middle-income countries. Figure 2.6 illustrates a clear contrast between the progress in China, India, Indonesia, Brazil, and Pakistan, where the combined access rate rose from 49 percent in 2010 to 77 percent in 2021, and the minimal progress in other LMIC (48 percent in 2010 to 52 percent in 2021. This is a stark reminder that good progress in the largest countries may obscure the lack of progress in a great many smaller countries.

Figure 2.6 • Percentage of population with access to clean cooking globally, in five most populous LMICs, and all other LMICs, 2000-21



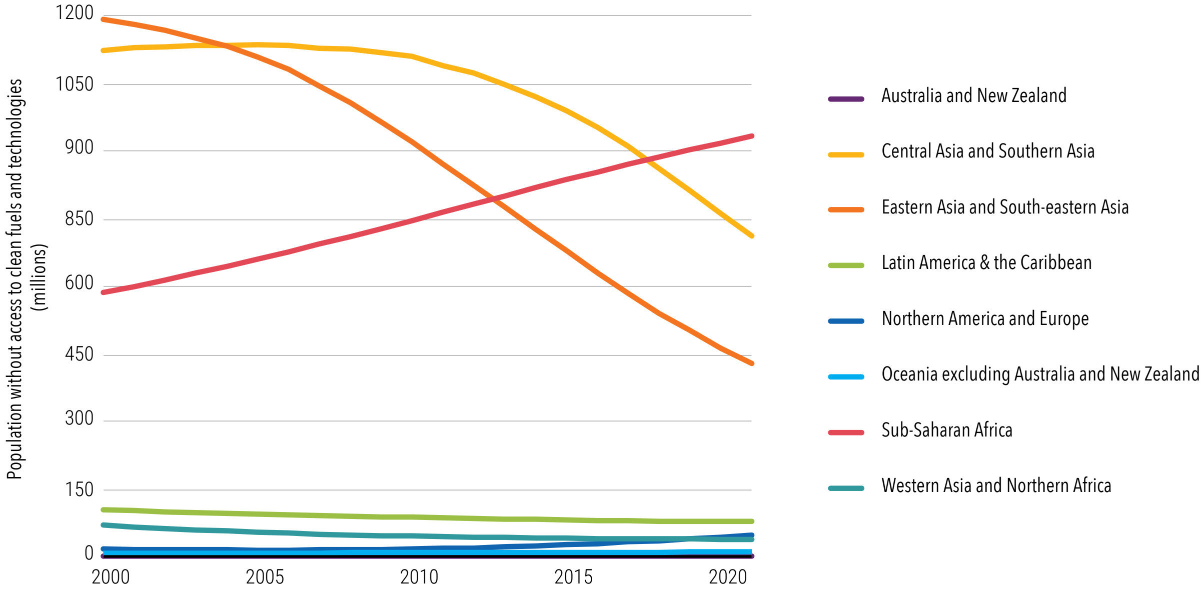
Source: WHO 2023.
LMICs = low- and middle-income countries.

THE ACCESS DEFICIT

On a global scale, the number of people with access to clean cooking has risen consistently over the last two decades (figure 2.5). However, the total number of people lacking access to clean cooking—a measure of the number exposed to the damaging health and socioeconomic effects of polluting fuels and technologies, referred to here as the "access deficit"—began to fall substantially only after 2010, dropping from its historic level of around 3 billion people to 2.3 billion people (2.0–2.6) in 2021.

Reductions in the total number of people lacking access have been slowed by both population growth and an uneven geographic distribution of progress. Figure 2.7 shows how the deficit has decreased consistently in Eastern Asia and South-eastern Asia since 2000, and in Central Asia and Southern Asia since 2010. Alarmingly, however, the access deficit in Sub-Saharan Africa has more than doubled since 1990, as population growth has outpaced limited progress in the percentage of the population with access to clean cooking. The deficit has grown 60 percent since 2000, reaching a total of 0.9 billion people (0.9–1.0) in 2021. Without new policies or interventions, the deficit is on track to reach 1.1 billion people by 2030, with no sign of abatement thereafter.

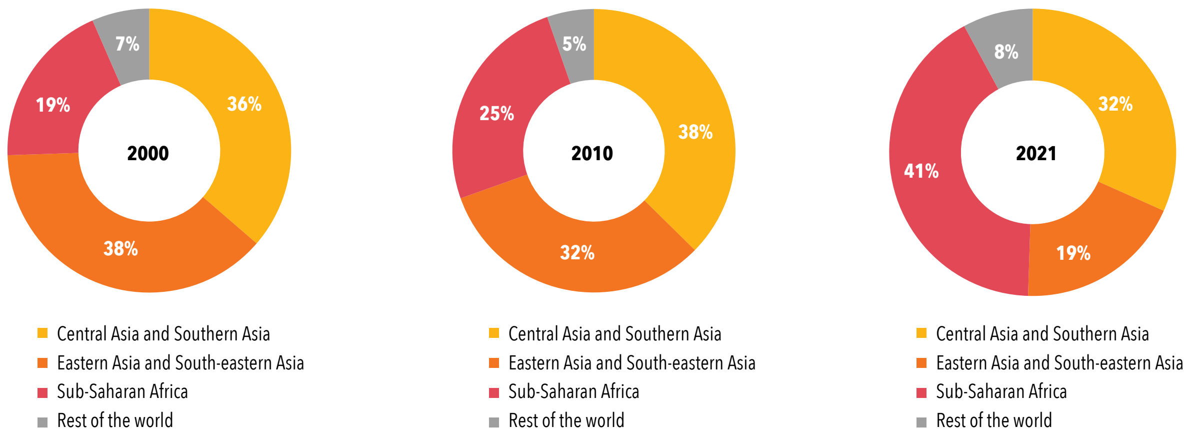
Figure 2.7 • Number of people without access to clean fuels and technologies, by region, 2000–21



Source: WHO 2023; Stoner and others 2021.

Figure 2.8 illustrates the changing regional composition of the global population lacking access to clean fuels for cooking between 2010 and 2021. In 2000, four in ten people lacking access to clean cooking lived in Central Asia and Southern Asia; four in ten in Eastern Asia and South-eastern Asian; and two in ten in Sub-Saharan Africa. By 2021, four in ten people without access lived in Sub-Saharan Africa as a result of decreases in the access deficit in the two Asian regions and a stark increase in the deficit in Sub-Saharan Africa. If current trends continue, almost six in ten people without access will reside in Sub-Saharan Africa by 2030.

Figure 2.8 • Proportion of the total global access-deficit in the three largest access-deficit regions and the rest of the world, 2000, 2010 and 2021



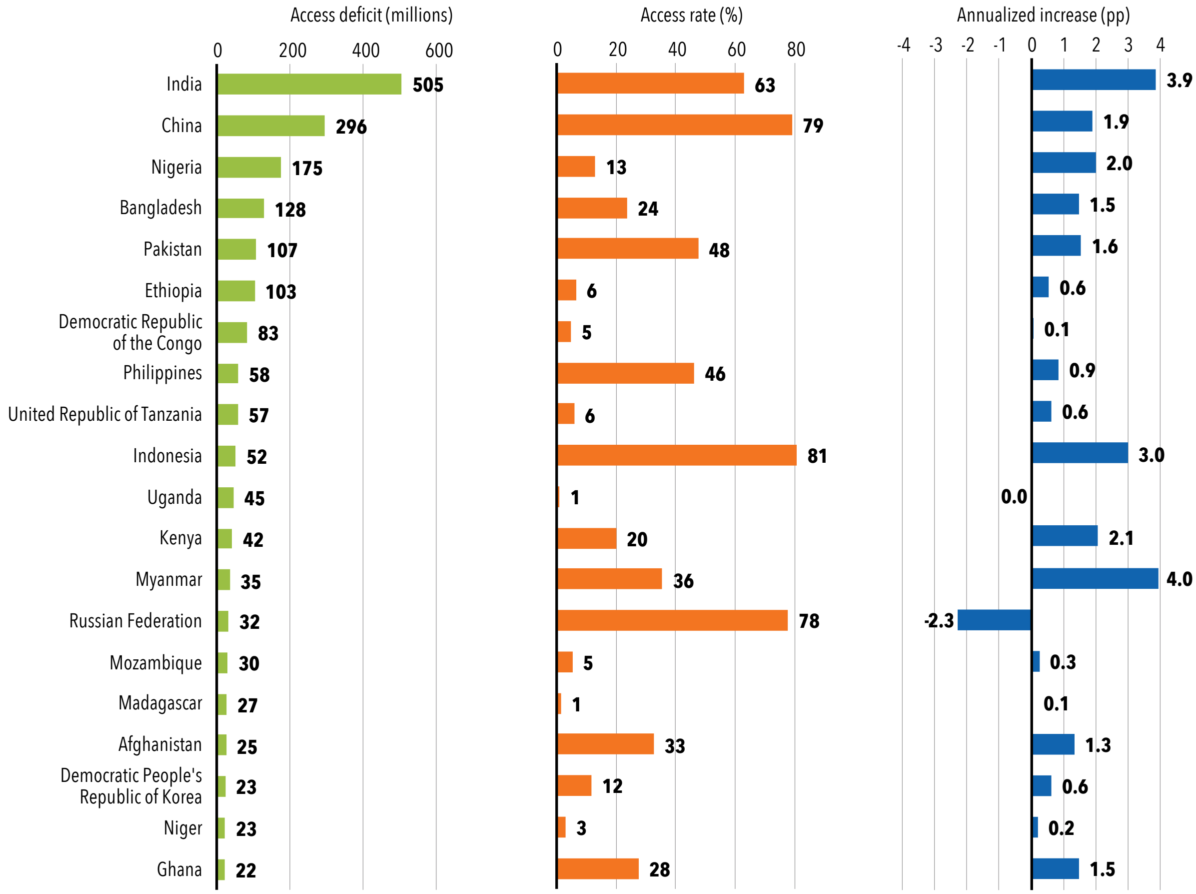
Source: WHO 2023; Stoner and others 2021.

ANALYSIS OF THE TOP 20 ACCESS-DEFICIT COUNTRIES

More than three-quarters (78 percent) of the world's people lacking access to clean cooking are found in the 20 countries shown in figure 2.9. India alone accounts for the largest share of the access deficit, with 505 million people lacking access, followed by China at 296 million.

In seven of the twenty countries, less than 10 percent of the population has access to clean fuels and technologies; the seven are Democratic Republic of the Congo, Ethiopia, Madagascar, Mozambique, Niger, Uganda, and the United Republic of Tanzania. Sixteen of the twenty countries have access rates below 50 percent.

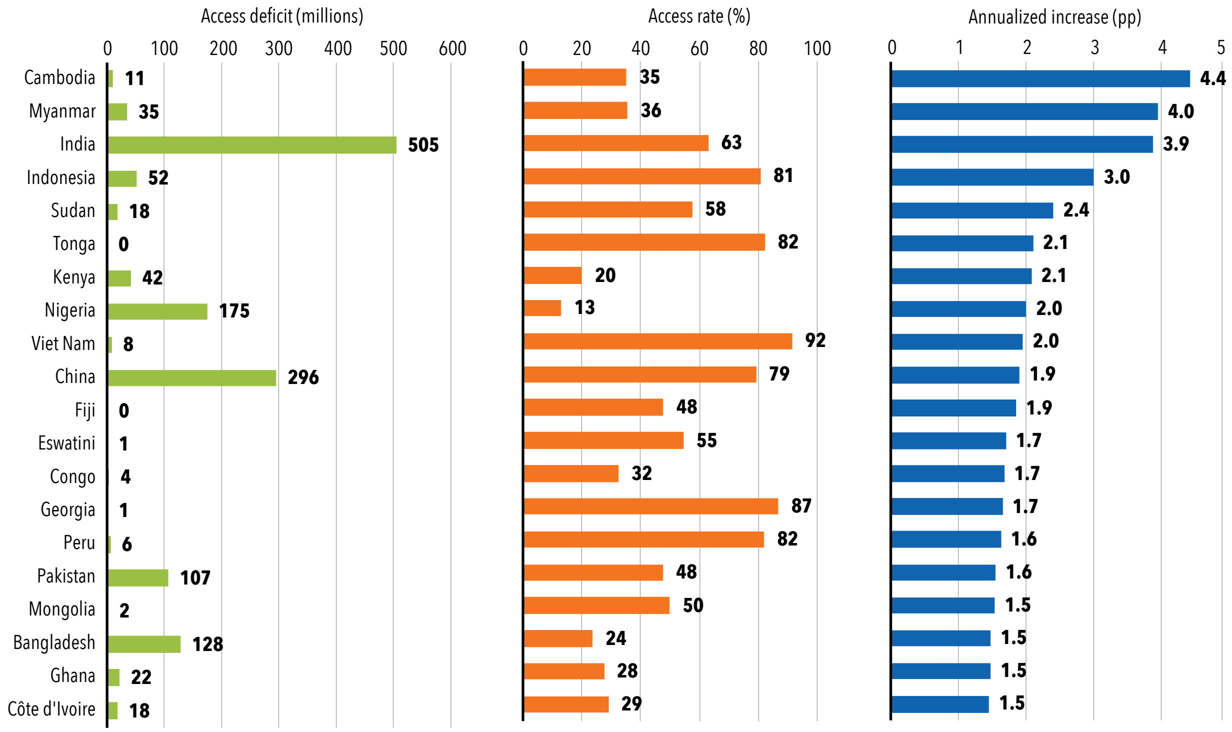
Figure 2.9 • The 20 countries with the largest access deficit by absolute population (green) , 2017 - 2021 average



Source: WHO 2023..
pp = percentage point.

Although India has the largest population without access to clean cooking, the rate of access in the country increased by 3.9 percentage points per year on average between 2017 and 2021 (figure 2.10). Cambodia had the highest rate of increase, at 4.4 percentage points per year, followed by Myanmar at 4 percentage points. Other countries with annual gains of at least 2 percentage points were India, Indonesia, Sudan, Tonga, Kenya, Nigeria, and Viet Nam.

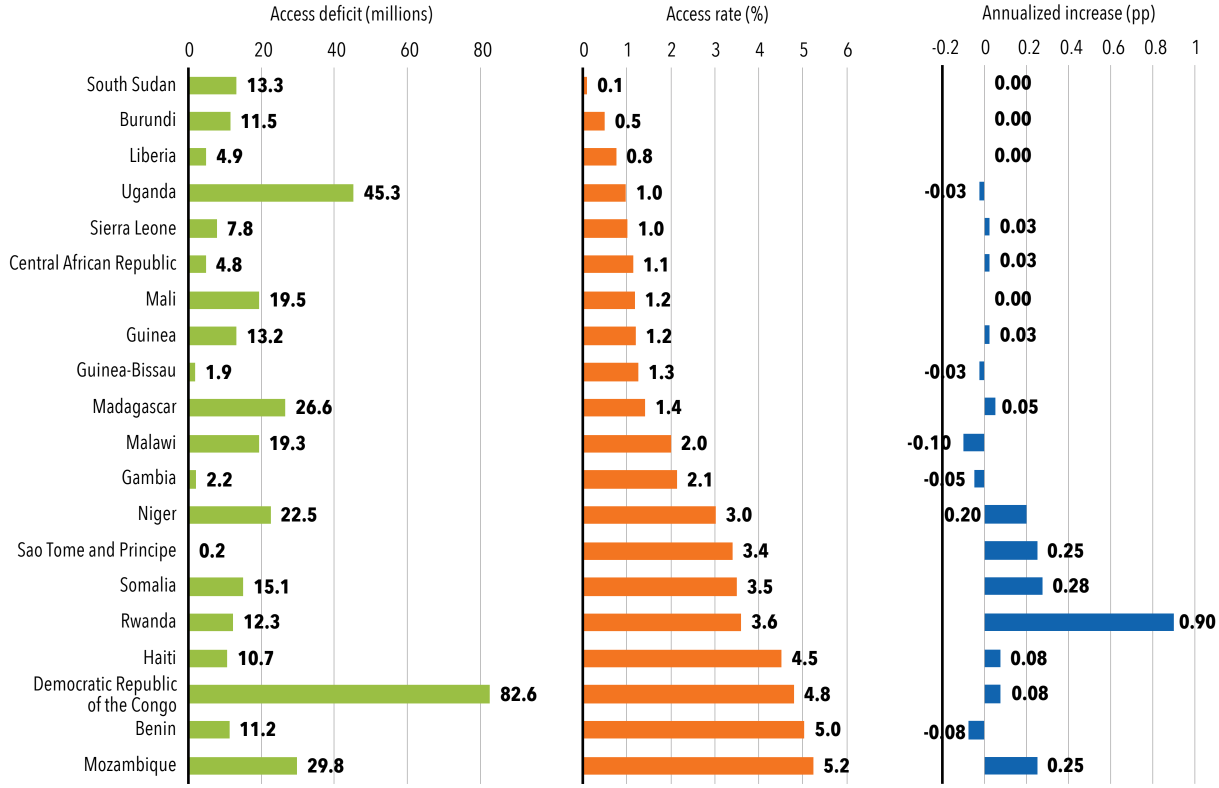
Figure 2.10 • The 20 countries with the largest annual increases in the percentage of people with access to clean fuels and technologies (blue), 2017–21 average



Source: WHO 2023.
pp = percentage point.

Nearly all of the 20 countries with the lowest access rates showed little or no sign of improvement (figure 2.11). In almost all of these countries, the average annual increase in access between 2017 and 2021 was below 0.4 percentage points per year; access decreased in some countries. Only Rwanda had a slightly higher average increase of 0.9 percentage points per year. All of these countries except Haiti are in Sub-Saharan Africa. These countries also have some of the least financing dedicated to clean cooking (SEforALL 2021).

Figure 2.11 • The 20 countries with the lowest rates of access to clean fuels and technologies (orange), 2017-2021 average

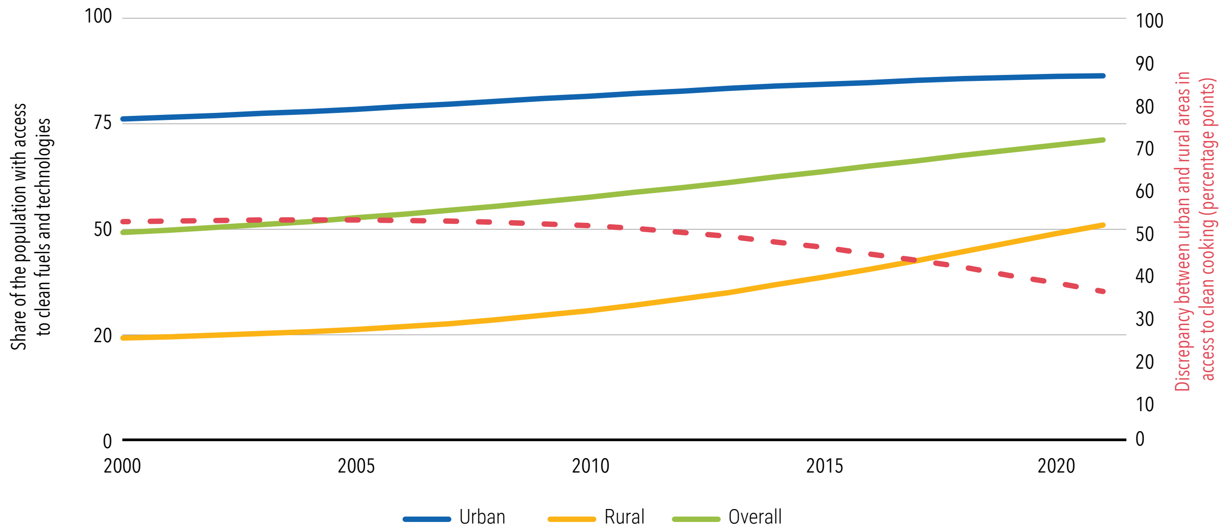


Source: WHO 2023.
pp = percentage point.

URBAN-RURAL DIVIDE

Urban areas have greater access to clean cooking than rural areas, but the gap is narrowing. The percentage of people with access in urban areas rose only slightly in the past decade—from 82 percent (78–84) in 2010 to 86 percent (83–89) in 2021 (figure 2.12). Over the same period, the percentage in rural areas rose from 31 percent (27–35) to 51 percent (46–56). Between 2000 and 2010, by contrast, the difference in access to clean cooking between urban and rural areas stood steadily at around 50 percentage points. By 2021 the gap had since fallen to 35 percentage points (29–41) and is expected to narrow further still to 23 percentage points in 2030 if current trends continue.

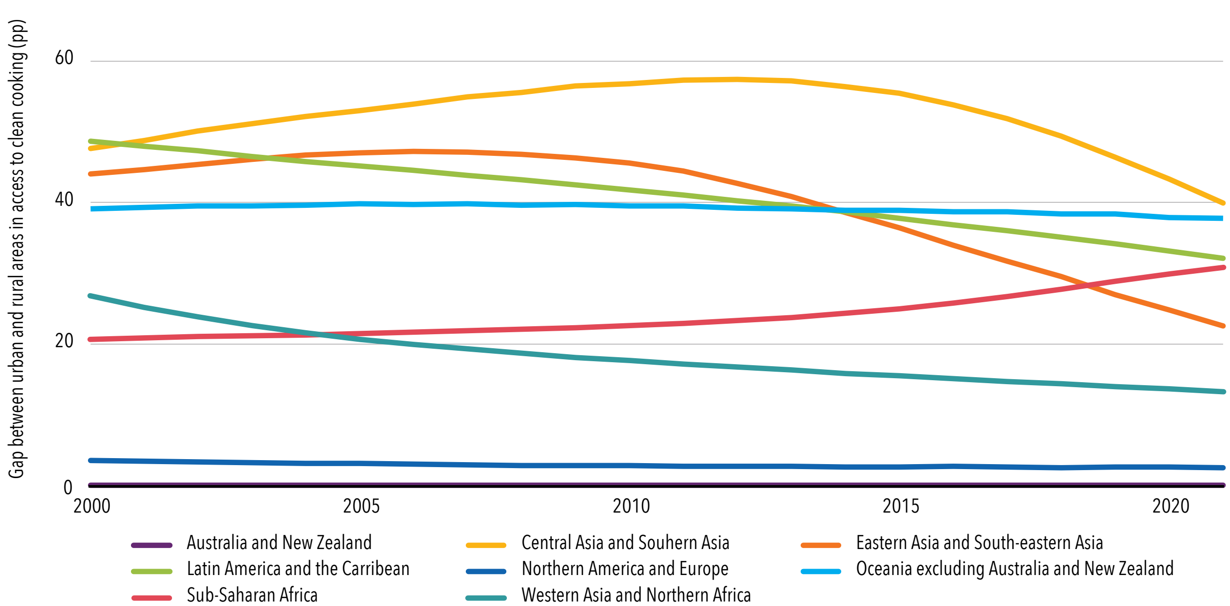
Figure 2.12 • Percentage of people with access to clean cooking in urban areas, rural areas, and overall (solid lines), and discrepancy in access between urban and rural areas (dashed line)



Source: WHO 2023.

The discrepancy in access between urban and rural areas is highest in Central Asia and Southern Asia (figure 2.13), at 40 percentage points (29–52). The gap is narrowing in all regions except Sub-Saharan Africa, where it is increasing sharply.

Figure 2.13 • Discrepancy in access between urban and rural areas, by region



Source: WHO 2023.
pp = percentage point.

From 2010 to 2021, access to clean cooking improved at an annual rate of 2.0 (1.3–2.6) percentage points per year in rural areas and 0.5 percentage points per year (0.0–0.9) in urban areas. The regions with the fastest progress in rural areas were Central Asia and Southern Asia, with an annual increase of 3.3 (2.0–4.3) percentage points since 2010, and Eastern and South-eastern Asia, 3.4 (1.4–4.9) percentage points. In Sub-Saharan Africa, the access rate in rural areas was stagnant, with annualized increases of just 0.1 percentage point over this period. Globally, progress in rural areas has accelerated sharply in rural areas since 2000, though there has been a slight deceleration since 2017. In urban areas, progress has steadily decelerated for more than 10 years. If these trends continue, the rate of access to clean cooking in urban areas is on course to stall and possibly begin declining as early as 2025.

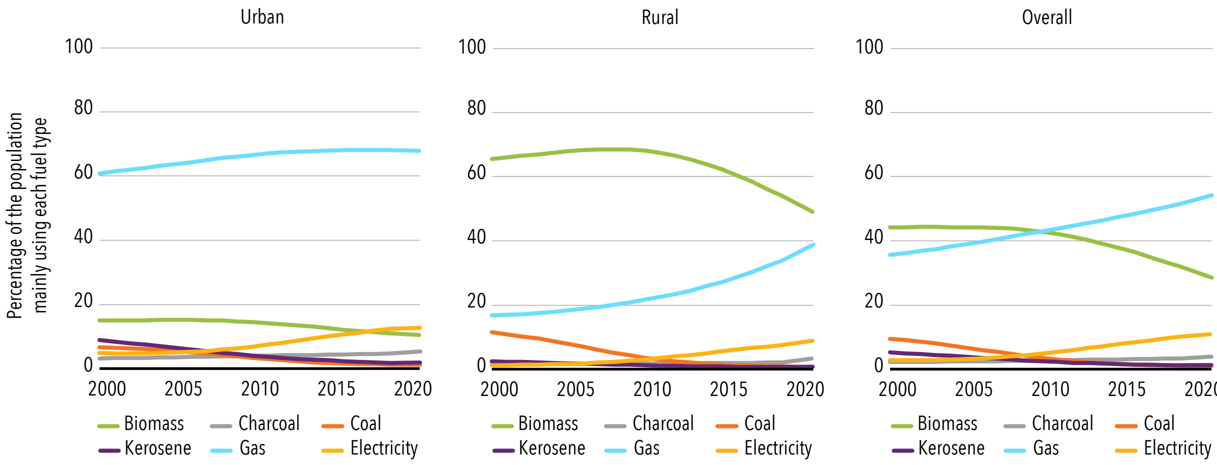
CHANGES IN THE FUEL MIX

Taking a deeper look at the specific fuels and technologies being used in 2021, gaseous fuels (LPG, natural gas, biogas[37]) were the main energy source for cooking of 55 percent (49–60) of people (3.6 billion) (figures 2.14 and 2.15); electricity was the man fuel for of 10 percent (7–14) of people (660 million). Unprocessed biomass (wood, crop waste, dung), a polluting alternative, was the main fuel for 29 percent (24–34) of people (1.9 billion); charcoal of 4 percent (3–4) (240 million). Only 1 percent of people used coal as their main fuel; a similar percentage used kerosene.

Unprocessed biomass, once the most commonly used fuel in low- and middle-income countries, was overtaken by gas around 2010 owing to the rapid growth of LPG programs in India, Indonesia, and Peru, among other countries. However, in rural areas, biomass was still the principal cooking fuel of 49 percent (44–54) of people (1.5 billion) in 2021, more than any other type of fuel. Use of unprocessed biomass may be decreasing in both urban and rural areas, but primary reliance on charcoal persists and is increasing in some areas, particularly urban areas of Sub-Saharan Africa, where it was used by 30 percent (27–34) of people (140 million) in 2021.

The percentage of people who use gas as their primary fuel is rising more quickly than those who use electricity in rural areas. Whereas the use of electricity is rising more quickly in urban areas. Among low- and middle-income countries, the use of electricity is highest in Eastern Asia and South-eastern, at 24 percent (15-34) of people or about 500 million people living in low- and middle-income countries of these regions in 2021.

Figure 2.14 • Percentage of people using each cooking fuel type in low- and middle- income countries, for urban areas, rural areas and overall

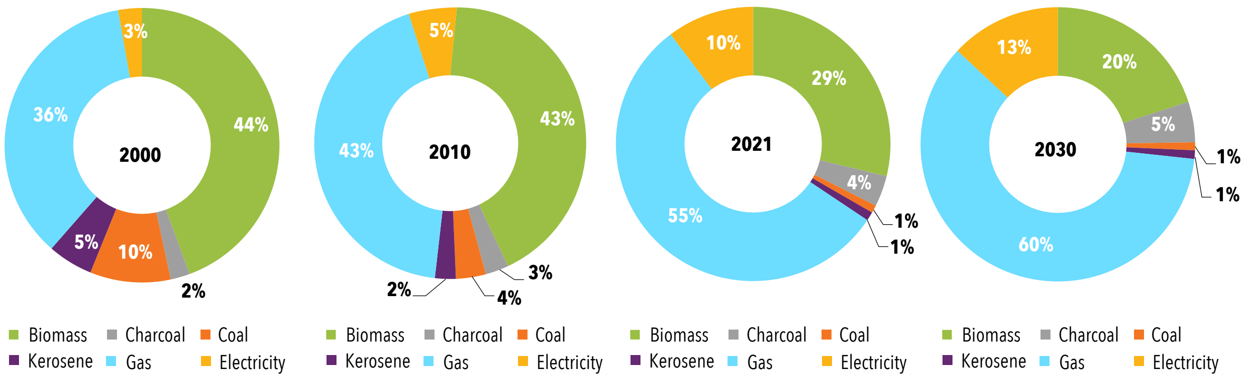


Source: WHO 2023.

37 Gaseous fuels (or gas) refers to LPG, natural gas, and biogas together, as many input surveys do not differentiate among the three.

Progress in the percentage of people using clean fuels and technologies for cooking has been accompanied by steep declines in the use of unprocessed coal and kerosene. In 2000, coal was mainly used by 10 percent (6-15) of the population (480 million people) in low- and middle-income countries, the overwhelming majority of whom (450 million) lived in Eastern Asia and South-eastern Asia (24 percent [13–38] of the population in this region). In 2000, kerosene was the main cooking fuel of 5 percent (4–7) of the population in low- and middle-income countries (260 million people), including 18 percent (14–22) of those (48 million) in urban areas of Sub-Saharan Africa and 26 percent (15–39) of those in urban areas of Oceania (excluding Australia and New Zealand). In 2021, the use of kerosene or coal as the main fuel for cooking fell to a combined 2 percent of the population in LMICs.

Figure 2.15 • Comparison of the percentage of people in LMICs using various fuel types in 2000, 2010 and 2021, with projection for 2030



Source: WHO 2023.

If current trends continue through to 2030, 60 percent of the population in low- and middle-income countries will mainly use gas; 20 percent unprocessed biomass; 12 percent electricity; 5 percent charcoal; 1 percent kerosene; and 1 percent coal. Gaseous fuels, rather than electricity, will account for most of the growth in the share of the population using clean fuels and technologies predominantly.

Fuel stacking (the simultaneous use of several different fuels and stoves) remains extremely common, but the statistics presented here address only the primary cooking fuel, as survey data typically do not account for other fuels used. The number of people relying exclusively on clean fuels is therefore likely to be much smaller than implied by the numbers cited here. Analysis of all cooking fuels used will be possible with greater adoption of survey questions that capture all fuels and technologies used for cooking (World Bank and WHO 2021).

Policy Insights

Clean cooking is a key element of sustainable development. Scaling it up saves lives, enhances well-being, and protects the climate, but the world is falling behind in attaining the goal of universal access by 2030. Putting the world back on track toward the goal will require an immediate boost in cross-sectoral collaboration and action. The need is urgent for public, private and nongovernmental actors working in health, energy, environment, finance, and social development to come together to elevate political commitment, dramatically increase investment, and step up cross-sectoral coordination. Advancing the transition to clean fuels and technologies is a guaranteed win-win for human health and well-being and protection of the natural environment and the climate. The greater the investment, the quicker the win.

CLEAN COOKING: AN ESSENTIAL INGREDIENT FOR IMPROVING LIVES AND GENDER EQUITY

Ensuring healthy lives and promoting well-being for all at all ages (SDG 3) require not only actions that address well-known health risk factors such as active and passive tobacco smoking, harmful use of alcohol, unhealthy diet, and insufficient physical activity, but also other actions that protect people from breathing polluted air in their homes.

In 2021, almost one-third (29 percent) of the world's population still lacked access to clean fuels and technologies for cooking. Such energy poverty puts the health and well-being of the poorest populations at risk, while also contributing to climate change, perpetuating gender inequity, and compromising efforts for sustainable development.

The health consequences that result from household air pollution are stark and tragic. The use of inefficient stoves paired with solid fuels and kerosene releases high-levels of air pollution that puts household members, particularly women and children, at greater risk of acute and chronic disease. The latest estimates for 2019 from the World Health Organization show that 3.2 million deaths are attributable to household air pollution each year (WHO 2022). About 240 000 deaths in children under the age of five are due to household air pollution (WHO 2021a). More than three-quarters of the deaths attributed to household air pollution are from noncommunicable diseases like ischemic heart disease, stroke, chronic obstructive pulmonary disease, and lung cancer. Failure to reach the target of universal access to clean cooking fuels and technologies will continue to claim millions of lives each year.

The lack of access to clean fuels and modern energy systems for cooking impacts beyond health, preventing many from living life to the fullest. The drudgery posed by reliance on inefficient stoves and fuels often falls disproportionately on women and children, particularly girls. The time loss from collecting fuels and preparing meals using inefficient methods keeps them from other social and productive activities like schooling or income-generation, thus hindering the quest for quality education and gender equality for all (SDGs 4 and 5). Such tasks also put them at risk of violence.

Given that current estimates consider only the impact of fuels used for cooking (WHO 2016), the global health toll of energy poverty in households would likely be even greater if the use of polluting fuels and devices for lighting and heating were also accounted for. Household energy is an important source of ambient (outdoor) air pollution (SDG 11); in some communities it accounts for over half of ambient air pollution (WHO 2016; WHO 2021).

EMPOWERING WOMEN ENTREPRENEURS IN CLEAN COOKING: ADVANCING BOTH GENDER EQUITY AND ACCESS TO ENERGY

Empowerment and mentorship programs for women entrepreneurs in the clean cooking value chain have proven effective in promoting a more gender-inclusive workforce. Better representation of women in energy sector policy- and decision-making and more active participation of women entrepreneurs in the clean cooking value chain are important ways to advance gender equity and ensure that efforts to expand access meet the needs of cookstove users (Clean Cooking Alliance 2023). For example, in Nepal, where a transition to e-cooking is underway, a lack of availability of after-sales services was becoming a challenge. To address this gap, the Women's Network for Energy and Environment, with the support of the Gender and Energy Innovation Facility, trained women who owned or worked in electrical appliance stores to provide maintenance and repair services for electric stoves. Such innovation promotes clean cooking, and women's participation in the energy value chain, all the while providing women with additional income and customers a place to go for appliance repair (ENERGIA 2022).

THE URGENT NEED FOR CLEAN COOKING TO COMBAT CLIMATE CHANGE

The lack of widespread access to clean fuels and technologies for cooking has been shown not only to imperil health and exacerbate gender inequality, but also to damage the globe's fragile climate through deforestation from unsustainable wood harvesting and burning of polluting fuels in inefficient stoves. These practices generate greenhouse gases and climate pollutants such as black carbon, which is the second-largest contributor to climate change after carbon dioxide (CO_2) (Bond and others 2013).[38] Household fuel combustion produces about half of the global emissions of black carbon (WHO 2016; Floess and others 2023) and is responsible for many of the climate change impacts seen today—disrupting regional environmental systems (such as the Arctic and the high mountain glaciers of the Himalayas) that are critical to human welfare, wildlife habitats, and surrounding ecosystems.

CLEAN ENERGY FOR COOKING: A PATHWAY TO CLIMATE AND HEALTH CO-BENEFITS

Expanding access to clean energy for cooking can immediately begin to mitigate these damages, offering an unparalleled opportunity for climate and health co-benefits. Black carbon's short lifespan in the atmosphere (on the order of days to weeks) means that reducing its emissions can slow warming immediately. Replacing biomass with electricity and LPG can thus bring large benefits to both human health and the climate by reducing greenhouse gas emissions as well as black carbon (Floess and others 2023) (box 2.1). The avoided emissions of methane, black carbon, carbon monoxide and other climate forcing pollutants released during the inefficient combustion of biomass (or other solid fuels) in traditional stoves is higher than the additional emissions that may result from using a mix of LPG and electricity, even after considering the total energy value chain from production to use. This would be true even without accounting for the avoided black carbon emissions and the impact of the use of biomass on forests (IEA 2022a).

Alternative clean fuels such as biogas could facilitate transitions to clean fuels in rural areas while mitigating the impact of other sources of climate pollutants such as agricultural waste. For example, the West and Central Africa Alliance for Biodigester Promotion was established to strengthen deployment of biodigesters across eight countries, building on the experience of the Africa Biogas Partnership Program. In 2021, across selected countries in Sub-Saharan Africa, household biodigester adoption increased to more than 27 000 systems—a 10 percent increase from 2020 (SNV 2022).

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38 Black carbon is one of the most potent short-lived climate pollutants. It absorbs sunlight and heats the atmosphere. It has also been associated with cardiovascular damage and premature mortality.

Box 2.1 • Clean household energy as a key climate change mitigation strategy

Transitioning from biomass to LPG and electricity for household energy is a net win for the climate, even after considering the entire energy life-cycle (Floess and others 2023). The analysis was conducted in 77 countries where at least 1 million people use polluting solid fuels and/or kerosene for cooking. Compared with a "business as usual" scenario, transitioning to all LPG, a mix of LPG and electricity, or all electricity reduced emissions of greenhouse gases by 17 percent, 31 percent, and 47 percent, respectively, and eliminated nearly all black carbon emissions from household cooking. The clean cooking scenarios yielded an average 5 mK reduction in global temperature by 2040 and a 6 Mt (99 percent) decrease in annual emissions of $PM_{2.5}$ by 2040.

Another analysis found similar results, showing that transitions to universal access to clean cooking by 2030 while leading to a slight increase in CO_2 emissions, overall led to net benefits for climate. Due to the avoided methane and nitrous oxide emissions from traditional biomass use, this analysis estimated that such a transition would result in a savings of 870 Mt CO_2-equivalents (IEA 2022a).

Such analyses add to the evidence base on the potential for clean household energy solutions to contribute significantly to climate change mitigation. Findings on the costs and potential impacts of efforts to promote clean household energy can be used not only to increase awareness and commitment to achieving clean household energy transitions but also to drive increased investment.

The mounting evidence on the climate, health, and social co-benefits of clean household energy transitions highlights the importance of including commitments to wider access in Nationally Determined Contributions as a key strategy for slowing climate change and advancing toward the goal of net-zero emissions by 2050.

KEEPING PACE WITH URBANIZATION

While the narrowing of the urban-rural disparity in access to clean cooking seen in most regions is encouraging,[39] urban areas' projected stalled progress in the next two years is important to note. Historically, households in rural areas tend to rely on solid fuels such as charcoal and biomass because of their cheaper cost, their availability, and the relative inaccessibility of cleaner alternatives. On the other hand, urban areas often have infrastructure in place, such as paved roads and electricity grids, that can facilitate transportation and distribution of cleaner energy fuels and appliances. However, with the rapid pace of urban population growth in many parts of the world, supplying clean energy services is a looming challenge for cities, particularly in slums and informal settlements that are often characterized by poverty and concentrated deprivation (UN Habitat 2022). To avoid such an unhealthy transition, recommendations are needed for policies to deal effectively with intra-urban inequities and the constraints of the urban poor in accessing clean fuels and technologies. Such policy insights can then inform governments and other stakeholders on how best to invest in clean cooking access in these impoverished areas so that poor and vulnerable populations are not forgotten.

39 The gap is narrowing in all regions except Sub-Saharan Africa, where it is increasing sharply.

ENSURING CLEAN COOKING AS PART OF BROADER ENERGY PLANNING

Universalizing access to clean cooking will require the inclusion of clean cooking within broader energy planning efforts. Integrated energy planning is a promising approach that takes a holistic look at a country's energy system when planning for household and institutional access to electricity and clean cooking (SEforALL 2023). A well-crafted integrated energy plan can unlock actionable market intelligence for the private sector, policy makers, and funders by identifying priority geographic areas for expanding energy access and the least-cost technology to be deployed. Having such data maximizes efficiency in building infrastructure to provide services where they are most needed. The new data-driven Nigeria Integrated Energy Planning Tool, developed under this framework, is powered by extensive geospatial modeling and layers of data. Covering electrification, clean cooking, and productive uses of electricity, it provides actionable intelligence for the government, donors, investors, and private sector stakeholders to plan and deliver the least-cost access to electricity and clean cooking (SEforALL 2021).

BUILDING COMMITMENTS FOR ACTION THROUGH NATIONALLY DETERMINED CONTRIBUTIONS AND ENERGY COMPACTS

Nationally Determined Contributions (NDCs) under the Paris Agreement on climate change and national clean cooking strategies and commitments, including energy compacts, can serve as opportunities or vehicles to pair political and financial commitments for scaling up action on clean cooking. As of October 2021, 67 countries included clean cooking- and other household energy-related goals in their NDCs (Clean Cooking Alliance 2021). Energy compacts have been mobilized since the United Nations (UN) High-Level Dialogue on Energy in September 2021 as a policy instrument to accelerate actions on clean cooking and other energy goals.

Ethiopia, Honduras, Kenya, Madagascar, Malawi, Nepal, Nigeria, Rwanda, Sierra Leone, and Zambia have all pledged in their energy compacts to accelerate access to clean cooking through 2030 and beyond. Not only low- and middle-income countries are committed. Netherlands and the United Arab Emirates have also pledged in their compacts to support clean cooking efforts (United Nations 2023). The Netherlands has recognized that clean cooking is a key solution to reducing carbon emissions and pledged its support for increased action to achieve universal access through multi-stakeholder partnerships, innovative business models, and financing strategies such as carbon credit markets to provide affordable clean cooking options to millions of the world's poorest and most vulnerable (United Nations 2023).

However, while the commitments are notable, most of the access targets specified in these compacts are below what would be required to achieve the SDG 7.1.2 target of universal access to clean cooking by 2030 (IEA 2022a). Nonetheless, countries pairing political and financial commitments to clean cooking have been able to show significant progress in the short term. This includes Kenya, which has been notably active in its political commitments and social enterprise efforts (box 2.2).

Other non-state actors, such as companies, regional and local governments, and nongovernmental organizations, have also joined in the commitment to accelerate access to clean cooking. For example, the Clean Cooking Alliance has launched a multilateral energy compact that aims to catalyze commitment and investment for clean cooking; the compact has been endorsed by more than 60 governments and organizations around the world (Clean Cooking Alliance 2023; United Nations 2023).

If realized, national targets to accelerate access to clean cooking, as spelled out in NDCs and energy compacts, have the potential to improve human health, livelihoods, the climate, and the natural environment at large. Promoting the

Box 2.2 • Kenya: Championing clean cooking

Over the last decade, Kenya's rate of access to clean cooking technologies rose by 15 percentage points, from 9 percent in 2012 to 24 percent in 2021. The increase translates into close to 10 million people gaining access. Kenya has been active on the clean cooking front at all levels, from much needed political support by the government and political leaders—including First Lady Rachel Ruto (Nation 2022)—to encouraging private enterprises that bring high-quality, energy-efficient, and affordable stoves and fuels to the most vulnerable and underserved populations (MECS 2021).

Although there have been setbacks in access to clean cooking as a result of the COVID-19 pandemic, numerous countries, Kenya among them, remain committed to accelerating action on clean cooking, as recently evidenced by their commitments in energy compacts (United Nations 2023).

Kenya has pledged in its energy compact to universalize household use of clean cooking technologies and fuels by 2028 through actions such as communication strategies, targeted subsidies, and consumer financing. Kenya's clean cooking commitment goes beyond just universal access for households. The country additionally pledges in the compact to transition all public institutions from the use of biomass cooking fuels by 2025. All micro, small, and medium-sized enterprises in the cooking and hospitality sectors will similarly convert to clean cooking solutions by 2028. Kenya has set a budget of USD 605 815 000 to achieve these goals.

Kenya's target to reach universal clean cooking by 2028 aligns with the country's announcement to develop a National eCooking Strategy, one of the first electric cooking strategies of its kind in Africa. The strategy will encourage the use of electric cooking appliances through media campaigns, cooking classes, and demonstrations. Kenya Power and Lighting Company has also begun to explore on-bill repayment for electric cooking devices to encourage households to switch (IEA 2022a).

Kenya's ambitious compact, political engagement, and eCooking strategy set an excellent example of a holistic approach to scaling up clean cooking to advance national agendas in health, development, and the environment.

use of a range of cleaner cooking fuel options such as electricity, LPG, ethanol, and biogas should thus be upheld as an important implementable action for countries to use to advance development outcomes, preserve nature, and mitigate and adapt to the effects of climate change.

TACKLING AFFORDABILITY TO ENHANCE THE ADEQUACY OF POLICIES

Subsidies can help bridge the affordability gap by reducing the upfront and recurring costs of clean cooking systems; they have been instrumental in expanding LPG use in multiple Latin American countries (MECS 2020) (box 2.3). Through the Indian government's Pradhan Mantri Ujjwala Yojana initiative, launched in 2016, hundreds of millions of dollars have been allocated to expand LPG coverage to over 50 million low-income households through targeted LPG subsidies, accompanied by the establishment of thousands of new LPG distributors to meet growth in demand (WHO 2018; Singh, Pachauri, and Zerriffi 2017; Ministry of Petroleum and Natural Gas 2016). China's coal-to-electricity program, in which a ban on household coal use was implemented alongside subsidies for new technologies, demonstrates policy mechanisms that jointly consider clean fuel adoption and disincentives for the use of polluting fuel (Barrington-Leigh and others 2019). The latter is an essential component of the clean energy transition process that is often overlooked, but equally critical to reduce air pollution and reap benefits to health and the climate.

Box 2.3 • Affordability: Learning from the Latin American clean cooking transition

Over the last three decades, low- and middle-income countries in the Americas have made substantial progress in scaling up clean cooking. Almost 90 percent of the population in the Americas now rely chiefly on clean fuels and technologies for cooking. Households in urban areas report almost exclusive use, with 97 percent of urban households mainly using clean fuels and technologies for cooking (97 percent of the urban population and 74 percent of the rural population). As a region and with some 75 million in mainly 10 countries lacking access to clean cooking, the Americas is on its way to a complete regional transition to clean cooking.

Understanding the factors that have enabled the successful transition of a majority of the population over the past 30 years can provide valuable lessons for other low- and middle-income countries working toward the elimination of polluting cooking practices.

Affordability of both stoves and recurring fuels costs is one of the greatest barriers for low-income households considering clean cooking solutions. Households often face hard choices when it comes to spending limited resources and, in many cases, clean cooking is often not prioritized. However, governments can take steps to tackle the affordability barrier. In the case of Latin America, the most common step has been end-user subsidies.

End-user subsidies for cooking stoves and fuels have been used in many Latin American countries since the 1970s, with variations in price point and delivery mechanism. Much can be learned from the historical record.

Bolivia, Ecuador, and El Salvador each has a rural population of about 30 percent. All three countries have provided substantial subsidies for LPG fuel for cooking. The subsidies cover 60–95 percent of the cost of LPG (Gould and others 2018; OLADE 2013).

In El Salvador, a 65 percent universal LPG subsidy was put in place in 1974; it was replaced in 2011 with a targeted subsidy of one 25-pound LPG cylinder per month per family, covering almost 70 percent of the population (Calvo-Gonzalez, Cunha, and Trezzi 2015). Access to clean fuels reached 93 percent in 2021, much higher than neighboring Central American countries without an LPG subsidy: Guatemala, 48 percent; Honduras, 50 percent; Nicaragua, 57 percent; and Mexico, 85 percent.

Largely as a result of subsidy policies, 95 percent of Ecuador's population uses LPG for cooking; Bolivia's figure is 82 percent. In comparison, Peru and Paraguay, neighboring countries with higher GDP per capita and similar or higher rates of urbanization, stand at 76 percent and 66 percent, respectively.

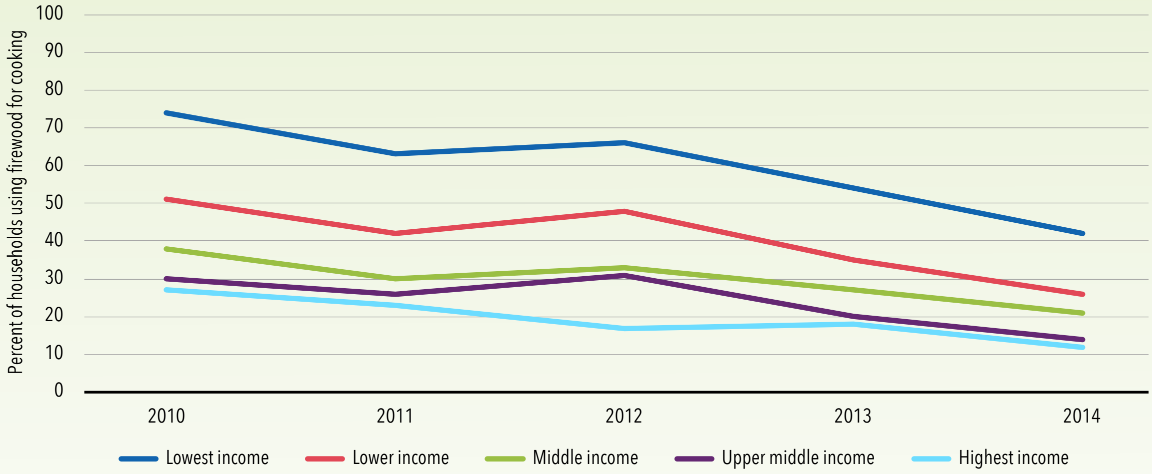
Implementing the subsidies was not without challenges. Each country faced different implementation issues. In Bolivia, for example, the lack of infrastructure to maintain a reliable distribution of LPG to remote and poorly connected areas presented problems. In El Salvador, the 2011 shift of the subsidy from universal to targeted had an almost immediate impact on fuel-use patterns, with many households reverting back to polluting cooking stoves and fuels (figure B.2.3.1). In light of this, the government quickly adapted the policy to be more targeted by income group, resulting in an immediate shift back to LPG usage among the poorest populations. Likewise, in Ecuador, because of the high costs of imported LPG, the government invested in a program to substitute local renewable electricity for LPG in 2014 (Gould and others 2018). Massive protests made it impossible to remove the LPG subsidy, however, and most households still cook with LPG.

These countries provide lessons on the use of end-user subsidies to support the transition to clean cooking:

- In some countries, the sustained practice of clean cooking is highly dependent on subsidies and very sensitive to changes in policy and price.

- Urbanization is a driver of change, but the urban-rural gap in access to clean fuels for cooking is also sensitive to fuel subsidy policies.
- Low-income countries may need sustained and focused development aid to overcome infrastructure and resource constraints, particularly in the most remote areas.
- Transitioning from LPG to electricity is complex, requiring investment in infrastructure and changes in cooking practices.

Figure B.2.3.1 • Use of firewood in rural areas of El Salvador by wealth



Source: Encuesta de Hogares de Propósitos Múltiples (EHPM 2014).

Scaling up investment in clean cooking is an investment in social goods. The timing is more critical than ever for policy makers and funders to redouble efforts to unlock finances for clean cooking. It is also important to understand lessons learned from past policies, such as those highlighted in the World Bank's Regulatory Indicators for Sustainable Development report (ESMAP 2022) and WHO's Household Energy Policy Repository (WHO 2021c).[40]

40 The Regulatory Indicators for Sustainable Energy (RISE) assesses countries' national policies and regulatory frameworks for sustainable energy according to a set of standard indicators. These resources can serve as a useful knowledge base to draw valuable lessons and spark discussions on what policy mechanisms are most likely to be successful and which might be implemented at scale. WHO's Clean Household Energy Policy Repository compiles national, regional, and local policies on clean household energy that include financial measures (such as taxes, subsides, or voucher programs), regulatory instruments (such as limits or bans on specific fuels or technologies), trade policies, direct investments, codes and standards, and information campaigns.

PATH FOR PROGRESS FOR SCALING UP CLEAN COOKING: URGENT ACTION REQUIRED FOR UNIVERSAL ACCESS BY 2030

There are encouraging signs that efforts to scale up clean cooking access are moving forward in some places. Transitioning to clean cooking is accelerating in certain countries—China, Ghana, Kenya, and India chief among them—that have made good progress in recent years through increased political support and advocacy, matched by adequate financial commitments and actions on the ground.

While there has been some progress over the past two decades in expanding access to clean fuels and technologies for cooking, there is an urgent need to further scale up ambition and action to achieve universal access to clean cooking by 2030. Enhanced innovation in delivery mechanisms paired with large-scale public investment to crowd in private investment is needed to lower the cost of clean cooking needed to accelerate progress. Furthermore, clean cooking needs to remain high on global political agendas. With the upcoming voluntary review of SDG 7 including clean cooking at the High-Level Political Forum as well as the SDG Summit and Climate Ambition Summit in September 2023, global leaders and governments will have the opportunity to demonstrate their commitments to clean cooking to achieve various health, climate and other cross-cutting goals.

Outlook

1.9 BILLION PEOPLE WILL STILL LACK CLEAN COOKING IN 2030

Regardless of whether one considers the current rate of progress in energy access, current policies, or pledged policies, the world is far off pace to achieve the universal target to clean cooking by 2030. Based on current trends, WHO estimates that 1.9 billion people will still lack access to clean cooking by 2030. The International Energy Agency's (IEA) Stated Policies Scenario yields similar figures, even after accounting for the positive impacts of policies already in place (IEA 2022b).

Under IEA's Announced Pledges Scenario,[41] which assumes that all aspirational targets announced by governments are met in full and on time, the outlook is less grim but still off-track, with an estimated 0.7 billion people still relying on traditional stoves and fuels in 2030.

Given current trends, the pledge made at the UN's 2021 High-level Dialogue on Energy to ensure that an additional 1 billion people would gain access to clean cooking solutions by 2025 will not be reached.[42] The number of people with access to clean cooking will increase by only 510 million from 2021 to 2025. The expected access deficit is largely concentrated in Sub-Saharan Africa, where almost 60 percent of the population is projected to still lack access to clean cooking in 2030.

41 IEA introduced the Announced Pledges Scenario in 2021. It aims to show to what extent the announced ambitions and targets, including the most recent ones, are on the path to deliver emissions reductions required to achieve net zero emissions by 2050 (IEA 2022b). Compared to the Stated Policies Scenario, it includes announcements on pledges and targets, regardless of whether these have been anchored in legislation or in Nationally Determined Contributions.

42 The pledge was made during the High-level Dialogue on Energy in 2021, as part of the Global Roadmap for Accelerated SDG7 Action in Support of the 2030 Agenda for Sustainable Development and the Paris Agreement on Climate Change (United Nations 2021).

COVID-19 AND SOARING ENERGY PRICES THREATEN CLEAN COOKING ACCESS FOR MILLIONS

The IEA estimates that the combination of the COVID-19 pandemic and current soaring energy prices will put basic electricity out of reach for almost 75 million people (IEA 2022a). The same affordability issues are expected to have an even more dramatic impact on the clean cooking transition, with 100 million people who recently transitioned to clean cooking expected to revert to using traditional biomass due to affordability issues. Between 2019 and 2021, Eastern Asia and Latin America and the Caribbean were the only regions to sustain progress in access to clean cooking (ESMAP 2022).

The goal of achieving universal access to electricity and clean cooking will require a massive increase in governmental efforts to regain the momentum. Yet only 39 of the 128 countries currently lacking universal access to clean cooking have set clean cooking targets, and less than half of those aim to achieve universal access by 2030 (IEA 2022a). The current policy ambitions are therefore far from the targets of SDG 7. It is necessary to improve implementation and raise the level of ambition in many countries to bridge the gap between the current situation and the SDG 7 targets.

CLEAN COOKING — AN IMPORTANT ELEMENT ON THE PATHWAY TO NET ZERO

Clean cooking is a potent way to fight climate change. The unsustainable harvesting of fuelwood and high-levels of emissions (particularly black carbon from inefficient household energy use) have detrimental effects on the climate, thus jeopardizing the future of humanity and the planet. Climate change is expected to cause approximately 250 000 additional deaths each year from 2030 to 2050 owing to malnutrition, malaria, diarrhea and heat stress alone (WHO 2021b).

The pathway to arresting the rise in the world's average temperature to +1.5 °C therefore requires immediate actions from the entire energy sector, and clean cooking can play an important role. Accounting for the emissions of the full energy lifecycle (i.e. both upstream and end-use emissions), shifting households entirely to LPG could curb short-lived climate pollutants emission almost entirely (Floess and others 2023). But for that to happen, under IEA's Net Zero Emissions by 2050 Scenario (IEA 2022b), the rate of improvement in access to clean cooking will have to rise dramatically from an annual increase of 1.7 percentage points between 2015 and 2019, to 2.7 percentage points, nearly double the current rate of progress. Looking at regional trends is critical, as access rates vary greatly. While low- and middle-income countries in Asia will have to improve their rate by 1.5 times, improvements in Sub-Saharan Africa will have to increase by a magnitude of 15 times (IEA 2022a).

CREATING A VOICE FOR CLEAN COOKING IN THE COMMUNITY

The benefits of clean cooking need to be better understood. From policy makers to the stove user, understanding the benefits and advantages of clean cooking is an important element needed to drive a sustained transition to clean cooking. Various efforts are underway to strengthen and coordinate positive messages about the environmental, climate, and health benefits of clean cooking to a broad set of stakeholders. For example, in Bangladesh, messages regarding the health benefits of clean cooking were mainstreamed into cooking TV shows to better reach younger audiences (Clean Cooking Alliance 2023). Similar efforts are being used in Ghana to integrate the health and environmental impacts of traditional and clean cooking into the school curriculum. Enhanced messaging via social media and local advertising is used in Kenya and Nepal, among other places, to broaden the uptake of clean cooking solutions. Good communication about the benefits of clean cooking is an essential complement to any policy or program.

COSTING THE CLEAN COOKING TRANSITION

According to the World Bank, the health costs alone from lack of clean cooking are estimated at USD 1.4 trillion per year (ESMAP 2020). Women are particularly affected, and their loss of productivity amounts to USD 0.8 trillion every year. When adding environmental costs, the price tag comes to USD 2.4 trillion a year, far greater than the cost of transitioning to universal modern energy cooking services (USD 148–156 billion annually over the next 10 years, for a total of USD 1.5 trillion). Greater efforts should be made to calculate with precision the negative externalities of failing to universalize access to clean cooking in terms of productive time lost, missed opportunities for schooling, and environmental damage. Given the direct effect of polluting fuels and technologies on climate change funding could be leveraged to fill at least part of the gap (UN DESA 2018).

NEED FOR ACTION FOR HEALTHIER LIVES AND ENVIRONMENT

The benefits of clean cooking are far too high to delay any further. Billions of the world's people are suffering from the adverse health, environmental, and economic effects of polluting cooking practices. The humanity faces unprecedented challenges with triple planetary-crisis of pollution including household air pollution, biodiversity loss and climate change. Clean cooking has been proving an effective entry-point to tackle and help mitigate the impacts, from economic losses to deterioration of life on our planet. The cost will continue to mount unless political and financial commitments rise to meet the challenge. The moment to act is now.

Methodological Notes

DATA SOURCES

The WHO Household Energy Database contains nationally representative household survey data (WHO 2018). Regularly updated, it relies on several sources (table 2.1) and serves as the basis for all modelling efforts in this report. The database contains more than 1,500 surveys conducted in 171 countries (including high-income countries) between 1960 and 2022. A quarter of the surveys cover the years 2013 to 2018; 250 new surveys cover 2016 to 2022. Modelled estimates are provided only if there is underlying survey data on cooking fuels, so there are no estimates for Lebanon, Libya and Bulgaria.

Population data are from United Nations (2018).

Table 2.1 • Overview of data sources for clean fuels and technology

NAME	ENTITY	NUMBER OF COUNTRIES	DISTRIBUTION OF DATA SOURCES (IN PERCENT)	QUESTION
Census	National statistical agencies	108	18.4	What is the main source of cooking fuel in your household?
Demographic and Health Survey (DHS)	Funded by USAID; implemented by ICF International	81	17.2	What type of fuel does your household mainly use for cooking?
Living Standards Measurement Survey (LSMS), income expenditure surveys, and other national surveys	National statistical agencies, supported by the World Bank	26	3.00	Which is the main source of energy for cooking?
Multiple Indicator Cluster Surveys (MICS)	UNICEF	80	10.90	What type of fuel does your household mainly use for cooking?
Study on Global AGEing and Adult Health (SAGE)	WHO	6	0.40	NA
World Health Survey	WHO	50	3.80	NA
National surveys		107	35.80	NA
Other		79	10.30	NA

MODEL

As household surveys are conducted irregularly and reported heterogeneously, the WHO Global Household Energy Model (developed in collaboration with the University of Glasgow) is used to estimate trends in household use of six fuel types:

- unprocessed biomass (e.g., wood)
- charcoal
- coal
- kerosene
- gaseous fuels (e.g., LPG)
- electricity

Trends in the proportion of the population using each fuel type are estimated using a Bayesian hierarchical model, with urban and rural disaggregation, drawing on country survey data. Smooth time functions were the only covariate. Estimates for total polluting fuel use (unprocessed biomass, charcoal, coal, and kerosene) and total clean fuel use (gaseous fuels, electricity, and an aggregation of other clean fuels, such as alcohol) are produced by aggregating estimates of relevant fuel types. Estimates produced by the model automatically respect the constraint that the total fuel use equals 100 percent.

GHEM is implemented using the R programming language and the NIMBLE software package for Bayesian modelling with Markov chain Monte Carlo (MCMC). Summaries can be obtained to provide both point estimates (e.g., means) and measures of uncertainty (e.g., 95 percent credible and 95 percent prediction intervals). The GHEM is applied to the WHO household energy database to produce a comprehensive set of estimates, together with associated measures of uncertainty, of the use of four specific polluting fuels and two specific clean fuels for cooking, by country, for each year from 1990 to 2019. Further details on the modeling methodology and validation can be found in Stoner and others (2020), and more detailed analysis of individual fuel use can be found in Stoner and others (2021).

Only surveys with less than 15 percent of the population reporting “missing”, “no cooking,” and “other fuels” were included in the analysis. Surveys were also discarded if the sum of all mutually exclusive categories reported was not within 98–102 percent. Fuel use values were uniformly scaled (divided) by the sum of all mutually exclusive categories, excluding “missing,” “no cooking,” and “other fuels.” Countries classified by the World Bank as high-income (58 countries) in the 2021 fiscal year were assumed to have transitioned to clean household energy. They are therefore reported as having >95 percent access to clean fuel and technologies; no fuel-specific estimates were reported for high-income countries. In addition, no estimates were reported for low- and middle-income countries without data suitable for modeling (Bulgaria, Lebanon, and Libya). Modeled specific-fuel estimates were reported for 130 low- and middle-income countries plus 3 countries with no World Bank income classification (Venezuela, Niue and Cook Islands); estimates of overall clean fuel use were reported for 191 countries.

UNCERTAINTY INTERVALS

Many of the point estimates we provide here are accompanied by 95 percent uncertainty intervals, which imply a 95 percent chance that the true value lies within the given range. Small annual changes in the point estimate may be statistical noise arising from either the modeling process or survey variability and may therefore not reflect a real variation in th e numbers relying on different fuels between years. The uncertainty intervals should therefore be considered when assessing changes in the access rate, or in the use of specific fuels, between years.

Moreover, for some countries a lack of recent survey data (e.g., in the last 10 years) naturally leads to very wide uncertainty intervals associated with estimates for 2021 and preceding years. For countries with very wide uncertainty intervals, point estimates should be treated with some caution.

GLOBAL AND REGIONAL AGGREGATIONS

Population data from the United Nations Population Division (United Nations 2018) were used to derive the population-weighted regional and global aggregates. Low- and middle-income countries without data were excluded from all aggregate calculations; high-income countries were excluded from aggregate calculation for specific fuels.

The aggregation methods used ensure that uncertainty in the percentage of people and absolute number of people using different fuels for cooking in individual countries propagate into the uncertainty intervals accompanying global and regional estimates.

ANNUALIZED GROWTH RATES

The annualized increase in the access rate is calculated as the difference between the access rate in year 2 and that in year 1, divided by the number of years to annualize the value:

(Access Rate Year 2–Access Rate Year 1) / (Year 2–Year 1)

This approach takes population growth into account by working with the final national access rate.

PROJECTIONS

Projected access rates, access deficits, and fuel use can be estimated using the GHEM, where uncertainty increases the further into the future estimates are calculated, reflecting how country trends may shift based on how unsettled they were during the data period.

Projections in this chapter are hypothetical scenarios in which no new policies or interventions (positive or otherwise) take place. As such, they are useful as baseline scenarios for comparing the effect of interventions. The scenarios are calculated by extrapolating current trends into the future.

The estimated year each country will achieve 95 percent access to clean fuels and technologies is taken from these projections.

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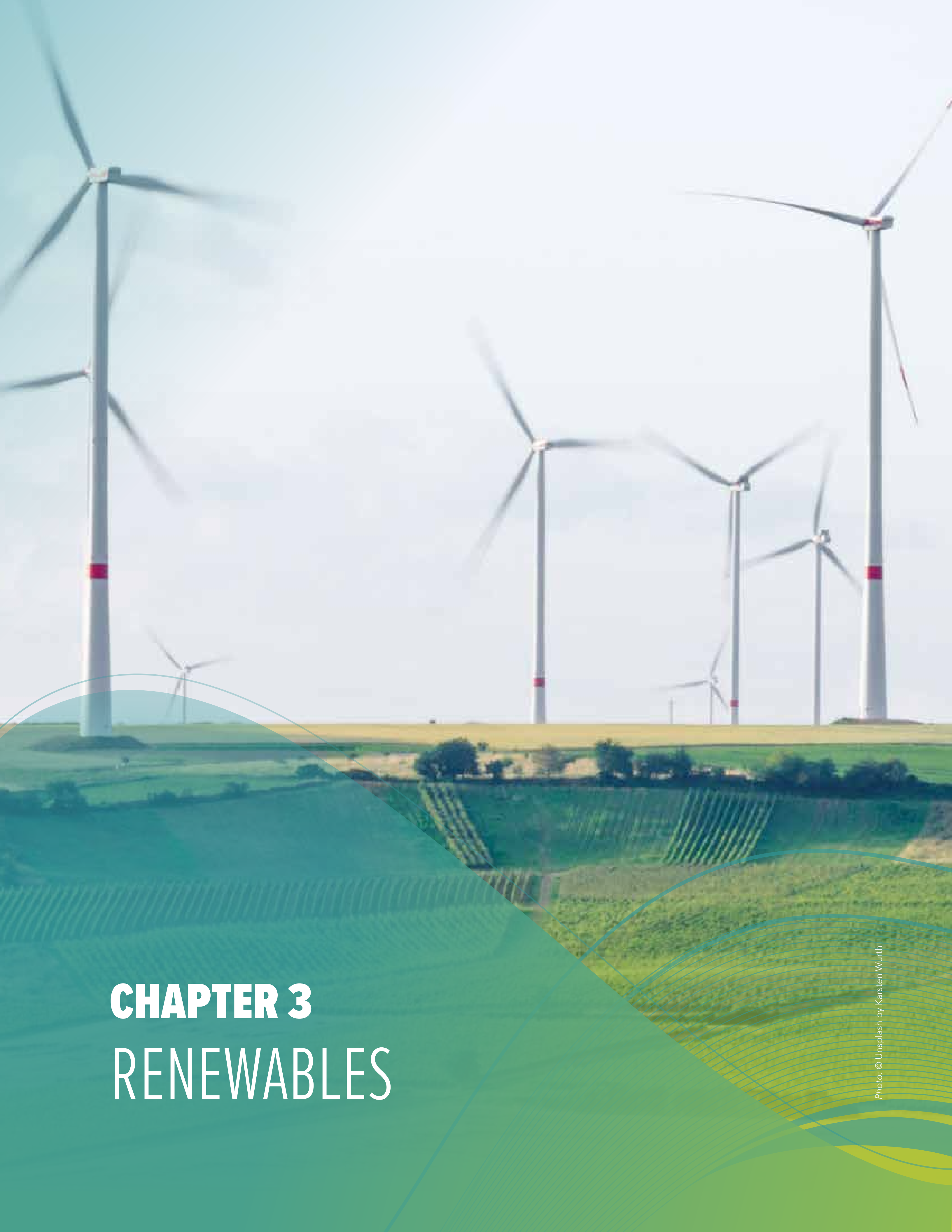


CHAPTER 3
RENEWABLES

Photo: © Unsplash by Karsten Wurth

Main Messages

- **Global trend.** In 2020, renewable energy consumption, including traditional uses of biomass, continued to grow at 2.6 percent year-on-year globally, despite a turbulent year due to the Covid-19 pandemic. This growth was driven largely by increases in renewable power generation, notably due to record additions of solar PV and wind capacity. Reduced energy consumption during the Covid-19 pandemic made 2020 a statistical anomaly, causing the share of renewables in total final energy consumption (TFEC), the central metric for SDG7.2, to increase by an unprecedented 1.4 percentage points to 19.1 percent.[43] However, this notable increase is not expected to repeat itself in 2021, as TFEC is anticipated to rebound close to pre-pandemic levels with the recovery of economic activity and restrictions of movements being lifted in most countries. When looking only at modern uses of renewables, their share of TFEC stood at 12.5 percent in 2020, only 3.8 percentage points more than a decade earlier, as the increase in TFEC exceeded those in modern uses of renewable energy consumption, underscoring the importance of energy efficiency (SDG7.3) and energy conservation actions.
- **Target for 2030.** While no quantitative milestone has been set for SDG target 7.2 which calls for "increasing substantially the share of renewable energy in the global energy mix", custodian agencies indicate that current trends are neither in line with the target's ambition nor with internationally agreed-upon climate objectives. To meet these objectives, the share of modern uses of renewables in TFEC would need to almost triple to 33-38 percent by 2030 depending on different pathway assumptions. Reaching these levels requires sustaining the accelerated renewables deployment seen in the electricity generation sector and considerably stepping up the share of renewables in heating and transport, alongside substantial progress in energy conservation.
- **Electricity.** Renewable electricity use grew more than 7 percent year-on-year in 2020, with the share of renewables in global electricity consumption increasing from 26.3 percent in 2019 to 28.2 percent. This is the largest annual progress recorded over the past three decades. Greater reliance on renewable electricity combined with the stabilization of global electricity demand in 2020 allowed nonrenewable electricity consumption to drop 2.8 percent year-on-year. Hydropower remains by far the largest source of renewable electricity globally, followed by wind and solar photovoltaic (PV). Yet the deployment of both wind and solar PV is accelerating; they recorded the largest absolute annual growth in 2020, and together represent two-thirds of the global increase in renewable electricity consumption observed since 2015.
- **Heat.** Renewable energy consumed for heating increased 0.9 percent to 42 exajoules (EJ) in 2020. Unfortunately, traditional uses of biomass represented almost 60 percent of this growth increasing the scale of negative health, social and environmental impacts of the lack of access to clean cooking. This was mainly caused by the Covid-19 pandemic that disrupted clean cooking fuel deliveries and imposed working restrictions reducing consumer ability to afford modern fuels, pushing many back to the traditional uses of biomass. The traditional

43 This calculation for the heat sector does not include renewable electricity used for heating or ambient heat harnessed by heat pumps. This exclusion reflects limited data availability at a global scale and the difficulty of quantifying the portion of electricity consumption devoted to heating.

use of biomass still accounted for nearly 14 percent (24 EJ) of global heating needs in 2020. In 2020, the share of modern uses of renewables in the global energy consumed for heating reached just 10.4 percent, only 1.2 percentage points higher than in 2015. The most-energy-intensive industries, such as steel, cement, chemicals, and aluminum, still rely heavily on fossil fuels for high-temperature heat. Processes based on renewable-derived alternatives like hydrogen are being explored. Yet the penetration of renewable energy remains challenging in these energy-intensive sectors, and it is therefore crucial to reduce the material intensity of industry, notably construction, to achieve a greater share of renewables in heat.

- **Transport.** The transport sector, affected as it was by policy responses to the pandemic, saw a 14 percent (-16.6 EJ) decline in global final energy consumption in 2020. Biofuel for transport declined in lockstep with oil consumption, leading to the largest reduction amongst renewable energy sources between 2020 and 2019, at an estimated 4 percent (-0.16 EJ). This was the first reduction in annual production in two decades. Biofuels—primarily crop-based ethanol and biodiesel—still supplied 90 percent of renewable energy used for transport. The remainder was mostly from renewable electricity, with its share in the TFEC for transport increasing to 0.4 percent (0.41 EJ) owing to rising sales of electric vehicles and a larger share of renewables in electricity used for transport. This brings the total share of renewable energy to 4 percent (up from 3.6 percent in 2019) for this sector, only 0.9 percentage point higher than in 2015.
- **Regional highlights.** In 2020, almost half of the global year-on-year increase in modern uses of renewable energy consumption was in Eastern Asia—led by China—where wind, hydropower, and solar PV dominated growth. Europe accounted for more than one-quarter of this increase in modern uses of renewable energy consumption, owing to favorable conditions for hydropower and the growth of wind and solar PV capacity. The share of renewables in TFEC increased in all regions in 2020, and grew the fastest in Latin America and Europe, supported in both cases by significant declines in TFEC. Sub-Saharan Africa accounts for the largest share of renewables in its energy supply at 71 percent, due to the predominance of traditional uses of biomass for heating and cooking in this region. Meanwhile, Latin America and the Caribbean has the largest share of modern uses of renewables in TFEC at 29%, owing to hydropower generation and the consumption of bioenergy in industrial processes and biofuels for transport in this region.
- **Top 20 energy-consuming countries.** Among the top 20 energy-consuming countries, Brazil and Canada continued to have the largest shares of modern uses of renewables in 2020, owing to their heavy reliance on hydropower for electricity and bioenergy for heat and transport. Except Türkiye, all countries saw an increase in the share of modern uses of renewables in their TFEC in 2020, with Indonesia achieving the largest year-on-year growth, followed by Brazil and the United Kingdom. Between 2010 and 2020, this share had declined in 3 of the 20 countries (Nigeria, Pakistan, and Türkiye), despite growing consumption of modern uses of renewable energy in all of them. In the same period, the consumption of nonrenewable energy increased in 11 of these countries. This highlights the importance of containing overall energy consumption and expediting the shift away from fossil fuels to achieve greater shares of renewables in the energy mix.
- **Installed renewable energy-generating capacity in developing countries.**[44] A record 268 watts per capita of renewable capacity were installed in 2021, representing a year-on-year growth rate of 9.8 percent. Despite this promising trend, more needs to be done toward indicator, 7.B.1, to "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 landlocked developing countries, in accordance with their respective programmes of support." This is especially crucial because the positive global and regional trends mask the reality that countries in the greatest need of support are being left behind, even among developing nations. Only four developing countries have more than 1,000 watts per capita, and they are the same as last

44 See chapter 7 for a list of the developing countries considered under this indicator.

year: Bhutan, Paraguay, the Lao People's Democratic Republic [PDR], and Uruguay. While renewables capacity per capita registered high growth in the developing world (at a compound annual growth rate [CAGR] of 9.6 percent over 2016–21), growth was lower for small island developing states (8.5 percent), least-developed countries (5.5 percent), and landlocked developing countries (3.8 percent). This trend underscores the urgent need for greater policy support and investment to ensure that all developing countries have the capabilities to contribute to global climate change mitigation efforts and meet SDG 7.

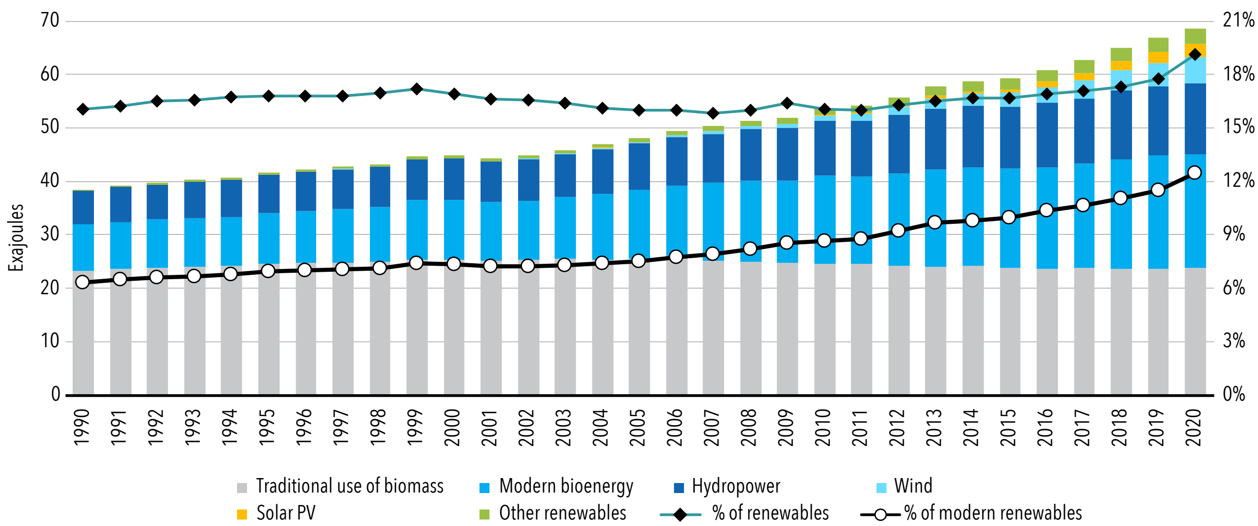
- **Recent trends.** Economic recovery packages in the wake of the Covid-19 pandemic, as well as the global energy crisis sparked by the war in the Ukraine led many countries to strengthen policy support for renewables in 2022. In addition, high fossil fuel prices worldwide have made solar PV and wind generation more competitive against other fuels, despite inflation, rising interest rates and component shortages contributing to renewable project prices also being on the rise. In 2022, 295 GW renewable generation capacity was added globally, with renewables accounting for 83% of all new power capacity added. Getting renewable deployment on track to reach SDG indicators 7.2.1 and 7.B.1, as well as achieve the ambitions of the Paris Agreement, will require ambitious targets, stronger and sustained policy support for renewables and energy conservation in all sectors, greater mobilization of public and private capital, as outlined in chapters 5 and 6, and holistic and concerted policy strategies to diversify and strengthen renewable technology supply chains which remain highly concentrated in just a small number of countries.

Are We on Track?

Globally, the share of renewable sources in TFEC remained relatively steady over the past three decades, with a slow upward trend in recent years (+3 percentage points over the past 10 years), owing mostly to the accelerated deployment of renewable electricity technologies.

