TRACKING SDG7

THE ENERGY PROGRESS REPORT 2021

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

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PARTNERS

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

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

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CONTENTS

EXECUTIVE SUMMARY

Photo: © Prabuddha/Adobe Stock
Community work for rural electrification

OVERVIEW

The 2021 edition of *Tracking SDG 7: The Energy Progress Report* monitors and assesses achievements in the global quest for universal access to affordable, reliable, sustainable, and modern energy by 2030. The latest available data and selected energy scenarios reveal that at today's rate of progress, the world is not on track to achieve SDG 7. This is particularly true of the most vulnerable countries and those that were already lagging. This report also examines various ways to bridge the gaps, chief among them the goal of significantly scaling up renewable energy while maximizing its socioeconomic benefits. Figure ES.1 offers a snapshot of the primary indicators.

This report was prepared as the COVID-19 pandemic and its broad social and economic disruptions entered a second year. The consequences of the pandemic are considered in this report, along with results from global modeling exercises—first to determine whether current policy ambitions are meeting the SDG 7 targets and, second, to identify what additional actions might be needed. The report also examines the investments levels required to achieve the goals. It presents scenarios drawn from the International Energy Agency's (IEA) flagship publication, *World Energy Outlook* (IEA 2020b), and the International Renewable Energy Agency's (IRENA) *Global Renewables Outlook: Energy Transformation 2050* (IRENA 2020a).

While renewable energy has demonstrated remarkable resilience during the pandemic, the unfortunate fact is that gains in energy access throughout Africa are being reversed: the number of people lacking access to electricity is set to *increase* in 2020, making basic electricity services unaffordable for up to 30 million people who had previously enjoyed access. The COVID-19 crisis has revealed the stark worldwide inequalities in access to reliable energy and health care, especially in rural and peri-urban areas, and has highlighted the need to expand energy access to help populations mitigate the effects of the crisis.

With the world preparing for the September 2021 launch of the first United Nations High-Level Dialogue on Energy in decades, the time is right to enhance international collaboration and progress toward SDG 7. In this context, the SDG 7 custodian agencies—IEA, IRENA, the United Nations Statistics Division (UNSD), the World Bank, and the World Health Organization (WHO)—urge the international community and policy makers to safeguard existing gains toward SDG 7; not to lose sight of the need for continued action on affordable, reliable, sustainable, and modern energy for all; and to maintain a strategic focus on the vulnerable countries needing the most support.

Universal access to electricity. SDG target 7.1 is universal access to affordable, reliable, sustainable, and modern energy services; 7.1.1 focuses on access to electricity. Recent progress in access to electricity was mixed, as is the outlook for 2030. While the share of people with access grew up to 90 percent in 2019, 759 million people still lack it. Half live in fragile and conflict-affected settings and 84 percent in rural areas. The IEA's Stated Policies Scenario projects that in 2030 some 660 million people will still lack access to electricity. About 940 million people will have to be connected by 2030 to reach universal access. The COVID-19 crisis threatens progress in some parts of the world. In Sub-Saharan Africa, the number of people without access to electricity most likely grew in 2020. This means the access rate will have to more than triple between now and 2030. In Sub-Saharan Africa alone, this would mean connecting around 85 million people each year through 2030.

Clean cooking solutions. If clean cooking fails to secure a foothold in the global political agenda, 2.4 billion people will be left with no access in 2030, according to IEA's Stated Policies Scenario. Continuing to rely on polluting fuels and inefficient technologies will have dramatic consequences for the environment, economic development, and most notably, on the health of women and children. The challenge in Developing Asia and Sub-Saharan Africa is to understand, first, how cultural, economic, and social factors combine to slow progress; and, second, how to expand acceptance of affordable and available solutions centered on cleaner fuels, cookstoves with very low emissions, and efficient electric appliances that can be plugged into the grid or run on solar photovoltaic (PV) panels connected to a battery.

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

2010	Latest Data
1.2 billion people without access to electricity	**759 million** people without access to electricity (2019)
3 billion people without access to clean cooking	**2.6 billion** people without access to clean cooking (2019)
16.4% share of total final energy consumption from renewables	**17.1%** share of total final energy consumption from renewables (2018)
5.6 MJ/USD primary energy intensity	**4.8 MJ/USD** primary energy intensity (2018)
10.6 USD billion international financial flows to developing countries in support of clean energy	**14 USD billion** international financial flows to developing countries in support of clean energy (2018)

Renewable energy. SDG target 7.2 is defined as a substantial increase in the share of renewable energy in the global energy mix. Renewable energy has seen unprecedented growth over the past decade, particularly for the generation of electricity. During the COVID-19 pandemic, renewables have proven more resilient than other parts of the energy sector, and their short-term outlook shows resilience in all regions, helped along by supportive policies and falling technology costs. Despite progress, however, the share of renewables in total final energy consumption (TFEC) is still only 17 percent, not much higher than the year before—because TFEC has grown at the same rate as renewables. The fact is that deployment levels of renewables are still quite far from those needed to meet SDG 7 and to achieve a meaningful decarbonization of the energy sector. The IEA's Sustainable Development Scenario shows that intensified policy support and cost reductions could push the share of modern renewables in TFEC above 25 percent, with renewables accounting for a little more than half of electricity supply. IRENA's Transforming Energy Scenario goes further, showing how the rapid growth in renewable energy could continue over the coming decade, with its share in TFEC reaching 28 percent by 2030 and the share of renewable sources in power generation reaching 57 percent. In the power sector, both the IEA and IRENA scenarios envisage that solar PV and wind will account for most renewables-based electricity generation by 2030. The outlook for the use of renewables in transport and heat is not as strong. Despite its large share of final energy consumption, heat receives limited policy attention globally compared with other end-use sectors.

Energy efficiency. SDG target 7.3 is to increase the global rate of improvement in energy efficiency by 2030 to 2.6 percent annually (doubling the average of 1.3 percent achieved annually between 1990 and 2010).[1] The rate of global primary energy intensity improvement—defined as the percentage decrease in the ratio of global total primary energy supply per unit of gross domestic product—has slowed in recent years. In the IEA's Stated Policies Scenario, lower fuel prices are a key reason for a further slowing of the rate at which the energy intensity of the global economy improves. The annual rate of improvement stays at around 2 percent annually for 2019–25 before rising slightly in subsequent years. In contrast, in the Sustainable Development Scenario, the average rate of improvement needed to meet the SDG 7.3 target has increased to 3 percent per year between 2018 and 2030, an increase of 0.4 percent from initial estimates prepared when the SDGs were developed.

International public financial flows. The SDG 7.a.1 indicator measures international public financial flows to developing countries in support of renewable energy. These flows amounted to USD 14 billion in 2018, a 35 percent decrease from an all-time high of USD 21.9 billion the year before. Nevertheless, the overall trend in public financial flows has been positive over the past decade, increasing threefold during the period 2010–18 when viewed as a five-year moving average. This trend, however, masks some important distributional discrepancies, with financial commitments concentrated in a few countries and thus failing to reach many of those most in need of international support. The 46 least developed countries (LDCs) received a mere 20 percent of public financial flows over the period 2010–18 and a total of USD 2.8 billion in 2018—the same level as in 2017 but lower than in 2016 and 2015. IEA and IRENA scenarios project that renewables investment needs to increase considerably — in the power sector alone, investment would need to grow from USD 300 billion to USD 550-850 billion a year throughout 2019-30. This would need to be supported by additional investments to an expanded and modernized electricity network and grid battery storage. International public financial flows are critical to reach these investment levels and to leverage the necessary amounts of private capital, especially in the midst of the COVID-19 pandemic, which has dramatically increased investors' risk perception and shifted public funding priorities in developing countries.

* * *

Although innovative policies and technologies continue to emerge and bring positive benefits to the energy sector, the impact of the COVID-19 pandemic has left us in a very different place from that foreseen in early 2020. The SDG 7 goals are now in jeopardy, and some elements of those goals are even more distant than before.

Conversely, the pandemic could also have a positive impact on reaching the goals. In a number of advanced economies, a decline in interest rates and accommodative monetary policy by central banks mean that base lending rates will stay lower for longer. Given the capital-intensive nature of many clean energy technologies, this could translate into lower deployment costs. Recovery plans designed to kickstart economic growth, protect workers, and create jobs could provide a substantial boost to the deployment of renewable energy technologies—for example, by developing strategies that make use of existing skills in the energy sector to support clean energy transitions. Lower fossil fuel prices could make it easier for governments to phase out fossil fuel subsidies. Part of how we get on track toward meeting SDG 7 depends on how governments respond to the economic crisis and the role of recovery packages in shaping a more sustainable future.

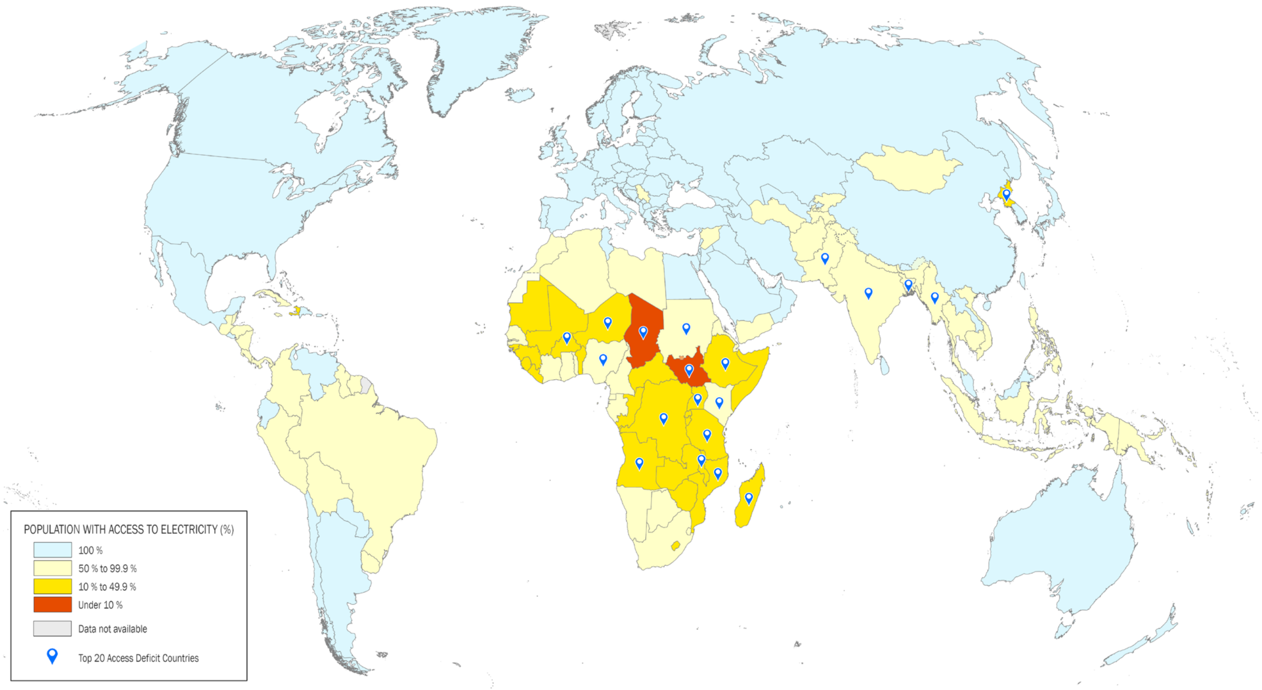
1 Revisions of underlying statistical data and methodological improvements explain the slight changes in historical growth rates from previous editions. The SDG 7.3 target of improving energy intensity by 2.6 percent per year in 2010–30 remains the same, although the latest data for the period 1990–2010 showed a rate of improvement in energy intensity of 1.2 percent per year.

ACCESS TO ELECTRICITY

The share of the global population with access to electricity (SDG 7.1.1) rose consistently from 83 percent in 2010 to 90 percent in 2019. Noteworthy electrification efforts brought access to 1.1 billion people worldwide between 2010 and 2019, shrinking the number of those without access from 1.2 billion in 2010 to 759 million in 2019.

The global advance in electricity access since 2010 masks unequal progress across regions (figure ES.2). In Latin America and the Caribbean, and in Eastern Asia and South-eastern Asia, the advance in electrification was enough to approach universal access, with more than 98 percent of the population enjoying access to electricity by 2019. That same year in Western Asia and Northern Africa, and in Central Asia and Southern Asia, 94 and 95 percent of the populations, respectively, had access to electricity. By contrast, Sub-Saharan Africa remains the world region with the largest access deficit, accounting for three-quarters of the global deficit. In Sub-Saharan Africa, the access rate was 46 percent in 2019, and 570 million people still did not have access to electricity. However, between 2017 and 2019, progress in access outstripped population growth, resulting in a drop in the number of unelectrified people in the region.

FIGURE ES.2 • Share of population with access to electricity in 2019

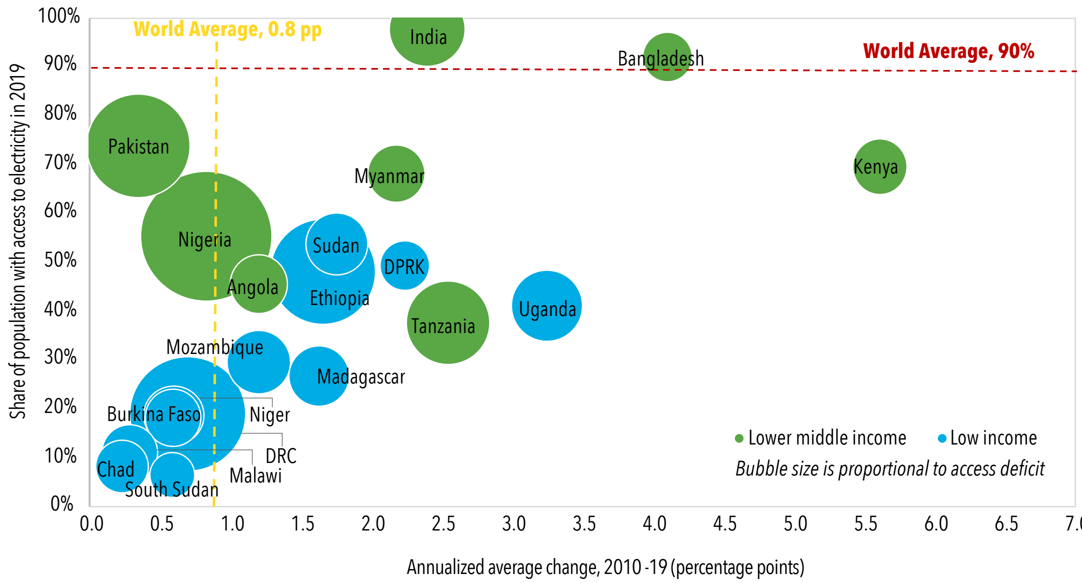


Source: World Bank 2021.

Note/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 on any map in this work 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.

Twenty countries with the largest populations lacking access to electricity accounted for 76 percent (580 million people) of the global access deficit (figure ES.3). Efforts in these countries are particularly important to make significant progress toward universal access. The three largest deficit countries—Nigeria, Democratic Republic of Congo, and Ethiopia (which replaced India in third place in 2019)—are in Sub-Saharan Africa. In 2019 these three countries accounted for 90 million, 70 million, and 58 million unserved people. Of the 20 countries, Bangladesh, Kenya, and Uganda have made the most progress in electrification, achieving annual growth in access of more than 3 percentage points since 2010, while more than half of the countries expanded electrification by less than 2 percentage points annually. In 9 out of the 20, access kept pace with population growth between 2010 and 2019.

FIGURE ES.3 • Electricity access in the top 20 access-deficit countries, 2010–19



Source: World Bank 2021.

Note: A country's "access deficit" is defined as the number of people in the country without access to electricity.

DPRK = Democratic People's Republic of Korea; DRC = Democratic Republic of Congo.

Major disparities in urban vs. rural access to electricity are also observable. The access rate in rural areas improved faster than in urban settings over the 2017–19 period, outpacing population growth. Nonetheless, in 2019, rural areas still accounted for 84 percent of the global population living without access to electricity (640 million unserved people). Meanwhile, urban areas have been approaching universal access, with the access rate standing more than 97 percent since 2016 (leaving 116 million people with no access in 2019). Fifty-eight percent of the unserved urban population in 2019 lived in fragile and conflict-affected settings.

Electrification through decentralized renewables-based solutions has advanced significantly since 2010, accelerating in recent years. The number of people connected to mini-grids (all technologies) more than doubled between 2010 and 2019, growing from 5 to 11 million people (IRENA 2020b). In 2019, 105 million people had access to off-grid solar solutions, rising from 85 million in 2016 (GOGLA 2020). Forty-nine percent of them reside in Sub-Saharan Africa, while 29 percent inhabit South Asia. According to analysis from RISE (ESMAP 2020), policy frameworks to support mini-grid and off-grid systems developed more rapidly after 2010 than did those for on-grid electrification.[2]

Despite the remarkable growth in electrification observed over the last decade, the world may still fall short of 100 percent access to electricity by 2030. Without taking into account disruptions from the COVID-19 crisis, annual growth in access would have to be an average growth of 0.9 percentage points per year by 2030 to meet the goal, higher than the 0.74 percentage points observed for the past three years. The annual rate of growth in electrification will have to improve greatly to close the gap by 2030. Under current policies and with the impact of COVID-19, 660 million people will remain without electricity access in 2030 (IEA 2020).

Owing to the socioeconomic impact of the COVID-19 pandemic, and given the complexities faced by the remaining unserved population, closing the access gap will become increasingly challenging. The balance between affordability and financial viability required to leave no one behind will not be easy to find. Reaching the last-mile households (who are mostly poor, vulnerable, and remote) while accelerating electrification in low-income countries, fragile countries beset by conflict and violence, and countries housing refugee camps occupied by millions of displaced people is the formidable challenge governments and the international community must overcome. Extraordinary measures must be designed and implemented to ramp up

2 RISE (Regulatory Indicators for Sustainable Energy) assesses countries' policy and regulatory support for each of the four pillars of sustainable energy: access to electricity, access to clean cooking (for 55 access-deficit countries), energy efficiency, and renewable energy.

electrification efforts to the levels required to achieve the 2030 target.

ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

In 2019, the share of the global population with access to clean cooking fuels and technologies grew to 66 percent (confidence intervals of 59–71 percent) from 63 (56-68) percent in 2018. The global population without access was 2.6 (2.2–3.1) billion people. Access to clean fuels and technologies in 2018 was only 9 percentage points higher than in 2010, when it stood at 57 percent (52–62 percent) of the global population. Recent trends suggest that the world will fall short of the 2030 target for universal access by almost 30 percent, reaching only 72 percent of the population. Increases of more than 3 percentage points per year would be required to achieve the goal of universal access to clean fuels and technologies by 2030. Without urgent action, the environmental, social, and health toll caused by household air pollution is likely to continue, affecting women and children in particular, because they bear a disproportionate share of the burden of gathering fuel and tending polluting stoves.

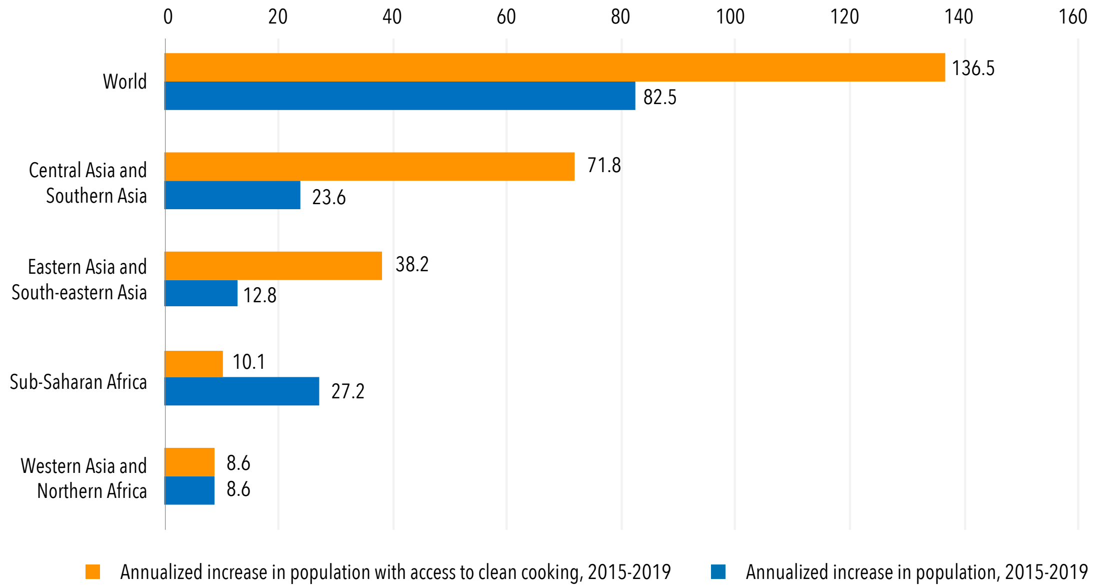
From 2010 to 2019, the global rate of access to clean cooking fuels and technologies increased annually by 1.0 percentage point (0.2–1.8). The gains were predominantly driven by increases in large, populous countries—mostly in the Central and Southern Asia region and the Eastern and South-eastern Asia region. Notably, progress by the five most populous low- and middle-income countries (Brazil, China, India, Indonesia, and Pakistan) was substantially faster than global progress overall. On a global scale, the percentage of the population gaining access has been largely matched by population growth, causing a decades-long stagnation in the number of people without access to clean cooking, referred to here as the "access deficit." Figure ES.4 illustrates the annualized increase in the number of people with access to clean cooking fuels and technologies compared with the annualized population increase, by region, for the 2015–19 period. Stagnation in the global access deficit disguises key regional trends. The access deficit has fallen steadily in Eastern and South-eastern Asia since 2000, and in Central Asia and Southern Asia since 2010. In Sub-Saharan Africa, meanwhile, growth of the population with access to clean cooking fuels and technologies has failed to keep pace with overall population growth; the region's access deficit rose by a factor of more than 50 percent after 2000, reaching a total of 910 million (880–930) people in 2019.

The top 20 access-deficit countries accounted for 81 percent of the global population without access to clean fuels and technologies in the period 2015 to 2019. In seven of these countries, the proportion of the population with access is no more than 5 percent. The seven are the Democratic Republic of Congo, Ethiopia, Madagascar, Mozambique, Niger, Tanzania, and Uganda. Sixteen of the twenty countries have access rates of less than 50 percent. On a positive note, Cambodia, Indonesia, and Myanmar achieved annual gains in access exceeding 2 percentage points in the period 2015–19.

The urban-rural discrepancy in access to clean cooking fuels and technologies dropped worldwide over the past decade. In 2019, the difference in access was 42 percentage points (31–51), with 85 percent (77–88) of urban dwellers having access, compared with 42 percent (35–50) of those living in rural areas. The access gap between the two areas has been decreasing since 2010, owing first to increased access in rural areas and second, to urban population growth, which is beginning to outpace access. The access disparity between urban and rural areas has been declining in most regions, except in Sub-Saharan Africa, where it grew from

23 percentage points in 2010 to 29 percentage points in 2019.

FIGURE ES.4 • Annualized increase in population and in the number of people with access to clean cooking (millions), 2015–19, by region



Source: WHO Global Health Observatory and UN population estimates.

Among low- and middle-income countries, the use of gaseous fuels (LPG, natural gas, and biogas) rose steadily from 36 percent (31–41) in 2000 (1.8 billion people) to 51 percent (45–58) in 2019 (3.3 billion people), overtaking unprocessed biomass fuels (wood, crop waste, and dung) as the predominant type of cooking fuel. Use of electricity for cooking has also risen, from 3 percent (2–4) in 2000 (140 million people) to 7 percent (4–12) in 2019 (450 million people), though the increase was far more notable in urban areas. Between 2000 and 2010, increases in the use of clean fuels appear to be explained by steep declines in the use of coal—particularly in rural areas, where it fell from 11 percent in 2000 to 2 percent in 2019, and kerosene, particularly in urban areas, where its use dropped from 9 percent in 2000 to 2 percent in 2019.

Among all the SDG 7 targets, clean cooking presents the greatest cause for concern owing to its slow progress. A continuation of a business-as-usual agenda is no longer acceptable: Clean cooking fuels and technologies must be made a top political priority with targeted policies. To achieve the universal target, a multisectoral and a coordinated effort is needed. All household energy needs, including cooking energy and electricity access, should be integrated into a national energy plan. Given the status of access to clean cooking, it is not possible to overstate the urgency for action, especially in Sub-Saharan Africa, where access is particularly low, and the absolute number of people relying on polluting cooking fuels and stoves continues to rise.

The WHO's guidelines on indoor air quality: household fuel combustion (WHO 2014) provide useful and accepted benchmarks on fuel use, emissions, human exposure levels, and health risks. The WHO Clean Household Energy Solutions Toolkit (CHEST) supports sector professionals and policy makers with ways to implement the recommendations contained in the WHO guidelines.

Finally, there is an urgent need to scale up investment. Public and private finance for clean cooking remains far below the necessary level. The economic costs of reliance on polluting fuels make a strong case for investment by countries to promote immediate transitions to clean cooking fuels and technologies.

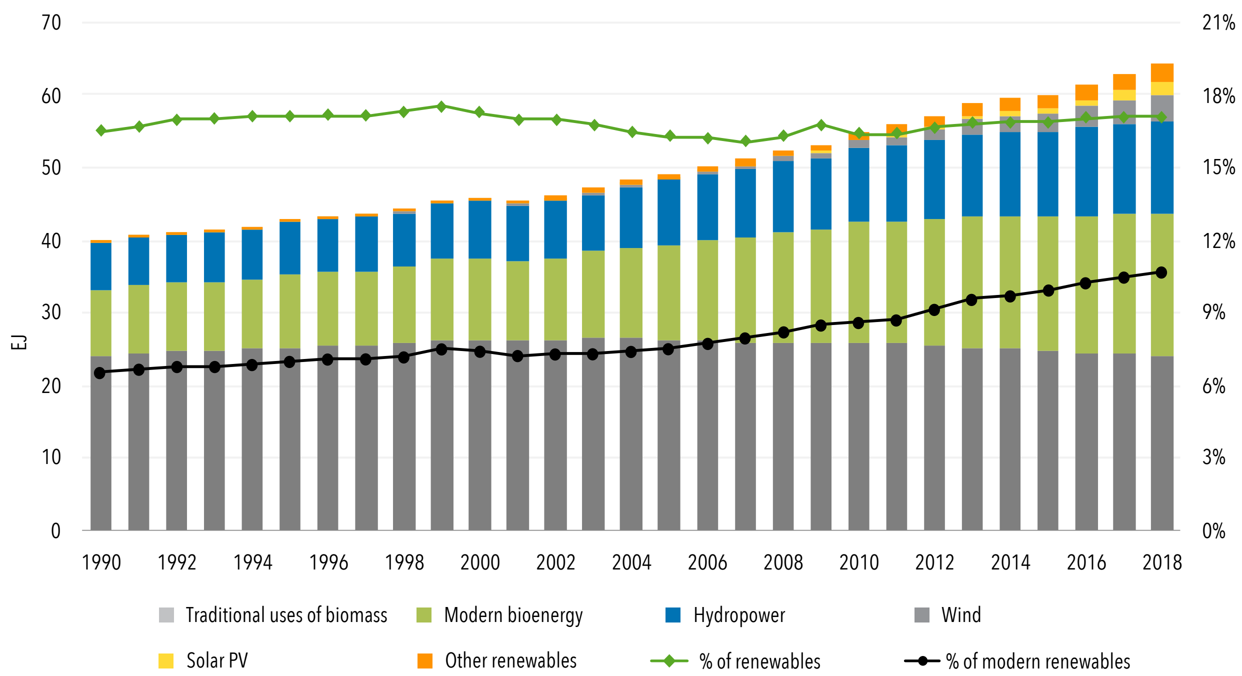
RENEWABLE ENERGY

Although renewable energy has shown unprecedented growth in recent decades, its share in TFEC has remained steady because consumption of renewables and TFEC have increased at similar rates. In 2018, renewable energy consumption, including traditional uses of biomass, grew 2.1 percent, as did TFEC, leaving renewables at the same 17.1 percent share of TFEC as in 2017. This underscores the importance of further scaling up renewable energy while containing energy consumption through energy efficiency so as to progress toward the SDG 7.2 target.

As in previous years, the fastest progress in renewable energy consumption is in the electricity sector, whereas the transport and heat sectors show much slower advances. Renewables consumption in the electricity sector grew almost 7 percent between 2017 and 2018, bringing its share to 25.4 percent —up from 24.7 percent in 2017. By way of comparison, the consumption of nonrenewables in the electricity sector increased by 3 percent year-on-year in 2018.

Hydropower remains by far the largest source of renewable electricity globally, followed by wind and solar PV. Together, wind and solar PV have shown the fastest growth rates among renewable electricity sources and are responsible for more than half of the increase in renewable electricity consumption observed over the past 10 years (figure ES.5).

FIGURE ES.5 • Renewable energy consumption by technology and share in total final energy consumption (TFEC), 1990–2018



Source: IEA 2020a; UN 2020.

In terms of new installations of electricity generation capacity, renewables have shown strong growth, moving up 7.9 percent in 2018 and 7.4 percent in 2019 (IRENA, 2020b; UN 2021). Since 2015, renewables have consistently outpaced installations in nonrenewable capacity. Renewable electricity now accounts for almost half of global modern renewable energy consumption and three-quarters of its year-on-year increase.

But electricity represented only 21 percent of global energy consumption in 2018, whereas heat and transport accounted for 47 percent and 32 percent, respectively. Ensuring access to affordable, reliable, sustainable, and modern energy for all implies a substantial increase in the share of renewable energy in these end-use sectors.

Renewable heat consumption (excluding traditional uses of biomass) increased 1.2 percent year-on-year in 2018, reaching 9.2 percent of total heat consumption, the same as in the two preceding years, and only one percentage point higher than ten years earlier.

Despite its dominant share in final energy consumption, the heat sector receives conspicuously little policy attention and support, despite the fact that demand for heating and cooling is expected to climb as building floor area continues to grow globally and developing countries expand their industries (IEA 2019). Mitigating the climate impact of this trend will require a rapid penetration of renewable heating technologies.

Decarbonizing heating and cooling uses will require governments to implement comprehensive policy packages that combine efficiency and renewable energy sources while phasing out the use of fossil fuels. Renewables-based electrification, renewable gases, sustainable biomass, direct use of geothermal heat, and solar thermal heat are all relevant technologies that could benefit from stronger policy support. Such policies will have to address long-standing barriers and be aligned with broad socioeconomic objectives and consolidated international actions. For instance, the phasing out of fossil fuel subsidies will require careful adjustment (or implementation) of fiscal and social policies to avoid adverse effects on vulnerable communities (IRENA, IEA, REN21 2020). Clear targets and policy consistency will be essential in order to provide investors the transparency and certainty they need. Integrated long-term plans should articulate with energy efficiency targets and include development plans for large infrastructure, such as district heating and cooling networks, which can be more efficient than decentralized systems in densely populated areas.

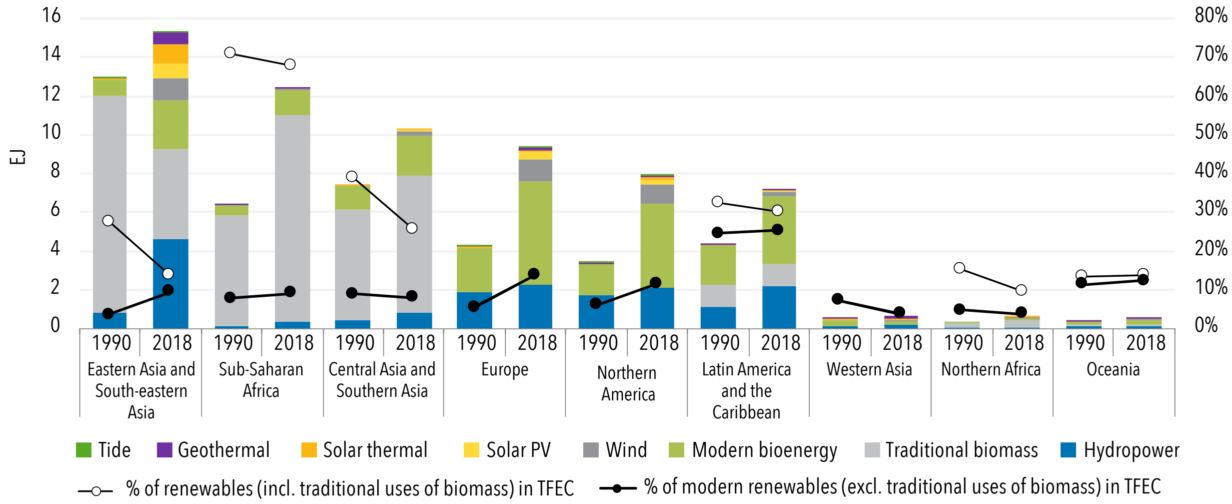
Renewable energy used in transport grew by 7 percent in 2018, the largest increase since 2012, bringing its total share of renewable energy to 3.4 percent, up from 3.3 percent in 2017. Biofuels, primarily crop-based ethanol and biodiesel, supplied 91 percent of that renewable energy. Nevertheless, the expansion of renewable electricity and of sales of electric vehicles are leading to record increases in the use of renewable electricity in transport.

Behind the global figure, important regional disparities should be noted. In 2018, as in all previous years since 1990, Sub-Saharan Africa has the largest share of renewable sources in its energy supply, with traditional uses of biomass representing more than 85 percent of the renewable energy consumed in the region. When traditional uses of biomass are excluded, Latin America and the Caribbean show the highest share of modern renewable energy consumption. This is due to the region's use of hydropower for electricity generation, of bioenergy for industrial processes (in particular in the sugar and ethanol industry), and of biofuels for transport.

At national levels, the share of renewable sources in energy consumption varies widely depending on resource availability, policy support, and the impact of energy efficiency and consumption patterns on total energy demand (figure ES.6). Of the top 20 energy-consuming countries, Brazil and Canada had the highest shares of modern renewables in 2018, relying on hydropower for electricity and bioenergy for heat and transport. China accounted for almost a fifth of global modern renewable energy consumption, yet this represented less than 10 percent of its TFEC. Germany, Italy, and the United Kingdom achieved the most progress in the share of modern renewables in TFEC between 2000 and 2018, mostly through the deployment of bioenergy (in particular for heat), wind, and solar PV, and by stabilizing or lowering their TFEC. The largest advances in 2018 were observed in Spain at +1.7 percentage points, owing to higher hydropower generation, followed by Indonesia at +1.4 percentage points, where a rapid uptake of bioenergy for power generation played a substantial role.

For the first time in 2018, a majority of new renewable electricity capacity was installed in developing countries, but substantial efforts will still be required to reach SDG 7. As demonstrated in the tracking of SDG indicator 7.b.1, developing countries had 219 watts per capita of installed renewable electricity capacity in 2019, a quarter of the 880 watts per capita in developed countries, which mirrors the differential in overall generating capacity.

FIGURE ES.6 • Renewable energy consumption and share in total final energy consumption by region, 1990 and 2018



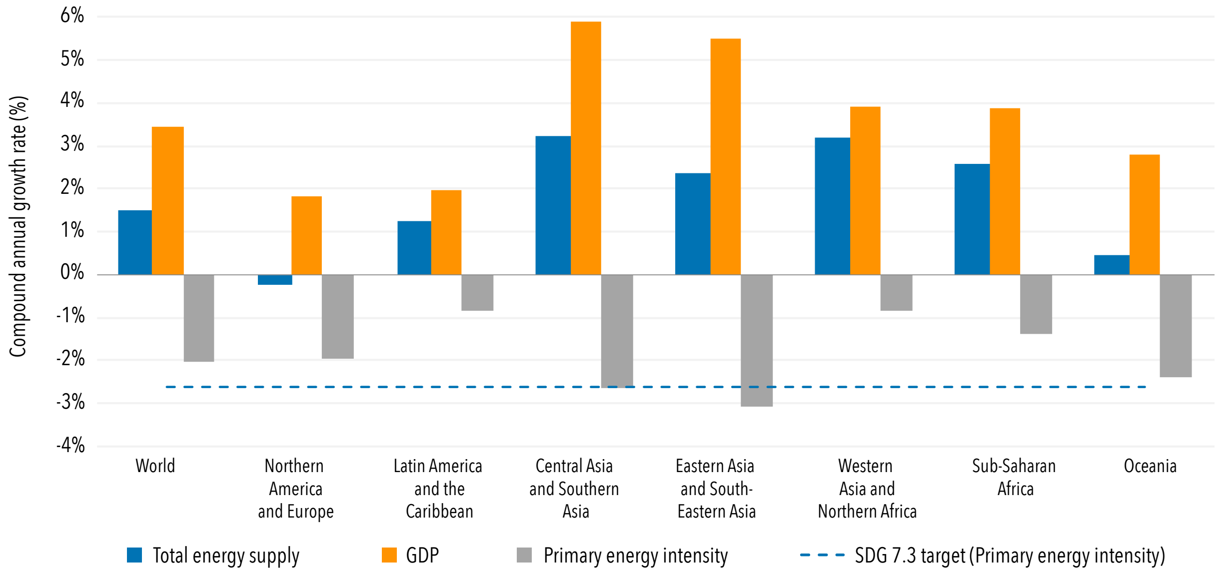
Source: IEA 2020a; UN 2020.

ENERGY EFFICIENCY

The rate of improvement in global primary energy intensity—the global proxy for improvements in energy efficiency—has slowed in recent years. Global primary energy intensity improvement is defined as the percentage decrease in the ratio of global total energy supply per unit of gross domestic product (GDP). It was 4.75 megajoules (MJ) per U.S. dollar (2017 PPP [purchasing power parity]) in 2018, a 1.1 percent improvement from 2017. This was the lowest annual rate of improvement since 2010. This is well below the annual 2.6 percent initially projected as a prerequisite to reaching the target of SDG 7.3, which continues to require an average annual rate of 3 percent every year through 2030 in order to meet the goal of doubling the global rate of improvement in energy intensity. While early estimates for 2019 indicated an upward trend, with an improvement rate of 2 percent, the outlook for 2020 suggests lower levels (0.8 percent) as a result of the COVID-19 pandemic and its disruptions. Nonetheless, the 3 percent target remains well within reach, provided sufficient and systematic investments are made in cost-effective energy efficiency improvements. Given the multiple benefits of energy efficiency, it is an obvious choice for government support, as reflected in the spate of recent stimulus packages throughout the world.

Since 2010, primary energy intensity worldwide has improved, although stark differences in trends are observable across regions (figure ES.7). Emerging economies in Central Asia and Southern Asia and in Eastern and South-eastern Asia have seen a spike in economic activity. The rise in total energy supply associated with such growth, however, has been mitigated in part by notable improvements in energy intensity, which have lowered the global energy intensity average. Over the same period, the total energy consumption of mature economies in Northern America and Europe fell slightly, reflecting slower economic growth and a decoupling of the economy from energy usage. Western Asia, Northern Africa, Sub-Saharan Africa, and Latin America and the Caribbean recorded the smallest average energy intensity gains over the period 2010–18 (less than 1.4 percent improvement per year), but these trends differed across regions. In Latin America and the Caribbean growth in both total energy supply and GDP was among the lowest worldwide, but it is also the least energy intensive region in the world, at 3.3 MJ/U.S. dollar (2017 PPP). In Western Asia, Northern Africa, and Sub-Saharan Africa, growth in both total energy supply and GDP was among the highest worldwide.

FIGURE ES.7 • Growth rates in total energy supply, GDP, and primary energy intensity at the world and regional levels, 2010–18



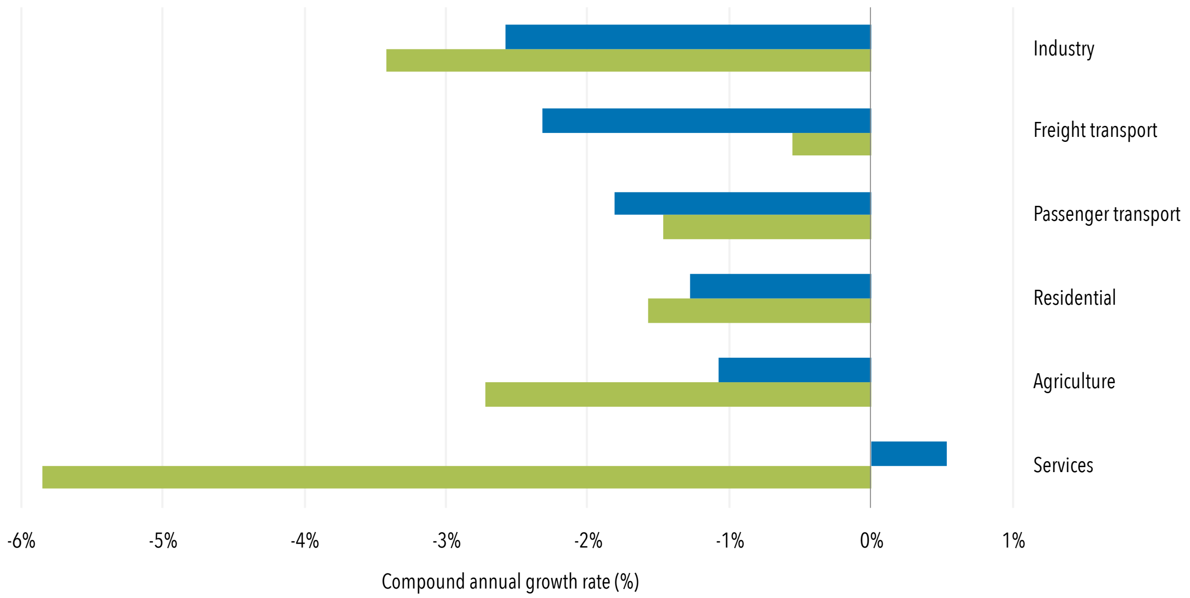
Source: IEA 2020a, UN 2020, and World Bank 2020.

Note: Most of the energy data cited here comes from a joint dataset 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 is sourced from the World Bank's World Development Indicators database (http://datatopics.worldbank.org/world-development-indicators/).

GDP = gross domestic product.

Using different energy intensity metrics, it is possible to examine the impact across different sectors. Compared with the period 1990–2010, the rate of improvement in energy intensity slowed across all sectors, with the exception of transport, where fuel efficiency standards drove improvements (figure ES.8). The decline in the rate of improvement from one period to the next is most noticeable in services, where energy intensity has worsened since 2010, but also in agriculture and, to a lesser extent, industry. All three of these sectors were significantly influenced by emerging economies, which rapidly improved their energy intensity during the period 1990–2010 as they mechanized production and shifted to higher-value goods and services.

FIGURE ES.8 • Compound annual growth rate of energy intensity by sector, 1990–2010 and 2010–18



Source: IEA 2020a, UN 2020, and World Bank 2020.

Note: See note to previous figure.

The impact of improvements in primary energy intensity is revealed by trends among its underlying components. Between 1990 and 2018, global GDP increased by a factor of 2.5 while global total energy supply grew by less than 65 percent. Growth in energy supply picked up in 2017 and continued to rise in 2018, growing 2.5 percent.

The difference in growth rates for global GDP and total energy supply is reflected in steady improvements in global primary energy intensity, which fell by a third between 1990 and 2018, signaling the gradual decoupling of economic growth from energy use. In the period 2010–18, global primary energy intensity fell by nearly 15 percent, one and a half times more than declines observed in the decade from 2000 to 2010.

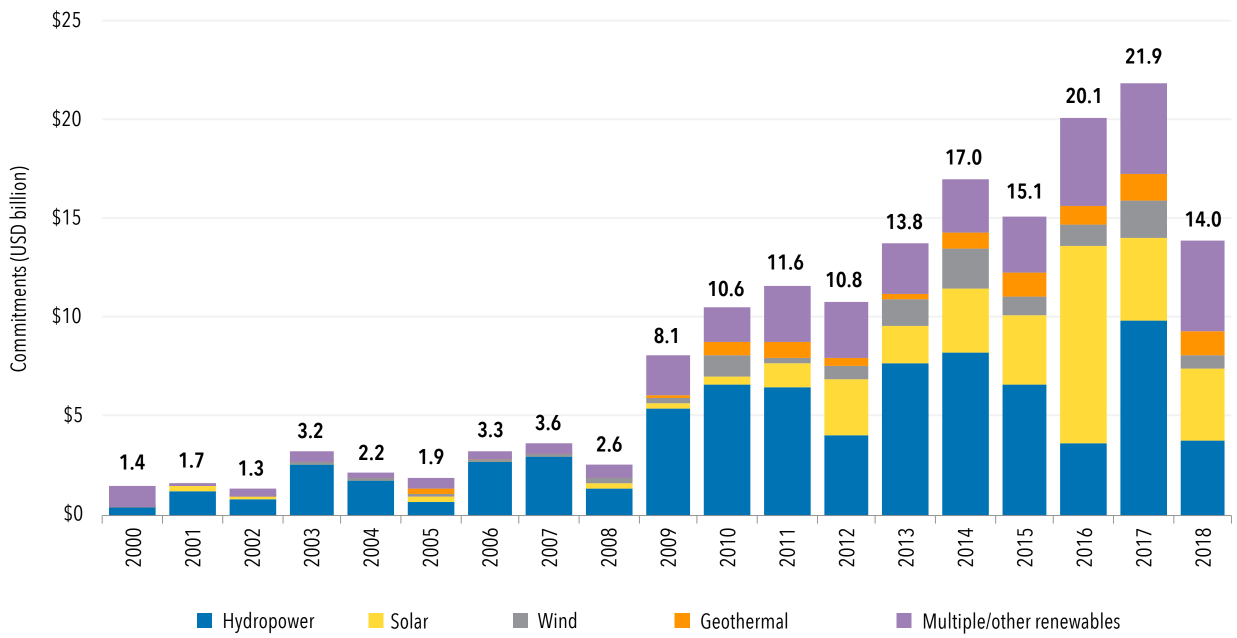
Improved energy efficiency at scale would be a key factor in achieving affordable, sustainable energy access for all. The recent slowdown of improvements in energy intensity, the significant potential opportunities for investment and economic recovery, and the pressing need for expanded access all point to the need for urgent action by governments to enact policies that would foster rapid progress toward the necessary annual improvement.

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

Although renewable energy investments are primarily sourced from the private sector, the public sector remains a critical source of finance, particularly for many developing countries. This edition of the *Energy Progress Report* includes, for the first time, a full chapter on SDG indicator 7.a.1 in order to illustrate trends in the use of international public finance to support renewable energy in developing countries.

Findings suggest that, although commitments dropped from an all-time high of USD 21.9 billion in 2017 to USD 14.0 billion in 2018, international public financial flows saw a threefold increase over the period 2010–18, viewed as a five-year moving average (figure ES.9).

FIGURE ES.9 • International public financial flows (commitments) to developing countries in support of clean energy, 2000–18, by technology (at 2018 prices and exchange rates)



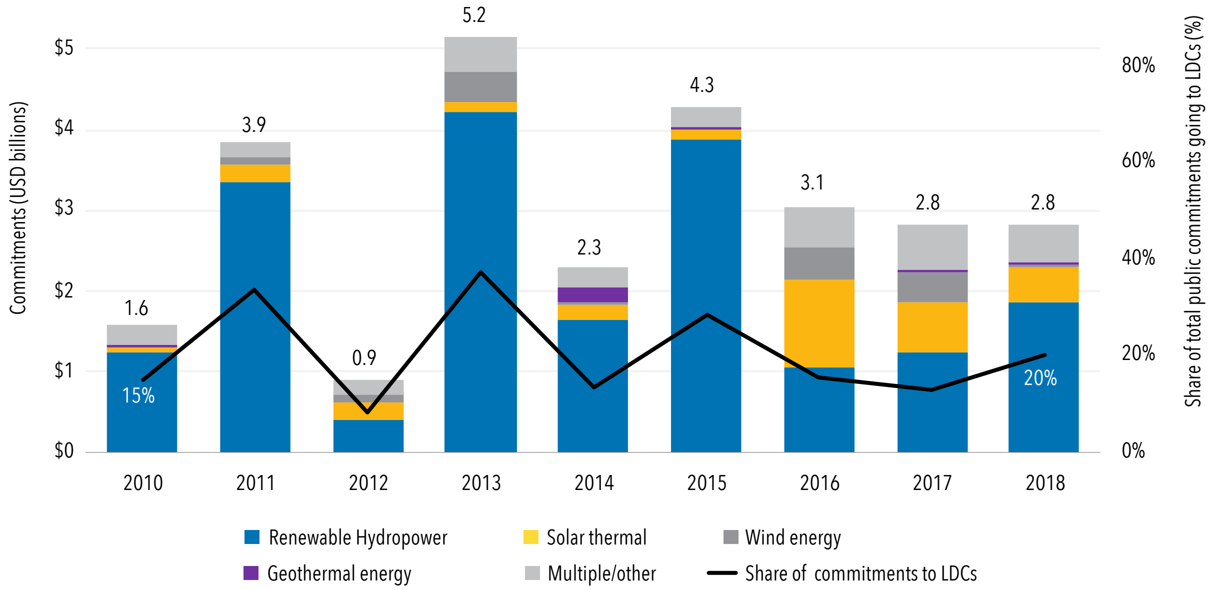
Source: IRENA and OECD 2021.

While notable across all technologies, the significant decline in 2018 was primarily attributable to a 61 percent drop in hydropower commitments, following a peak in 2017 owing to a large single-project commitment. In the period 2010–18, hydropower received the largest share of commitments, while more recent years have seen flows increasingly redirected toward solar energy, which received 20–25 percent of total commitments in 2016–18. Lately, a larger share of commitments has also been targeted toward other (or multiple) renewables including non-technology-specific support to multipurpose green funds and infrastructure such as grids and storage.

International public financial flows grew across all regions over the period 2010–18, with the largest increases observed in Central and Southern Asia, and Oceania, which showed six- and fourfold increases, respectively (when viewed as a five-year moving average). Sub-Saharan Africa, on the other hand, saw only a doubling of financial flows over the same period.

A closer look at the data reveals that investments were concentrated in a few countries, although the distribution across population has improved since 2010. The 46 LDCs received around 20 percent of commitments over the 2010–18 period and a total of USD 2.8 billion in 2018, the same level as in 2017 yet lower than in 2016 and 2015 (figure ES.10). Most of these countries are found in Sub-Saharan Africa, home to most of the world's top access-deficit countries.

FIGURE ES.10 • International public financial flows (commitments) to LDCs in support of clean energy, 2000–18, by technology (at 2018 prices and exchange rates)



Source: IRENA and OECD 2021.

In light of the current COVID-19 crisis and in line with the urgent need to scale up overall investment in renewable energy, international public financial flows to developing countries need to rise substantially and target more of the countries that have fallen furthest behind in reaching SDG 7.

Closing the investment gaps in developing countries will require substantial and coordinated efforts from a variety of stakeholders. When resources are limited, they should be used strategically to mobilize additional private capital, especially in sectors and regions that private investors perceive as too risky to invest in. In those markets where the private sector can finance generating capacity, public sources can be harnessed to finance infrastructure (such as grid refurbishment and extension), system flexibility (including energy storage), and instruments to de-risk projects, among other uses.

Since the COVID-19 outbreak, donors have deployed more and more capital for emergency response, with their initial focuses the protection of lives and livelihoods and the reduction of debt loads. In the post-COVID transition phase, aligning public financial flows toward low-carbon and climate-resilient development will be critical to help accelerate progress toward SDG 7, thereby securing broader economic development and boosting employment.

TRACKING PROGRESS ACROSS TARGETS: INDICATORS AND DATA

Well-designed and well-funded data collection on national energy statistics and trends plays a fundamental role in how countries monitor their progress in achieving the targets of SDG 7. It also enables international organizations to track progress on a global basis.

The international custodian agencies charged with tracking progress toward the SDG 7 targets collect and validate data from national administrations; they then elaborate the data into indicators used to measure progress toward the targets. Each target is monitored using one or more indicators, in line with the framework devised by the United Nations Statistics Division. Progress toward increasing the share of renewable energy in the global energy mix, for example, is measured by the share of renewable energy share in total final energy consumption. Similarly, progress in energy efficiency is monitored through the energy intensity of the economy, measured in terms of primary energy intensity and GDP.

Chapter 7 presents the indicators adopted by the custodian agencies for each target.[3] It also describes the work done at national and international levels to obtain the underlying data. For example, SDG indicator 7.a.1 focuses on public financial flows to developing countries in support of clean energy research and development and renewable energy production. The indicator measures public financial flows based on data extracted from IRENA and OECD databases.

Rigorous and consistent methodology is a particular concern if data are to be comparable across countries and credible in the eyes of policy makers. In this report, the methodology used to track each target is explained in technical terms at the end of the chapters devoted to the SDG 7 targets and then summarized in layman's terms in chapter 7, along with observations on how data collection and methodologies (which are mutually dependent) can and should be improved and further standardized.

Good-quality data are vital for informed policy making at country, regional, and international levels. Improved data quality worldwide is made possible through national and international cooperation. At the national level, cooperation among statistical offices across policy domains is key to optimizing the use of data-collection resources. For example, household surveys could and should be redesigned to support tracking across SDG 7 targets. International cooperation strengthens the effort to track progress toward SDG 7 by raising awareness about the need for good-quality data, standardized methodologies, and common frameworks for surveys.

As the staff of the custodian agencies work together to track progress toward SDG 7, they are grateful for the work and dedication of their colleagues pursuing similar ends in national administrations worldwide.

3 This report is based on the work of the several custodian agencies in tracking progress across the SDG 7 targets: 7.1—access (World Bank, WHO); 7.2—renewables (IEA, IRENA, UNSD); 7.3—energy efficiency (IEA, UNSD); 7.a—international cooperation (OECD, IRENA); 7.b—public financial flows (IRENA).

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PARTNERSHIP

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

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

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- African Development Bank (AfDB)
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- 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)
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- Responsibility for the chapter on indicators and data was shared by all the custodian agencies, coordinated by IEA (Roberta Quadrelli, Pouya Taghavi) and UNSD (Leonardo Souza, Agnieszka Koscielniak).

DATA SOURCES

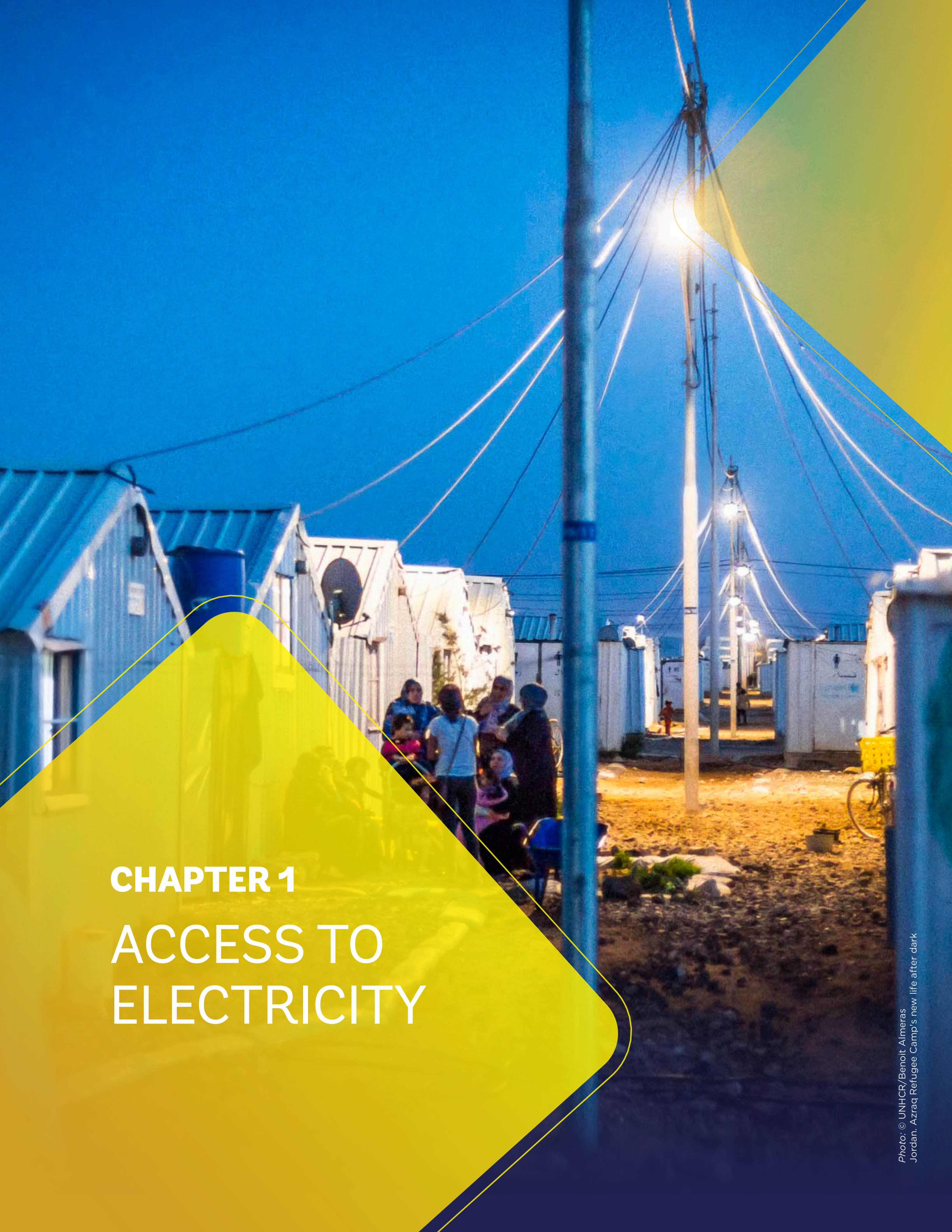
The report draws on two meta-databases of global household surveys—the Global Electrification Database managed by the World Bank, and the Global Household Energy Database managed by WHO. Energy balance statistics and indicators for renewable energy and energy efficiency were prepared by IEA (Roberta Quadrelli and Pouya Taghavi with support from Arnau Risquez Martin and Alexandre Bizeul) and UNSD (Leonardo Souza, Agnieszka Koscielniak, Costanza Giovannelli). The indicator on per capita installed renewable energy capacity in developing countries was prepared by IRENA (Adrian Whiteman, Gerardo Escamilla). The same is true of the indicator on international financial flows to developing countries, which is based on the IRENA Public Investments Database and the OECD/DAC Creditor Reporting System. Data on gross domestic product and value-added were drawn mainly from the World Bank's World Development Indicators database. Population data are from the United Nations Population Division.