In 2020, governments worldwide imposed restrictions on most social and economic activities to slow the spread of the pandemic. This curtailed transport, industrial production, and services, and prompted a significant energy demand shock, with global TFEC dropping 4.7 percent year-on-year. At the same time, global renewable energy consumption, including traditional uses of biomass,[45] grew 2.6 percent from the year before to 68.6 EJ. This increased renewables' share to 19.1 percent of TFEC in 2020, or 1.4 percentage points higher than the previous year (figure 3.1).[46]

Figure 3.1 • Renewable energy consumption and share in TFEC by technology, 1990–2020



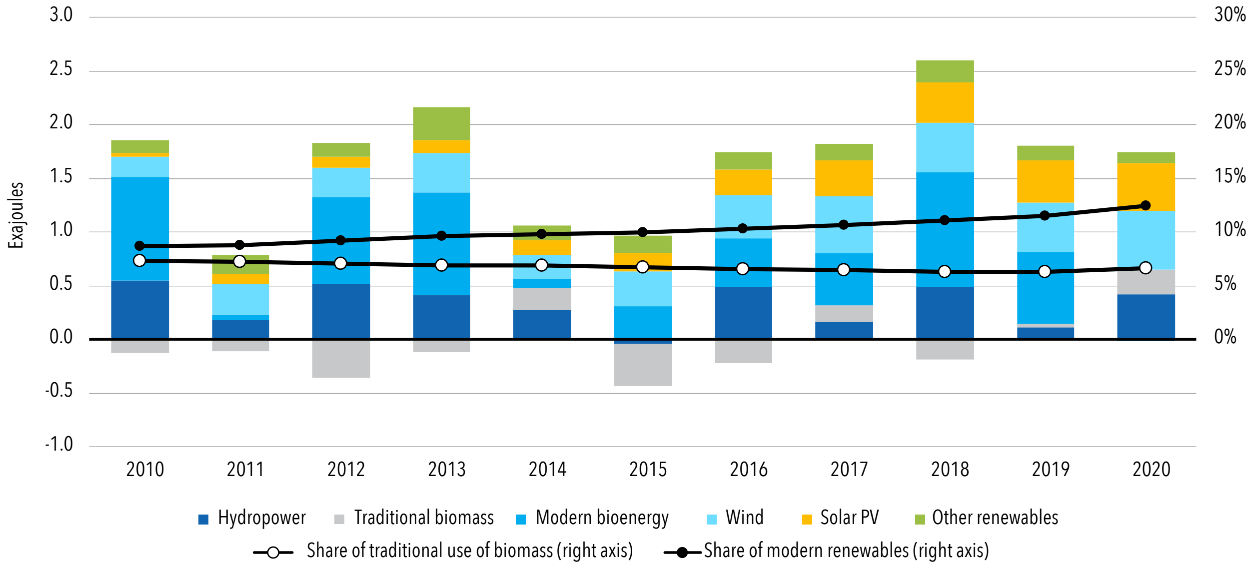
Sources: International Energy Agency and United Nations Statistics Division.
PV = photovoltaic; TFEC = total final energy consumption.

45 The term "traditional uses of biomass" refers to the use of local solid biofuels (wood, charcoal, agricultural residues, and animal dung), which are burned using basic methods, such as traditional open cookstoves and fireplaces. The low conversion efficiency of such methods can result in adverse environmental effects, as well as indoor pollution causing health hazards. The energy consumed in such practices, which are still widely used in households in parts of the developing world, is difficult to estimate due to their informal and noncommercial nature. For purposes of this report, "traditional uses of biomass" refer to the residential consumption of primary solid biofuels and charcoal in non-OECD countries. Although biomass of low conversion efficiency is used in OECD countries as well—for example, in fireplaces burning split logs—such use is not covered by the phrase. Modern uses of bioenergy—along with solar PV, solar thermal, geothermal, wind, hydropower, and tidal energy—is one of the "modern uses of renewable" sources analyzed in this report.

46 The data in this report reflect revisions from last year's edition. Traditional uses of biomass for heat were revised upward by 0.13 EJ (+0.5 percent) globally for 2019, with the majority of the change accounted for by Vietnam (+0.10 EJ, +597 percent) and Indonesia (+0.05EJ, +8 percent), and to a lesser extent by Uganda (-0.06 EJ, -11 percent). Global modern uses of biomass were revised upward by 0.12 EJ (+0.6 percent), with Uganda (+0.17 EJ, +102 percent) and Poland (+0.12 EJ, +40 percent) accounting for the largest upward revision and South Africa (-0.06 EJ, -53 percent) and the United Kingdom (-0.05 EJ, -16 percent) seeing the largest downward changes. Global solar thermal heat consumption was also revised slightly upward (+0.013 EJ, +0.9 percent for the year 2019), primarily due to changes in China. The regional groupings discussed in this section follow the United Nations' M49 regional classification (https://unstats.un.org/unsd/methodology/m49/https://unstats.un.org/unsd/methodology/m49/).

From 2019 to 2020, wind, solar PV, and hydropower made the largest contributions to the growth of renewable energy use, followed by traditional uses of biomass and geothermal energy (figure 3.2).

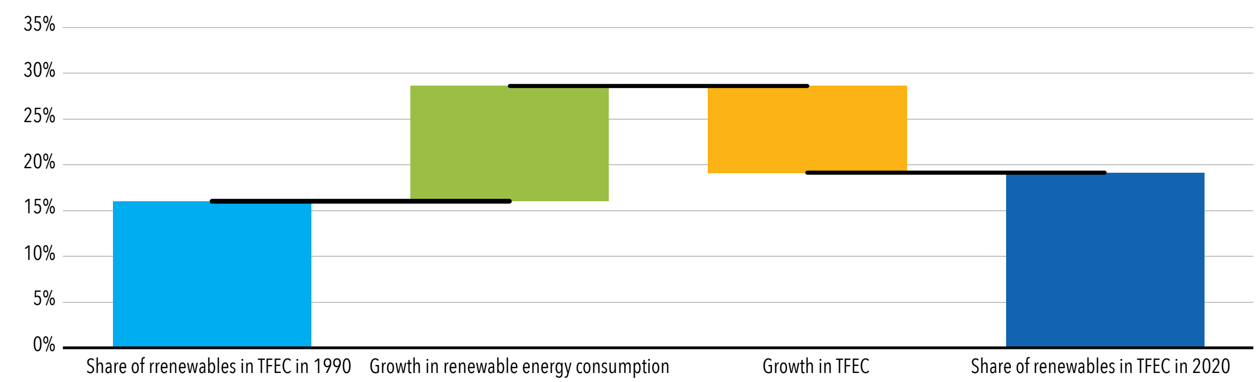
Figure 3.2 • Increase in renewable energy consumption by technology and share of modern uses of renewable energy and traditional uses of biomass in TFEC, 2010–20



Sources: International Energy Agency and United Nations Statistics Division.
Note: In 2020, modern uses of bioenergy consumption remained stable as declining consumption in the residential and transport sectors offset increasing consumption in the electricity and industry sectors.
PV = photovoltaic.

Since 1990, global renewable energy consumption grew almost 80 percent, but this increase corresponds only to a quarter of the increase in TFEC over the same period. The share of renewable energy in TFEC has remained relatively steady as a result (figure 3.3). Two trends have coexisted during the past decade and a half: the share of modern uses of renewables—that is, excluding traditional uses of biomass—in TFEC increased from 8.7 percent in 2010 to 12.5 percent in 2020, with the strongest growth in the power sector, whereas traditional uses of biomass declined 7 percent from their highest point in 2006, although stabilizing since 2016. Achieving SDG 7 and providing access to affordable, reliable, and sustainable energy for all requires considerable and sustained acceleration in the uptake of modern uses of renewables, in the transition to more efficient uses of biomass and substantial progress in energy conservation.

Figure 3.3 • Impact of increase in TFEC on the growth of renewables' share in TFEC globally, 1990–2020



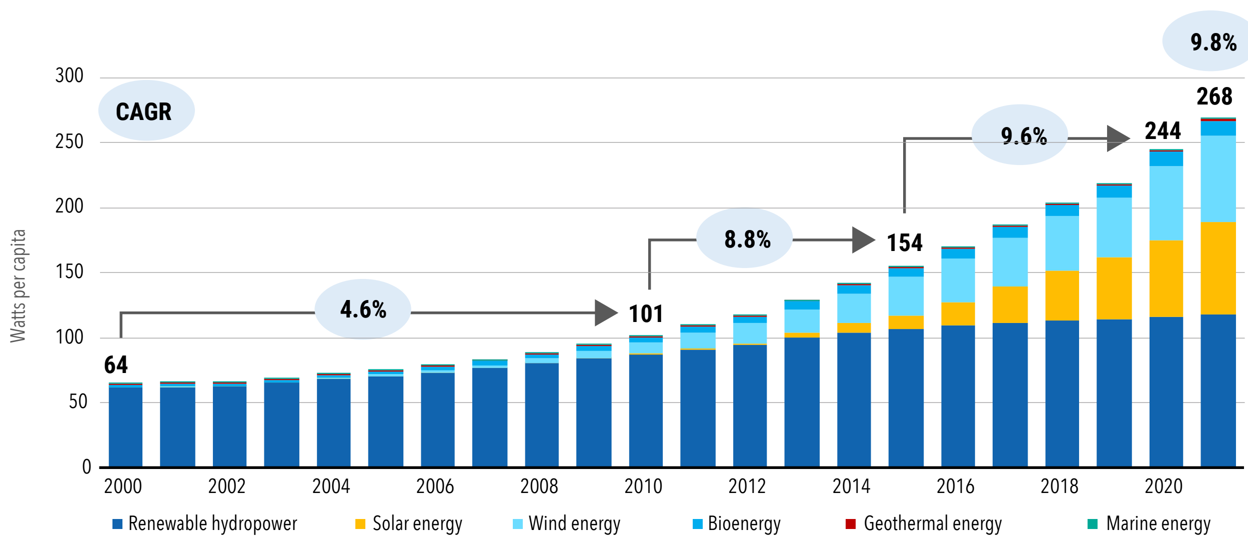
Sources: International Energy Agency and United Nations Statistics Division.
TFEC = total final energy consumption.

Over the past decade, modern uses of bioenergy use saw the largest absolute increase, accounting for almost one-third of the increase in modern uses of renewable energy consumption, and followed by hydropower, wind, and solar PV. In that period, solar PV and wind grew the fastest, with average annual growth rates of 39 percent and 17 percent, respectively.

Overall, bioenergy, including traditional use of biomass, remained the largest renewable source of energy. It accounted for 13 percent of global final energy consumption and represented two-thirds of renewables' portion in 2020, followed by hydropower, wind, and solar PV.

In developing countries, the share of installed renewable energy–generating capacity in electricity has continued to grow over the past 10 years. It grew at an increasing CAGR of 8.8 percent in 2010–15 to 9.6 percent between 2015 and 2020, with growth being consistent, at 9.8 percent, in 2021 (as shown in figure 3.4). This growth is mainly driven by the increasing affordability of solar and wind energy, which have become less expensive than the cheapest new fossil fuel alternative (IRENA 2022a).

Figure 3.4 • Installed renewable energy–generating capacity in developing countries, 2000–21; and CAGR for selected periods



Sources: International Renewable Energy Agency.
CAGR = compound annual growth rate.

Looking Beyond the Main Indicators

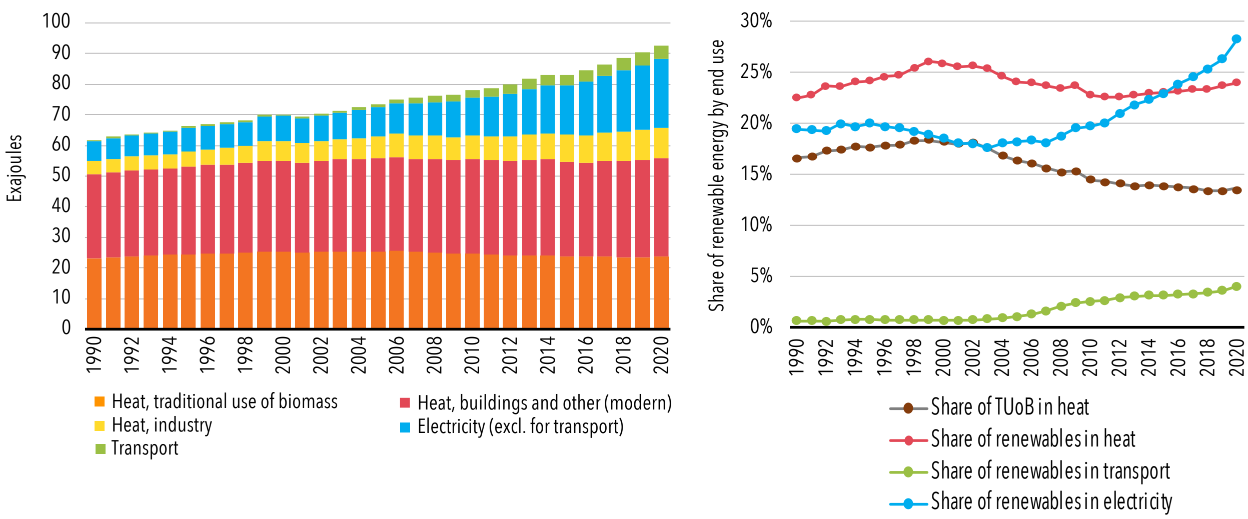
Ensuring access to affordable, reliable, sustainable, and modern energy for all implies a substantial increase in the share of renewable energy in all three main end-use categories: electricity, transport, and heat, which accounted, respectively, for 22 percent, 29 percent, and 49 percent of TFEC in 2020 (figure 3.5).

Electricity has had the largest and most dynamic share of renewables in final consumption, increasing from 26.2 percent in 2019 to 28.3 percent in 2020. Renewable electricity accounts for one-third of global renewable energy consumption (half of modern uses of renewable energy consumption) and almost nine-tenths of its year-on-year increase. The rapid increase in renewables' share in the electricity sector is partly driven by continuous addition of new capacity, most of it wind and solar PV. In 2020, this trend was also supported by a 0.2 percent decline in final electricity consumption.

In the **heat** sector, renewable sources accounted for 24 percent of the energy consumed. More than half of that corresponds to traditional uses of biomass, which increased 1 percent in 2020. Excluding traditional uses of biomass, the consumption of modern uses of renewables for heat increased 0.9 percent year-on-year, whereas global heat demand saw a modest decrease (-0.6 percent year-on-year), owing to reduced economic activity. This allowed nonrenewable energy used for heat to decline by 1 percent in 2020.

Including renewable electricity use, the **transport** sector represents only 9 percent of global modern uses of renewable energy consumption. It is the end-use sector with the lowest renewable energy penetration, at only 4 percent of final energy consumption in 2020. Biofuels supply the large majority (90 percent) of renewable energy consumption in transport, whereas renewable electricity use is slowly emerging, owing to the uptake of electric rail transport and electric vehicles.

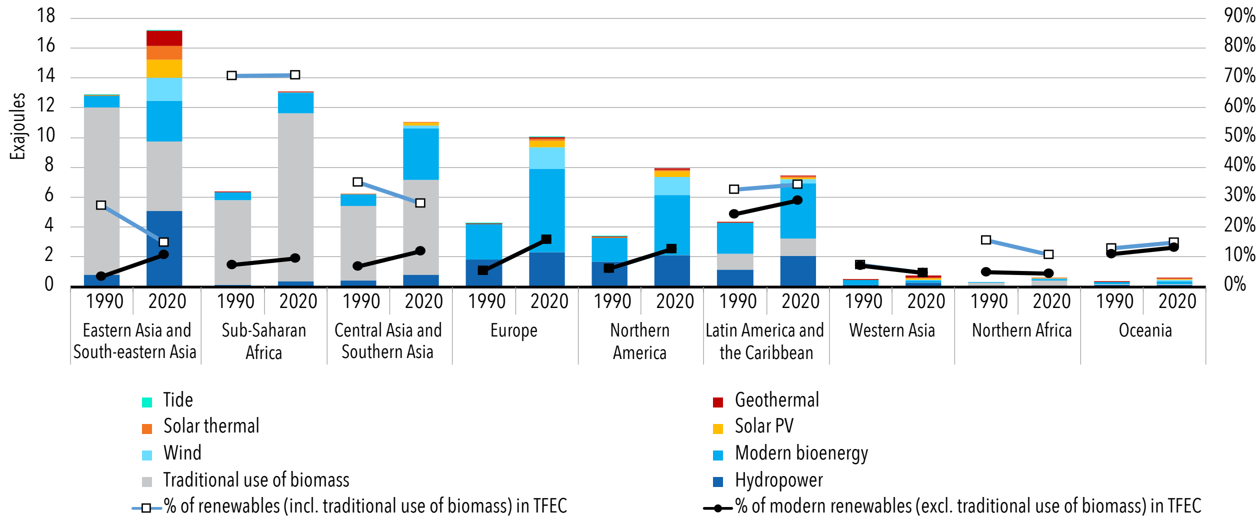
Figure 3.5 • Renewable energy consumption and share by end use, 1990–2020



Sources: International Energy Agency and United Nations Statistics Division.
Note: Electricity used for transport is included under transport.
TUoB = traditional use of biomass.

Strong disparities exist across regions. Sub-Saharan Africa has the largest share of renewable sources in its energy supply, with traditional uses of biomass representing more than 60 percent of the total energy consumed in this region (figure 3.6). Meanwhile, Latin America and the Caribbean has the largest share of modern uses of renewables in TFEC (29 percent of TFEC in 2020), owing to the significant use of hydropower in electricity generation and the consumption of bioenergy for industrial processes (especially in the sugar and ethanol industry) and biofuels for transport.

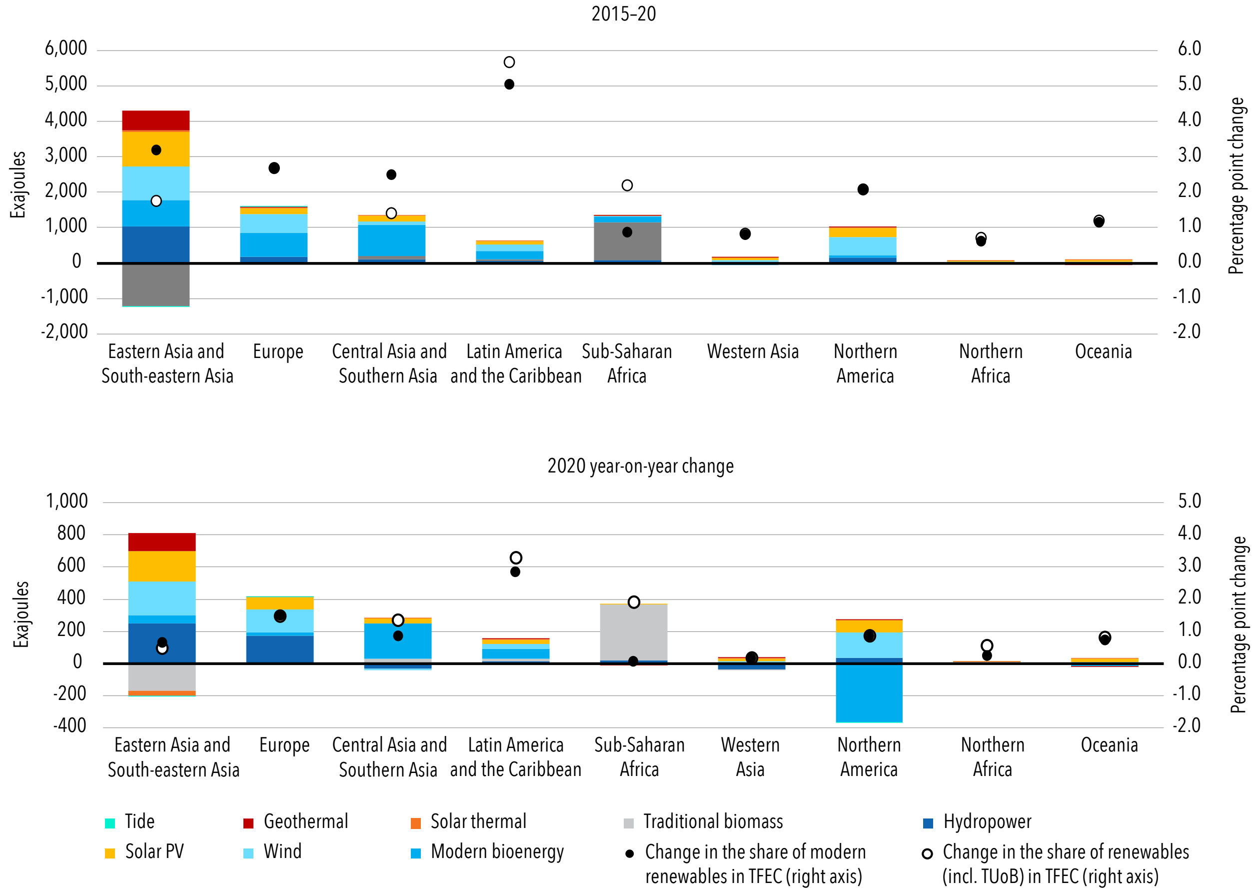
Figure 3.6 • Renewable energy consumption and share in TFEC by region, 1990 and 2020



Sources: International Energy Agency and United Nations Statistics Division.
PV = photovoltaic; TFEC = total final energy consumption.

In 2020, almost half of the global year-on-year increase in modern uses of renewable energy consumption was accounted for by Eastern Asia, due primarily to the deployment of wind, hydropower, and solar PV, as well as, to a lower extent, geothermal (figure 3.7). Europe accounted for more than one-quarter of this year-on-year growth, owing to favorable conditions for hydropower and the expansion of wind and solar PV capacity. The share of renewables in TFEC grew the fastest in Latin America and Europe (respectively +2.8 and +1.5 percentage points in 2020), supported in both cases by significant declines in TFEC (-7.7 percent and -5.5 percent, respectively—the largest declines after Northern America). Consumption of modern uses of bioenergy declined 8 percent year-on-year in Northern America (due in part to reduced activity, and, hence consumption, in the pulp and paper industry, and lower demand in the residential sector amid a mild winter in 2019–20). While traditional uses of biomass continued to decline in Eastern and South-eastern Asia, this trend was offset by increasing consumption in Sub-Saharan Africa, in part driven by population growth.

Figure 3.7 • Change in renewable energy consumption and the share of renewables in TFEC by region, 2015–20; and year-on-year change, 2020

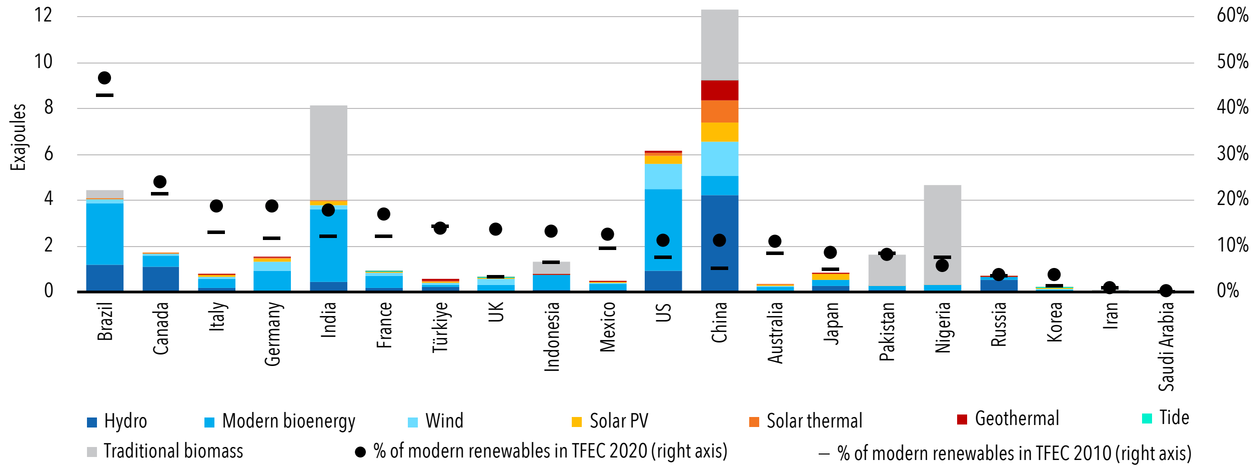


Sources: International Energy Agency and United Nations Statistics Division.
PV = photovoltaic; TFEC = total final energy consumption; TUoB = traditional use of biomass.

The share of renewable sources in national energy consumption varies widely depending on resource availability, policy support, and the total energy demand due to consumption patterns and energy efficiency performance. Among the top 20 energy-consuming countries, Brazil and Canada still had the largest shares of modern uses of renewables in 2020 (respectively 46 percent and 24 percent of TFEC), owing to heavy reliance on hydro for electricity, biofuels for transport, and biomass for heating—especially in industry (figure 3.8). China alone accounted for more than one-fifth of the global modern uses of renewable energy consumption, yet this represented just 11 percent of its TFEC.

Between 2010 and 2020, the share of modern uses of renewables in TFEC grew the fastest in the United Kingdom and Germany, due to a decline in energy demand (in part due to the impact of the COVID-19 crisis) combined with the development of wind, bioenergy, and solar PV. They were followed by Indonesia, which saw rapid deployment of biofuels, and China, which saw large hydropower developments and the growth of solar PV, geothermal, and solar thermal.

Figure 3.8 • Renewable energy consumption, 2020; and share of modern uses of renewables in TFEC, 2010 and 2020, for the top 20 energy-consuming countries



Sources: International Energy Agency and United Nations Statistics Division.
PV = photovoltaic; TFEC = total final energy consumption.

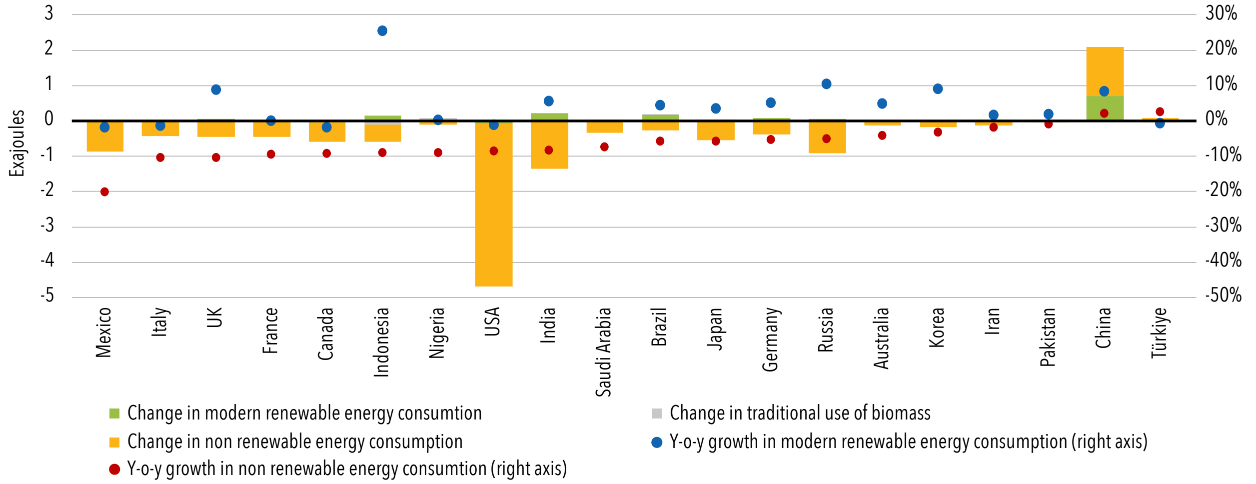
In 2020, most countries saw a declining energy demand resulting from disruption of social and economic activities due to COVID-19 policy responses. Eighteen of the top 20 energy consumers (except China and Türkiye) recorded a lower TFEC in 2020 than in 2019 (figure 3.9).

Indonesia recorded the largest year-on-year growth in the share of modern uses of renewables (+3.3 percentage points) in 2020, followed by Brazil (+2.4 percentage points), and the United Kingdom (+2.1 percentage points). This growth in Indonesia resulted from greater bioenergy consumption in transport and industry combined with a 7 percent year-on-year decline in TFEC, whereas Brazil's achievement came mostly from increased bioenergy use in industry. Growth in the United Kingdom resulted mostly from the deployment of wind power, while TFEC was down more than 8 percent year-on-year.

All top 20 energy-consuming countries (except Türkiye) had increased shares of modern uses of renewables in their TFEC in 2020. Between 2010 and 2020, this share declined in 3 of the 20 countries (Nigeria, Pakistan, and Türkiye) despite growing consumption of modern uses of renewable energy in all of them. In the same period, the consumption of nonrenewable energy increased in 11 of them. This highlights the importance of containing the overall energy consumption through both energy efficiency and sufficiency,[47] and expediting the move away from fossil fuels to achieve greater shares of renewables in the energy mix.

47 Energy sufficiency corresponds to the actions of tailoring and scaling energy-related infrastructure, technology choices, social organizations, lifestyles, and behaviors to fundamental needs, while selectively avoiding nonessential energy-intensive services and consumptions, in order to allow affordable access to energy for everyone's needs and fair access to energy wants, while keeping the impacts of energy use within environmental limits. Sufficiency is meant not only as reducing consumption (conservation) but also the operating principle of limiting damage while also supporting human and ecological well-being (Darby and Fawcett 2018; Marignac 2019). Energy efficiency and sufficiency are two complementary dimensions of energy conservation. While energy efficiency actions aim at reducing the energy consumption–energy service demand ratio, energy sufficiency aims at containing energy services demand through frugality and alternative choices of satisfiers to meet human needs.

Figure 3.9 • Annual change in renewable and nonrenewable energy consumption in the top 20 energy-consuming countries, 2020

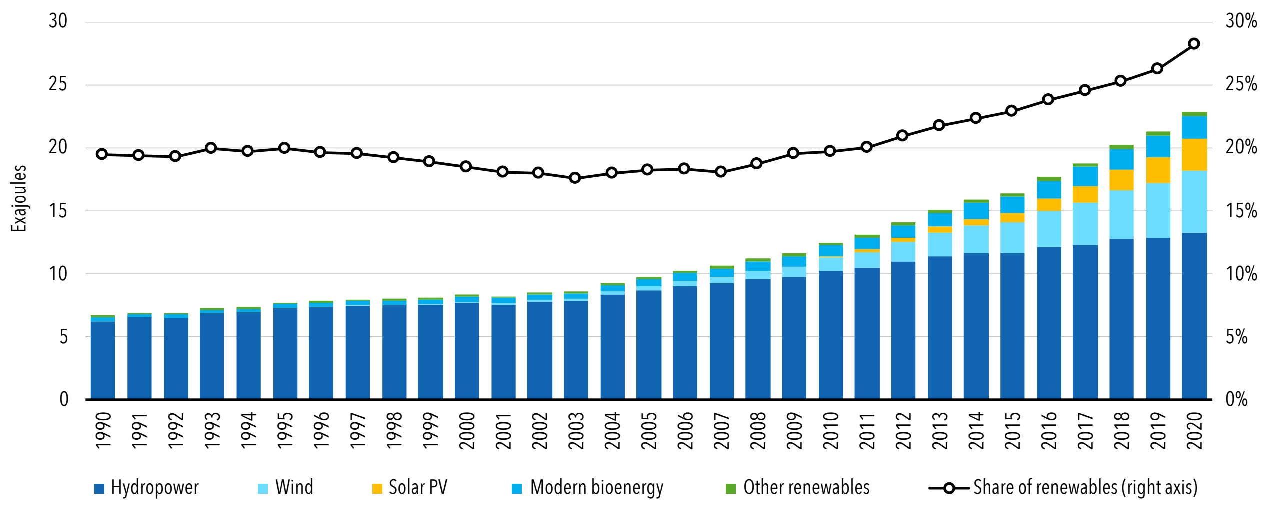


Sources: International Energy Agency and United Nations Statistics Division.
Y-o-y = year-on-year.

ELECTRICITY

Electricity accounted for 22 percent of TFEC globally in 2020 and is the fastest-growing end use. Electricity consumption doubled over the past 23 years, increasing 27 percent since 2010.[48] Yet, global annual electricity consumption remained steady at 80 EJ in 2020. Global renewable electricity consumption increased more than 7 percent (+1.5 EJ) year-on-year in 2020, whereas nonrenewable electricity consumption declined 2.8 percent (-1.6 EJ). The share of renewables in electricity generation consequently increased by 1.9 percentage points to 28.2 percent in 2020—the largest annual growth and the largest share among all end uses (figure 3.10).

Figure 3.10 • Global renewable electricity consumption by technology, 1990–2020



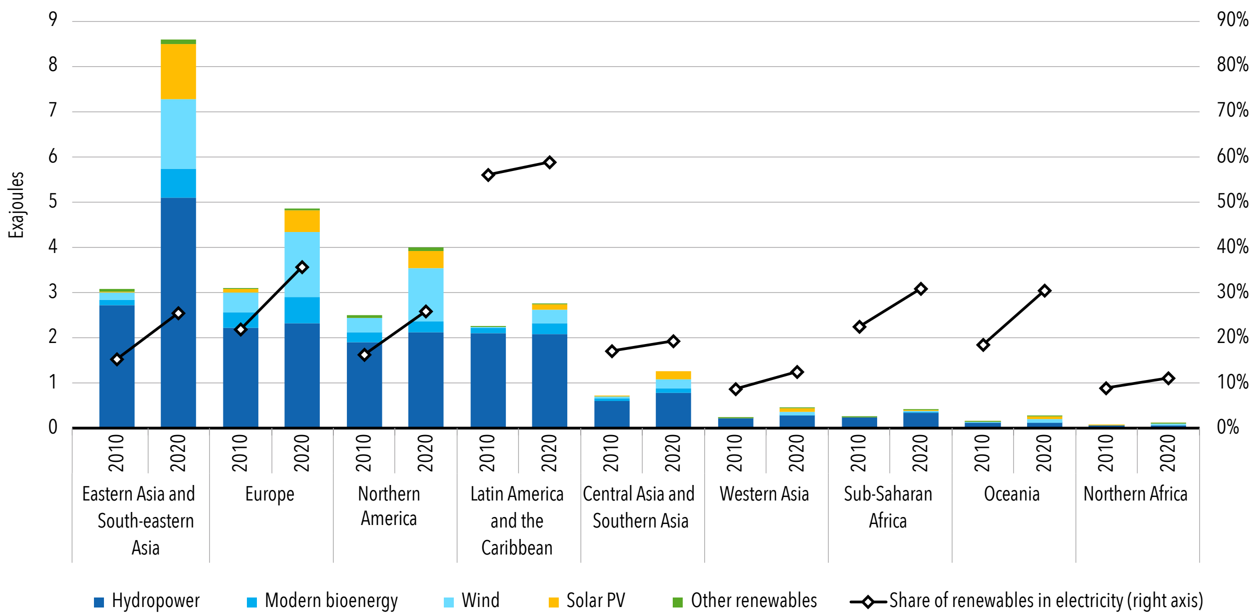
Sources: International Energy Agency and United Nations Statistics Division.
PV = photovoltaic.

48 Among the largest factors driving this trend is the rapidly growing use of electricity for space cooling, with air conditioners and electric cooling fans accounting for about 10 percent of the global electricity consumption in 2018 (IEA 2018).

Wind, solar PV, and hydropower accounted for, respectively, 36 percent, 29 percent, and 28 percent of the annual increase in renewable power generation in 2020. The majority of the remaining growth was accounted for by bioenergy. Hydropower remained the largest renewable source of electricity globally and for each region, accounting for 59 percent of renewable power generation and 17 percent of total electricity generation.

Latin America and the Caribbean had the largest share of renewable sources in power generation, with hydropower alone representing 45 percent of the regional electricity generation in 2020. That year, renewables' share of electricity generation grew the fastest in Europe, increasing by more than 4 percentage points year-on-year to account for nearly 36 percent of the total generation. This was mostly driven by favorable hydrological conditions for hydropower, rapid growth of new wind and, to a lesser extent, solar PV capacity, as well as a 3 percent decline in annual electricity demand. Thanks to rapidly declining costs and policy support, wind and solar PV together accounted for more than 60 percent of the increase in renewable electricity consumption over the past decade globally. This share exceeds 80 percent in Europe, Northern America, and Oceania (figure 3.11). However, soaring prices of energy and materials and shortages of critical minerals, semiconductors and other components are posing potential roadblocks to the scale up of renewable electricity development in the future (Box 3.1).

Figure 3.11 • Renewable electricity consumption and share of renewables in electricity by region, 2010 and 2020



Sources: International Energy Agency and United Nations Statistics Division.
PV = photovoltaic.

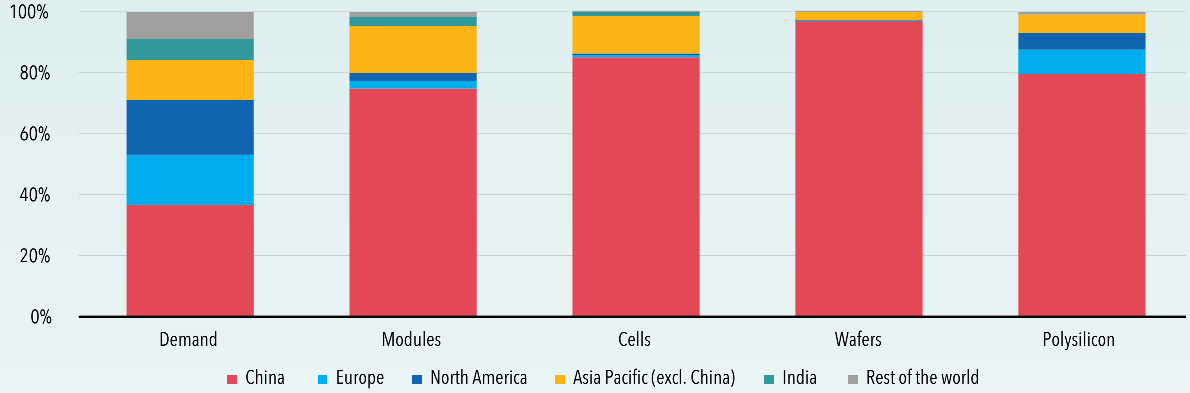
Box 3.1 • Building resilient supply chains: The case of wind and solar photovoltaic

Meeting international energy and climate goals requires solar photovoltaic (PV) and wind capacities to grow on an unprecedented scale in the coming decades. The International Energy Agency's (IEA's) Roadmap to Net Zero Emissions by 2050, for instance, depicts more than a quadrupling of global annual solar PV and wind capacity additions to, respectively, 630 gigawatts and 390 gigawatts by 2030 (IEA 2021).

Yet the economic impacts of the COVID-19 pandemic and the war in Ukraine have highlighted the vulnerability of global energy and technology supply chains. Soaring prices of energy and materials and shortages of critical minerals, semiconductors, and other components are increasing uncertainty for investors and posing potential roadblocks for the energy transition. Between the first half of 2020 and that of 2022, rising material costs contributed to a 25 percent rise on average in PV modules' prices, and up to a 20 percent increase in the prices of wind turbines outside China, after years of sustained decline (IEA 2023).

High levels of concentration make supply chains vulnerable to incidents, be they related to an individual country's policy choices, natural disasters, technical failures, or company decisions. Currently, renewable energy technology supply chains, especially those for manufacturing solar PV and wind technologies, as well as the materials they rely on, remain heavily concentrated geographically. For instance, China's share of all the manufacturing stages of solar panels (such as polysilicon, ingots, wafers, cells, and modules) exceeds 80 percent—more than double its share of global PV demand (figure B3.1.1) (IEA 2022b). Manufacturing of wind turbines is also largely concentrated geographically, with China alone accounting for 60 percent of global manufacturing capacity, and Europe having a leading role in markets outside China. The top 15 wind turbine manufacturers accounted for almost 90 percent of the total capacity deployed in 2021 (IEA 2023).

Figure B3.1.1 • Solar PV manufacturing capacity by country and region, 2021



Source: IEA 2022b.
APAC = Asia-Pacific region excluding India; NAM = North America ; RoW = rest of the world.

Strengthening and diversifying supply chains for both materials and manufacturing will be critical to reduce risk exposure and build resilience into supply chains and ensure security of supply. For many countries, diversification can also enhance local value creation and contribute to realizing the objectives under the 2030 Agenda. Industrial policies can facilitate wider job creation beyond those in installation and operation by supporting efforts to leverage and further build local capabilities across solar and wind supply chains (IRENA 2017, 2018). This is especially important for developing countries as they seek to move from being exporters of raw materials to producing higher-value products.

Governments can leverage comprehensive risk assessments of supply chains and identify competitive advantages in order to mobilize investment for key supply chain segments, for instance, through financing and fiscal incentives and derisking instruments. Furthermore, they need to support the development of workforce skills in anticipation of future needs.

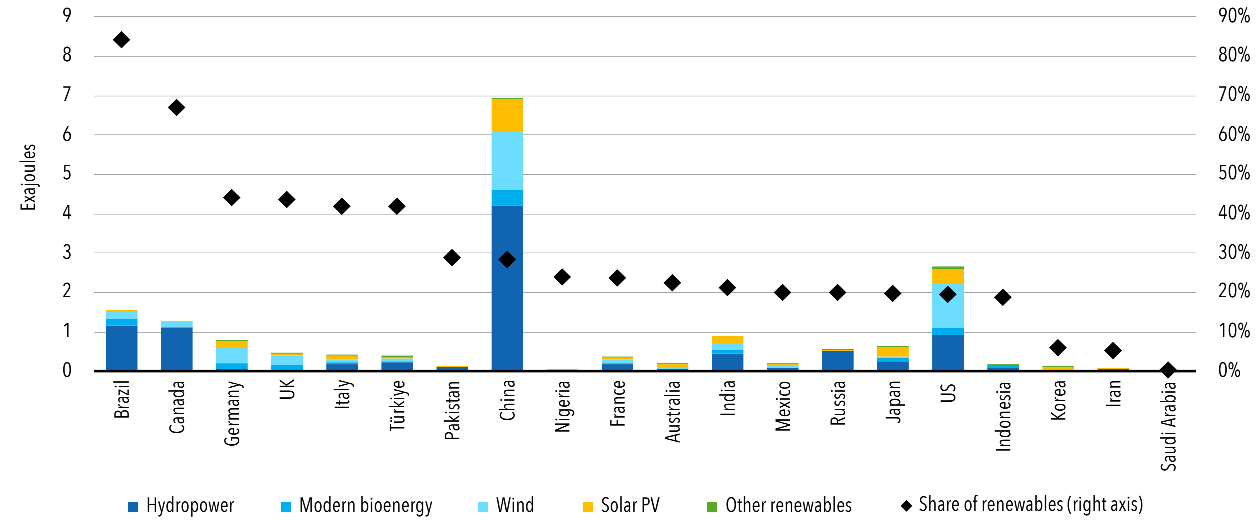
In addition, countries can support innovations in product design that reduce and diversify material inputs, especially for critical materials such as copper and silver, and make equipment more durable, reusable, and recyclable. Recycling provides an opportunity to secure a reliable secondary source of materials, while helping avoid negative environmental, social, and health impacts associated with raw material mining.

Specific attention should be paid to raw material requirements for renewable technologies. Mining projects can face lead times of more than 10 years from when their development begins to when they achieve the first production. This increases the risk of critical mineral supply becoming a major bottleneck in renewable energy supply chains. Reducing permitting time, without compromising on environmental standards, or on engagement with local communities, can help ensure that mining capacity will be scaled up in line with the requirements of the energy transition. Considering that the natural endowment for minerals differs across countries, international cooperation and strategic partnerships remain crucial.

At the same time, environmental and social risks along supply chains need to be considered and addressed. International cooperation on the development of clear and stringent environmental and social sustainability standards will be key to ensure worker protection, social inclusion, adhesion to labor rights, as well as the adoption of low-carbon and material- and energy-efficient manufacturing practices in facilities. Considering that bulk and critical material production is one of the most-emission-intensive stages of supply chains, policies should also focus on expanding lead markets for near-zero emission materials and increasing minimum recycled content requirements, traceability standards, and governance regulations.

The top 20 energy-consuming countries show contrasting trends in terms of the share of renewables in electricity generation, which varies from almost 0 percent to over 80 percent. Brazil and Canada are by far the countries with the largest shares, owing to large hydropower capacities (figure 3.12). Wind and solar PV together (i.e., nondispatchable renewables) constitute the largest renewable electricity sources in Germany, Japan, Mexico, the Republic of Korea, the United Kingdom, and the United States. Their combined share in renewable power generation ranged between 45 percent and 74 percent in these countries. The share of renewables in electricity consumption grew the fastest in the United Kingdom, Germany, Mexico, and France, with 6.4, 4.2, 4, and 3.7 percentage point increases, respectively. In each of these countries, this growth was supported by a year-on-year decline of more than 3 percent in total electricity demand.

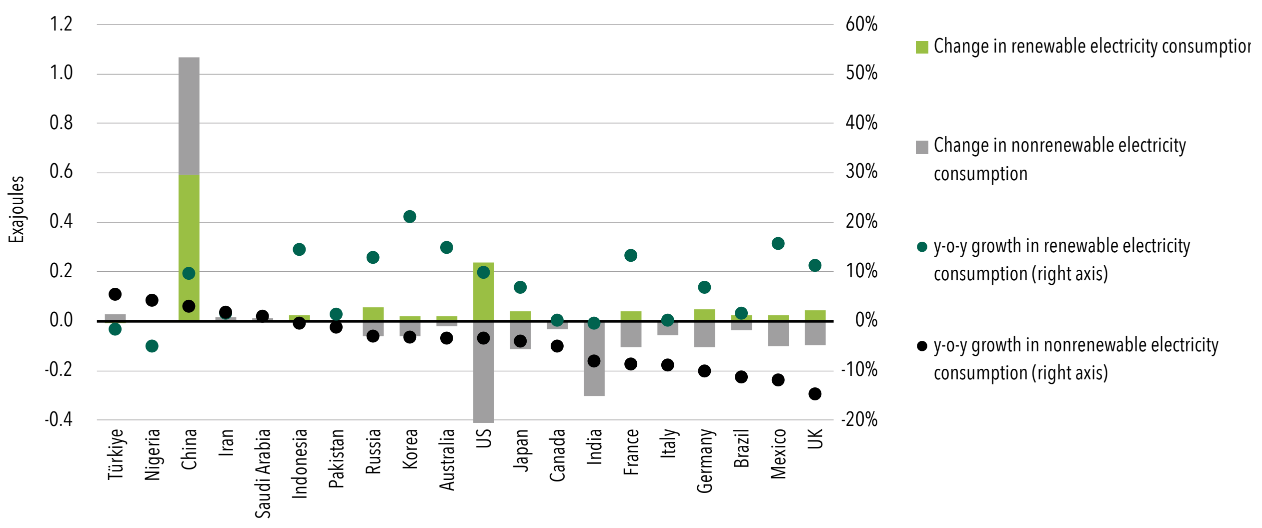
Figure 3.12 • Renewable energy consumption in electricity in the top 20 final energy consumers by source and country, 2020



Sources: International Energy Agency and United Nations Statistics Division.
PV = photovoltaic.

Between 2019 and 2020, China accounted for 39 percent of the global annual increase in renewable electricity generation, with wind and solar PV together accounting for more than half of the national growth. The United States, the Russian Federation, Germany, and the United Kingdom were the next largest contributors to this growth, together contributing one-quarter of it. In 2020, China was also responsible for the largest absolute increase in nonrenewable electricity consumption, followed by Türkiye, the Islamic Republic of Iran, Saudi Arabia, and Nigeria, while the other top 20 final energy consumer countries witnessed a decline in nonrenewable electricity consumption that year (figure 3.13).

Figure 3.13 • Year-on-year change in renewable and nonrenewable electricity consumption for the top 20 final energy users by country, 2020



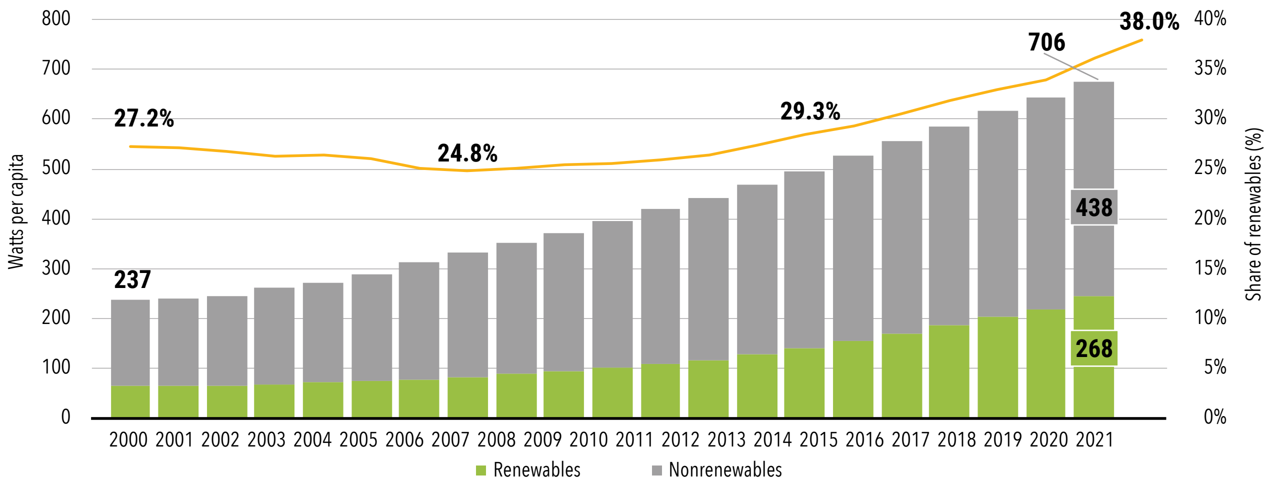
Sources: International Energy Agency and United Nations Statistics Division.
EJ = exajoule; y-o-y = year-on-year.

Installed renewable energy-generating capacity in developing countries (in watts per capita)

Renewable electricity generation is becoming increasingly important in developing countries[49] as electricity demand rises due to population growth, changing lifestyles, and development patterns. Reflecting this, SDG 7 includes a target to "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 landlocked developing countries, in accordance with their respective programmes of support" by 2030. Progress toward SDG indicator 7.B.1, which measures the increase in renewable energy–generating capacity (in watts per capita) in developing countries, is tracked in this chapter for the third year.

The share of installed renewable energy–generating capacity in developing countries has been on the rise since 2007, when it stood at 24.8 percent. In 2021, the share of renewables reached its peak, at 38 percent, with 268 watts per capita of installed renewable capacity (see figure 3.14). This is close to the world average of 38.3 percent and the 38.8 percent of developed countries. Although 2020 saw a record for renewable energy–generating absolute capacity additions, with 186 gigawatts (GW) added in developing countries, the 174 GW of renewable power added in these countries in 2021 represents a 6 percent contraction from the previous year. This could be attributed to the severe impacts of the COVID-19 pandemic on many countries, which may have diverted public funds and attention away from renewable power installations in 2021, as well as from supply chain disruptions and financing challenges in a context of rising commodity prices. More detailed analysis would be needed to determine the specific factors behind this decline.

Figure 3.14 • Annual growth of renewable energy–generating capacity in developing countries, and share of renewables, 2000–21

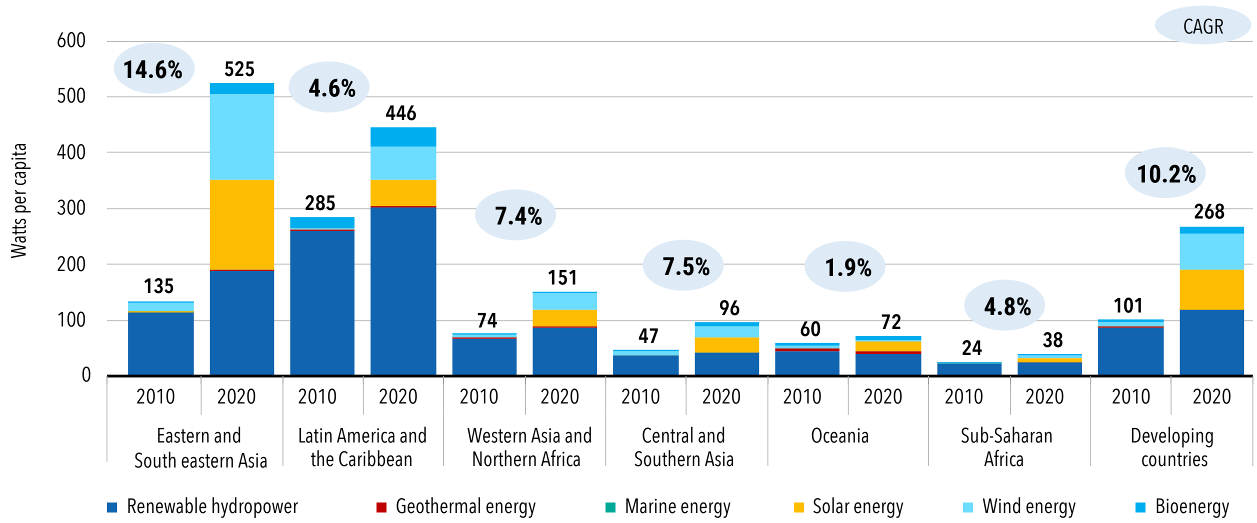


Source: International Renewable Energy Agency.

Additions to renewable energy–generating capacity have been growing at a steady pace over the past two decades and have consistently outpaced population growth in developing countries. In the first decade of the 21st century, the CAGR of renewable capacity was 4.6 percent per capita. This figure was surpassed by an 8.6 percent CAGR during 2010–15; then, in 2015–20, the CAGR increased further, to 9.6 percent. In 2021, the growth rate continued to accelerate, reaching 9.8 percent (figure 3.15), whereas addition of nonrenewable capacity decreased by 2 percent between 2020 and 2021, from 77.1 GW to 75.7 GW. This trend of decreasing nonrenewable additions began in 2016 after reaching an all-time high of 137.7 GW in 2015.

49 See chapter 7 for a list of the developing countries considered in this indicator.

Figure 3.15 • Growth in renewable energy–generating capacity per capita by technology across regions, 2010–21



Source: International Renewable Energy Agency.
CAGR = compound annual growth rate.

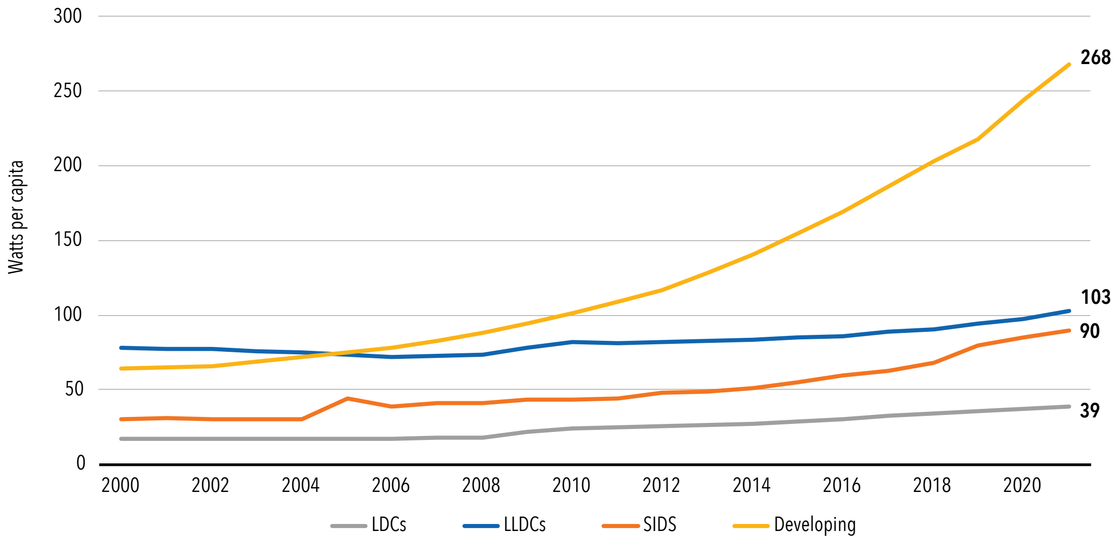
Over the past decade, growth in renewable energy-generating capacity varied across regions. The greatest capacity growth was seen in Eastern and South-eastern Asia, from 135 to 525 watts per capita between 2010 and 2021, primarily due to additions of wind and solar power. Lao PDR, China, and Korea showed the most growth in the region. In Latin America and the Caribbean, capacity increased by 57 percent, from 285 to 446 watts per capita, primarily due to wind energy (35 percent), solar energy (28 percent), and hydropower (27 percent). Uruguay, Chile, and Panama recorded the largest increase in renewables-fueled capacity per capita in this region.

Solar and wind power led to a doubling of per capita renewable energy-generating capacity in Western Asia and Northern Africa, and Central and Southern Asia in 2010–21, with Bhutan, Türkiye, and the United Arab Emirates in the lead. The lowest renewable capacity per capita was recorded in Sub-Saharan Africa, which will require specific support.

Meanwhile, growth rates across country groups reveal concerning disparities, with small island developing states (SIDS), least-developed countries (LDCs), and landlocked developing countries (LLDCs) lagging even behind other developing countries (figure 3.16). At current annual growth rates, LDCs would need almost 40 years, LLDCs would need 25 years, and SIDS would need 13 years to reach a level of deployment similar to the average levels in developing countries in 2021.

Closing the geographic gap in the deployment of renewables-based generating capacity will require tailored policies and investment measures to ensure a just and sustainable energy transition in the long term. The ambitious deployment of renewable energy-generating capacity across regions is crucial to avoid locking in unsustainable and polluting energy choices and to prevent the creation of stranded assets.

Figure 3.16 • Renewable energy–generating capacity per capita by country group, 2000–21



Source: International Renewable Energy Agency.
SIDS = small island developing state; LDC = least-developed country; LLDC = landlocked developing country.

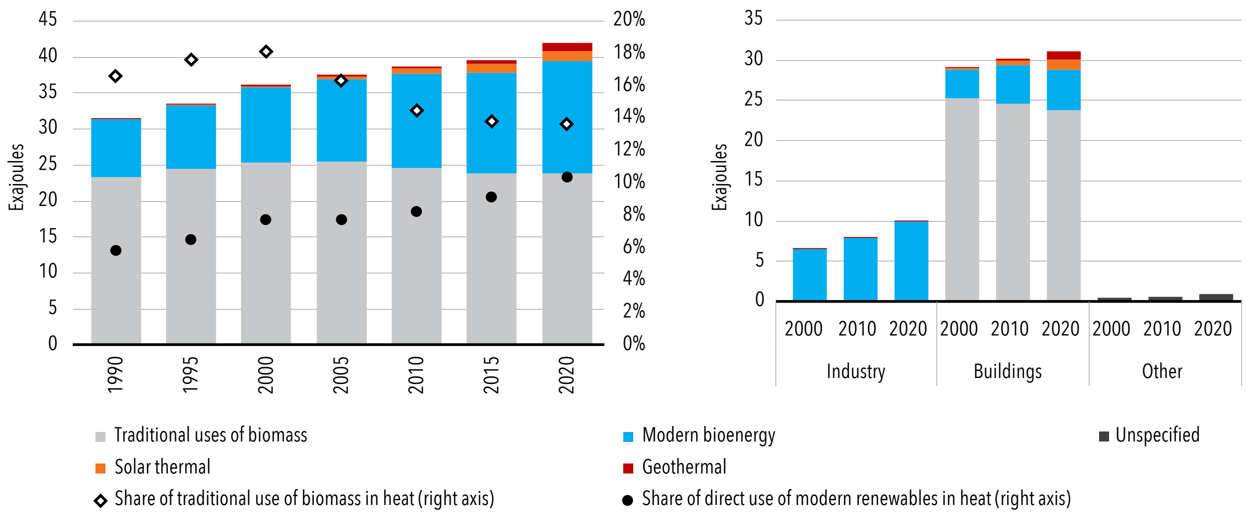
HEAT

Heat is the largest energy end use worldwide, accounting for half of global final energy consumption (175 EJ). In 2020, total energy consumption for heat declined by an estimated 0.6 percent compared with 2019. The heating sector remains heavily reliant on fossil fuels, considering three-quarters of global heat demand is met with coal, gas, and oil. Meanwhile, traditional uses of biomass grew 1 percent in 2020, accounting for almost 14 percent (24 EJ) of the global energy consumption for heat. Excluding traditional uses of biomass, as well as ambient heat harnessed by heat pumps[50] (for which data are scarce), direct renewable heat consumption increased 0.9 percent year-on-year to just over 18 EJ in 2019. This represented 10.4 percent of the total energy consumed for heat, only 2 percentage points higher than ten years earlier (figure 3.17).

Despite its dominant share in the final energy consumption, the heat sector received limited policy attention and support until recently. In 2022, renewable heat received several supporting policy updates based on energy security considerations; however, progress toward SDG target 7.1 (ensuring universal access to affordable, reliable, and modern energy services—for instance, for cooking and space and water heating) and SDG target 7.2 requires greater ambition and stronger policy support. Such support includes significant improvements in sufficiency, energy efficiency and conservation, and material efficiency (especially for energy-intensive materials, such as cement and steel, which come from hard-to-decarbonize sectors) along with rapid deployment of renewable heat technologies to transition away from fossil fuels and inefficient and unsustainable uses of biomass.

50 The rapid spread of heat pumps over the past decade is making ambient heat an increasingly important heat source, although its importance globally is difficult to estimate because data are unavailable for some markets. Because of scarce data, this report does not account for it, although ambient heat (in excess of any nonrenewable 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 decarbonizing the heat sector.

Figure 3.17 • Renewable heat consumption by source and sector, 1990–2020



Sources: International Energy Agency and United Nations Statistics Division.
Note: Indirect consumption of renewable heat through renewable electricity is not represented in this figure.

Bioenergy accounts for about 86 percent (15.6 EJ) of direct[51] modern uses of renewables for heat globally. It accounts for about one-tenth of the energy consumed for heat in industry and one-twentieth in the buildings sector. Industry is responsible for two-thirds of modern uses of bioenergy, with the majority concentrated in subsectors producing biomass residues on-site, such as wood, and pulp and paper industries, as well as the sugar and ethanol industries. In 2020, modern uses of bioenergy consumption for heat grew 1.8 percent year-on-year in industry while dropping 2.5 percent in the buildings sector. The growth in consumption was mostly due to increasing use of bioenergy in Brazil and India's sugar and ethanol industries, while the decline was due partly to mild winter conditions in large heating markets. The increased use of bioenergy requires paying specific attention to potential trade-offs and synergies amongst food-energy systems as discussed in box 3.2.

Global **solar thermal** consumption remained relatively steady in 2020 compared with 2019, accounting for 7.7 percent (1.4 EJ) of modern uses of renewables for heat; yet it still met less than 1 percent of the total final heat demand. China continued to dominate solar thermal developments, accounting for 73 percent of the global solar thermal capacity in operation and 71 percent of newly installed capacity in 2020 (IEA-SHC 2021). However, the global market for solar thermal declined further in 2020, partly due to COVID-19 lockdown measures disrupting construction and installation activities, but also due to limited policy support and the increasing interest of policy makers in end-use electrification—which meant that small-scale solar water heating systems face competition from not only heat pumps but also rooftop PV systems in some key markets (IEA-SHC 2020). From this perspective, hybrid photovoltaic-thermal (PVT) systems offer enormous potential.[52] The global market for PVTsystems grew rapidly, at 13 percent, in 2021, reaching over 0.75 GW of thermal capacity and 0.25 GW of electricity capacity (IEA-SHC 2022). Although domestic solar water

51 Renewables also contribute to heat supply indirectly through renewable electricity used for heating and district heat networks. Accounting for these indirect uses, and excluding ambient heat harnessed by air-source heat pumps, renewable electricity is actually the second-largest modern uses of renewable heat source after bioenergy, and the fastest-growing source. It accounted for almost half of the increase in the total (direct and indirect) modern uses of renewable energy consumption for heating in 2018, owing to the increase in renewables' penetration in the power sector along with heat electrification through the use of electric heat pumps and boilers. The buildings sector is responsible for the majority of electricity consumption for heating.

52 PV thermal systems combine PV cells with thermal collectors, which allow them to convert solar radiation into both usable thermal and electrical energy.

Box 3.2 • Agri-food and renewable energy: Linkages between SDG 7 and SDG 2

Energy and food systems are deeply entwined. About 30 percent of the world's energy is consumed within agri-food systems—from production to food consumption—the majority of which are fossil fuel–based (FAO 2011).[a] Energy-related greenhouse gas emissions in agri-food systems alone are estimated at 1.6 metric gigatons of carbon dioxide equivalent per year, or 12 percent of the total from the agriculture sector in 2018, and the number is growing (Tubiello and others 2021).

On-farm energy use is a significant component of agricultural productivity (Flammini and others 2022). Over the past two decades, on-farm energy consumption in Europe and the Americas remained stable, despite growth in production—thanks to increased efficiencies and agronomic progress. Meanwhile, on-farm energy use grew significantly in Asia owing to increased mechanization of agriculture with irrigation pumps, farm machinery, and inputs such as chemical fertilizers; Asia's share accounted for over half the global total in 2018. Meanwhile, the African continent, where food demand continues to grow, has seen only marginal growth of on-farm energy use, which represented about 4 percent of the global total (IRENA and FAO 2022). The disparity in energy use around the world suggests untapped potential to increase productivity, strengthen supply chains, reduce food and income losses, and improve food security.

Continuing to meet energy needs in agriculture through fossil fuels across continents poses significant challenges in terms of accessibility, affordability, lack of resilience to supply and price shocks, and environmental impacts, particularly climate change. A joint approach to the energy transition and the transformation of agri-food systems is necessary to meet current and future demand in these sectors, while advancing the Sustainable Development Goals and the Paris Agreement on Climate Change.

Renewable energy solutions can play an important role in meeting energy needs for electricity, heating, and transport in agri-food systems. From primary production to processing, storage, and consumption, various renewable energy applications are now being deployed to displace the use of fossil fuels. Solar irrigation, among the most mature applications, is being adopted to improve access to water, thus enabling multiple cropping cycles, raising incomes, and increasing resilience to changing rainfall patterns. In India, nearly half of the farmers using solar pumps reported an increase of 50 percent or more in their annual incomes compared with rain-fed irrigation (GOGLA 2019). Meanwhile, in Rwanda, smallholder farmers adopting solar irrigation pumps improved their yields by about a third (Energy4Impact 2021). The total installed capacity of solar pumps grew from 20 megawatts in 2012 to 670 megawatts in 2021. The majority of this capacity is in Asia, led by irrigation programs (IRENA 2022d).

Renewables-based agro-processing systems are offering an increasingly cost-effective alternative to fossil fuels—one that leads to cost reduction, encourages local value addition, and reduces food losses. In some regions, up to 21 percent of food is lost before reaching the market (FAO 2019). Alongside processing (e.g., drying), cold storage and refrigeration are a necessity to increase shelf life; cut losses; and maintain the quality of products from crops, livestock, and fisheries. Improving access to refrigeration could prevent the spoilage of up to a quarter of the perishable foods currently produced in countries with less-developed cold storage infrastructure (Lange and others 2016). Further, global cold chains, which involve portable or stationary cold storage from production until retail, already account for about 5 percent of food-system greenhouse gas emissions—a figure expected to rise, making a renewables-based transition a necessity (Tubiello and others 2021).

Integrated food–energy systems will be key to scale up bioenergy use while managing potential trade-offs between climate-safe energy transitions and food security. For instance, the International Renewable Energy Agency's (IRENA's) 1.5°C Pathway projects that the share of modern uses of biomass in total final energy consumption needs to increase to 18 percent (from 3 percent in 2018) to meet the demand in the transport, industry, and buildings sectors (IRENA 2022c). Feedstock production from agriculture and forestry residues, as well as organic waste, needs to be scaled to meet the bioenergy demand. Further opportunities also exist with the colocation of food and energy crops, as well as with photovoltaics (i.e., agri-voltaics), to help reconcile potentially competing land uses as renewable energy deployment accelerates.

Increasing renewables' use in agri-food systems requires coordinated action across a range of areas, including improving the data and information base, facilitating access to financing for investors (farmers and enterprises), mainstreaming cross-sector integration and systemic thinking in policy and planning efforts, prioritizing low-risk, high-impact actions in the near term (including renewable energy applications aiming at reducing food losses), and promoting innovation in the development of technologies and energy-efficient appliances (e.g., agro-processing equipment) (IRENA and FAO 2022).

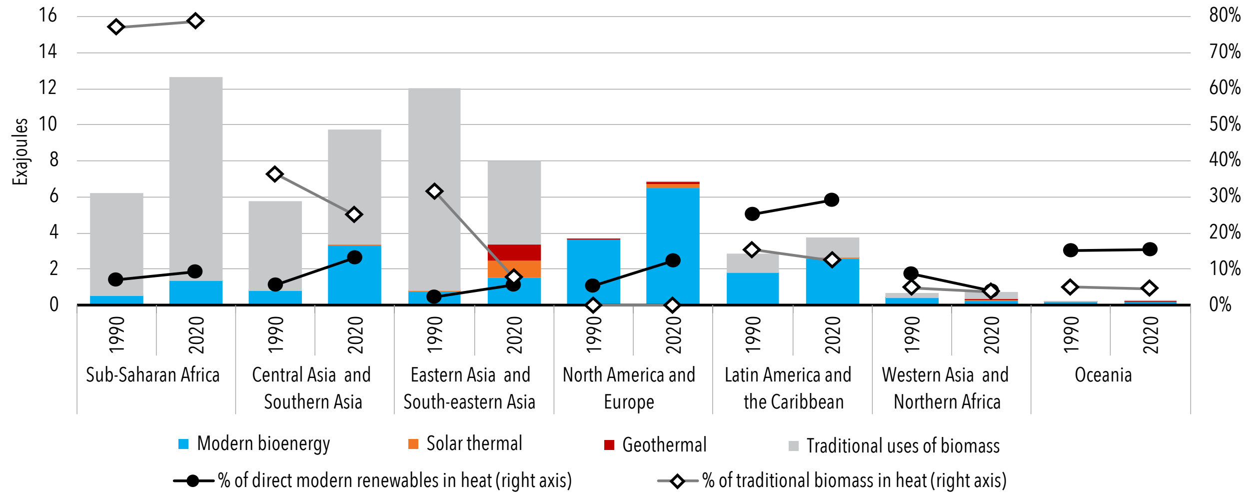
a. The energy used in agri-food systems includes direct energy for primary production as well as shares of the energy demands for fertilizer manufacturing, food processing, storage, and other inputs.

heaters still represent the large majority of installations, there is also growing interest in large-scale solar thermal systems for industrial applications or connected to district heating networks, which continue to develop as a niche market while significant potential remains untapped. Solar thermal cooling offers great potential to decarbonize space cooling, especially since the greatest demand coincides with the highest solar potential, reducing the load of electric air conditioners at peak times during summer months. However, technology deployment is currently very limited.

Global **geothermal** heat consumption grew almost 11 percent in 2020 and represented 5.9 percent (1.1 EJ) of modern uses of renewables for heat. This growth was driven almost exclusively by China. About 60 percent of geothermal heat is harnessed by ground-source heat pumps worldwide (Lund and Toth 2020). The large majority of applications concern the buildings sector, with bathing, swimming, and space heating (primarily via district heating) being the most prevalent end uses globally. China is responsible for more than four-fifths of the global geothermal heat consumption, followed by Türkiye and the United States, which together account for almost one-tenth.

Traditional uses of biomass are primarily concentrated in Sub-Saharan Africa and Asia (figure 3.18). These uses are the most common in Nigeria, followed by India, China, Ethiopia, Pakistan, the Democratic Republic of Congo, and Uganda, and, together, these countries account for two-thirds of the global consumption. Even though traditional uses of biomass showed a slightly declining trend since 2006, their levels in 2020 were still similar to those in 1990 on a global scale. Contrasted trends are observed across regions and countries over the past decade, with especially significant declines in Eastern Asia (especially in China), as well as in Indonesia and Vietnam. These declines were partly compensated by strong population-driven increases in Sub-Saharan Africa (especially in Nigeria, Ethiopia, Uganda, and the Democratic Republic of Congo) as well as in Pakistan.

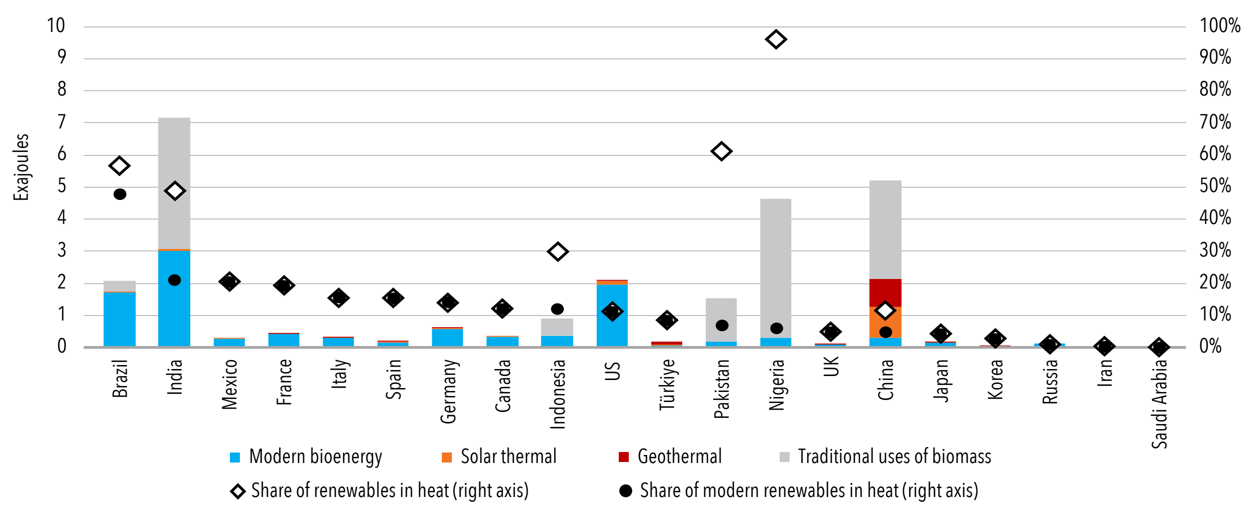
Figure 3.18 • Renewables consumption in heat by region, 1990 and 2020



Sources: International Energy Agency and United Nations Statistics Division.
Note: Indirect consumption of renewable energy through electricity for heat is not included in this figure.

Between 2010 and 2020, China and India together represented more than two-thirds of the global increase in modern uses of renewables consumed for heat. Together with the United States and Brazil, they were responsible for 45 percent of the global heat demand and accounted for half of global modern uses of renewable heat consumption in 2020 (figure 3.19). This results from large consumption of bioenergy in the "pulp and paper" industry and for residential heating in the United States, extensive use of bagasse in the Brazilian and Indian sugar and ethanol industry, and notable deployment of solar thermal water heaters and geothermal heat in China. Europe is responsible for another quarter of global modern uses of renewable heat consumption, owing to the deployment of residential wood and pellet stoves and boilers (e.g., in France, Germany, Italy) and the use of biomass in district heating (e.g., the Nordic and Baltic countries, Germany, France, Austria). Further, renewable heat consumption was supported indirectly by the growing consumption of renewable electricity through electric heaters and heat pumps, as well as the harnessing of ambient heat with heat pumps in China, the United States, and the European Union – albeit the later is not quantified in this report (IEA 2022a).

Figure 3.19 • Renewable heat consumption and share of renewables in total heat consumption among the top 20 energy-consuming countries, 2020



Sources: International Energy Agency and United Nations Statistics Division.
Note: Indirect consumption of renewable energy through electricity for heat is not included in this figure.

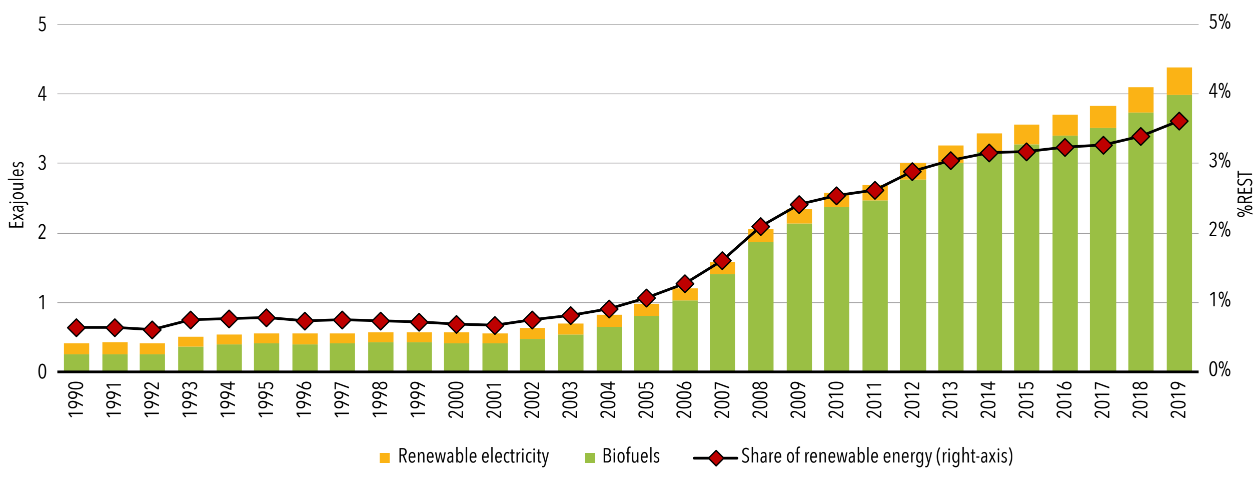
TRANSPORT

Global final energy consumed for transport declined by 14 percent(-16.6 EJ) in 2020. This resulted from COVID-19 policy responses curtailing economic activity and disrupting transport in most regions of the world. Meanwhile, biofuel demand for transport declined less severely, with an estimated 4 percent drop in consumption (-0.16 EJ) in 2020 compared with 2019. There are three reasons behind this relative resilience of biofuel demand. First, biofuels continued to meet an increasing share of the energy demand, climbing from 3.3 percent to 3.6 percent of the final energy consumed for transport. Second, in some large biofuel markets, transport demand declined less than the global average. For instance, Brazil's transport demand declined by only 7 percent, leading to a less severe percentage drop in biofuel demand. In addition, biodiesel blended with diesel fuels actually grew 6 percent globally, offsetting more severe drops in ethanol demand. Yet, 2020 saw the first reduction in annual biofuel production in two decades. The biggest year-on-year declines in output were for US and Brazilian ethanol and European biodiesel.

Still, liquid biofuels, mainly crop-based ethanol and biodiesel blended with fossil transport fuels, represented 90 percent of the renewable energy consumed for transport. The majority of the remainder came from renewable electricity used in vehicles and trains, which grew by 0.02 EJ year-on-year in 2020, the second-largest expansion since 1990. Part of this growth was due to an expanding electric vehicle fleet. The number of electric vehicles on the road grew from 7.1 million in 2019 to 11.3 million in 2020. The electricity powering these vehicles is also increasingly coming from renewable sources. Renewables' share of total electricity used for transport climbed from 20 percent in 2010 to 28 percent in 2020.

The increasing use of renewable electricity in transport combined with an overall decline in fossil fuel demand for transport led to the second-largest annual increase in the renewable fuel share in transport since 1990, reaching 4 percent in 2020, up from 3.6 percent in 2019 (figure 3.20).

Figure 3.20 • Global renewable fuel share in transport and totals for renewable electricity and biofuels, 1990–2020



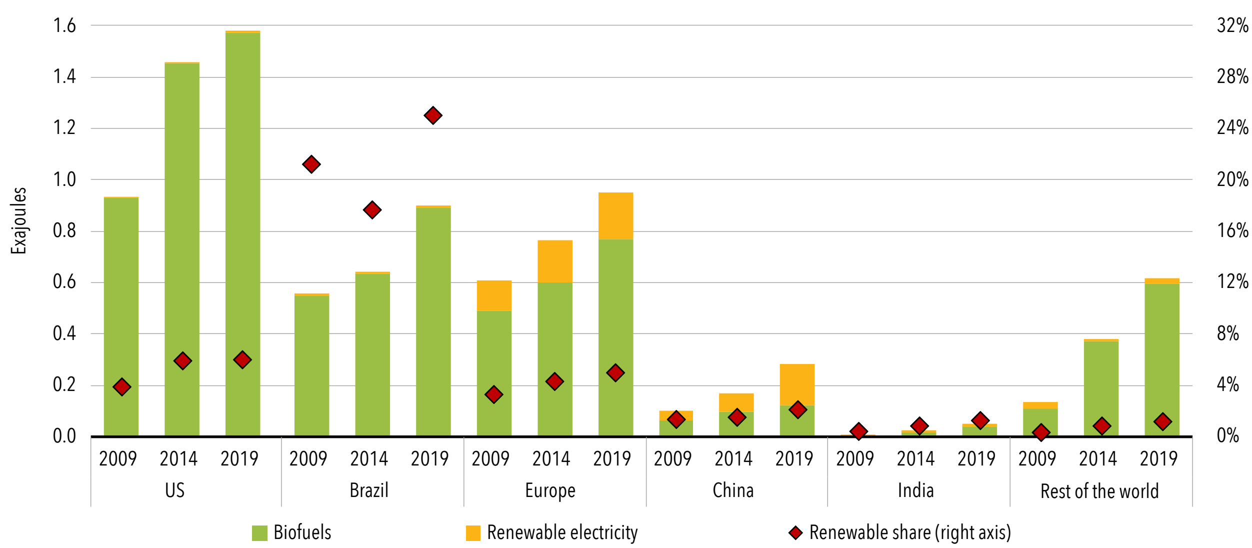
Sources: International Energy Agency and United Nations Statistics Division.
RES-T = Renewable energy used for transport .

Over the past decade, the amount of renewable energy used for transport has grown by two-thirds. The growth has been supported by country-level policies to expand biofuels, electrify transport, and increase renewable electricity generation. Biofuel policies have driven the largest growth in renewable energy, while renewable electricity has played a smaller, but growing, role. But despite many successes at the country level, these policies have only marginally kept ahead of the growing fossil fuel demand, leading to only a small increase in the renewables share (1.5 percentage points in the past ten years).

From a regional and country perspective, the United States, Brazil, and Europe account for almost 80 percent of the renewable energy used in transport. However, other regions, too, are seeing increasing shares (figure 3.21). In the United States and Brazil, biofuels—primarily crop-based ethanol and biodiesel—provide 99 percent of the renewable energy used in transport. By contrast, in Europe, renewable electricity represents 20 percent of the renewable energy consumed in transport. Meanwhile, in China, renewable energy in transport grew almost 80 percent between 2015 and 2020, with renewable electricity accounting for two-thirds of this growth. Renewable electricity represented more than half of all renewable energy used in transport in this country in 2020—thanks to increasing shares of renewables in power generation and electrification of transport efforts in parallel with only modest biofuel policy support. In 2020, China had 48 percent of the global light-duty electric vehicle fleet, aside from over 500,000 electric buses. In India, biofuel support policies have more than doubled renewable energy use in transport since 2015.

Expanding the share of renewable sources in the energy used for transport will require a combination of policies that support biofuels, while ensuring that feedstock supplies meet the most stringent sustainability criteria: transport electrification and renewable electricity generation, as well as active mobility, transit efficiency (efficiency by design), and the phaseout of fossil fuels for transport. These policies must be steadily strengthened where they are already in place and introduced where they are not yet.

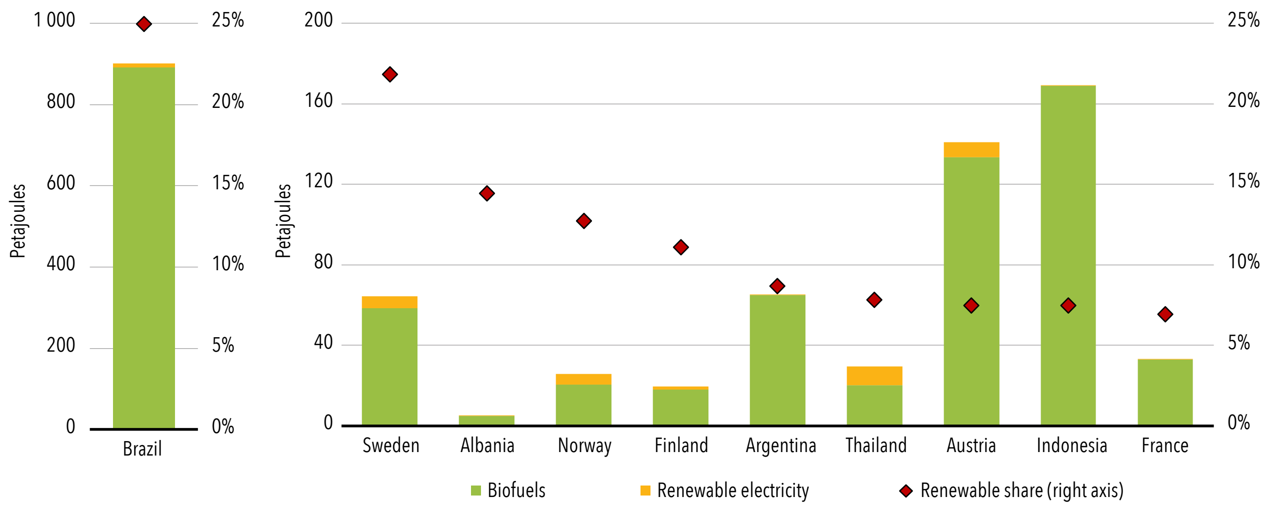
Figure 3.21 • Renewable energy share in transport and total renewable energy for selected countries, 2010, 2015, and 2020



Source: International Energy Agency and United Nations Statistics Division.

Across all countries and regions, the United States, Brazil, Europe, China, and India together constitute an 86 percent share of transport renewable energy consumption driven by policy support for biofuels and electrification. In 2020, Brazil, Sweden, Albania, Norway, Indonesia, and Finland recorded the largest shares of renewables in transport energy consumption, all above 10 percent (figure 3.22).

Figure 3.22 • Top ten countries by renewable energy share in transport, 2020



Sources: International Energy Agency and United Nations Statistics Division.

Policy Insights

Despite significant progress on SDG 7 over the past decade, the findings in this chapter underscore the need for greater ambition to achieve this goal, which in turn will enable and influence the realization of most other SDGs, including SDG 13 on climate targets, SDG 3 on health through pollution reduction, and SDG 8 on decent work and economic growth, among others. To this end, long-term commitments, supported by well-designed targets, comprehensive plans, and timelines, are needed to set clear directions and expectations for stakeholders to align their activities. The more detailed, specific, and credible a target is, the more likely it can catalyze public and private investments. Targets also need to be ambitious enough to step up from historical trends and align renewable energy deployment with SDGs and international climate ambitions. This section provides an overview of key considerations for countries as they design their renewable energy targets.[53]

Design elements of renewable energy targets. While designing renewable energy targets, decisions need to be made regarding their statistical bases; scope and coverage in terms of sectors and end uses; indicators; technology specificity; and implementation modalities (figure 3.23).

The *statistical basis* relates to whether targets are determined as a share of a mix relative to a baseline, that is, percentage-based targets (e.g., share of energy supply, electricity generation mix, percentage of vehicles) or a fixed absolute amount (e.g., capacity added, number of solar water heaters installed). Although targets expressed as a share of a mix may provide more clarity on how ambitious climate goals are, since they imply phasing out (or opting out of) fossil fuel–based energy and systems, they can be difficult to implement and monitor for multiple reasons. One such reason is that both the renewable energy deployed and the total energy demand/supply change over time. Targets expressed as absolute amounts can provide clearer commitment from policy makers and more certainty for market

53 The section is based on IRENA's report Renewable Energy Targets in 2022: A Guide to Design. For more details, please refer to the full report (IRENA 2022b).

participants and investors as they stipulate a specific quantity that must be installed or produced by a specified time. They are also easier to monitor than percentage-based targets.

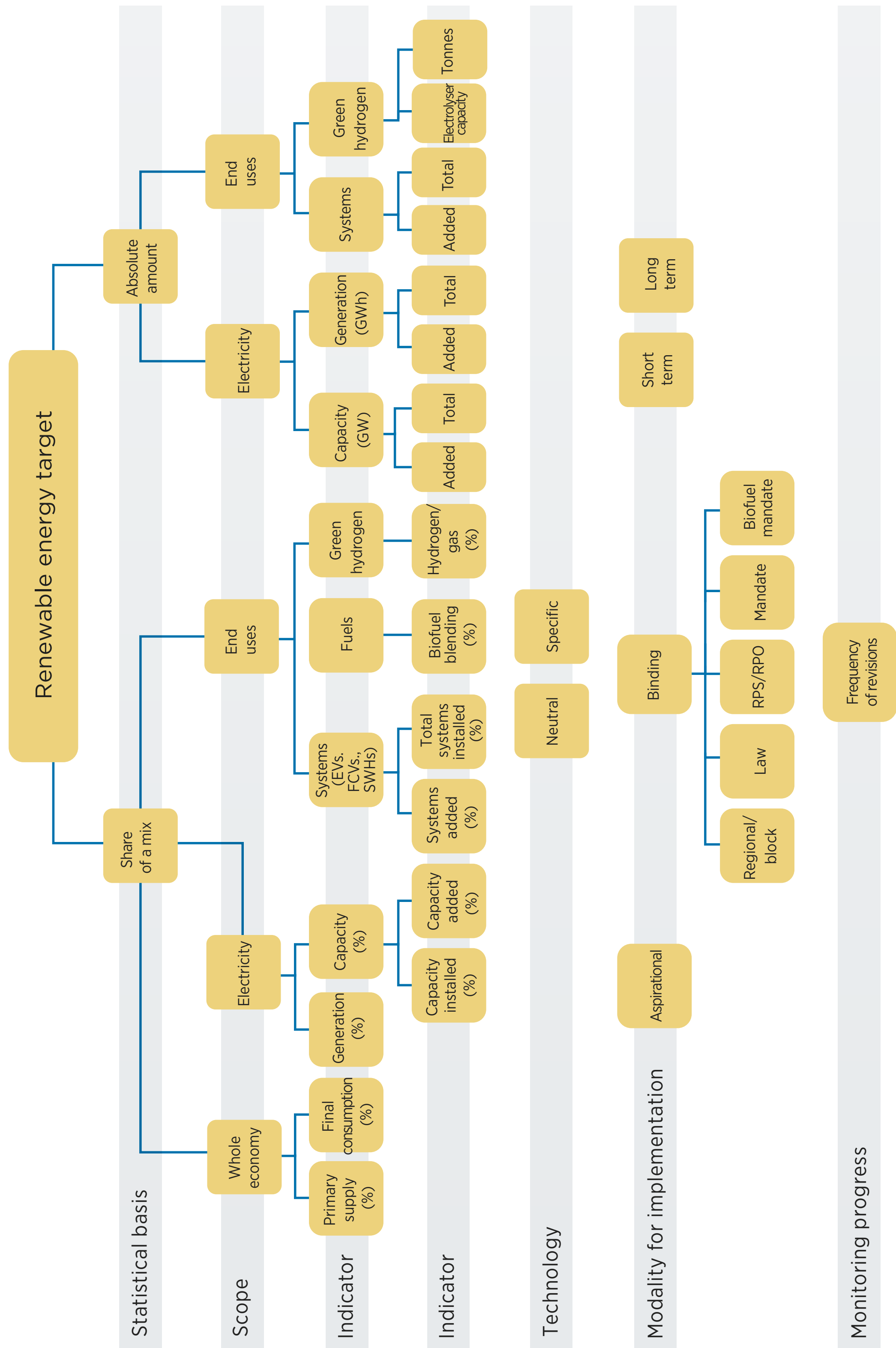
Scope and coverage relate to whether a target covers the entire energy sector or specific end uses. While the former provides a comprehensive view of the target's impact with regard to climate goals and energy security, the latter may provide a clearer signal for the development of local supply chains for specific technologies. Many countries have used a combination of both.

Targets can be set based on a range of indicators that vary in terms of scope and coverage. For percentage-based targets covering the entire energy sector, their applicability to the TFEC or total energy supply needs to be decided. For percentage-based targets in the power sector, a decision is needed on whether they represent a share of the generation or installed capacity. In end uses, a decision is needed on whether percentage-based targets represent a share of the total number of systems added by/after a given year (e.g., bans on the sales of combustion engine vehicles in the European Union and the state of California by 2035 correspond to a target of 100 percent of vehicles added after 2035 to be electric) or a share of the total in use by a given year (e.g., Paris's ban on all combustion engine vehicles by 2030 corresponds to 100 percent of vehicles on the road being electric).

Technology specificity relates to whether a target should be technology neutral or technology specific. While technology-neutral targets can be strategic in the early stages of renewable energy development, since they allow markets to identify the most cost-effective technologies, technology-specific targets can enable further diversification of the energy mix, with benefits such as resilient systems and fewer integration issues. They can also enable the development of local value chains for selected technologies. This can, for instance, help in addressing the risk that power-grid investments, including auxiliary services, storage, and flexibility measures, may not be identified early enough in current electricity markets, the importance of which is further explained in box 4.3.

Modalities for target implementation relate to whether a target is mandatory or aspirational, and short to medium term or long term. They determine the process for reviewing and revising a target.

Figure 3.23 • Key decisions for setting renewable energy targets



Source: IRENA 2022b
EV = electric vehicle; FCV = fuel cell vehicle; GWh = gigawatt-hour; SWH = solar water heater.

Target design should begin with considering how the target(s) will serve the desired policy goal(s). Possible objectives may include greenhouse gas emissions reduction in line with SDG 13 on climate; pollution reduction in line with SDG 3 on health; energy access, reliability, and affordability in line with SDG 7; job creation and economic growth in line with SDG 8; and other socioeconomic development and environmental goals set out in the UN 2030 agenda.

Reductions of emissions and energy imports. Targets may be expressed as a share of the energy mix, covering the entire energy sector, in order to address the phasing out (or opting out of) of fossil fuel–based energy and systems. This approach can provide greater clarity on the level of ambition related to the climate goals and the reduction of energy imports (for countries that are fossil fuel importers). Targets that reduce the supply of fossil fuels in their raw form (defined as a share of the primary energy supply) have greater potential to reduce energy imports and emissions across the entire process of energy conversion to consumption, including inefficiencies.

However, using primary energy as a statistical basis for setting a renewable energy target poses a problem related to the methodology used to calculate the primary energy equivalents of renewables. To overcome this, they can be translated into targets as shares in the final energy consumption. Once the overall target for the energy sector has been defined and aligned with wider emissions reduction and energy import minimization goals, a target can be broken down into the different sectors and end uses, such as the power, transport, and heating and cooling sectors, taking into account electrification plans. For example, Portugal's target of a 47 percent share of renewables in its final consumption by 2030 translates into a share of 20 percent renewables in transport, 38 percent in heating and cooling, and 80 percent in electricity. When setting such targets, energy demand must be predicted taking into consideration traditional variables that influence forecasts (e.g., population, economy, climate and weather, lifestyles and cultural choices), in addition to many components of the energy transition, such as energy efficiency targets and measures and increased electrification of end uses, among other factors.

In the power sector, targets expressed as renewables' share in electricity generation are more effective than targets expressed as renewables' share in installed capacity for achieving emissions reductions or fossil fuel savings. This is because progress monitoring excludes projects that sit idle or get curtailed.

For end uses, regarding systems such as electric vehicles or solar water heaters, for instance, targets in the form of a share of the total number of systems in use by a given year (for instance, X percent of vehicles on road must be electric vehicles) can help achieve climate and pollution goals, and energy security when fossil fuels are imported; yet targets expressed as total number of systems (e.g., Paris's ban on all combustion-engine cars by 2030) can be more effective, since they can require the phaseout of fossil fuel alternatives (e.g., all combustion-engine cars).

Universal energy access and clean cooking. Access targets expressed as percentages of population with access to electricity and clean cooking are independent of demographic changes. Additionally, separate targets specific to electrification and clean cooking are required, which have to be translated into an absolute capacity or absolute number of systems to deploy. Electricity access targets expressed as installed renewable capacity (including off-grid technologies) are easier to plan, monitor, and achieve. However, it is difficult to assess how effective these targets are in determining whether systems are being used and maintained. Output-based targets (e.g., renewables-based gigawatt-hours of electricity representing a percentage of the total electricity generation) focus on production and technology utilization. For renewables-based clean cooking, targets framed as the total number of systems to deploy (e.g., total number of biodigesters introduced) by a given deadline are easier to define, monitor, and implement than percentage-based targets.

Development of local industries for energy transition–related technologies. Translating percentage-based targets into absolute-amount targets can provide further clarity to market participants and investors and plays a role in the development of local industries for these technologies. Examples of such targets include specific capacities that must be installed (e.g., megawatts of power or number of solar water heaters) or produced (e.g., megawatt-hours generated). In particular, technology-specific targets can be instrumental in developing or enhancing local value chains for these technologies as well as leveraging local capacities. This was evident in countries that pursued technology-specific targets, such as Morocco and South Africa, where, further bolstered by policies to aid local industries, the solar and wind sectors flourished across different parts of the value chain, leading to an increase in jobs and income.

Overall, when setting national climate targets, policy makers must account for the following considerations.

- First, a balanced combination of long-term targets, further segmented into a series of short- to medium-term targets, is ideal for achieving a combination of policy objectives (in the presence of a robust policy framework to support the targets). Long-term targets provide an indication of a country's overall commitments and provide a key signal to developers, investors, service providers, and manufacturers regarding the long-term trajectory in a market. Short- to medium-term targets provide additional credibility as well as a pathway to achieving long-term objectives. They also create a sense of urgency and motivate stakeholders to act. They enable more effective implementation and rapid learning from the policy process and can coincide with investment and electoral cycles. In the case of five-year plans (e.g., China's), their periodic nature provides a high level of flexibility and adjustment. Setting short- to medium-term targets by backcasting a long-term trajectory can reconcile short-term goals with long-term objectives.
- Second, for these targets to be effective, they should be implemented together with policy instruments that are incorporated into legislation and/or institutional mandates for government agencies, corporate institutions, and other stakeholders.
- Finally, a key principle for effective renewable energy targets is to link them closely to the regular monitoring of market conditions so as to make them more ambitious in line with changes in policy objectives and priorities that call for greater ambition, market dynamics, lower renewable energy costs, and learning curves.

Methodological Notes

DEFINITIONS

Renewable energy sources. Total renewable energy from hydropower, wind, solar photovoltaic, solar thermal, geothermal, tide/wave/ocean, renewable municipal waste, solid biofuels, liquid biofuels, and biogases.

Renewable energy consumption. Final consumption of direct renewables along with the amount of electricity and heat consumption estimated from renewable energy sources. Ambient heat harnessed by heat pumps is not accounted for in this report, due to limited data availability.

Direct renewables. Bioenergy, and direct uses of solar thermal and geothermal energy.

Total final energy consumption. The sum of the final energy consumption in the transport, industry, and other sectors (equivalent to the total final consumption minus nonenergy use). Total final consumption excludes energy transformed into other forms of energy (e.g., natural gas used to generate electricity), as well as energy used by energy industries.

Traditional uses of biomass. Biomass uses are considered traditional when biomass is consumed in the residential sector in countries outside the Organisation for Economic Co-operation and Development. International Energy Agency statistics divide traditional uses of biomass into primary solid biomass, charcoal and unspecified primary biomass, and waste.

Traditional consumption/use of biomass is a "conventional proxy" because it is estimated rather than measured directly.

Modern uses of renewable energy consumption. Total renewable energy consumption minus traditional consumption/use of biomass.

METHODOLOGY FOR THE MAIN INDICATOR

The indicator used in this report to track SDG target 7.2 is the share of renewable energy in total final energy consumption (TFEC). Data from the International Energy Agency and the United Nations Statistics Division energy balances are used to calculate the indicator based on this formula:

$$\%TFEC_{RES} = \frac{TFEC_{RES} + \left(TFEC_{ELE} \times \frac{ELE_{RES}}{ELE_{TOTAL}}\right) + \left(TFEC_{HEAT} \times \frac{HEAT_{RES}}{HEAT_{TOTAL}}\right)}{TFEC_{TOTAL}}$$

The variables are derived from energy balance flows: TFEC is total final energy consumption as defined in table 3.1, ELE is gross electricity production, and HEAT is gross heat production, while the subscript RES indicates renewable energy sources.

The denominator is the TFEC of all energy products (as defined in table 3.1). The numerator, renewable final energy consumption, is a series of calculations showing the sum of the direct consumption of renewable energy sources and the final consumption of electricity and heat estimated to have come from renewable sources. To determine final renewable energy consumption, the consumption of electricity and heat deemed to come from renewable sources is assigned based on renewables' share in gross production.

METHODOLOGY FOR ADDITIONAL METRICS BEYOND THE MAIN INDICATOR

Renewable energy is consumed in mainly three sectors: electricity, heat, and transport. Consumption is calculated based on the energy balance and defined as follows:

Electricity refers to the amount of electricity consumed by end users. Electricity used in transport is excluded from this aggregation. Electricity used to produce heat is also excluded, because official data at the final energy service level are unavailable.

Heat refers to the amount of energy consumed for heating in industry and other sectors, as well as other uses not in electricity and transport, such as fuel used to pump water. Electricity used for heat is not included in this aggregate, due to the scarcity of official data at the final energy service level. The heat category here is not equivalent to the final energy end-use service. It is also important to note that in this chapter, in the context of an "end use," heat does not refer to the same quantity as the energy product, "heat," in the energy balance used in the above formula.

Transport refers to the amount of energy consumed in the transport sector. The majority of the electricity used in transport is consumed in the rail and road sectors, and, in some cases, in pipeline transport. The renewable electricity consumed in the transport sector is estimated by multiplying the annual shares of renewable sources in gross national electricity production by the amount of electricity used nationally in the sector.

METHODOLOGY FOR INDICATOR SDG 7.B.1

Indicator 7.B.1 measures the installed renewable energy–generating capacity in developing countries (in watts per capita). It is computed by dividing the maximum year-end installed capacity of renewable electricity–generating power plants by the country's midyear population. Data from the International Renewable Energy Agency (IRENA) are used to calculate this indicator.

IRENA's electricity capacity database contains information on installed electricity-generating capacity, measured in megawatts. The data set covers all countries and areas from the year 2000, records whether capacity is on-grid or off-grid, and is divided into 36 renewable energy types, which together constitute the six main sources of renewable electricity. For the population part of this indicator, IRENA uses population data from the United Nations World Population Prospects (UN 2021).

More details on the methodology used in this chapter can be found in the SDG indicators metadata repository (https://unstats.un.org/sdgs/metadata/files/Metadata-07-0b-01.pdf).

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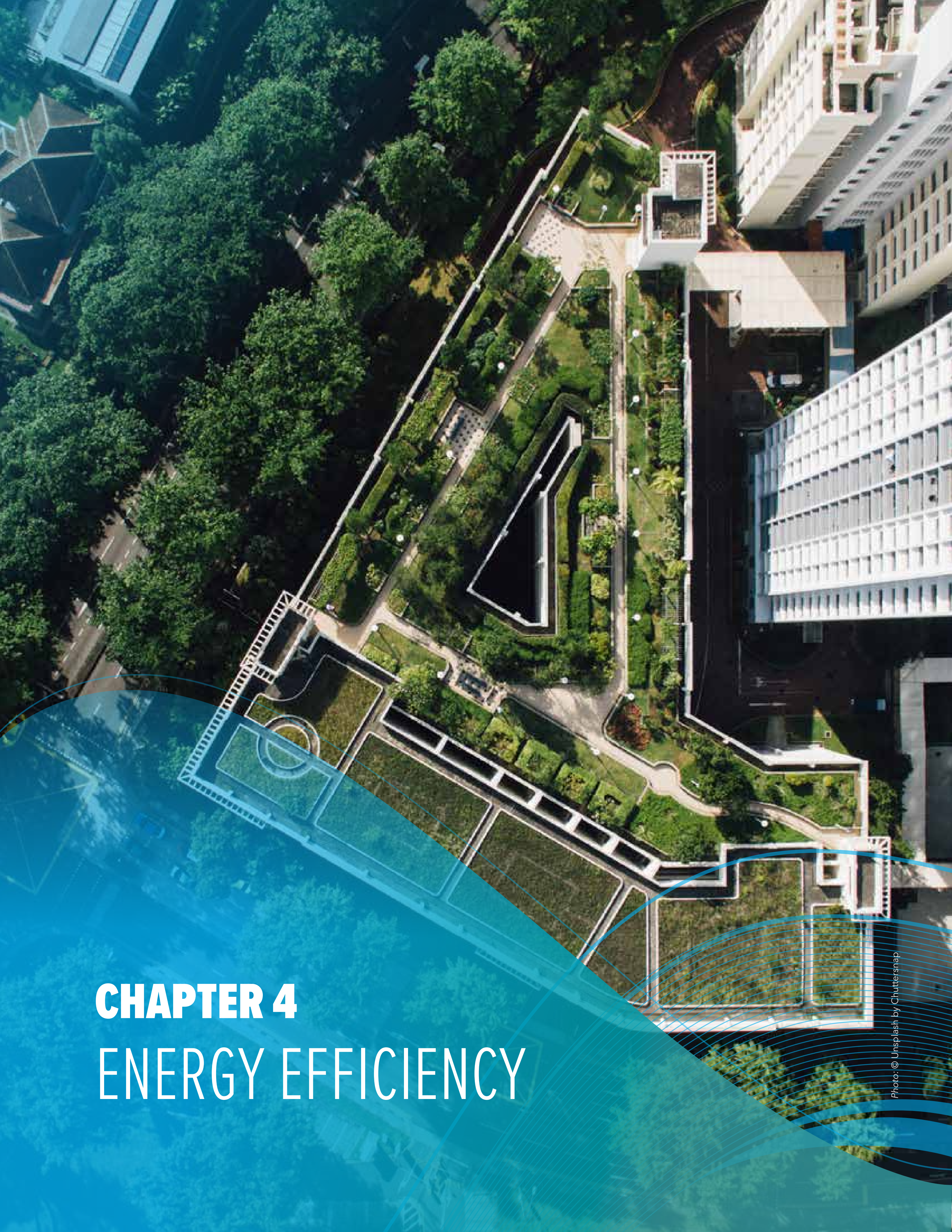

CHAPTER 4
ENERGY EFFICIENCY

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Main Messages

- **Global trend.** Primary energy intensity[54]—defined as the percentage decrease in the ratio of total energy supply per unit of gross domestic product (GDP)—improved at a consistently higher rate over the past decade (2010–20) than it did in the previous two (1990–2010). However, the rate of improvement declined to 0.6 percent in 2020, largely because of Covid-19–induced lockdowns and travel restrictions, and the radical shifts in the global economy that accompanied the initial lockdowns in that year. This makes 2020 the worst year for energy intensity improvement since the global financial crisis, with worldwide energy intensity declining to 4.63 megajoules (MJ) per 2017 US dollar. The pandemic makes it difficult to draw firm conclusions regarding whether the slowdown in 2020 reflects wider changes in the pace of structural energy efficiency improvements. However, the low energy prices seen during the pandemic have quickly faded, replaced by record high energy prices, prompting a renewed focus on improving energy efficiency, shielding consumers and industry, and improving energy security and sustainability.
- **2030 target.** The decade 2010–20 saw stronger energy intensity improvements on average, yet these remained below the target set under the United Nations Sustainable Development Goals (SDGs), of achieving, on average, a doubling of the global energy efficiency improvement rate between 2010 and 2030, compared with the 1990–2010 level. Globally, energy intensity improved at 1.8 percent annually between 2010 and 2020, surpassing the 1.2 percent rate seen between 1990 and 2010, although it remains well below the SDG target 7.3 of 2.6 percent on average required over the entire SDG time horizon (2010–30). Estimates for 2021 point to continued low progress in intensity improvement due to the COVID-19 crisis, although early estimates for 2022 suggest a rebound to higher levels of improvement, aided by renewed policy support and urgency in the wake of the energy crisis. Future annual improvements would need to increase to over 3.4 percent per year to make up for lost ground and meet SDG target 7.3 .
- **Regional highlights.** Eastern and South-eastern Asia came close to the initial target of 2.6 percent improvements annually, reaching 2.3 percent on average between 2010 and 2020. This was driven by robust efforts to phase out older, inefficient industrial capacity, improve the energy efficiency of buildings and industry, and shift increasingly toward industries that are less energy intensive. Average annual improvement rates in Northern America and Europe (2.0 percent), Central Asia and Southern Asia (2.0 percent), and Oceania (1.8 percent) were also above the global average and historical trends. The lowest improvement rates were achieved in Western Asia and Northern Africa (0.7 percent), followed by Latin America and the Caribbean (1.0 percent) and Sub-Saharan Africa (1.0 percent). Data on absolute energy intensity reveal wide regional differences, especially in regions with low access levels, and where households must rely on the traditional use of bioenergy for cooking. For example, energy intensity in Sub-Saharan Africa is close to double that in Latin America and the Caribbean. This highlights the strong interlinkage between universal access to clean cooking and reaching SDG target 7.3. In a similar manner, increasing renewables' shares in electricity generation improves supply efficiency by eliminating losses incurred in the conversion of primary (nonrenewable) fuels into electricity. This relationship highlights the synergies between SDG targets 7.2 and 7.3.

54 Hereafter referred to as "energy intensity." See note to figure 4.8 for the definition of energy intensity by sector.

- **Trends in the top 20 energy-consuming countries.** Comparing the periods 2000–10 and 2010–20, the annual rate of energy intensity improvement increased in 14 of the 20 countries with the largest total energy supply in the world. However, less than half of the top energy-consuming countries had improvement rates higher than the global average. Energy intensity continued to improve the fastest in the United Kingdom and China, at an annual average of 3.5 percent and 3.3 percent, respectively, between 2010 and 2020, followed by Indonesia, at 3.1 percent. Energy intensity also continued to improve at rates beyond SDG target 7.3 in Japan and Germany (at 2.9 and 2.7 percent, respectively). In 2020, the COVID-19 pandemic slowed energy intensity improvements across 12 of the top 20 energy-consuming countries, including routine leaders in efficiency, such as China and Indonesia.
- **End-use trends.** Energy intensity improved faster across all sectors, except the residential buildings sector, in 2010–20 compared with the previous decade. Intensity improvement was the fastest in the freight transport sector, at 2.2 percent a year, followed by passenger transport, at 1.9 percent. Notable progress can also be seen in industry (1.6 percent), which spans a range of energy-intensive economic activities. This is a major enhancement since sectoral energy intensity had deteriorated in the preceding period. Sectoral improvement rates were the lowest in the residential sector, where energy intensity improvement slowed from 1.9 percent in the previous period to 1.2 percent annually between 2011 and 2020.
- **Policies and investment in efficiency.** The year 2020 saw only a slight decline in overall energy efficiency investments (at nearly USD 380 billion) despite the COVID-19 crisis, even though trends differed widely across sectors and regions. Europe, China, and Northern America accounted for nearly 80 percent of the spending. Moreover, in recent years, energy efficiency incentives, regulations, and information campaigns have received major support from clean energy recovery spending and energy crisis packages. Over USD 250 billion of government spending has been allocated to efficiency in buildings and industry, and an additional USD 180 billion has been allocated to low-carbon vehicles between 2020 and December 2022. It is important to continually update energy efficiency standards and labels, building codes, and energy efficiency obligation (EEO) schemes to reflect the latest technology and market trends.

Are We on Track?

SDG 7 commits the world to ensure universal access to affordable, reliable, sustainable, and modern energy. Under this goal, target 7.3 calls for global advances in energy efficiency by doubling the global rate of energy intensity improvement relative to the average rate over the period 1990–2010—which meant improving energy intensity by 2.6 percent per year in 2010–30.[55] Energy efficiency improvement and energy wastage reduction also play a part in the pace and cost of progress on universal access to energy and renewable energy. Energy intensity is the ratio of the total energy supply to the annual GDP created—in essence, the energy used per unit of wealth created. We can use this measure of energy intensity to observe how energy use rises or falls, while also looking for the (social and economic) development factors that may affect the corresponding rates, along with other factors, such as weather and behavior change. In general, energy intensity declines as energy efficiency improves.

Progress toward SDG target 7.3 is measured by tracking the year-on-year percentage change in energy intensity. Initially, the United Nations recommended an annual improvement rate of 2.6 percent between 2010 and 2030 to achieve the target, although global progress has been slower than that in all years except 2015. This means that energy intensity now needs to improve at no less than 3.4 percent globally from 2020 to 2030. In other words, energy intensity needs to improve at almost twice the rate in the past decade (which was itself almost 50 percent faster than between 1990 and 2010). An even greater improvement, at 4.2 percent, is needed to reach the International Energy Agency's (IEA's) Net Zero Emissions by 2050 Scenario (NZE)[56] (figure 4.1).

Globally, energy intensity has improved gradually since 1990[57] (figure 4.2). Recent numbers show that global energy intensity improved only 0.6 percent in 2020, to 4.63 MJ/USD (2017 PPP [purchasing power parity]), in the context of the COVID-19 crisis. This was the lowest rate of improvement since the global financial crisis. Moreover, historical GDP and energy intensity data suggest that large declines in GDP, such as those occurring in 2020, tend to be followed by declines in future energy intensity improvement rates (IEA 2020). For example, GDP was increasing at over 5 percent per year globally in 2006 and 2007; it fell to 3 percent in 2008 and then to zero in 2009. Energy intensity data show corresponding declines in energy intensity improvement rates not only in 2008 and 2009 but also 2010, when global GDP growth returned to precrisis levels of about 5 percent. This is consistent with the low expected energy efficiency improvement for 2021.

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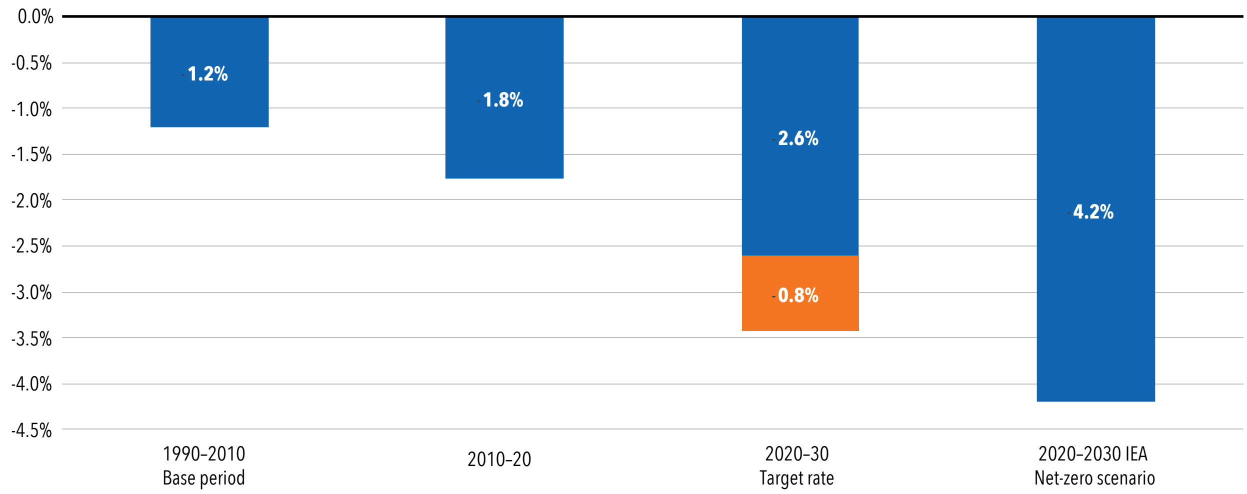
55 Revisions of underlying statistical data and methodological improvements explain the slight changes in growth rates in the base period (1990–2010) from previous editions. SDG target 7.3 of improving energy intensity by 2.6 percent per year in 2010–30 remains the same, however.

56 The Net Zero Emissions by 2050 Scenario maps out a path to stabilize the global average temperature rise to 1.5°C, alongside universal access to modern energy by 2030.

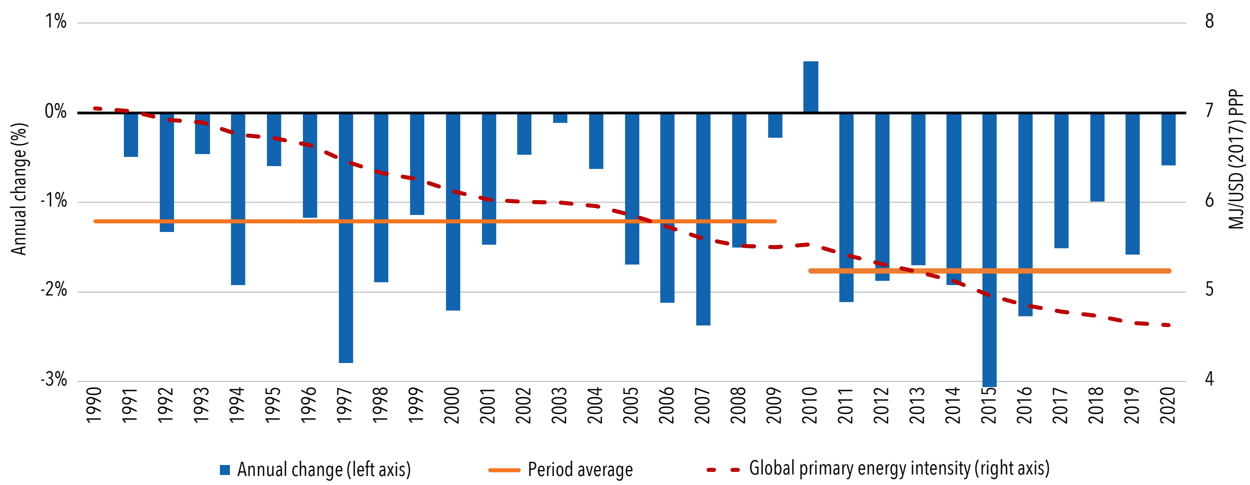
57 The majority of the energy data in this chapter comes from a joint data set built by the International Energy Agency (https://www.iea.org/data-and-statistics/) and the United Nations Statistics Division (https://unstats.un.org/unsd/energystats/). GDP data are sourced from the World Bank's World Development Indicators database (http://datatopics.worldbank.org/world-development-indicators/).

Figure 4.1 • Growth of primary energy intensity by period and target rate, 1990–2030



Sources: IEA, UN, and World Bank (see footnote 4).

Figure 4.2 • Global primary energy intensity and its annual change, 1990–2020



Sources: IEA, UN, and World Bank (see footnote 4).
MJ = megajoule; PPP = purchasing power parity.

Looking Beyond the Main Indicators

COMPONENT TRENDS

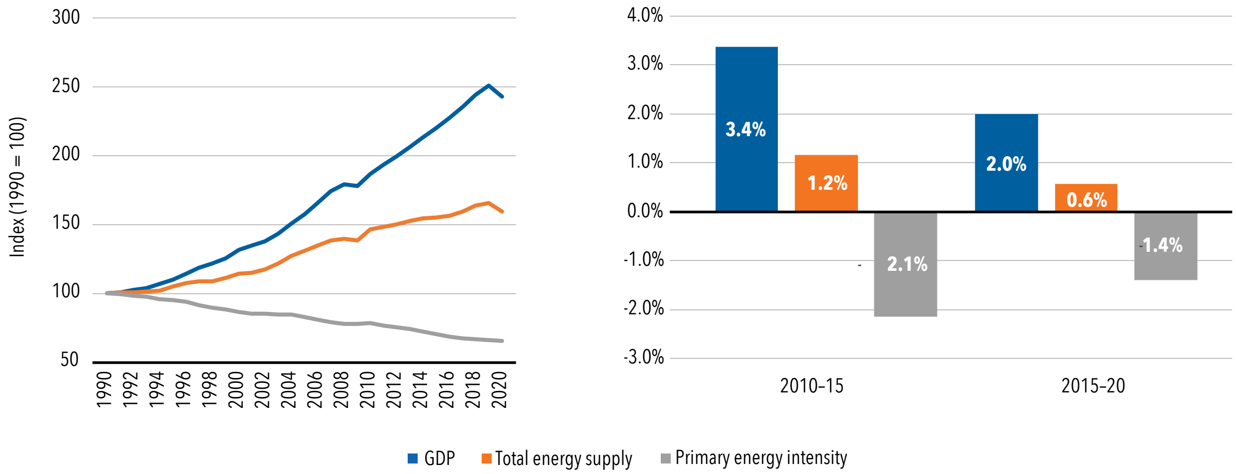
Between 2019 and 2020, for the first time since the global financial crisis in 2009, both GDP and total energy supply decreased, by 3.2 and 3.8 percent, respectively. Meanwhile, GDP declining slightly less than energy supply, resulting in a small improvement in energy intensity. However, this improvement was the smallest since 2010, and in the aftermath of the global financial crisis. This trend is due to energy-intensive industry's larger share of energy demand and slower efficiency progress, especially in the buildings and industrial sectors (IEA 2021d).

Over the longer term, the impact of energy intensity improvement is revealed by trends in its underlying components (figure 4.3, left). Between 1990 and 2020, global GDP increased by a factor of 2.4, whereas global total energy supply[58] grew 60 percent, signaling trends in the decoupling of energy use from economic growth. This resulted in a consistent improvement in global energy intensity, which fell by more than a third between 1990 and 2020.

However, there has been a decline in energy intensity improvements more recently. Between 2010 and 2015, energy intensity improved by 10.2 percent, but it grew much slower, at 6.8 percent, between 2015 and 2020 (figure 4.3, right).

Recent trends in energy efficiency are discussed in box 4.1.

Figure 4.3 • Trends in the underlying components of global primary energy intensity, 1990–2020; and growth rates of GDP, total energy supply, and primary energy intensity, 2010–20



Sources: IEA, UN, and World Bank (see footnote 6).
GDP = gross domestic product.

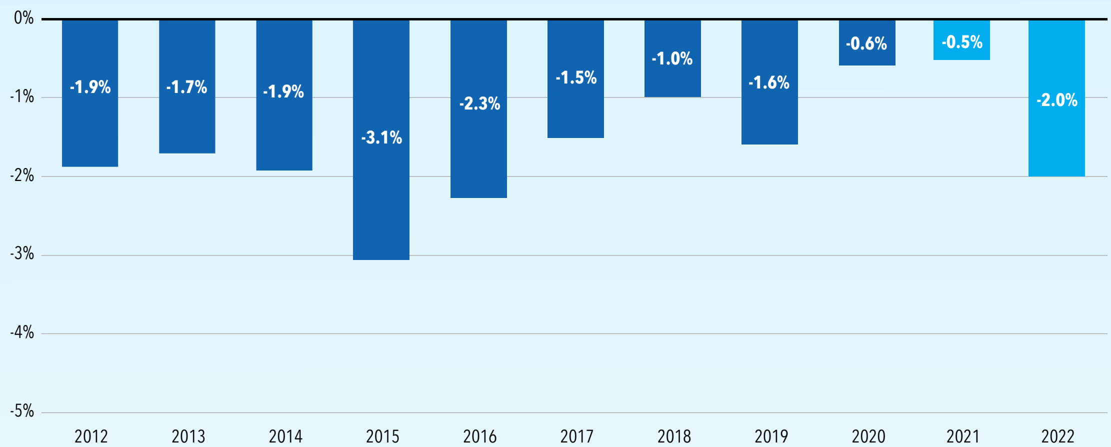
58 "Total primary energy supply" has been renamed "Total energy supply" in accordance with the International Recommendations for Energy Statistics (UN 2018).

Box 4.1 • Recent energy efficiency trends

The COVID-19 pandemic and then the energy crisis following Russia's invasion of Ukraine have disrupted energy and economic trends in recent years.

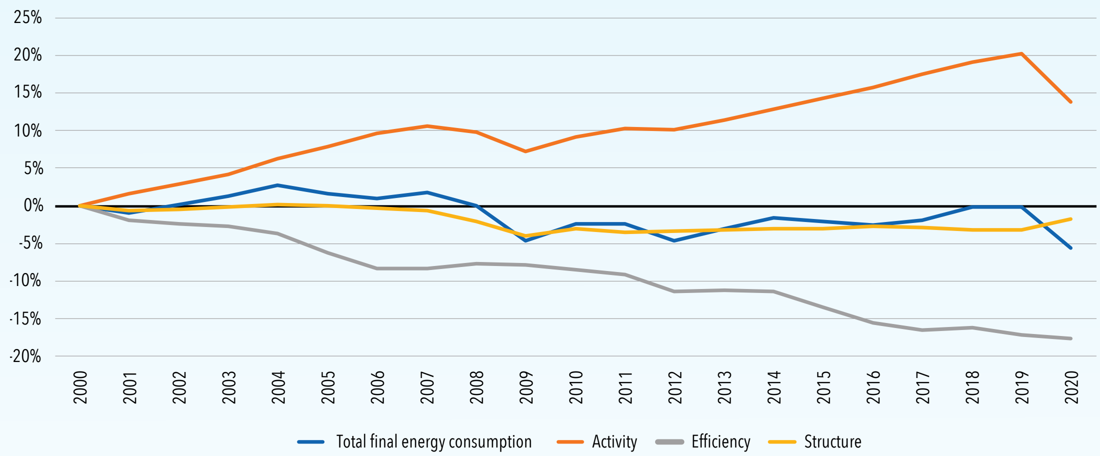
The year 2020 was one of the worst in terms of advancement in energy efficiency. Energy intensity improved by a mere 0.6 percent owing to low energy demand and prices, technical efficiency sluggish improvements in technical efficiency, and a shift in economic activity away from less energy-intensive services, such as hospitality and tourism. Initial estimates for 2021 suggest even less improvement of energy efficiency, at 0.5 percent, although there may have been a turning point in 2022, with initial estimates suggesting progress at about 2 percent.

Figure B4.1.1 • Growth rate of global primary energy intensity, 2012–22



Sources: IEA, UN, and World Bank (see footnote 4); IEA 2022c.

Figure B4.1.2 • Change in energy demand and demand drivers in IEA countries, 2000–20



Sources: IEA, UN, and World Bank (see footnote 4); IEA 2022c.
Note: Change in total final energy consumption is the net effect of changes in activity, efficiency, and structure across buildings, transport, and industry. For example, in residential buildings, activity refers to population, structure refers to per capita floor area, and efficiency refers to energy use per floor area.

However, early estimates suggest that 2022 could be a turning point for energy efficiency. The energy crisis proved a strong reminder of the importance of energy efficiency for energy security as well as energy and carbon dioxide emissions savings. Price increases also increased the value of energy efficiency, and diminished payback times. This led to accelerated energy efficiency investments, a rising wave of energy awareness campaigns, strengthening of building codes, and increased electrification of transport and heating (IEA 2022b). Improvement in energy efficiency is therefore expected to rebound, at 2 percent. However, this is still slower than what is needed to reach SDG 7 targets. Sustained effort is needed to accelerate that trend.

REGIONAL TRENDS

The COVID-19 crisis significantly affected both energy consumption and GDP in all regions. As a general trend, GDP declined in all regions in 2020. This was followed by a rebound in 2021, with regional variations depending on the timing and length of pandemic-related restrictions. In 2020, these shifts brought about significant swings in energy intensity, as energy consumption in Eastern Asia, South-eastern Asia, Sub-Saharan Africa, and Oceania continued to rise, putting upward pressure on energy intensity. And while energy consumption declined in Latin America, the decline in GDP was greater, also leading to a slowdown in energy intensity improvements. In Northern America and Northern Africa, energy intensity improved generally (that is, it decreased), although at lower rates than in the previous years. In Europe, energy intensity worsened slightly (that is, increased), while remaining stable in Western Asia and Northern Africa, and in Central Asia and Southern Asia.

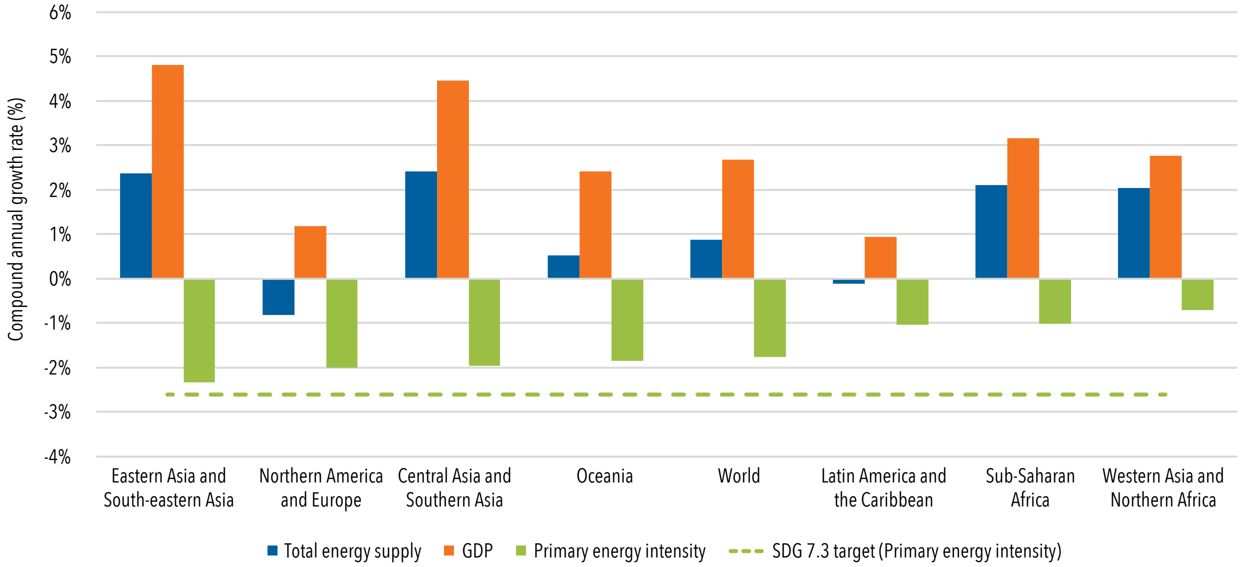
Energy intensity has improved across the world since 2010, but significant differences in trends are observed across regions (figure 4.4). Economies in Central, Southern, Eastern, and South-eastern Asia have seen a rapid increase in economic activity, and the associated increase in total energy supply has been mitigated in part by significant improvements in energy efficiency, which have put downward pressure on the global average.

Over the same period, economies in Northern America and Europe experienced a slight decrease in their total energy consumption, which reflects slower economic growth and a decoupling of the economy from energy usage. This last trend was enabled by a continued shift toward industrial activities consuming less energy and the greater energy efficiency that is typically observed when mature policies are in place, especially in buildings (Northern America) and industry (Europe). In these economies, energy intensity improved at rates slightly above global trends, leading to absolute energy intensity levels slightly below the global average (figure 4.5). Similar trends and absolute energy intensity levels have been observed for Oceania, where total energy supply increased modestly, whereas GDP grew faster than in Northern America and Europe.

Latin America and the Caribbean, Western Asia and Northern Africa, and Sub-Saharan Africa recorded the smallest average gains in energy intensity improvement over the period 2010–20 (1 percent per year or less). However, trends differed across these regions. In Latin America and the Caribbean, total energy supply decreased slightly, and GDP growth was among the lowest worldwide. The region is also the less energy-intensive in the world, at 3.3 MJ/USD (2017 PPP) (figure 4.5). On the other hand, in Western Asia and Northern Africa, and Sub-Saharan Africa, total energy supply and GDP grew at rates higher than the global average. In absolute terms, economic output in Sub-Saharan Africa is highly energy intensive, at 6.3 MJ/USD (2017 PPP). The figure for Western Asia and Northern Africa was 4.3 MJ/USD (2017 PPP) (figure 4.5).

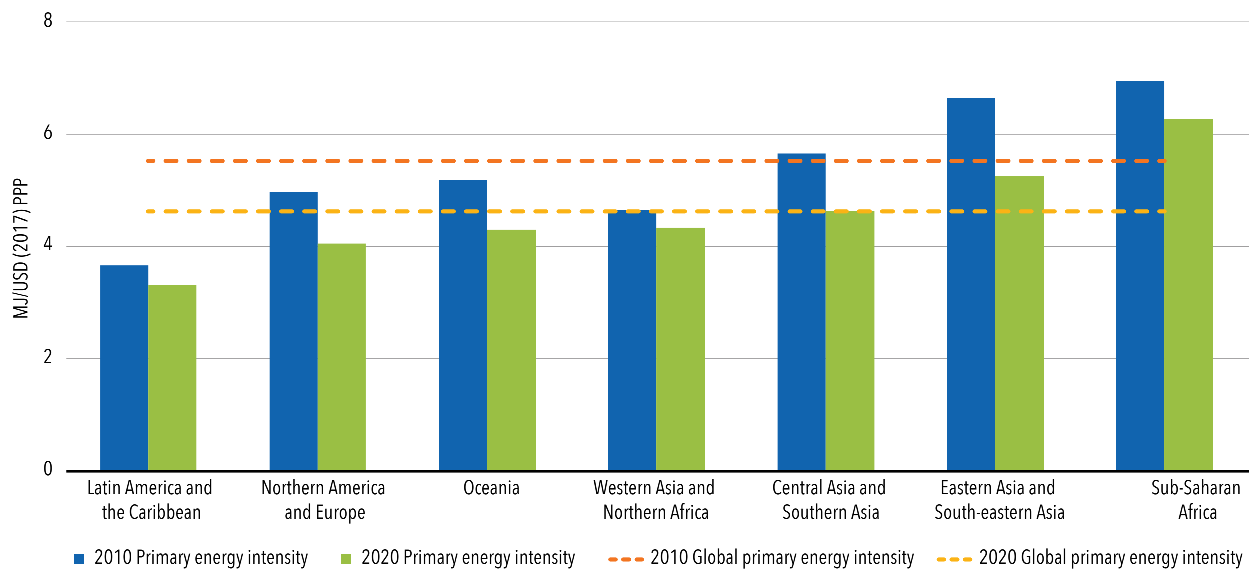
Three regions (Eastern Asia and South-eastern Asia, Latin America and the Caribbean, Western Asia and Northern Africa) saw energy efficiency improvements double in 2010–20 compared with those in 1990-2010. However, the absolute level remained relatively low, at 0.7 and 1 percent, respectively, for the last two regions.

Figure 4.4 • Growth rate of total energy supply, GDP, and primary energy intensity at a regional level, 2010–20



Sources: IEA, UN, and World Bank (see footnote 4).
GDP = gross domestic product; SDG = Sustainable Development Goal.

Figure 4.5 • Primary energy intensity at a regional level, 2010 and 2020



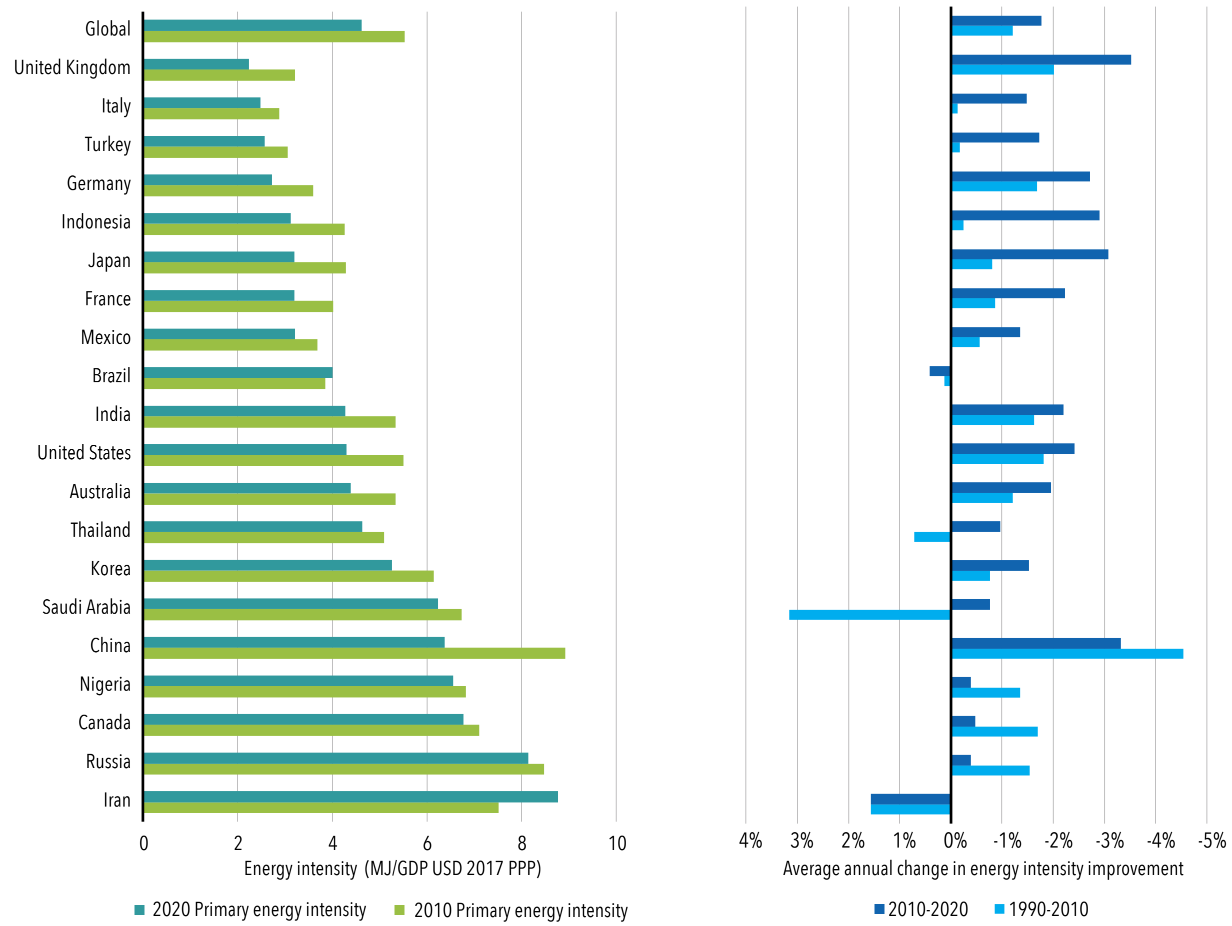
Sources: IEA, UN, and World Bank (see footnote 4).
MJ = megajoule; PPP = purchasing power parity.

MAJOR COUNTRY TRENDS

Improving energy intensity in the top 20 energy-consuming countries is central to realizing SDG target 7.3, considering these countries account for approximately three-quarters of the global GDP and energy consumption. Over the period 2010–20, 14 of these 20 countries achieved faster energy intensity improvements than the previous decade, although only five (China, the United Kingdom, Indonesia, Japan, and Germany) exceeded the level of 2.6 percent required by SDG 7.3 (figure 4.6). In addition, intensity improvement doubled in six countries in 2010–20 compared with 1990–2010. These are Mexico, France, Indonesia, Japan, Turkey, and Italy. This list includes both developed economies and major emerging economies, showing that all countries can double their energy efficiency improvement rates, despite differences in their starting improvement levels.

However, in more than half of these 20 countries, the COVID-19 crisis reversed the trend, with energy intensity worsening. For a quarter of them, including countries like China and the United Kingdom, which had significantly decreased their energy intensity over the decade, 2020 turned out to be the worst year for energy efficiency.

Figure 4.6 • Primary energy intensity, 2010 and 2020; and average improvement in annual energy intensity, 1990–2010 and 2010–20, in the top 20 energy-consuming countries with the largest total energy supply



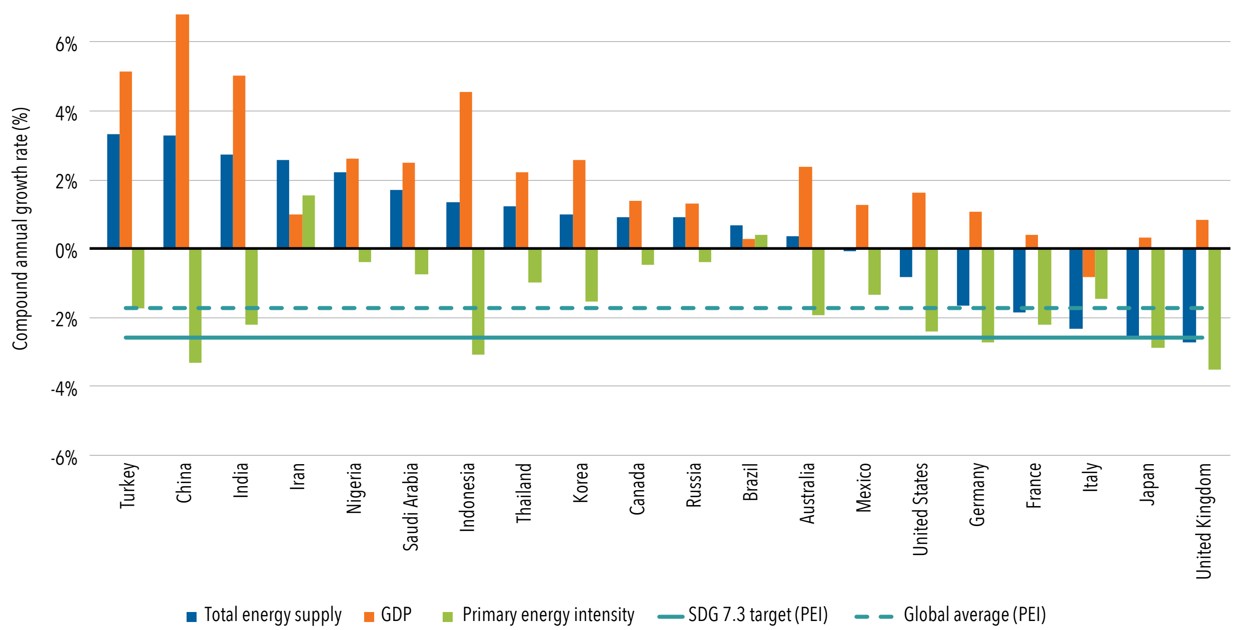
Sources: IEA, UN, and World Bank (see footnote 4).
Note: Countries along the y-axis are ordered by total energy supply. The average annual change in energy intensity improvement is based on a compound annual growth rate.
GDP = gross domestic product; MJ = megajoule; PPP = purchasing power parity.

In absolute terms, the energy intensity of 8 of the top 20 energy-consuming countries has remained above the global average over the past decade (figure 4.6). Two of these, the Islamic Republic of Iran and Russia, are also among the 25 countries with the highest energy intensities worldwide.

Countries where progress has been the slowest include those where energy-intensive fossil fuel extraction represents a major share of GDP. These include the Islamic Republic of Iran, Brazil, Nigeria, Saudi Arabia, the Russian Federation, and Canada. In this respect, a relatively high level of energy intensity reflects a challenge as well as an opportunity for strategies to diversify to more knowledge-based or service-oriented economies. The annual rate of change in energy intensity therefore represents an important indicator and a potential policy target to track both diversification and energy efficiency goals.

On the other hand, certain countries have made progress by diminishing energy intensity further below the global average, including Australia, India, Indonesia, Japan, and the United Kingdom. While China still remains above the global average in energy intensity, it has diminished significantly over the past decade.

Figure 4.7 • Growth rate of total energy supply, GDP, and primary energy intensity in the 20 countries with the largest total energy supply, 2010–20



Sources: IEA, UN, and World Bank (see footnote 4).
Note: Countries along the x-axis are ordered by total energy supply.
GDP = gross domestic product; PEI = primary energy intensity; SDG = Sustainable Development Goal.

Between 2010 and 2020, the economies of the United States, the United Kingdom, Japan, Germany, and France expanded as their energy use declined (figure 4.7). These trends suggest that economic growth is being decoupled from energy use. The economies of these countries have strong, decade-long records of policy action on energy efficiency and have economic structures characterized by high-value, service-related activities that consume less energy. Meanwhile, in countries to the left in the above chart, such as China, India, the Islamic Republic of Iran, Nigeria, Saudi Arabia, and Indonesia, higher growth rates of energy demand are generally expected as new infrastructure requiring energy-intensive industrial products, such as steel and cement, is being built. Many people may also be gaining access to modern energy services for the first time, which also results in higher energy demand in the buildings and transport sectors.

In 2020, GDP fell by approximately 3 percent globally and energy consumption declined by 4 percent due to the temporary effects of COVID-19. This was followed by 6 percent global GDP growth and 5 percent growth in energy demand in 2021. This means particular care must be taken while interpreting results that use 2020 as the latest year of comparison for energy consumption, considering it was an exceptional year.

END-USE TRENDS

A variety of metrics (as discussed in the note to figure 4.8) can be used to examine energy intensity across key sectors, such as industry, transport, buildings, and agriculture. Over the period 2010–20, energy intensity improved at an accelerated rate across all sectors, except the residential buildings sector (figure 4.8).

In the industry sector, which comprises highly energy-intensive economic activities, for example, cement, iron, and steel manufacture, energy intensity improved by 1.6 percent per year, on average, during the 2010s. Energy intensity improved at an annual average rate of 1–2 percent over 2010–20 for chemicals, nonmetallic minerals, and metals. In manufacturing consuming less energy, annual efficiency improvements averaged at 2–4 percent per year over the same period (IEA 2022b). This was a major improvement since sectoral energy intensity had deteriorated in the preceding period. The progress was largely driven by emerging Asian economies, such as China and India, through, for example, more efficient manufacturing processes (IEA 2017). Furthermore, the framework for mandatory energy efficiency policies tends to be more developed in the industry sector than any other sector around the world (IEA 2018). Industrial energy consumption declined 3 percent in 2020 due to the COVID-19 crisis. This decline was however cushioned by the rising share of energy-intensive activities in China, which navigated the year with fewer restrictions. This increase in energy-intensive activities also accounts for energy intensity deteriorating in the industry for the first time since the global financial crisis.

Between 2010 and 2020, energy intensity declined the fastest in the freight transport sector, at 2.2 percent annually. This decline is steeper than the 0.4 percent annual decrease observed in 2000–10. Energy intensity for passenger transport also improved slightly faster (at 1.9 percent a year) in the past decade than in the earlier one (1.8 percent). In 2020, the largest decline in energy consumption was in the transport sector (falling 14%). Lower occupancy rates in planes, trains, and public transport resulted in less efficient use of energy in the sector. Sales of new cars also fell, resulting in an overall vehicle stock that was older and less efficient. However, electric car sales performed well in 2020, with 3 million cars sold. This accounted for 5 percent of global car sales. To put this in context, however, sales of sport utility vehicles (SUVs) constituted about 40 percent of all passenger car sales in 2019, up from just 20 percent 10 years earlier. Such vehicles are typically heavier and less efficient, consuming approximately 20 percent more energy than medium-sized vehicles (IEA 2021b).

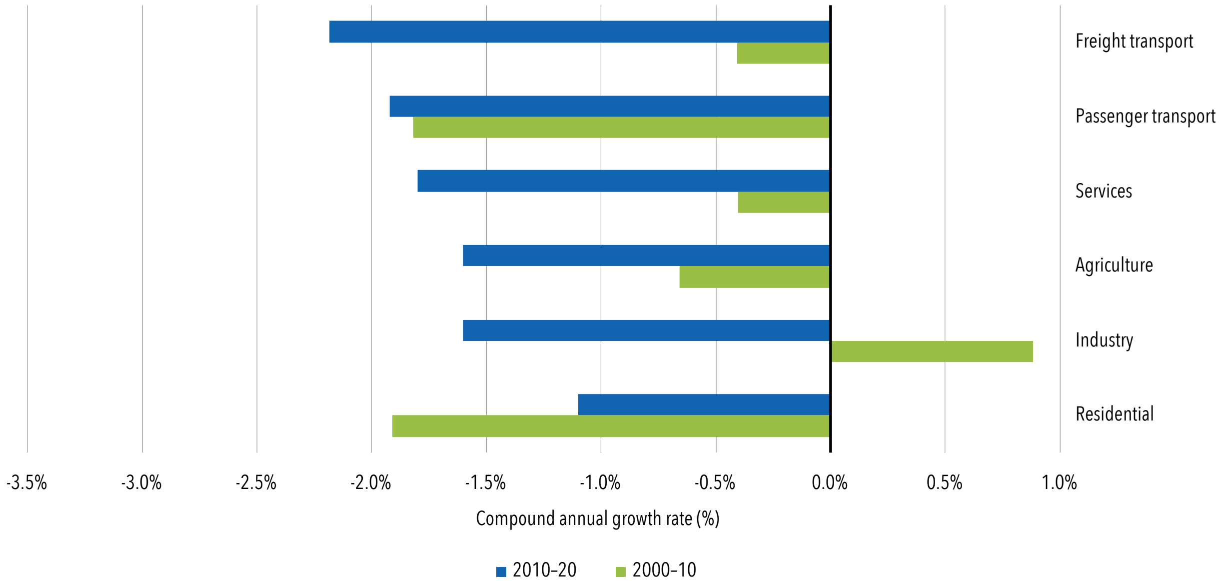
More broadly, electric vehicles saw a decade of rapid growth, which is expected to continue in the 2020s, thanks to supportive policy frameworks, financial incentives, reducing cost, and expanding charging infrastructure. Based on current trends and policies, the number of electric cars, vans, heavy trucks, and buses on the road is set to reach 145 million worldwide by 2030 (IEA 2021h).

The residential sector, which accounts for nearly a third of the global energy consumption, saw a slowdown in energy intensity improvements, from 1.9 percent in the first decade of the new century to 1.1 percent annually between 2010 and 2020. The sectoral final energy demand was the least affected by the COVID-19 restrictions in 2020. It decreased by just 0.3 percent, with a slight increase in floor area, 1.3 percent, and energy intensity improving at a pace comparable to that in previous years.

In the services sector, energy intensity improved by 1.8 percent annually between 2010 and 2020, a significant improvement from the 0.4 percent rate in the previous decade. The sector was deeply affected by the COVID-19 crisis, with energy consumption down 6 percent and energy intensity down 3.1 percent.

Energy intensity also improved significantly for agriculture—from 0.7 percent a year in 2000–10 to 1.6 percent between 2010 and 2020. This resulted from the sector's economic output outpacing the growth in energy demand.

Figure 4.8 • Compound annual growth rate of energy intensity by sector, 2000–10 and 2010–20



Sources: IEA, UN, and World Bank (see footnote 4).
Note: The measures for energy intensity used here differ from those applied to global primary energy intensity. Here, energy intensity for freight transport is defined as the final energy use per tonne-kilometer. For passenger transport, it is defined as the final energy use per passenger-kilometer. For residential use, it is defined as the final energy use per square meter of floor area. In the service, industry, and agriculture sectors, energy intensity is defined as the final energy use per unit of gross value-added (USD 2017 PPP). In the longer term, it would be desirable to develop more refined sectoral and end-use-level indicators that make it possible to examine energy intensity by industry (e.g., cement, steel) or end use (e.g., heating, cooling). Doing so will not be possible without more disaggregated data and statistical collaboration with relevant energy-consuming sectors.

Box 4.2 • Expanding the scope and scale of efficiency

The scope and scale of energy efficiency are being driven by a more systemic thinking, use of digitalization, and more integrated policy making.

There is a growing necessity for energy efficiency given the mounting pressures to decarbonize and electrify in conjunction with emerging disruptions in clean technology supply chains and critical mineral supply risks (IEA 2023). System efficiency, encompassing circularity and efficient use of resources, can unlock energy efficiency potential across the entire energy value chain and can reduce energy consumption in all sectors. Systematic reviews of greenhouse gas emissions and resource flows indicate that material handling and use account for 70 percent of greenhouse gases emitted (CGRi 2021). Driving down emissions requires expanding the boundaries of energy efficiency beyond reducing the energy requirements of end uses such as buildings, appliances, industrial plants, and vehicles. Circularity can dramatically improve the efficiency of systems through closing resource loops, slowing resource loops or flows, and narrowing resource flows to reduce environmental and climate pressures, as well as risks of raw material shocks to economies (OECD 2022). Systemwide efficiency is therefore crucial to enable cost-effective decarbonization pathways.

Taking a more systemic approach—enabled by digitalization—is already showing significant improvements and potential across a range of end uses and sectors. In this context, extending product policies to cover relevant energy-consuming systems has the potential to reduce annual global consumption by 9 percent (17 exajoules) (4E IEA 2022b). In Europe alone, sensors and data analytics for optimizing motor-driven systems could bring additional electricity savings of 50–100 terawatt-hours per year by 2030 (4E IEA 2022a). Further, the adoption of energy management systems has been shown to cut energy usage in industries and businesses by up to 30 percent (UNIDO n.d.). Buildings analytics and automation can cut energy use by one-quarter (ACEEE 2017), and smart streetlighting can reduce energy demand by up to 80 percent (IEA 2021g).

Behavioral interventions to support energy efficiency can also be boosted by a digital inclusive systemic approach. Behavioral interventions aim to trigger socially desirable behaviors—by removing barriers to such behaviors or creating disincentives to socially damaging behaviors. Digital devices can simplify energy saving actions and remove unnecessary barriers through automation and clear prompts (IEA 2021i). Successful behavioral interventions to bolster energy efficiency have facilitated conservation by using techniques such as feedback mechanisms, which track households' energy consumption patterns, or targeted prompts, which alert consumers to pay particular attention to their energy usage at peak times. Feedback mechanisms show consumers how their energy consumption patterns evolve throughout the day and across seasons. Consumers can be given real-time feedback via in-home displays, mobile applications, or web portals receiving data from smart metering systems. A 2015 impact assessment by the Smart Metering Early Learning Project observed that consumers with smart meters and in-home displays used 1.5 percent less natural gas and 2.2 percent less electricity in 2011 compared with those equipped with conventional meters (UK Department of Energy and Climate Change 2015).

However, this is only scratching the surface of what digitally powered efficiency can do. Smarter electricity systems can improve the productivity of renewable energy generation, reduce transmission and distribution losses, and extend asset lifetime, and they can increase systems' efficiency, through making electricity demand more flexible. Smarter cities can plan and orchestrate systems to reduce energy demand across buildings, transport, and services. Moreover, digital technologies that allow for greater visibility of energy and resource usage and better management can help deliver efficiency across resource extraction, material production, and component and technology manufacturing so as to enable use at different stages, including end-of-life. Digital technologies can be used to make data-driven decisions and optimize the performance of systems and processes, aside from creating and capturing value throughout the life cycle of assets (OECD 2022). They help reduce the need for materials and critical minerals through resource-efficient manufacturing and product design, improve the productivity of assets, extend products' and assets' life, and enhance resource recovery and material reuse. For example, the recovery of waste heat generated by data centers, wastewater treatment, industries, and commercial sector can in some cases be connected to district heating systems through a circular economy approach. Recent research indicates that circular economy approaches could reduce global greenhouse gas emissions by 39 percent and cut virgin resource use by 28 percent (CGRi 2021).

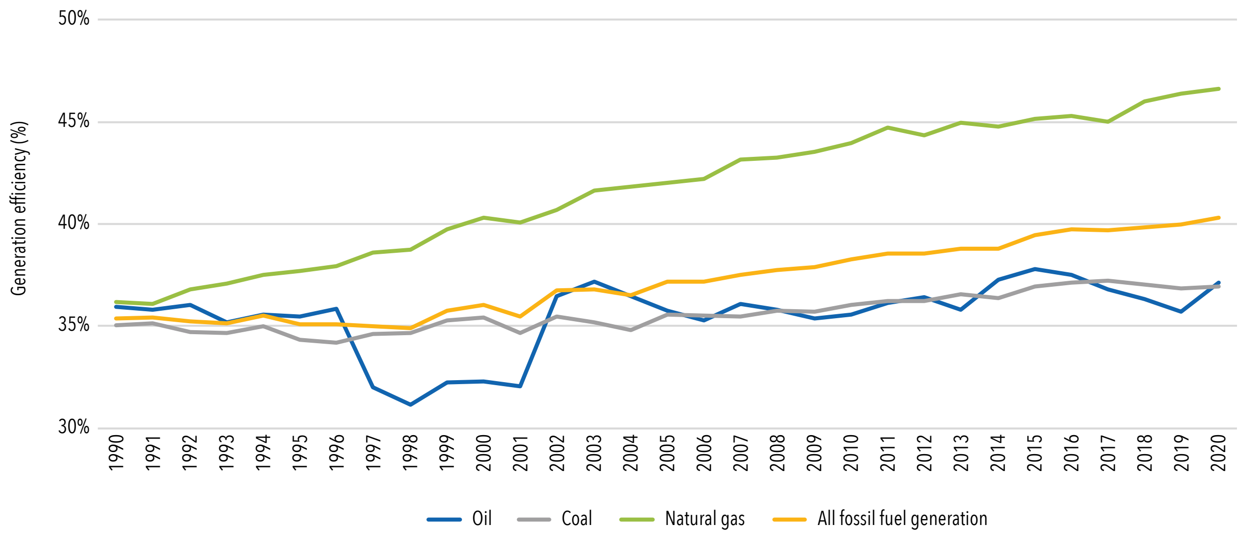
Leveraging these energy efficiency opportunities requires new approaches to more integrated policies. However, here again, digitalization can provide part of the solution. Access to unprecedented volumes of data, which were previously unobservable or were only observable and collected at prohibitive costs, enables policy makers to better understand and manage resources and waste, and this can be combined with advanced analytics to help rethink the design and operation of production and consumption systems, and energy and transportation systems.

TRENDS IN EFFICIENCY OF ELECTRICITY SUPPLY

The rate of improvement in global energy intensity is influenced not only by improvements in end-use efficiency but also by changes in the efficiency of electricity supply. These changes include reductions in transmission and distribution losses due to a modernized supply infrastructure and improvements in the efficiency of fossil fuel generation. After showing flat rates of improvement during the 1990s, the efficiency of fossil fuel–based electricity generation improved steadily between 2000 and 2020 (figure 4.9). Efficiency improvements in natural gas–based electricity generation balanced out slower improvements in the efficiency of coal- and oil-based electricity generation.

Another factor affecting the efficiency of global electricity supply is the share of renewable energy sources in the mix. Statistically, most renewable energy technologies are treated as being 100 percent efficient, even though minor losses do occur in the conversion of resources such as sunlight and wind into electricity. Thus, more renewable energy in the electricity mix generally boosts the efficiency of electricity supply.