REVIEW AND CONSULTATION

The public consultation and peer review process was coordinated by UNSD. Substantive comments were provided by BMZ (Alexander Kauer, Paul Recknagel), the Clean Cooking Alliance (Colm Fay, Donnee Alexander, Jillene Connors Belopolsky, Julie Ipe), SEforAll (Alvin Jose, Brian Dean, Christine Eibs Singer, Clotilde Rossi Di Schio, Eduarda Zoghbi, Emi Mizuno, Ingrid Rohrer, Jem Porcaro, Min Hyejung, Olivia Coldrey, Tamojit Chatterjee), and UNDP (Marcel Alers). IEA's internal review process was led by Kieran McNamara. IRENA's internal review process was led by Rabia Ferroukhi, with contributions from Anindya Bhagirath, Celia García-Baños, Arieta Gonelevu Rakai, Carlos Guadarrama, Ulrike Lehr, Divyam Nagpal, Bishal Parajuli, Jef Vincent, and Sandra Lozo (Consultant). 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 Rohit Khanna, Nathyeli Acuna, Zuzana Dobrotkova, Raluca Golumbeanu, Ivan Jaques, Rhonda Jordan, Federico Querio Dana Rysankova, Zubair Sadeque, and Yabei Zhang.

OUTREACH

The communications process was led by Anita Rozowska (World Bank) in coordination with the custodian agencies' communication focal points: Kieran McNamara and Merve Erdil (IEA), Emma Aberg and Nanda Febriani Moenandar (IRENA), Ceridwen Johnson and Paul Safar (WHO) and in coordination with Dan Shepard and Pragati Pascale (UNSD). The online platform (http://trackingSDG7.esmap.org) was developed by Advanced Software Systems, Inc. The report was edited, designed, and typeset by Duina Reyes and Steven Kennedy.



CHAPTER 1

ACCESS TO ELECTRICITY

Photo: © UNHCR/Benoit Almeras
Jordan. Azraq Refugee Camp's new life after dark

MAIN MESSAGES

- **Global trend:** The share of the world's population with access to electricity grew from 83 percent in 2010 to 90 percent in 2019.[1] Worldwide, 1.1 billion people gained access between 2010 and 2019.[2] With the spread of electrification, the number of people lacking access fell from about 1.2 billion in 2010 to 759 million in 2019 during this period. Continuous progress was made from 2017 to 2019, with 130 million people gaining access to electricity each year, slightly more than the average of 127 million people who gained access each year between 2010 and 2017.
- **Target for 2030:** Notwithstanding the remarkable growth in electrification recorded over the last decade, the present pace will not be sufficient to achieve indicator 7.1.1 of the Sustainable Development Goals (SDGs) by 2030. To meet the goal of 100 percent access to electricity, before considering disruptions from the COVID crisis, the pace of growth must accelerate to 0.9 percentage points each year through 2030, compared with the 0.74 percentage points achieved between 2017 and 2019. The necessary annual rate of growth required to reach universal access will be possible only through adoption and implementation of measures that challenge the status quo. Taking into account population growth and risks arising from the COVID-19 pandemic, a total of 940 million people will have to gain access the next nine years if universal access is to be achieved. Under current and planned policies, however, and given the effects of the pandemic, only 280 million people are projected to gain access to electricity over the period, which would leave 660 million people without access in 2030 (IEA 2020a).[3] Comprehensive electrification strategies, innovative business models and technologies, and a combination of supply- and demand side subsidies are some of the building blocks required to ramp up electrification efforts. In addition to progress in access, the quality, affordability, and reliability of electricity service will remain salient for many countries.
- **Regional highlights:** Most regions showed expansion of electrification over the past decade. However, progress toward the target of universal access to electricity has shown different trends across regions since 2010. In the regions of Latin America and the Caribbean, and Eastern and South-eastern Asia, more than 98 percent of the population had access to electricity by 2019.[4] In Western Asia and Northern Africa, and in Central Asia and Southern Asia, 94 and 95 percent of the population, respectively, enjoyed access in the same year. In Sub-Saharan Africa, by contrast, the 2019 rate of access was just 46 percent: 570 million people still lacked access to electricity. Sub-Saharan Africa accounts for three-quarters of the global population without access. However, between 2017 and 2019, electrification advanced faster than population growth, contributing to an annual average reduction of 2 million in the number of unserved people.
- **Fragile and conflict-affected countries:** The level of access to electricity in the 39 countries on the World Bank's list of fragile and conflict-affected countries (World Bank 2020a) grew faster than the global average annual growth of 0.8 percentage points, rising from 45 percent of the total population in 2010 to 54 percent in 2019. However, the annual increase in access did not outpace population growth between 2010 and 2019. About half of the global access deficit came from these countries in 2019. Overall, 364 million people in fragile and conflict-affected settings were without electricity in 2019 (compared with 359 million in 2010). Focusing on refugees and their surrounding host communities, data gathered by the United Nations High Commissioner for Refugees (UNHCR) in 18 countries between

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1 Access to electricity (also referred to as "electrification" or "the electrification rate") refers in this report to the share of the population with access to electricity over a specified time period or geographic area. It is defined as the ability of the end user to consume electricity for desired services. Where surveys based on the Multi-Tier Framework, a method for measuring access to energy (ESMAP 2015, 2016), have been conducted (about 20 countries), access to electricity service from Tier 1 to Tier 5 is considered. Elsewhere, electricity access is calculated by a binary measure of "connected" or "not connected" derived from existing household surveys, such as the DHS and LSMS (World Bank and IEA 2015).

2 This chapter incorporates both short- and long-term trends to better understand the global effects of improved electricity access.

3 The Stated Policies Scenario (STEPS) in IEA's "World Energy Outlook 2020" (IEA 2020a) takes into account COVID's impact on GDP and its estimated impact on access progress in 2020 and 2021, as of September 2020.

4 United Nations classifications are used for the names and composition of the country groupings used in this report (https://unstats.un.org/unsd/methodology/m49/).

2018 and 2020 reveals that even though host communities had on average 34 percent access and refugees 19 percent only, the access rates for refugees and host communities remain very low. Owing to secondary displacement movements and the difficulty of conducting field surveys, data collection in fragile and conflict-affected settings is challenging, with attendant effects on data quality and reliability.

- **Urban-Rural distribution in electricity access:** Although progress in rural areas was faster than in urban settings over the 2017–19 period, rural areas still accounted for 84 percent of the global population living without access to electricity (640 million people) in 2019. The rural access rate rose globally from 70 percent in 2010 to 81 percent in 2019, outpacing population growth. Particularly, Central Asia and Southern Asia, and Oceania made the greatest progress, with annual growth in access of around 3 percentage points between 2010 and 2019. On the other hand, urban areas are approaching universal access, with the average access rate standing at 97 percent since 2016 (leaving 116 million people with no access in 2019). The progress in urban areas made between 2010 and 2019 also outpaced population growth across regions. Covering the last mile in both urban and rural areas will require addressing complexities in affordability, reliability, and the cost of deploying solutions to reach populations living in isolated or informal settlements and consuming small quantities of electricity.
- **The Top 20 access-deficit countries:** In 2019, the 20 countries with the largest populations lacking access to electricity made up 76 percent (580 million people) of the global access deficit.[5] Therefore, efforts to narrow the gap in electricity access for these countries are particularly important for progress on indicator 7.1.1. The three countries with the largest deficits are in Sub-Saharan Africa. Nigeria and the Democratic Republic of Congo (DRC) topped the list in 2019, with 90 million and 70 million people, respectively, lacking access. Ethiopia became the third largest access-deficit country in 2019 (displacing India), with about 58 million unserved people. Over the past decade, the rate of progress in the DRC and Nigeria trailed population growth, resulting in net increases in the access deficit of 14 million and 7 million people. In 9 of the 20 countries, access kept pace with population growth (Bangladesh, Democratic People's Republic of Korea, Ethiopia, India, Kenya, Myanmar, Sudan, Tanzania, and Uganda). Bangladesh, Kenya, and Uganda made the most progress in electrification, achieving annual growth in access of more than 3 percentage points after 2010.[6]
- **Decentralized renewable energy:** Electrification through decentralized renewables-based solutions has advanced rapidly since 2010. The number of people connected to mini-grids powered by various technologies more than doubled between 2010 and 2019, growing from 5 to 11 million people (IRENA 2020). Of those connected to solar mini-grids, 33 percent are connected at Tier 1 of the Multi-Tier Framework (the lowest level of energy access) while the remainder are connected to Tier 2 or higher. In 2019, 105 million people had access to off-grid solar solutions,[7] up from 85 million in 2016 (GOGLA 2020). Forty-nine percent lived in Sub-Saharan Africa, and 29 percent in South Asia. Since 2010, policy frameworks to support mini-grid and off-grid systems have developed more quickly than those for on-grid electrification (ESMAP 2020a).
- **Affordability gap:** More than 25 million people in developing Asia and Africa could lose the ability to afford an essential bundle of electricity services by the end of 2020 (see box 1.1). Two-thirds of the total live in Sub-Saharan Africa, representing about 3 percent of the region's currently connected population. Because the COVID-19 pandemic could slow progress in access, widen the affordability gap, and cause delays in payments, it is important for the international community to support the ability of governments to preserve affordability, economic growth, health, and gender equality.
- **The effects of COVID-19:** Disruptions related to the pandemic are expected to slow or even reverse progress in electrification as utilities and off-grid service providers face financial difficulties. The lack of reliable energy access has already caused health problems. More than 70 percent of the health facilities in Sub-Saharan Africa have no access to reliable electricity, and one in four has no access at all. Electrification of health facilities (and other public institutions) is essential for vaccine deployment and storage, as well as broader efforts to mitigate and recover from the pandemic.

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5 The top-20 access-deficit countries in 2019 were: Nigeria, Democratic Republic of the Congo, Ethiopia, Pakistan, Tanzania, India, Uganda, Mozambique, Sudan, Madagascar, Niger, Angola, Myanmar, Burkina Faso, Malawi, Kenya, Chad, Democratic People's Republic of Korea, Bangladesh, and South Sudan.

6 The access rates of Kenya for 2016 and 2019 depend on two types of surveys: Multi-Tier Framework (MTF) and national census (Kenya National Bureau of Statistics 2019). The two capture the service level in different ways. During the internal consultation process with the World Bank country team, it was agreed, for data accuracy, that data for years 2016 and 2019 would be sourced from the MTF (53.1 percent) and Census (69.7 percent), respectively.

7 GOGLA defines eligible off-grid solar lighting products as systems that include a solar panel, a battery and at least one light point.

ARE WE ON TRACK?

Ninety percent of the world's population had access to electricity in 2019 (figure 1.1). Taking into account current and planned policies as well as COVID-19's impacts, it is projected that 92 percent of the global population will have access by 2030, leaving close to 660 million people without it (IEA 2020a).

Between 2010 and 2019, the global population without access dropped from 1.2 billion to 759 million. In each of the three last years of the period (2017–19), an annual average of 130 million people gained access, easily outstripping the average annual population growth of 82 million and marginally exceeding the progress recorded over the 2010–17 period, during which an average of 127 million people gained access each year. The global access rate over the entire period was driven chiefly by a group of countries that made startling progress. Kenya and Mali, for instance, each scored annual growth of more than 6 percentage points, with electrification outpacing population growth from 2017 to 2019. However, the global progress masks disparities across regions and sets of countries. The 46 least-developed countries still had an access rate of just 53 percent in 2019, trailing the global average,[8] while 51 percent of the world's population without access to electricity lived in low-income countries and 48 percent in fragile and conflict-affected areas.[9]

FIGURE 1.1 • Percentage of population with access to electricity

Source: World Bank 2021; IEA 2020.

Thirty-nine countries attained universal access after 2010—15 of them in Latin America and the Caribbean.[10] Another 95, densely clustered in Sub-Saharan Africa, were still below the level of target 7.1 in 2019. About a quarter of the 95 access-deficit countries improved their annual electrification rates by more than 2 percentage points between 2010 and 2019. Seven of the 25 fastest-improving countries are also among the top 20 access-deficit countries: Bangladesh, Democratic People's Republic of Korea, India, Kenya, Myanmar, Uganda, and Tanzania (figure 1.2). Half of the access-deficit countries were located in Sub-Saharan Africa, where an annual average of more than 24 million people gained access each year after 2010, advancing the regional access rate from 33 percent in 2010 to 46 percent in 2019. Among the countries in Sub-Saharan Africa, some, such as Kenya and Eswatini, achieved annual growth of more than 2 percentage points over the 2010–19 period, but they are still short of the rate required to achieve universal access by 2030.

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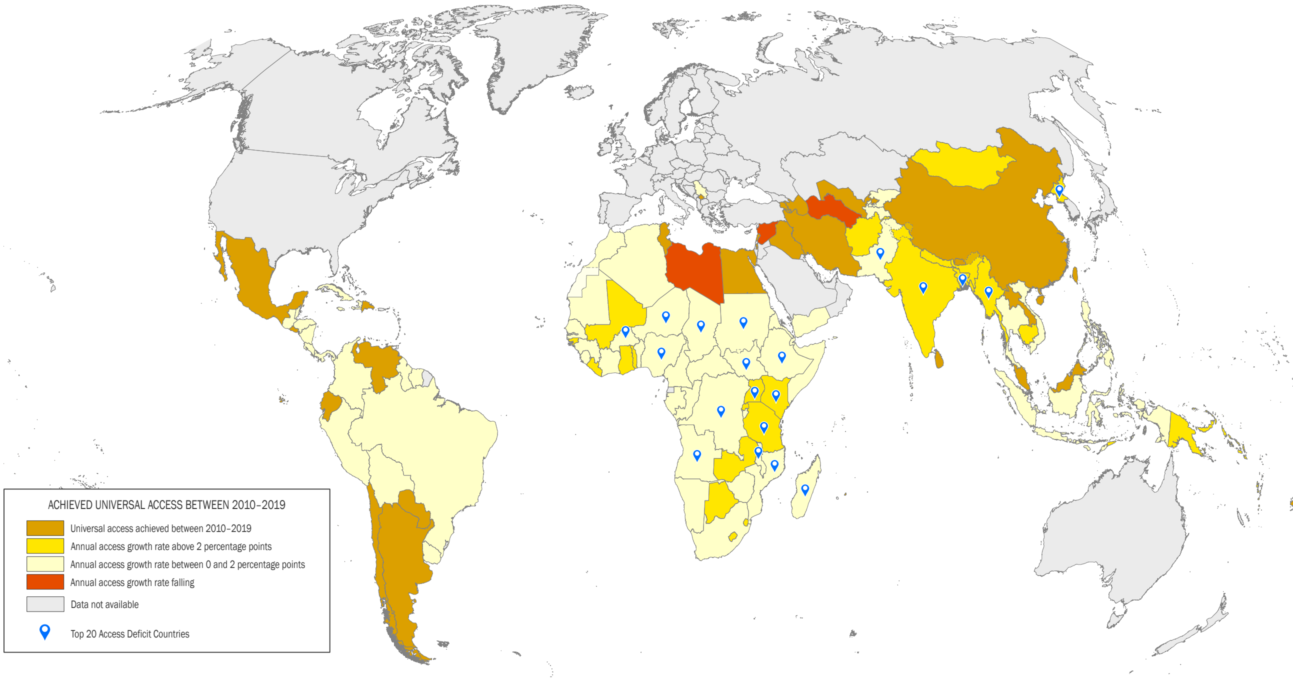
8 The electricity access rate in the least-developed countries (United Nations 2020) rose from 33 percent in 2010 to 53 percent in 2019.

9 Countries with a per capita gross national income of less than USD 1,035 are classified as low-income (World Bank 2020b). Countries affected by violent conflict are identified based on a threshold number of conflict-related deaths relative to the population (World Bank 2020a). The two categories are not mutually exclusive.

10 The 39 countries that achieved universal access are Anguilla, Antigua and Barbuda, Argentina, Armenia, Aruba, Azerbaijan, Bhutan, British Virgin Islands, Chile, China, Cook Islands, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Iran, Iraq, Kiribati, Kosovo, Lao PDR, Lebanon, Malaysia, Maldives, Mauritius, Mexico, Nauru, Palau, Paraguay, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Seychelles, Sri Lanka, State of Palestine, Tunisia, Tuvalu, Uzbekistan, and Venezuela.

FIGURE 1.2 • Annual increase in access to electricity in access-deficit countries, 2010–19



Source: World Bank 2021.

Note/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 on any map in this work 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.*

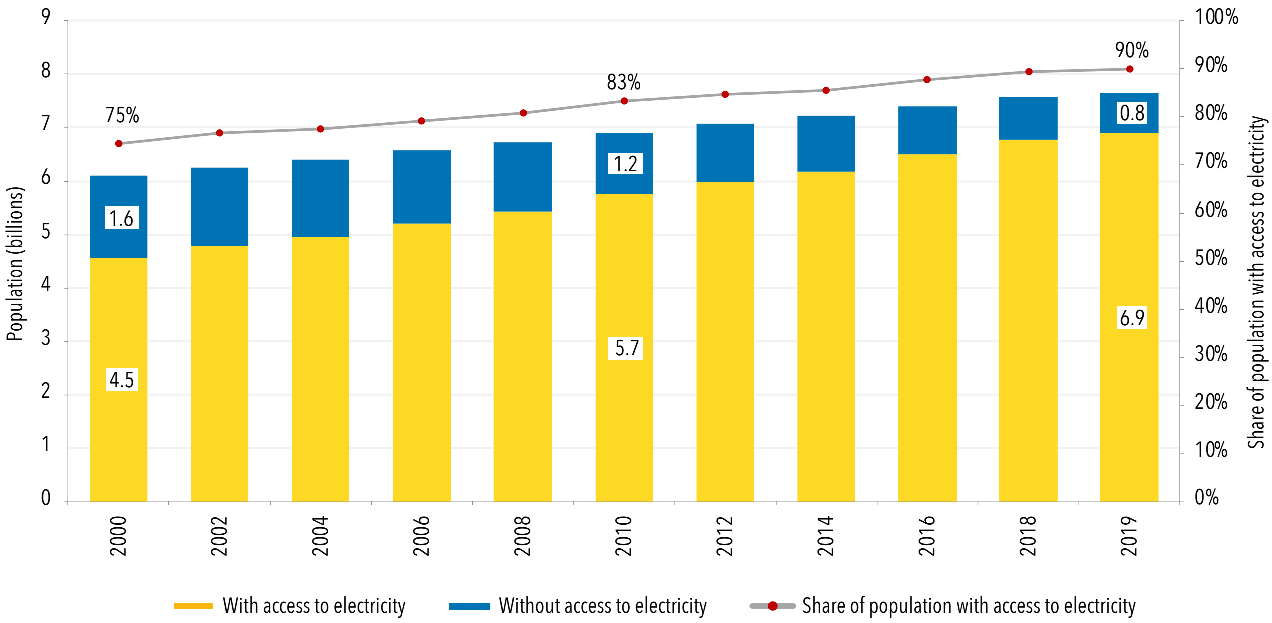
LOOKING BEYOND THE MAIN INDICATORS

This chapter reviews progress in access to electricity by considering various socioeconomic electrification patterns across regions and countries using data for the 2000–19 period. The purpose of the analysis is to examine global efforts to reach the target of universal access by 2030 and to ensure continuous gains in electrification worldwide. The methodology used in compiling the database is presented at the end of the chapter. In addition to the analytical findings, the chapter provides policy insights into electrification efforts and their contribution to a sustainable recovery from the COVID-19 pandemic through a literature review and country case studies.

ACCESS AND POPULATION

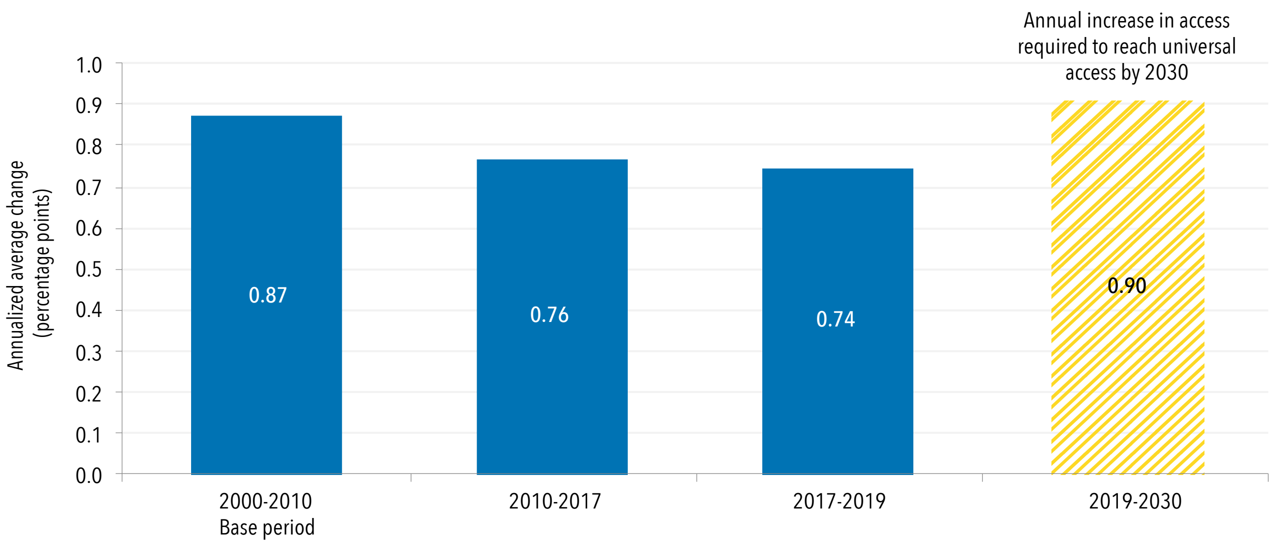
In comparison with past decades, progress in electrification since 2010 has been remarkable. However, its pace still needs to accelerate if the 2030 target is to be met. Globally, electrification expanded from 83 percent of the world's population in 2010 to 90 percent in 2019 (figure 1.3), while the population without access dropped from 1.2 billion to 759 million. Between 2017 and 2019, access grew by 0.74 percentage points per year, and progress was slower than the average annual increase of 0.90 percentage points required to achieve universal access by 2030 (figure 1.4). In view of the modest progress over the last three years of the period, and of the current pandemic and the difficulty of electrifying the populations that remain unserved, the final stretch to the road to universal access is bound to be challenging. At the same time, quality of supply, affordability, and reliability are still serious issues for many countries. Affordability is examined in box 1.1.

FIGURE 1.3 • Gains in electricity access, 2000–19



Source: World Bank 2021.

FIGURE 1.4 • Average annual increase in access to electricity



Source: World Bank 2021.

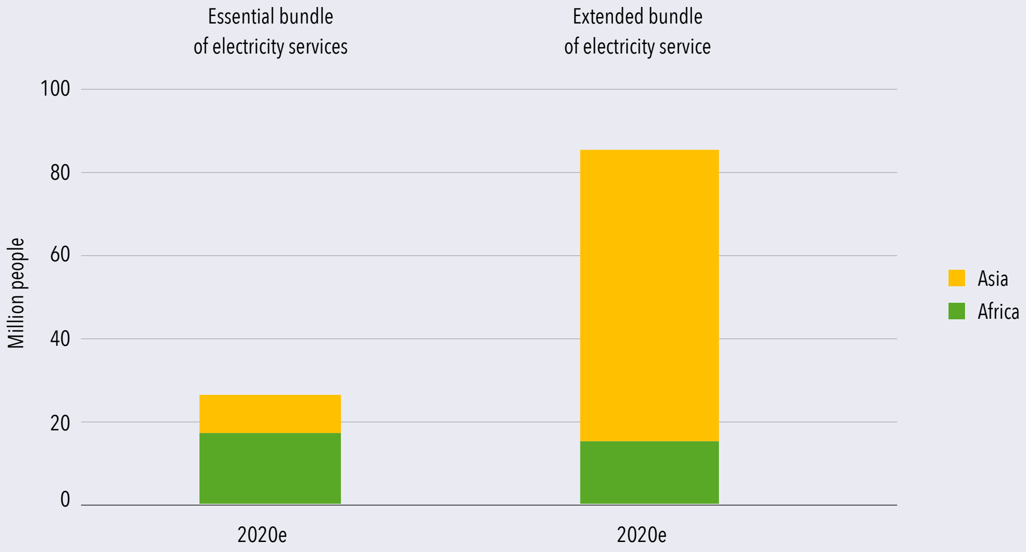
BOX 1.1 • ENERGY POVERTY AND COVID-19

The economic fallout from the COVID-19 crisis has lowered the incomes of many vulnerable people in emerging markets and developing economies. Recent analysis shows that up to 100 million people, mainly in Sub-Saharan Africa and developing Asia, were likely pushed into extreme poverty in 2020, and a further 200 million people are at risk of falling into poverty (Lakner and others 2020). The decline in welfare has major consequences for the most vulnerable households, who may be forced to make trade-offs between their energy needs and other demands, and therefore return to inefficient traditional fuels.

Estimates from the International Energy Agency, using data from Lakner and others (2020), show that more than 25 million people in developing Asia and Africa may have lost the ability to afford an essential bundle of electricity services by the end of 2020 (IEA 2020a).[a] Two-thirds of those affected were in Sub-Saharan Africa, accounting for around 3 percent of the connected population in the region. Between 5 and 10 percent of the connected population in Ethiopia, Nigeria, Democratic Republic of the Congo, and Niger may have been affected. A further 85 million connected people, mainly in developing Asia, may have lost the ability to pay for an extended bundle of electricity services. The difference in emphasis between losing access to the essential bundle of electricity services in Sub-Saharan Africa and losing access to the extended bundle in Asia reflects different circumstances: Sub-Saharan Africa has relatively more people at risk of being pushed into extreme poverty (less than USD 1.90/day) owing to COVID-19, while in Asia (and in particular India) the crisis is likely to affect more people at higher poverty lines (USD 3.20/day or USD 5.50/day) but with a greater likelihood of recovering after the crisis.

A similar pattern is observed for poor households' access to clean cooking fuels and technologies, which is sensitive to changes in incomes and fuel prices. Many households in rural or peri-urban areas could therefore revert to charcoal, kerosene or fuelwood. A survey conducted by the University of Liverpool before and during a community-wide lockdown in an informal settlement of Nairobi found that confinement measures caused a major loss of income for around 95 percent of surveyed households (Shupler and others 2020). As a result, nearly 15 percent of households that had been using LPG as a primary cooking fuel before the COVID-19 crisis reverted to kerosene, and a further 13 percent switched to gathering free firewood to meet their cooking needs. In the settlement, kerosene has a per-meal fuel cost almost 60 percent higher than bulk LPG, but a full cylinder of LPG has a high upfront cost. If a similar trend were found across all of Sub-Saharan Africa, nearly 25 million people would be at risk of reverting to traditional fuels (IEA 2020a).

FIGURE B1.1.1 • People with access to electricity in Asia and Africa at risk of losing the ability to pay for basic electricity services in 2020



Source: IEA 2020a; using Lakner and others (2020).

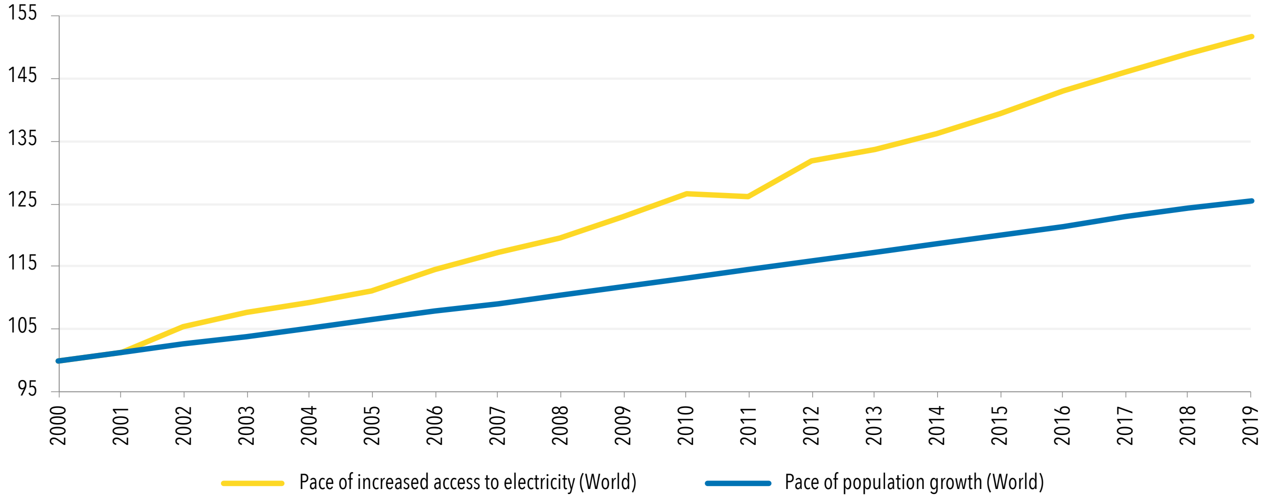
Solutions are available to support continued access to energy services. Some countries introduced measures to protect vulnerable customers (and, in so doing, sometimes aggravated the financial distress of utilities already affected by decreased demand). Côte d'Ivoire, Ghana, Mali, Nigeria, Senegal, and Togo provided free electricity to poor households for several months in 2020. Uganda removed value-added tax on liquefied petroleum gas (LPG) in June 2020. India's government guaranteed free LPG refills for some of the poorest members of society between April and September 2020. The Energy Access Relief Fund, an initiative of several development finance institutions, has provided liquidity support to energy access companies (off-grid, mini-grid, and clean cooking) to allow them to continue serving their customers and maintain jobs.

Other indirect policies could also help countries avoid a reversal of progress on access to energy. For example, some consumer finance mechanisms (such as pay-as-you-go) could allow households to purchase modern fuels in smaller amounts, commensurate with their income structure. Support provided to markets and supply chains for different clean cooking fuels could also lead to lower prices, making it possible for vulnerable households to maintain their use. In addition, some communities with access to distributed renewables showed greater livelihood resilience in the onset of COVID-19. For instance, in India, solar-powered digital service centers have helped maintain access to services that supported business transactions while communities were under lockdown (SEKCO Foundation 2020).

a. A household is at risk of losing its ability to pay for a specific bundle when electricity spending exceeds 5 percent of household spending. The essential bundle of electricity services includes a mobile phone charger, four lightbulbs operating four hours per day, a fan used for three hours per day, and a television for two hours per day, equating to 500 kilowatt-hours (kWh) per household per year. The extended bundle includes the essential bundle plus one refrigerator and twice the hours for the fan and the television, equating to 1 250 kWh per household per year with standard appliances. "Basic electricity services" are defined as services provided under either the essential or extended bundle.

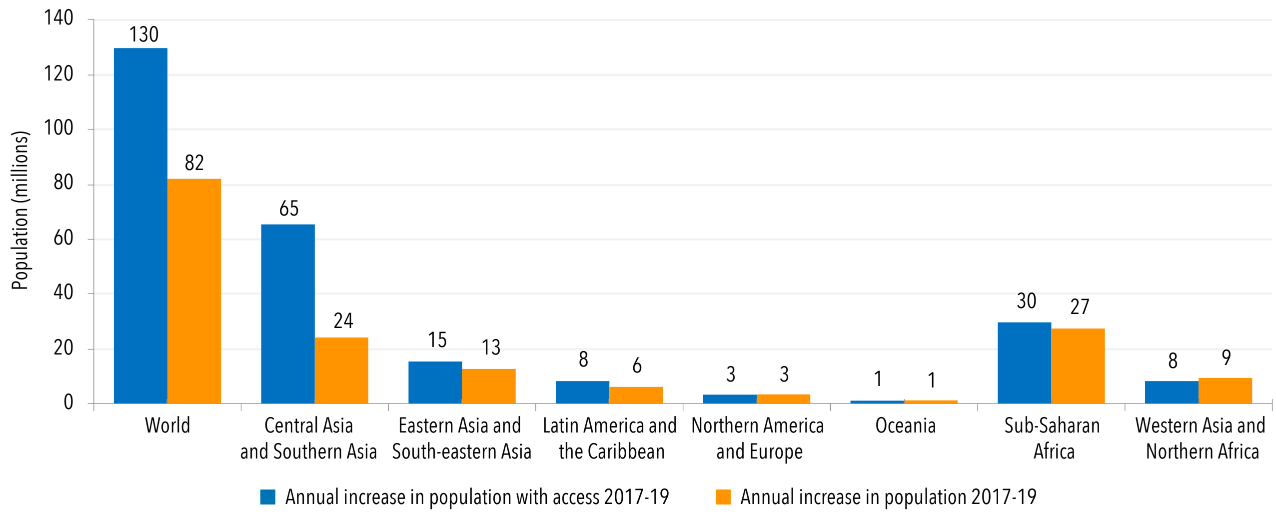
Global electrification outpaced world population growth between 2010 and 2019 (figure 1.5). The trend persisted in 2017–19, as 130 million new people were electrified each year against world population growth of 82 million (figure 1.6). Correspondingly, the world's unserved population fell by 95 million in 2017–19. The progress in access resulted primarily from advances in Central Asia and Southern Asia, where an annual average of 65 million people gained access in 2017–19, surpassing population growth of 24 million.[11] The rapid pace of annual growth in electrification was mainly driven by advances in India and Bangladesh. Meanwhile, though it has the largest remaining access deficit, the pace of electrification in Sub-Saharan Africa (30 million people each year) outstripped population growth of 27 million over the same period. Therefore, the number of people without access to electricity in the region fell by about 2 million people each year between 2017 and 2019.[12]

FIGURE 1.5 • Growth in electricity access vs. growth in global population, 2000–19 (indexed, 2000 = 100)



Source: World Bank 2021.

FIGURE 1.6 • Annual increase in electrification and population, 2017–19, by region



Source: World Bank 2021.

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11 Between 2017 and 2019, electrification outpaced population growth in the following countries of the region: Bangladesh, Bhutan, India, Iran, Maldives, Pakistan, Sri Lanka, and Tajikistan.

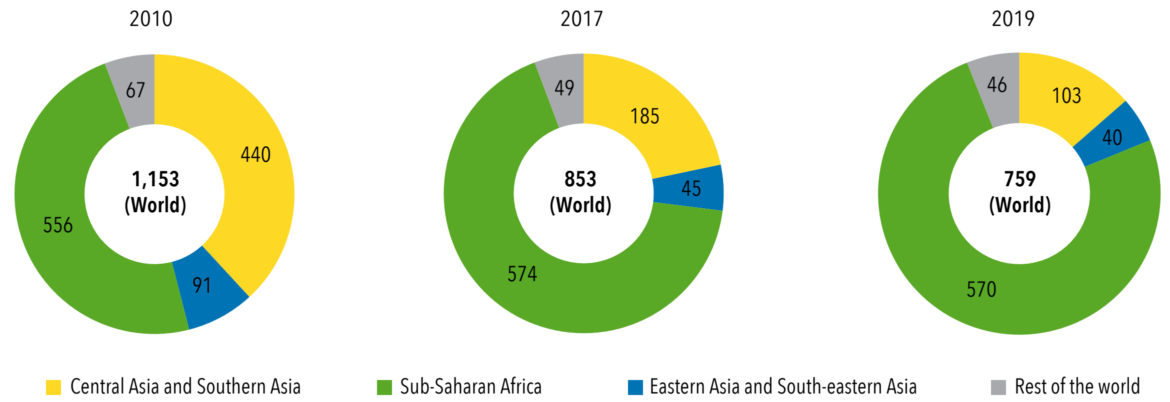
12 Between 2017 and 2019, electrification outpaced population growth in the following countries of Sub-Saharan Africa: Benin, Botswana, Cabo Verde, Cameroon, Comoros, Côte d'Ivoire, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Mali, Mauritius, Mozambique, Namibia, Rwanda, Senegal, South Africa, South Sudan, Tanzania, Togo, and Uganda.

THE ACCESS DEFICIT

Although the number of people without access to electricity dropped steadily from 1.2 billion in 2010 to 759 million in 2019, progress varied from region to region. For Sub-Saharan Africa, the share of the population with access to electricity grew from 33 percent in 2010 to almost 46 percent in 2019. However, the global access deficit is increasingly centered on Sub-Saharan Africa, home to 75 percent of the world's population without access in 2019. In fact, with population growth, the absolute deficit in Sub-Saharan Africa has grown since 2010, with 570 million people lacking access in 2019 (figure 1.7). Electrification lagged notably behind population growth in DRC, Nigeria, Niger, Chad, Malawi, and Burkina Faso. Thanks to Kenya and Mali, however, where the annual growth rate in access was more than 6 percentage points in 2017–19, electrification outpaced population over the last two tracking years for the region as a whole, resulting in a drop of about 2 million unserved people in each of the three years.

During the period between 2010 and 2019, the most significant drop in the deficit was found in Central Asia and Southern Asia, where it shrank fourfold from 440 million in 2010 to 103 million in 2019 (figure 1.7). The countries driving the decline were Afghanistan, Bangladesh, India, and Nepal. Eastern Asia and South-eastern Asia also showed improvement, reaching more than 98 percent access in 2019 (from 96 percent in 2010). Meanwhile, Latin America and the Caribbean is approaching universal access. Compared to 96 percent of people connected in 2010, the level of access to electricity of the region in 2019 was 98 percent, leaving 10 million people without access, most of them living in Haiti, Nicaragua, Guatemala, Honduras, and Peru.

FIGURE 1.7 • Regional access deficits (in millions of people without access) for 2010, 2017, and 2019



Source: World Bank 2021.

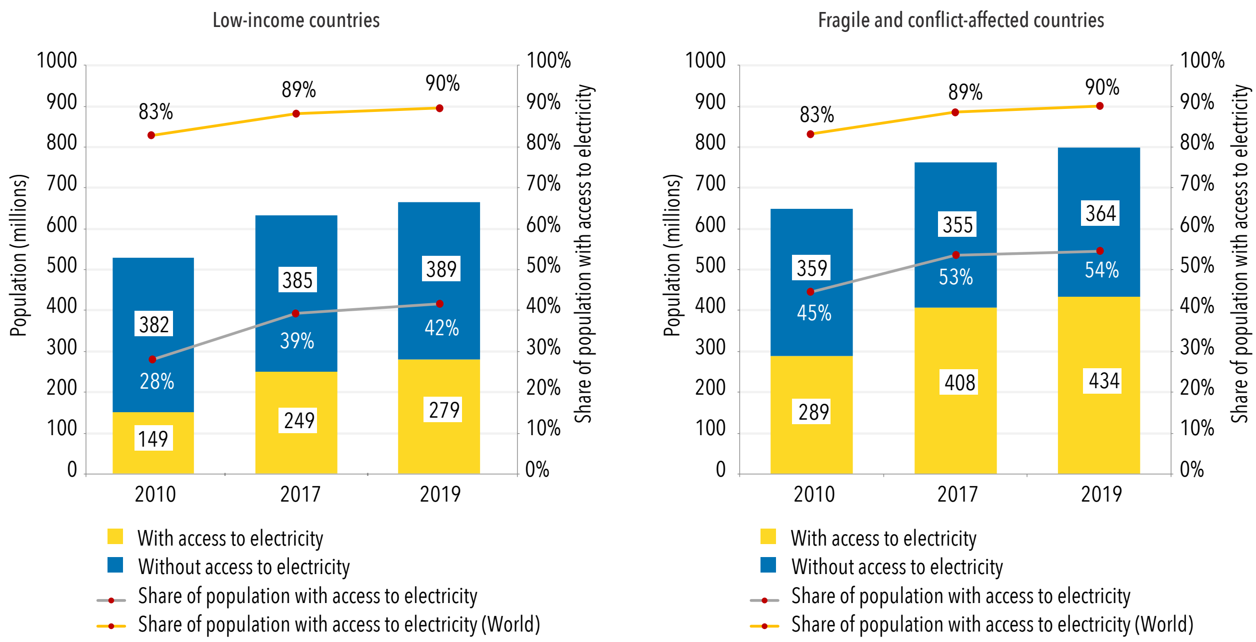
Low-income countries and those affected by fragility and conflict have shown progress in access over the past two decades, but they still lag in efforts to expand electrification. More than half of the globe's unserved population lives in the world's 29 low-income countries (those with a gross national income below USD 1,035), where the share of the population enjoying access to electricity grew rapidly from 28 percent in 2010 to 42 percent in 2019 (figure 1.8). Several countries in the group stand out for their annual rate of growth in access from 2010 to 2019. For example, Afghanistan (6 percentage points), Uganda (3 points), and Rwanda (3 points) achieved substantial advances. Between 2017 and 2019, access grew only slightly—from 39 percent to 42 percent—in the low-income group, with 279 million people electrified in 2019. During the same period, however, annual growth in access for these countries trailed population growth. An annual average of 15 million people gained access to electricity, while the population grew by more than 17 million per year. In Chad, Malawi, Syria, and Yemen, growth in access was outstripped by growth in population between 2017 and 2019.

In fragile and conflict-affected countries, the access rate rose from 45 percent in 2010 to 54 percent in 2019, still much lower than the global average.[13] The population lacking access to electricity and living in situations of fragility and conflict grew from 359 million in 2010 to more than 364 million in 2019. The countries in

13 The ongoing conflict in the Central African Republic has interrupted electrification efforts. As a result, the access rate in 2019 was almost the same as in 2010 (around 10 percent).

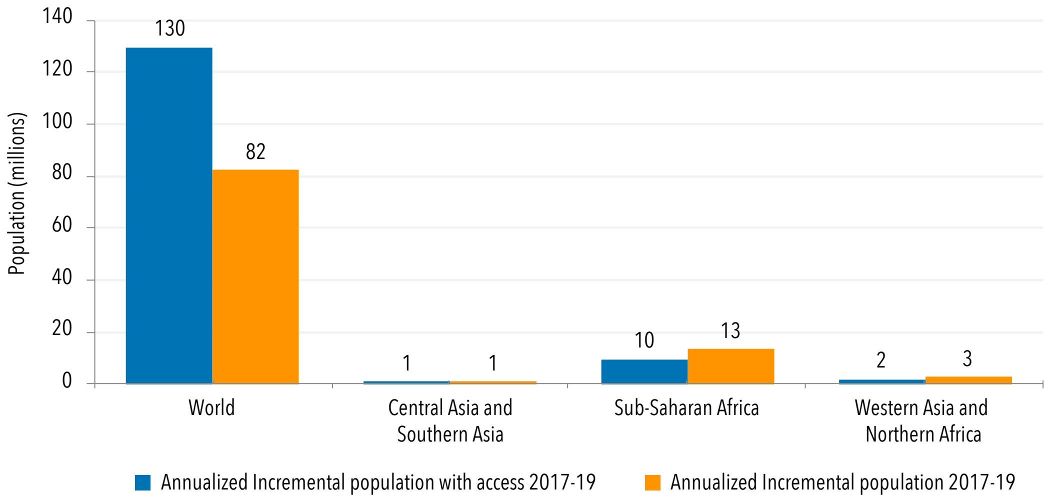
the group with the greatest annual increases in access from 2010 to 2019 were Timor-Leste (6 percentage points), Afghanistan (6 points), Papua New Guinea (5 points), Kiribati (4 points), and Solomon Islands (4 points). Still, almost half of the world's unserved people in 2019 (48 percent) were found in fragile and conflict-affected contexts. Although the annual advance in access for such countries in Sub-Saharan Africa, and Western Asia and Northern Africa did not keep pace with population growth, the opposite was true in Central Asia and Southern Asia (figure 1.9). Some fragile countries, such as Sudan and Niger, refined off-grid and mini-grid solutions for their electrification planning, while grid-based electrification efforts stalled (ESMAP 2020a). More up-to-date, reliable and granular data are needed to improve policy in the fragile and low-income environments that present the most complex challenges. Household surveys capturing the various dimensions of electricity access (quality of service, affordability, legality), supplemented with geospatial tools, can provide the comprehensive picture needed to set priorities, make more informed decisions, and better target electrification efforts.

FIGURE 1.8 • Gains in electricity access in low-income countries and fragile and conflict-affected countries, 2010, 2017, and 2019



Source: World Bank 2021.

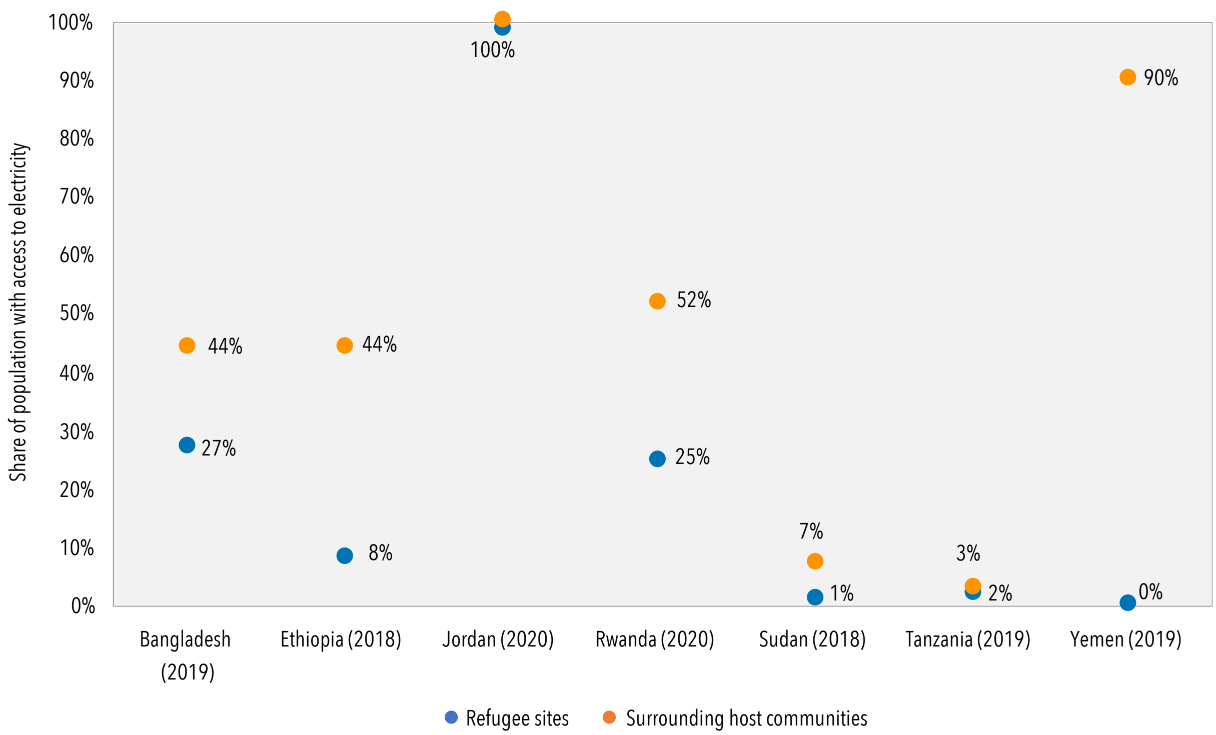
FIGURE 1.9 • Annual increase in electrification and population in fragile and conflict-affected countries, 2017–19, by region



Source: World Bank 2021.

Do refugees and other forcibly displaced persons enjoy rates of access to electricity similar to those of their surrounding host communities? Although more data are needed to understand energy access for the forcibly displaced, recent data gathered in 18 countries by the UNHCR show that, on average, surrounding host communities have twice the access to electricity of the forcibly displaced: 34 percent vs. 19 percent (UNHCR 2021). Jordan, at 100 percent for both groups in 2020, is an exception (figure 1.10). The most conspicuous disparities in coverage are found in Yemen, where the refugee site at Kharaz had no access at all in 2019, whereas the host community had 90 percent. Refugees at 27 sites in Ethiopia, five in Sudan, and three in Tanzania suffered from far lower electricity coverage than in other countries.[14] The host communities in Tanzania also had a very low access rate (3 percent).

FIGURE 1.10 • Access to electricity for refugee sites and nearby host communities



Source: UNHCR 2021.

THE URBAN-RURAL DIVIDE

Despite starting from a lower point, access to electricity has improved more quickly in rural areas than in urban areas since 2010, boosted by the uptake of decentralized energy and greater attention to the agenda of "leaving no one behind" (ESMAP 2020). The access gap between rural and urban shrank from 26 percentage points in 2010 to 16 in 2019 (figure 1.11). Nevertheless, access remains lower in rural areas than in urban areas. Whereas 81 percent of rural residents were connected to electricity in 2019, leaving 640 million without access, 97 percent of urban dwellers had access (with 116 million unserved).[15] Each year between 2017 and 2019, 49 million rural residents gained access to electricity (vs. 81 million in urban areas), outpacing rural population growth over the same period (figure 1.12). In Central Asia and Southern Asia, annual progress in rural access (an additional 46 million people per year) surpassed annual population growth almost sevenfold

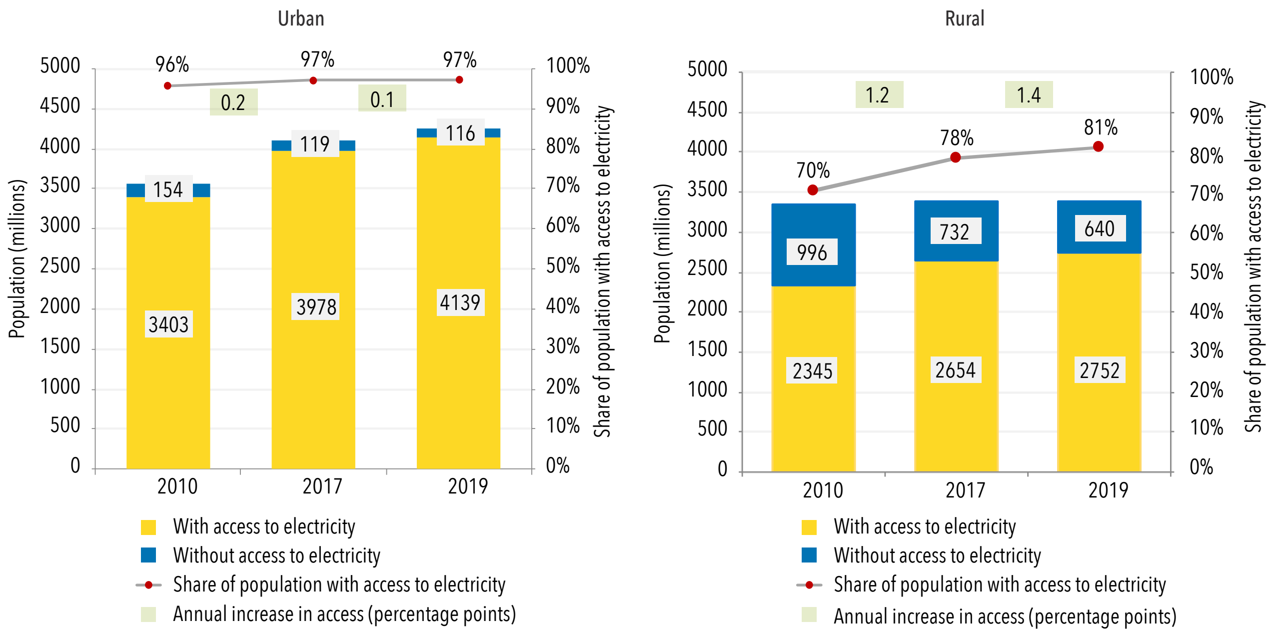
14 The 27 sites in Ethiopia were Adi Harush, Awbarre, Aysaita, Bambasi, Barahle, Bokolmanyo, Buramino, Dilo, Endabaguna, Gure Shombola, Hilaweyn, Hitsats, Jewi, Kebribeyah, Kobe, Kule, Magado, Mai Aini, Melkadida, Okugo, Pugnido, Sheder, Sherkole, Shimelba, Tierkidi, Tongo, and Tsore. The five sites in Sudan were Abuda, Fau 5, Girba, Kilo 26, and Wad Sharifey. The three sites in Tanzania were Mtendel, Nduta, and Nyarugusu.

15 Due to the lack of population data, the numbers of people without access in rural and urban areas do not sum to the total access deficit.

between 2017 and 2019. In the meantime, rural electrification in Sub-Saharan Africa, where more than half of the world's unserved rural population lives, kept pace with population growth, shrinking the access deficit.

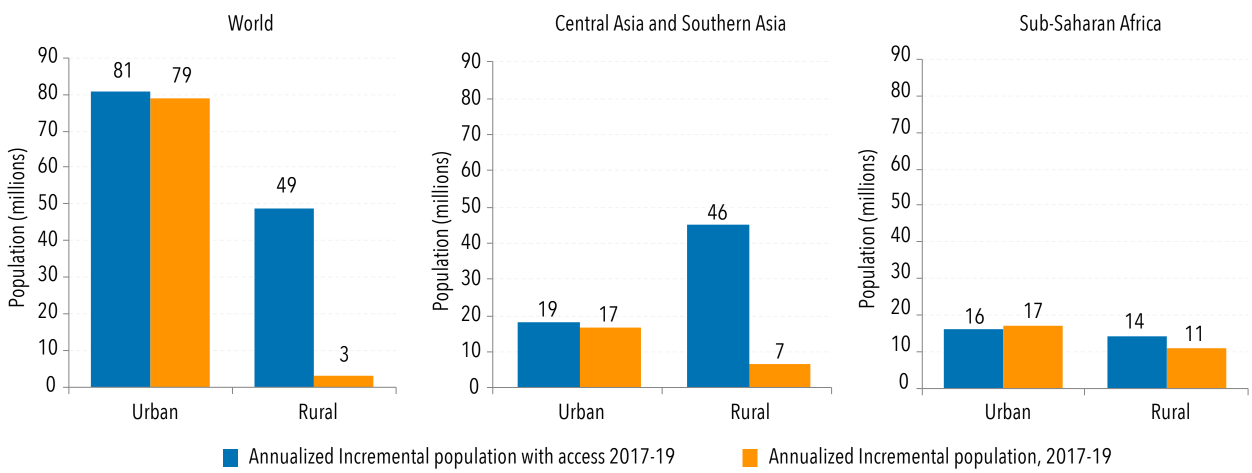
Compared with advancing rural access from its low baseline, sustaining the pace of electrification in urban areas faces several complexities. Major efforts will be required to keep up with population growth in urban areas, in part because the latter (at 78 million) was 13 times higher than in rural areas (6 million) over the 2010–19 period. Urban access efforts brought electricity to 81 million additional people each year, on average, outpacing population growth by 1.5 million between 2017 and 2019. While annualized incremental urban access in Central Asia and Southern Asia kept pace with population growth, it trailed population growth in Sub-Saharan Africa. Globally, 84 percent of the urban deficit in 2019 was in Sub-Saharan Africa.

FIGURE 1.11 • Gains in electricity access in urban and rural areas, 2010, 2017 and 2019



Source: World Bank 2021.

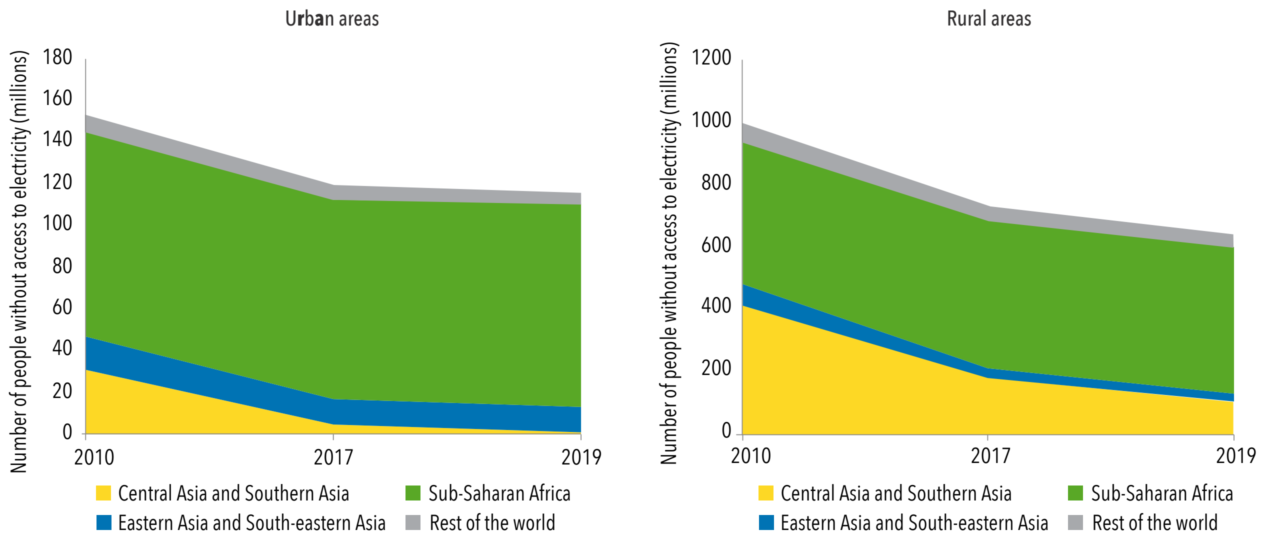
FIGURE 1.12 • Annual incremental growth in access and population in urban and rural areas of Central Asia and Southern Asia and Sub-Saharan Africa, 2017–19



Source: World Bank 2021.