Figure 4.9 • Trends in the efficiency of global fossil fuel–based electricity generation, 1990–2020



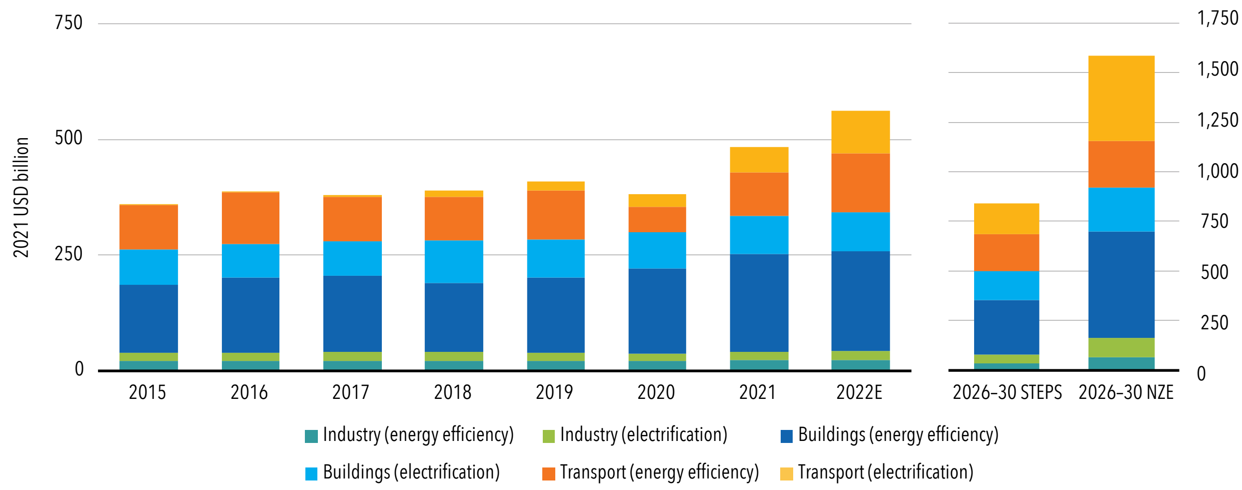
Sources: International Energy Agency; and United Nations Statistics Division.

ENERGY EFFICIENCY INVESTMENTS

In 2020, overall energy efficiency investments declined only slightly (at nearly USD 380 billion) despite the COVID-19 crisis (figure 4.10). However, trends differed widely across sectors and regions, with Europe, China, and Northern America accounting for nearly 80 percent of the spending. Unprecedented growth in the buildings sector, concentrated in Europe, outweighed a substantial decrease in transport efficiency investments, whereas spending in the industry sector remained largely unchanged. Investment in energy efficiency measures in buildings accounted for two-thirds of the total efficiency spending in 2020. This was possible due to the scale-up of the efficiency policies implemented before the COVID-19 crisis and the early effects of economic recovery measures (IEA 2021c).

The current energy crisis then led to accelerated energy efficiency investments, with governments, industry, and households investing USD 560 billion in 2022. This is a new record, yet it is little more than one-third of the more than USD 1.5 trillion in yearly average investments required between 2026 and 2030 to achieve the IEA Net Zero Emissions by 2050 Scenario. Energy efficiency–related spending constitutes two-thirds of all clean energy and energy recovery spending, with USD 1.0 trillion mobilized between 2020 and 2022. However, there exists a regional imbalance in government-approved energy efficiency spending, with the majority coming from developed economies. Governments elsewhere have considerable potential to use recovery packages to boost spending, which would create jobs and promote economic growth (IEA 2022b).

Figure 4.10 • Energy efficiency investment by sector, 2015–22; and by scenario, 2026–30



Source: IEA 2022c.
NZE = Net Zero Emissions by 2050 Scenario; STEPS = Stated Policies Scenario.

Policy Recommendations and Conclusions

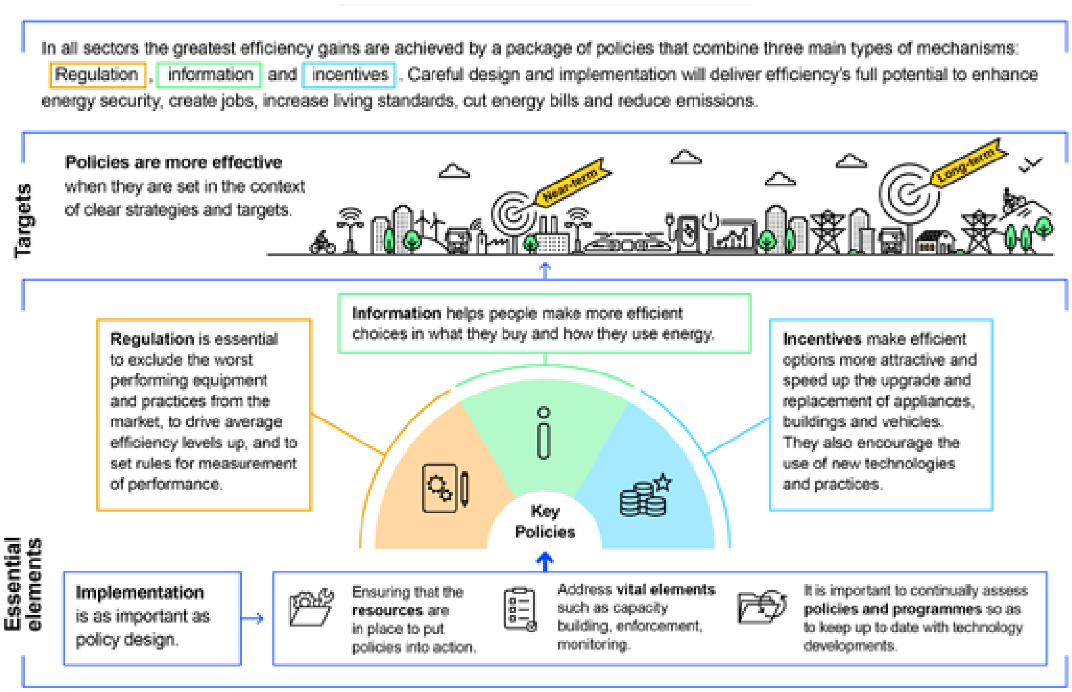
Continued shortfalls in energy intensity improvement, especially in 2020 and 2021, imply that strengthened government policies on energy efficiency are needed to meet SDG target 7.3 by 2030. Energy intensity is expected to improve at a faster pace in 2022, but not on par with the rate now required to reach SDG 7. The current energy crisis was a strong reminder that in addition to helping reach the target, well-designed and well-implemented energy efficiency policies can deliver a range of benefits beyond energy and emissions savings. These include better energy security, reduced exposure to global shifts in energy prices, reduced energy bills for households and businesses, new jobs in energy efficiency retrofits, and improved health owing to better air quality,

Strong policy action is also vital to signal investors that energy efficiency is a long-term priority. This will help to create more certainty for investors and catalyze the transformative investments required to return the world to a path to meet SDG target 7.3.

ENERGY EFFICIENCY POLICY

Governmental policy tools to improve energy efficiency can be grouped in three main categories (figure 4.11): (i) regulatory instruments mandating higher efficiency levels in buildings, appliances, vehicles, and industry; (ii) fiscal or financial incentives to encourage installation of energy-efficient equipment and retrofits; and (iii) information programs to help energy users make informed decisions. The following section describes some options and policies.[59]

Figure 4.11 • Policy package approach to strengthening energy efficiency



Source: IEA 2022e.

59 More information and examples can be found in IEA's Global Policies Database (IEA 2022b), the World Bank's Regulatory Indicators for Sustainable Energy (RISE) (World Bank 2021), and the Global Status Report of Renewable Energy Policy Network for the 21st Century (REN21 2019).

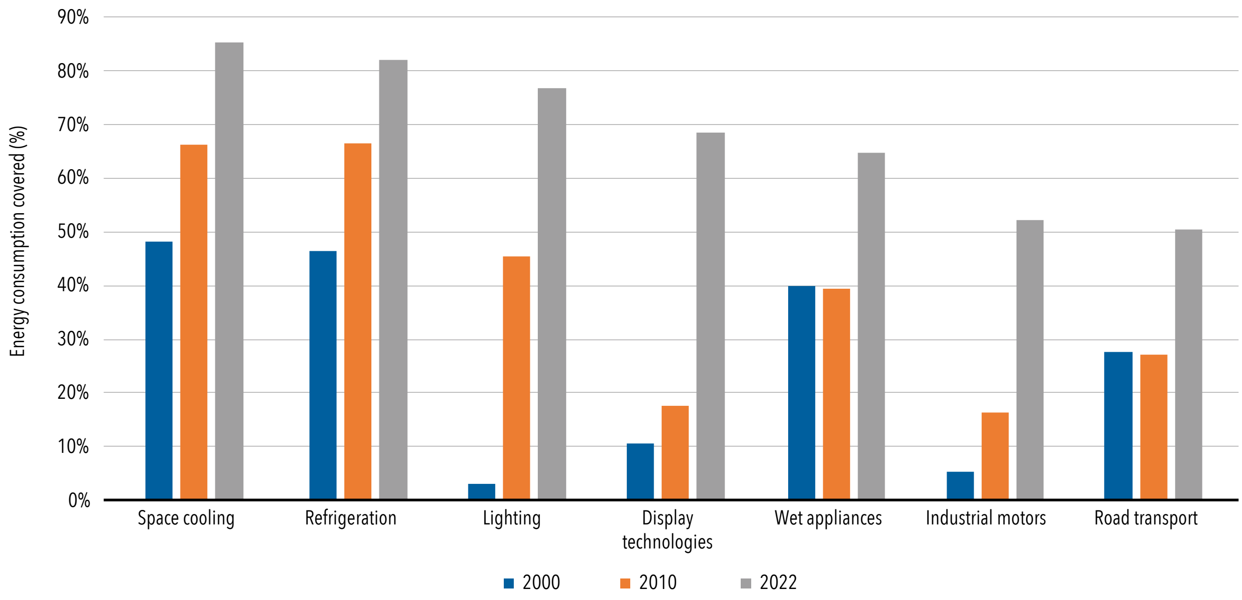
Standards and labels

More than a hundred countries now have mandatory performance standards and/or labels related to the energy efficiency of key end uses such as air conditioners, refrigeration, lighting, industrial motors, and passenger cars (IEA 2021c). Additional or expanded standards and labeling schemes are under development in more than 20 countries, mainly in Asia and East and Southern Africa. Regularly adjusting ambition levels to reflect the latest technological progress, performance standards, and labels can add substantial reductions in energy consumption. This has been demonstrated by well-established programs over recent decades, which delivered annual savings of about 15 percent (IEA 2021a). However, policies are still lacking in many markets seeing rapid growth in the ownership of appliances, industrial equipment, and vehicles.

More broadly, performance standards and labels apply to more than a hundred types of appliances and equipment in the commercial, industrial, and residential sectors. However, policy coverage is often low. For example, only 40–50 countries have implemented minimum performance standards for washing machines, dishwashers, or TVs. As a result, expanding programs in countries where policies presently cover only a limited number of products offers significant scope for further efficiency gains.

Performance standards and labels now cover a high percentage of key energy-consuming end uses in Europe and Northern America, which adopted them early. Globally, such policies are most used for appliances. For example, minimum energy performance standards currently apply to more than 80 percent of the global energy use for air conditioners and refrigerators; this is in comparison with less than half of the energy use for industrial motors and road transport (figure 4.12).

Figure 4.12 • Global energy use coverage of mandatory energy efficiency standards for key end uses, 2000, 2010, and 2022



Source: IEA analysis for IEA (2022b based on CLASP (2021) and other sources.
Note: Coverage for space cooling, refrigeration, and lighting is shown for residential sectors.

There is also significant variation in the strength of programs across countries. Significant scope exists for enhanced international cooperation in this area to help governments introduce new standards, learn from others' experience, and adopt best practices. IEA published several policy toolkits summarizing the main tools policy makers can use to enhance energy efficiency across various sectors (IEA 2022d).

Building codes

Energy codes address a critical part of improving the energy performance of buildings. They set the minimum energy standards for new buildings and can also trigger requirements for major refurbishments or renovations to meet aspects of existing building codes. Building energy codes typically address operational energy use by focusing on envelope performance standards, including for walls, windows, and roofs, as well as major end-use energy services equipment, such as heating, cooling, lighting, and ventilation (IEA 2022b).

Thirty-one emerging and developing countries are actively developing new building codes . This is in addition to the 80 countries that already have fully operational building codes (of which 69 have mandatory requirements, and 11 use performance standards such as voluntary, model codes, or city-based standards). This means the total number of countries with building codes will soon be 111. Approximately 85 countries have no known building codes in place or under development.

Energy efficiency obligation schemes

EEO schemes are commonly used market-based programs that are employed by policy makers to specify an outcome, for example, energy savings or cost-effectiveness to be delivered by a utility or another market participant (e.g., an energy services company). Auction programs, which are related but less commonly used market mechanisms, allow market actors to bid for funds to deliver specific energy savings.

As of 2022, there are 48 EEO programs in 23 jurisdictions. In the European Union, 16 countries are operating EEOs, and in the United States alone, 24 states have EEOs, called Energy Efficiency Resource Standards. A new EEO was launched in Hungary in 2021, whereas no EEOs are being developed in Korea, and Bosnia and Herzegovina. Of the EEOs in force, the vast majority encompasses multiple sectors. Only 4 percent of EEOs target the residential sector and 2 percent are aimed exclusively for the industrial sector.

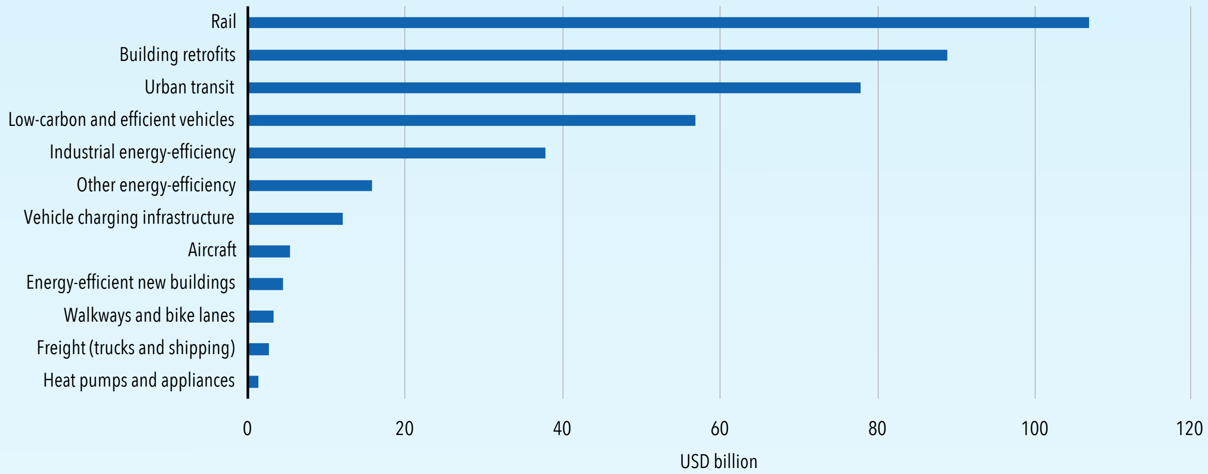
Behavior and awareness campaigns

The 2022 energy crisis also saw a new wave of behavior and awareness campaigns to help consumers reduce energy expenditure and support energy security, especially in Europe. For example, the EU Save Energy Communication outlined the European Commission's two-pronged approach of promoting mid- to long-term efficiency improvements while achieving immediate energy savings through behavioral changes. This is reflected in many national strategies, including Denmark's "Sammen sparer vi på energien" (Together we save energy) campaign and Germany's "80 Millionen gemeinsam für Energiewechsel" (80 million together for energy saving), which also provide citizens with information to carry out home energy retrofits. In Japan, Tokyo Electric Power Company launched Power Saving Challenge 2022, which awarded points for saving power, which could be exchanged for goods using online retailers such as Amazon.

Box 4.3 • Recovery spending and energy efficiency

Between 2020 and April 2022, governments worldwide helped mobilize approximately USD 1 trillion for energy efficiency–related actions. Of this, USD 270 billion was direct public spending by governments, which is projected to mobilize a further USD 740 billion of private and other public spending (IEA 2022c). This amounts to two-thirds of the total clean energy recovery spending. The major share of energy efficiency–related spending targeted transport, especially rail and urban transit, and buildings.

Figure B4.3.1 • Total energy efficiency–related government clean energy recovery spending from 2020, announced as of April 2022



Source: IEA 2022c.

At least 16 high-profile national plans are driving this progress on efficiency.

For instance, the energy efficiency provisions of the US Inflation Reduction Act are estimated at about USD 95 billion. This includes USD 20 billion of clean transportation tax credits for electric vehicles, investment in zero-emissions vehicles for the US Postal Service, public services, and zero-emissions equipment for port infrastructure. About USD 53 billion has been earmarked for energy efficiency in buildings, including tax credits for residential electrification and energy-efficient appliances. Another USD 16 billion is targeted toward the manufacturing sector, including grants and loans for electric vehicle production, and tax credits for other clean manufacturing.

Energy savings is also one of the central pillars of the European REPowerEU plan. The plan foresees an increase in EU-wide energy savings from 9 percent to 13 percent of the target under the Energy Efficiency Directive, with the goal of doubling the deployment rate of heat pumps to about 10 million cumulative units over 2023–27 and accelerating electrification, especially in industry.

In Japan, the Green Transformation Plan strengthened building codes and annual energy reporting systems for large-scale consumers, including for demand response measures. Through a three-year efficiency investment plan, it will also provide subsidies of JPY 500 billion for replacing old facilities in factories and buildings.

The production-linked incentive in India aims at enhancing the competitiveness of the country's manufacturers, helping them attract investments in cutting-edge technology, create efficiencies and economies of scale and enhance exports. Among others, it targets the automobile industry, specifically to encourage the manufacturing of electric and hydrogen-based vehicles.

Campaigns have also been used to great effect outside of Europe to tackle past and current energy crises. In response to a hydroelectricity supply crisis in Brazil during 2021, the government launched an awareness campaign alongside financial incentives to reduce energy use at peak hours. In Korea, following large-scale blackouts in 2011, awareness campaigns used social media and popular culture channels, as well as conventional media and public advertisements.

The energy crisis has also seen a significant increase in support to consumers to switch to public transport. For example, Luxembourg has implemented one of the world's most generous public transport programs, making bus, tram, and funicular second-class tickets free of charge in Luxembourg City and throughout the country.

POLICIES TO DRIVE DIGITALLY ENABLED SYSTEMWIDE EFFICIENCY

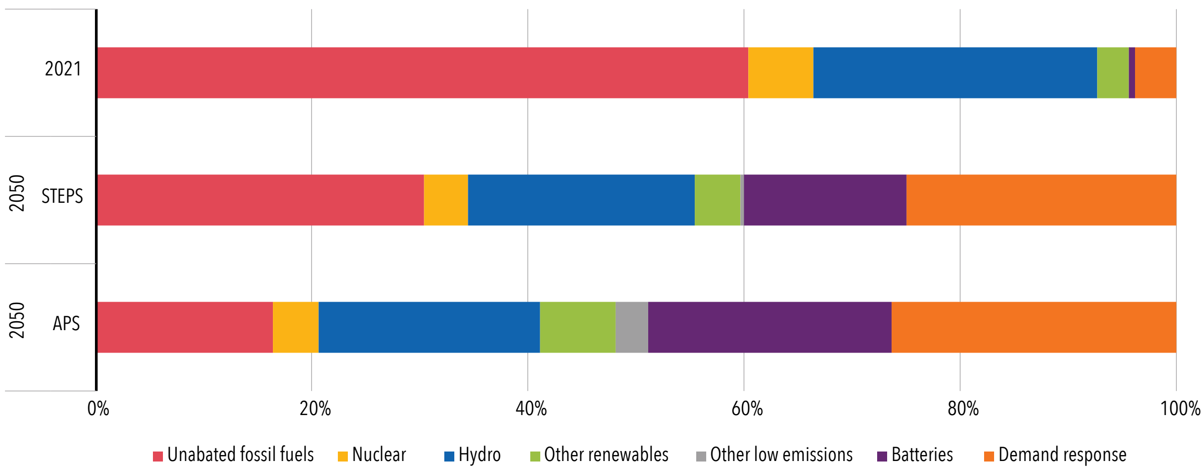
Digitalization is transforming the energy sector and promises to accelerate progress toward SDG target 7.3. With proliferation of digital devices and low-cost sensors, a wealth of granular and continuously updated data is now available to optimize energy supply and use. Over the past five years, there has been a 33 percent increase per year in the deployment of energy-related connected devices with automated controls, the growth being for appliances, devices, and sensors in end-users premises alone. Deployment is expected to reach 13 billion in 2023, up from 11 billion the year before (4E EDNA 2021). Meanwhile, global smart meter deployment reached 1,134 million units, and it could be at 1,598 million units in 2030 (IEA 2022b). Grids, appliances, smart charging, and distributed generation are also being increasingly automated. Approximately 319 million distribution sensors are currently deployed globally, and grid operators are steadily increasing their investments in digital grids.

Digitalization helps direct energy efficiency measures so they have the greatest effect and yield the greatest benefits. For example, energy management systems and related technologies can significantly reduce energy consumption in the buildings sector. In this context, smart energy management by the US General Services Administration, including digitally enhanced energy efficiency and demand response management, could cut the operating costs of buildings by 20 percent (ACEEE 2019). The IEA 4E Technology Collaboration Programme estimates that smart home technologies can help decrease household energy use by 20–30 percent (4E 2018).

Digitalization also offers system-wide benefits, including increased reliability and resilience, improved operational efficiency, cost reductions, and investment optimization. This enables customers to participate more actively, including in voluntary peak reduction schemes. In addition, digitalization can foster economic and social development. For instance, digitally enabled mobile communication technology can play a crucial role in bringing decentralized clean energy solutions to vulnerable urban or marginalized communities via innovative business models. These models, enabled by smart meters and two-way digital communication, have helped customers in urban, peri-urban, and rural areas in developing countries to install efficient technologies in their dwellings by allowing them to pay back the costs in instalments. Across Africa, 5 million people gained access to electricity through pay-as-you-go solar home electricity systems in 2018 alone (IEA 2019). Digitalization can also help monitor and raise awareness on energy use. This can result in actions to increase energy savings and reduce bills, which are of relevance in a number of regions, including Sub-Saharan Africa.

Digitalization is also critical for accommodating growing shares of variable and distributed renewables. According to IEA's Net Zero Emissions by 2050 Scenario, electricity networks will need four times more flexibility by 2050 to accommodate increasing shares of variable renewable resources (wind, solar) (IEA 2022f). A growing share of the flexibility will be added by distributed resources and demand response (figure 4.13) .

Figure 4.13 • Electricity system flexibility by source and scenario, 2021 and 2050



Source: IEA 2022g.
Note: STEPS shows the trajectory implied by today's policy settings. APS assumes that all aspirational targets announced by governments are met on time and in full, including their long-term net-zero and energy-access goals. Unabated fossil fuels include unabated coal and gas, and oil. Other renewables include bioenergy, geothermal, and solar thermal. Other low-emissions sources include hydrogen and ammonia, and fossil fuels with carbon capture, utilization, and storage.
APS = Announced Pledges Scenario; STEPS = Stated Policies Scenario.

To take full advantage of the opportunities offered by digitalization, national and subnational governments should consider developing policies to apply digital technologies comprehensively to improve efficiency and produce positive social and economic outcomes across sectors and systems. They should, for example:

- Leverage digital tools to improve energy efficiency through behavioral change. For instance, providing consumers with real-time energy use–related feedback helps them reduce their consumption. This can often be via connected digital devices, including smart meters, to alert consumers to their consumption patterns or, in cases where they are subject to time-of-use rates, to variations in energy prices. Home energy reports are an example of a feedback mechanism that can help reduce residential electricity consumption by 2.2 percent and natural gas consumption by up to 1.6 percent (IEA 2021i). Japan worked with major utilities to send customized energy use reports to 300,000 households, resulting in a 2 percent sustained decrease in energy consumption. (Users TCP and IEA 2020). Smart technologies such as connected thermostats also add cost-effective energy savings. Case studies show that the installation of a thermostat alone can generate 10 percent savings on heating and space cooling costs (US DoE n.d.).
- Leverage digital tools to increase energy savings at peak times. Several demand response programs were launched or expanded last year (IEA 2022e). For instance, the UK National Grid ESO launched a new program, Demand Flexibility Service, in November to deliver more than 2 gigawatts of demand response when needed.
- Build capacity to use digital tools. A range of actors can provide capacity building to meet differing needs. The World Bank has set up the Utility Knowledge Exchange Platform to provide insights and peer-to-peer learning opportunities for utilities in developing countries. In India, the India Smart Grid Forum published a smart grid handbook for regulators and policy makers with the support of Shakti Sustainable Energy Foundation. This was in response to a need to raise awareness about and build a common understanding of smart grids.
- Chart the steps needed to make progress on standardization and embedded interoperability. They should systematically address barriers to data access, sharing, and use, and ensure robust data protection and cyber resilience mechanisms for the entire energy value chain. In this context, in 2021, the United Kingdom adopted a comprehensive energy system digitalization strategy and action plan (UK BEIS 2021).

- Create innovative approaches to more integrated policies. These would also leverage data and analytics to better design, implement, and monitor energy efficiency policies (IEA 2021f). In 2022, the European Union presented its action plan on digitalization in energy systems to increase the efficient use of energy resources. The plan included measures to increase consumers' control over their energy use and ensure efficiency and circularity of the information and communication technology sector (EC 2022), while strengthening cybersecurity.

Initiatives such as IEA's Digital Demand-Driven Electricity Networks (3DEN) are developing recommendations for how to accelerate the uptake of digital technologies for demand-side flexibility and energy efficiency. 3DEN outputs include two reports:

- A report titled "Smart Grids in Emerging Markets and Developing Economies," which is expected to be published in June 2023 and will focus on the near-term challenges that digitalization can help mitigate and how short- to medium-term investments in physical and digital infrastructure can bring multiple benefits, such as grid resilience and improved financial standing.
- A report titled "Grids of the Future," which is expected to be published in Q4 2023 and focuses on the transformational role that digitalization can play in supporting net-zero transitions and achieving higher power system efficiency.

Outlook

The rate of energy intensity improvement continues to remain below the annual 2.6 percent initially projected as a prerequisite for reaching SDG target 7.3. The COVID-19 crisis only worsened an already concerning trend, with energy intensity improving by only 0.6 percent in 2020, compared with average annual growth of 1.2 percent over 2015–20, and 1.8 percent between 2010 and 2015. To double the global rate of energy intensity improvement by 2030 (i.e., SDG target 7.3), energy intensity must improve at an average of 3.4 percent per year through 2030 to make up for slow progress in the past. This rate would need to be even higher (consistently over 4.2 percent for the rest of this decade) to put the world on track to reach net-zero emissions from the energy sector by 2050, as envisioned in IEA's Net Zero Emissions by 2050 Scenario (IEA 2021d).

Estimates for 2021 point to sustained slow improvement of energy intensity as the effects of the COVID-19 crisis continue. However, early estimates for 2022 suggest that the improvement rate will return to the average of the previous decade, as the energy crisis puts more pressure on energy consumption. The energy crisis led to a swift increase in energy efficiency–related investments, with USD 560 billion invested in energy efficiency by governments, industry, and households in 2022, which is a new record (IEA 2022b).

Nevertheless, energy efficiency policies and investments in cost-effective energy efficiency measures must be scaled up significantly to mitigate the consequences of the energy crisis, as well as bring SDG target 7.3 within reach. Given the multiple benefits of energy efficiency, it is an obvious choice for government support, and this has been reflected in a range of recent stimulus packages throughout the world. Energy efficiency–related spending constitutes approximately two-thirds of the total USD 1 trillion mobilized by governments with their recovery measures between 2020 and 2022 (IEA 2022b).

One of the benefits of energy efficiency is that improved efficiency at scale would be pivotal in achieving affordable and sustainable energy access for all. Continued low levels of intensity improvement, the significant potential opportunities for investment and economic recovery, and the pressing need for expanded access underline the urgency of government actions to foster annual intensity improvement of at least 3.4 percent. As underlined by the recommendations of the United Nations' High-Level Dialogue on Energy, efficiency measures and strategies need to address the main barriers to the adoption of such measures and promote structural and behavioral change to support the achievement of SDG target 7.3 (UN 2021).

Many national and subnational governments already have policies to reach their energy efficiency goals. Successful policies of various types are in force around the world, including energy efficiency standards, financial incentives, market-based mechanisms, capacity-building initiatives, and regulatory measures. All of these encourage investment in energy efficiency and catalyze energy markets in favor of cleaner, more efficient operations. IEA published several policy toolkits summarizing the main tools to use across various sectors (IEA 2022d).

Digitalization has also been an emerging trend reshaping the energy landscape and facilitating progress toward improved energy efficiency. Wide-scale data collection, analysis, and application can help direct energy efficiency measures to where they can be the most impactful. This will in turn offer significant opportunities to improve energy efficiency outcomes. Digitalization can also support deep decarbonization by helping leverage power system flexibility and widen energy access, thanks to innovative business models.

The technology and resources to double energy efficiency improvement by 2030 are all available. Given that, the current low improvement rates and low investments point to a major missed opportunity for the global community. Making energy efficiency a priority in policies and investments over the coming years can help achieve SDG target 7.3, promote economic development, improve health and well-being, and ensure universal access to clean and efficient energy.

Methodological Notes

Total energy supply (TES) (MJ)	This represents the amount of energy available in the national territory during the reference period. It is calculated as follows: TES = Primary energy production + Import of primary and secondary energy – Export of primary and secondary energy – International (aviation and marine) bunkers – Stock changes (Definition consistent with International Recommendations for Energy Statistics). *Data sources:* Energy balances from the International Energy Agency (IEA), supplemented by United Nations Statistics Division (UNSD) for countries not covered by IEA as of 2017
GDP in USD 2017 PPP	This sum is derived by adding the gross value added by all resident producers in an economy and any product taxes, then subtracting from the result any subsidies not included in products' value. It is calculated without making deductions for the depreciation of fabricated assets or for the depletion and degradation of natural resources. GDP is measured in constant USD 2017 PPP. *Data source:* WDI database: http://datatopics.worldbank.org/world-development-indicators/
Primary energy intensity in MJ/USD (2017 PPP)	$Primary\ energy\ intensity = \frac{TES\ (MJ)}{GDP\ (USD\ 2017\ PPP)}$ The ratio of TES to GDP is measured in MJ per USD (2017 PPP). Energy intensity indicates how much energy is used to produce one unit of economic output. A lower ratio indicates that less energy is used to produce one unit of economic output. Energy intensity is an imperfect indicator, since changes, especially those in the structure of economic activity, are affected by factors other than energy efficiency.
Average annual rate of improvement in energy intensity (%)	Calculated using compound annual growth rate (CAGR): $CAGR = \left(\frac{EI_{t2}}{EI_{t1}}\right)^{\frac{1}{(t2-t1)}} - 1\ (\%)$ Where: EI_{t2} is energy intensity in year $t1$ and EI_{t1} is energy intensity in year $t2$. Negative values represent decreases (or improvements) in energy intensity (less energy is used to produce one unit of economic output or per unit of activity), whereas positive values indicate increases in energy intensity (more energy is used to produce one unit of economic output or per unit of activity).
Total final energy consumption (TFEC) in MJ	Sum of the energy consumed by different end-use sectors, excluding nonenergy uses of fuels. TFEC is broken down into energy demand in the following sectors: industry, transport, residential, services, agriculture, and others. It excludes international marine and aviation bunkers, except at the world level, where it is included in the transport sector. *Data sources:* Energy balances from IEA, supplemented by UNSD for countries not covered by IEA as of 2017
Value-added in 2017 USD PPP	Value-added is the net output of a sector after adding all outputs and subtracting intermediate inputs. It is calculated without making deductions for the depreciation of fabricated assets or the depletion and degradation of natural resources. The industrial origin of value-added is determined by the International Standard Industrial Classification, revision 3. *Data source:* WDI database

Industrial energy intensity in MJ/USD (2017 PPP)	$Industrial\ energy\ intensity = \frac{Industrial\ TFEC\ (MJ)}{Industrial\ value-added\ (USD\ 2017\ PPP)}$ Ratio of industrial TFEC to industrial value-added. It is measured in MJ per USD (2017 PPP). *Data sources:* Energy balances from IEA and value-added from WDI
Services energy intensity in MJ/USD (2017 PPP)	$Services\ energy\ intensity = \frac{Services\ TFEC\ (MJ)}{Services\ value-added\ (USD\ 2017\ PPP)}$ Ratio of services TFEC and services value-added. It is measured in MJ per USD (2017 PPP). *Data sources:* Energy balances from IEA and value-added from WDI
Agriculture energy intensity in MJ/USD (2017 PPP)	$Agriculture\ energy\ intensity = \frac{Agriculture\ TFEC\ (MJ)}{Agriculture\ value-added\ (USD\ 2017\ PPP)}$ Ratio of agriculture TFEC to agriculture value-added. It is measured in MJ per USD (2017 PPP). *Data sources:* Energy balances from IEA and value-added from WDI
Passenger transport energy intensity in MJ/passenger-kilometer	$Passenger\ transport\ energy\ intensity = \frac{Passenger\ transport\ TFEC\ (MJ)}{Passenger\text{-}kilometers}$ Ratio of passenger transport final energy consumption to passenger transport activity. It is measured in MJ per passenger-kilometer. *Data source:* IEA Mobility Model
Freight transport energy intensity in MJ/tonne-kilometer	$Freight\ transport\ energy\ intensity = \frac{Freight\ transport\ TFEC\ (MJ)}{Tonne\text{-}kilometers}$ Ratio of freight transport final energy consumption to freight transport activity. It is measured in MJ per tonne-kilometer *Data source:* IEA Mobility Model
Residential energy intensity in MJ/unit of floor area	$Residential\ energy\ intensity = \frac{Residential\ TFEC\ (MJ)}{Residential\ floor\ area\ (m^2)}$ Ratio of residential TFEC to square meters of residential building floor area. *Data source:* IEA Mobility Model
Fossil fuel–based electricity generation efficiency (%)	$Generation\ efficiency = \frac{Electricity\ output\ from\ coal, oil, and\ natural\ gas}{Coal, oil, and\ natural\ gas\ input}\ (\%)$ Ratio of fossil fuel–based (coal, oil, and gas) power generation and fossil fuel–based TES input to power generation. *Data source:* IEA Energy Balances
Power transmission and distribution losses (%)	Power transmission and distribution losses (%) $Power\ transmission\ and\ distribution\ losses = \frac{Electricity\ losses}{(Electricity\ output\ main + Electricity\ output\ CHP + Electricity\ imports)}\ (\%)$ Where: Electricity losses are electricity transmission and distribution losses, Electricity output main is electricity output due to the primary activity of producer electricity plants, and Electricity output CHP is electricity output from combined heat and power plants (CHPs). *Data source:* IEA Energy Balances

GDP = gross domestic product; MJ = megajoule; PPP = purchasing power parity; USD = US dollars; WDI = World Development Indicators.

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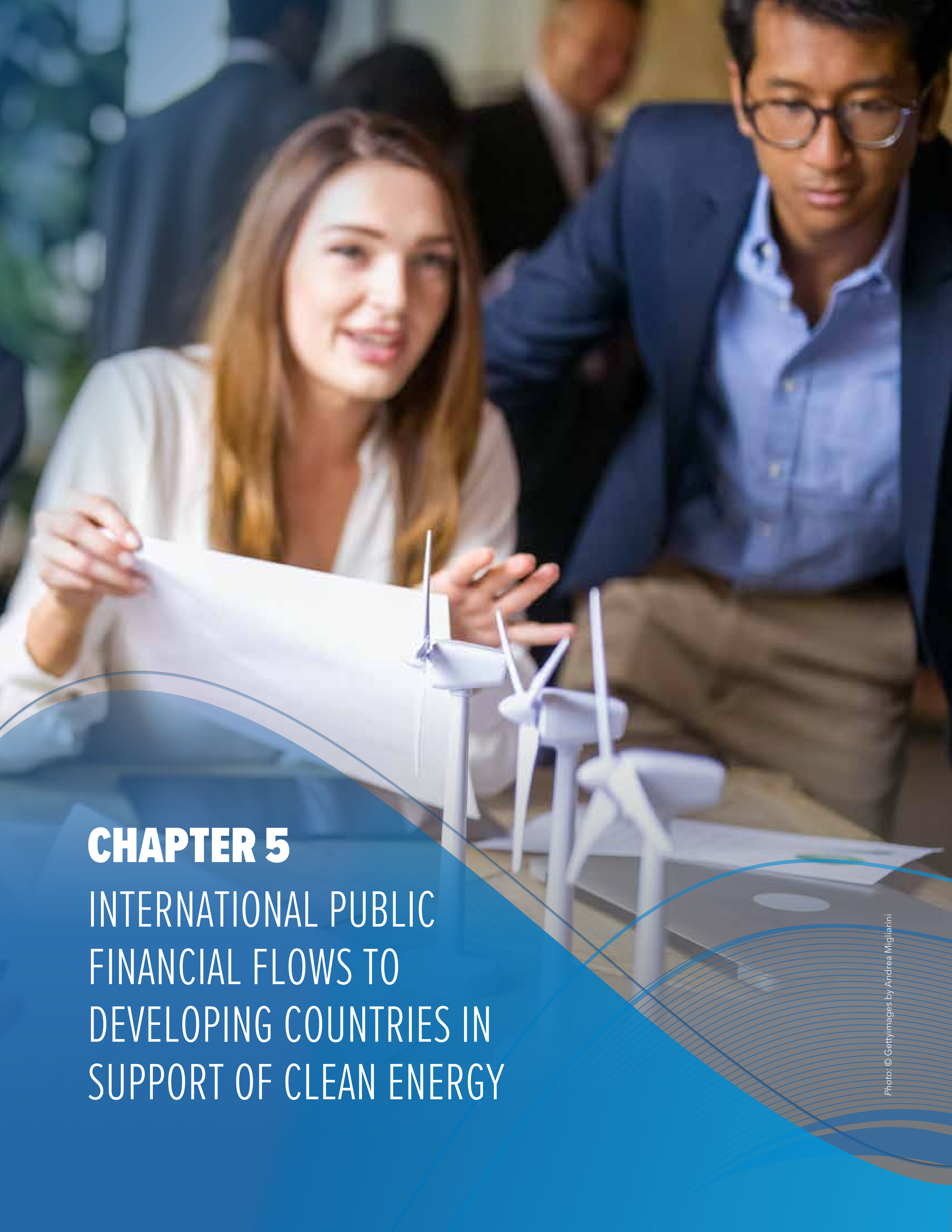


CHAPTER 5

INTERNATIONAL PUBLIC FINANCIAL FLOWS TO DEVELOPING COUNTRIES IN SUPPORT OF CLEAN ENERGY

Photo: © Gettyimages by Andrea Migliarini

Main Messages

- **Global trends.** Tracking of Sustainable Development Goal (SDG) indicator 7.a.1 reveals that international public financial flows in support of clean energy in developing countries started decreasing before the COVID-19 pandemic and continued to do so through 2021. In 2021, these flows amounted to USD 10.8 billion, an 11.4 percent drop from 2020, 35 percent less than the 2010–19 average, and only about 40 percent of the 2017 peak of USD 26.4 billion. The downward trend in public investments is expected to have continued in 2022; data released in 2023 will provide a clearer picture of the impacts of the energy crisis in Europe sparked by the war in Ukraine on public financial flows. The decreasing trend in international public financial flows may delay achievement of SDG 7, especially for least-developed countries (LDCs), landlocked developing countries (LLDCs), and small island developing states (SIDS).
- **The target for 2030.** There is no quantitative target for international public financial flows under indicator 7.a.1, but the declining trend in flows indicates that the world is not on track to meet the goal of enhancing international cooperation to facilitate access to clean energy research and technologies for countries in need. Given the role of financing for progress toward SDG 7 (as outlined in chapter 6, which discusses investment needs in more detail), international public flows must increase substantially and be targeted to countries most in need of financial aid. Directing international public flows toward clean energy solutions has become more difficult since 2020 because of the reallocation of public resources to recovery from the COVID-19 pandemic, especially since the war in Ukraine.
- **Technology highlights.** Commitments continued to shift from hydropower to solar energy in 2021. Solar attracted the largest share of flows (43 percent), followed by multiple/other renewables (33 percent) and hydropower (16 percent); wind and geothermal energy received less than 10 percent of total flows. Since 2018, an increasing share of commitments has fallen into the multiple/other renewables category, which includes energy funds, green bonds, and other government-led programs to support renewables, energy efficiency, and electricity access. This category is growing in importance as interest in funding mechanisms that target multiple energy technologies at once increases.
- **Regional highlights.** International public flows declined by 13 percent in 2020 and by another 11.4 percent in 2021, but several regions saw increases in 2021. In 2021, Northern America and Europe received 81 percent more funding than in 2020 (an increase of USD 180 million); flows to Sub-Saharan Africa rose 45 percent (an increase of USD 1,213 million); and flows to Eastern Asia and South-eastern Asia increased 23 percent (an increase of USD 251 million). In other regions, flows declined. Latin America and the Caribbean experienced the largest drop in international public finance, at 62 percent (a decline of USD 2,295 million). Flows declined by about 59 percent (USD 582 million) in Western Asia and Northern Africa, 42 percent (USD 9 million) in Oceania, and 8 percent (USD 232 million) in Central Asia and Southern Asia.

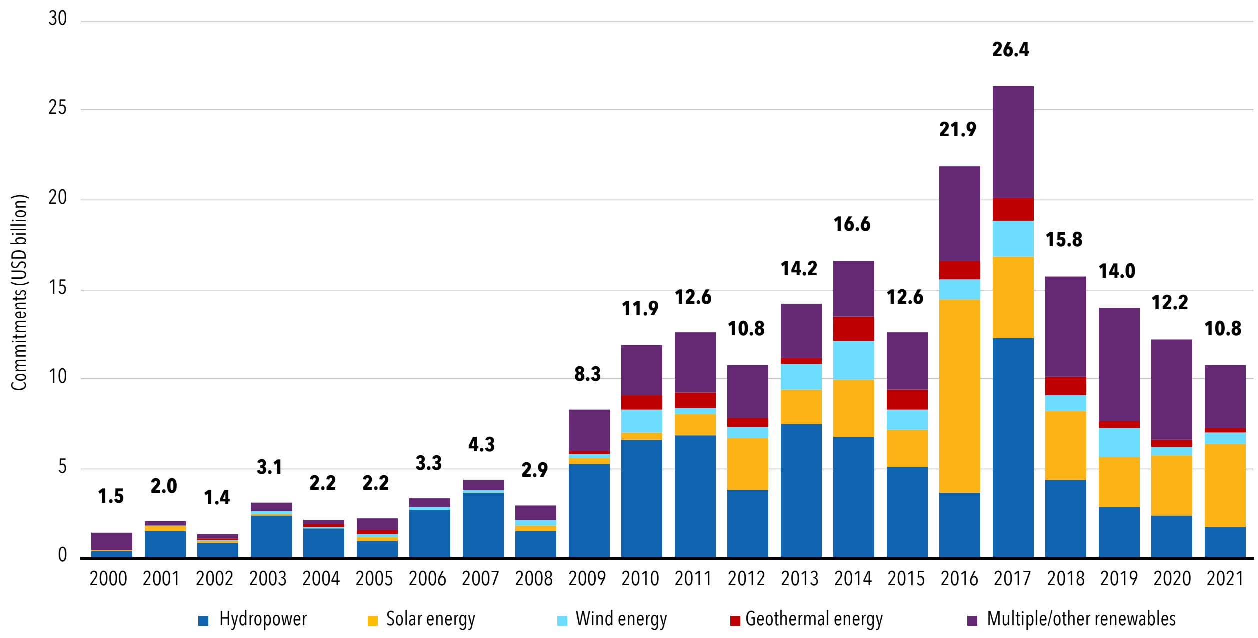
- **Country highlights and regional per capita flow distribution.** Commitments are becoming marginally more widely distributed, although they remain heavily concentrated. During 2010–19, 36 countries received 80 percent of all commitments; over the longer period of 2010–21, the number increases slightly to 38, including commitments to unspecified countries and subregions without allocations.[60] The share of countries that received no commitments fell to less than 20 percent in 2021; over the past decade, only three countries received no international commitments. Flows to the countries most in need (LDCs, LLDCs, and SIDS) fell in 2021, and these countries had lower flows in absolute terms than others. Their per capita allocations, however, were 1.85, 2.39 and 3.23 USD per capita, all larger than the developing country average of 1.24 USD per capita.
- **Financing instrument highlights.** The share of debt instruments in international public financing sources declined steadily after 2018; in 2021, it stood at two-thirds of flows, down from nearly 90 percent in 2018. The share of grants, equity, and guarantees increased. The increase in grants is a boon to recipient countries, as these instruments do not carry the burden of future repayment. At the same time, the absolute decline in loan flows—which typically make up a substantial portion of public financial flows for projects—makes it harder to secure finance for both larger, commercially viable projects and start-ups with limited resources.

60 Such investments are termed "residual/unallocated" or "unspecified countries" when they are not specifically directed to countries. When commitments are residual/unallocated for a specific region, they are considered as part of the regional totals. When they are directed to unspecified countries, this category is treated separately at the regional level.

Are We on Track?

The volume of public international financial flows to developing countries in support of clean energy research and development and renewable energy production (together referred to as renewables throughout this chapter) decreased in 2020 and 2021.[61] In 2021, these flows totalled USD 10.8 billion, down 11.4 percent from 2020 (figure 5.1). This level matched the investment levels of 2012, the lowest investment levels recorded over the last 10 years. It is 35 percent lower than the average of USD 16.7 billion for 2010–19 and only about 40 percent of the 2017 peak of USD 26.4 billion.[62] The trend of decreasing financial flows to support clean energy started before the COVID-19 pandemic and continued through 2021.

Figure 5.1 • Annual international public financial flows toward renewables in developing countries, by technology, 2000–21



Source: IRENA and OECD 2023.
Note: The "multiple/other renewables" category is further explained on page 5 and in the methodology section at the end of this chapter.

Three main factors account for this decline. First, flows from specific donors are cyclical and variable. Second, large shifts in public funds took place because of the COVID-19 pandemic. Third, methodological factors—such as changes in exchange rates and prices, updates to the methodology used to measure the indicator, and challenges in classifying certain technologies—affect the value of commitments.

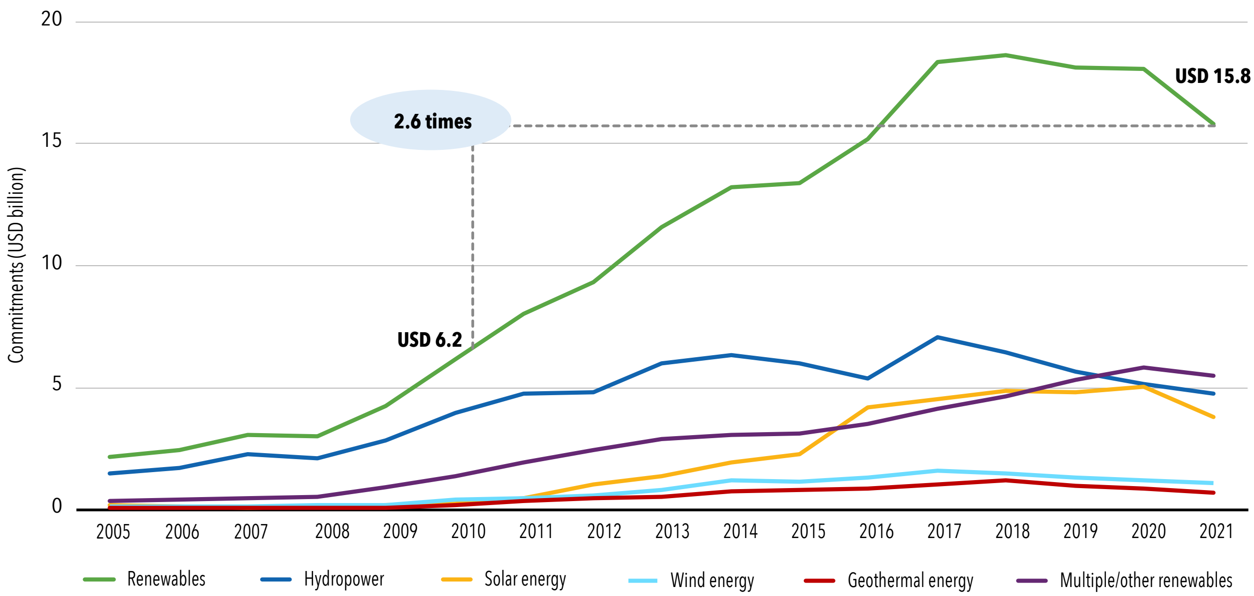
61 International public financial flows include official development assistance and other official flows that are transferred internationally to other countries. They are referred to as flows, commitments, and financing in this chapter. These flows are reported at the time they were officially committed, not at the time they were disbursed. Sixty-eight institutions or donors made commitments during the 2000–21, through 236 agencies. For more information, see the methodology section of this chapter.

62 Unless stated otherwise, all commitment amounts are expressed in US dollars (USD) in 2020 constant prices and exchange rates. Constant amounts are adjusted for inflation rate changes in commitment provider countries as well as changes in exchange rates between the provider currency and the USD over the same period. For more information, see the methodology section of this chapter.

Change in the investment landscape for hydropower is one of the drivers behind the decline in international flow of public finance. Historically, hydropower investments made up about a third of all public investments. Except for three major commitments from China in 2017, the number of investments in hydropower projects has been declining since 2013. Over the past decade, excluding the exceptional flows in 2016 and 2017, annual commitments for hydropower investments ranged from USD 10 to USD 17 billion.

Public investment flows fluctuate widely, with hundreds of commitments, including multibillion-dollar ones, in some years and fewer and smaller commitments in others. For this reason, a five-year moving average provides a more meaningful analysis of the trend over time (figure 5.2).

Figure 5.2 • Five-year moving average of international public financial flows to renewable energy, by technology, 2010–21



Source: IRENA and OECD 2023.

The moving average for the five years ending in 2021 was USD 15.8 billion, 2.6 times larger than the moving average for the five years ending in 2010 of USD 6.2 billion. In 2021, it dropped by 12 percent, from USD 18 billion in 2020. The trend toward smaller investments per commitment is reflected by the five-year moving average of USD 8.5 million per commitment in 2021, down from USD11.4 million in 2020. The average commitment in 2021 was as low as it was in 2008, during the global financial crisis.

The downward trend in public investments is expected to continue in 2022. The five-year moving average in 2022 will not include the all-time high of 2017, making it unlikely that 2022 flows will equal or surpass the USD 26.4 billion five-year average of 2017. Flows might still outpace expectations and show resilience against the downward trend, however, revitalizing public investment in countries in need of financial support. As a growing number of donor countries and institutions are committing to ending support for fossil fuels, there is a chance for these resources to be channelled into enhanced support for renewable energy in developing countries (COP26 Presidency 2021).

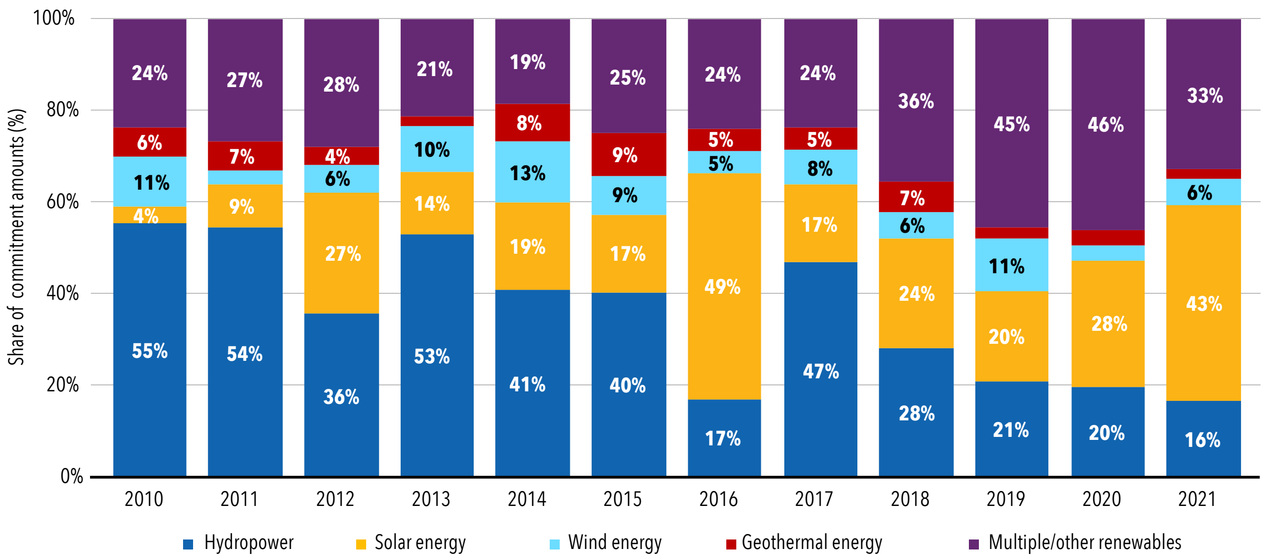
Looking Beyond the Main Indicators

Looking at the 7.a.1 indicator in multiple ways helps identify the directions of international public flows in terms of technologies, geographical regions, countries,[63] and financial mechanisms, as summarized below.

TECHNOLOGY TRENDS

International public investors categorize international public flows to clean energy by the type of renewable energy involved: hydropower, solar, wind, geothermal, and multiple/other (figure 5.3).[64] The categorization of multiple/other renewables is more complex because of unclear commitment descriptions in financial databases and a lack of detail on the financial breakdown for each technology. This category also includes bioenergy commitments which are almost negligible; multipurpose financial instruments, such as green bonds and investment funds; and commitments targeting a broader range of technologies, such as renewable energy and electrification programs, technical assistance activities, energy efficiency programs, and other infrastructure-supporting renewable energy.

Figure 5.3 • Share of international public financial flows to renewable energy, by type of energy, 2010–21



Source: IRENA and OECD 2023.

The multiple/other renewables category is growing in importance as there is increasing interest in funding mechanisms that target multiple energy technologies at once. Financing including public, private, international, and domestic flows and issuances of green, social, sustainable, and sustainability-linked (GSSS) bonds in developing countries tripled

63 In this chapter, the word country refers to a territory, area, or other unspecified location within the scope of SDG 7.a.1.

64 The "multiple/other renewables" category is further explained in the methodology section at the end of this chapter.

in 2021, reaching USD 159 billion (IRENA and CPI 2023).[65] Lack of consensus among governments, international organizations, and multilateral development banks on how to categorize climate financial flows based on technologies is causing diverging classifications (Shishlov and Censkowky 2022) and increasing the share of flows grouped under multiple/other renewables. This misalignment of classifications may exclude flows from this dataset altogether and reduce the accuracy of this tracking exercise. (This issue was briefly discussed in the 2020 edition of this report.)

The shift from hydropower to solar energy commitments continued in 2021. Solar energy attracted the largest share of flows (43 percent), followed by flows to multiple/other renewables (33 percent) and hydropower (16 percent). Wind and geothermal energy received less than 10 percent of flows. The dominance of solar power is also reflected across the broader landscape of renewable energy investments globally (public and private investments, including domestic flows across all countries). In 2021, solar technologies (mainly photovoltaic [PV]) accounted for 53 percent of global investments, followed by wind (41 percent), bioenergy (4 percent), and hydropower (2 percent) (IRENA and CPI 2023).

Substantial changes in the distribution of flows in 2016 and 2017 reflected abnormally large commitments and increases in the volume of investments. Since 2018, there have been no large single-project commitments to shift the technology mix and skew the flows. Trends since 2018 therefore provide clearer insights into annual investments across technologies: Flows to hydropower declined, overtaken by commitments to solar energy and multiple/other renewables.

The five-year averages are bell curve–shaped, with different time horizons. Wind energy and hydropower were the first to peak, in 2017, at USD 1.6 billion and USD 7.1 billion, respectively. The year after, geothermal energy peaked, at USD 1.2 billion. In 2020, solar energy and multiple/other renewables peaked at USD 5 billion and USD 5.8 billion, respectively. Unless large commitments manifest in the coming years, this pattern will continue, reflected by lower five-year averages for overall and technology-specific flows.

Some 675 million people still lack electricity access as highlighted in Chapter 1. Given the importance of off-grid renewable energy solutions in closing the energy access gap, it is encouraging to see donors and other actors increasing flows to these solutions. Although these investments still represent a small portion of the overall financing of energy access and renewables, they are a crucial, and cost-effective, part of closing the access deficit.

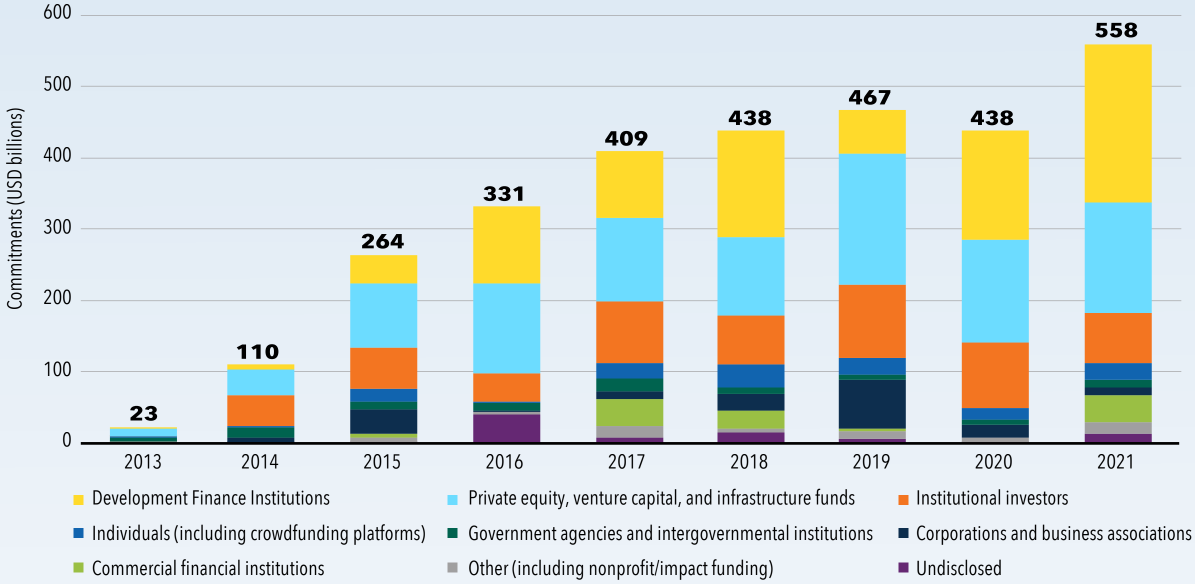
At the same time, current investment levels fall far short of the USD 15 billion needed in the sector each year between 2021 and 2030 (ESMAP 2022; ESMAP and others 2022). Support will be needed on the supply side for off-grid solar companies and on the demand side to enhance affordability for consumers (mainly through public funding). Box 5.1 provides an overview of investment trends in developing countries in the off-grid sector.

65 IRENA and CPI (2023)'s analysis of the global landscape of renewable energy finance has a broader coverage than the main indicator of interest in this chapter under SDG 7.a.1. It covers renewable energy investments in both developed and developing economies and considers both (i) public and private investments, and (ii) domestic and international flows. International public financial flows (as analyzed in this report) therefore make up a small, although important portion of overall financial activity for renewable energy globally.

Box 5.1 • Off-grid renewable energy investments in developing countries, 2010–21

Despite the COVID-19 pandemic and its economic fallout, investments in the off-grid renewable energy sector continued to grow in the last three years, bringing electricity to millions of people. Annual investments in off-grid renewable energy reached a record high of USD 558 million in 2021 (Wood Mackenzie 2022). Recent growth has been driven by investments in Sub-Saharan Africa, particularly East Africa and more recently West Africa. The scope of investments has gradually expanded from residential to commercial and industrial applications.

Figure B5.1.1 • Annual financial flows to renewable energy, by instrument, 2010–21



Source: Adapted from Wood Mackenzie (2022a).

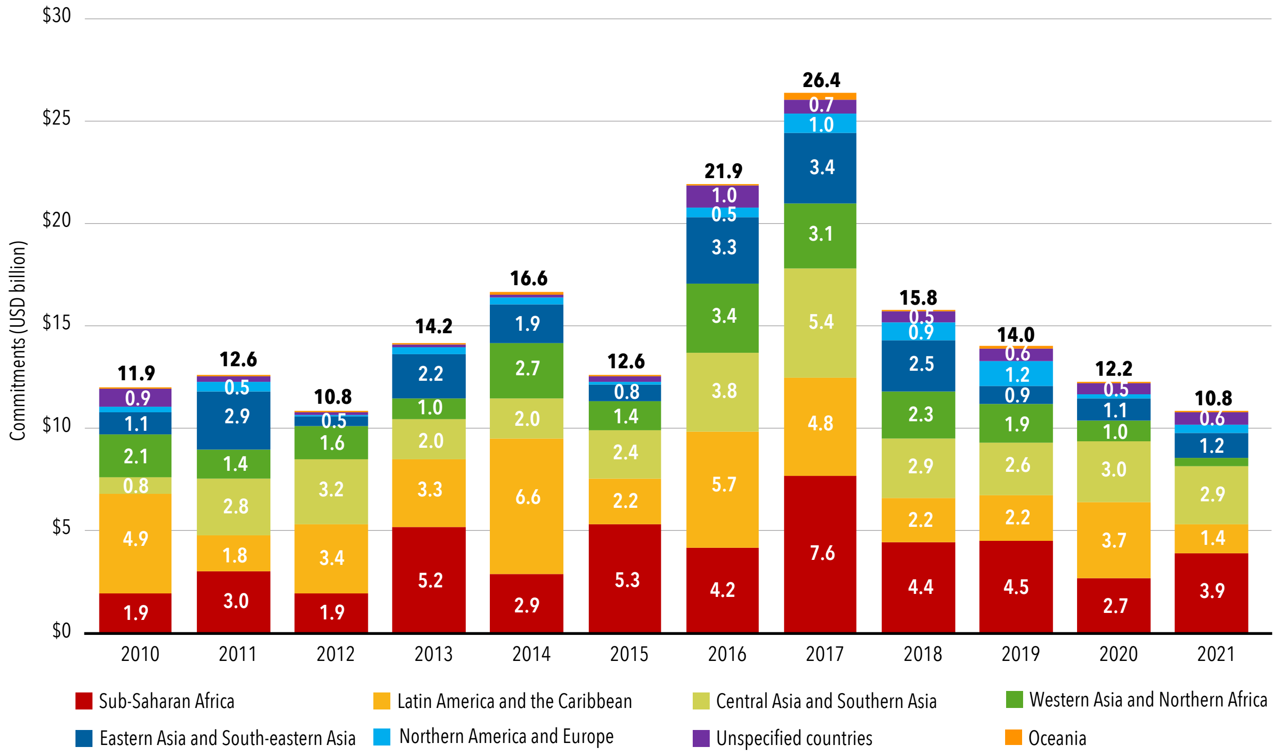
Support from international public financial institutions was vital for the sector in 2020–21, when the share of public financing climbed from 30 percent in 2015–19 to 44 percent, as public financial institutions provided USD 435 billion in support. Development finance institutions provided much of this capital. Their commitments exceeded those of private equity, venture capitalists, and infrastructure funds, which dominated the sector before the pandemic. More than 80 percent of the investments were international flows, highlighting the importance of this source of public financing for the off-grid sector.

Source: IRENA and CPI 2023.

REGIONAL TRENDS

International public flows decreased by 13 percent in 2020 and fell another 11.4 percent in 2021. Several regions saw increases in 2021, however (figure 5.4).

Figure 5.4 • Annual international public financial flows to renewable energy, by region, 2010–21



Source: IRENA and OECD 2023.

Regional changes from 2020 to 2021. In 2021, flows to Northern America and Europe[66] rose 81 percent (USD 180 million); flows to Sub-Saharan Africa rose 45 percent (USD 1,213 million); flows to Eastern Asia and South-eastern Asia rose 23 percent (USD 251 million); and flows to "unspecified countries"[67] rose 4 percent (USD 21 million).

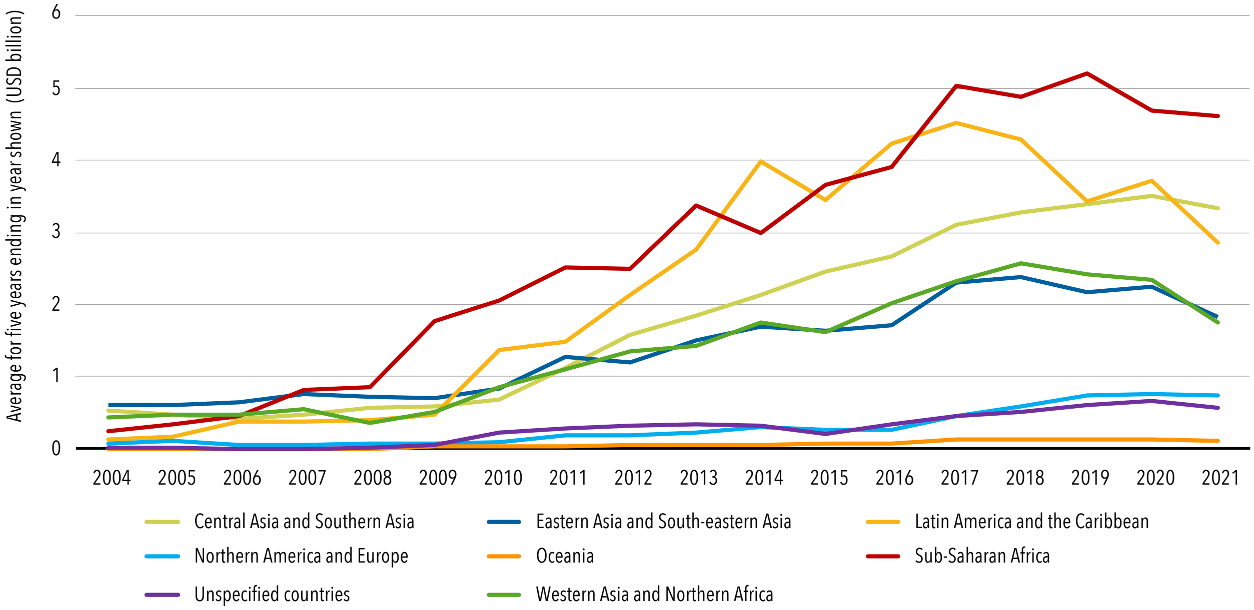
Flows to other regions declined. Latin America and the Caribbean experienced the largest drop in international public finance, with a decrease of 62 percent (USD 2,295 million). Flows to Western Asia and Northern Africa fell by about 59 percent (USD 582 million), flows to Oceania fell 42 percent (USD 9 million), and flows to Central Asia and Southern Asia fell 8 percent (USD 232 million).

66 "Northern America and Europe" is included as a region for the first time this year. It captures flows to eight countries in Europe (Albania, Belarus, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia, Moldova, Serbia, and Ukraine). No data were recorded for Northern America. The region is nevertheless referred to as Northern America and Europe, following the United Nations' M49 regional classification.

67 "Unspecified countries" refers to commitments to multiple countries or commitments not directed to a specific region. Regional bonds and funds and umbrella loans for multiple projects usually fall into this category.

Given annual fluctuations, five-year averages provide a clearer picture of regional trends (figure 5.5)

Figure 5.5 • Five-year moving average of international public financial flows to renewable energy, by region, 2004–21



Source: IRENA and OECD 2023.

Sub-Saharan Africa was the top recipient in 2021, with a five-year average of USD 3.9 billion (36 percent of all commitments). Annual commitments decreased by 1.2 percent in 2021, but the decrease was significantly less than in other regions. The five-year average commitments to the region more than doubled between 2010 and 2021, with hydropower projects attracting significant investment, especially from China, and notable commitments to solar energy.

Funding for hydropower projects in Sub-Saharan Africa dropped to less than 10 percent of flows in 2021, and multiple/other flows reached 45 percent, revealing significant diversification of investments. About 43 percent of 2021 flows (USD 1.7 billion) were in the form of grants – which do not add to the existing burden of debt for the region; standard loans represented less than 15 percent of the total.

Considering the broader landscape of renewable energy investment (including both private and domestic flows across developed and developing economies), Sub-Saharan Africa attracted less than 1 percent of overall investments in 2021, despite its high renewable energy potential and unmet energy needs (IRENA and CPI 2023).

The five-year average for **Central Asia and Southern Asia** was USD 2.8 billion in 2021, more than any other region except Sub-Saharan Africa. The figure dipped for the first time since 2010, dropping by 5.9 percent (from USD 3.5 billion in 2020 to USD 3.3 billion in 2021). These five-year average flows were almost five times greater in 2021 than in 2010, thanks to steady increases in funding for solar and wind energy as well as occasional large hydropower projects. Growth in the region is largely dependent on standard and concessional loans, with only some small equity investments, however. The multimillion dollar debt agreements with banks, governments, and other development agencies could lead to debt sustainability issues.

Looking at the broader renewable energy investment (including both private and domestic flows across developed and developing economies), Central Asia and Southern Asia attracted less than 3.3 percent of global investments in 2021 (IRENA and CPI 2023).

Latin America and the Caribbean received commitments of USD 1.4 billion in 2021 (13 percent of the total), its lowest inflow since 2009. The region experienced the largest annual decrease of any region in the last several years. In 2021, public flows to the region were around one-third of the high of 2020 (USD 3.7 billion). In 2020, Latin America and the Caribbean was the only region to experience an increase in flows, driven by a USD 400 million credit line to Paraguay and a USD 300 million COVID-19 recovery package for Costa Rica.

The five-year average for the region decreased by over 23 percent, from USD 3.7 billion in 2020 to USD 2.9 billion in 2021, indicating that the slowdown in investment is worsening. The 108 percent growth in the five-year average over the period was also lower than the global average of 157 percent.

The region saw large investments in renewable energy auctions and hydropower projects over the past decade, but a global slowdown in these projects has reduced the interest of investors in targeting the region. Investors prefer to use standard and concessional loans in the region; provision of grants, equity, guarantees, and credit lines is limited.

Zooming out to the broader landscape of renewable energy investment (including both private and domestic flows across developed and developing economies), Latin America and the Caribbean attracted 5 percent of global investments in 2021 (IRENA and CPI 2023).

In 2021, **Western Asia and Northern Africa,** a region that has been experiencing a slowdown in international public flows over the last decade received USD 400 million in commitments, a 59 percent decline from the USD 983 million in 2020. In 2021, standard and concessional loans comprised the largest shares of flows. They went to solar energy (32 percent) and multiple/other renewables (67 percent). These flows took the form of credit lines to governments, combined renewable energy investments, government support programs, and unclassified or improperly classified commitments.

The five-year average confirms this trend. Although average annual commitments doubled between 2010 and 2021 (less than the average increase of 157 percent across regions), there was a 26 percent decrease in average commitments (the largest among regions), which fell from USD 2.3 billion in 2020 to USD 1.7 billion in 2021. This declining trend can be attributed to reduced commitments from top investors and the decline in interest in solar energy investments, which dominated between 2014 and 2019.

In 2021, countries in **Northern America and Europe** received USD 400 million, up from USD 221 million in 2020 but down from the all-time high of USD 1.2 billion in 2019. The five-year average declined by 1.5 percent, from USD 752 million in 2020 to USD 741 million in 2021. Most flows were directed to multiple/other renewables and wind energy, as the potential for renewable energy in these countries limits the attraction of flows to other technologies. Funded projects included government programs for technology scale-ups, governance, international cooperation, capacity building, and maintenance operations, as well as retro-fitting projects and various umbrella plans supporting renewables. Debt instruments and equity were the main forms of investment in this region.

Commitments to **Eastern Asia and South-eastern Asia** rose slightly to USD 1.3 billion, in 2021, up from USD 1.1 billion in 2020 and USD 912 million in 2019. This region received 12 percent of all investments in 2021, the same share it has received since 2010.

The five-year average trend declined by 17 percent in 2021 to USD 1.9 million, down from USD 2.2 billion in 2020. It has grown 121 percent since 2010.

Historically, the region attracted flows to hydropower projects. More recently, flows included more investments in solar, wind, and geothermal energy. The region's large hydropower and geothermal projects cause flows to vary widely from year to year. Standard and concessional loans continue to be the most common form of funding for this region.

Reviewing the broader landscape of renewable energy investment globally (including both private and domestic flows across developed and developing economies), the region attracted 56 percent of global investments in 2021 (IRENA and CPI 2023).

A total of USD 568 million went to **unspecified countries** in 2021, a 4 percent increase from the previous year but still lower than the USD 609 million in 2019. Because of the multi-technology, regional, or global nature of these flows, this category includes a larger proportion of equity investments (18 percent of flows in 2021 and 14 percent since 2000).

The five-year average of annual commitments to unspecified countries has been steady, at around USD 550 million, since 2017. Because of their underlying financial mechanisms (green bonds, regional funds, and international grants), these funds are often directed to multiple regions or countries. In recent years, some of these commitments have been directed to COVID-19 recovery packages for renewables and energy efficiency in multiple countries, as well as technical assistance and knowledge products.

Oceania received the least investment of all regions, at just USD 12 million in 2021 (0.5 percent of the total), down 42 percent from the USD 21 million received in 2020. It received USD 135 million in 2019.

The five-year average shows an annual decrease of 6.5 percent in commitments to the region. Historically, commitments were directed to solar energy and multiple/other renewables in the form of technical assistance and government support programmes. Oceania stands out for the type of financial instruments used, with almost two-thirds of historic commitments in the form of grants.

Box 5.2 describes the sources of international public flows by country and instrument, share of flows directed towards technologies, as well as recipients' share of flows.

Box 5.2 • International public flows to renewables: Who's funding what and to whom?

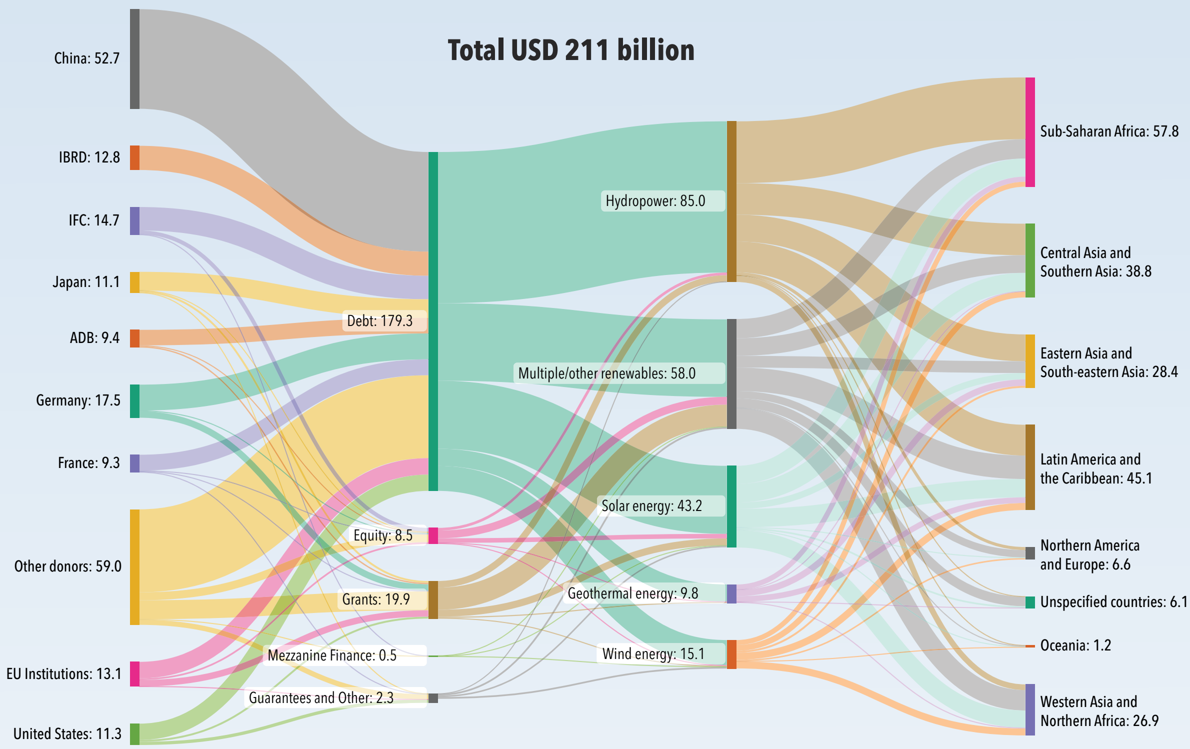
Donors. Most international public flows to renewables since 2000 have come from China, followed closely by Germany, the International Finance Corporation (IFC), EU institutions, the International Bank for Reconstruction and Development (IBRD), the United States, Japan, the Asian Development Bank, and France. Together, these nine investors account for three-fourths of all funding; another 59 institutions supplied the remaining funds.

Figure B5.2.1 shows how much money is flowing from donors, by financial instrument, type of renewable energy, and region. The sizes of the channels are proportional to the flow amounts, shown as values in 2020 USD billions.

Financial instruments. Debt instruments (including standard loans, concessional loans, bonds, reimbursable grants, and other debt securities) have been the primary financial instrument. Debt finance is also common, because investments tend to be capital-intensive, with a fixed element in the cost and revenue structure of the underlying asset. Renewable energy projects require high initial capital expenditure and are often underpinned by long-term power purchase agreements or regulated remuneration. Concerns about debt sustainability have increased in many countries, particularly since COVID-19.

Grants are the second-largest instrument. Although they make up less than 10 percent of flows, they play a key role in both funding projects and helping attract private capital. Going forward, grants; concessional debt financing (denominated in local currencies); and other innovative, non-debt funding mechanisms can help meet the funding needs of countries while ensuring that these flows do not increase their debt burden.

Figure B5.2.1 • International public flows to renewables by donors, financial instrument, technology, and recipient region, 2000–21



Source: IRENA and OECD 2023.

Technologies. Hydropower projects received the highest level of debt financing, followed by multiple/other renewables and solar energy. They did so partly because of the underwriting process of multilateral development banks, which assess project risks and profitability before approving loans so that commercial banks can underwrite development projects, which must follow specific guidelines. Most grants went to multiple/other renewables, as they targeted multi-technology funds, programs, and grant requirements. Countries can meet grant requirements with policy plans or programs to roll out multiple renewables.

Recipients. Over the last two decades, all regions received even amounts of commitments, except in the area of hydropower investment, which is more predominant for countries in Sub-Saharan Africa. Renewable technology choices for investment were also distributed equally across regions, except for hydropower.