The access deficit for both urban and rural areas has been increasingly concentrated in Sub-Saharan Africa since 2010 (figure 1.13). In 2019, 97 million urban residents in the region and 471 million rural residents lacked access. By contrast, the access deficit of Central Asia and Southern Asia shrank in both urban and rural areas over the 2010–19 period as a result of major electrification efforts in both settings. The annual decrease in the deficit between 2010 and 2019 was 3 million in urban areas and 34 million for rural areas. The rural access deficit in the region was particularly sharp: from 409 million in 2010 to 101 million in 2019. Likewise, since 2010, the access deficits for urban and rural areas in Eastern Asia and South-eastern Asia have fallen annually by 0.5 million and 5 million, respectively. As a result, the region's access deficit in 2019 was 12 million in urban areas and 28 million in rural.

FIGURE 1.13 • Evolution of access deficits in urban and rural areas, by region, 2010, 2017, and 2019



Source: World Bank 2021.

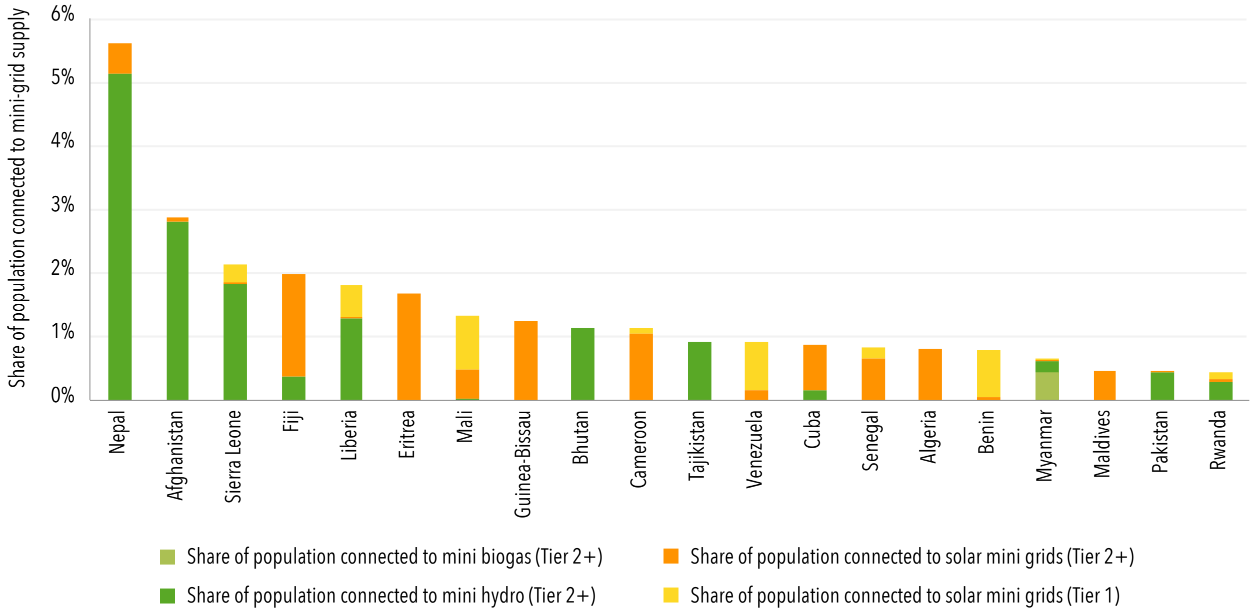
DECENTRALIZED ELECTRIFICATION

Tracking growth in access to electricity through decentralized renewables-based solutions has been challenging for several reasons, including market structures, the variety of solutions and systems, and the multiplicity of players involved along value chains. Today, supply-side data are available in databases maintained by the International Renewable Energy Agency (IRENA) and the association of producers of off-grid solar energy (GOGLA); demand-side figures are made available through the Multi-Tier Framework.

Electrification through decentralized renewables-based solutions has grown significantly since 2010, accelerating in the last few years. The number of people connected to mini-grids using solar, hydro, and biogas technologies has more than doubled between 2010 and 2019, with 11 million people connected in 2019 (IRENA 2020c).[16] In 2019, India, Nepal and Afghanistan had the most people connected to mini-grids (regardless of technology). Nepal, Afghanistan, and Sierra Leone had the highest share of the population served by mini-grids (figure 1.14). Connections to solar mini-grids have grown almost sixfold over the period, to 3.4 million people. In 2019, 67 percent of those connected to solar mini-grids enjoyed Tier 2+ access. Indonesia, India, and Algeria had the largest number of people connected to solar mini-grids in 2019.

16 For the purpose of measuring energy access, IRENA defines mini-grids as distribution networks supplying electricity to residential consumers and not connected to a country's main grid.

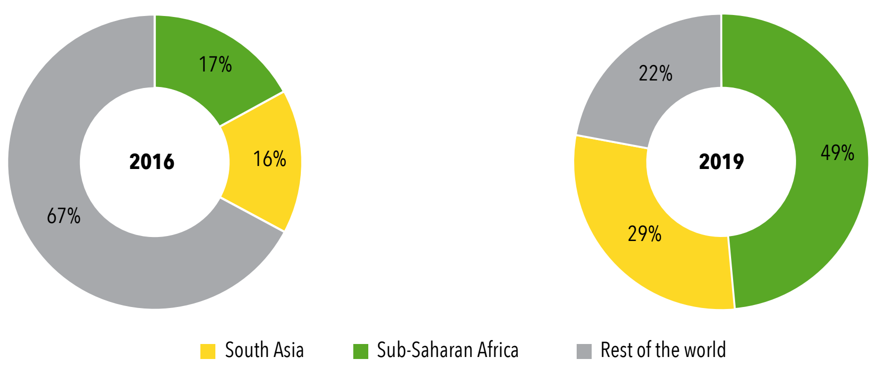
FIGURE 1.14 • Top 20 countries with the highest rates of access to mini-grid supply (Tier 1 or higher), 2019



Source: IRENA 2020c.

In 2019, 105 million people had access to off-grid solar solutions, up from 85 million in 2016.[17] As shown in figure 1.15, almost half lived in Sub-Saharan Africa, and 29 percent in South Asia (GOGLA 2021a). The countries with the largest number of people connected to off-grid solutions in 2019 were India (28 million), Kenya (17 million), and Ethiopia (8 million). Access to Tier 1 solutions expanded significantly between 2016 and 2019, from 38 million to 62 million people (figure 1.16). Access to Tier 2 solutions grew even faster, expanding fivefold over the same period to 10 million people in 2019. Progress in Sub-Saharan Africa was especially notable, with off-grid solar sales nearly tripling between 2016 and 2019 (figure 1.15). Fifty-one million people in the region were connected to off-grid solar solutions in 2019 (all tiers). Kenya (17 million), Ethiopia (8 million), and Uganda (4 million) are the top three.

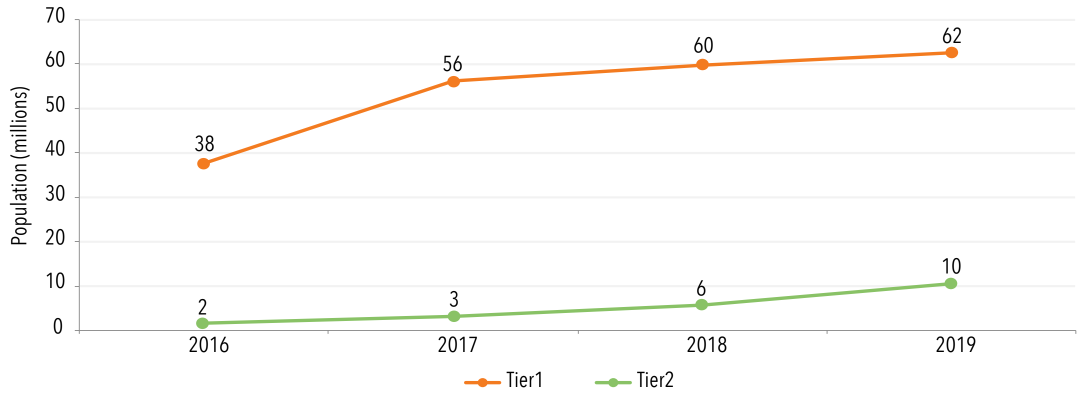
FIGURE 1.15 • Share of people connected to off-grid solar solutions, 2016–19



Source: GOGLA 2021a.

17 GOGLA defines eligible off-grid solar lighting products as systems that include a solar panel, a battery, and at least one light point.

FIGURE 1.16 • Number of people (millions) connected to off-grid solar products by tier, 2016-19

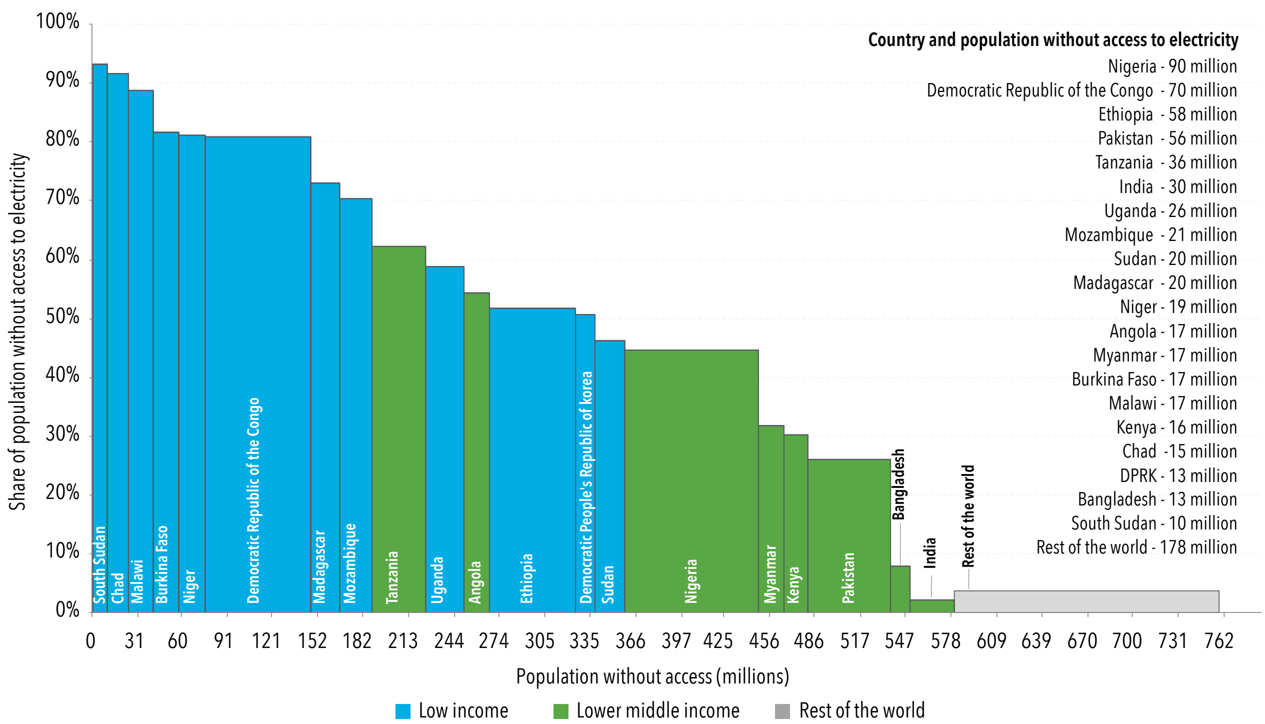


Source: GOGLA 2021a

COUNTRY TRENDS

In 2019, 76 percent (580 million) of the world's unserved population lived in the top 20 access-deficit countries (figures 1.17 and 1.18). The top three countries are in Sub-Saharan Africa: Nigeria (90 million), DRC (70 million), and Ethiopia (58 million). India rounded out the top five access-deficit countries and instead, Tanzania newly joined in 2019. India, which had the third-largest deficit in 2018, achieved a significant reduction in its population without access to electricity in 2019. South Sudan is new in the top 20, replacing Yemen.

FIGURE 1.17 • Share of population and total population without access to electricity, top 20 access-deficit countries, and rest of world, 2019



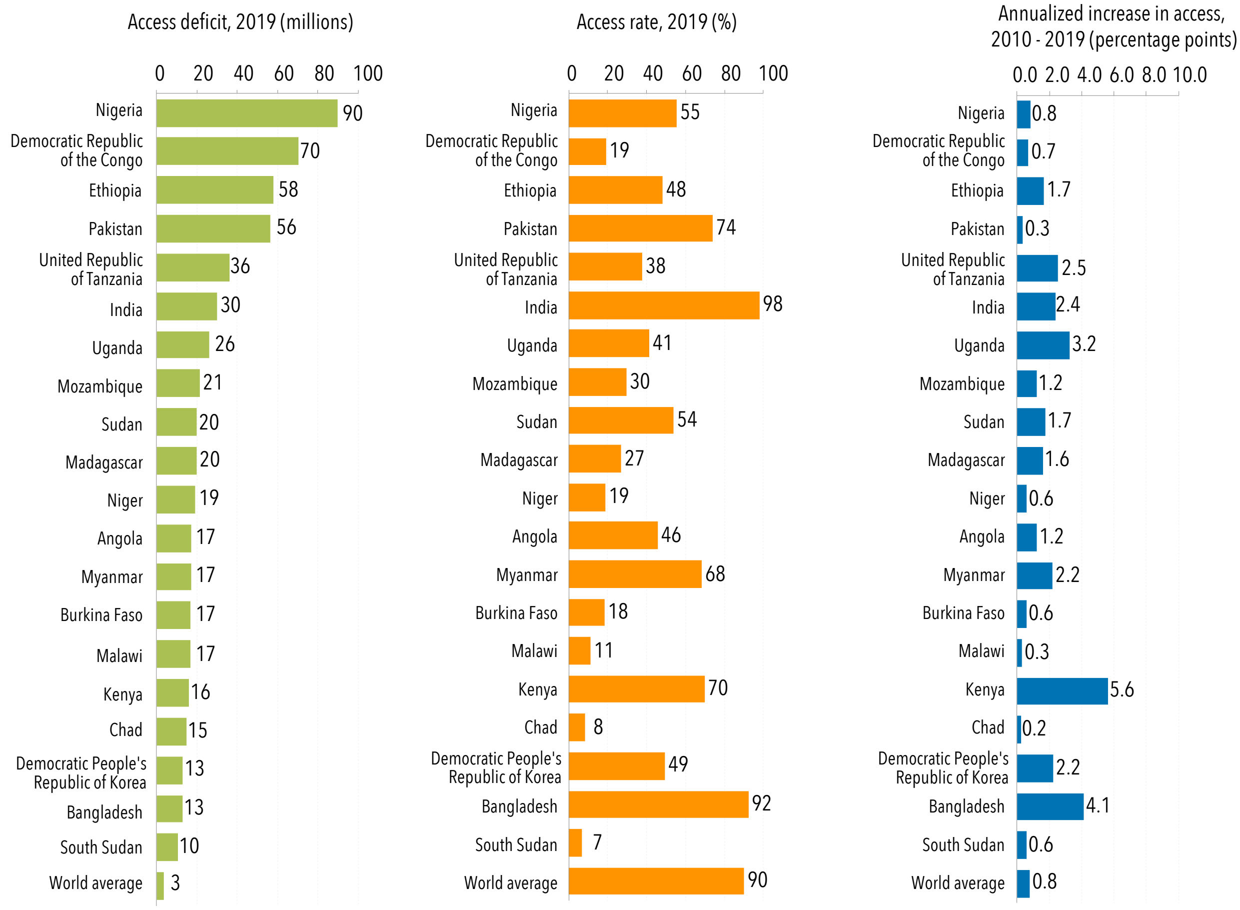
Source: World Bank 2021.

In about half of the top 20 deficit countries, access did not keep pace with population growth. In Nigeria, where 90 million people lacked access to electricity in 2019 (12 percent of the global access deficit), the deficit expanded by 1.3 million each year between 2017 and 2019. Nigeria's access rate grew by 0.8 percentage points each year from 2010 to 2019 period—not as fast as the total population. As a result, the number of people without access increased by 7 million from 2010, bringing the total deficit to close to 90 million in 2019. Similarly, for the DRC, the access rate improved by 0.7 percentage points annually over the same period, not enough to keep up with population growth. The population without access in the DRC rose by about 14 million after 2010, reaching 70 million in 2019.

Ethiopia and Pakistan, both of which had unserved populations of more than 50 million in 2019, increased their access rates by 1.7 and 0.3 percentage points annually after 2010. Electrification outperformed population growth in Ethiopia during the 2010–19 period, but not in Pakistan. In India, the access rate reached 98 percent in 2019, following annual growth in access of 2.4 percentage points since 2010. With electrification efforts outpacing population growth, the number of people without access to electricity in India dropped from 101 million in 2017 to 30 million in 2019, an annual decrease of 36 million.

Among the 20 countries with the largest deficits, Bangladesh, Kenya, and Uganda have made the most progress in electrification, as they achieved annual growth in access of more than 3 percentage points between 2010 and 2019 (figure 1.18). Consequently, the access deficits in these countries have shrunk over the past decade.

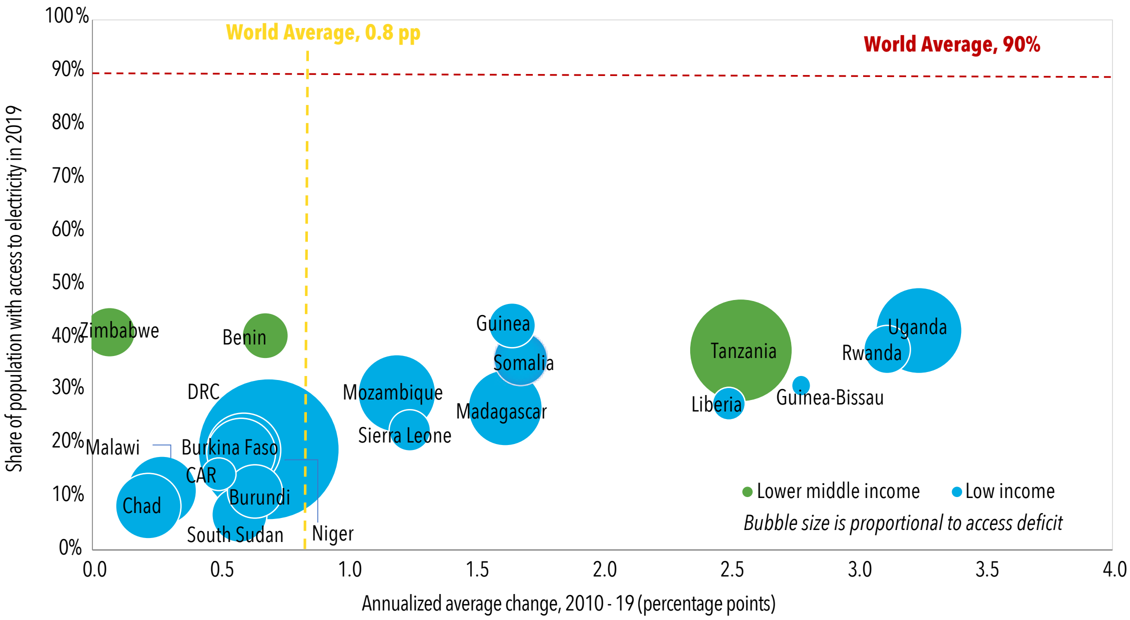
FIGURE 1.18 • Electricity access in the top 20 access-deficit countries by population, 2010–19



Source: World Bank 2021.

All of the world's 20 least-electrified countries are in Sub-Saharan Africa, where a majority of the global unserved population live (figure 1.19). South Sudan had the lowest access rate in 2019 (7 percent), followed by Chad (8 percent), Burundi (11 percent), and Malawi (11 percent). Uganda's annualized increase in access of more than 3 percentage points from 2010 to 2019 was the largest among the 20 countries. Half of the 20 least-electrified countries expanded access at an annual rate greater than the world average between 2010 and 2019. In the 2017–19 period, annual access growth in 6 of the 20 countries outpaced population growth. Those countries were Uganda, Tanzania, Rwanda, Liberia, Guinea-Bissau, and Guinea. With annual access growth more than 3 percentage points, Uganda and Guinea showed greater progress in electrification than the rest of the group over the period.

FIGURE 1.19 • Electricity access in the 20 least-electrified countries, 2010–19

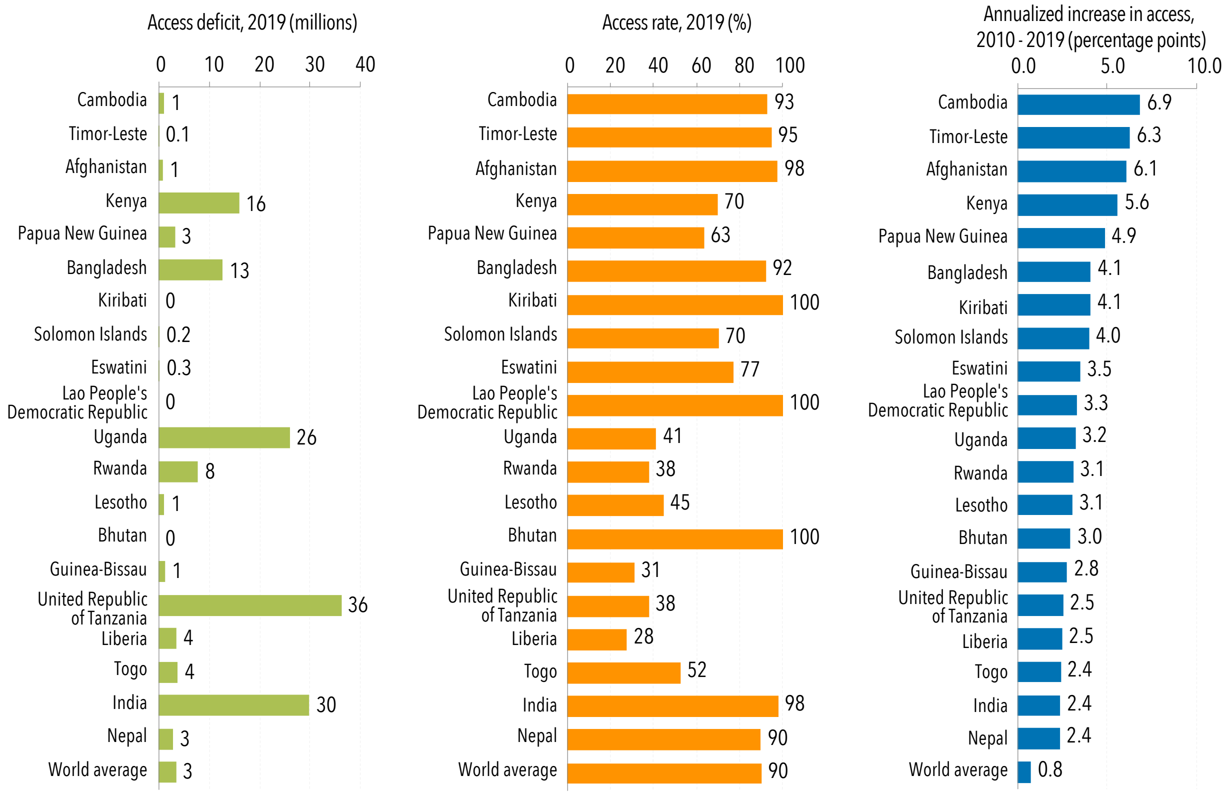


Source: World Bank 2021.

Four countries—Cambodia, Timor-Leste, Afghanistan (where only about 35 percent of the population has grid access), and Kenya—electrified at rates exceeding 5 percentage points annually between 2010 and 2019 (figure 1.20) by pursuing electrification strategies adapted to each country's circumstances (such as fragility or population density). Some countries with low access rates, such as Guinea-Bissau and Liberia, were among the fastest-electrifying, underscoring the importance of policies that promote an enabling environment for fast growth.

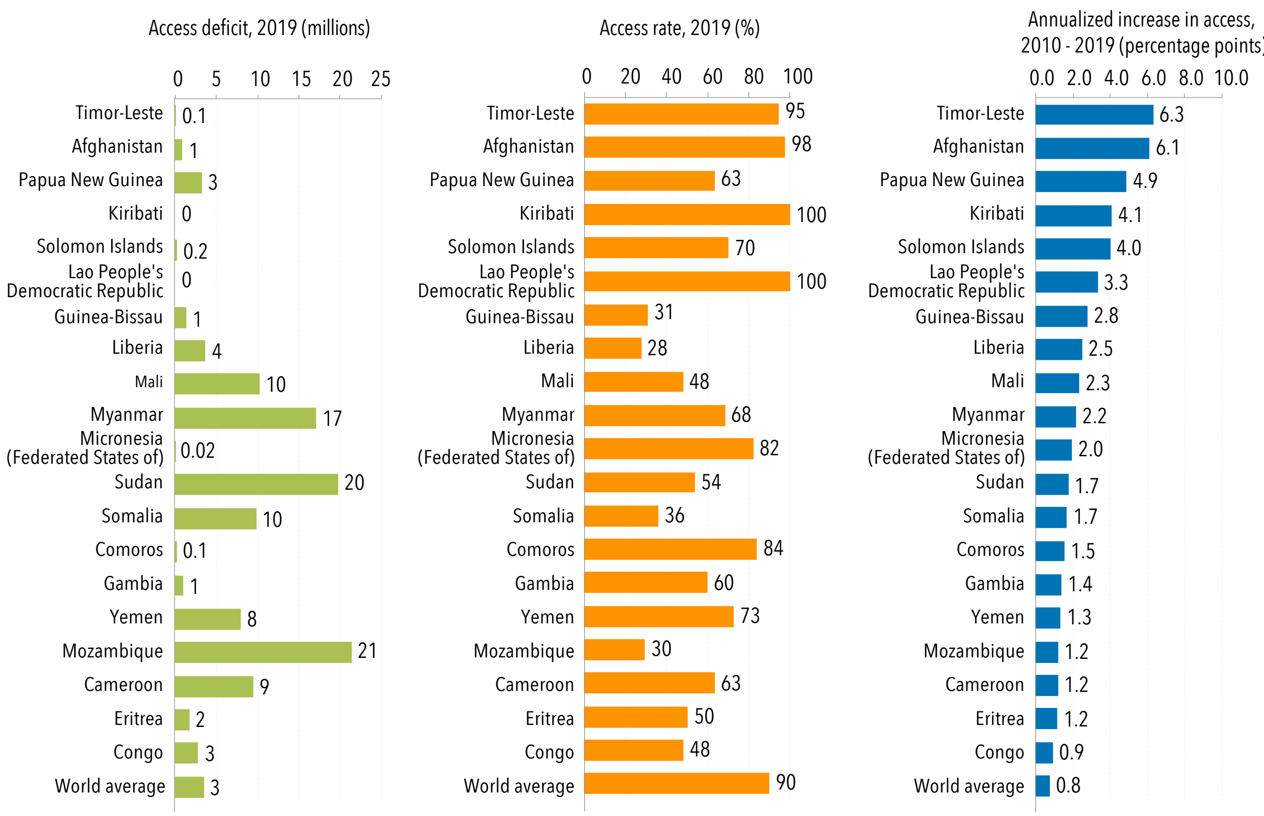
Some countries facing fragility, conflict, and violence made progress over the 2010–19 period (figure 1.21). Nigeria, Myanmar, and Cameroon, for example, began to adopt electricity access regulations over the period covered by this report (ESMAP 2020a). The access deficit in Cameroon and Myanmar dropped each year after 2010, falling to 9 million and 17 million, respectively, in 2019. The lesson is that a relevant regulatory framework can enable advances in electrification.

FIGURE 1.20 • Electricity access in the 20 fastest-electrifying countries, 2010–19



Source: World Bank 2021.

FIGURE 1.21 • Electricity access in the 20 fastest-electrifying countries characterized by fragility, conflict, and violence, 2010–19



Source: World Bank 2021.

POLICY INSIGHTS

Governments and the international community have built up a great deal of momentum toward meeting the 2030 target for universal access to electricity. Promising results can be seen in many countries. With less than a decade remaining to reach the target, new challenges—first and foremost the COVID-19 pandemic—are threatening these auspicious trends, placing additional pressure on stakeholders to meet the 2030 target. Although the full impact of the pandemic on electricity access is not yet clear, continued disruptions (for example, in supply chains and to consumers' incomes) are expected to impede electrification, slowing and in some cases even reversing progress as utilities and decentralized energy providers grapple with financial difficulties and governments suffer constraints in their capacity to make necessary investments. The pandemic has also highlighted the centrality of reliable electricity to the delivery of public services and the ability to respond resiliently to social and economic challenges. As countries deploy funds to stimulate a rapid and inclusive recovery from the economic devastation wrought by COVID-19, expanding access to electricity, within the wider context of SDG 7, must remain a priority (IRENA 2020a).

IMPERATIVE: AN IMMEDIATE RESPONSE TO SUSTAIN ELECTRIFICATION EFFORTS

As policy makers prepare recovery packages, policies and regulations to support electrification will underpin access strategies and invite private sector participation. The 2020 edition of Regulatory Indicators for Sustainable Energy (ESMAP 2020a) shows that electrification policies have made strong advances since 2010, with progress quickening after 2017. As the least-cost way to provide power to more than half the population without access by 2030, mini-grid and off-grid sources of electricity are expected to play a key role in achieving the SDG 7 goal of universal access (IEA 2020a). Happily, regulatory frameworks for such systems are increasingly common, attesting to their perceived potential. Even in fragile, conflict-prone, and violent settings, there are clear signals of the success of mini-grids and stand-alone systems, with the result that about half of fragile countries developing legal frameworks to support electrification since 2010.[18] Integrated approaches based on data-driven, least-cost electrification planning have been shown to be effective in making progress toward universal energy access (in Nepal and Togo, for example). But because gaps too often appear between policies and regulations as written and how those policies and regulations are implemented, policy makers should ensure that beneficial policies and regulations are properly implemented.

For policy makers intent on sustaining the pace of electrification, mitigating the adverse impacts of the pandemic on both national utilities and the nascent mini-grid and off-grid solar industries has become a priority. Still, the crisis has hamstrung these vibrant but still developing industries, which consist chiefly of startups and small-to-medium-sized businesses. Acquiring customers and servicing even existing customers have been hampered by supply-chain disruptions, lockdown provisions, and lower incomes in the pockets of consumers. In the first half of 2020, global sales fell 26 percent compared with the same period in 2019 (GOGLA 2019), depriving some 5 million people from gaining access to electricity. According to a survey carried out by EnDev (2020), the collection rate of more than 40 of the 600 responding companies dropped by more than half. And the vast majority of companies have not been able to obtain any financial support since the outbreak of the pandemic. While their only revenue stream is under intense pressure, companies must continue to service their debt, straining their cash flow.

In many developing countries where utilities were already under financial duress, the pandemic has made matters worse—to the point of jeopardizing their ability to provide essential services. This is particularly problematic since state-owned enterprises account for more than a third of global energy investment and 90 percent of grid spending in developing economies (IEA 2020a). The recession, along with restrictive measures, has led to a sudden drop in energy sales from the most profitable industrial and commercial consumers, which account for more than 70 percent of their revenues. In India, the demand for electricity is expected to be 7 to 17 percent lower by 2025 due to the COVID-19 economic shock. In Nepal, the bill

18 At the same time, policies for on-grid electrification have not advanced much over the past decade. Improvements in utility creditworthiness have made scant progress since 2010 (ESMAP 2020a).

collection rate dropped to less than 10 percent from an average of around 95 percent (IFC 2020). Preliminary analysis shows that the average cost of supply will increase by 13.5 percent. In countries such as Nepal, the adjusted cost of supply for an unreformed electric utility is projected to increase much more (by 72 percent) from NPR 12/kWh (USD 0.10) per unit in fiscal year 2020 to NPR 20.7/kWh (USD 0.175) in fiscal year 2024 (IFC 2020). Meanwhile, the drop in revenue collections and the rise in operational costs put utilities at an even greater risk of under-recovery of costs. Only half of African utilities were recovering their operation and maintenance costs before the COVID-19 crisis. That share will drop to 14 percent if demand drops by 15 percent and collections by 10 percent (Elahi, Srinivasan, and Mukurazhizha 2020). In addition, sector-specific policies introduced by a number of countries (such as bill reductions, cancellations, or deferrals) will have the greatest short-term, negative impact on utility finances. So far, out of 67 surveyed countries, only 8 were found to offer direct or indirect government liquidity support to utilities (IFC 2020).

In this context more than ever, energy service providers—including utilities, mini-grid operators, and off-grid companies—require access to low-cost working capital and project finance with lengthy repayment periods.[19] As a response to COVID-19's threat to the survival of the nascent energy access industry, and to preserve the gains in energy access achieved in the past decade, several initiatives have emerged. An example is the COVID-19 Energy Access Relief Fund (EARF), a global fund established by multiple public and private financiers and the African Development Bank's COVID-19 Off-Grid Recovery Platform, which provides relief and recovery capital to businesses that expand access to energy.

Beyond short-term responses, however, broader support is needed to bring both utilities and decentralized energy service providers to the point where they can again support accelerated electrification. As part of their efforts to support governments, the development community must expand the options for blended finance. For instance, impact bonds could be structured around concrete, measurable impacts in order to attract impact investors and unlock equity finance for small and medium-sized energy enterprises. Risk-mitigation instruments could raise the availability, and improve the terms, of local commercial debt financing for energy service providers and electric appliance distributors, among others, thereby leveraging this type of finance to unlock equity and other forms of investment. Financing for appliances and technical assistance to stimulate demand for productive uses are also critical. Both would stimulate demand from households that presently consume very little efficient energy. The effort would entail collaboration with utilities and asset financiers to obtain flexible payment arrangements for appliance users. With digitalization (such as integration of the Internet of things in devices, smart metering, and other real-time data capabilities), these innovations could transform the sector, improve accountability, reduce costs, and provide efficiencies across the value chain. Data derived from end users can provide unprecedented insight into consumer affordability, propensity to pay, credit scoring and risk, and so on, to help design more effective interventions that expand energy access.

The pandemic has exposed weaknesses in the health infrastructure of the developing world. The electrification of health facilities, in particular, is expected to be the focus of greater governmental efforts to improve that infrastructure. Electrification of health facilities is critical for COVID-19 prevention, response, including for vaccine deployment and storage, and resilient recovery from the pandemic. Yet more than 70 percent of health facilities located in Sub-Saharan Africa have no access to reliable electricity, and one in four has no electricity at all. The adverse impacts of such deficiencies on human capital development are well known. In 2017, only 35 percent of primary schools in Sub-Saharan Africa and 50.7 percent of those in Southeast Asia had access to electricity (UNESCO 2019). Even before the pandemic, efforts to increase public institutions' access to electricity were intensifying (Elahi, Srinivasan, and Mukurazhizha 2020), as improvements in renewable energy and battery storage technologies for mini-grids and stand-alone systems have made service provision not only more affordable but also rapidly deployable. But in many cases plans for longer-term operation and maintenance (O&M) of such systems are inadequate, jeopardizing their sustainability. Public institutions require long-term service provision supported by dedicated O&M budgets and implemented through innovative business models (public and private) to ensure technical, operational, and financial sustainability. Quality standards and enhanced monitoring systems suited to local contexts are also necessary.

Long-term O&M should be designed in light of each country's institutional and governance framework. Countries with a centralized governance structure might have a more centralized approach to managing it than countries with strong subnational (state or regional) governance structures. In some cases, energy ministries or national utilities will be responsible for ensuring smooth operation of stand-alone systems, whereas in other cases a specialized authority within the health or education ministry may be responsible.

19 Public financing has played an especially pivotal role in the financing of off-grid renewables, providing, on average, 32 percent of commitments during 2013–18, compared with an average public share in total renewable energy investments of 14 percent (IRENA and CPI 2020, especially box 1 in chapter 5).

Solar-battery systems might be facility-owned but managed by local private companies specializing in off-grid solar and mini-grid systems. Alternatively, the battery systems might be owned and operated entirely by the private sector under a service model or leasing scenario. In some countries utilities are highly capable in rural areas and can install, operate, and maintain solar-battery systems; Kenya and Ethiopia are examples. In others, local mini-grid developers can play this role (Nigeria, Myanmar)—for example, by integrating the facility's electricity system into its mini-grid or by supporting the facility under a service contract. Off-grid service led by the private sector is currently being explored in Niger and Uganda, with longer-term power purchase agreements for supply, installation, and O&M. Service contracts for extended O&M under public procurement have been implemented in Myanmar.

CLOSING THE ACCESS GAP

Over time, the access gap will become more challenging to close. Annual investment of USD 41 billion is required to achieve universal residential electrification, but only one-third of that, or USD 16 billion, was destined in 2018 for the 20-odd high-impact countries that have a particularly large weight in aggregate global performance (SEforAll 2020a).[20] Unserved people continue to live mainly in scattered, hard-to-reach settlements with weak infrastructure, making the equation between affordability and financial viability ever harder to solve. Beyond rural populations, pandemic-related measures (including lockdowns) have disproportionally affected those who are already the most vulnerable.

In fragile, conflict-affected, and violent settings, countries face additional constraints to expanding access, such as security, as well as other forms of fragility that can make service more difficult to supply and less affordable. In addition to an enabling ecosystem—one featuring ambitious targets, dedicated policies and regulations, tailored delivery models, financing for consumers and businesses, technology innovation, and capacity building (IRENA 2019b)—more out-of-the-box thinking is needed on appropriate business models and methods of leveraging public and private resources in such settings.

More than 90 percent of refugees in camps have limited access to electricity (UNHCR 2021). Access to sustainable electricity has a tremendous impact on all aspects of life for refugees and local host communities, safe water, ensuring adequate hygienic conditions, preventing gender-based violence, improving the quality of education for children and youth, and ensuring the reliability of healthcare services. UNHCR's Global Strategy for Sustainable Energy aims to boost access to safe and sustainable energy solutions, while minimizing environmental impact. Promoting integrated approaches is critical to increase the inclusiveness, effectiveness, and sustainability of interventions in emergencies as well as protracted refugee situations. This includes supporting joint efforts among humanitarian, development, governmental, and private actors to finance interventions in settings characterized by displacement, while also advocating for innovative financing mechanisms and inclusive, predictable, and simplified regulatory frameworks. In Jordan for example, large-scale solar plants installed in refugee camps boosted access to electricity within the camp and in neighboring communities. Promoting policies that encourage large-scale investments in access to electricity in areas hosting refugees will make a tremendous contribution to local communities' development, scale up livelihood opportunities, attract additional investments from the private sector, and establish a solid foundation for sustainable development.

ADDRESSING THE AFFORDABILITY GAP

By 2019, measures of consumers' ability to afford electricity showed rapid improvement across regions (ESMAP 2020a). Since then, however, the economic impact of the pandemic has hit electricity customers hard, widening the affordability gap and provoking payment delays or defaults. In Sub-Saharan Africa, the pandemic will push as many as 40 million people into extreme poverty (World Bank 2020c). Most interventions have been focused on building robust enabling environments and providing supply-side subsidies (concessional financing, results-based financing, and grants) as a first step in closing the access gap. These have provided governments with various tools for reducing risks or costs for energy providers and strengthening commercial markets, striving to reach economies of scale and bring down the market price. But they have not been able to bridge the affordability gap that prevents the poorest and most vulnerable consumers from obtaining electricity.

20 The high-impact countries account for about two-thirds of the global electrification deficit. They are Angola, Bangladesh, Burkina Faso, Chad, Congo (Democratic Republic of), Ethiopia, India, Kenya, Korea (Democratic People's Republic of), Madagascar, Malawi, Mozambique, Myanmar, Niger, Nigeria, Pakistan, Sudan, Tanzania, Uganda and Yemen.

Demand-side subsidies in the off-grid sector have emerged as a new instrument to enable governments to leave no one behind. Widely used in grid electrification, where grid connections are increasingly subsidized and where low-income consumers often benefit from so-called lifeline tariffs, demand-side subsidies in the off-grid sector aim directly at lowering the price consumers pay and making solutions affordable to the poorest households. Subsidies may go directly to the household through cash transfers or vouchers, or they may be channeled through companies that offer pro-poor, results-based financing or lifeline tariffs. In the latter case, they must be designed to target specific groups depending on their energy needs, including the different needs of women and men (SEforAll 2020b).

Governments will need to implement parallel supply- and demand-side subsidies to reach universal access. Rwanda decided to launch an end-user subsidy pilot in 2019 to complement supply-side subsidies that were not enough to reach certain customers (GOGLA 2021b). With implementation support from the Development Bank of Rwanda (BRD) and Energy Development Corporation Limited, Rwanda's government is delivering a consumer subsidy scheme valued at USD 47 million for solar home systems and clean cooking solutions. The subsidy is paid directly to participating off-grid solar companies in multiple disbursements. Eligible households must make a customer contribution. Companies can use an online platform to determine if a household is eligible for the subsidy or has already received a subsidized system.

When designing such mechanisms, governments should consider early on the long-term sustainability of subsidy programs and potential exit strategies. To minimize the risk of market distortion and fit the mechanisms to the country's context, it is important to consult with all stakeholders at the outset of the design process and think about subsidies in an integrated manner—considering those in reach of the grid, potential customers of decentralized technologies, and the variety of service models. In Uganda, the Electricity Connection Policy was introduced in 2018 with the ambition of increasing Uganda's electricity access to 60 percent by 2027 through connection subsidies for consumers located close to the existing network. About 300,000 households and businesses have received free electricity connections, benefiting 1.5 million Ugandans. Implemented by the Rural Electrification Agency, the policy also provides low-cost wiring solutions (such as "ready boards") for the poor and bulk supplies of connection materials to service providers to enable them to make new connections.

BUILDING BACK BETTER: ELECTRICITY ACCESS TO SUPPORT A SUSTAINABLE RECOVERY

In both pandemic and post-pandemic contexts, there will be calls for urgent action on health care, water and sanitation, livelihoods, job creation, education, and safety (through street lighting and better communication). The expansion of electricity access through the modernization of existing grids and the development of mini-grid and off-grid solutions can contribute to recovery efforts while building resilience against future shocks (climate, health, and other).

To draw maximum socioeconomic benefits from electrification, the access gap should be closed by promoting productive uses of electricity (box 1.2). Kenya's recent efforts at last-mile electrification have not resulted in any real increase in consumption of electricity beyond basic services, putting into question the viability of costly grid connections. Thinking beyond simple electricity connections requires a holistic approach. To date, Kenya's electrification programs, like most, have encouraged supply while overlooking the need to stimulate demand, especially demand for productive uses of electricity. The components of a holistic program include:

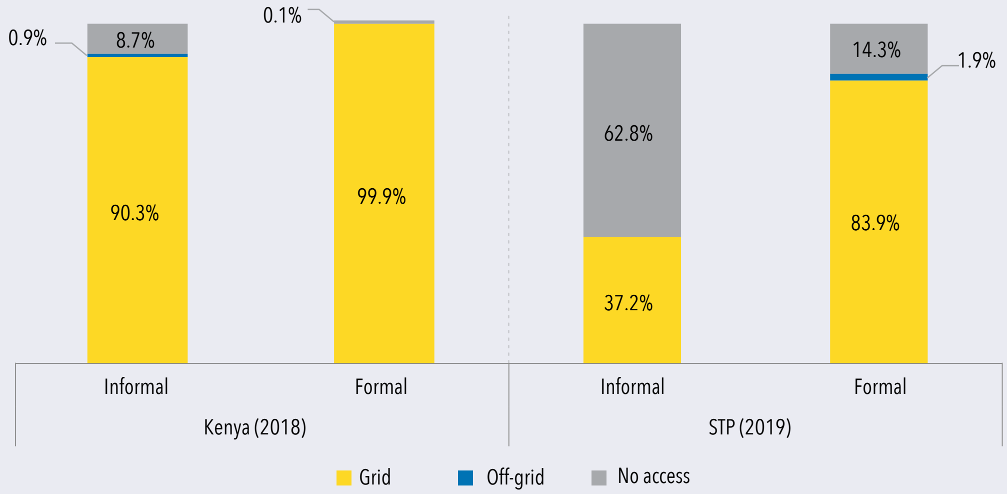
- A favorable policy and regulatory environment cutting across sectors, such as agriculture, cottage industry, dairy, fisheries, etc.;
- Public awareness of the benefits of electricity and their links with livelihood activities;
- Access to markets and other infrastructure services;
- Access to tailored financing for both end users and enterprises;
- Affordable energy-efficient appliances;
- Microenterprise training and business development services; and
- Understanding of underlying gender gaps that limit women's access to finance.

BOX 1.2 • ELECTRICITY ACCESS FOR PRODUCTIVE USES: A SNAPSHOT FROM THE MULTI-TIER FRAMEWORK[A]

Effective electrification is linked to its potential to create jobs and generate income. The right data can help planners design electrification programs in a way that maximizes their benefits for jobs and income generation—including assessing the impact of the quality and reliability of energy supply. Information from formal and informal manufacturing and services firms in Kenya (2018), Nepal (2018), and São Tomé and Príncipe (2019) was collected through the MTF.

The national grid is the primary source of electricity for enterprises in surveyed countries (figure B1.2.1). However, access to grid electricity varies widely, ranging from a nationwide average of 95 percent in Kenya (99.9 percent for formal and 90.3 percent for informal enterprises) to 60.6 percent in São Tomé and Príncipe (83.9 percent for formal and 37.2 percent for informal enterprises). The challenge of electrification is severe for São Tomé and Príncipe, where 62.8 percent of the informal enterprises and 14.3 percent of formal enterprises did not have access to any source of electricity. The share of off-grid sources is negligible, with just 0.9 percent of informal and 0.1 percent of formal firms in Kenya, and 2 percent of formal enterprises in São Tomé and Príncipe using off-grid sources to power their business. In Nepal, the sample included only grid-connected enterprises.

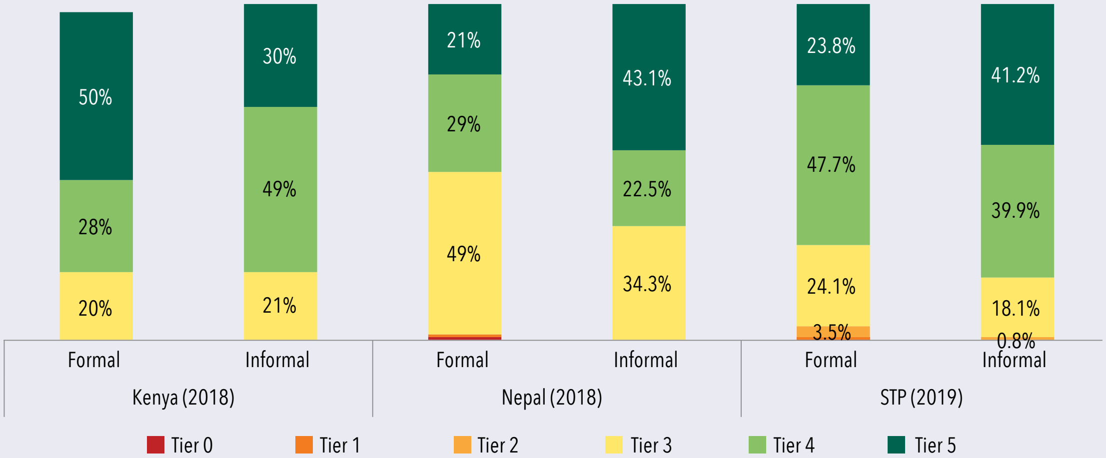
FIGURE B1.2.1 • Energy access by source in Kenya (2018) and São Tomé and Príncipe (2019)



Source: ESMAP forthcoming a, b, and c.

Given the varying degrees of grid access in the surveyed countries, the MTF framework (which looks at access in a multidimensional way) provides a good understanding of the overall level of service the firms receive from their electricity source. Almost all of the enterprises received from the grid service at Tier 3 or above once they were connected (figure B1.2.2). This included enterprises in São Tomé and Príncipe, where grid penetration was very low, especially for informal enterprises. At the aggregate level for the three countries, 35 percent of grid connected enterprises had Tier 5 service; 28 percent were in Tier 3.

FIGURE B1.2.2 • MTF Tier distribution for grid connected enterprises



Source: ESMAP forthcoming a, b, and c.

Poor reliability and quality of service affects the functioning of enterprises and ultimately the creation of jobs and the generation of income. Reliability of service (unscheduled interruptions) was one of the main constraints that enterprises faced with their electricity service. At the country level, 65 percent of enterprises in Kenya, 52 percent in Nepal, and 68.7 percent in São Tomé and Príncipe reported having between four and fourteen service interruptions a week (figure B1.2.3). Quality of service (low or fluctuating voltage) was a constraint for 19.5 percent of enterprises in Kenya and 38.8 percent in Nepal (figure B1.2.4). Quality was also an issue in São Tomé and Príncipe, with 56.4 percent of formal enterprises reporting voltage issues.[a,b] To cope with these issues, enterprises use backup energy solutions, which add costs and reduce profits.

FIGURE B1.2.3 • Reliability of grid (unscheduled interruptions)

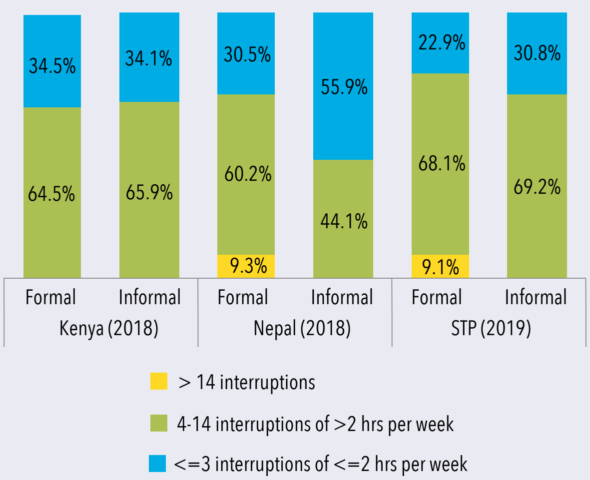
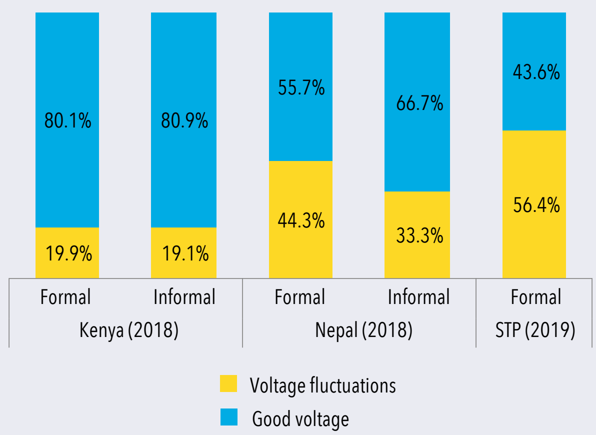


FIGURE B1.2.4 • Quality of grid service (voltage fluctuations)



Source: ESMAP forthcoming a, b, and c.

a. The MTF measures not only whether users receive energy services, but also whether these services are of adequate quality, reliable, affordable, safe, and available when needed (ESMAP 2016; Bhatia and Angelou 2014).

b. Due to data limitations, quality tier analysis was not available for the informal sector in São Tomé and Príncipe.

ELECTRICITY ACCESS AS A CATALYST FOR GENDER EQUALITY AND ECONOMIC GROWTH

Women continue to face challenges that hinder their full inclusion in the energy sector. These trends constrain the inclusion of women as leaders in the sector and detract from their roles as policy makers and decision makers. For example:

- Most households lacking electricity services live in poverty. For every 100 boys living in extremely poor households there are 105 girls (UNSD 2015).
- The energy sector attracts and hires science, technology, engineering, and mathematics (STEM) professionals; yet, worldwide, women comprise only 35 percent of STEM students in higher education (UNESCO 2017).
- Women represent 32 percent of the renewable energy workforce—a low figure yet considerably higher than in the oil and gas sector, where women make up only 22 percent of the workforce (IRENA 2019a).

Solutions are available; the way forward, clear. Studies from several regions show that women are 9 to 23 percentage points more likely than men to gain employment outside the home following electrification (Rewald 2017). Evidence shows that over the past decade, the income generated from women's labor participation explained 30 percent of the reduction of extreme poverty in Latin America and the Caribbean, ameliorating the precarious financial circumstances of millions of families (World Bank 2012).

The energy sector, in cooperation with relevant industries, must deepen global knowledge and replicate best practices related to the status of women. For example, the Energy Sector Management Assistance Program at the World Bank published "Stepping Up Women's STEM Careers in Infrastructure" (Schomer and Hammond 2020), which is intended to underpin and expand existing knowledge on gender equality issues. The report includes case studies, best practices, and entry points for World Bank projects.

The necessary knowledge creation should provide evidence about what types of investments work for attaining gender equality in the sector. Those who work on intervention design must have data that both quantifies and illuminates the various dimensions of gender inequities in various contexts.[21] They should consult with women's groups and others who are working to bridge persistent gender gaps in the sector. The design of interventions should draw on programs that encourage women's participation or improve access to energy service. In the energy access context, a global survey found that the lack of access to training and skills development was the biggest challenge to facilitate women's participation in the off-grid sector (IRENA 2019a). Finally, mechanisms are needed that allow programs and tools to be monitored and evaluated in ways that support transparency and accountability. If governments are to unleash the potential of women as change agents in reducing both poverty and inequality, then the energy sector must redouble its efforts to bring women into each stage of this sector by bridging gender gaps in opportunity and access.

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21 For example, within the World Bank, ESMAP is undertaking data analysis to understand the drivers behind gender gaps in energy access and identify patterns. A first stream of statistical analyses uses MTF data to analyse gaps between female and male-headed households across several indicators of electricity access, while taking into account the effect of location and household expenditure. Additional analysis will be conducted using national expenditure or budget surveys (compiled and harmonized by the World Bank's Global Poverty Working Group database) that explore the impact of additional factors behind gender gaps in household electricity access—such as marital status, education, occupation, age of the household head, household size, dependency ratio, etc. Similar work on gender gaps in access to modern energy cooking solutions is slated to follow.

METHODOLOGY

DATABASE

The World Bank's Global Electrification Database compiles nationally representative household survey data and census data from 1990 to 2019. It also 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. At the time of this analysis, the Global Electrification Database contained 1,282 surveys from 139 countries, excluding surveys from high-income countries (as classified by the United Nations). In general, since 2010, 28 percent of countries have published or updated their electricity data each year in time for global data collection. Greater investment in data collection and capacity building is needed to permit a more comprehensive and accurate understanding of the electricity access picture (chapter 6).

ESTIMATING MISSING VALUES

Surveys are typically published every two to three years, but they can be irregular and infrequent in many regions. To estimate values, a multilevel, nonparametric modeling approach developed by the World Health Organization to estimate clean fuel usage[22] was adapted to predict electricity access and used to fill in the missing data points for the time period between 1990 and 2019. Where data are available, access estimates are 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 is applied for all countries with at least one data point. In order to use as much real data as possible, results based on survey data are reported in their original form for all years available. The statistical model is used to fill in data only for years where they are missing and to conduct global and regional analyses. In the absence of survey data for a given year, information from regional trends was borrowed. The difference between real data points and estimated values is clearly identified in the database.

Countries considered "developed" by the United Nations and classified as high-income are assumed to have electrification rates of 100 percent from the first year the country joined the category.

In the period between 1990 and 2010, the statistical model is generally based on insufficient data points or outdated household surveys. To avoid having electrification trends from 1990 to 2010 overshadow efforts since 2010, the model was run twice in the present report:

- With survey data + assumptions from 1990 to 2019 for model estimates from 1990 to 2019
- With survey data + assumptions from 2010 to 2019 for model estimates from 2010 to 2019

The first model extrapolates electrification trends for the years from 1990 to 2019 given the available data points. The second considers only real data collected from 2010 and estimates the historical evolution in the most recent years. Eventually, the outputs from the two models are combined to draw a final value of access to electricity. If survey data are available, the original observations remain in the final database. Otherwise, taking account of a positive linear trend in electrification, a larger value between the two models is chosen as a final data point.

22 The model draws from the solid-fuel-use modeling for household cooking used in Bonjour and others (2013).

MEASURING ACCESS TO ELECTRICITY THROUGH OFF-GRID SOURCES

Off-grid dataGOGLA's off-grid solar and energy access and tier estimates shared for the purpose of compiling this report are calculated using the off-grid solar sales data shared by "affiliates" in the bi-annual data collection undertaken by GOGLA, Lighting Global, and the Efficiency for Access Coalition. Affiliates include GOGLA members, companies selling products that meet Lighting Global's quality standards, and appliance companies affiliated with the Low Energy Inclusive Appliances program.

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, affiliated companies fill out a questionnaire on their product sales by country, system type/size, and business model, also sharing specific product specifications and capacities. Although companies are ultimately responsible for the accuracy of the self-reported data submitted, the data are quality checked by an independent consultancy (Berenschot), as well as GOGLA, Lighting Global, and the Energy Savings Trust. While both the manufacturers and distributors of off-grid solar products report their sales to GOGLA, the results of this data collection shared in public reports cover products sold by manufacturers of off-grid solar products only. 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 (sales to distributors, governments, and nongovernmental organizations) as well as direct business-to-customer sales. The latest Market Trends Report (ESMAP 2020b) estimates that sales of 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 the standardized impact metrics created by the GOGLA Impact Working Group, to calculate the tiers of energy access, additional steps are taken:

- *Tier 1:* To estimate Tier 1 energy access, a "SEforAll factor" is applied to sales numbers. Here, a calculator tool developed under the SEforAll initiative has been applied to the database to estimate the service-level impact of smaller technologies. The tool reviews the system size and capacity of each product and estimates whether a product has helped to unlock either partial or full Tier 1 access. It then calculates the total number of people who have achieved partial or full Tier 1 access so as to provide an overall estimate of the number of people with Tier 1 access.
- *Tier 2:* Products that have a capacity of more than 50 Watt peak (Wp) or are over 20 Wp 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 included in ESMAP's Multi-Tier Framework. Please note that products that have enabled a household to achieve Tier 2 access are not included in the final Tier 1 estimates.