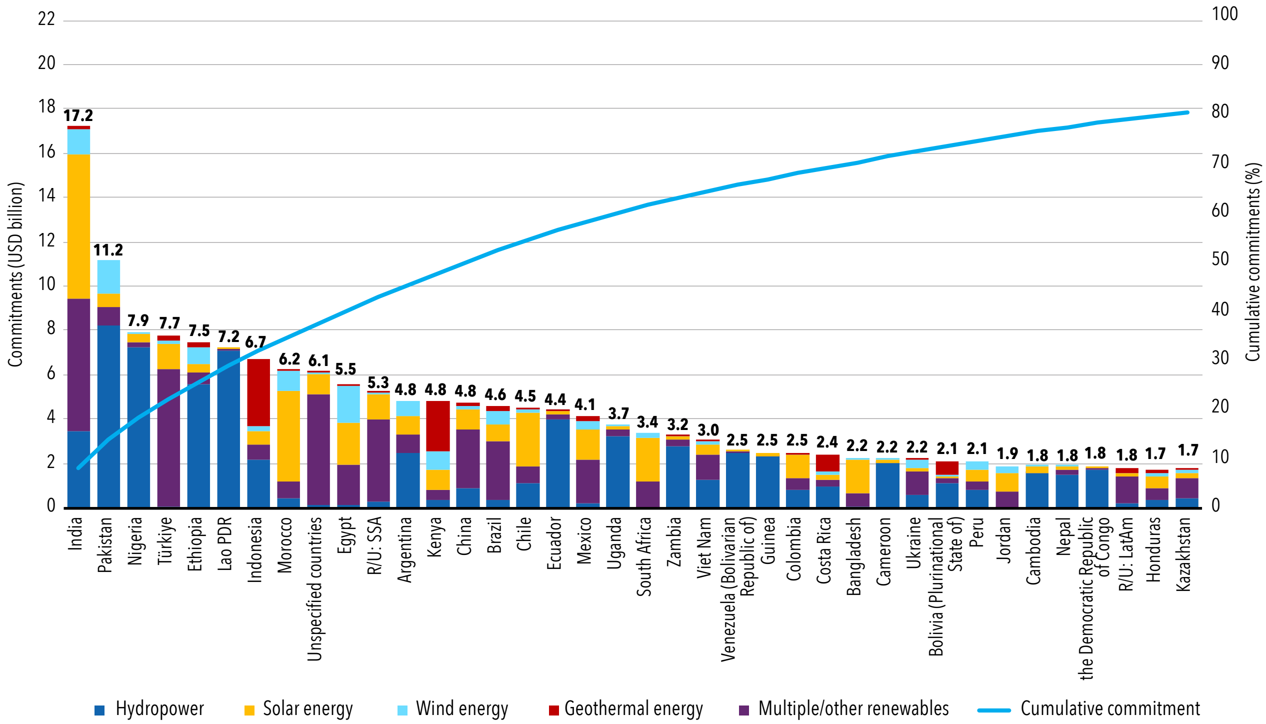
The data highlight the significant role of China and other top investors in financing renewable energy, as well as the dominance of debt as the preferred financial instrument.

COUNTRY TRENDS

During 2010–19, 36 countries received 80 percent of all commitments. Over 2010–21, the number was 38 (figure 5.7), including commitments to unspecified countries and subregions without allocations.

The slightly improved distribution is a result of several factors. First, fewer investments are now allocated to specific countries; signalling that more commitments are distributed to multiple countries. Second, expanding the analysis to cover a longer period flattens the variability of flows and reveals a more even distribution. Third, although the number of donors investing in renewables decreased in 2020–21, the top investors slightly increased the number of recipients they support.

Figure 5.6 • International public financial flows to renewable energy by top recipients, by type of energy, 2010–21



Source: IRENA and OECD 2023.
Note: R/U = residual/unallocated official development assistance; SSA = Sub-Saharan Africa; LatAm = Latin America and the Caribbean; Lao PDR = the Lao People's Democratic Republic"

TOP RECEIVING COUNTRIES IN RECENT YEARS

Although the distribution of flows is wider when averaged over several years, international public financial flows remain highly concentrated among a small group of countries, with 23 countries receiving 80 percent of all commitments in 2020. In 2021, the number of countries receiving most of the commitments was even smaller, with only 19 countries receiving the bulk of flows. India was the top recipient of international flows for the past two years, followed by Pakistan, Brazil, and Mexico.[68]

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68 The UN system does not define "developing country." This chapter is based on a list of developing countries that the UN Statistics Division uses for statistical uses (UNSD 2022). This report adapts that list to exclude countries that are not targeted by international aid and territorial entities associated with high-income countries.

India received USD 2.9 billion in 2020–21, or more than 8 percent of all commitments in the past two years. Its consistent pipeline of a vast array of smaller projects reduces the volatility of flows from one year to another. India has been the top recipient for 6 out of 22 years, more than any other country. The United States, the Asian Development Bank (ADB), and Germany were the top donors. Solar energy received more than two-thirds of inflows. During 2020–21, 90 percent of flows were debt, of which 76 percent were standard loans. This growing market for renewables attracts large volumes of loans for project development, particularly on-grid solar PV (USD 1,093 million) and off-grid solar PV (USD 616 million).

Pakistan was the second-largest recipient, with USD 1.7 billion in 2020–21. In 2020, 70 percent of commitments to Pakistan went to hydropower, which increased to 82 percent in 2021. Debt instruments made up more than 90 percent of commitments between 2010 and 2021. During this period, various multilateral development banks, including the IBRD, the ADB, the Asian Infrastructure Investment Bank (AIIB), and the Islamic Development Bank, were the top providers of funds.

Brazil is not typically a top recipient of international public financing, because its own development bank, BNDES, channels significant domestic public flows to renewable energy projects. Nonetheless, the country received USD 1.4 billion in international public financial flows, in the form of concessional loans, in 2020–21. As Brazil's development bank already funds many infrastructural projects, the majority of international public flows support government programs or are used to capitalize climate action funds. Some international public money did flow to specific projects, such as the Casablanca PV Bifacial Solar Power Project and the Neoenergia Green Renewable Energy Generation Framework Loan. During 2020–21, the European Investment Bank (EIB), Japan, and the Inter-American Investment Corporation (IDB Invest) were the top international donors in Brazil.

Mexico has attracted increasing flows (predominantly loans) since 2010. Many fund new solar PV projects, likely driven by the 2013 energy reform, which allowed more international developers into the country, and the subsequent rounds of successful renewable energy auctions. Notable flows during 2020–21 included a USD 241 million loan from the US International Development Finance Corporation to finance half of the cost of 426 MW of solar PV, a USD 100 million concessional loan from the Japan International Co-operation Agency to support a solar PV power plant, and a USD 226 million loan from the French Development Agency for the modernization and rehabilitation of hydropower plants.

Reaching those farthest behind

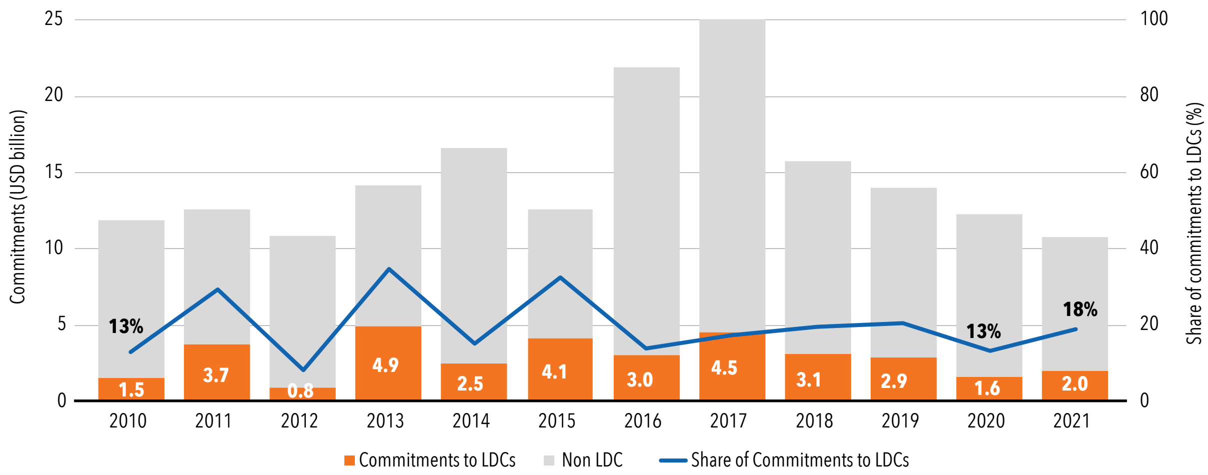
Analyzing the flow of international public finance to support renewable energy in the 46 LDCs, 32 LLDCs, and 40 SIDS[69] yields insights into flows to the poorest countries.[70]

Historically, LDCs received a small share of international public flows (figure 5.7). Flows to LDCs decreased in the past two years, dropping to USD 1.6 billion in 2020 and USD 2 billion in 2021.

69 The United Nations' M49 regional classification includes 53 SIDS; this report excludes 13 of them from the SDG 7.a.1 classification, as explained in the methodology section at the end of the chapter. The exclusion has a negligible effect on the analysis, as only Saint Kitts received financial flows (totaling to USD 19 million, or less than 0.6 percent of all flows received by SIDS since 2000).

70 The country categories are regularly updated in line with the United Nations' latest M49 classification. There were no changes during 2022. Some countries appear in more than one category.

Figure 5.7 • International public financial flows to renewable energy in least-developed and non-least-developed countries, 2010–21

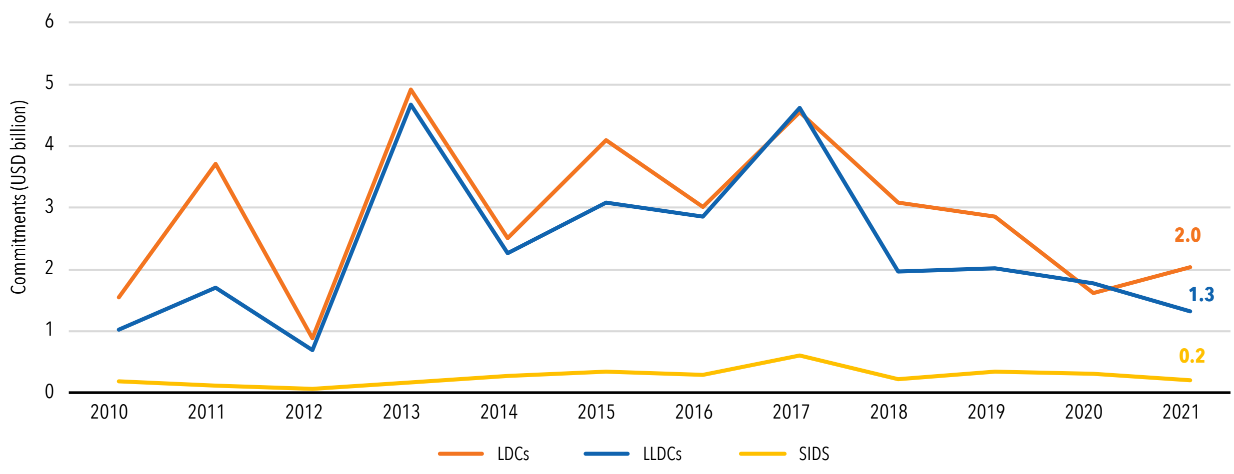


Source: IRENA and OECD 2023.

For the first time, all 46 LDCs received international public flows in 2020 (although 5 of them did not receive any flows in 2021). These flows have been increasingly concentrated in a few countries, with the Lao People's Democratic Republic, Uganda, Zambia, Guinea, and Ethiopia attracting half of the flows in 2021, despite being home to just 19 percent of the people living in LDCs.

LLDCs and SIDS receive even less financial support than LDCs (figure 5.8). The 32 LLDCs face trade and development challenges because of their lack of sea access and geographical remoteness. There has been a declining trend in standard loans, from 83 percent in 2015 to 19 percent in 2021, and a concomitant rise in concessional loans, grants, and equity investments. The share of flows to LLDCs increased slightly in 2020 before falling to 12 percent in 2021. All LLDCs except Burundi and the Central African Republic received commitments in 2020 or 2021.

Figure 5.8 • International public financial flows to least-developed countries, landlocked developing countries, and small island developing states, 2010–21



Source: IRENA and OECD 2023.

The 40 SIDS are geographically remote, depend heavily on external markets, and are particularly vulnerable to climate change. Historically, they received less than 2 percent of international public commitments. This share increased slightly to 2.4 percent in 2020 and 2.5 percent in 2021. However, this relative increase hides an absolute decrease in flows from USD 338 million in 2019 to USD 300 million in 2020 and USD 198 million in 2021.

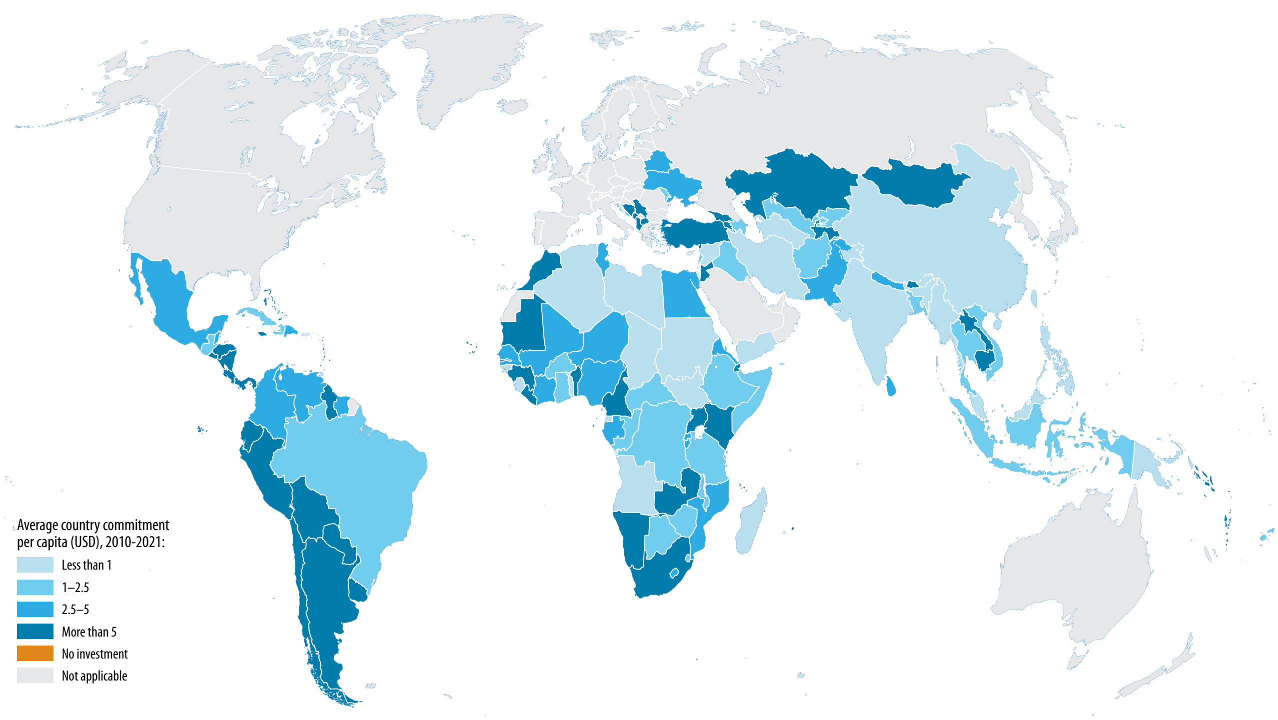
Flows to SIDS reflect an even distribution to the population, with 70 percent of flows going to countries where 70 percent of the population lives. However, four SIDS (Grenada, Seychelles, Trinidad and Tobago, and French Polynesia) have not received more than USD 10 million of international public flows since the start of the millennium. Positively, 45 percent of flows to SIDS since 2000 have been in the form of grants.

LDCs, LLDCs, and SIDS struggle with high debt burdens, which limit their capacity to develop and mitigate the challenges posed by climate change (box 5.3).

Distribution of financial flows among countries

Figure 5.9 shows the average distribution of per capita international public financial flows across countries between 2010 and 2021. The number of countries that did not receive any commitments decreased to less than 20 percent in 2021. Over the past decade, only three countries received no international public commitments. Most countries receiving more than USD 5 per capita are island countries in Oceania.

Figure 5.9 • Average per capita international public financial flows for renewable energy, by country, 2010–21



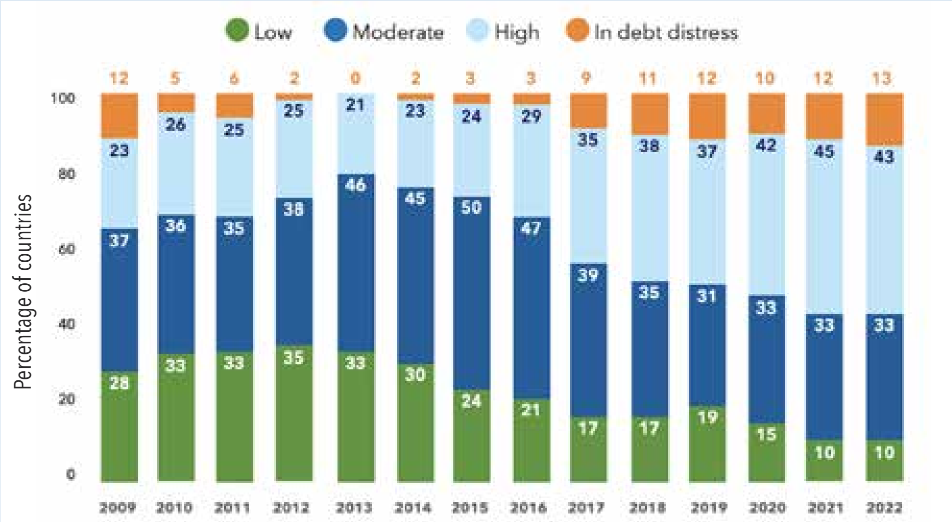
Source: The data on international public financial flows to developing countries supporting clean energy underlying this map were drawn from IRENA and OECD (2023).
Disclaimer: This map was produced by the Geospatial Operations Support Team of the World Bank based on the Cartography Unit of the World Bank. The boundaries, colors, denominations, and other information shown do not imply any judgment on the part of the custodian agencies concerning the legal status of or sovereignty over any territory or the endorsement or acceptance of such boundaries.

Box 5.3 • International public financial flows to countries most in need and least capable of paying back debt

The countries most in need of international financial flows are LDCs, LLDCs, and SIDS. They need debt-free instruments to ease financial stress, especially post-COVID (Volz and others 2020).

The proportion of countries in or at high risk of debt distress more than doubled between 2015 and 2022 (figure 5B.3.1). With debt risks increasing in low-income countries, vulnerabilities will affect both debtors and creditors and the overall global economy.[a]

Figure 5B.3.1 Percent of countries in or at high risk of debt distress, 2009–22



Source: IMF 2022.

Around 80 percent of debt in lower-income countries is denominated in foreign currencies, making these countries highly vulnerable to currency and international trade shocks. In many countries, expenditures for debt servicing exceed expenditures for health, education, and other social services (UN 2021). Middle-income economies allocated a median of 41 percent of their government revenues to debt servicing in 2021; low-income economies spent 28 percent of their revenues on repaying debt (Steinhauser 2022).

Support for increased public finance is particularly important for LDCs in Sub-Saharan Africa, which are eligible for debt-free assistance from the IMF and the World Bank. However, LDCs have historically received more than 80 percent of flows in the form of loans and concessional loans; only 16 percent have been in grants. The international public financing architecture must change to avoid stressing governments even more with unsustainable debt.

a. The World Bank and IMF classify low-income countries for fiscal year 2023 as countries with a per capita GNI of $1,085 or less based on the World Bank Atlas method. They include Afghanistan, Burkina Faso, Burundi, the Central African Republic, Chad, the Democratic Republic of Congo, Eritrea, Ethiopia, The Gambia, Guinea, Guinea-Bissau, the Democratic People's Republic of Korea, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Rwanda, Sierra Leone, Somalia, South Sudan, Sudan, the Syrian Arab Republic, Togo, Uganda, Yemen, and Zambia.

This year's methodological change for inclusion and exclusion of countries from the list of recipients yields a more accurate reflection of the international distribution of public flows, weighted by population to compare investments across countries.[71] The global average per capita investment was USD 2.24 during 2010–21, a value in line with the last two editions of this report.

These distributions highlight the fluctuating nature of international public financial flows, as one year may bring millions to a particular country and the next year may bring none. Only by reviewing multiple years can one accurately assess the distributions of these flows. Table 5.1 provides a summary of the decade-long flow distribution across countries, groups of countries, and geographical regions.

Table 5.1 • Distribution of international public financial flows by country group

	USD PER CAPITA			PERCENTAGE CHANGE	
COUNTRY GROUP	**2010–21**	**2020**	**2021**	**2010–21**	**2020–21**
All recipients	2.24	1.67	1.24	–45	–26
Country grouping					
LDC	3.00	1.50	1.85	–38	–23
LLDC	4.81	3.31	2.39	–50	–38
SIDS	4.49	4.94	3.23	–28	–53
Region					
Sub-Saharan Africa	3.59	1.99	1.90	–47	–4
Latin America and the Caribbean	5.45	5.50	2.04	–63	–63
Central Asia and Southern Asia	1.44	1.46	1.34	-7	-9
Western Asia and Northern Africa	4.21	2.09	0.83	–80	–60
Eastern Asia and South-eastern Asia	0.84	0.45	0.50	–40	–11
Northern America and Europe	4.95	1.28	5.09	3	298
Oceania	6.64	1.62	0.91	–86	–44

Source: IRENA and OECD 2023.

On average, recipients received USD 2.24 per capita during 2010–21. Oceania was the top regional recipient, at USD 6.64 per capita. Central Asia and Southern Asia received USD 1.44 per capita and Eastern Asia and South-Eastern Asia USD 0.84 per capita.

Looking at trends in the distribution of flows by population, a continuation of the decreasing trend in flows can be observed over the past two years, with all recipient countries receiving on average USD 1.67 and USD 1.24 per capita, respectively, during 2020 and 2021. Unfortunately, the countries most in need (LDCs, LLDCs, and SIDS) received smaller shares of flows in 2021 than in 2020. SIDS experienced the largest decrease in per capita flows, receiving USD 3.23 per capita, a 53 percent drop from USD 4.94 per capita in 2020. LLDCs received USD 2.39 per capita in 2021 and LDCs USD 1.85 per capita. Per capita flows declined by 38 percent in LLDCs and 23 percent in LDCs in 2002. All three country groups received a distribution of flows across populations that was more even than other regions or than the developing countries average. But investments are reaching fewer people, because of a decrease in overall flows; a larger share of commitments targeting entire regions; and, to a lesser degree, an increase in regional populations.

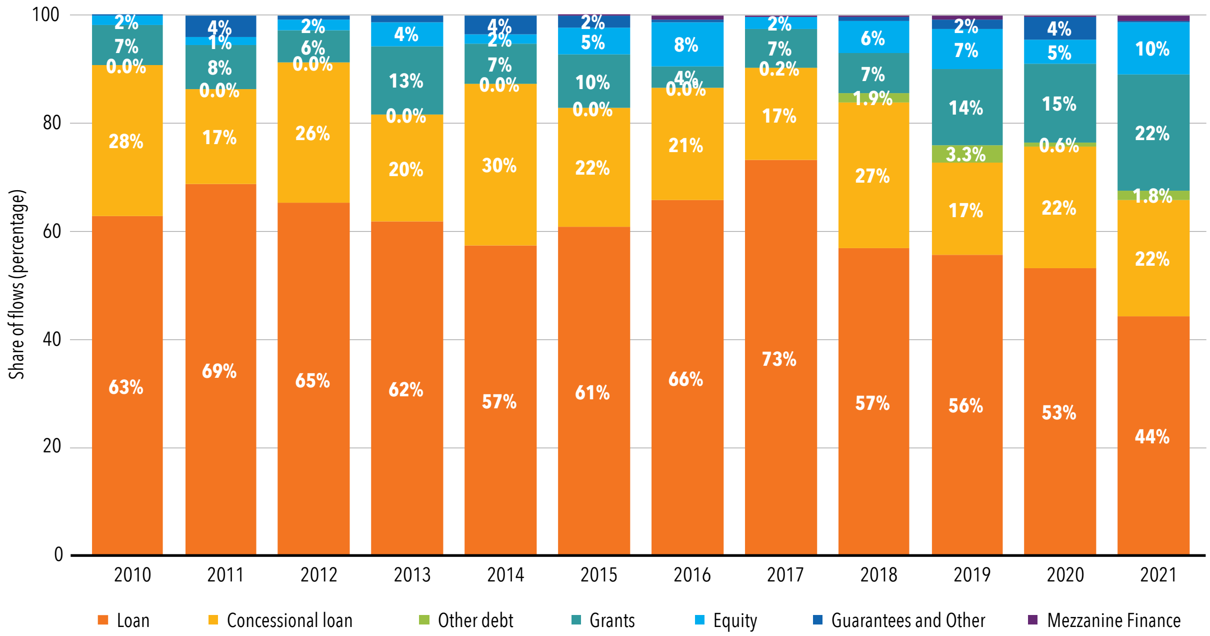
71 See the methodology section of this chapter for more information about the inclusion and exclusion of countries from the list of recipients.

INVESTMENTS BY FINANCING INSTRUMENTS

The flows of international public financing to recipient countries have been declining since 2019, with a mixed impact. On the one hand, the flow of grants has remained strong—a boon to recipient countries, as grant instruments do not carry the obligation of future repayment. On the other hand, an absolute decline in total flows presents a serious concern for countries that urgently need funds to bring renewable energy projects online.

Figure 5.10 shows the main instruments used to finance international public flows. It shows that the mix of financial instruments supporting renewable energy has been evolving in recent years. The proportion of debt instruments from public financing sources has declined to two-thirds of flows in 2021 from nearly 90 percent in 2018. At the same time, the share of grants, equity, and guarantees has increased.

Figure 5.10 • International public financial flows to renewable energy, by instrument, 2010–21



Source: IRENA and OECD 2023.

In 2021, standard loans totalled USD 4.7 billion, down from USD 6.5 billion in 2020. They accounted for 44 percent of all flows, the smallest share recorded during the last decade, down from an average of 64 percent between 2010 and 2020. The largest loan in 2021 was a USD 520 million loan to fund the Balakot Hydropower Development Project in Pakistan. Other large loans focused on solar energy projects and programs.

Half of all loans went to solar energy, 20 percent to hydropower, 13 percent to multiple/other renewables, 10 percent to wind energy, and 2 percent to geothermal energy. The distribution favored solar energy over hydropower. China did not fund any hydropower projects in 2021. There are concerns about using loans to fund renewables in a post-pandemic recovery, especially in LDCs, LLDCs, and SIDS, as overuse of loans could push these countries further into unsustainable external debt situations (IMF 2022).

Concessional loans reached USD 2.3 billion in 2021, a 15 percent decrease from USD 2.7 billion in 2020; these loans represented 22 percent of all flows in 2021. The distribution of concessional loans was similar to the distribution of standard loans, with 44 percent going to solar energy, 27 percent to multiple/other renewables, 22 percent to hydropower, and the rest to geothermal and wind energy. Among the top concessional loans are USD 369 million to fund solar energy access and lighting in Ethiopia, USD 226 million to modernize and rehabilitate hydropower plants in Mexico, and USD 166 million for a Germany-India solar partnership program.

Grants reached USD 2.3 billion in 2021, up 30 percent from USD 1.8 billion in 2020. This increase was greater than that of other flows, raising the share of grants from 15 percent of commitments in 2020 to 22 percent in 2021. Grants during 2020–21 went primarily to multiple/other renewables and solar energy. The largest grant in 2021 was USD 585 million for the Common Provisioning Fund, a component of the European Fund for Sustainable Development Programme Plus (EFSD+). It funds activities in Sub-Saharan Africa. It was followed by USD 168 million of investments in regional Sub-Saharan Africa infrastructure, a USD 142 million Somali Electricity Sector Recovery Project, and USD 120 million for accelerating electricity access in Niger. Grants are essential for countries in need of public finance, because they do not add to the existing burden of debt, help prove project viability, and reduce the perception of risk for international private finance actors (Polzin and Sanders 2020) and engage smaller local private investors in certain contexts (Curtin, McInerney, and Gallachóir 2017).

Equity reached USD 1 billion in 2021, up 46 percent from USD 564 million in 2020; it represented 10 percent of all flows in 2021. In 2021, half of equity investment went to funds targeting multiple renewable energy technologies, with the rest equally distributed between solar and hydropower energy. Equity is subdivided into two main instruments: common equity and shares in collective investment vehicles. Common equity is normally directed to specific energy sources; shares in collective investment vehicles normally target multiple renewables. The largest investments were a USD 147 million stake in Klinchenberg, a vehicle for Norfund's joint venture with Scatec to develop hydropower in Africa; USD 83 million to the UK Climate Investments (UKCI) fund; and a USD 80 million stake in Fourth Partner Energy in India.

Guarantees and credit lines reached less than USD 10 million in 2021, a 98 percent decrease from USD 500 million in 2020. They represented a negligible share of flows in 2021. In 2020, the credit line to promote sustainable energy in Paraguay was the most prominent use of this financial instrument. In 2021, there was only one guarantee, worth USD 9.6 million, for a loan to Punjab Renewable Energy Systems in India for the construction of seven biomass briquetting plants.

Mezzanine finance reached USD 121 million in 2021, a 175 percent increase from USD 44 million in 2020.[72] It represented 1 percent of flows in 2021. Mezzanine finance allows for the conversion of debt into equity in certain cases.

72 Mezzanine finance includes three instruments: subordinated loans, preferred equity, and other hybrid instruments, including convertible debt or equity. In case of default, subordinated loans are repaid only after all senior obligations have been satisfied. For the increased risk, mezzanine debt holders require a higher return for their investment than secured or more senior lenders. In the event of a default, preferred equity is repaid after all senior obligations and subordinated loans have been satisfied and before common equity holders are paid. It is a more expensive source of finance than senior debt but a less expensive source than equity.

Policy Insights

International public flows decreased in the past few years, jeopardizing efforts to achieve SDG 7 and implement the broader 2030 Sustainable Development Agenda (United Nations, 2015). Notwithstanding international initiatives to revamp these flows, the underlying issues in the global public finance landscape are complex and require increased efforts to understand and address them.

The international public flows presented in this chapter represent just a fraction of the total global financial flows supporting renewables. Domestic public flows, domestic and international private flows, and flows directed to countries that are not included in the scope of indicator 7.a.1 must be added to the figures document here. In 2021, these flows for renewables reached an estimated USD 430 billion (IRENA and CPI 2023).

Even with these flows, the current pace of investment falls far short of the investments required to limit the global temperature increase to 1.5°C while closing the energy gap and advancing development imperatives. Scenarios suggest that we may need investments of at least around USD 1.3 trillion a year (in current prices) must be directed to renewable power and the direct use of renewables between 2021 and 2030, and at least USD 2 trillion a year is needed for broader power sector investments, including power grids and flexibility (IRENA 2022; IEA 2022). Chapter 6 discusses investment needs across indicators in more detail.

The following recommendations identify actions policy makers could consider to narrow the financing gap in the energy transition in a way that reaches those farthest behind.

Enhance international collaboration among countries, international donors, and private investors to address economic challenges and drive systemic reforms.

The uncertain macroeconomic outlook, high inflation levels, currency fluctuations, and tighter fiscal circumstances around the world are stymying the energy transition. Given the high upfront cost of renewable energy projects, higher costs of capital may also slow the transition, particularly for lower-income countries, which already have growing debt vulnerabilities and low sovereign credit ratings. International collaboration will be key to achieve equitable, inclusive, and resilient economies; realize SDG 7; and help countries recover from the economic shocks of the COVID-19 pandemic.

Increase donor flows to regions and countries with vast untapped potential and immense needs, as well as reevaluate their portfolios and disbursement processes.

The contraction, for the third year in a row, of international public flows to developing countries in support of clean energy is concerning, as is its concentration in a small number of countries. International public flows in 2021 were 35 percent below the 2010–19 average. In 2000–21, three-quarters of international flows were from nine investors (a mix of countries and MDBs) and fewer than 40 countries out of 151 received 80% of all commitments. High-income countries should honor existing ODA obligations, significantly increase their international public flows, and ensure that these flows are fairly distributed to countries in need. This also means a larger push for portfolio diversification with more grants, mezzanine finance, concessional debt, and export credits. Capitalization of multilateral and UN–linked funds or programs from international organizations could improve fund allocation.

Redirect funds from fossil fuels to renewables.

About half of all international public flows during 2010–19 went to nonrenewable technologies, as highlighted in last year's report. Donors must accelerate switching their investments from fossil fuels to renewables. As the urgency of such a transition becomes more apparent, more investors—public and private—should pledge to stop funding fossil fuels. Doing so is urgently needed given the global rebound in fossil fuels subsidies in 2021 (IRENA and CPI 2023). One way to increase flows to renewables would be to redirect fossil fuel funds, while simultaneously providing a safety net to ensure adequate standards of living for vulnerable populations. IRENA (2022) scenarios suggest that almost USD 1 trillion in annual investments in fossil fuel–based technologies currently planned by governments should be redirected toward energy transition technologies and infrastructure.

Transform lending to developing countries, including by enhancing collaboration through development finance institutions and multilateral development banks, developing innovative products, and assessing risk appetites.

Many developing countries need both an increase in public finance for renewables and an increase the share of non-debt instruments. Debt burdens are rising, leading to distressed situations in low-income countries, stretching many to the breaking point (see box 5.3). This makes non-debt instruments a preferred option for funding renewable energy infrastructure in some contexts as they may carry the benefit of not adding to the existing debt-burden of countries. The international public financing architecture must thus change. The Bridgetown Initiative, spearheaded by Barbados, calls for providing emergency liquidity, changing some terms regarding how funding to developing countries is made and repaid, and expanding multilateral lending to governments to address systemic challenges that are at the heart of the crises. A wide range of other options includes boosting multilateral development banks' investing capacity (Léautier 2022) and developing innovative frameworks, such as liquidity facilities, to mobilize capital and mitigate risks (IRENA and CPI 2023).

Encourage governments and international donors to rethink the way renewable energy investment risk is defined, in order to increase the pool of public funds available to support renewables.

Private investments accounted for almost 70 percent of global renewable energy investment in 2020, most of it directed to richer economies. This trend reflects the preference of mainstream private capital for lower-risk investments that prioritize financial returns over social, environmental, and climate-related gains. As a result, private capital tends to go to countries with lower real or perceived risks or to frontier markets only if risk-mitigation facilities are provided.

The current financing architecture needs a more comprehensive way to define risk to account for environmental, planetary, and social risks. It should include the risk of leaving a large part of the population out of the energy transition and locked into underdevelopment and the risk of failing to meet the SDGs (IRENA and CPI 2023). At the same time, public funds should continue to be used to mobilize private capital, when possible. National governments can take a range of actions to attract more private sector investments, including regulatory interventions, making it easier to do business and ensuring policy consistency in support of renewables.

Efforts like the Sustainable Renewables Risk Mitigation Initiative can help mobilize more investments by providing a toolkit that shows countries how to methodically address critical risks perceived by the private sector while increasing socioeconomic benefits.

Encourage donors to assess how to best leverage limited public resources, review risk-management practices, and introduce innovative financing instruments.

Public funds are limited, so governments have been focusing on what is available on de-risking projects and improving their risk-return profiles to attract private capital. Among risk-mitigation instruments, sovereign guarantees have dominated. Regulators, credit-rating agencies, and international institutions such as the IMF treat such guarantees as contingent liabilities, however, possibly hampering a country's ability to take on additional debt for critical infrastructure development and other investments (IRENA 2020a). Moreover, sovereign debt is already stressed to the breaking point in many developing countries grappling with high inflation and currency fluctuations or devaluations in the wake of the COVID-19 pandemic. In this macroeconomic environment, many countries cannot access affordable capital in international financial markets or provide sovereign guarantees as a risk-mitigation instrument.

Given the urgent need to step up the pace and geographic spread of the energy transition, and to capture its full potential in achieving socio-economic development goals, more innovative instruments such as blended finance instruments are needed that help underinvested countries reap the long-term benefits of the energy transition without putting their fiscally constrained economies at a further disadvantage (IRENA and CPI 2023).

Use public flows to continue to expand beyond project investments, with a view to increasing their effectiveness to support a just energy transition, including closing energy access gaps.

Priority focus areas should include supporting areas such as education, awareness, and planning, as well as putting in place a policy framework to enable the energy transition and close the energy access gap. Most assessments of investment needs for the energy transition focus on the financing of technological avenues, overlooking the fact that policy interventions and frameworks also require funding. A holistic framework encompasses not only deployment policies that include direct investments in government-owned energy transition assets or policies to attract private investments but also policies that support the integration of renewables into the energy system and the economy as a whole, including capacity building, training, structural change, and just transition policies. Governments need fiscal space to enact such policies; international public flows in support of these policies will be crucial (IRENA and CPI 2023).

Develop a standardized and more granular system for reporting on and tracking renewable energy investments to better track public international flows, including disbursements.

One reason behind the growing share of commitments under the multiple/other renewables category is methodological: unclear commitment descriptions in financial databases and a lack of detail on the financial breakdown for each technology. The prevalence of multi-technology commitments, such as green bonds and investment funds, and technical/policy assistance activities reduce the classification accuracy of financial flows for the energy sector.

A standardized system for reporting on and tracking renewable energy investments would help better track commitments. Such a system could include categories and subcategories identifying renewable energy technologies, energy access initiatives (off-grid solutions for rural communities, mini-grids); project capacities (in energy units); and socioeconomic impacts. Such a system would require collaboration between international organizations, governments, private sector developers, and multilateral development banks to build guidelines, frameworks, and energy-based classification criteria (NGFS, 2019) In many cases, commitments do not translate to disbursements (SEforALL, 2020). Disbursements are more difficult to track and compare against commitments, further complicating analyses.

International public finance stakeholders could do a better job of tracking disbursements, thereby deepening the understanding of gaps between commitments and disbursements. Detailed and transparent data should be compiled and published to facilitate well-informed financing decisions, increase donor accountability, and help identify funding gaps (Michaelowa and Namhata 2022).

Overall, achieving SDG7 by 2030 will require substantial investments in renewable energy. Redirecting investments from fossil fuels, increasing ODA commitments, innovating funding mechanisms, making commitment reporting more transparent through robust international collaboration, and introducing structural reforms in international public finance are all necessary steps. This will require strong political will and collaboration among global stakeholders. With consistent and concerted effort, we have the tools to achieve the needed investments and meet the SDG7 targets.

Methodological Notes

DATA SOURCES

SDG indicator 7.a.1 relies on two databases to track international public financial flows: the Creditor Reporting System (CRS) of the OECD's Development Assistance Committee (DAC) and IRENA's Renewable Energy Public Finance Database.

The CRS database includes ODA and other official flows provided by investors to countries for renewable energy.[73] These flows include official loans, grants, and equity investments that DAC countries receive from foreign governments and multilateral agencies to support renewable energy research and production, including hybrid systems. Investors self-report these figures, which the OECD consolidates and categorizes. We extracted this data from the OECD/DAC CRS from 2000 onward; removed private donor flows, mostly from philanthropic organizations; and filtered it to include clean energy investments per the following codes:

- 23210: Energy generation, renewable sources from multiple technologies, renewable energy generation programs that cannot be attributed to a single technology (codes 23220–23280 below); fuelwood/charcoal production should be included under code 31261
- 23220: Hydroelectric power plants, including energy-generating river barges
- 23230: Solar energy for centralized grids
- 23231: Solar energy for isolated grids and standalone systems
- 23232: Solar energy thermal applications
- 23240: Wind energy for water lifting and electric power generation
- 23250: Marine energy, including ocean thermal energy conversion and tidal and wave power
- 23260: Geothermal energy for generating electric power or directly as heat for agriculture or other purposes
- 23270: Biofuel-fired power plants, including the use of solids and liquids produced from biomass for direct power generation. Also includes biogases from anaerobic fermentation (such as landfill gas, sewage sludge gas, fermentation of energy crops and manure) and thermal processes (also known as syngas); waste-fired power plants making use of biodegradable municipal waste (household waste and waste from companies and public services that resembles household waste, collected at installations specifically designed for their disposal with recovery of combustible liquids, gases, or heat). See code 23360 for nonrenewable waste-fired power plants.
- 23410: Hybrid energy electric power plants
- 23631: Electric power transmission and distribution (isolated mini-grids).

IRENA's database includes additional loans, grants, and equity investments received by countries from all foreign governments, multilateral agencies, and development finance institutions for clean energy research and development and renewable energy production, including in hybrid systems. It covers the same technologies and activities as the CRS but excludes all flows extracted from the CRS to avoid duplication of data.

73 Find the data here: https://stats.oecd.org/Index.aspx?DataSetCode=crs1.

DEFLATION OF NOMINAL USD PRICES TO CONSTANT PRICES AND EXCHANGE RATES

Commitments are measured in millions of US dollars at constant prices and an exchange rate for a base year. The base year is updated annually and usually reflects a two-year lag in the publication cycle (that is, the 2020 cycle will report 2018 constant prices).

International finance flows expressed in nominal terms are deflated to remove the effects of inflation and exchange rate changes so that all flows, from all donors and years, are expressed as the purchasing power of a US dollar in a recent year (2020 in this report). A combination of the OECD DAC deflators for DAC donors and deflators calculated by IRENA for other international donors not included in the CRS database is used. The formula below converts the nominal investment amounts in current USD to USD at constant prices and exchange rates:

$$USD_{constant,n,m} = \frac{USD_{current,n}}{DAC\ Deflator_{,n,m}}$$

where n is the current year (nominal) and m the constant year.

The OECD publishes DAC deflators for every donor. (For more information, see https://www.oecd.org/dac/financing-sustainable-development/development-finance-standards/informationnoteonthedacdeflators.htm.)

In some cases, IRENA tracks flows from donors that are not identified in the DAC list and that do not have an allocated DAC deflator. When this happens, IRENA follows the same methodology as the OECD to calculate country-specific DAC deflators.

REGIONAL AGGREGATIONS AND CLASSIFICATIONS

This year, the countries included in this indicator were modified in order to track international financial flows to countries in need of international financial assistance. The UN system does not define developing and developed countries (or areas), but its Statistical Division publishes a list of countries classified as "developing" or "developed" for statistical uses. In 2021, the UN discontinued this classification, raising questions about how to assign these countries to development groupings.

The eight countries added starting in the 2023 edition represented around USD 4.9 billion of new flows over the 2000–21 period. The 36 countries removed represented USD 404 million of flows, mostly from Qatar and Saudi Arabia. The eight added countries were historically excluded from the developing country list but are identified by the Organisation for Economic Co-operation and Development (OECD) as ODA recipients and thus tracked in their international public flows. It made sense to include them for this reason. Of the countries removed from the indicator, high-income countries are not generally targeted by donors or investors for international aid purposes, mainly because they have bountiful domestic resources. A second group no longer included are countries associated with high-income countries, as defined by the World Bank classification of countries by income levels. This group includes territories of other high-income countries (such as American Samoa) or areas highly influenced by another country's central budgeting and planning (such as French Guiana).

Table 5.1 Changes to country classification for the 7.a.1 indicator

COUNTRIES ADDED IN 2023 (NEW RECIPIENTS OF OFFICIAL DEVELOPMENT ASSISTANCE)	COUNTRIES REMOVED IN 2023 (BECAUSE PRIOR INCLUSION WAS EXCEPTIONAL)	TERRITORIES NO LONGER INCLUDED BECAUSE ASSOCIATED WITH HIGH-INCOME COUNTRIES
Albania, Belarus, Bosnia and Herzegovina, Montenegro, the Republic of Moldova, North Macedonia, Serbia, Ukraine.	Bahrain, Brunei Darussalam, Kuwait, Oman, Qatar, the Republic of Korea, Saudi Arabia, Singapore, the United Arab Emirates, Western Sahara.	American Samoa, Aruba, Bonaire, Sint Eustatius and Saba, British Indian Ocean Territory, British Virgin Islands, Cayman Islands, Curaçao, Falkland Islands (Malvinas), French Guiana, French Southern and Antarctic Territories, Guadeloupe, Guam, Martinique, Mayotte, Northern Mariana Islands, Pitcairn, Puerto Rico, Réunion, Saint Barthélemey, Saint Kitts and Nevis, Saint Martin (French Part), Sint Maarten (Dutch Part), South Georgia and the South Sandwich Islands, Turks and Caicos Islands, United States minor outlying islands, United States Virgin Islands.

This modification was driven by the lack of formality of the "developing country" classification, personalized appeals IRENA received over the years from countries requesting their exclusion from this indicator, and guidance by other custodian agencies.

The United Nations introduced a distinction for the "developing" classification in the standard country or area codes for statistical use (known as M49) in 1996. It removed it in December 2021 because it had become outdated and did not reflect the reality in many countries. The UN Statistical Division still refers to "developing countries" in the SDG indicators but notes that "the exact composition of the group may vary, depending on the mandate, membership or analytical interest of the custodian agency responsible for the particular indicator or use other available groupings such as by income-level" (UNSD 2022).

The developing country classification will continue to lose significance through the 2020s as countries self-identify as more developed and ask to be taken out of this classification. Over the past few years, IRENA received requests by country officials to remove their countries from the 7.a.1 indicator, mainly because these countries do not perceive themselves as needing international financial assistance to develop their renewable energy sectors.

After reviewing this situation with other custodian agencies of various SDG indicators that are designed for "developing countries" and the UN Statistics Division, IRENA decided to make the changes shown above. Where commitments could not be categorized under specific countries or territories, they were classified as "Residual/unallocated ODA," followed by the name of the region. Where the region was unclear, the commitment was classified under "Unspecified countries." (Last year this group was described as "Unspecified, developing countries."). In terms of data aggregation, residual flows to specific regions are aggregated under the geographical region aggregates. Residual flows to "unspecified countries" are aggregated directly under the totals, rather than under any region.

Chapter 7 discusses these classifications.

MEASUREMENT OF FINANCIAL FLOWS THROUGH COMMITMENTS

Financial flows are recorded as donors' commitments. A commitment is defined as a firm obligation, expressed in writing, and backed by the necessary funds. Bilateral commitments are recorded as the full number of expected transfers for the year in which commitments are announced, irrespective of the time required for the completion of disbursements, which may occur over various weeks, months, or years.

Tracking financial commitments can yield quite different results than approaches that consider financial disbursements. Although disbursement information would provide a more accurate picture of actual financial flows to renewable energy each year, data on disbursements are often limited or not available. The focus on commitments allows for a more comprehensive and granular analysis of financial flows and ensures methodological consistency across different data sources. Measuring commitments, however, may produce large annual fluctuations in financial flows when large projects are approved. In addition, financial commitments may not always translate into disbursements, as contracts may be voided, cancelled, or altered. Any changes must be reflected in annual values.

FINANCIAL INSTRUMENTS

The financial instruments used by public financial institutions were categorized based on the OECD list of financial types and the IRENA classifications for concessional loans and credit lines (table 5.2). This taxonomy excludes debt-relief mechanisms. Not all these instruments have commitments allocated to them yet.

Table 5.2 Instruments used to finance renewable energy

INSTRUMENT	DESCRIPTION
Debt	
Standard loan	Legal debt obligations assumed by the recipient comprising transfers in cash or in kind (the creditor also acknowledges the nontradability of obligations should any claim arise from nonpayment). As payment obligations on a standard loan are senior obligations (loans entitle creditors to receive payments against their claims before anyone else), they are referred to as senior loans. These loans have better lending terms than those provided by private financial institutions, including longer payment terms, lower interest rates, and low or negligible grant elements. These loans are not necessarily market-rate loans. In cases where no concessional information is available, they are categorized as loans, not concessional loans.
Concessional loan	Loans that meet ODA criteria of at least a 45 percent grant element for LDCs, LLDCs, and SIDS; 15 percent for lower-middle income countries; and 10 percent for upper-middle- income countries and multilateral development banks within the CRS database or when specified as "concessional" by the public donor itself in the IRENA Public Investments database. Concessional loans also incur external debt from recipients after receiving transfers in cash or in kind, albeit at a significantly lower interest rate than developed countries could get from commercial banks or private finance institutions.
Bonds	Fixed-interest debt instruments issued by governments, public utilities, banks, or companies that are tradable in financial markets.
Asset-backed securities	Securities whose value and income is backed by a pool of underlying assets.
Reimbursable grant	Contribution provided to a recipient institution for investment purposes with the expectation of long-term reflows at conditions specified in the financing agreement. The provider assumes the risk of total or partial failure of the investment; it can also decide when to reclaim its investment.
Other debt securities	These are financial instruments that represent a debt obligation, which are neither standard loans, concessional loans, bonds, nor asset-backed securities. They can be issued by various entities, including governments, corporations, or financial institutions. Other debt securities may include instruments such as promissory notes, commercial paper, or medium-term notes. These securities typically have varying maturities, interest rates, and risk profiles, and they may be traded in secondary markets, providing liquidity to investors. They serve as an alternative means of raising capital or financing projects, offering issuers and investors additional options for diversifying their portfolios and managing risk.
Grants	
Standard grant	Transfers in cash or in kind that create no legal debt for the recipient.
Interest subsidy	Payment to soften the terms of private export credits, loans, or credits by the banking sector.
Capital subscription on deposit basis	Payments to multilateral agencies in the form of notes and similar instruments, unconditionally cashable on sight by the recipient institutions.
Capital subscription on encashment basis	Payments to multilateral agencies in the form of notes and similar instruments, unconditionally cashable on sight by the recipient institutions.

Mezzanine finance	
Subordinated loan	A loan that, in the event of default, will be repaid only after all senior obligations have been satisfied. In return for this increased risk, mezzanine debt holders receive a higher return for their investment than secured or more senior lenders.
Preferred equity	Equity that, in the event of default, will be repaid only after all senior obligations and subordinated loans have been satisfied but before common equity holders are paid. It is a more expensive source of finance than senior debt, a less expensive source than equity.
Other hybrid instruments	Instruments include convertible debt or equity.
Equity	
Common equity	Share of the ownership of a corporation that gives the owner claims on the residual value of the corporation after the corporation meets creditors' claims.
Shares in collective investment vehicles	Collective undertakings through which investors pool funds for investment in financial and/or nonfinancial assets. These vehicles issue shares (for corporate structures) or units (for trust structures).
Reinvested earnings	Reinvested earnings are applicable only to foreign direct investment (FDI). Reinvested earnings on FDI consist of the retained earnings of a direct foreign investment enterprise that are treated as if they were distributed and remitted to foreign direct investors proportionally to their ownership of the equity of the enterprise and then reinvested by them in the enterprise.
Guarantees	
Guarantees/ insurance	Promise of indemnification up to a specified amount in the case of default or nonperformance of an asset (such as a failure to meet loan repayments or to redeem bonds or expropriation of an equity stake). Guarantees typically cover political and/or commercial (credit, regulatory/contractual) risks that investors are unwilling or unable to bear.
Credit line	Arrangement between a bank and a borrower establishing a maximum loan balance that the bank will permit the client to maintain. A credit line guarantees that funds will be available, but no financial assets exist until funds are advanced.

CHANGES TO THE DATA

Several revisions were made to this year's public investments database. Some commitments were cancelled, some were reclassified to different years, some recipient countries were removed from the dataset, and all figures were updated to reflect 2020 prices and exchange rates.

Table 5.3 • International public flows to renewable energy before and after the 2023 revisions, 2000–19

YEAR	BEFORE REVISION (2019 USD MILLIONS)	AFTER REVISION (2020 USD MILLIONS)	DIFFERENCE (2020 USD MILLIONS)
2000	1,424	1,469	45
2001	1,668	2,038	370
2002	1,321	1,381	60
2003	3,097	3,102	5
2004	2,116	2,166	50
2005	1,961	2,218	257
2006	3,238	3,327	89
2007	4,272	4,349	77
2008	2,778	2,919	141
2009	8,145	8,263	118

YEAR	BEFORE REVISION (2019 USD MILLIONS)	AFTER REVISION (2020 USD MILLIONS)	DIFFERENCE (2020 USD MILLIONS)
2010	11,171	11,912	741
2011	11,689	12,603	914
2012	10,294	10,808	514
2013	13,580	14,176	596
2014	15,691	16,626	935
2015	12,660	12,588	-72
2016	20,410	21,874	1,464
2017	24,657	26,365	1,708
2018	14,244	15,752	1,508
2019	12,526	13,987	1,461

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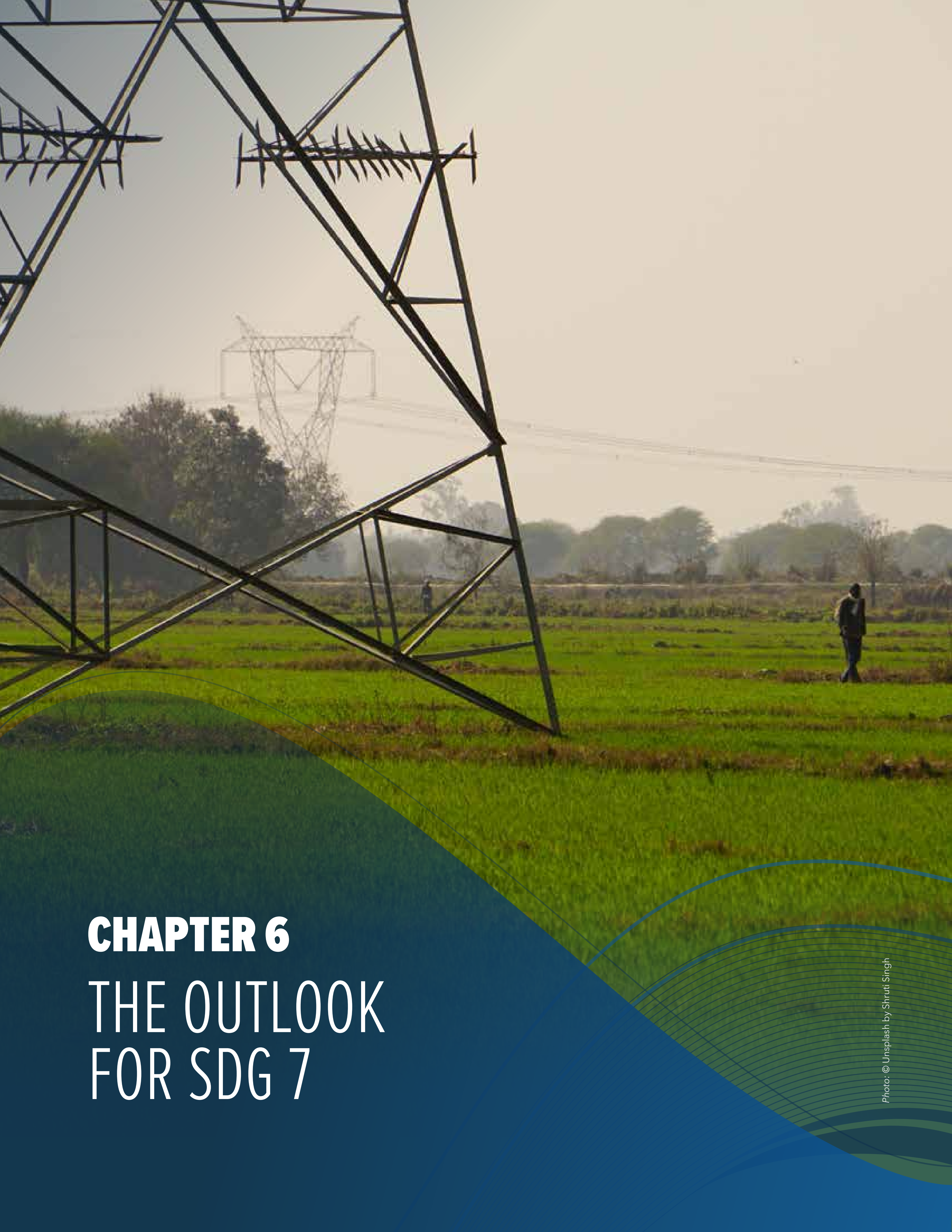

CHAPTER 6
THE OUTLOOK FOR SDG 7

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Main Messages

- **Outlook for progress toward 2030 goals.** The current energy and inflation crisis, triggered by the energy crisis two years after the COVID-19 pandemic, has continued to impede global progress on Sustainable Development Goal (SDG) 7. Energy security concerns sparked government responses that have accelerated the deployment of renewables and energy efficiency, improving the outlook to 2030 for SDG targets 7.2 and 7.3. This momentum is already helping curb emissions, which rose less than initially feared in 2022, with growth in solar, wind, electric vehicles, heat pumps, and energy efficiency limiting the impacts of increased coal and oil use amid the global energy crisis. Without this progress, emissions could have grown three times faster in 2022. However, price pressures, reduced household income, continued supply chain bottlenecks, and strained finances within developing economies are decelerating progress in access to electricity and clean cooking. These trends and new policies are captured under the Stated Policies Scenario of the International Energy Agency (IEA) and the Planned Energy Scenario of the International Renewable Energy Agency (IRENA), both of which depict a trajectory that is off track for achieving SDG 7. IEA's Net Zero Emissions by 2050 Scenario and IRENA's 1.5°C Scenario lay out pathways to bridge the gap and put the world's energy system on track to achieve or surpass the SDG targets most closely related to energy (those under SDG target 3.9, SDG 7, and SDG 13).[74]
- **Outlook for access to electricity.** For the first time in decades, the number of people without electricity access globally is likely to have increased in 2022, due to the energy crisis. IEA's Stated Policies Scenario projects that 660 million people would still lack access to electricity in 2030, of whom approximately 560 will be in Sub-Saharan Africa and approximately 70 million in Developing Asia. While there is limited progress on the horizon for countries with weak energy access–related institutions and policies, the outlook is better for countries that have strong institutional and policy support for access and have already made historic progress in bringing access to their population (e.g., Ethiopia, Senegal, and Kenya in Sub-Saharan Africa and countries in Developing Asia, which are still set to reach near-universal access by 2030). Between 2021 and 2030, 110 million people globally must be connected each year to achieve SDG target 7.1, the majority of them being in Sub-Saharan Africa.
- **Outlook for access to clean cooking.** According to IEA's Stated Policies Scenario, over 1.9 billion people globally would continue to rely on traditional uses of biomass, kerosene, or coal for cooking in 2030 in the absence of additional policies and measures. This reliance on polluting fuels will have dramatic consequences for the environment, economic development, and health, especially of women and children. Similarly to electricity access, clean cooking has seen limited progress due to rising energy prices, especially increases in the costs of liquefied petroleum gas (LPG) cylinders, which drove millions in Africa and Asia to revert to traditional fuels for cooking. Achieving universal access to clean cooking by 2030 requires tackling affordability and cultural barriers, as well as administrative and infrastructure barriers, although technologies to help achieve the goal are widely available. Meanwhile only one-third of the countries facing a lack of access to clean cooking have dedicated programs and policies. Sub-Saharan Africa lags behind other regions in this regard.

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74 The majority of this chapter is based on results from IEA's World Energy Model and analysis in the World Energy Outlook (IEA 2022a), and thus uses certain geographical groupings used in the Outlook. "Developing Asia" refers to non-OECD (Organisation for Economic Co-operation and Development) Asia countries.

- **Outlook for renewable energy.** Several governments announced new policy packages that include substantial support for renewable energy. These contribute to the share of modern renewables in the total final energy consumption (TFEC) increasing from 12 percent in 2021 to 18 percent under IEA's Stated Policies Scenario and 16 percent in IRENA's Planned Energy Scenario by 2030. Under both scenarios, the majority of the growth in renewables-based electricity generation by 2030 is due to solar photovoltaic (PV) and wind. Although the renewable energy target under SDG 7 is not quantified, stated policies are inadequate to remain on track for achieving net-zero emissions in energy by 2050, consistent with the global objective to limit end-of-century warming to 1.5°C. IEA's Net Zero Emissions by 2050 Scenario shows that by 2030, there should be 33 percent modern renewables in TFEC. In the power sector, renewables would need to account for over 60 percent of electricity generation by 2030. Under IRENA's 1.5°C Scenario, the renewables share in TFEC and electricity generation would reach 38 percent and 65 percent respectively, by 2030. Greater efforts are also needed to increase renewables penetration in transport and heating, both directly (through the use of biofuels and biogas) and indirectly (through electrification). There are three times as many countries with renewable electricity targets as there are with renewable heat targets, even though the second group has a considerable share in TFEC.[75]
- **Outlook for energy efficiency.** Energy intensity —total energy supply per unit of gross domestic product (GDP)— is expected to decrease by 2 percent in 2022 after two years of slow progress during the pandemic. Surging energy costs and supply disruptions amid the energy crisis have led governments and consumers to specifically focus on improving efficiency. There has been an increase in government efforts to incentivize efficiency, including incentives for building retrofits, strengthened efficiency standards for buildings and appliances, notably, to move away from natural gas for heating, support for electric vehicles, and incentives for behavior changes to reduce energy use. These efforts are reflected under IEA's Stated Policies Scenario, according to which global energy intensity improves at 2.4 percent annually in 2021–30 from 1.8 percent in 2010–20. However, global energy intensity would need to improve at more than 3.4 percent annually to achieve SDG 7 by 2030. Under IEA's Net Zero Emissions by 2050 Scenario, this rate would increase to well over 4 percent a year, reflecting more aggressive efficiency mandates, including bans on the sale of the most inefficient equipment in the coming decade and codes mandating new buildings reach net-zero standards. Under IRENA's 1.5°C Scenario, energy intensity would need to improve at over 3 percent per year in 2020–30.
- **Investment needs.** Annual clean energy investments in renewable power, renewable fuels, efficiency, end-use electrification, and grids and networks, as well as access to modern energy, reached almost USD 1.2 trillion in 2021, a 15 percent growth as compared with the 2015–20 average. By 2030, annual clean energy investments under IEA's Stated Policies Scenario are expected to reach USD 2 trillion annually. However, clean energy investments would need to reach USD 4 trillion annually by 2030 under IEA's Net Zero Emissions by 2050 Scenario. Much of this investment is directed to renewables and efficiency. Reaching universal energy access by 2030 requires only a small share of this total, with annual investments of approximately USD 30 billion in electricity and USD 6 billion in clean cooking, according to IEA's Net Zero Emissions by 2050 Scenario. Under IRENA's 1.5°C Scenario, investments in energy transition technologies and related infrastructure amount to USD 4.7 trillion a year through 2030, a 150 percent increase in these types of investments compared with the Planned Energy Scenario.
- **Energy projects addressing SDG 7, specifically access, still have insufficient public financing to mobilize the larger volumes of investment required to reach SDG 7.** International public finance to support developing economies needs to increase. Key areas for action, especially in emerging and developing economies, include improving models of concessional finance to derisk further investment and mobilizing more private capital into climate solutions. (Chapter 5 discusses in more detail trends in international public financial flows in support of clean energy in developing countries and key areas for action.)

75 "Heat" in this chapter refers to the energy consumed to produce heat for industry, buildings, and other sectors. Heat as a final energy service refers to the energy available to end users to satisfy their needs, after considering transformation losses.

Presentation of Scenarios

This chapter describes the results of global modeling exercises to determine whether current policy ambitions are sufficient to meet the SDG 7 targets and identify what additional actions might be needed. It also examines what investments are required to achieve the corresponding goals. Scenarios for the targets are taken from IEA's World Energy Outlook (IEA 2022a) and IRENA's World Energy Transitions Outlook: 1.5°C Scenario (IRENA 2022). Both explore two types of scenarios: one in which energy trends evolve under today's policies and another based on policies that would deliver on all energy-related SDGs, including substantially reducing air pollution that causes deaths and illness (SDG 3.9) and taking effective action to combat climate change (SDG 13). The wide gap between the two types of scenarios is illustrated in box 6.1 (using the IEA scenarios).

IEA's Stated Policies Scenario explores how energy trends would evolve under today's policies; it does so assuming that no additional policies are implemented. It helps policy makers evaluate their current plans in order to assess whether they are sufficient to reach their long-term targets and goals. This scenario does not take countries' decarbonization pledges, Nationally Determined Contributions, or access targets as givens, but conducts bottom-up modeling that considers how policies, pricing policies, efficiency standards and schemes, electrification programs, and specific infrastructure projects would influence energy trends.

IEA's Net Zero Emissions by 2050 Scenario takes the SDG targets for 2030 and net-zero emissions in the energy sector by 2050 as its targets and works backward to determine what would be needed to achieve the outcomes in a cost-effective and plausible manner.[76] Under this scenario, by 2030, universal access to both electricity and clean cooking would be achieved, modern renewables would reach 32 percent of TFEC, and energy efficiency gains would exceed the SDG 7 targets, with average annual improvements in global energy intensity reaching 4.3 percent a year between 2021 and 2030. After this critical near-term period, the scenario emphasizes efficiency, renewables, and clean fuels, bringing energy sector emissions to net zero by 2050 and limiting the end-of-century global temperature increase to 1.5°C over preindustrial levels.

IRENA's Planned Energy Scenario provides a perspective on energy system development based on governments' energy plans and other planned targets and policies. IRENA's 1.5°C Scenario describes an energy transition pathway aimed at limiting global average temperature increase to 1.5°C by the end of the 21st century relative to preindustrial levels. It is underpinned by six technological avenues and measures that would achieve major emissions reductions between today and 2050, paving the way toward a net-zero carbon world by mid-century. The scenario also provides insights into the socioeconomic footprint of the global energy transition.

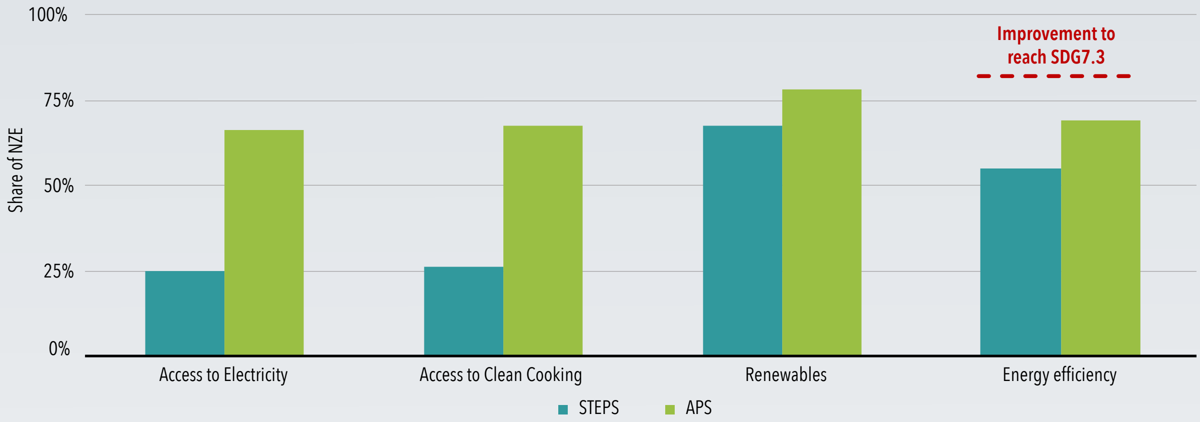
76 More information on IEA's Net Zero Emissions by 2050 Scenario can be found at https://www.iea.org/reports/world-energy-model/net-zero-emissions-by-2050-scenario-nze.

Box 6.1 • IEA's Announced Pledges Scenario: How government ambitions stand against SDG 7

IEA's Announced Pledges Scenario assumes that all aspirational targets announced by governments are met on time and in full, including their long-term net-zero pledges and energy-access goals.

Assuming all countries fulfilled their national climate and access pledges, the world would progress about two-thirds of the way toward achieving SDG targets 7.1 and 7.3, and 80 percent of the way toward meeting SDG target 7.2 for renewables. Comparing this trajectory to the Stated Policies Scenario highlights a growing implementation gap requiring further policies and measures by countries to reach their goals, especially for access (figure B6.1.1).

Figure B6.1.1 • Level of advancement over SDG 7 by scenario as a percentage share of the Net Zero Emissions by 2050 Scenario, 2030



Source: IEA 2022[a].
Notes: Hundred percent advancement is achieved under the Net Zero Emissions by 2050 Scenario, which is consistent with and more ambitious than SDG 7. For access to electricity and clean cooking, the level of advancement is assessed as the number of people gaining access by 2030. For SDG target 7.2 (renewables), this is assessed as the share of renewables in TES. For SDG target 7.3 (energy efficiency), this is assessed as the average annual decrease of energy intensity.
APS = Announced Pledges Scenario; NZE = Net Zero Emissions by 2050 Scenario; STEPS = Stated Policies Scenario.

Of the 113 countries without universal access to electricity, only 25 have targets to reach universal access prior to or by 2030, while 29 have less ambitious targets. This leaves 59 countries without electricity access targets. Under the Announced Pledges Scenario, only two-thirds of the population still lacking access to electricity by 2030 receive it. This translates into 290 million people without access in 2030—less than half the number under the Stated Policies Scenario (660 million).

About 30 percent of countries without universal access to clean cooking have targets in place today, although only 15 percent have targets in line with SDG target 7.1. If all these targets, as stated under the Announced Pledges Scenario, are achieved, 780 million people would still be without electricity access in 2030, 60 percent less than under the Stated Policies Scenario.

Under the Announced Pledges Scenario, the share of renewables in total final energy consumption would reach 26 percent by 2030—as against 33.6 percent under the Net Zero Emissions by 2050 Scenario, but still higher than the 22.7 percent under the Stated Policies Scenario. SDG 7 has a target for substantially increasing renewables' share in the global energy mix. Significant advancement in this regard is achieved under both scenarios, highlighting current focus on related technologies.

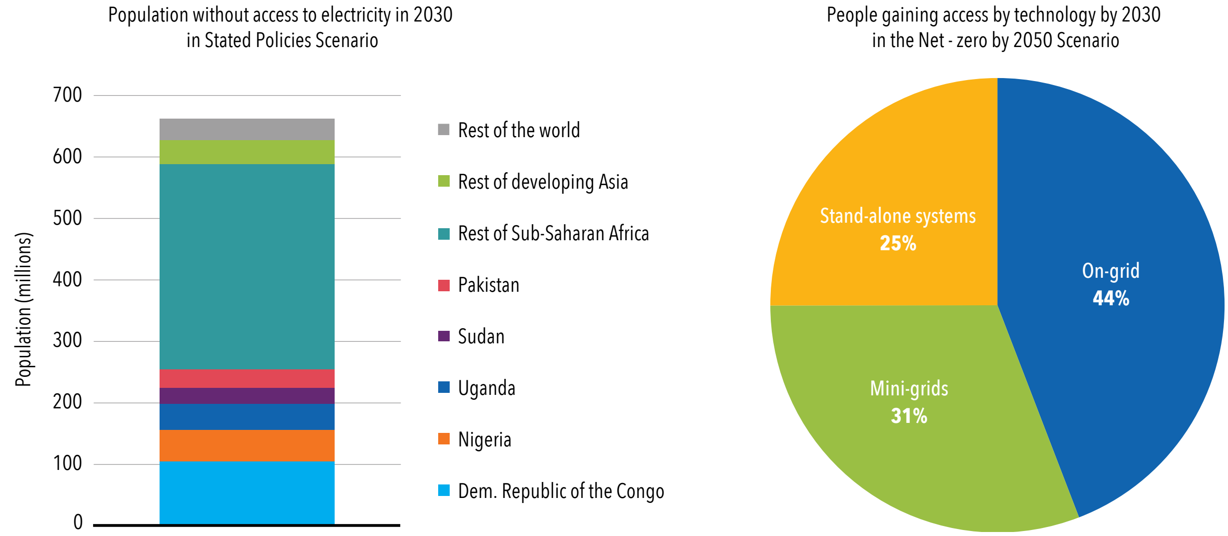
Energy intensity under the Announced Pledges Scenario would improve on average by 3 percent every year by 2030—a significant improvement as compared with the Stated Policies Scenario (2.4 percent) but still below the 3.4 percent required to meet SDG target 7.3. Under the Net Zero Emissions by 2050 Scenario, energy intensity improves 4.3 percent on average yearly, which is more ambitious than SDG target 7.3.

Outlook for Access to Electricity

IEA estimated that the number of people without electricity access global likely increased in 2022, reversing decades of decreasing trend. This increase is largely in Sub-Saharan Africa, due to reasons including supply chain disruptions and the energy crisis causing rising inflation levels and interest rates following two years of the COVID-19 pandemic. Effects included higher costs for electricity systems (e.g., according to GOGLA, solar home systems prices increased 28–36 percent between 2020 and 2022 [Lighting Global/ESMAP and others 2022]) and for financing new electrification projects, and, at the same time, a drastic increase in the number of people in extreme poverty (World Bank 2023), making it more challenging to acquire and maintain access to electricity. Investment in power infrastructures is also slowing down due to the rising debts that most utilities were already facing (IEA 2022[a]).

In the medium and long term, access to electricity is expected to improve through 2030, after the situation has stabilized. Trends vary significantly across countries, many of which will not reach universal access by 2030 under current conditions. Under the Stated Policies Scenario, 660 million people (roughly 8 percent of the global population) would remain without access by 2030, 85 percent of whom are in Sub-Saharan Africa (figure 6.1). Less than half of the countries without universal access to electricity have official targets, and only about 22 percent have targets at least as ambitious as SDG indicator 7.1.1 (see box 6.1). Countries without electrification plans and enabling frameworks are not on target. However, SDG target 7.1.1 remains within reach in countries with adequate policies, holistic electrification plans, including both grid and off-grid solutions, and sufficiently resourced implementing institutions. The IEA's Net Zero Emissions by 2050 scenario shows a pathway to achieve SDG7.1.1 where more than half of the population gaining access by 2050 do so with off-grid solutions such as mini-grids and stand-alone systems.

Figure 6.1 • Global population without access to electricity under IEA's Stated Policies Scenario and delivery of electricity connections under IEA's Net Zero Emissions by 2050 Scenario, as of 2030



Source: IEA 2022[a].

Developing (non-OECD) Asia remains on track to reach near-universal access, with only 2 percent of the population without electricity in 2030. According to IEA's Stated Policies Scenario, the highly populated countries of Bangladesh and the Philippines are on a pathway to reach full access before 2030, whereas India and Indonesia already reached universal access. IEA's Stated Policies Scenario shows that efforts need to be stepped up in other Asian countries, such as Afghanistan, Mongolia, and Pakistan, if the region is to achieve 100 percent access in 2030. In Central and South

America, only the most remote population will remain without access by 2030, with the region reaching an access rate of 98 percent. The only exception is Haiti, one of the poorest countries in the world, which is expected to still see a large share of its population without access in 2030.

Besides improvements in policies and electrification plans in some Sub-Saharan African countries, the prospects for achieving SDG 7.1.1 remain unlikely; about 40 percent of countries do not have official electrification plans or track progress periodically.

Access to finance is often more challenging for countries that have the greatest need to improve access quickly. International support is essential especially under the current economic conditions, with concessional finance being a viable option to lower the perceived risk for private investors. However, country governments must implement robust electrification plans and allocate capital to access projects accordingly (IEA 2022[a]).

IEA's Net Zero Emissions by 2050 Scenario indicates that almost 90 percent of new connections will be renewables-based. Although the component costs for solar and hybrid mini-grids, as well as solar home systems, increased between 20 and 36 percent in 2022, their costs are likely to begin declining in the near future.

To bridge the gap and achieve universal access by 2030, 110 million people must gain access to electricity on average every year between 2021 and 2030—80 percent of whom in Sub-Saharan Africa. Efforts needs to be increased especially in the Democratic Republic of Congo, Niger, Nigeria, Sudan, Tanzania, and Uganda, which together are home to half of the region's population projected to lack access in 2030.

Delivery technology varies by region under IEA's Net Zero Emissions by 2050 Scenario. In Sub-Saharan Africa, 42 percent of connections by 2030 would be directly to the grid, 31 percent would be connected to mini-grids, and the remainder would be stand-alone systems (mostly solar home systems). In Developing Asia, just over half of new connections would be directly to the grid, and almost a third would be connected to mini-grids.

IEA's Net Zero Emissions by 2050 Scenario proposes a sustainable pathway to achieve universal access to electricity by 2030. However, this implies that governments and donors increase the access focus of development plans and programs. This includes addressing affordability issues (which remain the primary reason behind people not getting electricity access or not benefiting from it), supporting the stand-alone and mini-grid sectors, implementing tracking and monitoring, and use of geospatial data and models as the basis for electrification planning, and, finally yet importantly, creating and providing resources to entities in charge of implementing these plans. Low-capacity off-grid energy solutions, such as small off-grid solar systems, will play an important role, particularly in reaching households in remote areas, but planning must include a strategy to support these households to benefit from energy services by stimulating household and productive uses demand and so gradually extending access through the use of bigger systems or connections to mini-grids or the national grid.

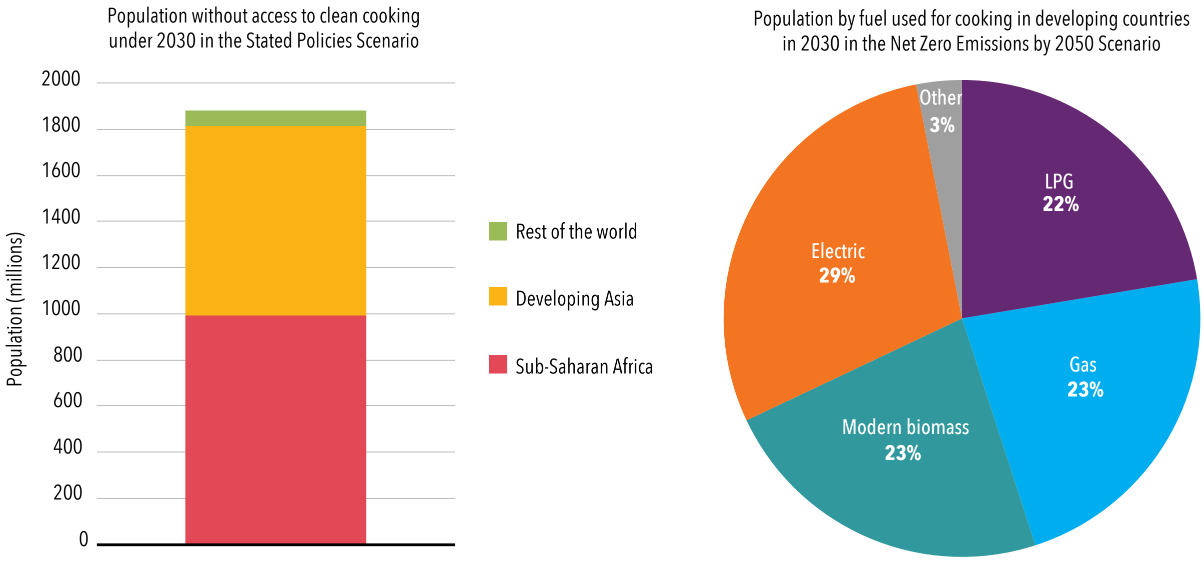
SDG 7.1.1 is achievable in theory with strong electrification plans. Between 2015 and 2019, seven countries in Sub-Saharan Africa (e.g., Côte d'Ivoire, Gambia, Kenya, and Rwanda) reached or surpassed the required progress levels. However, in 22 other countries, representing more than half the population without access in the region (including Chad, the Democratic Republic of Congo, Madagascar, Malawi, Mozambique, and Niger), there has been an increase in the number of people without access in the same period (IEA 2022b). Many of the successful electrification plans aim to maximize the benefits of energy access by considering the needs of health facilities, schools, agricultural enterprises, and similar organizations alongside those of households. Under the Net Zero Emissions by 2050 Scenario, achieving universal access to electricity by 2030 requires an annual investment of USD 30 billion through 2030 on generation, electricity networks, and decentralized solutions through smart and efficient integrated delivery programs. However, in 2019, only approximately USD 10 billion were spent on improving electricity access globally. Recent trends reveal an increase in domestic public financing, which is helping mobilize more private finance (SEforALL 2021). Ultimately, energy access must look beyond basic access to electricity and facilitate the increasing use of energy services sufficient to underpin socioeconomic prosperity and well-being, as also illustrated by the World Bank Multi-Tier Framework.

Outlook for Access to Clean Cooking Fuels and Technologies

Recent decades saw a decline in the number of people without access to clean cooking globally. This decline reflects efforts to reduce the reliance on biomass among vulnerable populations, with the aim of improving indoor air quality, at the same time reducing the time spent gathering fuel, and curbing deforestation and greenhouse gas emissions from the incomplete combustion of biomass. Forest degradation, sometimes leading to outright deforestation, is yet another grave consequence of the unsustainable harvesting of fuelwood, chiefly for producing charcoal, to be used in cities.

Progress has been uneven and was primarily driven by countries in Asia (e.g., China, India, Indonesia, and so on), whereas Sub-Saharan Africa saw a continued increase in the number of people without access to clean cooking. The current energy crisis and the related inflationary environment in the wake of the COVID-19 pandemic have exposed consumers to a dual threat of reduced income and higher prices of clean cooking fuel (e.g., LPG). Some countries have implemented policies to counter this trend, although millions, especially in Sub-Saharan Africa, have reverted to traditional uses of biomass. This led improvements to slow down between 2020 and 2022. Although progress is expected to return to historical levels in certain regions, the outlook for clean cooking remains of serious concern: under today's policies, the world would be far from achieving universal access to clean cooking solutions by 2030, with 1.9 billion people still without access (figure 6.2).

Figure 6.2 • Population without modern cooking solutions in 2030 and population with clean cooking technologies under IEA's Net Zero Emissions by 2050 Scenario



Source: IEA 2022[a].
Note: The number of people without access to clean cooking in 2030 is significantly lower than that in previous editions of the World Energy Outlook. This is due to a downward revision in the historic number of people cooking with traditional biomass in China. This revision by the World Health Organization is based on recent surveys.
LPG = liquefied petroleum gas.

In 2030, the population without access to clean cooking solutions is projected to be divided almost equally between Developing Asia and Sub-Saharan Africa. In Developing Asia, the projected access rate in 2030 is 81 percent, leaving 821 million people without access. Significant progress is projected for India, where the number of people without access is expected to reduce from 504 million in 2022 to 323 million in 2030, indicating an access rate of 80 percent from the current rate of approximately 68 percent.

To achieve the objective of the Net Zero Emissions by 2050 Scenario in line with SDG 7, every household in the world would have access to clean cooking by 2030. To do that a set of different clean cooking technologies and fuels needs to be deployed (figure 6.2). A significant increase in policies and investments will be required to support the above achievement, which would provide over 290 million people with access to clean cooking solutions each year.

Achieving the objective of the Net Zero Emissions by 2050 Scenario and SDG 7.1.2 would require rapid ramp-up of access programs to reduce the upfront cost of stoves while ensuring affordability of clean cooking fuels, train people to use new cooking equipment safely and effectively, and deliver awareness programs (e.g., cooking classes or recipes that help adapt culinary practices to improved cookstoves). Supporting infrastructure (e.g., fuel delivery and storage systems, a stable supply chain of cooking equipment within the country, and workers to help administer the above programs) also needs to be ramped up (IEA 2021) to ensure accessibility and sustainably of supply. Many regions have scalable LPG solutions but lack consistently available fuel distribution services; also, LPG remains exposed to market prices, leaving users vulnerable to price spikes without government intervention. Alternative fuels for cooking, such as biogas, must also play a role in rural areas, but biodigesters to produce biogas require support to cover the high upfront cost, the availability of sufficient feedstock, and training on their use and maintenance. Electric cooking appliances such as microwaves or electric pressure cookers represent an increasingly popular mode of clean cooking, particularly in urban areas and areas powered with grid electricity. A World Bank report, for example, compared the cost of cooking with electricity with cooking with other fuels in Kenya (ESMAP 2020). At the time of publication, in September 2020, electric stoves were found to be only marginally more expensive than LPG stoves. However, with current surges in LPG prices and advances in electric stoves, electric cooking will continue to be increasingly attractive.

In some countries, utilities and off-grid solution providers offer all-electric cooking bundles and programs, since increasing electric cooking can increase the profitability of providing electricity access. Improved biomass stoves (ISO Tier > 1) are of fundamental importance to reach SDG 7.1.2, especially in rural areas, and fuels such as ethanol can help cover gaps in certain regions. Reaching universal access to clean cooking by 2030 requires an all-solutions approach to meet the diverse needs in different countries and in rural and urban environments.

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, long-term scenarios charting various paths for the energy sector to reach net zero by 2050 find that renewables would need to constitute a third of TFEC by 2030 to be on track.

Despite the impact of the current energy crisis and the COVID-19 pandemic on supply chains and components costs, the outlook for renewables under IEA's Stated Policies Scenario and IRENA's Planned Energy Scenario remains positive in all regions, due to supportive policies. Under IEA's Stated Policies Scenario, the share of all renewables (including traditional uses of biomass) in TFEC is projected to increase from 18.5 percent in 2021 to 23 percent in 2030, and the share of modern renewables is projected to increase from 12 percent in 2021 to 18 percent in 2030. These projections are higher than in previous outlooks because many countries accelerated renewable energy projects as part of their plans to increase energy security amid the current energy crisis. By contrast, IRENA's Planned Energy Scenario sees the share of modern renewables in TFEC increasing to 16 percent in 2030, due to much wider deployment of renewables in the power sector and in end-use electrification.

Power-sector renewables remain the fastest-growing source of energy globally. Renewable sources of electricity remained resilient during the recent crisis period, experiencing only minor setbacks. Besides short-term concerns about supply chains, renewables annual capacity additions in 2021–30 are poised to more than double the 2015–20 trends, thanks to increased government plans to expand renewables projects. This growth will be driven by solar PV and wind. By 2025, renewables will surpass coal as the primary means of producing electricity. Of the renewable sources of electricity, solar PV would be the strongest performer, meeting almost half (46 percent) of the increased electricity demand over the period. It is closely followed by wind (42 percent). Hydropower would remain the largest low-emission source of electricity globally through 2030. It would also provide flexibility and other power system services.

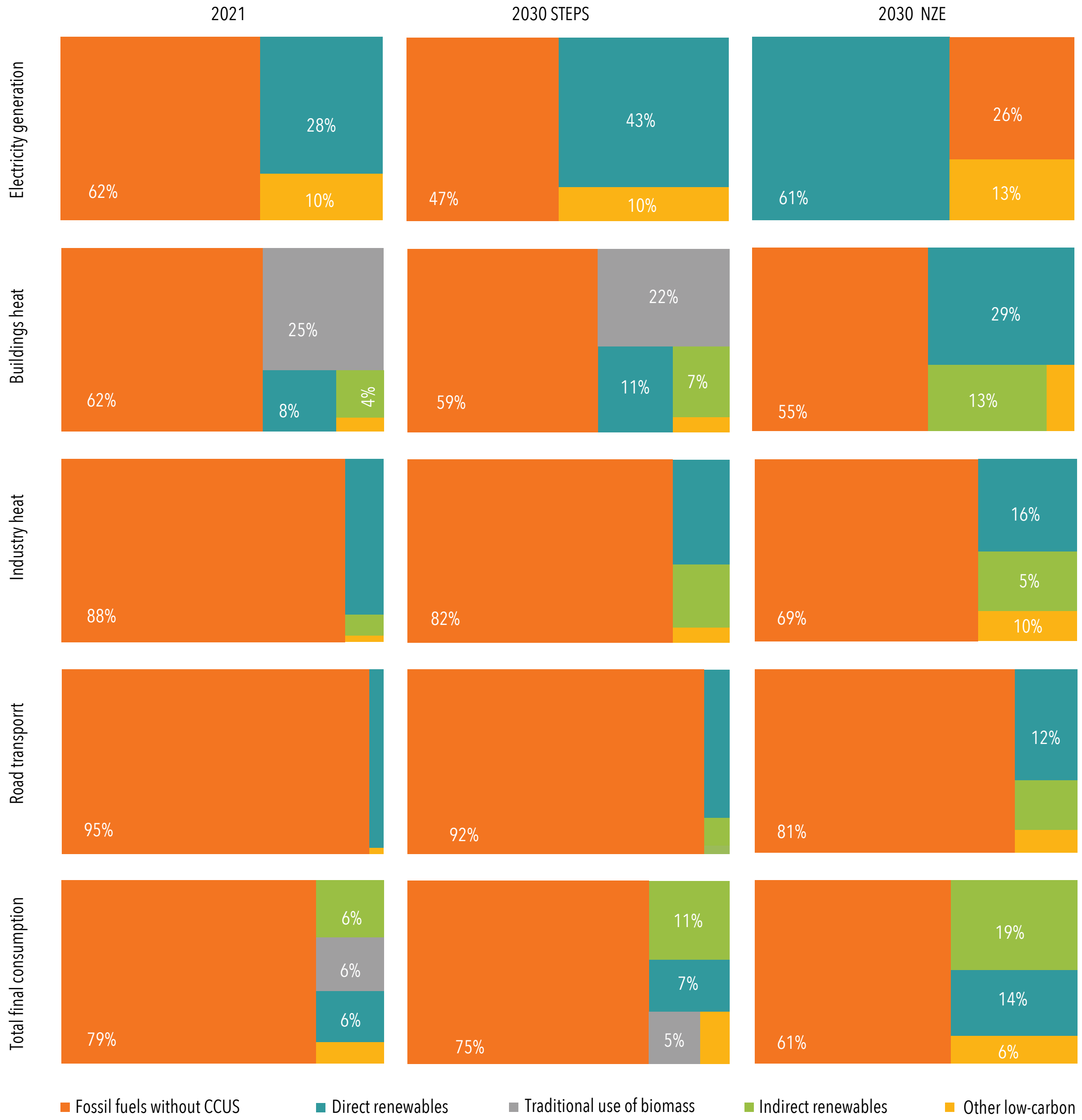
Direct uses of renewables have grown steadily but slowly in end-use sectors. Modern bioenergy would account for the largest share of growth in end-use renewables through 2030. In the transport sector, liquid biofuels see strong growth, although their use will be limited if new blending requirements are not adopted in places where they do not currently exist. The transport sector would also see increased use of electricity, which will result from electromobility leveraging the increasing renewables share in the mix. The use of renewables also increases for heating in the industry and buildings sectors, with modern bioenergy accounting for the largest share of the growth, driven by renewables requirements in Europe and some pilots in China. There is also an increase in the demand for biogas and modern biomass for heating, driven by growth in industry (IEA 2022[a]).

The outlook for growth for end-use renewables depends to a large extent on further policy action at a time of economic difficulty and competing budgetary pressures. There is a risk that some targets may not be enforced, but end-use renewables can be a part of the toolkit for improving energy security especially when they are sourced locally. Supportive policies may play an important role in new policy packages, especially for transport biofuels, which would support agricultural production as well as emissions reductions.

INSIGHTS ON BRIDGING THE GAP FROM IEA'S NET ZERO EMISSIONS BY 2050 SCENARIO

The projected increases in the use of renewable energy that are likely to occur under stated policies fall short of what is required to achieve global goals for climate protection and sustainable development. Under IEA's Net Zero Emissions by 2050 Scenario, use of renewables increases twice as rapidly as under stated policies. Under this more ambitious scenario, modern renewables would reach just over one-third of TFEC in 2030 (figure 6.3).

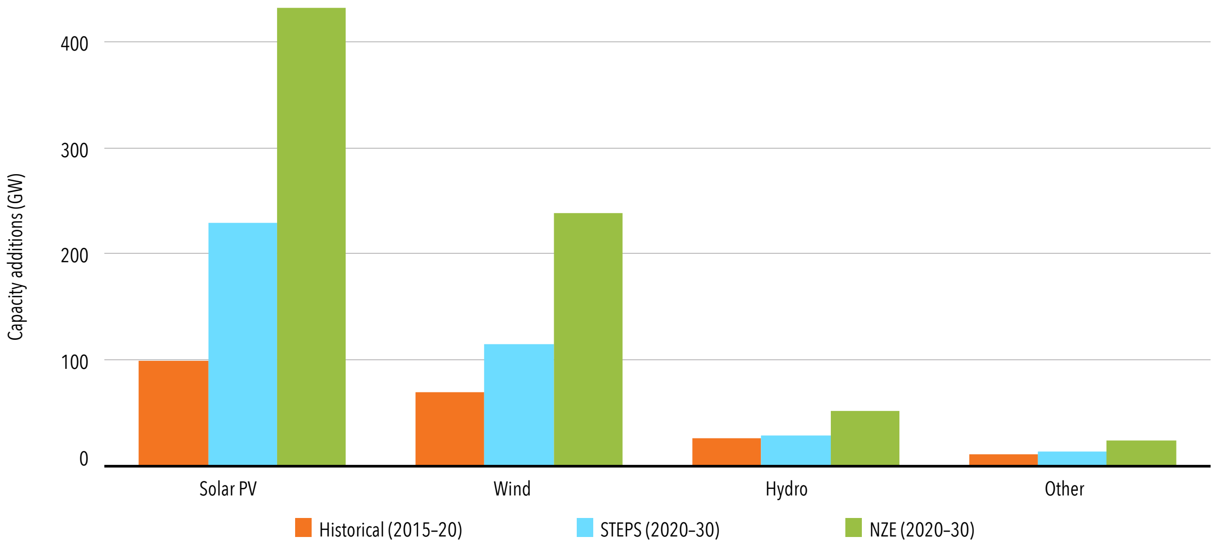
Figure 6.3 • Share of renewables in total final energy consumption under IEA's Net Zero Emissions by 2050 Scenario, 2010–30



Source: IEA 2022[a].
CCUS = carbon capture, utilization, and storage; NZE = Net Zero Emissions by 2050 Scenario; STEPS = Stated Policies Scenario.

As can be seen in figure 6.3, the share of renewables-based electricity generation would grow the fastest: from the current 28 percent to just over 60 percent by 2030, or almost 18 percentage points higher than in the Stated Policies Scenario. Globally, renewables-based electricity generation would grow 12 percent a year to approximately 23,065 terawatt-hours (TWh) by 2030. This would result from unprecedented capacity additions of solar PV and wind, reaching annual averages of, respectively, 430 gigawatts (GW) and 240 GW between 2021 and 2030 (figure 6.4). Annual investment in renewables-based power would triple over the decade to over USD 1.2 trillion a year by 2030; this would be supported by additional spending on expanding and modernizing electricity networks and battery storage and enhancing the operational flexibility of existing assets to better integrate renewables.

Figure 6.4 • Technology-based comparison of average annual renewables-based electricity capacity additions under IEA's Net Zero Emissions by 2050 Scenario and the Stated Policies Scenario



Source: IEA 2022[a].
GW = gigawatt; NZE = Net Zero Emissions by 2050 Scenario; PV = photovoltaic; STEPS = Stated Policies Scenario.

Under IEA's Net Zero Emissions by 2050 Scenario, increased electrification of energy end uses is a primary means to increase renewables' share in TFEC. The share of electricity in final energy demand would increase to 31 percent by 2030, compared with about 24 percent under the Stated Policies Scenario. Electrification of transport and heat would be the primary drivers of this growth.

Direct use of renewables, principally liquid biofuels, would account for, on average, 12 percent of road transport fuel; combined with growing electrification, the share of renewables in transport would increase to nearly 17 percent by 2030 (IEA 2022[a]).

The use of renewables for heat applies to space and water heating, cooking, industrial processes, and other uses. The heat can be provided directly by bioenergy, solar thermal, or geothermal or indirectly through electricity and district heat produced from renewable sources. Switching to direct use of renewables—through use of solar thermal water heating, biomass, and low-carbon gases, for example—would also reduce the use of fossil fuels. In 2021, renewables accounted for 9 percent of the total energy consumed for heating worldwide. By 2030, this share would increase to 20 percent under the Net Zero Emissions by 2050 Scenario.

The share of traditional uses of biomass in TFEC would decline to 5 percent by 2030 under the Stated Policies Scenario marking only a 1 percentage point decrease from 2021 levels and due to low achievements in clean cooking access. Under the Net Zero Emissions by 2050 Scenario, traditional uses of biomass would be phased out completely, since developing countries would replace them with more modern and efficient fuels and technologies.

Across regions, variations in energy policy, socioeconomic trends, and natural resource endowments result in different growth trajectories for renewables. Developing economies would account for over 80 percent of the growth in electricity generation through 2030 under the Stated Policies and almost 90 percent of this growth in the Net Zero Emissions by 2050 Scenario. Under the Stated Policies Scenario, renewables-based electricity generation would grow from 10 percent in the Middle East and 16 percent in Northern Africa, at the low end, to over 80 percent in Central and South America, where hydropower is the backbone of the power mix. Under the Net Zero Emissions by 2050 Scenario, the share of renewable electricity generation would increase in every region, approaching or surpassing half of all electricity generation by 2030 in many regions.

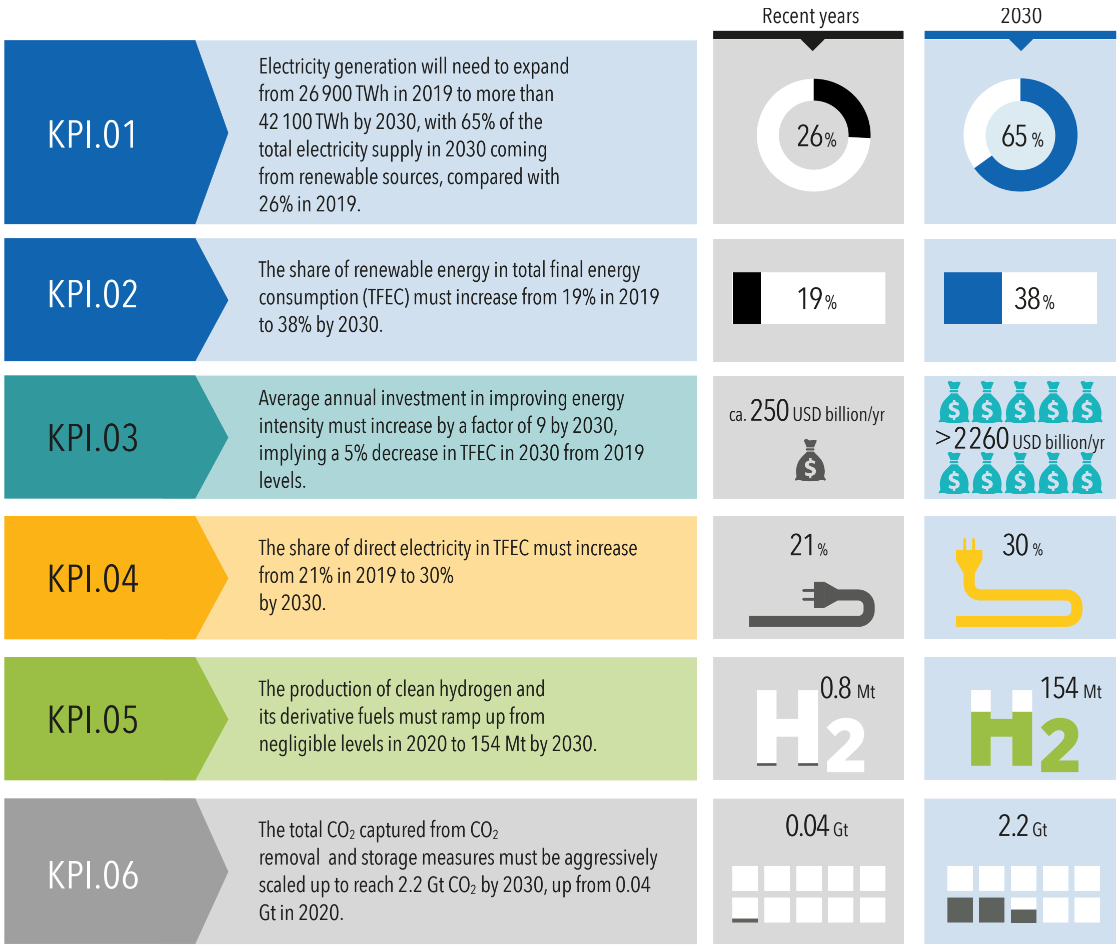
IEA's Net Zero Emissions by 2050 Scenario sees the supply of low-emissions hydrogen[77] increasing from 0.3 million metric tons (Mt) today to 90 Mt in 2030 and 450 Mt in 2050, reaching 10 percent of TFEC. Achieving net-zero emissions by 2050 would also require carbon-capture technologies. Under the Net Zero Emissions by 2050 Scenario, carbon dioxide (CO2) captured using carbon capture, utilization, and storage, as well as CO2 removal (CDR) technologies, would amount to just above 1.2 metric gigatons (Gt) in 2030, excluding nature-based measures.

INSIGHTS ON BRIDGING THE GAP FROM IRENA'S 1.5°C SCENARIO

IRENA's 1.5°C Scenario requires a significant scale-up of renewable energy and energy-efficient solutions but also other energy transition technologies and related infrastructure. It entails a transformation of how societies consume and produce energy. The decade to 2030 will be crucial for scaling up no-regret options. IRENA's 1.5°C Scenario details six key performance indicator categories, which provide a broad overview of the required level of transition (figure 6.5). This includes scaling the renewable energy share in TFEC to 28 percent and in electricity generation to 65 percent by 2030, with a corresponding increase in the share of energy supplied from electricity to 30 percent. Investments in improving energy efficiency need to increase by a factor of 9. Clean hydrogen production would need to increase to over 150 Mt by 2030. Finally, some investment in CDR technologies will also be required, namely, in hard-to-decarbonize sectors, such as industry.

77 Low-emissions hydrogen refers to hydrogen that is produced from water using renewables- or nuclear-based electricity or derived from fossil fuels with minimal methane emissions and processed in facilities equipped to avoid CO2 emissions, for example, using carbon capture, utilization, and storage technologies with a high capture rate. Low-emissions hydrogen is also derived from bioenergy. In this report, the total demand for low-emissions hydrogen is greater than the total final consumption of hydrogen, because the former additionally includes hydrogen inputs to produce low-emissions hydrogen-based fuels and biofuels, and generate power, and also for oil refining, and for producing hydrogen and consumed on-site in industry.

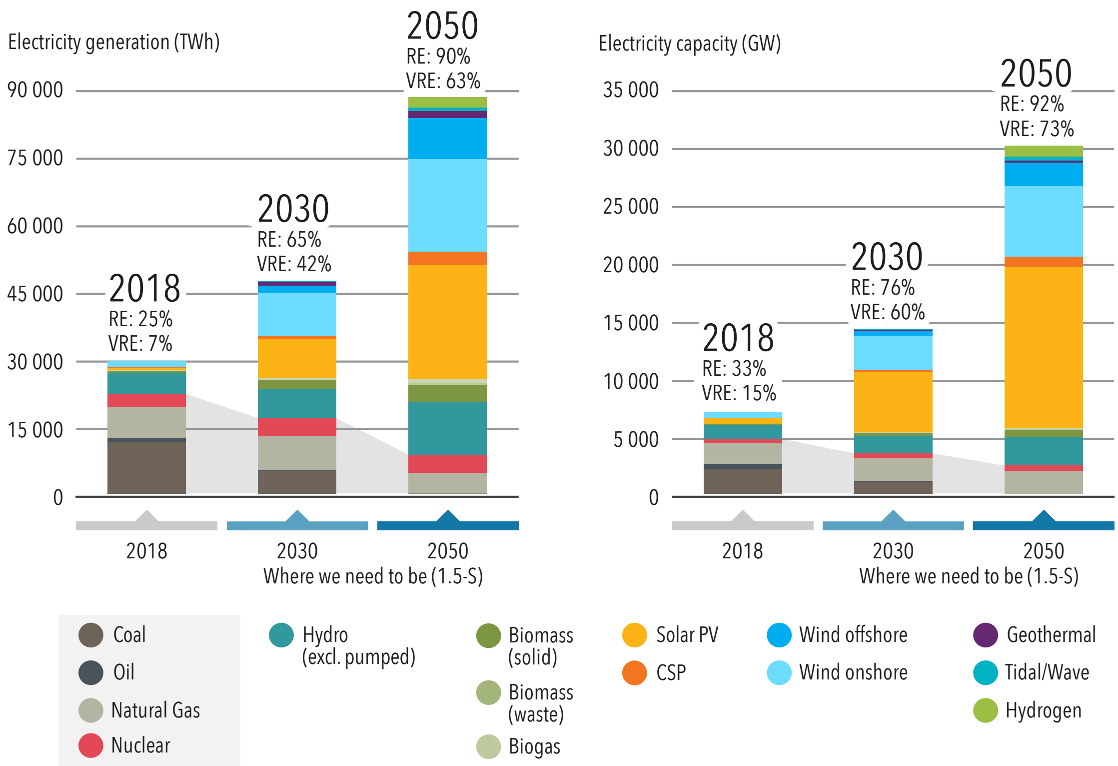
Figure 6.5 • Key performance indicators for IRENA's 1.5°C Scenario in 2030



Source: IRENA 2022.
CO_2 = carbon dioxide; Gt = metric gigaton; KPI = key performance indicator; Mt = million metric tons; TWh = terawatt-hour.

Advancing the energy transition at the needed pace and scale would require almost complete decarbonization of the electricity sector by mid-century. Under the 1.5°C Scenario, rapid electrification of heat and transport applications along with the increased green hydrogen production would drive a significant growth in electricity demand. By 2030, renewables would supply 65 percent of the total electricity needs (figure 6.6). Such a transition in the global electricity sector could be realized by accelerating the deployment of all forms of renewable power technologies, including wind (onshore and offshore), solar PV, hydro, biomass, and geothermal. At the same time, additional flexibility in the power sector will be required. Although the types of technologies and solutions are specific to power systems, key technologies include storage, greater interconnection, market and regulatory reforms, and demand response, among many others.

Figure 6.6 • Electricity generation and capacity by source in 2018, 2030, and 2050 under IRENA's 1.5°C Scenario



Source: IRENA 2022.
1.5-S = 1.5°C Scenario; CSP = concentrated solar power; GW = gigawatt; PV = photovoltaics; RE = renewable energy; TWh = terawatt-hour; VRE = variable renewable energy.

Direct electricity consumption in end-use sectors would increase to 31,000 TWh by 2030, compared with approximately 23,000 TWh in 2020. This increase in electricity demand will be seen across all sectors, even though transport will by far see the largest growth. In addition to the rapid growth in direct electrification needs, 3,100 TWh would be needed to produce green hydrogen by 2030. In total, direct and indirect electrification would have a 32 percent share in the final demand in 2030, an increase from approximately 21 percent in 2020.

Under the 1.5°C Scenario, the transport sector, and in particular road vehicles, would see rapid transition over the decade. The stock of electric cars would grow from 26 million in 2022 (estimated) to over 380 million by 2030. The share of electricity in final transport energy consumption would grow from 1 percent in 2020 to over 9 percent by 2030.

Direct uses of renewables (e.g., bioenergy, solar thermal, and geothermal) are needed to bring much-needed solutions to hard-to-electrify energy services in the transport, buildings, and industry sectors. Under the 1.5°C Scenario, direct uses of renewable fuels in final energy would need to grow to 55 exajoules (EJ) in 2030, up from 45 EJ in 2020.

Under IRENA's 1.5°C Scenario, clean hydrogen production would grow from under 1 million metric tons today to 154 million metric tons by 2030.[78] This hydrogen would largely be used in industrial applications in the corresponding decade, although a small quantity would be used in the transport and buildings sectors.

78 Clean hydrogen here refers to the combination of hydrogen produced by electrolysis powered from renewables (green hydrogen) and hydrogen produced from natural gas in combination with carbon capture and storage by steam methane reforming (blue hydrogen).

Box 6.2 • Linkages between SDG 7 and SDG 12: Circular economy and end-of-life management for solar photovoltaic (PV) technologies

Solar PV is expected to play a pivotal role in energy transitions and support progress toward SDG 7 and SDG 13 on climate change, as highlighted in this section. However, solar PV modules currently have an estimated average service lifetime of 25–30 years, after which their performance can deteriorate and they can be prone to failure. Increasing quantities of solar PV equipment will thus reach the end of their lifetime in upcoming years: according to IRENA's estimates, following a pathway compatible with the 1.5°C Scenario, cumulative solar PV waste would exceed 3.9 million metric tons by 2030 and could reach more than 212 million metric tons globally by 2050 (IRENA 2023).

In line with SDG 12 ("responsible consumption and production"), these end-of-life flows of solar PV equipment need to be managed proactively with a circular economy perspective.[a] In this light, solar PV design and manufacturing based on circular approaches through reduced requirement of toxic and critical material and increased durability, performance, and recyclability of PV panels, as well as reuse of PV modules and components, can reduce material flows and relevant impacts on the environment. Moreover, the benefits of recycling are manifold: recycling provides an alternative to landfilling and associated environmental pollution and health issues. It also provides an opportunity to recover valuable elements and secure a reliable secondary source of raw materials, helping avoid adverse environmental, social, and health impacts associated with raw material mining. It can also generate employment opportunities and support local economic activity.

IRENA estimates that by 2030, about 1.2 million metric tons of material can be recycled from solar PV waste, and 17.7 million metric tons by 2050. This recovered material could comprise a significant share of the future total material demand. Assuming systematic collection of end-of-life modules and recovery rates of 85 percent, the recycling of solar PV modules could meet almost 70 percent of the silver demand and more than 20 percent of the demand for aluminum, copper, glass, and silicon. While recovered materials do not yet generate sufficient revenue to offset the costs of the recycling processes,[b] they could nevertheless represent a significant market value, accounting for about USD 0.5 billion by 2030, USD 3.3 billion by 2040, and more than USD 8.8 billion by 2050 (IRENA 2023).

However, there are barriers to address in order to tap the potential of solar PV recycling. These include technical challenges (e.g., inefficient recycling technologies), and lack of the required infrastructure, logistics, and services; lack of information and data on the accurate composition of PV modules, as well as the estimated quantities and location of to-be-decommissioned PV panels, and their time to decommissioning; unclear regulations; low market confidence for project investors or potential second-hand panel users; and lack of profitability. Industry and industry associations can initiate voluntary programs to encourage and promote circularity practices, such as recycling programs or circularity-based product design. Voluntary industrial standards could also be used to enable companies' action that supports a circular economy for solar PV (IRENA 2023).

Since PV recycling is yet to be a profitable business, policies and measures are urgently needed to address barriers and promote circular economy pathways. Currently, only about 62 policies and programs from 16 countries are focused on the circular economy of solar PV panels; these are primarily led by governments, industry, and industry associations. Available policy tools for governments include landfill bans, extended producer responsibility, exemption from regulations, government guidance, financial and fiscal support, product labeling, recycling programs, and working groups. Examples can be found in Canada, China, the European Union, the Republic of Korea, Japan, and the United States. It is particularly crucial to develop and implement comprehensive regulatory frameworks to define stakeholders' responsibilities, financing models, and the minimum requirements for collection and recycling. These should cover PV recycling processes as well as module designs for easier recyclability of future end-of-life equipment. Finally, recycling policies should be complemented by strategies to extend a module's overall service lifetime through reuse, repair, and manufacturing.

a. Circular economy principles include the reduction of consumption initially, for instance, by reducing energy and material needs through sufficiency and efficiency measures. They then imply strategies to increase product lifetimes, for instance, by repairing and reusing solar PV equipment, and recovering materials through recycling processes.

b. For example, in the United States, recycling costs range from USD 15 to USD 45 per solar panel, which exceeds the value of the recovered material, which currently stands at USD 2 in the country. Meanwhile, disposal at nonhazardous landfills can cost less than USD 1 per panel and less than USD 5 per panel at hazardous waste landfills (Curtis and others 2021).

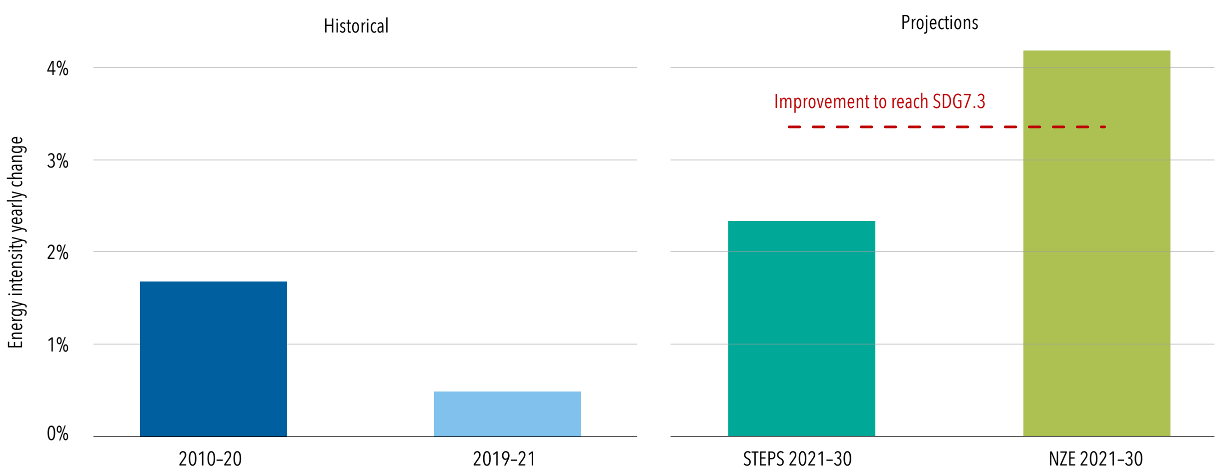
Under the 1.5°C Scenario, the role of CDR is limited to targeting process emissions from cement, iron and steel, hydrogen, and chemical production, with limited deployment for waste incinerators. Total CO2 captured from carbon capture and storage, carbon capture and utilization, bioenergy coupled with carbon capture and storage, and other CDR measures[79] must be scaled up aggressively to reach 2.2 metric gigatons of carbon dioxide (GtCO2) by 2030, from 0.004 GtCO2 in 2019.

To ensure the energy transition is sustainable as renewable energy deployment accelerates, it will also be critical to adopt circular economy approaches and plans for the end-of-life management of different renewable energy technologies. Box 6.2 provides more insights on this topic, focusing on the solar PV sector.

Outlook for Energy Efficiency

Global energy intensity, measured by the ratio of the total energy supply and GDP, is the key indicator to measure global progress on energy efficiency. The ongoing energy crisis is expected to contribute to improving this metric by 2 percent in 2022 after two years of slow progress. Surging energy costs, energy security concerns, and supply disruptions and looming shortages have as a matter of fact brought sharp focus on efficiency improvement, with governments worldwide looking to energy-saving measures to shield consumers from rising prices and secure supply. This follows a significant slowdown caused by the COVID-19 pandemic and a stronger-than-expected rebound in energy consumption in 2021. Early estimates for 2022 indicate, therefore, a slight recovery, with energy intensity improving at a rate of 2 percent. Greater attention to energy efficiency policies and retrofits incentives in Europe, Northern America, and Eastern Asia enhances the outlook towards 2030 to 2.4 percent under the Stated Policies Scenario; this is slightly stronger than progress on energy intensity over the decade ending 2020 (figure 6.7).

Figure 6.7 • Historical and projected improvement in global annual energy intensity by scenario, 2010–30



Source: IEA 2022[a].
NZE = Net Zero Emissions by 2050 Scenario; SDG = Sustainable Development Goal; STEPS = Stated Policies Scenario.

79 CDR measures and technologies include nature-based measures such as reforestation, as well as direct carbon capture and storage, bioenergy with carbon capture and storage, and other approaches that are currently experimental.

The improvement under the Stated Policies Scenario came against the backdrop of a previous slowdown, which occurred in the wake of strong improvements in energy intensity in the mid-2010s. That slowdown was in large part triggered by the significant slowdown caused by the COVID-19 pandemic, as well as by slower trends in China, where modern production processes have now replaced inefficient industrial capacity after decades of progress in the latter's phaseout. Recent increased action has helped compensate for the slowdown, although annual improvements are still far below where they need to be. Annual improvement until 2030 would now need to average 3.4 percent, as compared to only 1.8% in the 2010-20 period, if the world is to meet the SDG 7.3.

The lingering effects of the energy crisis are deemed to have helped overall energy efficiency–related investments increase by 16 percent in 2022, to just over USD 560 billion. This has reversed the effects caused by the pandemic on the previous trends under the Stated Policies Scenario. In addition, the large increase in industrial activity in China due to increased demand for durable goods worldwide during the pandemic subsided during 2022.

Volatile fuel prices have meanwhile also informed global policy responses and had an important influence on the rate of energy efficiency improvements. Before the onset of the energy crisis, many energy-importing countries were already implementing policies to shield consumers from price spikes in natural gas (concentrated in Europe), coal (concentrated in China), and LPG (concentrated in developing economies). These price shocks had resulted in many governments providing financial support, which is draining government coffers and driving a renewed zeal for energy efficiency projects. Enhanced energy efficiency mandates and incentives could however be seen as a more economical alternative to household price supports and could inform the next phase of recovery response measures, alongside mandates for fuel storage facilities, the increased use of renewables, and extensions of the life of existing plants, all of which are under consideration in many countries to reduce dependence on oil and gas, especially Europe. In developed economies, higher energy prices also drive energy efficiency investments and behavioral changes focused on reducing consumption by private sectors and by citizens in their homes.

Energy efficiency is one of the building blocks of IEA's Net Zero Emissions by 2050 Scenario. The COVID-19 pandemic resulted in a decline of TFEC in 2020 and 2021, but it is now set to recover. Under IEA's Net Zero Emissions by 2050 Scenario, accelerated improvements in energy efficiency would occur across all energy end uses and would cause global energy to peak before 2025 and decline rapidly thereafter. To realize the Net Zero Emissions by 2050 Scenario, the world must overshoot SDG target 7.3, improving energy intensity by 4.3 percent between 2021 and 2030, instead of the 3.4 percent needed to reach the target. This acceleration would require more stringent standards and incentives as well as bans on the sale of inefficient stock.

Under IEA's Net Zero Emissions by 2050 Scenario, global energy supply would decline 5.3 percent between 2021 and 2030, with advanced economies leading the way. This would decrease the total energy supply by 14 percent over this period. This decline would occur despite strong economic growth highligting the importace of energy efficiency in the scenario.

Early implementation of efficiency improvements across all sectors is essential to move to a more sustainable trajectory. In the transport sector, improvements in efficiency mean that on average, conventional passenger cars sold in 2030 would consume 30 percent less energy than they did in 2019, and new trucks would consume 20 percent less fuel. By 2030, electric cars would account for over 60 percent of car sales (up from 4.6 percent in 2020), and fuel cell or electric vehicles would account for 30 percent of heavy truck sales (up from less than 0.1 percent in 2020). Meanwhile, other modes of transportation common in developing countries would also see efficiency improvements. For example, electric two/three-wheelers would see sales growth from 17 percent of the total today to 77 percent by 2030 under the Net Zero Emissions by 2050 Scenario in emerging economies. Under the Net Zero Emissions by 2050 Scenario, by 2030, over 80 percent of household appliances and air conditioners sold in advanced economies will feature the most efficient technologies available as of 2025 limiting electricity demand from the building sector. Emerging markets and developing economies will reach this 80 percent level by the mid-2030s. In industry, industrial facilities will become more efficient due to the deployment of improved electric motors, heat pumps, and agricultural irrigation pumps, and the wider implementation of energy management systems.

IEA's Net Zero Emissions by 2050 Scenario also requires ramping up energy efficiency programs to incentivize efficiency-focused construction of new buildings and retrofits. These programs would also help manufacturers accelerate upgrades to production lines so as to produce more efficient equipment. Efficiency improvements across all end uses in the buildings sector, as well as the achievement of universal access to clean cooking, would cause a decline in the total energy demand by almost a quarter in residential buildings between 2020 and 2030, despite a 25 percent increase in the provision of energy services due to population and economic growth. In the existing buildings stock, deep energy retrofits can reduce energy use by more than 60 percent. Approximately 30 percent of the global building stock that will exist in 2030 is yet to be built. In some countries, including India, the figure is over 50 percent. However, nearly three-quarters of countries do not have mandatory energy codes for new buildings. Under the Net Zero Emissions by 2050 Scenario, all countries would introduce mandatory energy-related building codes, and existing codes would become more rigorous. This will reduce the average energy intensity of new buildings by nearly 50 percent over 2020–30.

Under IRENA's 1.5°C Scenario, energy intensity would need improve at an average annual rate of over 3 percent per year in 2020–30. To realize this, investments in improving energy efficiency need to increase by a factor of 9. A key step in this regard is the deployment of energy efficiency measures that improve technical efficiency (e.g., more efficient boilers, air conditioners, motors, heat pump systems, and appliances), as well as the deployment of technologies that promote end uses that consume renewables directly (e.g., solar thermal). In the buildings sector, all new construction would need to be designed to achieve zero-energy consumption standards from 2030 onward. For existing buildings, the rate of renovation would need to double, to 2 percent of the buildings stock a year, through 2030.

Investments Needed to Achieve SDG 7

Annual clean energy investments to reach SDG 7, which include renewable power, renewable fuels, efficiency, end-use electrification, and grids and networks, increased by 15 percent in 2021 as compared with the 2015–20 average. It reached almost USD 1.2 trillion. These investments were key to step up progress in renewables and energy efficiency, and partial offset the increased use of coal and oil. Without the record advancement in clean energy in 2021-22, emissions could have grown three times.

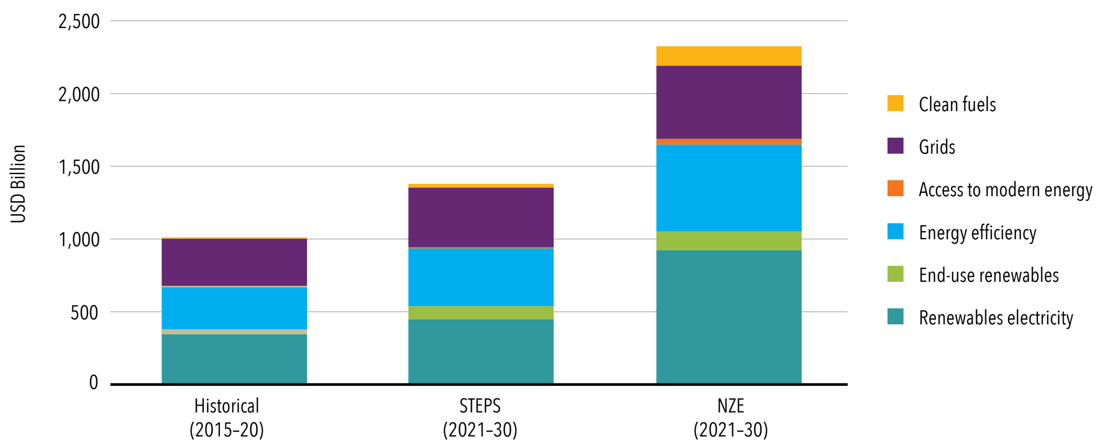
Annual clean energy investments averaged about USD 1 trillion between 2015 and 2020, although outlooks from both IEA and IRENA emphasize the urgency of scaling up investments in the energy transition. Under IEA's Net Zero Emissions by 2050 Scenario, clean energy investments as defined above must average at USD 2.3 trillion a year and reach USD 4 trillion between 2021 and 2030 to achieve the SDG 7 targets (figure 6.8), while clean energy investments under the Stated Policy Scenario would average at USD 1.4 trillion between 2022 and 2030.

The majority of the investment to meet SDG 7 under the Net Zero Emissions by 2050 Scenario would be directed toward the generation of renewable electricity (including storage) and end-use efficiency, which account for USD 948 billion and USD 590 billion a year, respectively. Renewables-based power investment needs to be supported by an additional average annual spending of USD 500 billion on the expansion and modernization of electricity networks.

Under IEA's Net Zero Emissions by 2050 Scenario, average annual investment of approximately USD 30 billion and USD 6 billion, respectively, would be required from 2021 to 2030 to achieve full energy access and clean cooking access in developing economies. More than half of this investment would have to be in Sub-Saharan Africa (IEA 2022[a]), although Developing Asia would see the bulk of investment in clean cooking access. These investments for access represent only 10 percent of the annual spending of the upstream oil and gas sector; they are within reach of the international community.

The financial resources available for advancing electricity and clean cooking access have been inadequate to achieve full access. In 2019, investments in electricity access represented only a third of the required levels and were focused on a few countries (IEA 2022[a]). Even more concerning were investments in access to clean cooking in the same year, which represented only a fraction of the required levels (in Africa, they would need to increase 15 times the current levels (IEA 2022[b])). International support through development aid and multilateral development banks will be essential to mobilize, and boost, access- and other energy-related investments and derisk them for private and local actors in emerging markets and developing economies.

Figure 6.8 • Average annual investment in selected technologies under IEA's Net Zero Emissions by 2050 Scenario, 2020–30



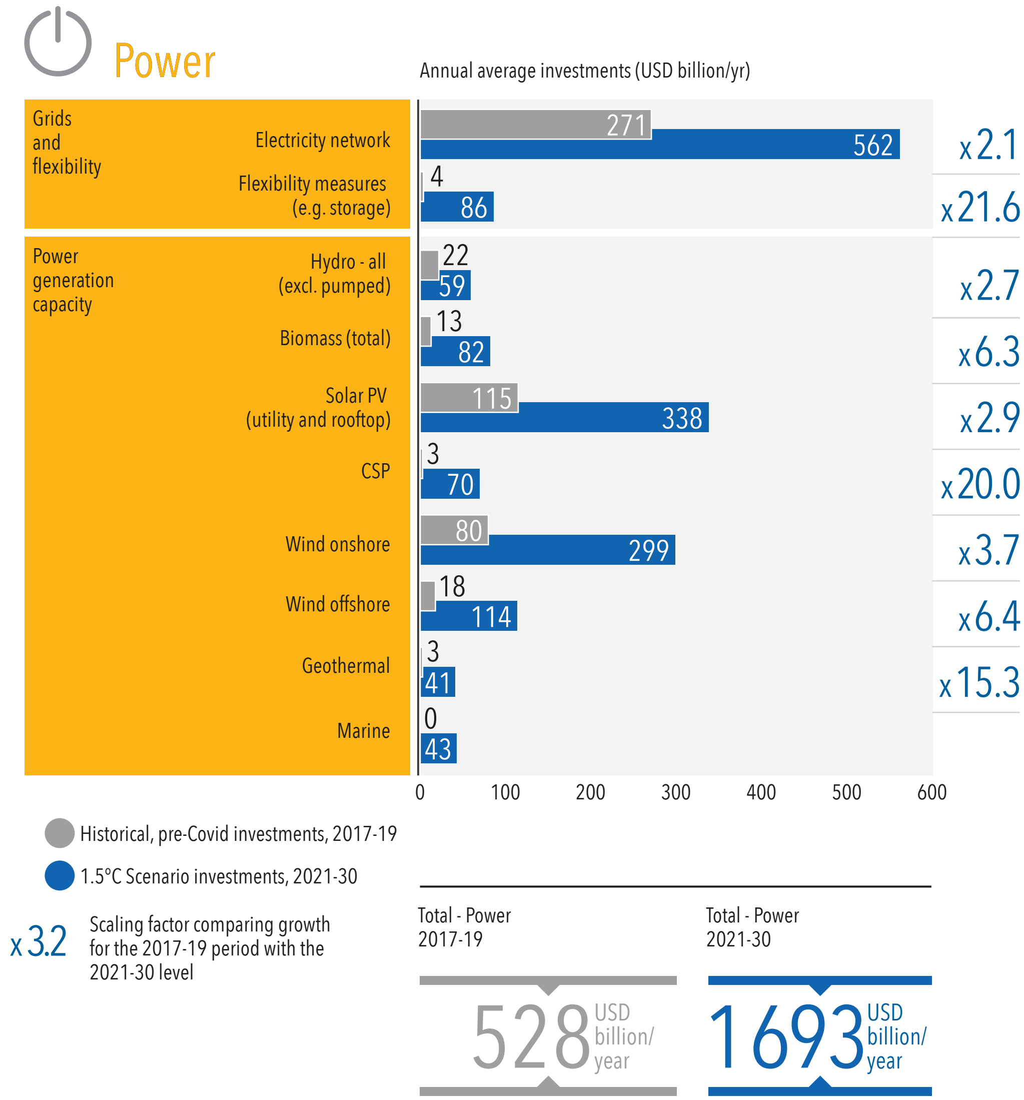
Source: IEA 2022[a].
NZE = Net Zero Emissions by 2050 Scenario; STEPS = Stated Policies Scenario.

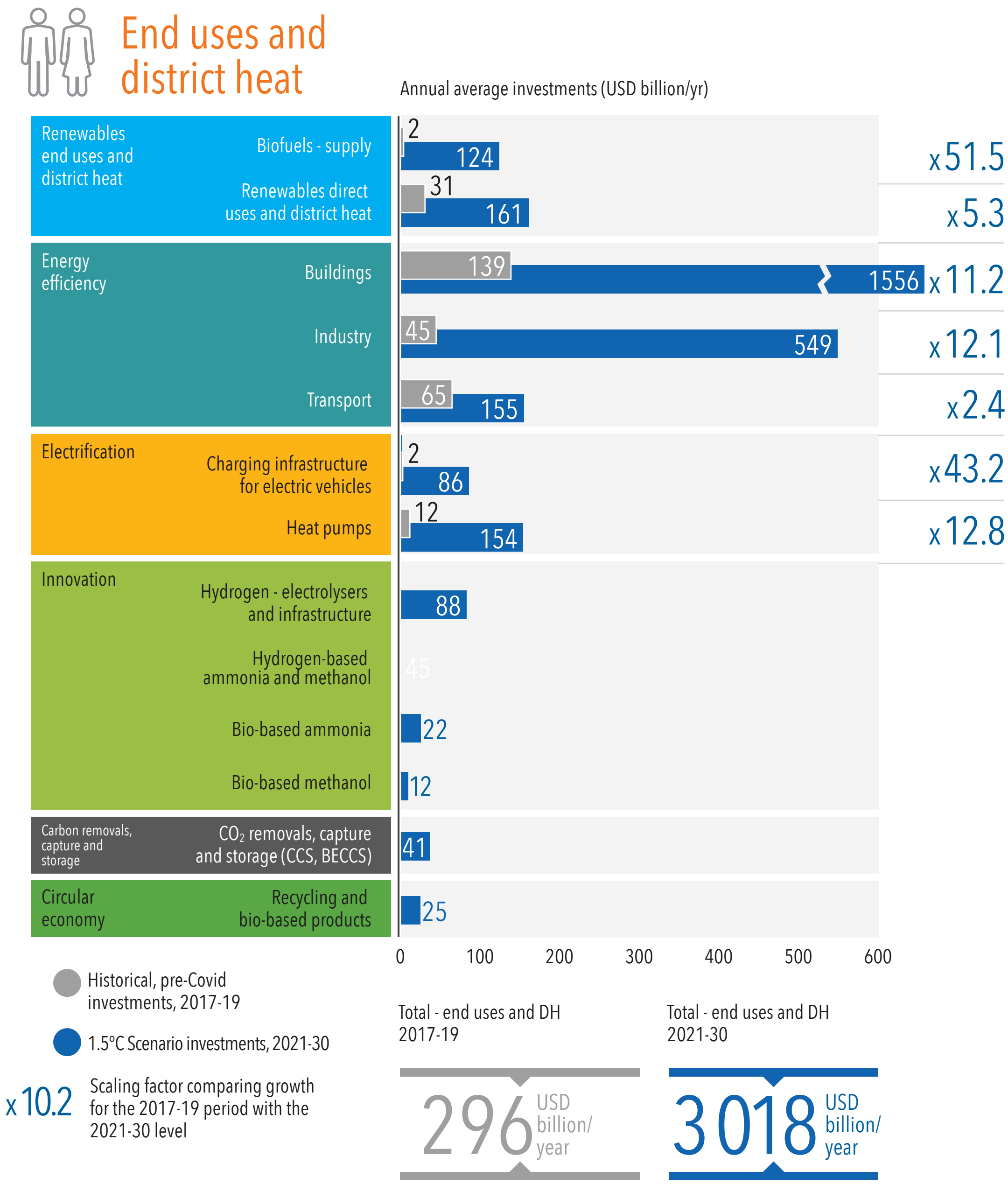
Under IRENA's 1.5°C Scenario, annual investment in renewables, efficiency, related electricity infrastructure/grids and flexibility measures, and hydrogen and biofuel supply would amount to USD 4.7 trillion (USD2015) a year through 2030 (figure 6.9).

In the power sector, increasing renewables generation capacity would require investment of USD 1.1 trillion a year. Additional investments of USD 0.6 trillion a year would also be required for related infrastructure, including grid extension and grid flexibility measures. The measures would range from better forecasting of renewable power generation to integrated demand-side flexibility and stationary battery storage, among others.

Substantial investment would also be required outside the power sector. The buildings sector would require significant energy efficiency investments (amounting to USD 1.6 trillion a year), aside from large investments (amounting to USD 0.15 trillion per year) in heat pumps. Energy efficiency will receive a considerable share of investments in the buildings sector. Meanwhile, energy efficiency investments in transport and industry would need to increase to USD 0.7 trillion per year, and investments in direct uses of renewables (solar thermal, geothermal, etc.) and fuels (bioenergy and others) across all sectors would need to increase to USD 0.29 trillion per year. Investments in electrolyzers, hydrogen supply infrastructure, and renewables-based hydrogen feedstocks would average USD 0.17 trillion a year. These sectors would need to see average annual investments of over USD 3 trillion per year.

Figure 6.9 • Average annual investments by technology and measures required between 2021 and 2030 under IRENA's 1.5°C Scenario





Source: IRENA 2022.

BECCS = bioenergy coupled with carbon capture and storage; CCS = carbon capture and storage; CO2 = carbon dioxide; CSP = concentrated solar power; DH = district heating; PV = photovoltaic.

Beyond investments in technology, policy makers also need to invest in implementing the required policy and regulatory framework to enable the energy transition. Beyond deployment policies, policies supporting the integration of energy transition–related technologies into the energy system are needed along with supporting policies for a conducive environment for the energy transition. Importantly, wider policies are needed to address structural challenges to realize the benefits of the energy transition, including the opportunity to create new jobs (box 6.3).

Box 6.3 • Linkages between SDG 7 and SDG 8: A focus on jobs

Achievement of SDG 7 is closely linked to the employment-related targets under SDG 8, which promotes full and productive employment and decent work for all. Between 2012 and 2021, jobs in the renewable energy sector increased from 7.3 million to 12.7 million (IRENA 2014; IRENA and ILO 2022). The energy transition will create millions of jobs, although accelerating the transition at the scale and speed to achieve climate goals and development objectives depends on creating a skilled workforce that taps a diverse pool of talents. IRENA estimates that jobs in the overall energy sector could increase to 139 million by 2030 following an ambitious pathway suitable for limiting temperature increases to 1.5°C. This is 31 percent more than the estimated jobs under current plans and commitments in the energy sector by 2030. The number of jobs in the renewable energy sector would increase from 12.7 million today to 38.2 million in 2030, more than double the projected 17.4 million jobs under current plans. Additionally, a projected 74 million jobs would be created in energy efficiency, electric vehicles, power systems/flexibility, and hydrogen (IRENA 2022).

However, the impact of the energy transition on the labor market would be manifold: it would lead to not only job creation but also outright job loss, apart from relocation and transformation. Misalignments would likely occur across different dimensions: job losses could exceed job gains at any given time (temporal). Further, there could be uneven job gains geographically, with more job creation in one country and more job losses in another (space). Also, the current skills of the labor force could be inadequate to meet the needs of the energy transition (educational). Further, changes in value and supply chains could affect sectors (sectoral).

How well a country responds to these structural changes will depend on a variety of factors, for example, its economic structure, demographics, skill base, and chosen policies, among others. Countries can design social and labor market responses informed by earlier national employment assessments to prepare for the transition's job impacts. Policy makers should develop an overarching just transition framework designed to restructure the economy and labor market and to complement their strategies for climate action. These frameworks must be based on national development objectives, specifically, maximizing employment and income opportunities while minimizing socioeconomic disruptions to the extent possible (IRENA and ILO 2022).

Efforts need to focus as much on the quality of jobs as on their quantity. Decent jobs are those that give fair compensation and have safe workplaces, where rights are respected. This entails adopting and implementing international labor standards, institutionalizing labor rights, and creating conditions that allow for unionization and collective bargaining arrangements within industries to ensure fair labor practices (ILO 2023).

Similarly, ensuring equal rights and adequate opportunities for women, youth, minorities, and marginalized groups is critical. Doing so contributes to SDG 5 on gender equality and SDG 10 on reducing inequality. Policies are needed to overcome barriers to entering the workforce, as well as to job retention and career advancement. Furthermore, industries must create supportive networks and systems to train and mentor women, youth, and minorities, to further develop their skills and participation.

Finally, important questions concern the geographies in which jobs will be created. Currently, China, Brazil, India, the United States, and members of the European Union lead in equipment manufacturing, project engineering, and installations. The bulk of renewable energy employment is in Asian countries, which accounted for 63.6 percent of jobs in 2021 (IRENA and others 2022). Especially in traditionally disadvantaged regions, local industrial capacity needs to be leveraged to enjoy the socioeconomic benefits of the energy transition. The renewables industry needs to support local value chains to stimulate local economies. Farsighted industrial policies can enable sustainable socioeconomic development in the long run. These may involve education and training programs for employees in specific sectors, supplier development programs, business incubation initiatives, incentives for small and medium enterprises, and the promotion of industrial clusters. Such policies can also contribute to creating the structural underpinnings for robust supply chains through infrastructure investments, an increase in local firms' access to finance and information, and an improvement in capacities across the value chain and, ultimately, the realization of SDG 7 and SDG 8 (IRENA and ILO 2022).

Conclusion

The energy sector continues to receive support through innovative policies and technologies, but the COVID-19 pandemic and the current energy crisis set progress back in ways that were not foreseen in 2019. Not only are current and planned policies not aligned to achieve SDG 7, but progress toward some targets has also been even slower than before.

For the first time in decades, the number of people without electricity access globally might have grown in 2022. At the same time, there has been a considerably higher perceived risk of lending money to a number of developing countries, making it more expensive for them to raise debt finance for energy technologies and improve energy access.

Meanwhile, the outlook looks more positive for renewables and efficiency. Low oil and gas prices were originally projected to be a barrier to the uptake of clean energy technologies and energy efficiency under IEA's Stated Policies Scenario. However, rising prices in 2022 and renewables- and efficiency-focused recovery plans in key economies made the outlook for renewables and efficiency stronger than it was a year ago. Recent price spikes and the crisis in Ukraine have also increased uncertainty in global oil and gas markets, putting renewed pressure on net importers to reduce exposure. Renewables, efficiency, and electrification are likely to play major roles in the policy responses to these events. These responses need to be substantial and reach beyond advanced economies if the world is to achieve the energy-related SDGs.

Continued efforts are also required to double the global annual energy intensity improvement rate to an average of 3.4 percent if the world is to achieve SDG target 7.3. The ongoing slump in economic activity and lingering economic uncertainty are likely to result in slower turnover of capital stock, but the inclusion of provisions for efficiency in some countries' economic recovery packages partially offsets that effect. Solar PV and wind remain the fastest-growing sources of energy globally. More policy support for renewable integration, electrification, and decarbonization will be needed to align with the Net Zero Emissions by 2050 and 1.5°C scenarios.

Getting on track to meet SDG 7 depends partly on how governments continue to support clean energy and energy-access investments. In advanced economies, initial support from recovery plans needs to evolve to more nuanced support that relies less on direct cash injections and more on derisking and guarantees to continue advancing these objectives. More pressingly, significant investments are needed in the energy transition in emerging markets and developing economies, especially in light of diminishing fiscal leeway. International support will be essential to not only directly mobilize investments but also catalyze higher private capital participation by derisking clean energy projects.

As policy makers chart the path ahead, it is worth bearing in mind that an energy transition ambitious enough to achieve SDG 7 can also help meet other social and economic objectives. With holistic policies in place, the energy transition can foster sustainable economic growth, create jobs, and improve welfare as emphasized throughout this report.

Methodological Notes

All investment figures from IEA scenarios are in constant 2021 USD at market exchange rate. Investment figures from IRENA scenarios are in constant 2015 USD at market exchange rate.

IEA METHODOLOGY

The analysis presented in this chapter is based on results from the World Energy Model (WEM) and IEA's analysis in the World Energy Outlook (WEO). Detailed documentation of the WEM methodology can be found at https://www.iea.org/reports/world-energy-model/documentation#abstract.

IEA models two scenarios. The Stated Policies Scenario is designed to provide decision-makers with feedback about their current course based on the stated policy ambitions. This scenario assumes that the COVID-19 pandemic was brought under control in 2021. It incorporates IEA's assessment of stated policy ambitions, including the energy components of announced stimulus or recovery packages (as of mid-2020) and the Nationally Determined Contributions under the Paris Agreement. Broad energy and environmental objectives (including country net-zero targets) are not automatically assumed to be met. They are implemented in this scenario to the extent that they are supported by specific policies, funding, and measures. The Stated Policies Scenario also reflects progress with the implementation of corporate sustainability commitments.

The Net Zero Emissions by 2050 Scenario is a normative IEA scenario that shows a narrow but achievable pathway for the global energy sector to achieve net-zero CO2 emissions by 2050, with advanced economies reaching net-zero emissions in advance of others. This scenario also achieves the key energy-related SDGs, achieving universal energy access by 2030 and major improvements in air quality. The scenario is consistent with limiting the global temperature rise to 1.5°C without a temperature overshoot (with a 50 percent probability), in line with reductions assessed by the Intergovernmental Panel on Climate Change in its Special Report on Global Warming of 1.5°C. This scenario is based on the following assumptions:

- Uptake of all available technologies and emissions reduction options is dictated by cost, technology maturity, policy preferences, and market and country conditions.
- All countries cooperate toward achieving net-zero emissions worldwide.
- An orderly transition occurs across the energy sector. It ensures the security of fuel and electricity supply at all times, minimizes stranded assets where possible, and avoids volatility in energy markets.

METHODOLOGY FOR ACCESS TO ELECTRICITY AND CLEAN COOKING

The projections presented in the WEO and in this chapter focus on two elements of energy access, households' access to electricity and clean cooking facilities, which are measured separately. IEA maintains databases on the levels of national, urban, and rural electrification rates. For the proportion of the population without access to clean cooking, the main sources are the World Health Organization's Household Energy Database and IEA's Energy Balances. Both databases are regularly updated and form the baseline for WEO energy-access scenarios to 2040.

The projections under the Stated Policies Scenario consider current and planned policies; recent progress; and population growth, economic growth, urbanization rate, and the availability and prices of different fuels. The Net Zero Emissions by 2050 Scenario identifies least-cost technologies and fuels to reach universal access to both electricity and clean cooking facilities. For electricity access, the analysis incorporates a Geographic Information Systems model based on open-access geospatial data, with technology, energy prices, electricity-access rates, and demand projections from the WEM. This analysis was developed in collaboration with the KTH Royal Institute of Technology, Division of Energy Systems Analysis (KTH-dESA), in Stockholm. Further details about the IEA methodology for energy-access projections can be found at https://www.iea.org/articles/defining-energy-access-2020-methodology.

METHODOLOGY FOR RENEWABLE ENERGY PROJECTIONS

Annual updates to WEO projections reflect the broadening and strengthening of policies over time, including renewables policies. Projections for renewable electricity generation are derived in the renewables submodule of the WEM, which projects the future deployment of renewable sources for electricity generation and the required investment. The deployment of renewables is based on an assessment of the potential of each source and its cost (bioenergy, hydropower, photovoltaic, concentrated solar power, geothermal electricity, wind, and marine) in each of the 25 WEM regions. In all scenarios, IEA modeling incorporates a process of learning by doing that affects costs. The model calculates deployment and the consequent yearly investment required for each renewable source in each region by including financial incentives for using the renewables, as well as nonfinancial barriers in each market; technical and social constraints; and the value added to systems by each technology in terms of energy, capacity, and flexibility.

METHODOLOGY FOR ENERGY EFFICIENCY PROJECTIONS

Energy intensity calculated as Total Energy Supply [TES] divided by GDP, is the key indicator for energy efficiency. Assumptions for short- to medium-term economic growth are largely based on estimates prepared by the Organisation for Economic Co-operation and Development, International Monetary Fund, and World Bank. Over the long term, growth in each WEM region is assumed to converge to an annual long-term rate, which depends on demographic and productivity trends, macroeconomic conditions, and the pace of technological change.

TES growth is based on the growth of Total final energy demand, which is calculated as the sum of energy consumption for each end use in each final demand sector. At least six types of energy are shown in each subsector or end use: coal, oil, gas, electricity, heat, and renewables. The main oil products, LPG, naphtha, gasoline, kerosene, diesel, heavy fuel oil, and ethane, are modeled separately for each final demand sector.

In the majority of equations, energy demand is a function of activity variables that are driven by the following factors:

- *Socioeconomic variables:* GDP and population are important drivers of sectoral activity variables that determine energy demand for each end use within each sector.
- *Prices for end users:* Historical time series data for coal, oil, gas, electricity, heat, and biomass prices within each sector are compiled based on IEA's Energy Prices and Taxes database and several external sources. Prices for end users are then used as explanatory variables affecting the demand for energy services.
- Technological parameters include recycling in industry and material efficiency.

All 25 WEM regions for energy demand are modeled in considerable sectoral and end-use detail:

- Industry is separated into six subsectors (with the chemicals sector disaggregated into six subcategories).
- Buildings energy demand is segregated into demand of residential and services buildings, which are then separated into six end uses. Within the residential sector, appliances' energy demand is segregated into four types of appliances.
- Transport demand is segregated into nine modes, with considerable detail for road transport.

IRENA METHODOLOGY

IRENA scenarios

IRENA's scenarios outlined in this report were developed by the Renewable Energy Roadmaps (REmap) team at IRENA's Innovation and Technology Centre, in Bonn. Since 2014, this team has produced a succession of road maps with ambitious pathways for deploying low-carbon technologies to create a clean, sustainable energy future at the global, regional, and country levels.

The findings in this report are based on IRENA's 2022 flagship publication World Energy Transitions Outlook: 1.5°C Pathway. The Planned Energy Scenario provides a perspective on energy system developments based on governments' energy plans and other planned targets and policies that were in place as of early 2022. The 1.5°C Scenario describes an energy transition pathway aligned with the ambition of limiting the average end-of-century global temperature increase to 1.5°C relative to preindustrial levels. For more information on the scenarios, methodology, and scope of this work, please visit www.irena.org/remap.

IRENA socioeconomic modeling

IRENA has been analyzing the socioeconomic implications of transition road maps since 2016. Its methodology uses a global econometric model with high regional and sectoral resolution (E3ME, from Cambridge Econometrics) to holistically capture multiple interactions between energy transition road maps with its accompanying policy baskets and global and national economic systems.

The resulting socioeconomic footprint is evaluated at a high level of detail, generating insights that inform policy making for a successful transition. Socioeconomic footprint results include GDP (aggregated economic activity), employment (economy wide and with high resolution within the energy sector), and welfare (using an index with five dimensions, economic, social, environmental, distributional, and access, each informed by two indicators).

A detailed drivers' methodology is used to facilitate understanding of the mechanisms producing the socioeconomic footprint results. Clearer insights on the links between transition goals and policies and their resulting impacts are provided.

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CHAPTER 7

TRACKING PROGRESS TOWARD SDG 7 ACROSS TARGETS: INDICATORS AND DATA

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A robust framework of indicators backed by statistical data is essential for countries working to achieve the Sustainable Development Goals (SDGs). Gathering the necessary data depends in turn on the existence of well-designed and well-resourced statistical systems. The development of standardized indicators for tracking progress toward policy goals helps countries compare their progress, identify areas where more work is needed, and make evidence-based decisions about where to focus their resources.

The international community has spurred efforts to improve data collection, analysis, and reporting. The definition and approval of 232 initial indicators (since expanded to 248) was an important step toward global monitoring.[80] Establishing the indicators created a common language and framework for development, aligning the efforts of governments, civil society, and the private sector toward shared goals. It also raised awareness of the importance of data and monitoring in development. Since the need for comprehensive and accurate data has grown in importance, the international community has spurred efforts to improve data collection, analysis, and reporting through new technologies and innovative approaches, which has in turn helped to identify gaps in development and track progress towards closing them. It has therefore played an important role in fostering consensus and enabling countries to track progress towards shared development goals.

Leveraging national data efforts worldwide, this annual report is a joint effort of the five custodian agencies responsible for monitoring progress toward the targets of SDG 7—universal access to affordable, reliable, sustainable, and modern energy by 2030 (table 7.1). The World Bank and World Health Organization are responsible for tracking progress toward SDG target 7.1 (universal access to modern energy services). The International Energy Agency (IEA), International Renewable Energy Agency (IRENA), and United Nations Statistics Division (UNSD) are responsible for SDG target 7.2 (the share of renewable energy in the energy mix). IEA and UNSD are responsible for SDG target 7.3 (improvements in energy efficiency). IRENA is also responsible for tracking target 7.a (international cooperation, with the Organisation for Economic Co-operation and Development) and for target 7.b (promotion of energy infrastructure). The World Bank's Energy Sector Management Assistance Program (ESMAP) produces and publishes the report.

This chapter provides a description summary of data and methodological challenges for each of the indicators. Further details can be found in the methodology section of each chapter and in the United Nations' metadata repository for SDG indicators (https://unstats.un.org/sdgs/metadata/).

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80 For complete information, see "SDG Indicators: Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development": https://unstats.un.org/sdgs/indicators/indicators-list/

Table 7.1 • SDG 7 targets, indicators, and custodian agencies

TARGET	INDICATOR	CUSTODIAN AGENCY OR AGENCIES	RELEVANT CHAPTER IN THIS REPORT
7.1–By 2030, ensure universal access to affordable, reliable, and modern energy services	7.1.1–Proportion of population with access to electricity	World Bank	Chapter 1
	7.1.2–Proportion of population with primary reliance on clean fuels and technology for cooking	World Health Organization	Chapter 2
7.2–By 2030, increase substantially the share of renewable energy in the global energy mix	7.2.1–Renewable energy share in total final energy consumption	International Energy Agency, International Renewable Energy Agency, UN Statistics Division	Chapter 3
7.b–By 2030, 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 landlocked developing countries, in accordance with their respective programs of support	7.b.1–Installed [renewables-based] generating capacity in developing countries (in watts per capita)	International Renewable Energy Agency	
7.3–By 2030, double the global rate of improvement in energy efficiency	7.3.1–Energy intensity measured in terms of primary energy and GDP	International Energy Agency, UN Statistics Division	Chapter 4
7.a–By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency, and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology	7.a.1–International financial flows to developing countries in support of clean energy research and development and renewable energy production, including in hybrid systems	International Renewable Energy Agency, Organisation for Economic Co-operation and Development	Chapter 5

Access to Electricity

Measuring access to electricity (SDG indicator 7.1.1) is not as straightforward as simply counting the number of people with electricity. It is a complex process involving data collection and validation efforts carried out by national and international players, including governments, energy utilities, private companies, and multilateral development organizations. Understanding the intricacies of electricity access in low-income countries and countries marked by fragility, conflict, or violence requires a comprehensive look at the multiple attributes of access in different settings.

Most microdata from household, enterprise, and agricultural surveys provide energy practitioners and ministries of energy with useful information but fail to capture the more nuanced aspects of electricity access in households—one example being the economic activities of individual members of a given household. Further complexities arise when trying to account for the scaling up of decentralized energy solutions that are not generally distinguished in routine national surveys and energy statistics.

Because the concept of access to electricity does not lend itself to easy definition, efforts are underway, through the World Bank's Multi-Tier Framework, to better capture the spectrum of energy services sought and used by households: capacity, availability, reliability, affordability, quality, formality, healthiness, and safety.[81] Such information can provide sharper and finer information about the number of people benefitting from interventions and the nature and magnitude of improvements in electrification. More detailed data from such efforts can provide important insights to guide policy and decision-making. Where data are not available for multi-tier metrics, country-level surveys or censuses complement data collection.

To improve the tracking of access, capacity-building activities, including bilateral and regional training of energy statisticians, must be further developed. The usability of datasets should also be improved by helping governments and energy practitioners apply new technologies and data analytics. For example, the Atlas of Sustainable Development Goals published online by the World Bank presents interactive storytelling and data visualizations on the trends in access to electricity, among other key SDG indicators.[82] Finally, exploring the use of large-scale open databases, such as satellite-based data that could provide real-time information, will help clarify where and how electricity is being used, as well as socioeconomic trends in its use.

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81 Information on the Multi-Tier Framework can be found at https://mtfenergyaccess.esmap.org/

82 A new edition of the Atlas of Sustainable Development Goals will be published in 2023. The 2020 edition can be found at https://datatopics.worldbank.org/sdgatlas/

Access to Clean Cooking Fuels and Technologies for Cooking

SDG indicator 7.1.2 measures the number of people using clean fuels and technologies as their main energy source for cooking in the household. Households considered to have access to clean cooking are those primarily relying on electricity, biogas, solar, alcohol fuels, natural gas, and liquefied petroleum gas for household cooking purposes. Here, “clean” refers to the combinations of fuels and technologies that meet the emissions targets set out in the WHO (2014) guidelines for indoor air quality and household fuel combustion. Improved data collection on the parallel use of multiple cooking solutions (also known as “stove stacking”) in low- and middle-income countries delivers a more complete representation of the population exposed to pollution and the resultant diseases. Presently, however, such data are too limited in geographic coverage to be used in global tracking efforts.

Household surveys and censuses are currently the primary data source for global estimates. Such data serves as primary input for the Global Household Energy Model applied to derive estimates on the use of clean cooking fuels and technologies. Knowing the extent to which these surveys capture modes and duration of use is therefore vital for designing, implementing, and monitoring the effectiveness and outcomes of clean cooking policies and programs.

By refining household surveys and censuses countries can gain a more complete picture of household energy use, access to clean cooking fuels and technologies, and the effects of cooking practices on air pollution, gender, climate and other impacts. WHO and WB developed a harmonized set of “Core questions on Household Energy Use” and the Guidebook “Measuring Energy Access”. The questions improve upon previous surveys by not only establishing whether a household has electricity access and what the main cooking fuel is, but also assessing the type of electricity access; the quality of access; impediments to access; the type of fuels and devices used for cooking, heating and lighting; and important safety and livelihood impacts of household energy use.

Beyond the SDG7 indicators, additional and more comprehensive questions included in surveys will also help in monitoring the trends and broader outcomes of clean cooking access. Currently, most household energy data collected by national household surveys do not capture everything needed to understand the role of energy services in poverty reduction and other impacts, therefore, do not permit extensive energy policy analysis. Including questions on cooking time, fuel collection, and health implications would increase the granularity of clean cooking estimates and help national and global policy makers devise better policies (World Bank and WHO 2021).

Renewable Energy

The share of renewable energy in total final energy consumption is the indicator used to track progress toward the SDG 7.2 target of substantially increasing the share of renewable energy in the global energy mix. Here, too, comprehensive data across all energy sources (renewable and nonrenewable) and stages of supply, transformation, and final consumption are needed for accurate tracking. The methodology used to derive total final energy consumption, total energy supply, and energy balances is detailed in United Nations (2018).

To increase the accuracy of tracking renewables, two methodological challenges must be met: (1) monitoring the rapid development of geographically distributed energy sources, such as off-grid and micro-grid solar PV and wind, and (2) improving the capacity of countries to measure traditional uses of biomass (solid biofuels) by households, the largest share of renewable (if not clean) energy in low- and middle-income countries.

Better national-level household and industry surveys on how solid biomass fuels are used in households and organizations could improve the reliability of renewable energy statistics. For example, including a broader range of questions about biomass use in households could help determine the extent to which its use can be considered a sustainable energy source. Traditional fuelwood harvesting is associated with deforestation, as a large fraction of fuelwood is not sustainably harvested. Despite this, fuelwood is currently assumed to be renewable energy for lack of an agreed definition of sustainable harvesting and for lack of measurements on fuelwood harvests. Survey-based data could prove valuable as a means to better quantifying the "renewable" fraction of biomass use. Such additional information could lead to significant revisions of previous estimates.

Energy Efficiency

Energy intensity, defined as the ratio of total energy supply to economic output, is used to track progress toward SDG target 7.3—doubling the global rate of improvement in energy efficiency (UN 2018). Measuring the total energy supply requires solid information on primary energy production across all sources, as well as trade in all energy products, among other things. The supply information is collected from administrative sources or through surveys of higher-level players, such as energy suppliers.[83] The information currently collected includes commercially traded energy sources and is of fairly good quality in most countries.

To improve tracking of energy intensity it will be important to analyze the drivers of demand across sectors, such as industry, transport, and buildings—both residential and commercial/industrial. The demand-side of data collection is much more complex, time-consuming, and expensive than supply-side collection owing to the diversity of end users. Therefore, consumer surveys can complement data-collection efforts when energy suppliers have limited or no information on how much energy is consumed by different types of users.

To analyze energy efficiency within sectors, countries must monitor intensities at the end-use level. Efficiency indicators might include energy expended per passenger-kilometer by vehicle type for transport; energy for space heating and cooling, by unit of area, for buildings; or energy per unit of physical production of a good for industry. More details on a methodological framework for energy efficiency indicators, as well as country experiences, can be found in IEA (2014).

Along with finer disaggregation of data, better energy efficiency indicators will depend on more coordination across organizations related to activities beyond the energy sector, encompassing building records, vehicle registrations, industrial reports, and so on. Many countries have already begun to collect end-use data and compile energy efficiency indicators to support their policy-making and planning.[84]

83 Data collected by various agencies in response to legislation or regulation (not necessarily for statistical purposes) may be used to compile energy statistics after ensuring their quality and addressing limitations related to their purpose.