Outputs destined for inclusion in this report were compiled by analyzing sales data for 2016, 2017, 2018, and 2019 and calculating the estimated impact using GOGLA's impact metrics for the off-grid solar energy sector[23] and the Tier 1 and Tier 2 approaches.

MINI-GRID DATA

IRENA's 2021 decentralized energy database compiles mini-grid data; data from national rural electrification programs; and data from international development projects, commercial vendors, and nongovernmental organizations. It covers only developing countries. Data are obtained from large databases (e.g., GOGLA and government agency websites and reports) as well as websites of other agencies and institutions active in the decentralized energy sector. The latter is obtained by reviewing data from previous years and by monitoring IRENA's daily media briefs. In merging of data from these sources, care is taken not to double-count observations from different sources and to ensure that planned projects and programs have been implemented. More details of the methodology used to compile the data can be found in IRENA (2021).

23 GOGLA Impact Metrics can be found at https://www.gogla.org/impact/gogla-impact-metrics.

CALCULATING THE ANNUAL CHANGE IN ACCESS

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)

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

COMPARING THE ELECTRIFICATION DATA METHODS OF THE WORLD BANK AND THE IEA

The World Bank and IEA maintain separate databases of global electricity access rates. The World Bank's Global Electrification Database derives estimates from a suite of standardized household surveys and censuses that are conducted in most countries every two to three years, in conjunction with a multilevel nonparametric model used to extrapolate data for the missing years, as described in the section on "Estimating missing values," above. This ensures that demand-side data are being collected. The IEA Energy Access Database sources data, where possible, from government reports of household electrification (usually based on utility connections), which focus more on supply side electrification data. IEA considers a household to have access if it receives enough electricity to power a basic bundle of energy services. The World Bank utilizes a similar structure called the Multi-Tier Framework that classifies access along a tiered spectrum, from Tier 0 (no access) to Tier 5 (highest level of access).

The two approaches can sometimes yield different estimates. Access levels based on household surveys are moderately higher than those based on energy sector data because they capture a wider range of phenomena, including off-grid access, informality, and self-supply systems.

A comparison of the two datasets in the previous edition of this report (and updated in this edition) highlights their respective strengths. Household surveys, typically conducted by national statistical agencies, offer two distinct advantages for measures of electrification. First, with longstanding efforts internationally to harmonize questionnaire designs, electrification questions are largely standardized across country surveys. Although not all surveys reveal detailed information on the forms of access, survey questionnaire designs can now 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.

Government data on electrification reported by national ministries of energy take the form of supply-side data on utility connections. Although not published by every government, these kinds of data offer two principal advantages over national surveys. First, administrative data are often available on an annual basis and, for this reason, may be more up to date than surveys, which are updated only every two to three years. Second, administrative data are not subject to the challenges that can arise when conducting field surveys. Household surveys (particularly those taken in remote and rural areas) may suffer from sampling errors that may lead to underestimation of the access deficit.

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CHAPTER 2

ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

Photo: © Thomas Trutschel/Photothek/Getty

MAIN MESSAGES

- **Global trends:** Current trends suggest that unless rapid action is taken to scale up clean cooking, the world will fall well short of the SDG 7 target of universal access to clean cooking fuels and technologies—by almost 30 percent. The result? Only 72 percent of the population will have access to clean cooking in 2030.[24] Annual increases of more than 3 percentage points will be required between now and 2030 to achieve the goal. In 2019, the share of the global population with access was 66 percent (59–71 percent),[25] leaving a third of the population—some 2.6 billion people (2.2–3.1 billion)—without access. Compared with 2010, access to clean fuels and technologies has risen to date by only 9 percentage points, from 57 percent (52–62 percent). Unless we accelerate action, the environmental, social, and health toll will continue, falling disproportionately on women and children, who bear primary responsibility for gathering fuel and preparing meals on polluting stoves.
- **Access and the 2030 target:** From 2010 to 2019, the global rate of access to clean cooking fuels and technologies increased annually by a percentage point (0.2–1.8). The acceleration in the rate was driven overwhelmingly by large, populous countries in Asia (from Central and Southern Asia to Eastern Asia and South-eastern Asia). In Sub-Saharan Africa, by contrast, population growth outpaced gains in access. In 2019, for the first time, more people without access to clean cooking fuels and technologies resided in Sub-Saharan Africa than in any other region, surpassing Central Asia and Southern Asia.
- **Regional highlights:** The regions of Central Asia and Southern Asia—along with Eastern Asia and South-eastern Asia—account for most of the access gains for the period 2010–19; each region saw annualized increases in access to clean cooking of 2.5 percentage points (0.3–4.5) and 1.4 percentage points (-0.6–3.4), respectively. The Latin America and Caribbean region has remained stable, with access at 88 percent (85–91) and an average annual increase of 0.3 percentage points (-0.2–0.8) for the period 2010–19. Marginal increases in access were seen in Sub-Saharan Africa, with annualized increases of 0.47 percentage points over the same time period.
- **Closer look at Sub-Saharan Africa:** Urgent progress is needed in Sub-Saharan Africa. In 2019, for the first time, more people without access to clean fuels and technologies reside in Sub-Saharan Africa than anywhere else, surpassing Central Asia and Southern Asia, which in 2018 housed the highest access deficit. The region's population grew by 26 million people per year between 2010 and 2019, while the population with access to clean fuels and technologies grew by only 8 million per year, resulting in an access-deficit population in this region of 910 million (880–930). In fact, the access deficit in Sub-Saharan Africa has risen by more than 50 percent since 2000.
- **Global and regional fuel trends:** Globally, the use of cleaner gaseous fuels increased consistently in the period 2010–19, reaching 51 percent (45–58) in low- and middle-income countries in 2019 and overtaking biomass as the dominant cooking fuel. Use of electricity for cooking also increased in that period, reaching 7 percent (4–12) in low- and middle-income countries. Globally, the use of kerosene declined. But its use remains notable in urban areas of low- and middle-income countries in Oceania, excluding Australia and New Zealand (10 percent [6–18]) and Sub-Saharan Africa (8 percent [6–11]).
- **Urban-rural divide:** The worldwide discrepancy between urban and rural areas in access to clean cooking fuels and technologies dropped over the past decade. In 2019, the difference in access was 42 percentage points (31–51), with 85 percent (77–88) of urban dwellers having access to clean fuels and technologies, compared with 42 percent (35–50) of rural dwellers. The access gap between urban and rural areas has decreased since 2010 owing, first, to improvements in rural access and, second, to urban population growth that is beginning to outpace the rate of growth in access to clean cooking. Differences in fuel trends suggest a steady rise in the uptake of gaseous fuels in rural areas, while use

24 SDG Goal 7.1—Ensure universal access to modern energy services; indicator 7.1.2—proportion of population with primary reliance on clean fuels and technology (https://sdgs.un.org/goals/goal7).

25 Parenthetical figures appearing after estimates throughout the chapter are 95 percent uncertainty intervals, as defined in methodology section at the end of this chapter.

of gaseous fuel has plateaued in cities. Reliance on electricity for cooking is growing in both urban and rural areas of low- and middle-income countries; however, it is rising at a much greater rate in urban areas, where growth is estimated at 0.44 percentage points per year, compared with 0.13 percentage points per year in rural areas.

- **The top 20 countries with access deficits:** Of the top 20 access-deficit countries, 10 are in Sub-Saharan Africa, 6 in Eastern Asia and South-eastern Asia, and 4 in Central Asia and Southern Asia. In total, they accounted for 81 percent of the global population without access to clean fuels and technologies in the period 2015–19. Of these countries, 7 have proportions of their respective populations with access at or below 5 percent, including Democratic Republic of the Congo, Ethiopia, Madagascar, Mozambique, Niger, Uganda, and Tanzania. Sixteen of the 20 countries have access rates of less than 50 percent. Meanwhile, Indonesia, Cambodia, and Myanmar achieved annual gains in access exceeding 2 percentage points in the period 2015–19.
- **Top 5 most populous countries:** During the period 2010–19, the top 5 most populous low- and middle-income countries (China, India, Indonesia, Brazil, and Pakistan) increased their combined access rate by 2.1 percentage points. During the same period, the average global access rate for all other low- and middle-income countries remained unchanged or stagnant. To ensure no one is left behind, political commitment and financial incentives must be prioritized in all access-deficit countries to achieve the universal target of SDG 7.
- **Investment needs scaling up:** Public and private finance for clean cooking remains far below the level of investment needed to achieve universal access to clean cooking by 2030. Estimates from various institutions, including Sustainable Energy for All, and the International Energy Agency (IEA) have reported that an annual investment of USD 4.5 billion is required to achieve clean cooking for all—or around USD 2 for every person without access in 2019. But the current level of investment is only a fraction of this—estimated at about USD 131 million in 2018 (SEforAll 2020), or around USD 0.05 for every person without access.
- **What are the costs?** In addition to the heavy environmental and health toll exacted by polluting cooking fuels and stove combinations, the economic costs of household reliance on these fuels and technologies are estimated to be on the order of USD 2 trillion per year (USD 1.4 trillion for health care costs, USD 0.8 trillion from lost productivity of women, and USD 0.2 trillion for environmental degradation)[26]—translating in 2019 to USD 1,000 for every person lacking access. In view of the monumental cost savings compared with the level of investment, an overwhelming economic case can be made for countries to invest in transitions to clean cooking.
- **Clean cooking in post-COVID-19 recovery:** Strategic policies and financial incentives will be key to recovering from setbacks in access to clean cooking and pollution exposure resulting from the COVID-19 pandemic. National governments will play a vital role in expanding targeted policies and subsidies so progress toward universal access to clean cooking can accelerate—particularly in Sub-Saharan Africa, where rapid progress is urgently needed.
- **Progress in policy:** The World Bank's annual Regulatory Indicators for Sustainable Energy (RISE) provides a snapshot of a country's policies and regulations. The 2020 edition (ESMAP 2020a) indicates that, of the 55 access-deficit countries included in the analysis, the number with advanced policy frameworks rose from none in 2010 to a total of eight in 2019, ultimately shifting about a quarter of access-deficit countries into the green zone on the RISE index.

26 ESMAP 2020b.

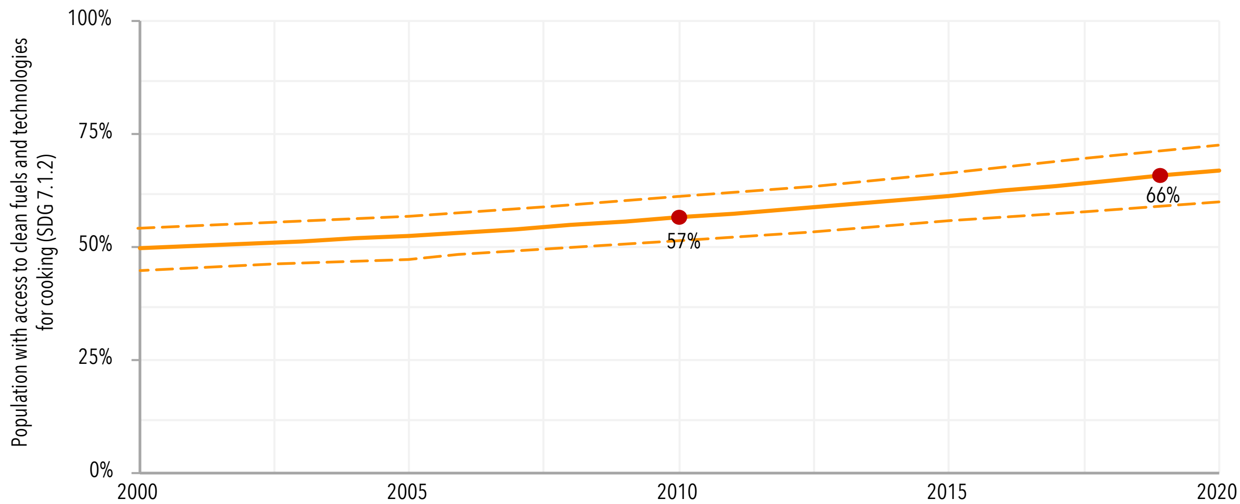
ARE WE ON TRACK?

Clean cooking must be prioritized and progress accelerated. In 2019, 66 percent (59–71) of the global population had access to clean cooking fuels and technologies—comprising electric, liquefied petroleum gas (LPG), natural gas, biogas, solar, and alcohol-fuel stoves. Technical recommendations defining "clean" fuels and technologies are set out in "WHO Guidelines for indoor air quality: household fuel combustion". (WHO 2014). Yet there remain some 2.6 billion (2.2–3.1) people who cook mainly with polluting fuels and technologies, using traditional stoves fueled by charcoal, coal, crop waste, dung, kerosene, and wood. Due to limitations in the underlying data, analyses use types of cooking fuel rather than cookstove-and-fuel combinations. The methodology section at the end of the chapter provides additional details.

Global access is tracked by surveying proportions of the population that rely mainly or primarily on clean cooking fuels and technologies. The global access rate has improved over the past few decades, albeit at an alarmingly slow pace (figure 2.1). By 2030, if states adopt only policies presently stated, only 72 percent of the population worldwide will have access to clean cooking fuels and technologies (IEA 2020).[27] This means that nearly a third of the global population will still not have transitioned to clean cooking by 2030; therefore the adverse health, environmental, and developmental impacts of polluting cooking solutions will persist among these vulnerable populations.

Furthermore, even 72 percent access fails to account for energy issues—like stove stacking, a practice involving the use of multiple fuels and technologies for cooking and other end uses, like space heating or lighting. When households stack a mix of cooking solutions, some polluting and others clean, the health and environmental co-benefits of the clean solutions are minimized (or negated altogether) because even one polluting fuel source can be a major source of smoke in and around the home. One common example of fuel stacking is the use of LPG for short cooking tasks like boiling water, while relying on biomass for longer tasks such as cooking beans. *The State of Access to Modern Energy Cooking Service* (ESMAP 2020b) assesses access in light of aspects of the cooking system beyond main fuel and technology, including affordability, convenience, stove stacking, and others. From the set of countries included in the report, it estimates that more than 4 billion people are thought to lack access to cooking services using modern energy. This information is necessary if appropriate policies are to be designed and can be provided as evidence to decision-makers.

FIGURE 2.1 • Percentage of the global population with access to clean cooking fuels and technologies

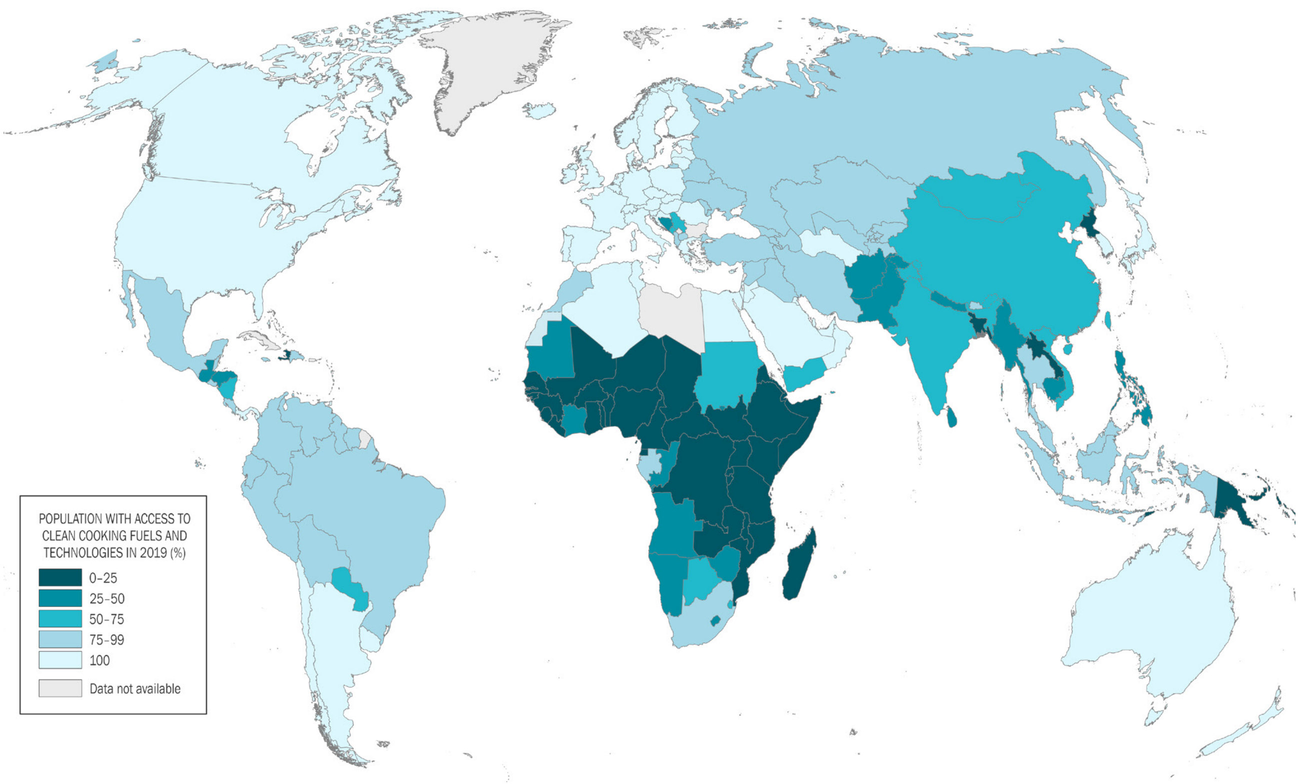


Source: WHO 2021.

27 IEA's Stated Policies Scenario takes into account policies and measures affecting energy markets that had been adopted as of mid-2020, together with relevant policy proposals. This scenario assumes only cautious implementation of current commitments and plans. The Stated Policies Scenario is contrasted in IEA's *World Energy Outlook* (2020) with the more ambitious Sustainable Development Scenario.

From 2000 to 2019, the proportion of people without access to clean fuels and technologies grew in Sub-Saharan Africa. As a result, for the first time more people without access to clean fuels and technologies resided in Sub-Saharan Africa in 2019 than in any other region. Indeed, when examining the geographic distribution of countries with low access rates, a large, continuous cluster is immediately visible in Sub-Saharan Africa (figure 2.2).

FIGURE 2.2 • Percent of population with access to clean cooking fuels and technologies by country, 2019



Source: WHO 2021.

Note/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 on any map in this work 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.

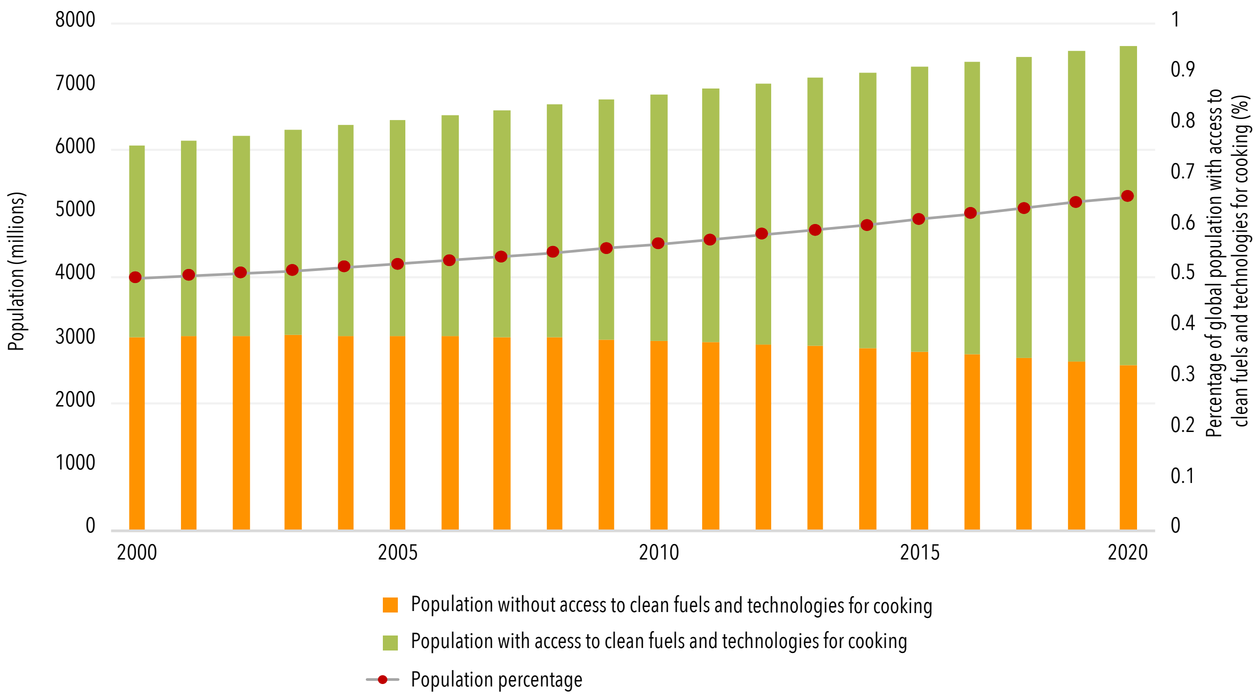
LOOKING BEYOND THE MAIN INDICATORS

ACCESS AND POPULATION

The global access rate to clean cooking fuels and technologies was 66 percent (59–71) in 2019. As seen in figure 2.3, the rate rose steadily between 2000 and 2019, with an annualized increase in access of 1.0 percentage points (0.2–1.8) between 2010 and 2019. Global values are dominated, however, by the most populous countries, several of which have seen recent and notable increases in the use of clean fuels and technologies. Figure 2.4 compares the global access rate for all countries, first, for the 5 most populous low- and middle-income countries, Brazil, China, India, Indonesia, and Pakistan, and, second, for the remaining low- and middle-income countries. While the top 5 most populous countries made steady progress, the global access rate for the others remained virtually unchanged between 2010 and 2019. To ensure that no one is left behind in the energy transition, clean cooking must be made a political priority in all access-deficit countries, accompanied by adequate financial and regulatory incentives and infrastructure.

In 2010, it was estimated that average annual increases of 2 percentage points would be necessary to achieve universal access to clean cooking. To make up for insufficient progress over the period 2010–19, however, the necessary annual increase in access rate now exceeds 3 percentage points, three times higher than the rate of progress seen in 2010–19. Meanwhile, the lack of improvement in the global access rate between 2010 and 2019 (when excluding the five most populous countries) identifies areas requiring urgent action to meet the global goal. If countries continue to make only marginal improvements, the farther the global community falls behind the goal of universal access by 2030. Again, transformative action is urgently needed.

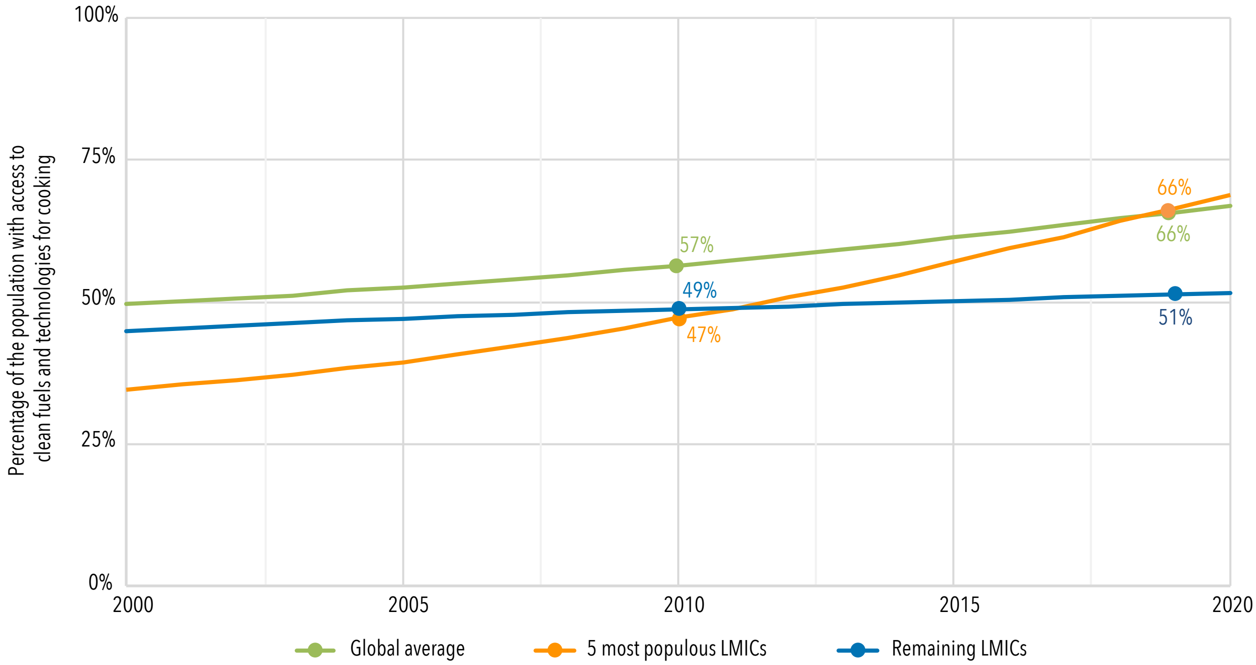
FIGURE 2.3 • Change over time in the absolute number of people (left axis) and percentage of the global population (right axis) with access to clean cooking



Source: WHO 2021.

FIGURE 2.4 • Percentage of the global population with access to clean cooking

Global average, 5 most populous low- and middle-income countries (China, India, Indonesia, Brazil, Pakistan), and low- and middle-income countries, excluding the 5 most populous



Source: Stoner and others 2021.

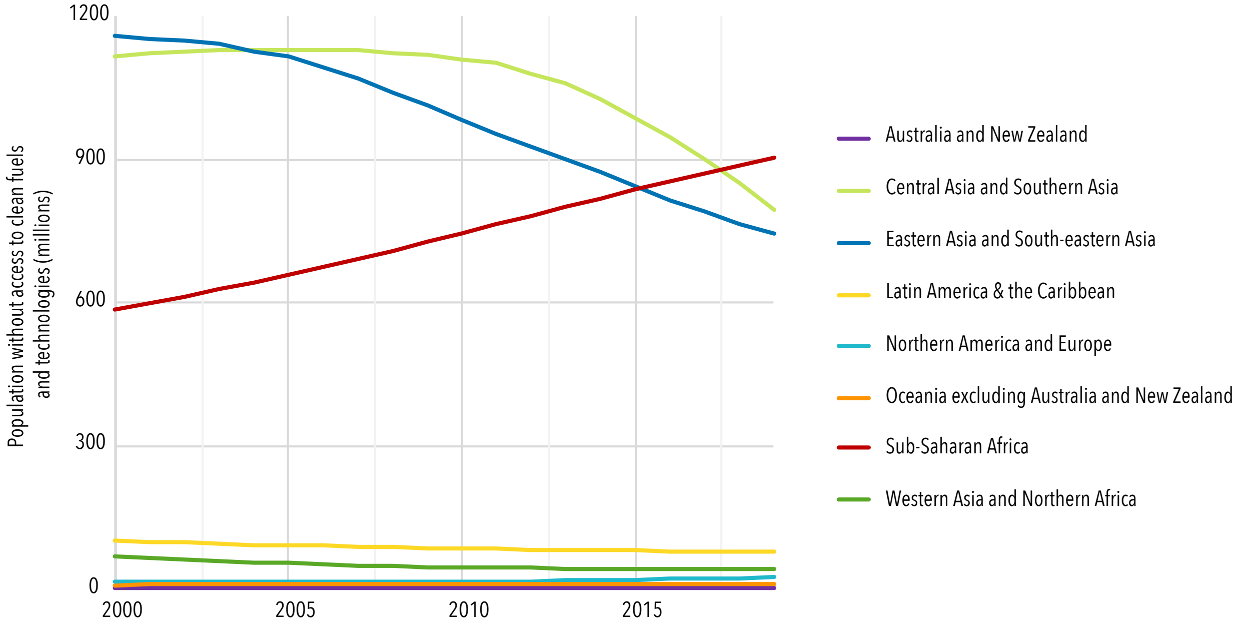
If trends continue without policy changes, the access deficit will shrink from 2.6 billion (2.2–3.1) to 2.3 billion people by 2030, about half of them residing in Sub-Saharan Africa and a quarter in Eastern Asia and South-eastern Asia. This is comparable to estimates derived under IEA's Stated Policies Scenario, which suggests that under current and planned policies 2.36 billion people will still lack access in 2030 (IEA 2020). As seen in previous years, however, population growth in Sub-Saharan Africa continues to outpace annual increases in the number of people having access to clean fuel and technologies. Over the period 2015–19, growth in the overall population of Sub-Saharan Africa outstripped growth in the number of people with access to clean cooking by around 18 million people each year. Thus, in this region, 894 million (874–911) people, or around 85 percent of the population, lack access to clean fuels and technologies for cooking. Unless action is taken to boost annual increases in access to clean cooking in Sub-Saharan Africa above population growth, global universal access will never be achieved.

THE ACCESS DEFICIT

On a global scale, the majority of gains (approximately 60 percent) among populations with access to clean cooking has been matched by population growth, causing a decades-long stagnation in the number of people lacking access to clean cooking—referred to here as the "access deficit." Estimates suggest this number hardly deviated from 3 billion people in any year between 2000 and 2010. Some progress was made in recent years, however, with the deficit dropping to 2.6 billion people [2.2–3.1] in 2019.