84 An example, beyond the IEA energy efficiency indicators themselves (IEA 2014) is the Odyssee database for Europe, https://www.indicators.odyssee-mure.eu/

International Financial Flows to Developing Countries in Support of Clean and Renewable Energy

Indicator 7.a.1 measures international public financial flows to developing countries for clean energy research, development, and renewable energy production, including in hybrid systems. It utilizes data from IRENA and the Organisation for Economic Co-operation and Development (OECD).

Good measurement of international public investment flows has four components: (1) tracking financial flows; (2) standardizing commitment details; (3) centralizing data collection; and (4) presenting flows in a constant way.

To track public financial flows, it is critical to understand how aid recipients intend to spend the investments for end-use projects and programs. Recipients are defined as end-use organizations and projects run by public investors. The amount of private finance leveraged through public funds, already tracked by OECD in its data on mobilizing private finance, makes a good complement to analyses of public flows. International financial flows are generally disbursed in multiple phases and through multiple stakeholders (local governments, ventures, or funds). Some commitments may also be cancelled or modified after data have been gathered. Thus, where reporting institutions revise financial investment figures, historical investment information covering several years should be included to disclose changes in amounts.

Standardizing commitment details by sharing best practices among public investors and donors, refining reporting directives, and encouraging public investors and donors helps ensure that collected data comply with international standards. The standardization process also increases accuracy and granularity. For example, granular commitment data may specify technology, type of finance (project-level finance, infrastructure, research, or technical assistance), and type of financial mechanism, among attributes.

Collections of investment data often fail to gather energy-related details. Currently, the collection of most data on public investments in clean energy and renewables remains decentralized, reducing consistency. For comparability across public donors, data collection must be centralized through the use of online data-entry portals and questionnaires prefilled to the extent possible with data from other agencies. The OECD/DAC Creditor Reporting System database is exemplary in this regard and also allows for self-reporting by donors.

Exchange rates and inflation must be taken into account when comparing international commitments across countries. The OECD methodology is used in this report to deflate international flows by adjusting for inflation from the year the flows occurred to a baseline year (2020) and by converting local-currency values to U.S. dollars using exchange rates from the baseline year (2020).

Installed Renewable Electricity: Generating Capacity in Developing Countries

Indicator 7.b.1 tracks the installed capacity of power plants that generate electricity from renewable sources of energy (expressed in watts per capita). The 36 energy types disaggregated by IRENA as renewable fall into six broad categories: hydropower; marine energy (ocean, tidal, and wave energy); wind energy; solar energy (photovoltaic and thermal energy); bioenergy; and geothermal energy.

Capacity is defined as the net maximum electrical capacity installed at year end. Assessing a country's capacity to produce electricity is a valuable way to track progress toward target 7.B because it is an actual reflection of efforts. For many nations, the focus on increasing electricity production, especially from renewable sources, is a crucial step in their journey toward sustainable and modernized services.

The capacity data are collected in the course of IRENA's annual questionnaire cycle. Countries receive questionnaires at the beginning of each year and report renewable energy data for the previous two years. To minimize the reporting burden, the questionnaires for some countries are prefilled with data collected by other agencies (e.g., Eurostat) and are then sent out to countries to provide any additional details requested by IRENA. Validated data, by country, are published each year in late June in IRENA's Renewable Energy Statistics Yearbook. Population data are extracted from the World Population Prospects (UN Population Division 2022). The population data represent the population of a country at mid-year (July 1).

A measure of indicator 7.b.1 in watts per capita is computed by dividing renewable electricity generating capacity at year end by the total population of the country for each country and year. The capacity data are drawn from the computation, and the data account for the immense variations in needs between countries. Population data are used instead of GDP, as population is the most basic indicator of country demand for modern and sustainable energy services.

Importantly, the indicator's focus on electricity capacity does not capture trends in the modernization of technologies in important energy-intense sectors such as heat production and transport. Overall, electricity accounts for only about a quarter of the energy used globally; the share is even lower in most developing countries. With electricity access continuing to increase, however, the relevance of the focus on electricity capacity will rise.

Conclusion

Since the first effort back in 2013, improvements in reporting, advances in countries' statistical capacities, and enhanced models have raised the quality, reliability, and consistency of data on progress toward SDG 7 targets. This progress should be seen as a reminder of the value of pursuing a common framework using standardized methodologies of data collection and estimation. Achieving the common framework will depend on cooperation among national statistical offices and between those offices and relevant international bodies. International cooperation in the compilation of global databases will harmonize estimates across regions and countries and raise awareness of the need for good data.

As the custodian agencies work together on global tracking of SDG 7, they have found ways to refine their collaboration and to strengthen their support to countries. For example, the custodial agencies responsible for this report host webinars for statistical agencies, produce statistical guidance and reports on data collection, and regularly consult with national statistical offices about the estimates they provide. Continuing efforts by the World Bank, WHO, and other custodians to mainstream energy access questions into national household surveys are an important form of support to those offices. Workshops to support national and regional data-collection efforts have also contributed to stronger capabilities. More such support is required to build national statistical capacities.

IEA and UNSD, in particular, have a long history of working together to build national reporting capacity. Both agencies participate in a set of workshops led by the United Nations Framework Convention on Climate Change to help countries improve their compilation of energy balances. More accurate energy balances lead to more accuracy in the estimation of indicators 7.2.1 and 7.3.1. Another example is the compilation of a policy brief by the SDG 7 Tracking Group for the 2023 High-Level Political Forum on Sustainable Development. As a byproduct of this report, the policy brief will contribute to the discussions of the High-Level Political Forum and support its work.

The SDG 7 custodian agencies emphasize the need to strengthen resources for enhanced national data collection within current and planned international programs on energy transitions. Building on recent improvements in data collection for the SDGs, domestic statistical capacities must be further strengthened. Resources should be increased for this purpose.

Finally, the custodian agencies would like to express their appreciation of the work and dedication of the many colleagues who collect national-level data around the world. Without their efforts, no precise estimates could be produced, and no tracking would be possible. Their work underpins the international efforts culminating in this report and ensures that the SDG 7 targets are kept in full view.

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Appendix: Regional Classifications of Countries/Territories

This report classifies countries and territories according to the United Nations' SDG classification for regions, the most recent classification for developing countries, and the special groupings for the least-developed countries (LDCs), landlocked developing countries (LLDCs), and small island developing states (SIDS) (table 7.2). The SDG regional groupings are not the same as the M49 regional grouping of the United Nations, which focuses more closely on geography. The United Nations discontinued its developing countries classification in late 2022. This report will continue to use the most recent UN classification of developing countries to ensure continuity for indicators 7.a.1 and 7.b.1 (as well as 12.a.1).

Table 7.2 • Groupings of regions, countries, and territories as used in this report

CATEGORY	COUNTRIES/TERRITORIES WITHIN THE CATEGORY
Northern America and Europe	Åland Islands, Albania, Andorra, Austria, Belarus, Belgium, Bermuda, Bosnia and Herzegovina, Bulgaria, Canada, Channel Islands, Croatia, Czechia, Denmark, Estonia, Faroe Islands, Finland, France, Germany, Gibraltar, Greece, Greenland, Guernsey, Holy See, Hungary, Iceland, Ireland, Isle of Man, Italy, Jersey, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Montenegro, Netherlands, Norway, Poland, Portugal, Republic of Moldova, Romania, Russian Federation, Saint Pierre and Miquelon, San Marino, Serbia, Slovakia, Slovenia, Spain, Svalbard and Jan Mayen Islands, Sweden, Switzerland, North Macedonia, Ukraine, United Kingdom of Great Britain and Northern Ireland, United States of America
Sub-Saharan Africa	Angola, Benin, Botswana, British Indian Ocean Territory, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, French Southern and Antarctic Territories, Gabon, Gambia, Ghana, Guinea, Guinea- Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Mozambique, Namibia, Niger, Nigeria, Réunion, Rwanda, Saint Helena, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Eswatini, Togo, Uganda, United Republic of Tanzania, Zambia, Zimbabwe
Latin America and the Caribbean	Anguilla, Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bolivia (Plurinational State of), Bonaire, Sint Eustatius and Saba, Brazil, British Virgin Islands, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Curaçao, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands (Malvinas), French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Barthélemy, Saint Kitts and Nevis, Saint Lucia, Saint Martin (French Part), Saint Vincent and the Grenadines, Sint Maarten (Dutch part), South Georgia and the South Sandwich Islands, Suriname, Trinidad and Tobago, Turks and Caicos Islands, United States Virgin Islands, Uruguay, Venezuela (Bolivarian Republic of)
Western Asia and Northern Africa	Algeria, Armenia, Azerbaijan, Bahrain, Cyprus, Egypt, Georgia, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, State of Palestine, Sudan, Syrian Arab Republic, Tunisia, Türkiye, United Arab Emirates, Western Sahara, Yemen
Oceania, excluding Australia and New Zealand	American Samoa, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia (Federated States of), Nauru, New Caledonia, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, United States minor outlying islands, Vanuatu, Wallis and Futuna Islands
Eastern Asia and South-eastern Asia	Brunei Darussalam, Cambodia, China, China, Hong Kong Special Administrative Region, China, Macao Special Administrative Region, Democratic People's Republic of Korea, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Mongolia, Myanmar, Philippines, Republic of Korea, Singapore, Thailand, Timor-Leste, Viet Nam
Central Asia and Southern Asia	Afghanistan, Bangladesh, Bhutan, India, Iran (Islamic Republic of), Kazakhstan, Kyrgyzstan, Maldives, Nepal, Pakistan, Sri Lanka, Tajikistan, Turkmenistan, Uzbekistan
Australia and New Zealand	Australia, Christmas Island, Cocos (Keeling) Islands, Heard Island and McDonald Islands, New Zealand, Norfolk Island

CATEGORY	COUNTRIES/TERRITORIES WITHIN THE CATEGORY
Developed countries	Åland Islands, Albania, Andorra, Australia, Austria, Belarus, Belgium, Bermuda, Bosnia and Herzegovina, Bulgaria, Canada, Channel Islands, Christmas Island, Cocos (Keeling) Islands, Croatia, Cyprus, Czechia, Denmark, Estonia, Faroe Islands, Finland, France, Germany, Gibraltar, Greece, Greenland, Guernsey, Heard Island and McDonald Islands, Holy See, Hungary, Iceland, Ireland, Isle of Man, Israel, Italy, Japan, Jersey, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Montenegro, (Kingdom of the) Netherlands, New Zealand, Norfolk Island, Norway, Poland, Portugal, Republic of Korea, Republic of Moldova, Romania, Russian Federation, Saint Pierre and Miquelon, San Marino, Serbia, Slovakia, Slovenia, Spain, Svalbard and Jan Mayen Islands, Sweden, Switzerland, Republic of North Macedonia, Ukraine, United Kingdom of Great Britain and Northern Ireland, United States of America
Developing countries	Afghanistan, Algeria, American Samoa, Angola, Anguilla, Antigua and Barbuda, Argentina, Armenia, Aruba, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belize, Benin, Bhutan, Bolivia (Plurinational State of), Bonaire, Sint Eustatius and Saba, Botswana, Brazil, British Indian Ocean Territory, British Virgin Islands, Brunei Darussalam, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Cayman Islands, Central African Republic, Chad, Chile, China, China, Hong Kong Special Administrative Region, China, Macao Special Administrative Region, Colombia, Comoros, Congo, Cook Islands, Costa Rica, Côte d'Ivoire, Cuba, Curaçao, Democratic People's Republic of Korea, Democratic Republic of the Congo, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Ethiopia, Falkland Islands (Malvinas), Fiji, French Guiana, French Polynesia, French Southern and Antarctic Territories, Gabon, Gambia, Georgia, Ghana, Grenada, Guadeloupe, Guam, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, India, Indonesia, Iran (Islamic Republic of), Iraq, Jamaica, Jordan, Kazakhstan, Kenya, Kiribati, Kuwait, Kyrgyzstan, Lao People's Democratic Republic, Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Malaysia, Maldives, Mali, Marshall Islands, Martinique, Mauritania, Mauritius, Mayotte, Mexico, Micronesia (Federated States of), Mongolia, Montserrat, Morocco, Mozambique, Myanmar, Namibia, Nauru, Nepal, New Caledonia, Nicaragua, Niger, Nigeria, Niue, Northern Mariana Islands, Oman, Pakistan, Palau, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Pitcairn, Puerto Rico, Qatar, Réunion, Rwanda, Saint Barthélemy, Saint Helena, Saint Kitts and Nevis, Saint Lucia, Saint Martin (French Part), Saint Vincent and the Grenadines, Samoa, Sao Tome and Principe, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Singapore, Sint Maarten (Dutch part), Solomon Islands, Somalia, South Africa, South Georgia and the South Sandwich Islands, South Sudan, Sri Lanka, State of Palestine, Sudan, Suriname, Eswatini, Syrian Arab Republic, Tajikistan, Thailand, Timor-Leste, Togo, Tokelau, Tonga, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Turks and Caicos Islands, Tuvalu, Uganda, United Arab Emirates, United Republic of Tanzania, United States minor outlying islands, United States Virgin Islands, Uruguay, Uzbekistan, Vanuatu, Venezuela (Bolivarian Republic of), Viet Nam, Wallis and Futuna Islands, Western Sahara, Yemen, Zambia, Zimbabwe
Least-developed countries (LDCs)	Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, South Sudan, Sudan, Timor-Leste, Togo, Tuvalu, Uganda, United Republic of Tanzania, Yemen, Zambia
Landlocked developing countries (LLDCs)	Afghanistan, Armenia, Azerbaijan, Bhutan, Bolivia (Plurinational State of), Botswana, Burkina Faso, Burundi, Central African Republic, Chad, Ethiopia, Kazakhstan, Kyrgyzstan, Lao People's Democratic Republic, Lesotho, Malawi, Mali, Mongolia, Nepal, Niger, Paraguay, Rwanda, South Sudan, Eswatini, Tajikistan, Turkmenistan, Uganda, Uzbekistan, Zambia, Zimbabwe
Small island developing states (SIDS)	American Samoa, Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Bonaire, Sint Eustatius and Saba, British Virgin Islands, Cabo Verde, Comoros, Cook Islands, Cuba, Curaçao, Dominica, Dominican Republic, Fiji, French Polynesia, Grenada, Guam, Guinea-Bissau, Guyana, Haiti, Jamaica, Kiribati, Maldives, Marshall Islands, Mauritius, Micronesia (Federated States of), Montserrat, Nauru, New Caledonia, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Sao Tome and Principe, Seychelles, Singapore, Sint Maarten (Dutch part), Solomon Islands, Suriname, Timor-Leste, Tonga, Trinidad and Tobago, Tuvalu, United States Virgin Islands, Vanuatu

CATEGORY	COUNTRIES/TERRITORIES WITHIN THE CATEGORY
"Developing countries" under the indicator 7.a.1. These are a modified list of countries specific to the international public finance flows	Afghanistan, Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Azerbaijan, Bahamas (the), Bangladesh, Barbados, Belarus, Belize, Benin, Bhutan, Bolivia (Plurinational State of), Bosnia and Herzegovina, Botswana, Brazil, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Central African Republic (the), Chad, Chile, China, China, Hong Kong Special Administrative Region, China, Macao Special Administrative Region, Chinese Taipei, Colombia, Comoros (the), Congo (the), Cook Islands (the), Costa Rica, Côte d'Ivoire, Cuba, Democratic People's Republic of Korea (the), Democratic Republic of the Congo (the), Djibouti, Dominica, Dominican Republic (the), Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Fiji, French Polynesia, Gabon, Gambia (the), Georgia, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, India, Indonesia, Iran (Islamic Republic of), Iraq, Jamaica, Jordan, Kazakhstan, Kenya, Kiribati, Kosovo, Kyrgyzstan, Lao People's Democratic Republic (the), Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Malaysia, Maldives, Mali, Marshall Islands (the), Mauritania, Mauritius, Mexico, Micronesia (Federated States of), Mongolia, Montenegro, Montserrat, Morocco, Mozambique, Myanmar, Namibia, Nauru, Nepal, New Caledonia, Nicaragua, Niger (the), Nigeria, Niue, North Macedonia, Pakistan, Palau, Panama, Papua New Guinea, Paraguay, Peru, Philippines (the), Republic of Moldova (the), Residual/unallocated ODA: Central Asia and Southern Asia, Residual/unallocated ODA: Eastern and South-eastern Asia, Residual/unallocated ODA: Latin America and the Caribbean, Residual/unallocated ODA: Northern America and Europe, Residual/unallocated ODA: Oceania excl. Aus. and N. Zealand, Residual/unallocated ODA: Sub-Saharan Africa, Residual/unallocated ODA: Western Asia and Northern Africa, Rwanda, Saint Helena, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Sao Tome and Principe, Senegal, Serbia, Seychelles, Sierra Leone, Solomon Islands, Somalia, South Africa, South Sudan, Sri Lanka, State of Palestine (the), Sudan (the), Suriname, Syrian Arab Republic (the), Tajikistan, Thailand, Timor-Leste, Togo, Tokelau, Tonga, Trinidad and Tobago, Tunisia, Türkiye, Turkmenistan, Tuvalu, Uganda, Ukraine, United Republic of Tanzania (the), Unspecified countries, Uruguay, Uzbekistan, Vanuatu, Venezuela (Bolivarian Republic of), Viet Nam, Wallis and Futuna Islands, Yemen, Zambia, Zimbabwe

SDG 7.1.1 • Proportion of population with access to electricity

Source: World Bank

COUNTRY	TOTAL ELECTRICITY ACCESS RATE (%)										URBAN ELECTRICITY ACCESS RATE (%)		RURAL ELECTRICITY ACCESS RATE (%)	
	2000		2005		2010		2015		2021		2021		2021	
Afghanistan	4		29		43	*d*	72	*d*	98	*g*	100	*g*	97	
Albania	99		99		100		100	*k*	100		100		100	
Algeria	99		99		99		99		100		100		99	
American Samoa														
Andorra	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Angola	24		29		35		42	*d*	48		75			
Anguilla	95		96		98		100		100					
Antigua and Barbuda	98		92	*d*	99		100	*m*	100	*m*	100	*m*	100	*m*
Argentina	96		97		99	*e*	100		100		100		100	
Armenia	99	*d*	100	*d*	100	*d*	100	*d*	100		100		100	
Aruba	92	*e*	100	*m*	93	*e*	100	*m*	100	*m*	100	*m*	100	*m*
Australia	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Austria	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Azerbaijan	99	*c*	99		100		100		100		100		100	
Bahamas	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Bahrain	100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Bangladesh	32	*d*	44	*g*	55	*g*	74		99		100		99	
Barbados	100	*m*	100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Belarus	89		92		94		97		100		100		100	
Belgium	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Belize	79	*e*	83		90	*e*	92	*c*	98		98		97	
Benin	22		26		34	*g*	30	*k*	42		67		18	
Bermuda	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Bhutan	31	*g*	60	*e*	73	*c*	95		100		100		100	
Bolivia (Plurinational State of)	70	*h*	68	*h*	88		92	*h*	99		100		95	
Bosnia and Herzegovina	99		99		99		100	*k*	100		100		100	

COUNTRY	TOTAL ELECTRICITY ACCESS RATE (%)					URBAN ELECTRICITY ACCESS RATE (%)	RURAL ELECTRICITY ACCESS RATE (%)
	2000	2005	2010	2015	2021	2021	2021
Botswana	27	37	52	62 *k*	74	93	25
Brazil	94	97 *h*	99 *k*	100 *h*	99	100	97
British Virgin Islands	97	98	98 *e*	100 *m*	100 *m*	100 *m*	100 *m*
Brunei Darussalam	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Bulgaria	88	91	94	97	100 *g*	100 *g*	99
Burkina Faso	9	11	13 *d*	16	19	68	
Burundi	3	3 *c*	5 *d*	8	10	63	2
Cabo Verde	59	67 *d*	81 *e*	86	96	95	97
Cambodia	17 *d*	21 *d*	31 *d*	63	83	99	77
Cameroon	41 *c*	47	53	59	65	95	25
Canada	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Cayman Islands	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Central African Republic	6 *c*	7	10 *c*	13	16	35	2
Chad	3	5	6 *c*	8 *d*	11	43	1
Channel Islands	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Chile	98 *h*	98	100	100 *h*	100 *m*	100 *m*	100 *m*
China	97	98	100 *k*	100	100	100	100
China, Hong Kong Special Administrative Region	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
China, Macao Special Administrative Region	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Colombia	95 *d*	97 *d*	97 *h*	98 *h*	100	100	100
Comoros	40	51	70	74	88	100	83
Congo	29	34 *d*	40	44	50	67	12
Cook Islands	98	98	99	100 *g*	100	100	
Costa Rica	97 *k*	99 *h*	99 *h*	99 *h*	100	100	100
Côte d'Ivoire	49	59 *d*	58	63 *k*	71	95	45
Croatia	100	100	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*

COUNTRY	TOTAL ELECTRICITY ACCESS RATE (%)										URBAN ELECTRICITY ACCESS RATE (%)		RURAL ELECTRICITY ACCESS RATE (%)	
	2000		2005		2010		2015		2021		2021		2021	
Cuba	97	*k*	97		98		99		100		100		100	
Curaçao	100		100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Cyprus	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Czechia	100		100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Democratic People's Republic of Korea					29		40		53					
Democratic Republic of the Congo	7	*c*	6	*g*	13		17		21		44		1	
Denmark	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Djibouti	56		57		58		59		65		73		37	
Dominica	81		86		91		97		100		100		100	
Dominican Republic	89	*h*	90	*h*	98	*h*	99	*h*	98	*g*	99	*g*	95	
Ecuador	94		96	*h*	97	*h*	99	*h*	100		100		100	
Egypt	98	*d*	99	*d*	99		99	*k*	100		100		100	
El Salvador	85	*h*	88	*h*	92	*h*	95	*h*	98	*g*	99		94	
Equatorial Guinea	65		65		66		66		67		90		1	
Eritrea	29		34		40		46		53		76		36	
Estonia	100		100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Eswatini	20		34		46	*c*	64		83		95		79	
Ethiopia	13	*d*	14	*d*	25		29	*d*	54		94		43	
Faroe Islands	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Fiji	77		82		92		93		92	*c*	96	*c*	87	
Finland	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
France	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
French Polynesia	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Gabon	74	*d*	82	*g*	89		87		92		99		27	
Gambia	34	*c*	30	*c*	47		55		64		83		31	
Georgia	100		98	*c*	100	*k*	100	*k*	100		100		100	
Germany	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*

COUNTRY	TOTAL ELECTRICITY ACCESS RATE (%)										URBAN ELECTRICITY ACCESS RATE (%)		RURAL ELECTRICITY ACCESS RATE (%)	
	2000		2005		2010		2015		2021		2021		2021	
Ghana	44	*e*	41	*k*	64	*e*	74		86	*e*	95	*e*	74	
Gibraltar	100		100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Greece	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Greenland	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Grenada	86		88		89		91		94					
Guam	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Guatemala	73	*h*	78		84		91		98		98		98	
Guinea	15		20	*d*	28		35		47		90		21	
Guinea-Bissau			5		6	*g*	20		36		61		16	
Guyana	75		78	*d*	83		88		93		98		91	
Haiti	34	*d*	35		37		41		47		82			
Honduras	67		69	*h*	81	*h*	90	*h*	94		100		86	
Hungary	100		100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Iceland	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
India	60		69		76	*g*	88	*d*	100		100		99	
Indonesia	86	*g*	85		94	*g*	98	*g*	99	*k*	100	*k*	98	
Iran (Islamic Republic of)	98	*d*	98		99		100	*k*	100		100		100	
Iraq	97		97		98		99		100		100		100	
Ireland	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Isle of Man	100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Israel	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Italy	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Jamaica	84		88		92	*g*	95	*g*	100		100		100	
Japan	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Jordan	99		99		100	*k*	100		100	*k*	100		99	
Kazakhstan	100		100	*k*	100	*k*	100	*c*	100	*k*	100	*k*	100	
Kenya	15		25		19	*d*	42	*d*	77		98		68	

COUNTRY	TOTAL ELECTRICITY ACCESS RATE (%)					URBAN ELECTRICITY ACCESS RATE (%)	RURAL ELECTRICITY ACCESS RATE (%)
	2000	2005	2010	2015	2021	2021	2021
Kiribati	56	70 *e*	63 *e*	91 *e*	93	88	
Kuwait	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Kyrgyzstan	100	99 *c*	99 *i*	99 *k*	100	100	100
Lao People's Democratic Republic	43	57 *e*	70	90 *e*	100	100	100
Latvia	100	100	100	100 *m*	100 *m*	100 *m*	100 *m*
Lebanon	99	99	99	100	100	100	100
Lesotho	4 *c*	10	17 *g*	32	50	81	38
Liberia			5	15	30	50	8
Libya	100 *k*	90	82	74	70	100	
Liechtenstein	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Lithuania	99	99	100	100 *m*	100 *m*	100 *m*	100 *m*
Luxembourg	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Madagascar	13	16	12 *g*	24	35	73	11
Malawi	5 *d*	7	9 *d*	11 *d*	14	54	6
Malaysia	99	99	99	100	100	100	100
Maldives	84 *e*	91	99	100	100	100	100
Mali	10	18	27	38 *d*	53	97	18
Malta	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Marshall Islands	69	76	89	92	100	96	100
Mauritania	19	18 *f*	34	40 *c*	48	90	
Mauritius	99 *e*	99	99	100	100 *e*	99	100
Mexico	98 *h*	99 *h*	99 *h*	99 *d*	100	100	100
Micronesia (Federated States of)	46 *e*	55	65 *e*	73	84	98	79
Monaco	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Mongolia	67 *e*	86 *g*	79 *c*	88	100	100	100
Montenegro	99	100 *c*	99	99	100	100	99
Morocco	70	79	96	97 *g*	100	100	100

COUNTRY	TOTAL ELECTRICITY ACCESS RATE (%)					URBAN ELECTRICITY ACCESS RATE (%)	RURAL ELECTRICITY ACCESS RATE (%)
	2000	2005	2010	2015	2021	2021	2021
Mozambique	6	12	19	24 *d*	31	77	4
Myanmar	42	47	49 *g*	61 *g*	72	94	63
Namibia	37 *d*	40	44	52 *g*	55	75	33
Nauru	99	99	99	99 *g*	100 *m*	100 *m*	100 *m*
Nepal	30	46	69 *k*	82	90 *c*	94 *c*	
Netherlands	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
New Caledonia	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
New Zealand	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Nicaragua	73	74 *h*	80	83	86	100	66
Niger	6 *c*	7 *g*	14	17 *g*	19 *d*	66 *d*	9
Nigeria	43	47	48 *d*	53 *d*	60 *c*	89 *c*	26
Niue	99	98	99	99	100	100	
North Macedonia	99	99	99	100	100	100	100
Northern Mariana Islands	100 *m*	100	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Norway	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Oman	100	100	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Pakistan	73	78	87	91	95	100	92
Palau	98	99 *e*	99	100	100	100	100
Panama	81 *e*	84	87 *e*	92	95 *g*	100 *g*	*m*
Papua New Guinea	12	14	20 *g*	18	21	65	14
Paraguay	90	95 *h*	97 *h*	99 *h*	100	100	100
Peru	72 *h*	77 *h*	88 *h*	94 *h*	96 *g*	99 *g*	84
Philippines	75	80	85	89 *f*	97	99	96
Poland	100	100	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Portugal	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Puerto Rico	100	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Qatar	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*

COUNTRY	TOTAL ELECTRICITY ACCESS RATE (%)										URBAN ELECTRICITY ACCESS RATE (%)		RURAL ELECTRICITY ACCESS RATE (%)	
	2000		2005		2010		2015		2021		2021		2021	
Republic of Korea	100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Republic of Moldova	99		99	*d*	99		100		100		100		100	
Romania	94		96		97		99		100	*m*	100	*m*	100	*m*
Russian Federation	98		98		99		96	*k*	100		99		100	
Rwanda	6	*d*	5	*d*	10	*d*	23	*d*	49		98		38	
Saint Kitts and Nevis	95		96		100		100	*m*	100	*m*	100	*m*	100	*m*
Saint Lucia	86		90		94	*e*	99		100		100		100	
Saint Martin (French Part)	100		100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Saint Vincent and the Grenadines	80		86		93		99		100		100		100	
Samoa	88		91		96		98		98	*e*	100		98	
San Marino	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Sao Tome and Principe	53	*c*	56		61		67		78		80		74	
Saudi Arabia	100		100	*m*	100	*m*	100	*m*	100	*g*	100	*m*	100	*m*
Senegal	38	*c*	47	*d*	57	*g*	61	*d*	68		94		43	
Serbia	100		100	*c*	100	*c*	100	*k*	100		100		100	
Seychelles	94		96		97	*e*	100	*m*	100	*m*	100	*m*	100	*m*
Sierra Leone	8		11	*c*	11	*c*	20		27		57		5	
Singapore	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Sint Maarten (Dutch part)	100		100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Slovakia	100		100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Slovenia	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Solomon Islands	5		19		35		55	*d*	76		79		75	
Somalia	2		15		52		51		49		71		31	
South Africa	72		81	*g*	83	*g*	85	*g*	89	*g*	87		93	
South Sudan					2	*e*	5		8		16		6	
Spain	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Sri Lanka	70		78		85	*g*	94		100		100		100	

COUNTRY	TOTAL ELECTRICITY ACCESS RATE (%)										URBAN ELECTRICITY ACCESS RATE (%)		RURAL ELECTRICITY ACCESS RATE (%)	
	2000		2005		2010		2015		2021		2021		2021	
State of Palestine	100	g	100	g	100	g	100	g	100		100		100	
Sudan	23	c	30		36		48		62		84		49	
Suriname	95		95		91	c	95		99		100		97	
Sweden	100	m	100	m	100	m	100	m	100	m	100	m	100	m
Switzerland	100	m	100	m	100	m	100	m	100	m	100	m	100	m
Syrian Arab Republic	93		92		93	g	90		89		100		75	
Tajikistan	98	c	99	c	99		98	k	100		99		100	
Thailand	82	d	93		100	f	100	c	100		100		100	
Timor-Leste	18		34		38	d	67	e	100		100		100	
Togo	17	c	27		31	c	45		56		96		25	
Tonga	86		89		93		100	k	100		100		100	
Trinidad and Tobago	91	e	95	g	100	m	100	m	100	m	100	m	100	m
Tunisia	95	g	99	k	100	j	100	k	100	k	100		100	
Türkiye	100		100		100	i	100	e	100		100		100	
Turkmenistan	100	d	100		100	i	100	c	100		100		100	
Turks and Caicos Islands	96	e	96		100	m	100	m	100	m	100	m	100	m
Tuvalu	95		96		97		98		100		100		99	
Uganda	7		9	d	12	g	19	d	45		72		36	
Ukraine	99		100	c	100		100		100		100		100	
United Arab Emirates	100	m	100	m	100	m	100	m	100	m	100	m	100	m
United Kingdom of Great Britain and Northern Ireland	100	m	100	m	100	m	100	m	100	m	100	m	100	m
United Republic of Tanzania	9		14		15	d	26		43		77		23	
United States of America	100	m	100	m	100	m	100	m	100	m	100	m	100	m
United States Virgin Islands	100	m	100	m	100	m	100	m	100	m	100	m	100	m
Uruguay	98		98		99	g	100	h	100	m	100	m	100	m
Uzbekistan	100		99		100		100		100	c	100	c	100	

COUNTRY	TOTAL ELECTRICITY ACCESS RATE (%)					URBAN ELECTRICITY ACCESS RATE (%)	RURAL ELECTRICITY ACCESS RATE (%)
	2000	2005	2010	2015	2021	2021	2021
Vanuatu	22	31	44 *k*	52	70	97	61
Venezuela (Bolivarian Republic of)	99 *h*	99	99	100 *g*	100	100	100
Viet Nam	88	96 *d*	97 *k*	99	100	100	100
Yemen	49	55	61	67	75	93	63
Zambia	17 *e*	23	22 *e*	31 *g*	47	86	15
Zimbabwe	34	36	39	34 *d*	49	85	32
World	**78**	**81**	**84**	**87**	**91**	**98**	**85**
Northern America and Europe	**99**	**99**	**100**	**99**	**100**	**100**	**100**
Latin America and the Caribbean	**92**	**94**	**96**	**97**	**98**	**100**	**97**
Central Asia and Southern Asia	**61**	**69**	**77**	**88**	**99**	**100**	**98**
Eastern Asia and South-eastern Asia	**92**	**94**	**96**	**97**	**98**	**100**	**98**
Western Asia and Northern Africa	**88**	**90**	**92**	**93**	**94**	**99**	**88**
Sub-Saharan Africa	**26**	**29**	**33**	**39**	**50**	**81**	**29**
Oceania	**82**	**81**	**82**	**81**	**81**	**98**	**47**

Note: Unless otherwise noted, data are World Bank estimates based on the statistical model described in Chapter 1.

a. Most surveys report data on the percentage of households with access to electricity rather than on the percentage of the population with access.
b. Rural data are calculated based on the urban and total population with access.
c. Based on Multi-Indicator Cluster Survey (MICS)
d. Based on Demographic and Health Survey (DHS)
e. Based on Census
f. Based on Living Standards Measurement Survey (LSMS)
g. Based on other National Surveys conducted by national statistical agencies
h. Based on Socio-Economic Database for Latin America and the Caribbean (SEDLAC)
i. Based on Europe and Central Asia Poverty Database (ECAPOV)
j. Based on Middle East and North Africa Poverty Database (MNAPOV)
k. Based on other official sources
l. Based on Multi-Tier Framework (MTF)
m. Based on assumption: where survey data were not collected, countries considered "high income" by the World Bank are assumed to reach universal access.

SDG 7.1.2 • Access to clean fuels and technologies for cooking

Source: World Health Organization, Global Health Observatory

COUNTRY	TOTAL CLEAN COOKING ACCESS RATE (%)				RURAL CLEAN COOKING ACCESS RATE (%)				URBAN CLEAN COOKING ACCESS RATE (%)			
	2000	2010	2015	2021	2000	2010	2015	2021	2000	2010	2015	2021
Afghanistan	7	20	27	35	1	6	11	18	30	69	79	85
Albania	39	66	76	84	19	44	57	68	67	86	91	94
Algeria	97	99	100	100	93	98	98	99	100	100	100	100
American Samoa												
Andorra	100	100	100	100	100	100	100	100	100	100	100	100
Angola	40	45	47	50	7	7	8	8	80	78	78	77
Anguilla												
Antigua and Barbuda	100	100	100	100	100	100	100	100	100	100	100	100
Argentina	96	99	100	100	76	93	96	98	98	100	100	100
Armenia	80	96	97	98	56	90	94	96	94	99	100	100
Aruba												
Australia	100	100	100	100	100	100	100	100	100	100	100	100
Austria	100	100	100	100	100	100	100	100	100	100	100	100
Azerbaijan	70	93	97	98	43	87	94	98	95	99	99	99
Bahamas	100	100	100	100	100	100	100	100	100	100	100	100
Bahrain	100	100	100	100	100	100	100	100	100	100	100	100
Bangladesh	8	13	18	26	1	2	5	10	34	42	50	59
Barbados	100	100	100	100	100	100	100	100	100	100	100	100
Belarus	94	99	99	100	86	96	98	99	99	100	100	100
Belgium	100	100	100	100	100	100	100	100	100	100	100	100
Belize	79	84	83	83	67	73	73	74	94	96	96	95
Benin	1	5	5	5	0	1	1	1	1	9	9	8
Bermuda												
Bhutan	28	64	78	87	10	49	66	80	86	96	97	98
Bolivia (Plurinational State of)	63	76	82	88	18	38	51	65	92	96	98	99

COUNTRY	TOTAL CLEAN COOKING ACCESS RATE (%)				RURAL CLEAN COOKING ACCESS RATE (%)				URBAN CLEAN COOKING ACCESS RATE (%)			
	2000	2010	2015	2021	2000	2010	2015	2021	2000	2010	2015	2021
Bosnia and Herzegovina	52	45	43	42	32	21	18	14	80	70	65	62
Botswana	44	58	62	66	20	28	28	26	70	82	84	86
Brazil	89	94	96	96	55	70	76	82	97	98	99	99
British Virgin Islands												
Brunei Darussalam	100	100	100	100	100	100	100	100	100	100	100	100
Bulgaria												
Burkina Faso	3	6	8	12	1	1	1	1	12	21	28	37
Burundi	0	0	0	0	0	0	0	0	1	0	0	0
Cambodia	4	12	21	44	1	4	10	34	16	45	60	74
Cameroon	10	19	22	23	1	2	2	2	21	37	40	39
Canada	100	100	100	100	100	100	100	100	100	100	100	100
Cabo Verde	62	70	75	82	30	33	40	53	90	91	93	95
Cayman Islands												
Central African Republic	1	1	1	1	0	0	0	0	1	1	1	2
Chad	3	3	4	8	2	0	0	0	4	10	18	33
Channel Islands												
Chile	100	100	100	100	100	100	100	100	100	100	100	100
China	40	58	71	83	21	34	50	70	69	81	86	91
Colombia	78	86	90	93	33	44	54	67	93	97	98	99
Comoros	0	3	6	11	0	1	2	4	1	7	14	25
Democratic Republic of the Congo	1	3	4	4	0	0	0	1	5	9	10	10
Congo	8	17	25	36	1	2	3	4	13	26	37	50
Cook Islands	80	82	80	79	42	35	30	25	98	98	98	98
Costa Rica	89	92	94	96	78	81	84	88	97	98	98	98
Côte d'Ivoire	17	19	23	32	3	1	1	1	34	37	46	61
Croatia	100	100	100	100	100	100	100	100	100	100	100	100

COUNTRY	TOTAL CLEAN COOKING ACCESS RATE (%)				RURAL CLEAN COOKING ACCESS RATE (%)				URBAN CLEAN COOKING ACCESS RATE (%)			
	2000	2010	2015	2021	2000	2010	2015	2021	2000	2010	2015	2021
Cuba	71	90	93	94	37	78	85	88	85	94	96	97
Curaçao												
Cyprus	100	100	100	100	100	100	100	100	100	100	100	100
Czechia	100	100	100	100	100	100	100	100	100	100	100	100
Denmark	100	100	100	100	100	100	100	100	100	100	100	100
Djibouti	4	6	8	10	1	1	0	0	4	8	10	12
Dominica	81	88	90	89	58	71	77	79	95	97	97	97
Dominican Republic	83	88	89	92	66	70	71	76	95	95	95	96
Ecuador	88	94	94	95	70	83	85	86	99	99	99	99
Egypt	83	99	100	100	73	99	100	100	96	100	100	100
El Salvador	58	77	85	93	24	48	65	83	83	93	96	97
Eswatini	25	39	48	58	10	23	32	44	60	80	86	90
Equatorial Guinea	18	23	24	24	4	5	5	4	30	34	33	31
Eritrea	4	8	10	12	0	1	1	1	11	21	23	24
Estonia	100	100	100	100	100	100	100	100	100	100	100	100
Ethiopia	1	2	4	8	0	0	0	0	2	11	18	27
Faroe Islands												
Fiji	28	33	40	51	10	14	19	28	47	51	59	69
Finland	100	100	100	100	100	100	100	100	100	100	100	100
France	100	100	100	100	100	100	100	100	100	100	100	100
French Polynesia												
Gabon	64	80	86	90	15	30	40	50	79	90	93	95
Gambia	4	3	2	2	2	1	0	0	5	4	3	2
Georgia	47	66	79	91	8	35	59	82	85	93	96	97
Germany	100	100	100	100	100	100	100	100	100	100	100	100
Ghana	6	15	21	30	1	4	7	12	14	28	36	46
Gibraltar												

COUNTRY	TOTAL CLEAN COOKING ACCESS RATE (%)				RURAL CLEAN COOKING ACCESS RATE (%)				URBAN CLEAN COOKING ACCESS RATE (%)			
	2000	2010	2015	2021	2000	2010	2015	2021	2000	2010	2015	2021
Greece	100	100	100	100	100	100	100	100	100	100	100	100
Greenland												
Grenada	92	93	91	88	93	92	90	87	94	95	95	94
Guam												
Guatemala	41	38	42	48	17	12	12	12	67	63	67	73
Guinea	1	1	1	1	0	0	0	0	1	1	2	2
Guinea-Bissau	1	1	1	1	0	0	0	0	4	3	2	2
Guyana	35	61	73	82	27	56	70	81	55	75	81	85
Haiti	2	4	4	4	1	1	1	1	6	7	7	6
Honduras	30	42	46	50	9	15	19	24	56	70	72	73
China, Hong Kong Special Administrative Region												
Hungary	100	100	100	100	100	100	100	100	100	100	100	100
Iceland	100	100	100	100	100	100	100	100	100	100	100	100
India	22	36	49	71	7	15	28	57	50	71	83	93
Indonesia	7	41	67	87	2	23	50	78	15	61	84	94
Iran (Islamic Republic of)	93	97	97	96	86	92	92	92	98	99	99	99
Iraq	70	95	98	99	53	90	96	99	79	98	99	100
Ireland	100	100	100	100	100	100	100	100	100	100	100	100
Isle of Man												
Israel	100	100	100	100	100	100	100	100	100	100	100	100
Italy	100	100	100	100	100	100	100	100	100	100	100	100
Jamaica	75	86	86	82	52	75	81	86	98	96	92	84
Japan	100	100	100	100	100	100	100	100	100	100	100	100
Jordan	100	100	100	100	99	100	100	99	100	100	100	100
Kazakhstan	85	92	93	94	69	83	87	90	97	98	98	98
Kenya	2	7	12	24	0	2	3	8	6	20	30	51

COUNTRY	TOTAL CLEAN COOKING ACCESS RATE (%)				RURAL CLEAN COOKING ACCESS RATE (%)				URBAN CLEAN COOKING ACCESS RATE (%)			
	2000	2010	2015	2021	2000	2010	2015	2021	2000	2010	2015	2021
Kiribati	1	3	6	12	0	1	1	2	1	6	11	20
Democratic People's Republic of Korea	2	6	9	12	1	1	1	1	2	9	13	19
Republic of Korea	100	100	100	100	100	100	100	100	100	100	100	100
Kosovo												
Kuwait	100	100	100	100	100	100	100	100	100	100	100	100
Kyrgyzstan	54	71	76	78	36	58	66	68	86	93	94	95
Lao People's Democratic Republic	1	4	6	9	1	1	1	2	3	10	15	21
Latvia	100	100	100	100	100	100	100	100	100	100	100	100
Lebanon												
Lesotho	16	31	36	41	8	15	18	21	47	73	78	82
Liberia	1	0	0	0	0	0	0	0	1	0	0	1
Libya												
Liechtenstein												
Lithuania	100	100	100	100	100	100	100	100	100	100	100	100
Luxembourg	100	100	100	100	100	100	100	100	100	100	100	100
China, Macao Special Administrative Region												
Madagascar	1	1	1	1	1	1	0	0	3	2	2	4
Malawi	2	2	2	2	0	1	1	0	12	11	10	6
Malaysia	98	98	96	94	96	94	93	90	100	99	99	98
Maldives	48	93	98	100	34	90	97	100	94	99	100	100
Mali	1	1	1	1	0	0	0	0	2	2	2	2
Malta	100	100	100	100	100	100	100	100	100	100	100	100
Marshall Islands	12	54	64	67	2	2	1	1	17	72	84	87
Mauritania	29	42	45	48	14	19	19	20	53	68	71	74
Mauritius	93	98	98	99	91	97	98	99	97	99	99	99

COUNTRY	TOTAL CLEAN COOKING ACCESS RATE (%)				RURAL CLEAN COOKING ACCESS RATE (%)				URBAN CLEAN COOKING ACCESS RATE (%)			
	2000	2010	2015	2021	2000	2010	2015	2021	2000	2010	2015	2021
Mexico	83	85	85	85	46	52	53	59	98	95	93	91
Micronesia (Federated States of)	11	12	13	13	3	5	4	3	28	31	33	34
Republic of Moldova	64	91	96	98	40	86	94	97	96	98	99	99
Monaco	100	100	100	100	100	100	100	100	100	100	100	100
Mongolia	23	35	44	53	2	7	11	16	40	50	60	71
Montenegro	66	63	62	62	44	41	42	44	83	75	72	71
Morocco	90	96	98	98	80	92	95	97	100	100	100	99
Mozambique	2	3	4	5	1	0	0	0	5	9	11	14
Myanmar	2	10	21	44	0	3	8	27	5	26	53	82
Namibia	34	41	44	47	11	12	12	13	77	76	75	72
Nauru	100	100	100	100	100	100	100	100	100	100	100	100
Nepal	6	21	28	35	2	10	15	22	24	64	67	63
Netherlands	100	100	100	100	100	100	100	100	100	100	100	100
New Caledonia												
New Zealand	100	100	100	100	100	100	100	100	100	100	100	100
Nicaragua	34	45	51	57	6	8	9	10	55	70	78	86
Niger	1	1	2	3	0	0	0	0	4	6	9	13
Nigeria	1	2	6	17	0	1	2	5	1	4	11	33
Niue	75	94	97	98	70	92	96	98	87	96	98	98
North Macedonia	56	68	73	79	37	44	50	59	69	85	90	92
Northern Mariana Islands												
Norway	100	100	100	100	100	100	100	100	100	100	100	100
Oman	100	100	100	100	100	100	100	100	100	100	100	100
Pakistan	24	35	42	51	4	11	17	28	66	82	86	87
Palau	54	51	47	43	70	59	51	43	50	50	47	42
Panama	100	100	100	100	100	100	100	100	100	100	100	100
Papua New Guinea	5	8	9	10	0	3	4	5	39	40	38	36

COUNTRY	TOTAL CLEAN COOKING ACCESS RATE (%)				RURAL CLEAN COOKING ACCESS RATE (%)				URBAN CLEAN COOKING ACCESS RATE (%)			
	2000	2010	2015	2021	2000	2010	2015	2021	2000	2010	2015	2021
Paraguay	48	57	65	70	17	28	36	42	72	77	84	86
Peru	42	66	75	86	4	14	24	45	59	84	91	96
Philippines	38	41	43	48	19	22	23	28	55	62	64	69
Poland	100	100	100	100	100	100	100	100	100	100	100	100
Portugal	100	100	100	100	100	100	100	100	100	100	100	100
Puerto Rico												
Qatar	100	100	100	100	100	100	100	100	100	100	100	100
Romania	100	100	100	100	100	100	100	100	100	100	100	100
Russian Federation	100	96	88	73	100	96	89	76	100	97	91	76
Rwanda	0	0	1	5	0	0	0	1	0	1	4	24
Samoa	18	27	31	37	9	18	23	30	45	57	62	66
San Marino	100	100	100	100	100	100	100	100	100	100	100	100
Sao Tome and Principe	0	1	2	4	0	0	0	1	0	2	3	5
Saudi Arabia	100	100	100	100	100	100	100	100	100	100	100	100
Senegal	35	33	28	29	7	7	6	6	68	64	53	54
Serbia	58	68	73	81	30	44	53	66	82	86	89	92
Seychelles	100	100	100	100	100	100	100	100	100	100	100	100
Sierra Leone	0	0	1	1	0	0	0	0	0	1	1	2
Singapore	100	100	100	100	100	100	100	100	100	100	100	100
Sint Maarten (Dutch part)												
Slovakia	100	100	100	100	100	100	100	100	100	100	100	100
Slovenia	100	100	100	100	100	100	100	100	100	100	100	100
Solomon Islands	9	8	8	9	4	2	2	1	37	37	36	36
Somalia	0	1	2	4	0	0	0	0	0	2	4	6
South Africa	56	77	84	88	30	56	64	70	77	89	93	96
South Sudan	0	0	0	0	0	0	0	0	0	0	0	0
Spain	100	100	100	100	100	100	100	100	100	100	100	100

COUNTRY	TOTAL CLEAN COOKING ACCESS RATE (%)				RURAL CLEAN COOKING ACCESS RATE (%)				URBAN CLEAN COOKING ACCESS RATE (%)			
	2000	2010	2015	2021	2000	2010	2015	2021	2000	2010	2015	2021
Sri Lanka	16	22	26	33	10	15	18	24	50	58	64	71
Saint Kitts and Nevis	100	100	100	100	100	100	100	100	100	100	100	100
Saint Lucia	86	95	96	94	94	96	95	94	72	94	97	98
Saint Vincent and the Grenadines	96	96	95	93	97	96	96	95	96	96	96	95
Sudan	7	32	47	63	6	23	37	55	18	54	67	77
Suriname	76	87	92	95	57	76	84	91	88	94	96	98
Sweden	100	100	100	100	100	100	100	100	100	100	100	100
Switzerland	100	100	100	100	100	100	100	100	100	100	100	100
Syrian Arab Republic	98	99	98	96	98	98	97	95	100	100	100	100
Tajikistan	36	69	78	86	21	59	71	81	79	95	97	98
United Republic of Tanzania	1	2	3	7	0	0	1	2	1	4	8	16
Thailand	59	73	79	85	46	63	70	79	86	88	89	91
Timor-Leste	1	5	9	15	0	1	3	5	4	12	21	34
Togo	0	3	7	11	0	0	1	1	1	8	15	24
Tonga	34	60	73	87	22	51	67	84	78	89	92	95
Trinidad and Tobago	100	100	100	100	100	100	100	100	100	100	100	100
Tunisia	94	99	100	100	91	99	99	100	96	100	100	100
Türkiye	90	94	95	95	78	83	84	85	98	99	100	100
Turkmenistan	99	100	100	100	99	100	100	100	100	100	100	100
Turks and Caicos Islands												
Tuvalu	12	47	66	75	9	26	35	41	10	64	87	95
Uganda	1	1	1	1	0	0	0	0	4	3	2	2
Ukraine	91	94	95	95	85	87	88	88	95	98	99	99
United Arab Emirates	100	100	100	100	100	100	100	100	100	100	100	100
United Kingdom of Great Britain and Northern Ireland	100	100	100	100	100	100	100	100	100	100	100	100
United States of America	100	100	100	100	100	100	100	100	100	100	100	100

COUNTRY	TOTAL CLEAN COOKING ACCESS RATE (%)				RURAL CLEAN COOKING ACCESS RATE (%)				URBAN CLEAN COOKING ACCESS RATE (%)			
	2000	2010	2015	2021	2000	2010	2015	2021	2000	2010	2015	2021
Uruguay	100	100	100	100	100	100	100	100	100	100	100	100
Uzbekistan	83	86	85	83	72	74	74	73	98	99	98	98
Vanuatu	16	12	9	7	4	3	2	2	59	39	28	19
Venezuela (Bolivarian Republic of)	98	97	97	96	79	80	82	84	100	99	99	98
Viet Nam	13	51	79	96	4	37	72	95	39	83	94	99
United States Virgin Islands												
State of Palestine												
Yemen	56	60	61	61	42	44	43	42	93	94	94	93
Zambia	14	16	14	10	1	2	2	2	38	38	30	20
Zimbabwe	34	30	30	30	5	5	6	7	88	82	80	78
Australia and New Zealand	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Central Asia and Southern Asia	26	37	48	65	9	16	26	49	57	73	82	89
Eastern Asia and South-eastern Asia	41	57	70	82	21	33	49	68	66	79	86	91
Latin America & the Caribbean	80	85	87	88	44	53	57	62	93	95	95	94
Northern America and Europe	>95	>95	>95	>95	>95	>95	>95	94	>95	>95	>95	>95
Oceania excluding Australia and New Zealand	10	12	13	15	<5	<5	6	7	42	44	45	46
Sub-Saharan Africa	9	12	14	18	<5	<5	<5	5	23	26	29	36
Western Asia and Northern Africa	80	89	91	93	65	79	82	84	92	>95	>95	>95
World	49	57	64	71	24	31	39	51	76	82	84	86

SDG 7.2.1 • Renewable energy share in the total final energy consumption

Data provided by the IEA and UNSD

UN COUNTRY NAME	SHARE IN TOTAL FINAL ENERGY CONSUMPTION (%)													FINAL CONSUMPTION OF RENEWABLE ENERGY (PJ)			TOTAL FINAL ENERGY CONSUMPTION (PJ)	SOURCE
	RENEWABLE ENERGY				SOLID BIOFUELS	LIQUID BIOFUELS	BIOGASES	HYDRO	TIDE	WIND	SOLAR	GEOTHERMAL	MUNICIPAL WASTE (RENEW)	ELECTRICITY CONSUMPTION (1)	HEAT RAISING (2)	TRANSPORT (3)		
	2000	2010	2015	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	
Afghanistan	45.0	15.2	17.5	17.6	7.4	0	0	10	0	0	0.3	0	0	18.8	13.5	0	183.9	a
Albania	41.4	37.0	38.5	44.6	8.8	5.6	0	29.3	0	0	0.9	0	0	22.7	7.4	4.3	77.1	b
Algeria	0.4	0.3	0.1	0.2	0	0	0	0	0	0	0.1	0	0	1.9	0.4	0.1	1556.6	b
American Samoa	0.0	0.0	0.2	0.5	0	0	0	0	0	0	0.5	0	0	0	0	0	3.2	a
Andorra	14.5	18.7	19.3	21.9	0.5	0	0	19.5	0	0	0.3	0	1.5	1.5	0	0	7	a
Angola	73.4	52.5	47.8	61.0	51.8	0	0	9.3	0	0	0	0	0	37.1	207.5	0	401	b
Anguilla	0.2	0.1	0.3	0.8	0.1	0	0	0	0	0	0.7	0	0	0	0	0	1.3	a
Antigua and Barbuda	0.0	0.0	0.4	0.7	0	0	0	0	0	0	0.7	0	0	0	0	0	5.7	a
Argentina	9.8	8.8	9.4	9.8	2.7	1.7	0	3.7	0	1.5	0.2	0	0	114.8	47.5	35.1	2005	b
Armenia	7.2	9.4	10.7	8.4	3	0	0	4.5	0	0	0.9	0	0	5.1	3.8	0.1	106.7	b
Aruba	0.2	5.5	6.7	8.7	0.4	0	0	0	0	7.7	0.5	0	0	0.5	0	0	6.4	a
Australia	8.4	8.2	9.3	10.9	4.7	0.1	0.2	1.4	0	1.9	2.6	0	0	170.2	163.4	9.6	3152.3	b
Austria	26.4	31.2	34.8	35.8	16.8	1.7	0.3	13	0	2.1	1.4	0.1	0.4	167.5	173.7	26	1026.4	b
Azerbaijan	2.1	4.4	2.3	1.2	0.4	0	0	0.7	0	0.1	0	0	0.1	3.4	1.4	0.1	393.9	b
Bahamas	0.0	1.3	1.5	1.4	1.4	0	0	0	0	0	0	0	0	0	0.3	0	20.8	a
Bahrain	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	202.8	b
Bangladesh	60.2	40.3	31.1	28.0	27.6	0	0	0.3	0	0	0.1	0	0	4.4	328.8	0	1191.5	b
Barbados	7.9	6.4	2.1	4.6	3	0	0	0	0	0	1.6	0	0	0.2	0.4	0	13.3	a
Belarus	5.6	7.3	6.8	8.4	7.9	0	0.1	0.2	0	0.1	0.1	0	0	3.7	51.8	0.1	663.8	b
Belgium	1.4	6.2	9.4	12.3	4.6	2.2	0.6	0.1	0	3.2	1.4	0	0.3	73.9	55.9	29.5	1297.9	b

UN COUNTRY NAME	SHARE IN TOTAL FINAL ENERGY CONSUMPTION (%)													FINAL CONSUMPTION OF RENEWABLE ENERGY (PJ)			TOTAL FINAL ENERGY CONSUMPTION (PJ)	SOURCE
	RENEWABLE ENERGY				SOLID BIOFUELS	LIQUID BIOFUELS	BIOGASES	HYDRO	TIDE	WIND	SOLAR	GEOTHERMAL	MUNICIPAL WASTE (RENEW)	ELECTRICITY CONSUMPTION (1)	HEAT RAISING (2)	TRANSPORT (3)		
	2000	2010	2015	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	
Belize	34.6	32.9	30.3	30.2	21.5	0	0	8.7	0	0	0	0	0	1.6	1.9	0	11.9	*a*
Benin	70.3	47.2	49.9	46.2	46.2	0	0	0	0	0	0	0	0	0	88.4	0	191.5	*b*
Bermuda	0.5	0.4	0.6	0.9	0.1	0.2	0	0	0	0	0.2	0	0.5	0	0	0	3.8	*a*
Bhutan	91.4	90.8	86.7	88.4	77.6	0	0	10.7	0	0	0	0	0	7.1	51	0	65.7	*a*
Bolivia (Plurinational State of)	29.8	19.9	14.2	16.9	12.4	0.6	0	3.4	0	0.1	0.4	0	0	10.8	31.1	1.5	257.8	*b*
Bonaire, Sint Eustatius and Saba	0.0	0.0	13.5	10.4	0.4	0	0	0	0	7.7	2.3	0	0	0.1	0	0	0.9	*a*
Bosnia and Herzegovina	19.4	19.6	25.2	37.7	31.5	0	0	5.8	0	0.3	0.1	0	0	10.4	53.1	0.1	168.4	*b*
Botswana	38.5	29.4	25.6	27.2	27.1	0	0	0	0	0	0.1	0	0	0	18.9	0	69.4	*b*
Brazil	42.7	46.8	43.6	50.1	24.4	9.6	0.1	13.2	0	1.9	0.9	0	0	1534.9	2068.1	823	8842.8	*b*
British Virgin Islands	0.9	0.7	1.0	1.4	1	0	0	0	0	0.3	0.1	0	0	0	0	0	1.4	*a*
Brunei Darussalam	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	41.4	*b*
Bulgaria	8.0	14.3	17.9	21.1	14.1	1.8	0.2	1.8	0	1	1.3	0.4	0.4	18.8	56.6	7.5	393.6	*b*
Burkina Faso	85.4	82.8	74.5	67.5	66.7	0	0	0.5	0	0	0.3	0	0	1.6	125.6	0	188.3	*a*
Burundi	93.2	92.6	91.2	83.5	82.3	0	0	1.1	0	0	0.1	0	0	0.7	48.5	0	59	*a*
Cabo Verde	27.9	21.2	26.3	23.4	20.7	0	0	0	0	2.5	0.3	0	0	0.2	1.4	0	6.5	*a*
Cambodia	81.6	64.8	60.6	51.4	44.8	0	0	6.1	0	0	0.5	0	0	19.8	131.6	0	294.5	*b*
Cameroon	84.6	78.7	78.1	78.9	74.5	0	0	4.4	0	0	0	0	0	15.1	250.7	0	336.7	*b*
Canada	22.0	21.1	21.8	23.8	5.1	1.1	0.1	15.8	0	1.5	0.2	0	0	1244.4	342.5	97.9	7065	*b*
Cayman Islands	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	5.1	*a*
Central African Republic	88.9	93.8	92.9	90.9	89.5	0	0	1.3	0	0	0	0	0	0.5	33.2	0	37.1	*a*
Chad	88.7	79.2	72.7	73.6	73.5	0	0	0	0	0	0	0	0	0	62.8	0	85.5	*a*
Chile	31.4	27.0	25.1	26.7	15.9	0	0.1	6.4	0	1.6	2.6	0.1	0	128.4	160	2.3	1087.4	*b*
China	29.6	12.3	12.2	14.8	4.2	0.2	0.4	5.1	0	1.8	2.1	1.1	0	6763.8	5219.4	313.1	83028.7	*b*

UN COUNTRY NAME	SHARE IN TOTAL FINAL ENERGY CONSUMPTION (%)													FINAL CONSUMPTION OF RENEWABLE ENERGY (PJ)			TOTAL FINAL ENERGY CONSUMPTION (PJ)	SOURCE
	RENEWABLE ENERGY				SOLID BIOFUELS	LIQUID BIOFUELS	BIOGASES	HYDRO	TIDE	WIND	SOLAR	GEOTHERMAL	MUNICIPAL WASTE (RENEW)	ELECTRICITY CONSUMPTION (1)	HEAT RAISING (2)	TRANSPORT (3)		
	2000	2010	2015	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	
China, Hong Kong Special Administrative Region	0.0	0.1	0.2	0.3	0	0.1	0.1	0	0	0	0	0	0	0.5	0.1	0.3	327.7	*b*
China, Macao Special Administrative Region	0.2	5.5	5.4	11.0	0.1	0	0	0	0	0	0	0	10.9	3.1	0	0	28.8	*a*
Colombia	27.9	29.6	31.5	31.3	15.8	2.5	0	12.9	0	0	0.1	0	0.1	155.4	176.8	28.7	1153	*b*
Comoros	69.9	66.0	64.1	48.3	48.3	0	0	0	0	0	0	0	0	0	3.8	0	7.9	*a*
Congo	64.9	54.8	64.2	71.9	70.3	0	0	1.6	0	0	0	0	0	1.3	55.9	0	79.6	*b*
Cook Islands	9.3	7.3	7.4	13.1	6.9	0	0	0	0	0	6.2	0	0	0.1	0.1	0	0.8	*a*
Costa Rica	32.9	40.4	38.3	36.4	12	0	0	17.6	0	3.1	0.2	3.6	0	35.6	16.5	0	142.9	*b*
Cote d'Ivoire	63.7	75.4	64.5	63.3	60.6	0	0	2.7	0	0	0	0	0	9	194.5	0	321.3	*b*
Croatia	26.8	29.8	33.1	32.4	18.5	1	0.8	8.7	0	2.7	0.4	0.3	0	34.8	48.8	3.4	268.4	*b*
Cuba	34.4	15.6	21.1	23.9	19.9	3.6	0	0.1	0	0	0.3	0	0	2.4	56.5	0	246.2	*b*
Curacao	0.1	0.5	1.3	2.8	0	0	0	0	0	2.5	0.3	0	0	0.7	0	0	24	*b*
Cyprus	3.1	6.5	10.4	15.0	2.5	1.7	0.7	0	0	1.3	6.6	0	2.2	1.9	6.3	1.1	61.8	*b*
Czechia	5.9	11.0	14.8	17.0	12.3	1.6	1.4	0.6	0	0.2	0.7	0	0.3	25.7	124.6	16.4	982.2	*b*
Democratic People's Republic of Korea	8.7	13.6	23.3	12.7	6.6	0	0	6.1	0	0	0	0	0	33.4	37.4	1	566.3	*b*
Democratic Republic of the Congo	97.9	96.8	95.8	96.2	92.4	0	0	3.8	0	0	0	0	0	32.1	778.7	0	843.2	*b*
Denmark	10.7	21.2	32.5	39.7	20	1.9	1	0	0	11.9	1.4	0	3.5	90.2	111.1	11.5	536.1	*b*
Djibouti	31.4	32.5	28.2	31.9	31.8	0	0	0	0	0	0.1	0	0	0	2.2	0	6.9	*a*
Dominica	11.1	10.3	8.7	8.3	4	0	0	4.1	0	0.1	0	0	0	0.1	0.1	0	1.5	*a*
Dominican Republic	19.1	16.9	14.9	16.7	12.9	0	0	1.6	0	1.5	0.7	0	0	9.8	32.7	0	254.6	*b*
Ecuador	19.4	11.8	13.1	20.1	4.3	0.1	0	15.5	0	0	0	0	0	72.9	18.7	0.5	457.8	*b*
Egypt	8.3	5.4	5.3	6.5	3.2	0	0	2.1	0	0.6	0.6	0	0	68	66.4	0.2	2068.4	*b*

UN COUNTRY NAME	SHARE IN TOTAL FINAL ENERGY CONSUMPTION (%)													FINAL CONSUMPTION OF RENEWABLE ENERGY (PJ)			TOTAL FINAL ENERGY CONSUMPTION (PJ)	SOURCE
	RENEWABLE ENERGY				SOLID BIOFUELS	LIQUID BIOFUELS	BIOGASES	HYDRO	TIDE	WIND	SOLAR	GEOTHERMAL	MUNICIPAL WASTE (RENEW)	ELECTRICITY CONSUMPTION (1)	HEAT RAISING (2)	TRANSPORT (3)		
	2000	2010	2015	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	
El Salvador	33.5	32.6	21.0	23.7	8.4	0	0.1	7	0	0	3	5.2	0	18.2	5.8	0	101.5	*b*
Equatorial Guinea	45.8	5.7	5.5	7.0	5	0	0	2	0	0	0	0	0	1.5	3.8	0	76.2	*a*
Eritrea	76.8	80.9	81.2	80.9	80.7	0	0	0	0	0	0.1	0	0	0	21.3	0	26.4	*b*
Estonia	19.8	25.3	28.2	40.0	33.4	1.4	0.6	0.1	0	3.2	0.5	0	0.8	12.2	31.4	2.1	114.4	*b*
Eswatini	59.4	72.4	71.7	66.0	61	0	0	4.9	0	0	0.1	0	0	4.6	22.9	0	41.7	*a*
Ethiopia	95.6	94.1	91.5	89.5	87.2	0	0	2.2	0	0.1	0	0	0	40.4	1556.2	0.2	1783.7	*b*
Falkland Islands (Malvinas)	1.4	3.8	4.9	4.7	1.1	0	0	0	0	3.5	0.1	0	0	0	0	0	0.5	*a*
Faroe Islands	2.8	3.4	7.5	5.3	0	0	0	3.7	0	1.6	0.1	0	0	0.5	0	0	9.7	*a*
Fiji	50.1	27.9	32.7	31.8	21.4	0	0	10.2	0	0	0.2	0	0	1.9	3.7	0	17.5	*a*
Finland	31.7	33.4	43.2	47.5	33.9	1.8	0.6	6.7	0	3.4	0.1	0	1.1	141.5	291.7	18.2	950.4	*b*
France	9.3	12.0	13.3	16.9	7.2	2.4	0.4	3.3	0	2.1	0.9	0.2	0.4	343.2	424.3	118.4	5252.3	*b*
French Guiana	23.8	29.4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*a*
French Polynesia	8.8	7.5	7.8	8.1	0.3	0	0	5.5	0	0	2.3	0	0	0.7	0.1	0	9.7	*a*
Gabon	72.8	85.8	81.9	90.1	88.2	0	0	1.9	0	0	0	0	0	3.4	151.8	0	172.2	*b*
Gambia	62.9	56.6	48.9	49.7	49.7	0	0	0	0	0	0.1	0	0	0	5.3	0	10.7	*a*
Georgia	47.3	39.1	27.5	23.5	5.4	0	0	17.4	0	0.2	0.1	0.3	0	30.2	10.2	0.6	175.4	*b*
Germany	3.7	11.6	14.6	18.6	5.7	1.9	2.2	0.7	0	5	2.2	0.1	0.9	745.6	596.9	157.9	8064.7	*b*
Ghana	71.6	51.9	44.0	40.3	34.1	0	0	6.1	0	0	0	0	0	22.2	122.3	0	359.1	*b*
Gibraltar	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	8.1	*b*
Greece	7.8	11.4	17.5	20.1	5.7	1.5	0.5	2	0	5.6	4.8	0	0	62.1	47.8	8.6	590.2	*b*
Greenland	9.2	10.1	13.1	11.5	0	0	0	11.1	0	0	0	0	0.4	0.9	0	0	8.4	*a*
Grenada	10.5	10.5	11.1	10.4	10	0	0	0	0	0	0.4	0	0	0	0.3	0	3.1	*a*
Guadeloupe	2.6	3.0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*a*

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	RENEWABLE ENERGY				SOLID BIOFUELS	LIQUID BIOFUELS	BIOGASES	HYDRO	TIDE	WIND	SOLAR	GEOTHERMAL	MUNICIPAL WASTE (RENEW)	ELECTRICITY CONSUMPTION (1)	HEAT RAISING (2)	TRANSPORT (3)		
	2000	2010	2015	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	
Guam	0.4	0.5	1.8	3.6	0.5	0	0	0	0	0	3	0	0	0.2	0	0	5.5	a
Guatemala	62.7	67.1	63.3	65.5	61.7	0	0	3.2	0	0.2	0.1	0.2	0	26.2	301	0	499.9	b
Guernsey	0.0	0.0	0.0	1.6	0	0	0	0	0	0	1.6	0	0	0	0	0	1.2	a
Guinea	85.5	75.7	76.2	65.8	63.1	0	0	2.7	0	0	0	0	0	4.4	103.3	0	163.7	a
Guinea-Bissau	91.2	87.8	87.2	87.2	87.2	0	0	0	0	0	0	0	0	0	25	0	28.7	a
Guyana	30.6	30.9	24.9	12.0	11.9	0	0	0	0	0	0.1	0	0	0.1	3.5	0	29.7	a
Haiti	80.8	79.0	76.1	76.3	76	0.2	0	0.1	0	0	0	0	0	0.2	106.4	0	139.7	b
Honduras	55.2	53.6	50.7	50.1	43.1	0	0	4	0	1	1.5	0.5	0	13.1	66.9	0	159.8	b
Hungary	5.2	13.5	15.6	14.8	10	1.6	0.3	0.1	0	0.4	1.5	0.7	0.2	22.1	74.2	12.4	736	b
Iceland	60.7	75.9	77.8	82.8	0	0.7	0.1	36.9	0	0	0	45.1	0	64.2	34.1	1	120.1	b
India	46.9	36.2	33.4	35.8	31.5	0.3	0.2	2	0	0.8	1	0	0	884.1	7165.9	73.2	22678.8	b
Indonesia	45.6	36.0	26.6	22.0	15.1	4.6	0.1	1.4	0	0	0	0.9	0	186.7	898.1	238.1	6011.7	b
Iran (Islamic Republic of)	0.4	0.9	0.9	1.0	0.3	0	0	0.7	0	0	0	0	0	50	21.4	0.1	6924.3	b
Iraq	0.4	1.7	0.8	1.1	0.1	0	0	1	0	0	0	0	0	8.3	0.9	0	853.9	b
Ireland	2.0	5.3	9.5	13.7	2	1.6	0.3	0.7	0	8.3	0.2	0	0.6	43.3	10.5	7.4	447.4	b
Isle of Man	0.0	1.9	2.2	2.1	0	0	0	0.4	0	0	0	0	1.8	0	0	0	2.2	a
Israel	6.0	8.6	3.7	5.6	0.2	0	c	c	0	0.1	5.2	0	0.1	13.1	18.1	0	555.2	b
Italy	5.1	12.8	16.6	18.7	7.2	1.7	0.9	4	0	1.6	2.3	0.6	0.3	400.5	319	68.2	4214.6	b
Jamaica	9.4	9.0	12.1	11.4	7.1	2.2	0	0.5	0	1.1	0.5	0	0	1.4	4.4	1.4	63.3	b
Japan	3.7	4.7	6.2	8.5	2.5	0.2	0	2.6	0	0.3	2.7	0.2	0.1	628.3	167.2	30.6	9769.9	b
Jersey	0.0	4.4	14.4	18.1	0	0	0	0	0	0	0	0	18.1	1.1	0	0	5.9	a
Jordan	2.1	3.0	3.2	11.0	1.2	0	0	0	0	1.9	7.9	0	0	14	12.1	0	236.3	b
Kazakhstan	2.5	1.4	1.7	1.8	0.1	0	0	1.3	0	0.1	0.2	0	0	26.6	2.1	1.2	1673.4	b

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	RENEWABLE ENERGY				SOLID BIOFUELS	LIQUID BIOFUELS	BIOGASES	HYDRO	TIDE	WIND	SOLAR	GEOTHERMAL	MUNICIPAL WASTE (RENEW)	ELECTRICITY CONSUMPTION (1)	HEAT RAISING (2)	TRANSPORT (3)		
	2000	2010	2015	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	
Kenya	78.1	76.1	72.0	72.5	68.5	0	0	1.6	0	0.5	0	1.9	0	30.1	511.8	0	747.5	*b*
Kiribati	54.7	50.2	47.3	42.8	41.6	0	0	0	0	0	1.1	0	0	0	0.6	0	1.4	*a*
Kosovo	28.3	20.8	20.4	25.9	24.4	0	0	1.1	0	0.4	0.1	0	0	1	15.6	0	63.8	*a*
Kuwait	0.0	0.0	0.0	0.1	0	0	0	0	0	0	0.1	0	0	0.6	0	0	633.9	*b*
Kyrgyzstan	35.2	25.6	23.5	30.0	0	0	0	30	0	0	0	0	0	39.8	0.1	0.1	132.7	*b*
Lao People's Democratic Republic	81.5	64.9	53.3	49.9	37.3	0	0	12.6	0	0	0	0	0	17.2	51	0	136.7	*a*
Latvia	35.8	33.1	38.1	43.8	32.8	1.3	1.5	6.7	0	0.5	0	0	0.9	14.8	52.8	2.1	159.1	*b*
Lebanon	4.9	5.7	4.2	6.7	3.2	0	0	2	0	0	1.5	0	0	3.9	7.8	0	174.6	*b*
Lesotho	56.7	53.0	44.9	41.4	35.6	0	0	5.9	0	0	0	0	0	2.4	14.7	0	41.3	*a*
Liberia	91.3	88.6	91.9	93.0	92.6	0	0	0.3	0	0	0	0	0	0.3	80.8	0	87.3	*a*
Libya	2.0	2.4	3.1	3.1	3.1	0	0	0	0	0	0	0	0	0	11.1	0	355.8	*b*
Liechtenstein	53.9	52.3	55.5	55.2	5.5	0	0.8	33.8	0	0	15.1	0	0	1.4	0.2	0	3	*a*
Lithuania	17.2	21.5	29.0	31.7	21.4	2	0.7	1.1	0	5.6	0.5	0	0.5	20.1	45	4.4	219.5	*b*
Luxembourg	6.8	3.7	9.1	20.8	6.9	4.4	1	1.2	0	4.6	2.2	0	0.6	17	5.1	6.4	137	*b*
Madagascar	82.2	86.7	83.0	84.8	83.7	0	0	1	0	0	0	0	0	3	225.5	0	269.6	*a*
Malawi	82.6	81.2	81.0	70.3	62.4	0.4	0	6.8	0	0	0.7	0	0	5.7	45.8	0.3	73.6	*a*
Malaysia	4.4	2.0	3.4	5.8	0.1	1.4	0	3.9	0	0	0.4	0	0	88.4	0	28.3	1996.7	*b*
Maldives	2.3	1.4	1.4	1.3	0.8	0	0	0	0	0.1	0.4	0	0	0.1	0.1	0	17.1	*a*
Mali	83.5	79.2	81.1	63.8	61.5	0	0	2.2	0	0	0.1	0	0	4.5	110.6	0	180.3	*a*
Malta	0.0	1.2	6.0	9.2	0.3	3	0.3	0	0	0	5.6	0	0	1	0.3	0.6	20.4	*b*
Marshall Islands	19.6	13.7	11.7	12.0	11.6	0	0	0	0	0	0.3	0	0	0	0.2	0	1.6	*a*
Martinique	1.7	2.5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*a*
Mauritania	44.4	34.0	28.2	23.8	22.5	0	0	0	0	0.6	0.6	0	0	0.8	14.6	0	64.7	*a*

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	RENEWABLE ENERGY				SOLID BIOFUELS	LIQUID BIOFUELS	BIOGASES	HYDRO	TIDE	WIND	SOLAR	GEOTHERMAL	MUNICIPAL WASTE (RENEW)	ELECTRICITY CONSUMPTION (1)	HEAT RAISING (2)	TRANSPORT (3)		
	2000	2010	2015	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	
Mauritius	20.4	12.8	11.5	9.4	6.2	0	0.3	1.2	0	0.2	1.5	0	0	2.3	0.7	0	31.7	*b*
Mayotte	16.2	10.0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*a*
Mexico	12.2	9.4	9.2	12.3	7.2	0	0	2.1	0	1.5	1.1	0.4	0	185.9	287.2	0.7	3843.1	*b*
Micronesia (Federated States of)	1.3	2.0	1.7	2.0	1.1	0	0	0.2	0	0.2	0.5	0	0	0	0	0	1.4	*a*
Mongolia	5.7	4.5	3.6	4.0	2.7	0	0	0.2	0	1	0.2	0	0	2.3	4.7	0	176.4	*b*
Montenegro	..	49.1	43.0	39.6	21.3	0	0	15	0	3.3	0.1	0	0	5.3	6.2	0	29.1	*b*
Montserrat	0.0	0.0	0.0	0.7	0	0	0	0	0	0	0.7	0	0	0	0	0	0.2	*a*
Morocco	15.3	13.9	11.3	10.9	7.6	0	0	0.4	0	2.2	0.7	0	0	20.7	48.2	0.1	631.9	*b*
Mozambique	93.6	84.9	80.9	80.9	69.9	0	0	10.9	0	0	0	0	0	37.1	234.2	0	335.3	*b*
Myanmar	80.2	84.9	70.4	59.8	55	0	0	4.7	0	0	0	0	0	38.6	451.2	0	819.7	*b*
Namibia	34.7	31.2	29.3	31.3	12.1	0	0	15.1	0	0.2	4	0	0	13.1	8.5	0	68.9	*b*
Nauru	0.0	0.0	0.1	1.4	0	0	0	0	0	0	1.4	0	0	0	0	0	0.5	*a*
Nepal	88.3	87.3	85.0	74.5	68.2	0	2	4.4	0	0	0	0	0	26.8	429.5	0	612.1	*b*
Netherlands	1.7	3.9	5.7	10.8	3.3	1.4	0.5	0	0	2.8	1.6	0.4	0.8	102.8	63.6	24.4	1767.2	*b*
New Caledonia	7.5	4.8	5.1	6.0	0.3	0	0	3.2	0	0.5	2	0	0	1.8	0.2	0	33.5	*a*
New Zealand	26.4	29.4	29.3	28.6	5.1	0	0.2	15	0	1.4	0.2	6.6	0	112	33	0.5	508.4	*b*
Nicaragua	58.4	54.4	50.0	52.1	46	0	0	1.8	0	1.8	0.1	2.5	0	9.2	47	0	107.8	*b*
Niger	87.6	80.7	78.9	81.9	81.8	0	0	0	0	0	0.1	0	0	0.2	114.3	0	139.8	*b*
Nigeria	86.2	86.5	82.2	82.5	82.1	0	0	0.4	0	0	0	0	0	23.8	4639.4	0	5652	*b*
Niue	0.6	26.7	22.4	22.7	0.6	0	0	0	0	0	22.2	0	0	0	0	0	0.1	*a*
North Macedonia	19.4	22.3	23.9	20.3	11.9	0	0.3	7	0	0.6	0.1	0.2	0	6.2	9.3	0	76.3	*b*
Northern Mariana Islands	0.0	0.0	0.0	0.3	0	0	0	0	0	0	0.3	0	0	0	0	0	2.6	*a*
Norway	60.2	56.7	57.3	61.3	5.1	2.2	0.3	49.5	0	3.5	0	0	0.8	395.5	45.4	22.7	756.3	*b*

UN COUNTRY NAME	SHARE IN TOTAL FINAL ENERGY CONSUMPTION (%)													FINAL CONSUMPTION OF RENEWABLE ENERGY (PJ)			TOTAL FINAL ENERGY CONSUMPTION (PJ)	SOURCE
	RENEWABLE ENERGY				SOLID BIOFUELS	LIQUID BIOFUELS	BIOGASES	HYDRO	TIDE	WIND	SOLAR	GEOTHERMAL	MUNICIPAL WASTE (RENEW)	ELECTRICITY CONSUMPTION (1)	HEAT RAISING (2)	TRANSPORT (3)		
	2000	2010	2015	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	
Oman	0.0	0.0	0.0	0.1	0	0	0	0	0	0	0.1	0	0	0.4	0	0	775.3	*b*
Pakistan	51.1	47.4	45.9	46.6	43.5	0	0	2.8	0	0.2	0.1	0	0	111.6	1534.2	0	3531.6	*b*
Palau	0.0	0.0	0.4	0.9	0	0	0	0	0	0	0.9	0	0	0	0	0	2.2	*a*
Panama	27.7	20.6	21.9	28.4	8.6	0	0	17.7	0	1.4	0.8	0	0	24.3	10.4	0	122	*b*
Papua New Guinea	66.4	55.3	55.1	54.3	50.5	0	0	2.7	0	0	0	1	0	5.2	69.7	0	138.1	*a*
Paraguay	70.4	63.6	60.5	61.4	39.8	2.7	0	19	0	0	0	0	0	49.4	103.8	6.9	260.5	*b*
Peru	38.6	32.2	27.4	31.6	15.5	1.9	0	12.9	0	0.8	0.5	0	0	104.5	116.3	12.5	737.8	*b*
Philippines	33.8	32.6	30.8	29.1	22.9	1.5	0	1.6	0	0.2	0.3	2.4	0	63.6	298.4	17.7	1306.2	*b*
Poland	6.9	9.5	11.9	16.1	11.9	1.5	0.3	0.2	0	1.7	0.3	0	0.1	86.7	339.9	45.6	2926.2	*b*
Portugal	20.1	27.8	27.2	31.2	14.3	1.8	0.2	6.5	0	6.6	1.6	0.1	0.2	96.4	81.4	11.1	605	*b*
Puerto Rico	0.5	0.7	1.9	2.5	0	0	0.1	0.3	0	0.8	1.4	0	0	1.4	0	0	57.7	*a*
Qatar	0.1	0.1	0.0	0.1	0.1	0	0	0	0	0	0	0	0	0	0.4	0	617.8	*b*
Republic of Korea	0.7	1.3	2.7	3.6	0.9	0.6	0.1	0.2	0	0.2	1.1	0.2	0.2	107.6	54.5	27.9	5238	*b*
Republic of Moldova	5.7	20.0	24.7	23.7	22.7	0	0.1	0.7	0	0.1	0	0	0	1.1	27.1	0	119	*b*
Reunion	11.7	16.4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*a*
Romania	16.4	24.1	23.7	24.1	14.8	2.1	0	4.5	0	2	0.5	0	0	68.4	143.6	22	972.4	*b*
Russian Federation	3.5	3.3	3.2	3.7	0.7	0	0	3	0	0	0	0	0	481.1	115.9	55.4	17524.4	*b*
Rwanda	86.8	90.5	86.3	81.7	79.9	0	0	1.8	0	0	0.1	0	0	1.6	69.1	0	86.5	*a*
Saint Helena	7.1	9.2	13.0	7.4	2.9	0	0	0	0	3	1.6	0	0	0	0	0	0.2	*a*
Saint Kitts and Nevis	26.4	1.0	1.6	1.4	0	0	0	0	0	0.9	0.5	0	0	0	0	0	1.9	*a*
Saint Lucia	24.1	13.2	11.5	10.0	9.6	0	0	0	0	0	0.4	0	0	0	0.5	0	5.3	*a*
Saint Pierre and Miquelon	0.4	1.6	1.0	1.1	1.1	0	0	0	0	0	0	0	0	0	0	0	0.6	*a*
Saint Vincent and the Grenadines	8.5	5.1	4.3	4.9	2	0	0	2.6	0	0	0.3	0	0	0.1	0.1	0	2.7	*a*

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	RENEWABLE ENERGY				SOLID BIOFUELS	LIQUID BIOFUELS	BIOGASES	HYDRO	TIDE	WIND	SOLAR	GEOTHERMAL	MUNICIPAL WASTE (RENEW)	ELECTRICITY CONSUMPTION (1)	HEAT RAISING (2)	TRANSPORT (3)		
	2000	2010	2015	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	
Samoa	59.7	41.3	37.5	37.5	32.6	0	0	3	0	0	1.8	0	0	0.2	1.5	0	4.4	a
Sao Tome and Principe	54.7	38.2	39.2	41.6	40.9	0	0	0.7	0	0	0	0	0	0	0.8	0	2	a
Saudi Arabia	0.0	0.0	0.0	0.1	0	0	0	0	0	0	0.1	0	0	2.1	0.3	0	4190.7	b
Senegal	47.5	49.5	39.1	38.6	37.3	0	0	0	0	0.5	0.9	0	0	2	46.1	0	124.6	b
Serbia	22.1	20.5	21.2	26.0	18.2	0	0.3	6.7	0	0.7	0	0.1	0	27.2	66.7	0.4	362.2	b
Seychelles	1.5	0.7	1.4	1.3	0.6	0	0	0	0	0.4	0.4	0	0	0	0	0	5	a
Sierra Leone	93.3	84.9	74.0	75.1	74	0	0	1	0	0	0	0	0	0.6	43	0	58.1	a
Singapore	0.3	0.5	0.6	0.9	0.2	0	0	0	0	0	0.4	0	0.4	4.1	0	0.2	476	b
Sint Maarten (Dutch part)	0.0	0.0	0.0	0.1	0.1	0	0	0	0	0	0	0	0	0	0	0	7.5	a
Slovakia	3.7	10.3	13.4	17.6	11.1	1.6	0.8	3.4	0	0	0.6	0	0.2	20.1	44.2	6.9	404.2	b
Slovenia	18.0	20.1	21.4	22.4	11.5	2.1	0.3	7.4	0	0	0.8	0.2	0	15.2	21.8	4.2	183.5	b
Solomon Islands	55.3	45.1	48.6	49.0	48.8	0	0	0	0	0	0.2	0	0	0	3.3	0	6.7	a
Somalia	93.3	93.6	94.5	95.5	95.4	0	0	0	0	0	0.1	0	0	0.1	114.9	0	120.4	a
South Africa	16.2	9.6	7.7	9.8	8	0	0	0.2	0	0.7	0.8	0	0	36.6	188.5	0.5	2311.7	b
South Sudan	..	..	27.5	33.2	33.1	0	0	0	0	0	0.2	0	0	0	7.9	0	23.8	b
Spain	7.9	14.4	16.3	19.3	5.6	2	0.3	3.1	0	5.8	2.6	0	0.1	341	172.2	64	2983.1	b
Sri Lanka	64.2	61.8	51.3	49.3	44.6	0	0	4.4	0	0.3	0.1	0	0	18.5	169.3	0	380.7	b
State of Palestine	17.5	14.1	11.0	15.0	3.7	0	0	0	0	0	11.3	0	0	4.9	5.7	0	70.8	a
Sudan	80.4	61.3	61.9	62.1	56.7	0	0	5.5	0	0	0	0	0	29.4	304.1	0	536.8	b
Suriname	23.6	22.1	11.6	14.7	3.5	0	0	11.1	0	0	0.1	0	0	3.1	1	0	28.2	b
Sweden	39.8	44.7	51.9	58.4	28.2	5.6	0.5	15.6	0	5.9	0.3	0	2.3	296.6	372.9	65.7	1258.9	b
Switzerland	18.2	20.6	23.9	26.4	5.9	1.1	0.4	15.8	0	0.1	1.5	0	1.6	118.5	52.7	13.9	702.1	b
Syrian Arab Republic	2.0	1.3	0.6	1.1	0.1	0	0	1	0	0	0	0	0	1.9	0.2	0	193.8	b

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	RENEWABLE ENERGY				SOLID BIOFUELS	LIQUID BIOFUELS	BIOGASES	HYDRO	TIDE	WIND	SOLAR	GEOTHERMAL	MUNICIPAL WASTE (RENEW)	ELECTRICITY CONSUMPTION (1)	HEAT RAISING (2)	TRANSPORT (3)		
	2000	2010	2015	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	
Tajikistan	62.4	61.8	48.1	38.8	0	0	0	38.8	0	0	0	0	0	49.8	0	0	128.6	*b*
Thailand	21.8	22.8	22.6	20.8	15	3	1.1	0.6	0	0.4	0.6	0	0.2	110.9	446.7	91.3	3114.7	*b*
Timor-Leste	0.0	34.8	18.0	11.4	11.3	0	0	0.1	0	0	0	0	0	0	0.7	0	6.3	*a*
Togo	77.1	65.8	81.0	76.6	75.5	0	0	1.1	0	0	0.1	0	0	1.1	71.7	0	95	*b*
Tonga	2.5	1.0	1.9	1.9	0.6	0	0	0	0	0.4	1	0	0	0	0	0	2.2	*a*
Trinidad and Tobago	0.8	0.4	0.4	0.5	0.5	0	0	0	0	0	0	0	0	0	0.5	0	99	*b*
Tunisia	14.2	12.6	12.5	12.9	11.3	0	0	0	0	0.4	1.1	0	0	2.3	38.8	0	319	*b*
Türkiye	17.3	14.2	13.3	13.7	1.7	0.1	0.3	5.6	0	1.8	1.6	2.7	0	387.6	186.6	6.7	4234.2	*b*
Turkmenistan	0.1	0.1	0.1	0.1	0.1	0	0	0	0	0	0	0	0	0	0.4	0	671.6	*b*
Turks and Caicos Islands	0.4	0.3	0.4	0.5	0.4	0	0	0	0	0	0.2	0	0	0	0	0	3.1	*a*
Tuvalu	0.0	0.4	3.0	6.7	0	0	0	0	0	0	6.7	0	0	0	0	0	0.1	*a*
Uganda	95.0	93.2	91.1	92.9	91.8	0	0	1.1	0	0	0	0	0	11.6	927.9	0	1011.2	*a*
Ukraine	1.3	2.9	4.1	8.7	6	0.1	0.1	1.1	0	0.5	0.9	0	0	45.9	110.5	4.6	1846.1	*b*
United Arab Emirates	0.1	0.1	0.1	0.9	0.1	0	0	0	0	0	0.8	0	0	17.8	1.8	0	2141.9	*b*
United Kingdom of Great Britain and Northern Ireland	1.0	3.1	7.7	13.5	4	1.4	0.7	0.5	0	5.5	1	0	0.4	431.6	103.1	73	4501.6	*b*
United Republic of Tanzania	93.7	89.7	86.2	84.0	82.8	0	0	1.1	0	0	0	0	0	10	719.2	0	868.6	*b*
United States of America	5.4	7.4	9.0	11.2	3.6	2.7	0.1	1.7	0	2	0.9	0.1	0.1	2647.3	2095.5	1415.4	55205.6	*b*
United States Virgin Islands	0.5	0.7	5.1	5.1	1.3	0	0	0	0	0	3.8	0	0	0.1	0	0	2	*a*
Uruguay	38.7	53.3	59.4	61.1	43.4	2.1	0	6.4	0	8.5	0.7	0	0	38.4	76.7	3	193.3	*b*
Uzbekistan	0.7	1.3	1.7	1.0	0	0	0	1	0	0	0	0	0	13.8	0.1	0.3	1378.3	*b*
Vanuatu	47.7	38.1	35.6	26.0	23.8	0.1	0	0.8	0	0.6	0.7	0	0	0.1	0.8	0	3.4	*a*
Venezuela (Bolivarian Republic of)	15.3	13.8	15.3	23.3	1.5	0	0	21.8	0	0	0	0	0	151.6	10.3	0	693.9	*b*
Viet Nam	57.7	34.6	26.5	19.1	8.9	0.1	0	8.8	0	0.1	1.2	0	0	278.2	236.4	2.7	2706.8	*b*

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	RENEWABLE ENERGY				SOLID BIOFUELS	LIQUID BIOFUELS	BIOGASES	HYDRO	TIDE	WIND	SOLAR	GEOTHERMAL	MUNICIPAL WASTE (RENEW)	ELECTRICITY CONSUMPTION (1)	HEAT RAISING (2)	TRANSPORT (3)		
	2000	2010	2015	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	
Wallis and Futuna Islands	3.9	3.7	4.0	3.5	2.8	0	0	0.5	0	0	0.2	0	0	0	0	0	0.3	*a*
Yemen	1.0	0.8	2.0	3.5	2.2	0	0	0	0	0	1.3	0	0	1.3	2.2	0	100.4	*b*
Zambia	90.0	88.6	83.1	81.8	71.7	0	0	10.1	0	0	0.1	0	0	35.3	249	0.1	347.5	*b*
Zimbabwe	69.5	82.5	81.0	84.4	80.1	0.5	0	3.8	0	0	0	0	0	15.5	318.5	1.9	398.1	*b*
World	16.9	16.0	16.7	19.1	11.1	1.1	0.2	3.7	0	1.4	1.1	0.4	0.1	22500.9	41941.9	4226.6	359061.5	*c*
Northern America (M49) and Europe (M49)	7.4	10.0	11.9	14.3	5.2	1.9	0.3	3.6	0	2.1	0.9	0.1	0.2	8770.2	6814.1	2435.9	125778.5	*c*
Northern America (M49)	7.3	9.0	10.7	12.7	3.8	2.5	0.1	3.4	0	1.9	0.8	0.1	0.1	3987.7	2437	1504.5	62283.4	*c*
Europe (M49)	7.4	11.0	13.1	15.8	6.6	1.3	0.6	3.6	0	2.3	0.9	0.2	0.4	4705.6	4376.9	955.3	63495.1	*c*
Latin America and the Caribbean (MDG=M49)	28.4	29.2	28.5	34.2	17.8	4.4	0	9.6	0	1.4	0.8	0.1	0	2753.6	3752.7	916	21703.4	*c*
Central Asia (M49) and Southern Asia (MDG=M49)	34.4	27.5	26.5	27.9	24.5	0.1	0.2	2	0	0.5	0.6	0	0	1256.4	9716.4	75.4	39570.4	*c*
Central Asia (M49)	3.6	2.8	3.3	3.1	0.1	0	0	2.9	0	0.1	0.1	0	0	118.9	2.7	3.3	3984.7	*c*
Southern Asia (MDG=M49)	39.5	31.0	29.0	30.7	27.2	0.2	0.2	1.9	0	0.6	0.7	0	0	1136	9713.7	72.2	35585.8	*c*
Eastern Asia (M49) and South-eastern Asia (MDG=M49)	23.1	13.5	13.0	14.8	5.5	0.5	0.3	4.4	0	1.3	1.9	0.9	0	8425.6	7996.7	742.9	116046.4	*c*
Eastern Asia (M49)	19.8	10.5	11.0	13.5	3.9	0.2	0.3	4.6	0	1.5	2.1	0.9	0	7573.7	5482.6	363.8	99135.8	*c*
South-eastern Asia (MDG=M49)	38.3	30.6	25.5	22.1	15	2.5	0.2	3.4	0	0.1	0.4	0.5	0	849.3	2514.1	380.6	16910.6	*c*
Western Asia (M49) and Northern Africa (M49)	8.4	6.2	5.4	6.3	2.7	0	0.1	1.7	0	0.5	0.8	0.5	0	589.6	727.8	7.6	21187.7	*c*
Western Asia (M49)	6.1	4.5	3.9	4.7	0.7	0	0.1	1.8	0	0.5	0.9	0.7	0	472.2	259.2	6.5	15719.2	*c*
Northern Africa (M49)	15.0	11.1	10.0	10.7	8.5	0	0	1.3	0	0.5	0.4	0	0	117.9	468.9	1	5468.5	*c*
Sub-Saharan Africa (M49)	72.5	70.9	68.7	70.8	68.6	0	0	1.9	0	0.1	0.1	0.1	0	415.7	12641.7	5.2	18440.9	*c*
Oceania (M49)	12.7	12.4	13.6	14.8	6.6	0.1	0.2	3.2	0	1.7	2.1	0.9	0	286.9	276.6	11.7	3895.9	*c*

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	RENEWABLE ENERGY				SOLID BIOFUELS	LIQUID BIOFUELS	BIOGASES	HYDRO	TIDE	WIND	SOLAR	GEOTHERMAL	MUNICIPAL WASTE (RENEW)	ELECTRICITY CONSUMPTION (1)	HEAT RAISING (2)	TRANSPORT (3)		
	2000	2010	2015	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	
Oceania (M49) excluding Australia and New Zealand (M49)	45.9	36.7	38.4	38.4	34	0	0	3.1	0	0.1	0.6	0.6	0	10.2	80.1	0	235.2	C
Australia and New Zealand (M49)	10.9	11.0	12.0	13.2	4.8	0.1	0.2	3.2	0	1.8	2.2	0.9	0	276.3	196.5	11.8	3660.7	C
Least Developed Countries (LDCs)	84.1	76.2	73.2	71.4	67.6	0	0.1	3.6	0	0	0.1	0	0	443.8	8026	0.6	11858.4	C
Small island developing States (SIDS)	25.2	17.8	18.4	19.6	17.2	0.6	0	0.9	0	0.4	0.4	0.1	0.1	37.6	321.3	2.3	1844.4	C
Landlocked developing countries (LLDCs)	43.6	41.9	44.9	44.9	40.6	0.1	0.1	4	0	0.1	0.1	0	0	444.2	4454.6	18.2	10940.4	C
Africa (M49)	60.7	56.5	54.8	57.1	54.8	0	0	1.7	0	0.2	0.2	0.1	0	527	13110.7	6.4	23909.4	C
Asia (M49)	24.2	15.8	15.2	16.9	9.4	0.4	0.2	3.6	0	1.1	1.5	0.6	0	10085.9	17973.7	812.8	171336.1	C
Americas (M49)	11.8	14.2	15.5	18.4	7.4	3	0.1	5.1	0	1.8	0.8	0.1	0	6842.8	6189.6	2420.4	83986.8	C
Caribbean (M49)	25.2	18.1	20.4	22.8	20.2	1.1	0	0.5	0	0.6	0.4	0	0	16.8	202.1	1.5	966.7	C
Central America (M49)	18.1	16.5	16.4	21.1	14.9	0	0	3.2	0	1.4	1	0.6	0	313.3	736.8	1.1	4989	C
Eastern Africa (M49)	88.0	87.5	84.8	84.8	81.6	0	0	2.8	0	0.1	0	0.2	0	200.1	5056.6	2.5	6202.8	C
Eastern Europe (M49)	4.3	5.7	6.3	7.7	4.1	0.4	0.1	2.5	0	0.3	0.2	0	0	777.5	1092.1	170.1	26567.9	C
Melanesia (M49)	54.2	43.4	43.8	43.6	39	0	0	3.4	0	0.1	0.4	0.7	0	9.1	77.7	0	199.1	C
Micronesia (M49)	4.8	5.1	5.5	6.8	5.3	0	0	0	0	0	1.5	0	0	0.2	0.8	0	15.3	C
Middle Africa (M49)	88.1	79.0	75.9	80.4	76	0	0	4.4	0	0	0	0	0	89.4	1545.2	0.1	2033.4	C
Northern Europe (M49)	15.4	18.7	25.2	31.5	12.5	2.1	0.6	8.8	0	5.3	0.6	0.6	1	1553.6	1095.8	209.1	9082.9	C
Polynesia (M49)	17.3	10.5	12.5	12.7	7.5	0	0	3.2	0	0	2	0	0	1	1.7	0	20.8	C
South America (M49)	32.8	34.5	33.2	39.0	18.6	6	0	12.2	0	1.5	0.7	0	0	2410.6	2813.7	914	15747.7	C
Southern Africa (M49)	18.4	12.0	9.9	11.8	9.9	0	0	0.4	0	0.7	0.8	0	0	45.8	253.4	0.6	2533	C
Southern Europe (M49)	8.7	15.4	18.1	21.0	8.4	1.7	0.5	4.3	0	3.4	2.2	0.3	0.2	1014.8	833.8	164.8	9593.6	C
Western Africa (M49)	83.3	82.0	77.6	76.4	75.4	0	0	0.9	0	0	0	0	0	72.4	5786.5	0	7671.7	C

UN COUNTRY NAME	SHARE IN TOTAL FINAL ENERGY CONSUMPTION (%)													FINAL CONSUMPTION OF RENEWABLE ENERGY (PJ)			TOTAL FINAL ENERGY CONSUMPTION (PJ)	SOURCE
	RENEWABLE ENERGY				SOLID BIOFUELS	LIQUID BIOFUELS	BIOGASES	HYDRO	TIDE	WIND	SOLAR	GEOTHERMAL	MUNICIPAL WASTE (RENEW)	ELECTRICITY CONSUMPTION (1)	HEAT RAISING (2)	TRANSPORT (3)		
	2000	2010	2015	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	
Western Europe (M49)	6.7	11.8	14.3	18.0	6.4	2	1.2	2.6	0	3.4	1.6	0.1	0.7	1551.3	1369.7	371.1	18250.7	c
Developing regions (MDG)	32.3	23.0	21.9	23.8	15.9	0.8	0.2	4.1	0	1	1.2	0.6	0	12791.5	34725.6	1724.9	206797.2	c
Developed regions (MDG)	7.1	9.6	11.5	13.9	5	1.7	0.3	3.5	0	2	1.1	0.2	0.2	9708.5	7202.4	2478	139826.1	c

REFERENCE
a. Source: Energy Balances, UN Statistics Division (2021)
b. Source: IEA (2021), World Energy Balances
c. Sources: IEA (2021), World Energy Balances; Energy Balances, UN Statistics Division (2021)

DEFINITIONS
Final consumption of renewable energy:
(1) Electricity consumption: Covers final consumption of renewable electricity in all sectors excluding transport
(2) Heat raising: Covers final consumption of renewable energy for heat raising purposes (excluding electricity) in manufacturing, construction and non fuel mining industries, household, commerce and public services, agriculture, forestry, fishing and not elsewhere specified.
(3) Transport:Covers final consumption of renewable energy (including electricity) in the transport sector.

NOTES
Allocation of renewable electricity and heat to final energy consumption:
To establish the contribution of each technology to the final consumption, the aggregated figures for electricity and commercial heat have to be allocated to the relevant technology. This can be done based on the proportions exhibited in production data, attributing the losses proportionally (GTF 2013). For instance, if total final consumption table reports 150 TJ for biogases, while total final consumption of electricity is 400 TJ and heat 100 TJ, and the share of biogases in total electricity output is 10 percent and 5 percent in heat, the total reported number for biogases consumption will be 195 TJ (150 TJ+400TJ*10%+100TJ*5%).

SDG 7.3.1 • Energy intensity measured in terms of primary energy and GDP

Source: IEA and UNSD

UN COUNTRY NAME	2000	2010	2015	2020	2000-2010	2010-2015	2015-2020	SOURCE
Afghanistan	1.6	2.5	2.4	2.6	4.2%	-0.7%	1.6%	*a*
Albania	4.1	2.9	2.7	2.4	-3.7%	-1.2%	-2.2%	*b*
Algeria	4.2	4.4	5.1	5.3	0.6%	2.7%	1.0%	*b*
American Samoa	..	..	..	..	..	..	..	*a*
Andorra	..	..	..	..	..	..	..	*a*
Angola	3.7	2.6	2.9	2.7	-3.4%	1.8%	-1.1%	*b*
Anguilla	..	..	..	..	..	..	..	*a*
Antigua and Barbuda	3.7	4.8	4.7	5.1	2.7%	-0.4%	1.8%	*a*
Argentina	3.7	3.3	3.4	3.5	-1.2%	0.6%	0.6%	*b*
Armenia	6.8	3.9	4.1	4.0	-5.4%	1.1%	-0.5%	*b*
Aruba	16.2	16.6	3.4	4.1	0.3%	-27.4%	3.9%	*a*
Australia	6.2	5.3	4.7	4.4	-1.5%	-2.6%	-1.3%	*b*
Austria	3.2	3.3	3.0	2.9	0.2%	-1.8%	-1.0%	*b*
Azerbaijan	14.7	3.9	4.3	4.7	-12.5%	1.9%	2.0%	*b*
Bahamas	2.3	2.5	2.4	2.9	0.7%	-0.7%	3.6%	*a*
Bahrain	10.4	9.6	9.1	9.5	-0.8%	-1.2%	0.9%	*b*
Bangladesh	2.6	2.5	2.3	2.0	-0.6%	-1.3%	-2.8%	*b*
Barbados	5.9	5.8	5.1	4.4	-0.2%	-2.5%	-3.0%	*a*
Belarus	12.9	7.0	6.1	5.8	-5.9%	-2.8%	-0.8%	*b*
Belgium	5.5	4.8	4.0	3.7	-1.4%	-3.9%	-1.1%	*b*
Belize	6.8	5.5	5.9	6.6	-2.1%	1.4%	2.1%	*a*
Benin	4.9	6.0	5.8	5.8	2.1%	-0.7%	-0.1%	*b*
Bermuda	1.5	1.5	1.6	1.4	0.1%	0.7%	-2.3%	*a*

UN COUNTRY NAME	2000	2010	2015	2020	2000-2010	2010-2015	2015-2020	SOURCE
Bhutan	18.4	10.1	8.7	8.3	-5.8%	-3.0%	-1.0%	*a*
Bolivia (Plurinational State of)	3.4	4.0	4.0	3.6	1.7%	-0.2%	-2.2%	*b*
Bonaire, Sint Eustatius and Saba	..	..	..	..	..	..	..	*a*
Bosnia and Herzegovina	6.4	6.7	6.0	6.2	0.5%	-2.3%	0.9%	*b*
Botswana	4.3	3.5	3.5	2.9	-2.1%	0.2%	-4.0%	*b*
Brazil	3.9	3.9	4.1	4.0	-0.1%	1.0%	-0.2%	*b*
British Virgin Islands	..	..	..	..	..	..	..	*a*
Brunei Darussalam	4.3	5.2	4.3	6.1	1.7%	-3.4%	6.9%	*b*
Bulgaria	9.1	5.5	5.4	4.7	-4.9%	-0.5%	-2.6%	*b*
Burkina Faso	5.5	5.4	4.9	4.4	-0.1%	-1.8%	-2.2%	*a*
Burundi	10.4	7.9	7.4	7.8	-2.6%	-1.4%	1.0%	*a*
Cabo Verde	3.3	3.0	2.6	2.6	-0.8%	-2.7%	0.0%	*a*
Cambodia	7.9	5.1	4.6	5.1	-4.4%	-1.9%	2.1%	*b*
Cameroon	6.0	4.5	4.6	4.4	-2.9%	0.6%	-1.2%	*b*
Canada	9.3	7.1	6.9	6.8	-2.6%	-0.7%	-0.2%	*b*
Cayman Islands	1.9	2.1	1.9	2.0	1.0%	-1.8%	1.1%	*a*
Central African Republic	7.7	6.8	9.4	8.4	-1.3%	6.8%	-2.2%	*a*
Chad	8.2	3.9	3.7	4.1	-7.1%	-1.4%	2.2%	*a*
Chile	4.5	3.6	3.4	3.6	-2.2%	-1.0%	1.0%	*b*
China	10.9	8.9	7.2	6.4	-2.0%	-4.2%	-2.5%	*b*
China, Hong Kong Special Administrative Region	2.5	1.6	1.5	1.3	-4.4%	-1.1%	-3.2%	*b*
China, Macao Special Administrative Region	1.1	0.5	0.6	1.0	-7.2%	3.1%	10.4%	*a*
Colombia	3.0	2.4	2.6	2.5	-2.2%	1.2%	-0.8%	*b*
Comoros	2.7	2.8	2.7	3.6	0.4%	-0.9%	6.1%	*a*
Congo	2.2	3.2	4.6	7.1	3.9%	7.8%	8.9%	*b*
Cook Islands	..	..	..	..	..	..	..	*a*

UN COUNTRY NAME	2000	2010	2015	2020	2000-2010	2010-2015	2015-2020	SOURCE
Costa Rica	2.4	2.5	2.2	2.0	0.3%	-2.1%	-2.4%	*b*
Cote d'Ivoire	4.2	4.5	4.0	3.4	0.7%	-2.5%	-2.8%	*b*
Croatia	4.3	3.7	3.4	3.2	-1.4%	-2.1%	-1.3%	*b*
Cuba	3.5	1.9	1.6	1.5	-6.1%	-3.2%	-0.9%	*b*
Curacao	23.0	20.3	24.8	9.9	-1.2%	4.1%	-16.8%	*b*
Cyprus	3.9	3.3	2.9	2.6	-1.9%	-2.1%	-2.6%	*b*
Czechia	6.7	5.4	4.6	4.1	-2.2%	-3.1%	-2.4%	*b*
Democratic People's Republic of Korea	7.2	6.0	3.2	6.0	-1.8%	-12.0%	13.3%	*b*
Democratic Republic of the Congo	16.5	14.9	14.9	13.4	-1.0%	0.0%	-2.0%	*b*
Denmark	3.0	2.9	2.3	2.0	-0.3%	-4.8%	-2.8%	*b*
Djibouti	6.0	4.4	2.4	1.9	-3.2%	-11.0%	-5.0%	*a*
Dominica	2.5	3.0	3.1	3.2	2.0%	0.8%	0.3%	*a*
Dominican Republic	3.9	2.6	2.2	1.9	-4.1%	-2.9%	-3.0%	*b*
Ecuador	3.3	3.5	3.3	3.1	0.6%	-1.3%	-0.9%	*b*
Egypt	3.3	3.7	3.5	3.0	1.1%	-1.1%	-2.8%	*b*
El Salvador	3.5	3.9	3.4	3.4	1.2%	-2.8%	-0.1%	*b*
Equatorial Guinea	1.6	2.4	3.3	3.7	4.2%	6.9%	2.0%	*a*
Eritrea	..	..	..	..	..	..	..	*b*
Estonia	8.0	7.1	4.9	4.0	-1.1%	-7.1%	-4.1%	*b*
Eswatini	6.2	5.2	5.0	4.7	-1.8%	-0.9%	-1.2%	*a*
Ethiopia	21.4	12.7	9.2	7.2	-5.1%	-6.1%	-4.8%	*b*
Falkland Islands (Malvinas)	..	..	..	..	..	..	..	*a*
Faroe Islands	..	..	..	..	..	..	..	*a*
Fiji	2.8	2.2	2.3	2.0	-2.2%	1.0%	-2.9%	*a*
Finland	6.6	6.2	5.5	5.1	-0.5%	-2.4%	-1.6%	*b*
France	4.4	4.0	3.7	3.2	-0.8%	-1.8%	-2.6%	*b*
French Guiana	..	..	..	..	..	..	..	*a*

UN COUNTRY NAME	2000	2010	2015	2020	2000-2010	2010-2015	2015-2020	SOURCE
French Polynesia	2.3	3.0	2.6	2.6	2.8%	-2.8%	0.2%	*a*
Gabon	3.0	9.1	7.2	6.4	11.6%	-4.5%	-2.3%	*b*
Gambia	3.1	2.9	3.5	3.2	-0.7%	3.6%	-1.6%	*a*
Georgia	6.0	3.6	4.2	4.0	-5.1%	3.4%	-1.0%	*b*
Germany	4.0	3.6	3.1	2.7	-1.1%	-2.9%	-2.5%	*b*
Ghana	4.9	3.3	3.0	3.0	-3.8%	-2.4%	0.1%	*b*
Gibraltar	..	..	..	..	..	..	..	*b*
Greece	3.6	3.1	3.2	2.9	-1.5%	0.6%	-2.2%	*b*
Greenland	..	..	..	..	..	..	..	*a*
Grenada	2.5	2.8	2.4	2.7	1.4%	-2.9%	2.1%	*a*
Guadeloupe	..	..	..	..	..	..	..	*a*
Guam	..	..	..	..	..	..	..	*a*
Guatemala	4.0	4.1	4.2	4.2	0.3%	0.1%	0.3%	*b*
Guernsey	..	..	..	..	..	..	..	*a*
Guinea	9.1	7.7	6.4	5.4	-1.6%	-3.8%	-3.3%	*a*
Guinea-Bissau	11.0	10.3	9.6	8.7	-0.6%	-1.6%	-1.8%	*a*
Guyana	5.8	4.7	4.0	2.7	-2.1%	-3.3%	-7.9%	*a*
Haiti	5.1	5.5	5.3	5.3	0.8%	-0.8%	0.0%	*b*
Honduras	4.7	4.9	5.2	4.4	0.4%	1.3%	-3.2%	*b*
Hungary	5.3	4.5	3.9	3.6	-1.5%	-3.0%	-1.5%	*b*
Iceland	11.2	15.0	13.6	12.9	3.0%	-2.0%	-1.0%	*b*
India	6.4	5.3	4.8	4.3	-1.8%	-2.1%	-2.3%	*b*
Indonesia	5.4	4.3	3.3	3.1	-2.4%	-5.2%	-0.9%	*b*
Iran (Islamic Republic of)	7.1	7.5	8.7	8.8	0.5%	2.9%	0.2%	*b*
Iraq	5.2	5.4	4.4	5.0	0.5%	-3.9%	2.6%	*b*
Ireland	3.2	2.5	1.7	1.2	-2.4%	-7.7%	-6.0%	*b*
Isle of Man	..	..	..	..	..	..	..	*a*

UN COUNTRY NAME	2000	2010	2015	2020	2000-2010	2010-2015	2015-2020	SOURCE
Israel	4.1	3.8	2.9	2.5	-0.7%	-4.9%	-3.5%	*b*
Italy	2.9	2.9	2.6	2.5	-0.2%	-1.9%	-1.1%	*b*
Jamaica	5.9	3.8	3.9	3.6	-4.3%	0.4%	-1.4%	*b*
Japan	4.7	4.3	3.5	3.2	-0.9%	-3.9%	-1.9%	*b*
Jersey	..	..	..	..	..	..	..	*a*
Jordan	4.6	3.6	3.8	3.5	-2.3%	1.2%	-1.6%	*b*
Kazakhstan	9.8	8.6	5.4	5.8	-1.3%	-8.8%	1.4%	*b*
Kenya	5.8	5.3	5.5	5.1	-1.0%	0.8%	-1.3%	*b*
Kiribati	5.7	7.0	6.0	6.5	2.1%	-3.2%	1.7%	*a*
Kosovo	7.8	7.7	6.3	5.8	-0.1%	-4.2%	-1.4%	*b*
Kuwait	6.9	7.4	7.1	8.5	0.7%	-0.9%	3.7%	*b*
Kyrgyzstan	6.4	5.1	5.8	5.1	-2.3%	2.6%	-2.7%	*b*
Lao People's Democratic Republic	3.8	3.3	3.8	4.3	-1.3%	2.9%	2.5%	*a*
Latvia	5.2	4.3	3.4	3.1	-2.0%	-4.4%	-1.5%	*b*
Lebanon	3.8	2.8	3.3	4.0	-2.9%	3.2%	4.0%	*b*
Lesotho	14.0	11.1	8.3	8.1	-2.3%	-5.6%	-0.5%	*a*
Liberia	9.7	13.1	11.2	14.0	3.0%	-3.1%	4.6%	*a*
Libya	4.7	4.2	6.5	6.1	-1.2%	9.2%	-1.3%	*b*
Liechtenstein	..	..	..	..	..	..	..	*a*
Lithuania	6.2	4.0	3.3	3.0	-4.3%	-3.7%	-1.8%	*b*
Luxembourg	3.2	3.1	2.4	2.0	-0.6%	-4.5%	-3.6%	*b*
Madagascar	6.1	6.1	7.4	9.4	0.0%	4.0%	4.9%	*a*
Malawi	5.2	3.8	3.3	3.2	-3.1%	-2.6%	-0.9%	*a*
Malaysia	5.5	5.2	4.7	4.5	-0.4%	-2.1%	-0.9%	*b*
Maldives	1.7	2.3	2.3	3.4	2.6%	0.8%	7.9%	*a*
Mali	4.8	4.9	5.2	5.4	0.1%	1.4%	0.7%	*a*
Malta	2.6	2.6	1.5	1.4	-0.2%	-10.0%	-1.9%	*b*

UN COUNTRY NAME	2000	2010	2015	2020	2000-2010	2010-2015	2015-2020	SOURCE
Marshall Islands	9.4	10.5	10.7	9.7	1.2%	0.4%	-2.0%	*a*
Martinique	..	..	..	..	..	..	..	*a*
Mauritania	2.6	2.8	3.0	3.4	1.0%	1.3%	2.6%	*a*
Mauritius	3.0	2.6	2.4	2.2	-1.3%	-1.8%	-1.6%	*b*
Mayotte	..	..	..	..	..	..	..	*a*
Mexico	3.6	3.7	3.3	3.2	0.2%	-2.2%	-0.5%	*b*
Micronesia (Federated States of)	7.2	4.1	5.7	5.6	-5.5%	6.7%	-0.3%	*a*
Mongolia	9.3	8.1	5.9	6.6	-1.3%	-6.2%	2.4%	*b*
Montenegro	..	4.6	3.7	3.8	..	-4.1%	0.4%	*b*
Montserrat	..	..	..	..	..	..	..	*a*
Morocco	3.6	3.5	3.3	3.4	-0.4%	-1.3%	0.7%	*b*
Mozambique	26.9	12.7	13.0	11.8	-7.3%	0.4%	-1.9%	*b*
Myanmar	12.1	4.2	4.0	3.6	-10.1%	-0.9%	-2.0%	*b*
Namibia	3.6	3.6	3.3	3.5	0.0%	-1.7%	1.4%	*b*
Nauru	17.4	8.7	5.4	5.1	-6.7%	-9.2%	-1.1%	*a*
Nepal	6.8	5.9	5.5	5.7	-1.5%	-1.4%	0.8%	*b*
Netherlands	4.2	4.0	3.4	3.1	-0.3%	-3.3%	-2.0%	*b*
New Caledonia	7.9	10.8	13.5	14.1	3.1%	4.7%	0.8%	*a*
New Zealand	5.6	4.6	4.5	3.9	-2.0%	-0.4%	-2.8%	*b*
Nicaragua	5.2	4.7	4.5	4.6	-1.0%	-1.0%	0.5%	*b*
Niger	5.8	5.5	5.5	5.0	-0.6%	0.1%	-2.0%	*b*
Nigeria	10.0	6.8	6.0	6.6	-3.8%	-2.4%	1.7%	*b*
Niue	..	..	..	..	..	..	..	*a*
North Macedonia	5.4	4.3	3.6	3.3	-2.2%	-3.9%	-1.4%	*b*
Northern Mariana Islands	..	..	..	..	..	..	..	*a*
Norway	4.3	4.6	3.8	3.4	0.7%	-3.6%	-2.5%	*b*
Oman	3.6	6.6	7.2	7.2	6.3%	1.6%	0.0%	*b*

UN COUNTRY NAME	2000	2010	2015	2020	2000-2010	2010-2015	2015-2020	SOURCE
Pakistan	5.1	4.5	4.2	4.0	-1.2%	-1.6%	-1.0%	*b*
Palau	11.1	10.6	8.6	10.5	-0.5%	-3.9%	4.0%	*a*
Panama	2.3	1.9	1.5	1.5	-2.0%	-4.1%	0.2%	*b*
Papua New Guinea	5.9	5.7	5.5	5.5	-0.4%	-0.7%	0.2%	*a*
Paraguay	3.6	3.1	3.0	3.3	-1.3%	-0.7%	2.0%	*b*
Peru	3.3	2.5	2.6	2.5	-2.7%	0.4%	-0.8%	*b*
Philippines	4.7	3.1	3.0	2.8	-4.0%	-1.2%	-1.2%	*b*
Poland	6.0	4.6	3.8	3.5	-2.6%	-4.0%	-1.6%	*b*
Portugal	3.3	2.9	2.9	2.6	-1.2%	-0.5%	-2.1%	*b*
Puerto Rico	0.1	0.2	0.5	0.5	7.3%	16.1%	-0.3%	*a*
Qatar	8.9	6.4	6.6	7.2	-3.3%	0.5%	1.8%	*b*
Republic of Korea	7.2	6.1	5.8	5.3	-1.6%	-1.3%	-1.8%	*b*
Republic of Moldova	8.1	6.4	5.3	5.1	-2.4%	-3.7%	-0.8%	*b*
Reunion	..	..	..	..	..	..	..	*a*
Romania	5.6	3.6	2.8	2.4	-4.4%	-4.6%	-2.9%	*b*
Russian Federation	12.1	8.5	7.8	8.2	-3.5%	-1.7%	1.0%	*b*
Rwanda	7.8	5.6	4.6	3.9	-3.3%	-3.8%	-3.3%	*a*
Saint Helena	..	..	..	..	..	..	..	*a*
Saint Kitts and Nevis	3.3	2.7	2.5	2.6	-1.8%	-1.8%	0.6%	*a*
Saint Lucia	3.1	3.2	3.0	3.4	0.4%	-1.0%	2.7%	*a*
Saint Pierre and Miquelon	..	..	..	..	..	..	..	*a*
Saint Vincent and the Grenadines	2.3	2.7	2.6	2.6	1.5%	-0.3%	0.1%	*a*
Samoa	5.7	3.8	4.3	4.1	-4.1%	2.8%	-0.8%	*a*
Sao Tome and Principe	4.5	4.2	3.9	3.4	-0.8%	-1.3%	-2.6%	*a*
Saudi Arabia	5.2	6.7	6.3	6.2	2.7%	-1.3%	-0.3%	*b*
Senegal	4.0	4.7	4.2	3.5	1.7%	-2.2%	-3.5%	*b*
Serbia	8.5	6.2	5.6	5.3	-3.1%	-2.0%	-1.2%	*b*

UN COUNTRY NAME	2000	2010	2015	2020	2000-2010	2010-2015	2015-2020	SOURCE
Seychelles	2.9	3.2	2.8	3.2	1.2%	-2.4%	2.4%	*a*
Sierra Leone	10.9	6.6	6.3	5.4	-4.9%	-1.1%	-2.8%	*a*
Singapore	3.5	2.5	2.7	2.5	-3.3%	1.6%	-1.4%	*b*
Sint Maarten (Dutch part)	..	..	8.2	8.3	..	..	0.2%	*a*
Slovakia	8.8	5.4	4.4	4.2	-4.7%	-4.1%	-1.1%	*b*
Slovenia	5.2	4.5	4.0	3.5	-1.5%	-2.6%	-2.6%	*b*
Solomon Islands	7.0	6.2	5.0	4.4	-1.2%	-4.2%	-2.4%	*a*
Somalia	11.2	11.9	9.7	8.5	0.6%	-3.9%	-2.7%	*a*
South Africa	9.2	8.0	7.0	7.0	-1.4%	-2.8%	0.0%	*b*
South Sudan	..	..	..	..	..	..	..	*b*
Spain	3.6	3.1	2.9	2.7	-1.6%	-1.4%	-1.4%	*b*
Sri Lanka	3.1	2.2	1.8	1.7	-3.4%	-4.4%	-0.5%	*b*
State of Palestine	2.9	2.6	2.8	3.2	-0.9%	1.4%	2.3%	*a*
Sudan	4.3	3.2	4.3	4.8	-2.8%	6.2%	2.0%	*b*
Suriname	4.2	3.1	3.6	4.7	-2.8%	2.6%	5.8%	*b*
Sweden	5.5	4.8	3.8	3.6	-1.5%	-4.6%	-1.1%	*b*
Switzerland	2.4	2.1	1.8	1.6	-1.5%	-3.1%	-1.9%	*b*
Syrian Arab Republic	13.6	11.6	11.1	10.7	-1.6%	-0.8%	-0.8%	*b*
Tajikistan	10.9	5.1	4.6	4.4	-7.4%	-2.0%	-0.8%	*b*
Thailand	4.9	5.1	5.1	4.6	0.3%	-0.1%	-1.8%	*b*
Timor-Leste	..	1.4	1.8	1.8	..	4.8%	0.2%	*a*
Togo	10.6	12.5	9.2	8.7	1.7%	-6.0%	-1.1%	*b*
Tonga	3.0	3.1	2.7	4.0	0.4%	-2.6%	7.8%	*a*
Trinidad and Tobago	18.8	20.9	19.2	17.7	1.0%	-1.7%	-1.6%	*b*
Tunisia	4.0	3.8	3.7	3.7	-0.7%	-0.6%	0.1%	*b*
Türkiye	3.3	3.1	2.7	2.6	-0.7%	-2.8%	-0.6%	*b*
Turkmenistan	29.9	21.7	13.6	11.1	-3.2%	-8.9%	-4.0%	*b*

UN COUNTRY NAME	2000	2010	2015	2020	2000-2010	2010-2015	2015-2020	SOURCE
Turks and Caicos Islands	3.4	5.4	4.8	6.3	4.8%	-2.5%	5.9%	*a*
Tuvalu	2.7	3.9	2.9	2.6	3.6%	-5.6%	-2.3%	*a*
Uganda	13.3	10.6	10.2	12.3	-2.2%	-0.8%	3.8%	*a*
Ukraine	15.2	9.9	8.1	7.0	-4.2%	-3.9%	-2.9%	*b*
United Arab Emirates	4.1	5.5	5.9	5.5	3.0%	1.4%	-1.3%	*b*
United Kingdom of Great Britain and Northern Ireland	4.1	3.2	2.6	2.2	-2.3%	-4.3%	-2.8%	*b*
United Republic of Tanzania	12.3	9.1	7.4	6.6	-3.0%	-4.0%	-2.4%	*b*
United States of America	6.7	5.5	4.9	4.3	-2.0%	-2.3%	-2.5%	*b*
United States Virgin Islands	..	..	..	..	..	..	..	*a*
Uruguay	2.7	2.6	2.8	2.9	-0.3%	0.9%	1.2%	*b*
Uzbekistan	26.5	13.4	7.5	7.5	-6.6%	-11.0%	0.2%	*b*
Vanuatu	3.7	3.7	3.6	4.3	-0.1%	-0.5%	4.0%	*a*
Venezuela (Bolivarian Republic of)	6.7	6.3	5.0	2.0	-0.6%	-4.5%	-16.6%	*b*
Viet Nam	4.1	4.4	3.5	4.1	0.7%	-4.4%	2.7%	*b*
Wallis and Futuna Islands	..	..	..	..	..	..	..	*a*
Yemen	2.5	2.7	1.9	1.8	0.8%	-6.6%	-0.8%	*b*
Zambia	12.8	7.9	7.4	7.6	-4.7%	-1.2%	0.5%	*b*
Zimbabwe	12.7	17.2	13.9	13.7	3.1%	-4.2%	-0.3%	*b*
World	6.1	5.5	5.0	4.6	-1.0%	-2.1%	-1.4%	*c*
Northern America (M49) and Europe (M49)	5.9	5.0	4.4	4.1	-1.8%	-2.3%	-1.6%	*c*
Northern America (M49)	6.9	5.6	5.1	4.5	-2.0%	-2.2%	-2.2%	*c*
Europe (M49)	5.2	4.5	3.9	3.7	-1.5%	-2.6%	-1.1%	*c*
Latin America and the Caribbean (MDG=M49)	3.9	3.7	3.5	3.3	-0.5%	-0.8%	-1.3%	*c*
Central Asia (M49) and Southern Asia (MDG=M49)	6.6	5.7	5.1	4.6	-1.5%	-2.2%	-1.7%	*c*
Central Asia (M49)	15.7	10.5	6.7	6.8	-3.9%	-8.6%	0.2%	*c*
Southern Asia (MDG=M49)	6.0	5.3	4.9	4.5	-1.3%	-1.4%	-1.9%	*c*

UN COUNTRY NAME	2000	2010	2015	2020	2000-2010	2010-2015	2015-2020	SOURCE
Eastern Asia (M49) and South-eastern Asia (MDG=M49)	7.0	6.7	5.7	5.3	-0.4%	-3.1%	-1.5%	c
Eastern Asia (M49)	7.5	7.3	6.2	5.7	-0.3%	-3.2%	-1.7%	c
South-eastern Asia (MDG=M49)	5.1	4.3	3.7	3.6	-1.7%	-2.8%	-0.7%	c
Western Asia (M49) and Northern Africa (M49)	4.4	4.7	4.5	4.3	0.5%	-0.7%	-0.7%	c
Western Asia (M49)	4.7	5.0	4.6	4.5	0.7%	-1.5%	-0.5%	c
Northern Africa (M49)	3.8	3.8	4.0	3.8	0.0%	1.2%	-1.1%	c
Sub-Saharan Africa (M49)	8.7	7.0	6.3	6.3	-2.3%	-2.0%	0.0%	c
Oceania (M49)	6.0	5.2	4.6	4.3	-1.5%	-2.3%	-1.4%	c
Oceania (M49) excluding Australia and New Zealand (M49)	4.1	4.0	4.1	4.1	-0.2%	0.1%	0.3%	c
Australia and New Zealand (M49)	6.1	5.2	4.7	4.3	-1.5%	-2.3%	-1.5%	c
Least Developed Countries (LDCs)	6.6	5.1	4.9	4.7	-2.5%	-0.6%	-1.0%	c
Small island developing States (SIDS)	3.8	3.1	3.0	2.7	-2.0%	-0.9%	-1.9%	c
Landlocked developing countries (LLDCs)	11.2	7.9	6.2	6.2	-3.5%	-4.8%	0.1%	c
Africa (M49)	6.6	5.7	5.5	5.4	-1.5%	-0.8%	-0.4%	c
Asia (M49)	6.5	6.2	5.4	5.0	-0.5%	-2.7%	-1.4%	c
Americas (M49)	6.0	5.0	4.5	4.1	-1.8%	-1.9%	-1.9%	c
Caribbean (M49)	..	..	..	..	..	..	..	c
Central America (M49)	3.6	3.6	3.3	3.2	0.2%	-2.1%	-0.5%	c
Eastern Africa (M49)	11.0	8.6	7.7	7.3	-2.4%	-2.1%	-1.2%	c
Eastern Europe (M49)	10.3	7.2	6.3	6.2	-3.4%	-2.6%	-0.3%	c
Melanesia (M49)	4.3	4.3	4.3	4.3	-0.1%	0.0%	0.4%	c
Micronesia (M49)	15.3	14.3	13.3	11.7	-0.6%	-1.5%	-2.5%	c
Middle Africa (M49)	6.3	5.1	5.5	5.7	-2.1%	1.6%	0.5%	c
Northern Europe (M49)	4.3	3.7	2.9	2.6	-1.6%	-4.4%	-2.5%	c
Polynesia (M49)	..	..	..	..	..	..	..	c
South America (M49)	4.0	3.7	3.7	3.4	-0.7%	-0.2%	-1.4%	c

UN COUNTRY NAME	2000	2010	2015	2020	2000-2010	2010-2015	2015-2020	SOURCE
Southern Africa (M49)	8.9	7.7	6.7	6.7	-1.5%	-2.8%	-0.1%	*c*
Southern Europe (M49)	3.4	3.1	2.9	2.7	-0.8%	-1.5%	-1.2%	*c*
Western Africa (M49)	8.0	6.2	5.5	5.7	-2.5%	-2.4%	0.5%	*c*
Western Europe (M49)	4.1	3.7	3.3	2.9	-0.9%	-2.7%	-2.4%	*c*
Developing regions (MDG)	6.2	5.9	5.3	5.0	-0.6%	-2.2%	-1.2%	*c*
Developed regions (MDG)	5.8	4.9	4.3	4.0	-1.7%	-2.5%	-1.6%	*c*

REFERENCE
a. Source: Energy Balances, UN Statistics Division (2022)
b. Source: IEA (2022), World Energy Balances
c. Source: IEA (2022), World Energy Balances; Energy Balances, UN Statistics Division (2022)

DEFINITIONS
Energy intensity: Energy intensity is defined as the energy supplied to the economy per unit value of economic output.

SDG 7.a.1 • International financial flows to developing countries in support of clean energy

Source: International Renewable Energy Agency, Organisation for Economic Co-operation and Development

COUNTRY	INTERNATIONAL COMMITMENTS (2020 USD MILLIONS)					AVERAGES (2020 USD MILLIONS PER YEAR)	
	2000	2010	2015	2020	2021	2000-21	2010-21
Afghanistan	0.0	38	5.1	49	0.0	*32*	*50*
Algeria	0.0	0.4	0.9	0.0	0.1	*0.4*	*0.4*
Angola	0.0	0.0	0.0	0.1	0.0	*4.5*	*8.1*
Antigua and Barbuda	0.0	0.0	7.2	6.5	0.0	*1.7*	*3.0*
Argentina	0.0	1.1	113	88	2.7	*220*	*393*
Armenia	0.0	96	24	26	49	*26*	*43*
Azerbaijan	4.9	192	80	0.0	0.0	*13*	*23*
Bahamas	0.0	0.0	0.0	190	2.3	*8.8*	*16*
Bangladesh	3.1	0.2	8.0	23	306	*101*	*167*
Barbados	0.0	0.0	0.1	0.0	0.0	*2.0*	*3.7*
Belize	0.0	0.0	0.0	0.0	2.8	*1.2*	*1.8*
Benin	0.0	0.2	566	1.8	43	*42*	*75*
Bhutan	5.1	23	129	0.8	0.8	*15*	*17*
Bolivia (Plurinational State of)	0.1	5.5	2.0	3.1	0.3	*96*	*167*
Botswana	0.0	11	0.0	0.0	40	*2.8*	*4.5*
Brazil	130	134	2.3	972	414	*210*	*352*
Burkina Faso	0.1	1.4	0.2	163	49	*22*	*35*
Burundi	0.0	14	2.6	112	0.0	*23*	*42*
Cabo Verde	0.0	72	3.3	2.5	11	*7.2*	*13*
Cambodia	0.0	673	8.4	28	30	*83*	*112*
Cameroon	0.0	53	2.1	45	6.9	*98*	*179*
Central African Republic	0.0	0.0	9.7	6.0	0.0	*4.9*	*8.6*
Chad	0.0	0.0	0.0	11	11	*5.4*	*7.1*
Chile	0.5	3.3	116	1.0	36	*206*	*354*
China	251	135	94	115	96	*216*	*280*
Colombia	0.0	3.6	23	50	94	*112*	*185*

COUNTRY	INTERNATIONAL COMMITMENTS (2020 USD MILLIONS)					AVERAGES (2020 USD MILLIONS PER YEAR)	
	2000	2010	2015	2020	2021	2000-21	2010-21
Comoros	0.0	0.0	1.0	17	0.0	*2.1*	*3.9*
Congo	0.2	0.0	0.0	0.3	0.5	*29*	*11*
Cook Islands	0.0	0.0	19	0.0	0.0	*2.4*	*4.5*
Costa Rica	0.1	7.9	448	300	14	*109*	*185*
Côte d'Ivoire	14	0.9	0.9	357	312	*61*	*110*
Cuba	0.8	4.3	77	3.0	0.1	*12*	*21*
Democratic People's Republic of Korea	0.0	0.0	0.0	0.0	0.0	*0.2*	*0.4*
Democratic Republic of the Congo	0.0	0.4	0.6	0.6	40	*80*	*125*
Djibouti	0.0	13	1.0	1.5	0.4	*5.1*	*8.3*
Dominica	0.0	0.0	0.0	0.0	0.0	*1.6*	*2.9*
Dominican Republic	12	81	0.1	1.0	100	*19*	*33*
Ecuador	2.3	2,781	32	70	2.6	*200*	*364*
Egypt	11	1,058	247	244	153	*251*	*388*
El Salvador	0.0	58	79	0.8	1.9	*59*	*109*
Equatorial Guinea	0.0	0.0	0.0	0.0	0.0	*21*	*0.3*
Eritrea	0.0	0.1	112	0.0	0.0	*9.2*	*17*
Eswatini	0.0	0.0	1.1	0.1	0.2	*1.1*	*1.3*
Ethiopia	1.6	95	317	3.9	392	*339*	*202*
Fiji	0.0	0.0	1.8	4.1	0.5	*5.4*	*2.0*
French Polynesia	0.0	0.0	0.0	0.0	0.0	*0.0*	*0.0*
Gabon	0.0	6.5	13	0.0	0.0	*21*	*5.2*
Gambia	0.0	0.0	0.0	31	0.0	*9.6*	*18*
Georgia	0.0	8.6	7.1	0.6	4.9	*29*	*51*
Ghana	4.3	25	63	17	15	*75*	*59*
Grenada	0.0	0.0	1.8	0.0	3.2	*0.4*	*0.8*
Guatemala	0.0	9.9	0.0	0.2	12	*11*	*18*
Guinea	0.2	0.0	1.3	0.0	0.0	*112*	*206*
Guinea-Bissau	0.0	0.0	0.0	0.0	0.0	*0.8*	*0.8*

COUNTRY	INTERNATIONAL COMMITMENTS (2020 USD MILLIONS)					AVERAGES (2020 USD MILLIONS PER YEAR)	
	2000	2010	2015	2020	2021	2000-21	2010-21
Guyana	0.0	1.2	1.5	1.5	2.9	*2.7*	*4.5*
Haiti	0.9	2.4	50	12	12	*10*	*18*
Honduras	34	133	411	83	17	*77*	*139*
India	500	383	930	1,677	1,275	*783*	*1,223*
Indonesia	2.4	47	392	416	350	*305*	*444*
Iran (Islamic Republic of)	64	0.0	0.2	0.0	0.0	*16*	*0.4*
Iraq	0.0	164	0.0	0.6	1.9	*30*	*46*
Jamaica	5.4	0.2	89	3.0	14	*13*	*22*
Jordan	0.0	7.1	260	37	23	*86*	*156*
Kazakhstan	0.0	1.4	50	28	43	*76*	*105*
Kenya	0.1	750	547	36	105	*218*	*374*
Kiribati	0.0	1.0	0.0	13	0.0	*1.3*	*2.0*
Kyrgyzstan	8.7	1.5	0.0	0.1	0.0	*8.2*	*14*
Lao People's Democratic Republic	0.0	11	82	0.4	0.0	*325*	*509*
Lebanon	0.0	1.7	38	0.2	2.1	*3.6*	*6.4*
Lesotho	0.0	0.0	0.0	76	0.4	*4.8*	*8.7*
Liberia	0.0	0.0	256	9.1	3.4	*25*	*46*
Madagascar	0.0	0.0	4.9	25	9.7	*9.0*	*14*
Malawi	7.1	16	66	3.5	16	*13*	*23*
Malaysia	146	0.2	0.2	3.9	0.0	*7.1*	*0.8*
Maldives	5.0	10	6.4	22	26	*5.6*	*9.8*
Mali	3.7	0.0	9.7	0.5	9.1	*37*	*60*
Marshall Islands	0.0	0.0	4.3	0.0	2.6	*3.0*	*4.3*
Mauritania	0.0	0.0	0.1	28	0.0	*19*	*33*
Mauritius	0.0	2.1	9.8	1.1	0.0	*8.8*	*16*
Mexico	2.5	84	218	936	307	*188*	*336*
Micronesia (Federated States of)	0.0	0.0	4.2	0.0	0.1	*3.2*	*4.2*
Mongolia	5.4	12	0.9	107	2.2	*29*	*48*

COUNTRY	INTERNATIONAL COMMITMENTS (2020 USD MILLIONS)					AVERAGES (2020 USD MILLIONS PER YEAR)	
	2000	2010	2015	2020	2021	2000-21	2010-21
Montserrat	0.0	0.0	2.1	0.0	0.0	*1.0*	*1.6*
Morocco	0.3	8.8	242	252	1.2	*281*	*434*
Mozambique	0.1	93	5.2	163	108	*40*	*70*
Myanmar	0.0	0.1	59	63	11	*39*	*34*
Namibia	0.1	49	0.0	0.0	0.2	*8.8*	*12*
Nauru	0.0	0.0	8.8	0.1	0.0	*1.8*	*3.1*
Nepal	12	24	19	59	97	*83*	*123*
New Caledonia	0.0	0.0	0.0	0.0	0.0	*2.8*	*5.1*
Nicaragua	0.0	136	69	144	180	*60*	*106*
Niger	0.2	0.0	0.0	131	243	*37*	*67*
Nigeria	0.0	0.6	48	269	33	*358*	*655*
Niue	0.0	0.0	0.0	0.0	0.0	*0.5*	*0.4*
Pakistan	0.0	272	1,236	871	786	*507*	*866*
Palau	0.0	0.0	5.3	0.1	0.1	*0.8*	*0.6*
Panama	0.0	9.1	66	265	0.0	*54*	*100*
Papua New Guinea	0.0	0.0	8.5	0.1	0.2	*4.0*	*7.4*
Paraguay	0.0	0.1	0.0	401	0.1	*33*	*45*
Peru	1.1	94	87	24	101	*96*	*167*
Philippines	13	83	23	1.7	45	*41*	*35*
Rwanda	0.2	2.2	0.0	279	83	*34*	*55*
Saint Helena	0.0	0.0	1.5	0.0	0.0	*0.1*	*0.1*
Saint Lucia	0.0	0.0	0.0	0.0	6.5	*0.8*	*1.5*
Saint Vincent and the Grenadines	0.0	0.0	0.0	0.0	0.0	*1.6*	*3.0*
Sao Tome and Principe	0.0	0.1	0.4	14	2.1	*1.1*	*1.9*
Senegal	0.2	1.1	34	109	26	*42*	*65*
Seychelles	0.0	0.0	0.1	0.0	0.0	*0.1*	*0.2*
Sierra Leone	0.0	9.5	0.0	1.5	15	*8.2*	*5.4*

COUNTRY	INTERNATIONAL COMMITMENTS (2020 USD MILLIONS)					AVERAGES (2020 USD MILLIONS PER YEAR)	
	2000	2010	2015	2020	2021	2000-21	2010-21
Solomon Islands	0.0	0.0	7.0	1.0	1.7	*12*	*22*
Somalia	0.0	0.0	0.3	0.2	142	*7.8*	*14*
South Africa	7.3	268	740	142	81	*155*	*279*
South Sudan	0.0	0.0	0.1	0.1	0.2	*1.4*	*2.6*
Sri Lanka	1.5	46	0.5	0.6	0.5	*62*	*74*
State of Palestine	0.0	1.4	24	12	24	*7.5*	*13*
Sudan	0.0	88	0.0	19	0.3	*75*	*30*
Suriname	0.0	0.0	0.0	3.0	0.5	*1.4*	*2.6*
Syrian Arab Republic	0.0	5.4	0.0	0.0	0.0	*0.2*	*0.5*
Tajikistan	0.0	6.8	0.2	46	56	*37*	*59*
Thailand	0.2	4.3	57	55	164	*54*	*97*
Timor-Leste	0.0	5.2	0.0	1.8	2.9	*1.0*	*1.1*
Togo	0.0	0.0	5.0	17	31	*3.7*	*6.9*
Tokelau	0.0	0.0	0.0	0.0	0.0	*0.4*	*0.8*
Tonga	0.0	5.9	15	2.1	2.1	*6.0*	*11*
Tunisia	4.6	135	9.2	21	2.6	*45*	*46*
Türkiye	135	292	443	368	123	*352*	*574*
Turkmenistan	0.0	0.0	0.1	0.0	0.0	*0.3*	*0.5*
Tuvalu	0.0	0.5	8.8	0.1	2.8	*2.1*	*3.9*
Uganda	27	30	517	22	3.9	*166*	*250*
United Republic of Tanzania	0.2	8.9	38	98	322	*45*	*76*
Uruguay	0.0	1.2	212	0.0	0.0	*49*	*87*
Uzbekistan	0.0	0.0	0.3	215	170	*42*	*74*
Vanuatu	0.0	0.9	7.5	0.9	2.0	*2.8*	*4.0*
Venezuela (Bolivarian Republic of)	0.9	1,306	0.4	0.0	0.0	*114*	*139*
Viet Nam	0.0	105	6.5	167	362	*136*	*164*
Zimbabwe	0.0	0.0	0.0	0.1	0.0	*16*	*28*

COUNTRY	INTERNATIONAL COMMITMENTS (2020 USD MILLIONS)					AVERAGES (2020 USD MILLIONS PER YEAR)	
	2000	2010	2015	2020	2021	2000-21	2010-21
Albania	0.2	7.0	25	0.0	54	*25*	*15*
Bosnia and Herzegovina	0.0	97	6.5	3.7	0.4	*27*	*46*
Belarus	0.0	0.1	0.0	0.4	0.0	*20*	*37*
China, Hong Kong Special Administrative Region	0.0	0.0	0.0	0.0	0.0	*0.0*	*0.0*
Kosovo	0.0	0.0	26	0.0	0.1	*6.5*	*12*
Libya	0.0	0.0	0.0	0.0	5.2	*0.2*	*0.4*
China, Macao Special Administrative Region	0.0	0.0	0.0	0.0	0.0	*0.0*	*0.0*
Republic of Moldova	0.0	19	0.5	0.1	0.3	*2.4*	*4.5*
Montenegro	0.0	0.2	86	17	0.0	*11*	*19*
Serbia	0.0	94	4.6	11	13	*42*	*65*
Trinidad and Tobago	0.0	0.0	0.0	0.3	0.0	*0.0*	*0.0*
Ukraine	0.0	1.2	11	41	269	*98*	*164*
North Macedonia	0.4	37	0.0	22	39	*8.1*	*15*
Wallis and Futuna Islands	0.0	0.0	0.0	0.0	0.0	*0.0*	*0.0*
Samoa	0.0	0.2	0.0	0.0	0.0	*1.8*	*3.4*
Yemen	1.5	0.3	0.0	1.1	7.8	*8.3*	*14*
Zambia	0.0	393	1,775	13	11	*146*	*244*
Residual/unallocated ODA: Central Asia and Southern Asia	3.6	1.8	0.0	2.3	136	*9.1*	*14*
Residual/unallocated ODA: Latin America and the Caribbean	2.4	10	120	117	53	*80*	*126*
Residual/unallocated ODA: Oceania excl. Aus. and N. Zealand	0.0	0.9	2.1	0.1	0.2	*1.7*	*3.1*
Residual/unallocated ODA: Sub-Saharan Africa	11	25	155	483	1,734	*239*	*416*
Residual/unallocated ODA: Western Asia and Northern Africa	0.0	7.5	39	0.0	7.8	*18*	*32*
Residual/unallocated ODA: Northern America and Europe	0.0	8.6	0.0	125	24	*58*	*105*

COUNTRY	INTERNATIONAL COMMITMENTS (2020 USD MILLIONS)					AVERAGES (2020 USD MILLIONS PER YEAR)	
	2000	2010	2015	2020	2021	2000-21	2010-21
Residual/unallocated ODA: Eastern and South-eastern Asia	0.0	22	55	137	149	*47*	*82*
Small Island Developing States (SIDS)	22.69	102.48	335.92	311.77	2,412.79		*2,686.47*
World	**1,469**	**11,912**	**12,588**	**12,229**	***10,775***	***9,588***	***14,975***
Sub-Saharan Africa	**78**	**1,946**	**5,310**	**2,692**	***3,904***	***2,624***	***3,967***
Latin America and the Caribbean	**192**	**4,865**	**2,230**	**3,676**	***1,381***	***2,051***	***3,507***
Eastern and South-Eastern Asia	**421**	**1,101**	**779**	**1,098**	***1,349***	***1,293***	***1,821***
Eastern Asia	256	147	95	222	98	*245*	*329*
South-eastern Asia	165	954	683	876	1,251	*1,048*	*1,493*
Northern Africa and Western Asia	**157**	**2,059**	**1,410**	**983**	**400**	***1,222***	***1,851***
Northern Africa	16	1,289	499	536	162	*653*	*898*
Western Asia	141	769	911	447	238	*569*	*953*
Central and Southern Asia	**600**	**806**	**2,384**	**2,992**	**2,760**	***1,769***	***2,782***
Central Asia	8.7	9.6	50	289	269	*163*	*253*
Southern Asia	591	796	2,334	2,703	2,491	*1,605*	*2,530*
Northern America and Europe	**0.5**	**264**	**160**	**221**	**400**	***298***	***482***
Northern America	0.0	0.0	0.0	0.0	0.0	*0.0*	*0.0*
Europe	0.5	264	160	221	400	*298*	*482*
Oceania	**0.0**	**9.4**	**91**	**21**	**12**	***52***	***82***
Oceania excluding Australia and New Zealand	0.0	9.4	91	21	12	*52*	*82*
Residual/unallocated ODA: Unspecified, developing countries	**20**	**862**	**224**	**548**	**568**	***279***	***482***
Least Developed Countries (LDCs)	64	1,543	4,099	1,609	2,033	*2,088*	*2,899*
Landlocked developing countries (LLDCs)	77	1,029	3,090	1,779	1,317	*1,677*	*2,334*
Small island developing States (SIDS)	24	186	339	300	198	*154*	*259*

SDG 7.b.1 • Installed renewable electricity-generating capacity (watts per capita)

Source: International Renewable Energy Agency

COUNTRY	WATTS PER CAPITA				
	2000	2010	2015	2020	2021
Afghanistan	9.8	8.6	9.0	9.3	9.3
Algeria	9.0	7.0	7.9	16	16
American Samoa	0.0	0.0	47	112	115
Angola	14	34	37	113	110
Anguilla	0.0	0.0	79	97	96
Antigua and Barbuda	0.0	1.2	38	182	181
Argentina	235	239	246	312	332
Armenia	323	383	448	511	545
Aruba	0.0	300	365	357	358
Azerbaijan	113	108	117	126	127
Bahamas	0.0	0.8	3.3	5.5	5.5
Bahrain	0.0	0.6	4.2	7.1	8.2
Bangladesh	1.8	1.8	2.4	3.1	3.4
Barbados	0.0	3.6	32	178	178
Belize	129	197	240	260	257
Benin	0.1	0.1	0.2	0.3	0.3
Bhutan	586	2,110	2,173	3,023	3,004
Bolivia (Plurinational State of)	44	57	57	89	103
Bonaire, Sint Eustatius and Saba	0.0	549	492	676	662
Botswana	0.0	0.1	0.9	2.3	2.3
Brazil	362	456	549	704	746
British Virgin Islands	0.0	21	24	22	22
Brunei Darussalam	0.0	3.0	2.8	3.2	11
Burkina Faso	2.7	2.2	2.2	4.5	4.4
Burundi	8.6	6.0	5.4	4.7	4.6
Cabo Verde	0.0	14	60	61	60

COUNTRY	WATTS PER CAPITA				
	2000	2010	2015	2020	2021
Cambodia	0.8	1.5	63	103	108
Cameroon	48	36	32	31	30
Cayman Islands	0.0	0.0	0.0	189	201
Central African Republic	5.0	4.1	4.0	3.6	3.5
Chad	0.2	0.2	0.2	0.2	0.2
Chile	290	362	473	654	764
China	60	173	344	631	716
Colombia	213	206	250	243	244
Comoros	0.0	2.2	2.0	1.8	1.8
Congo	28	19	41	40	39
Cook Islands	3.6	5.6	166	280	281
Costa Rica	358	426	482	610	619
Côte d'Ivoire	36	29	26	33	32
Cuba	5.2	55	55	111	114
Curaçao	21	50	236	315	314
Democratic People's Republic of Korea	197	160	178	190	189
Democratic Republic of the Congo	51	38	32	30	29
Djibouti	0.0	0.0	0.3	0.3	18
Dominica	112	102	100	99	98
Dominican Republic	53	55	72	130	138
Ecuador	136	157	160	301	298
Egypt	41	39	37	56	57
El Salvador	97	134	148	253	252
Equatorial Guinea	8.2	5.1	93	80	78
Eritrea	0.0	0.3	2.6	6.5	7.0
Eswatini	101	113	149	143	150
Ethiopia	6.1	21	26	40	40

COUNTRY	WATTS PER CAPITA				
	2000	2010	2015	2020	2021
Falkland Islands (Malvinas)	84	728	701	638	635
Fiji	130	162	210	230	238
French Guiana	698	612	652	616	602
French Polynesia	192	178	259	306	304
Gabon	134	100	164	145	142
Gambia	0.0	1.0	1.5	1.3	1.3
Georgia	600	704	631	730	762
Ghana	60	46	56	53	52
Grenada	0.0	2.3	9.3	30	30
Guadeloupe	114	248	371	476	503
Guam	0.0	0.5	190	207	206
Guatemala	62	90	136	165	163
Guinea	15	13	33	29	61
Guinea-Bissau	0.0	0.0	0.2	0.6	0.6
Guyana	29	71	73	67	66
Haiti	6.7	5.8	5.5	7.1	7.0
Honduras	66	74	147	183	181
India	24	42	59	96	105
Indonesia	26	28	33	39	41
Iran (Islamic Republic of)	31	114	127	136	136
Iraq	27	73	61	37	37
Jamaica	21	35	38	90	90
Jordan	2.9	2.4	16	183	195
Kazakhstan	148	137	162	263	369
Kenya	25	25	34	43	45
Kiribati	0.7	3.6	20	23	22
Kuwait	0.0	0.0	1.4	24	25

COUNTRY	WATTS PER CAPITA				
	2000	2010	2015	2020	2021
Kyrgyzstan	596	559	622	572	564
Lao People's Democratic Republic	99	387	642	1,055	1,143
Lebanon	65	57	46	65	66
Lesotho	38	36	35	33	33
Liberia	1.4	1.0	0.9	19	18
Libya	0.0	0.6	0.8	0.8	0.9
Madagascar	6.5	6.0	7.0	7.0	6.8
Malawi	27	20	22	24	27
Malaysia	120	97	243	258	265
Maldives	0.0	4.4	14	55	62
Mali	7.5	19	21	20	21
Marshall Islands	0.7	6.0	20	37	39
Martinique	0.0	75	181	352	357
Mauritania	0.0	0.0	13	27	26
Mauritius	91	128	133	189	189
Mayotte	0.0	39	53	59	57
Mexico	111	120	145	214	237
Micronesia (Federated States of)	19	4.9	13	31	30
Mongolia	6.1	13	29	85	84
Montserrat	0.0	0.0	0.0	56	226
Morocco	43	48	67	94	95
Mozambique	124	95	82	73	71
Myanmar	7.6	46	63	65	64
Namibia	132	117	154	201	198
Nauru	0.0	3.9	19	170	168
Nepal	12	26	30	47	70
New Caledonia	361	453	434	695	692

COUNTRY	WATTS PER CAPITA				
	2000	2010	2015	2020	2021
Nicaragua	30	64	97	109	107
Niger	0.0	0.1	0.3	1.1	1.1
Nigeria	17	13	12	10	10
Niue	0.0	30	185	485	486
Oman	0.0	0.0	0.5	36	41
Other non-specified areas in Eastern Asia	94	125	171	388	471
Pakistan	34	36	39	55	56
Palau	0.2	16	51	97	97
Panama	208	264	519	548	587
Papua New Guinea	39	40	38	34	34
Paraguay	1,442	1,527	1,432	1,334	1,317
Peru	109	120	151	191	191
Philippines	49	51	55	62	67
Puerto Rico	26	43	124	181	221
Qatar	0.0	0.0	9.5	8.7	9.0
Republic of Korea	34	58	142	394	470
Réunion	183	316	412	462	470
Rwanda	5.1	4.9	9.4	12	12
Saint Barthélemy	0.0	0.0	0.0	2.2	2.2
Saint Kitts and Nevis	0.0	46	76	87	87
Saint Lucia	0.0	0.1	4.3	22	22
Saint Martin (French Part)	0.0	0.0	74	15	16
Saint Vincent and the Grenadines	50	52	60	72	72
Samoa	82	64	70	135	133
Sao Tome and Principe	16	13	12	12	12
Saudi Arabia	0.0	0.1	0.7	3.1	12
Senegal	1.1	2.3	2.4	22	25
Seychelles	0.0	0.0	75	122	182

COUNTRY	WATTS PER CAPITA				
	2000	2010	2015	2020	2021
Sierra Leone	0.9	8.4	12	12	12
Singapore	38	25	44	94	110
Solomon Islands	0.7	1.3	3.4	5.3	5.1
Somalia	0.0	0.0	0.2	1.2	1.6
South Africa	27	19	61	162	172
South Sudan	0.0	0.0	0.0	0.1	0.1
Sri Lanka	62	70	88	111	117
State of Palestine	0.0	0.0	2.7	23	35
Sudan	15	42	40	40	40
Suriname	376	330	327	315	312
Syrian Arab Republic	94	38	82	72	70
Tajikistan	647	630	590	553	541
Thailand	57	70	112	165	166
Timor-Leste	0.0	0.4	0.9	1.1	1.1
Togo	13	10	9.1	8.7	14
Tokelau	13	15	654	578	571
Tonga	0.6	1.1	27	74	73
Trinidad and Tobago	4.0	2.0	2.5	2.4	2.3
Tunisia	7.4	11	29	33	33
Türkiye	176	237	396	585	628
Turkmenistan	0.3	0.2	0.2	0.2	0.3
Turks and Caicos Islands	0.0	0.0	0.8	21	21
Tuvalu	0.6	20	190	209	206
Uganda	11	14	21	27	26
United Arab Emirates	0.0	1.3	15	222	275
United Republic of Tanzania	18	14	13	11	11
United States Virgin Islands	0.0	0.0	90	100	101

COUNTRY	WATTS PER CAPITA				
	2000	2010	2015	2020	2021
Uruguay	471	541	830	1,091	1,092
Uzbekistan	64	63	61	60	63
Vanuatu	3.1	18	29	38	37
Venezuela (Bolivarian Republic of)	541	509	498	583	589
Viet Nam	43	101	176	397	438
Yemen	0.0	0.0	2.1	7.8	7.7
Zambia	182	140	142	134	146
Zimbabwe	62	65	62	77	76
World	**64**	**101**	**154**	**244**	**268**
Sub-Saharan Africa	**27**	**24**	**28**	**37**	**38**
Latin America and the Caribbean	**246**	**285**	**334**	**422**	**446**
Eastern and South-Eastern Asia	**55**	**135**	**258**	**466**	**525**
Eastern Asia	62	168	331	611	693
South-Eastern Asia	38	55	86	134	143
Northern Africa and Western Asia	**65**	**74**	**102**	**143**	**151**
Northern Africa	28	33	36	49	50
Western Asia	100	111	160	228	244
Central and Southern Asia	**30**	**47**	**60**	**89**	**96**
Central Asia	194	188	195	214	240
Southern Asia	23	41	55	84	90
Oceania	**57**	**60**	**67**	**72**	**72**
Oceania (exc. Australia and New Zealand)	57	60	67	72	72
Least Developed Countries (LDCs)	17	24	29	37	39
Landlocked developing countries (LLDCs)	78	82	85	97	103
Small island developing States (SIDS)	31	44	55	85	90

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The Energy Progress Report is a joint report of the Custodian Agencies – the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the United Nations Statistics Division (UNSD), the World Bank, and the World Health Organization (WHO).

It receives inputs from the SDG 7 Technical Advisory Group which comprises more than 30 organizations around the world and has been made possible with the support of our partners.

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