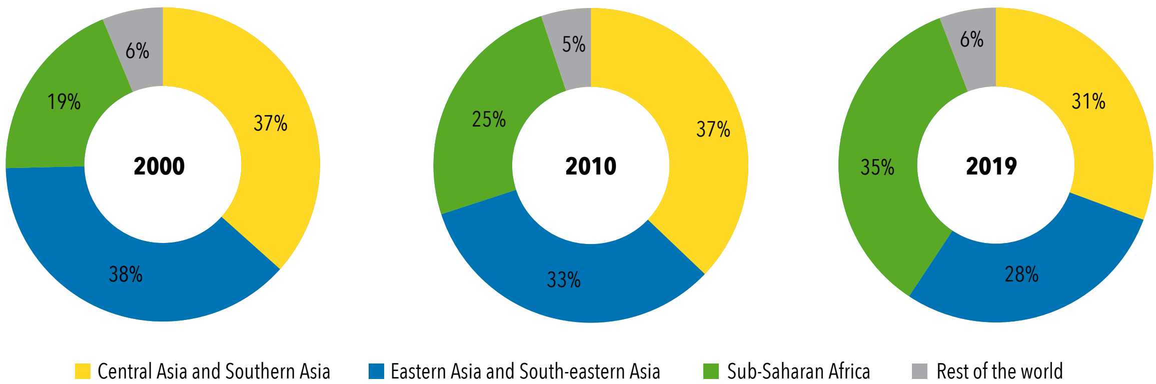
Stagnation in the global access deficit disguises key regional trends. As illustrated in figure 2.5, the access deficit has decreased consistently in Eastern Asia and South-eastern Asia since 2000 and in Central Asia and Southern Asia since 2010. In Sub-Saharan Africa, meanwhile, progress in the percentage of the population with access to clean fuels and technologies has failed to keep pace with population growth. Indeed, the access deficit in Sub-Saharan Africa has risen by more than 50 percent since 2000, reaching a total of 910 million [880–930] people in 2019.

FIGURE 2.5 • Access deficits by region (population without access to clean fuels and technologies), 2000 to 2019



Source: WHO 2021.

FIGURE 2.6 • Proportion of the total global access-deficit in the three largest access-deficit regions and the rest of the world, 2000, 2010, 2019



Source: WHO 2021.

As illustrated in figure 2.6, from 2000 to 2019, the proportion of the global population living in Sub-Saharan Africa that have no access to clean fuels and technologies rose from approximately one-fifth to one-third of the total. Meanwhile, the proportion residing in Eastern Asia and South-eastern Asia fell by 9 percentage points, and the proportion residing in Central Asia and Southern Asia dropped 6 points. As a result, in 2019 more people without access to clean fuels and technologies lived in Sub-Saharan Africa than in any other region. If observed trends in access and population continue, by 2030 Sub-Saharan Africans will be the dominant population with an access deficit—accounting for some 49 percent of the total deficit in 2030. This represents a substantial geographic redistribution of the global access deficit and associated health, economic, and societal burdens. Future policies should take these trends into account.

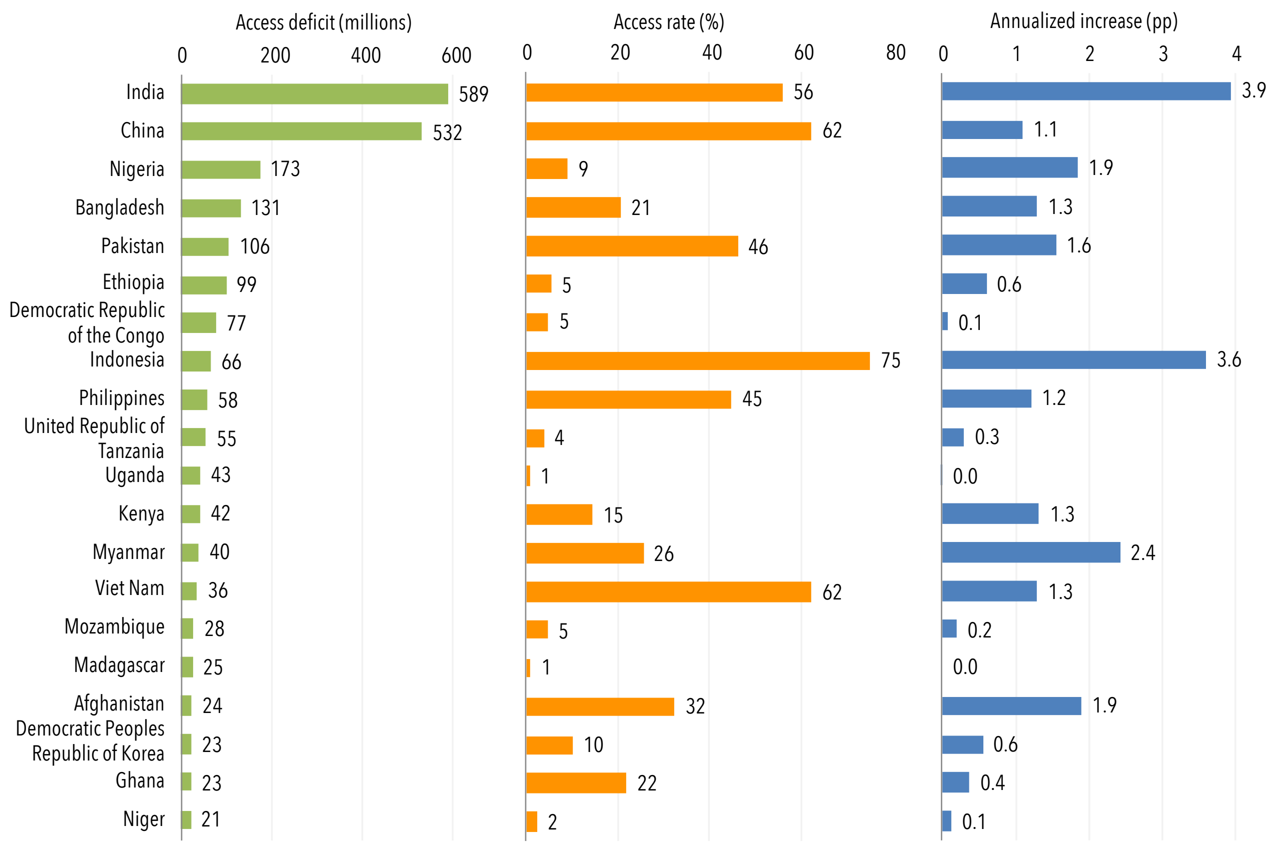
ANALYSIS OF THE TOP 20 ACCESS-DEFICIT COUNTRIES

The top 20 access-deficit countries (figure 2.7) accounted for 81 percent of the global population (2015–19 average) without access to clean cooking.[28] At 22 percent (589 million people), India alone still accounts for the largest single share of the access deficit, followed by China, at 20 percent (532 million people). At the same time, of these 20 countries, India and Indonesia alone achieved annualized increases above the 3 percentage points needed to achieve universal access by 2030.

In 7 of the 20 countries the proportion of the population with access to clean fuels is less than or equal to 5 percent (2015–19 average): Democratic Republic of Congo, Ethiopia, Madagascar, Mozambique, Niger, Uganda, and Tanzania. Sixteen of the 20 countries have access rates under 50 percent (figure 2.8).

FIGURE 2.7 • The 20 countries with the largest populations lacking access to clean cooking fuels and technologies, 2015–19 average

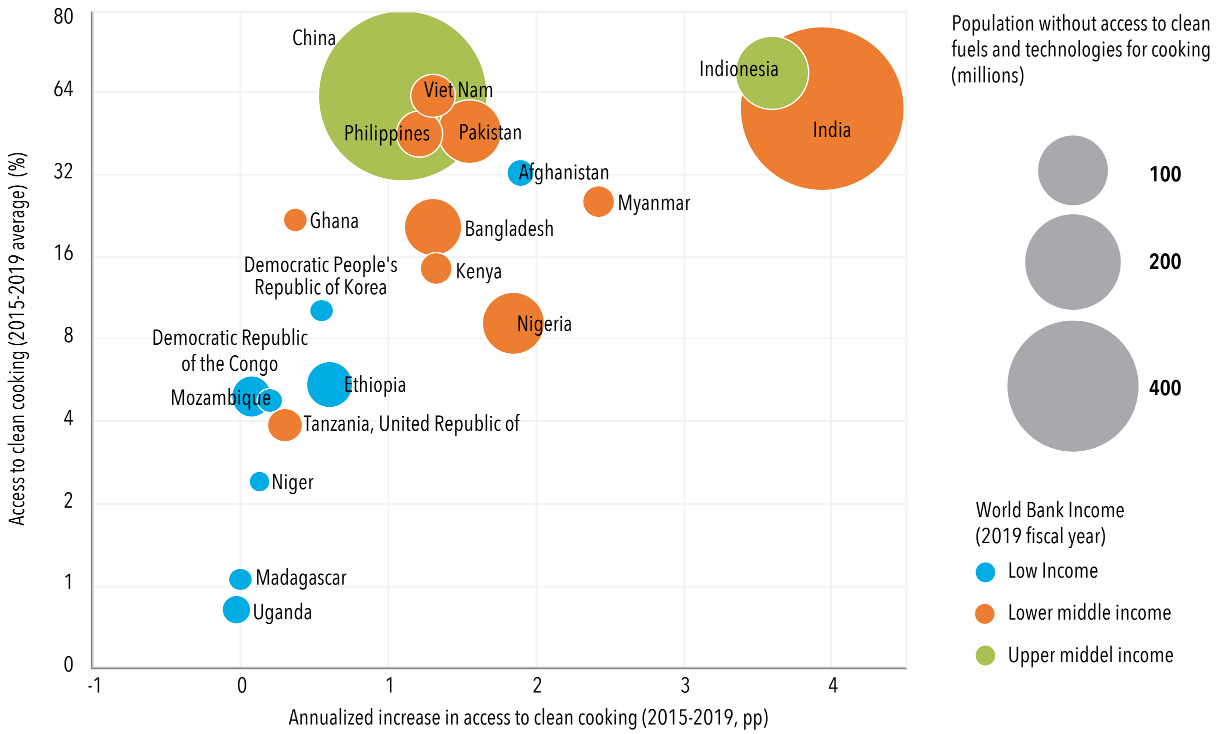
Left: the number of people without access to clean cooking. *Center*: the percentage of those with access to clean cooking. *Right:* the annualized increase in access to clean cooking.



Source: WHO 2021.

28 The top 20 access-deficit countries are those with the largest access-deficit populations (2015–19 average). These are Afghanistan, Bangladesh, China, Democratic People's Republic of Korea, Democratic Republic of Congo, Ethiopia, Ghana, India, Indonesia, Kenya, Madagascar, Mozambique, Myanmar, Niger, Nigeria, Pakistan, Philippines, Uganda, United Republic of Tanzania, and Vietnam.

FIGURE 2.8 • The 20 countries with the largest access deficits to clean cooking fuels, 2015–19



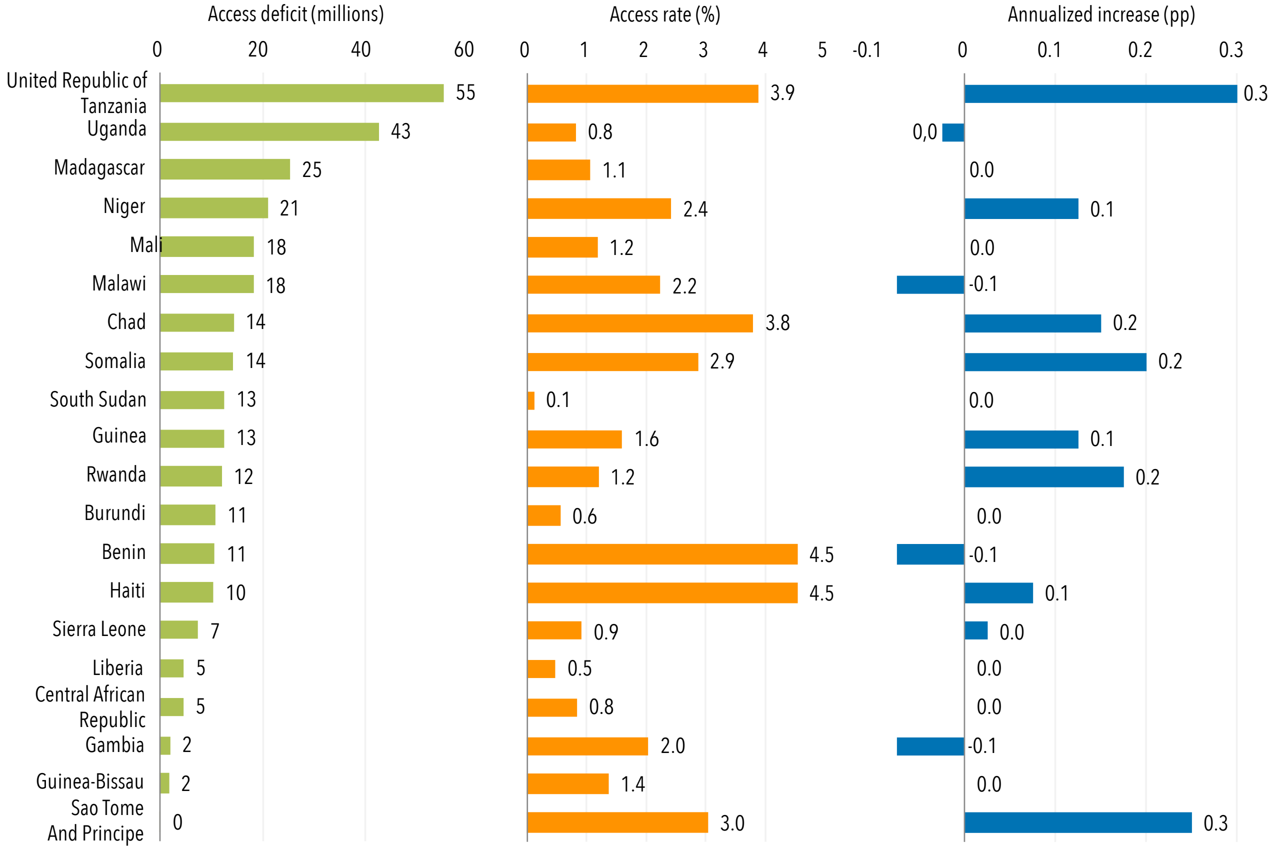
Source: WHO 2021.

Meanwhile, the 20 countries with the lowest access rates[29] show little to no sign of improvement, represented by near-zero annualized increases between 2015–19 (figure 2.9). While India has the largest population without access to clean cooking, access rose most rapidly there between 2015 and 2019, with an annualized increase of 3.9 percentage points. Rapid annual gains in access (more than 2 percentage points) were also seen in several countries between 2015 and 2019 (figure 2.10), notably Indonesia (3.6 points), Cambodia (2.9 points), and Myanmar (2.4 points).

29 The 20 countries with the lowest percentage of the population primarily using clean fuels and technologies (2015–19 average) were Benin, Burundi, Central African Republic, Chad, Gambia, Guinea, Guinea-Bissau, Haiti, Liberia, Madagascar, Malawi, Mali, Niger, Rwanda, Sao Tome and Principe, Sierra Leone, Somalia, South Sudan, Tanzania, and Uganda.

FIGURE 2.9 • The 20 countries with lowest percentage of the population with access to clean cooking fuels and technologies, 2015–19 average

Left: the number of people without access to clean cooking. *Center*: the percentage of people with access to clean cooking. *Right*: the annualized increase in access to clean cooking.



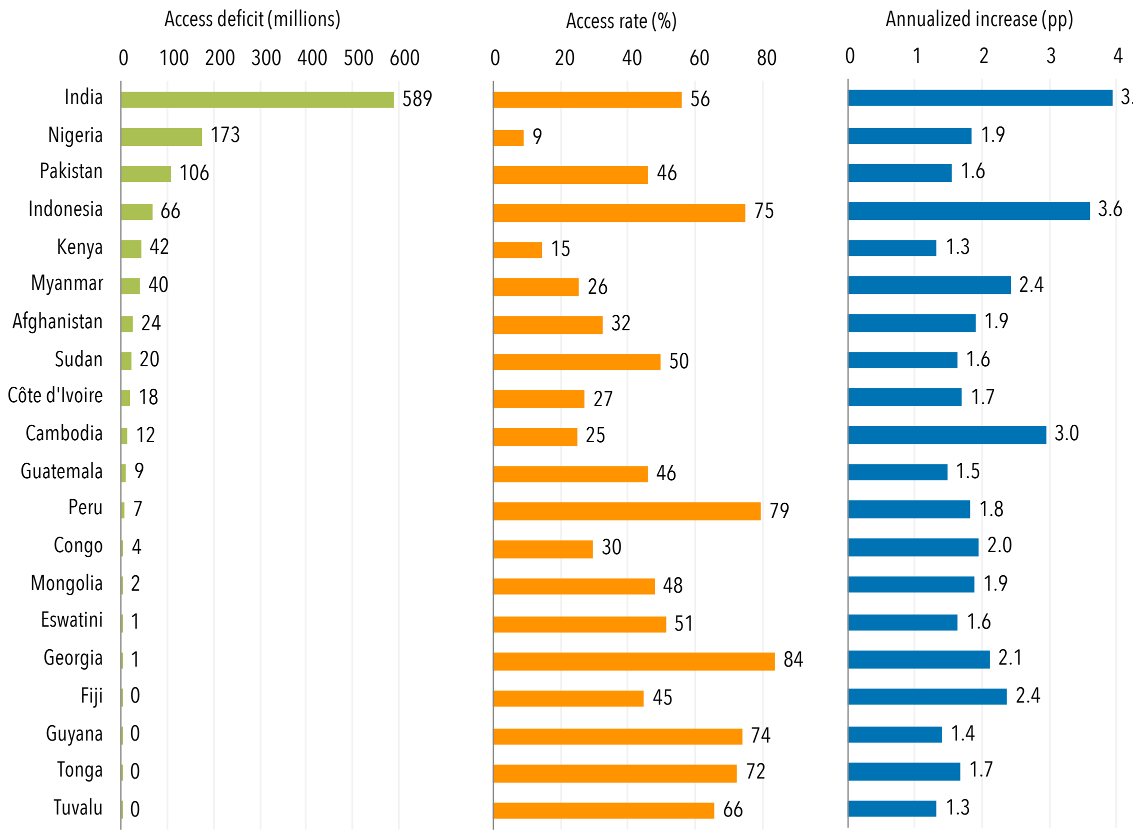
Source: WHO 2021.

Overall, in the 20 countries with the lowest population shares having access to clean fuels and technologies (figure 2.9), the annualized access gains between 2015 and 2019 were small (always less than 0.4 percent). Indeed, estimates suggest that a few countries may have seen declines in access during the same period. All of these 20 countries are among the least-developed countries and, with the exception of Haiti, are in Africa, further highlighting the urgent need to address access deficits in Africa. Figure 2.10 shows the 20 countries with the fastest annualized increases[30] (2015–19) in access to clean cooking. Despite relatively steep increases in access, the population without access remains notable in some of the larger countries. Those with the largest deficits also received limited financing in 2018—for example, Nigeria, Pakistan, and Myanmar —and thus face challenges for scaling up clean fuels and technologies, while a few countries attracted the bulk of the financing – for example, Bangladesh, Kenya, and India (SEforAll 2020).

30 The 20 countries with the highest annualized increases in access to clean fuels and technologies (2015–19) were Afghanistan, Cambodia, Congo (Democratic Republic of), Côte d'Ivoire, Eswatini, Fiji, Georgia, Guatemala, Guyana, India, Indonesia, Kenya, Mongolia, Myanmar, Nigeria, Pakistan, Peru, Sudan, Tonga, Tuvalu.

FIGURE 2.10 • The 20 countries with the fastest-growing population shares with access to clean cooking fuels and technologies, 2015–19 average

Left: the number of people without access to clean cooking. *Center*: the percentage of people with access to clean cooking. *Right*: the annualized increase in access to clean cooking.



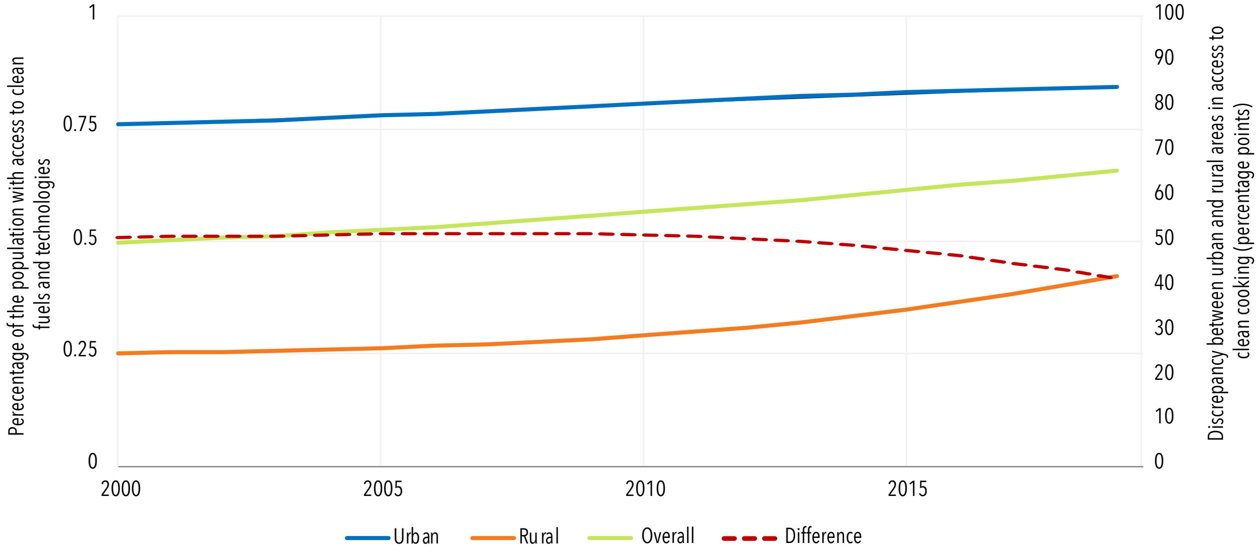
Source: WHO 2021.

THE URBAN-RURAL DIVIDE

A vast urban-rural disparity persists in access to clean cooking solutions. Urban areas enjoy greater access for various reasons, including better infrastructure for distribution of clean fuel and technology, greater availability of clean fuels, and higher household incomes. Figure 2.11 shows the percentage of the global population with access to clean fuels and technologies in urban areas, rural areas, and overall, from 2000 to 2019. In 2019, the urban access rate was 85 percent (77–88); rural access stood at 42 percent (35–50).

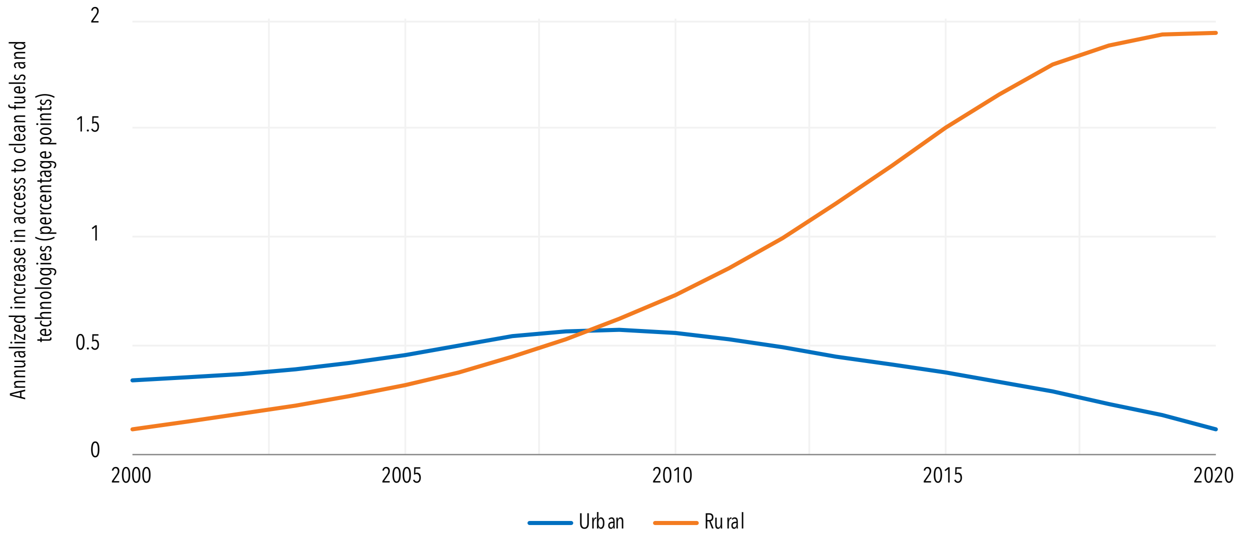
Between 2000 and 2010 the global disparity between urban and rural areas in access to clean cooking was fairly constant at just over 50 percentage points (52 percentage points [45–57] in 2010). But by 2019 this had fallen to 42 percentage points (31–51). The drop is explained by trend changes in the annual increase in access to clean fuels and technologies for urban and rural areas (figure 2.12). In rural areas, the annual increase rose consistently, from only 0.1 percentage point between 2000 and 2001 to 2.1 percentage points between 2018 and 2019. In contrast, the annual increase in cities fell consistently over the past decade, from a high of 0.6 percentage points in 2007–08 to only 0.2 percentage points in 2018–19. This means that, while access has accelerated in the more rural areas, it has been decelerating in urban areas. In fact, if trends continue—and if population growth continues to outpace access to clean fuels—the proportion with access to clean cooking is projected to fall in urban areas as the new decade begins. Meanwhile, some countries with rapid access growth will reach near-universal access, limiting their significant influence over the current rate of progress in the global access rate.

FIGURE 2.11 Percentage of people with clean cooking access in urban areas, rural areas, and overall (solid lines), and urban-rural discrepancy in access (dashed line)



Source: WHO 2021.

FIGURE 2.12 • Annual increase in access to clean fuels and technologies for urban and rural areas



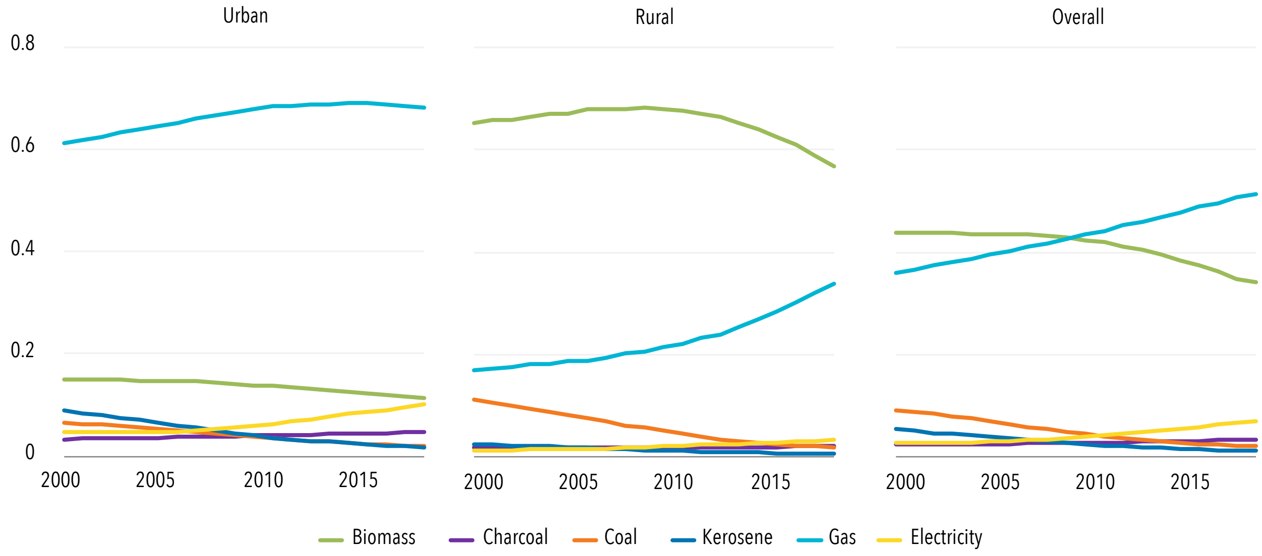
Source: Stoner and others 2021.

In 2019, Central Asia and Southern Asia, at 45 percentage points (32–58), had the greatest urban-rural disparity in access to clean fuels and technologies. In both this region and in Eastern Asia and South-eastern Asia, the discrepancies were growing prior to 2010—when it was 57 percentage points (46–66) in Central Asia and Southern Asia and 47 points (26–65) in Eastern Asia and South-eastern Asia—before falling sharply in recent years. At the same time, the disparity has fallen consistently since 2000 in both the Latin America and the Caribbean and in Western Asia and North Africa. It is growing in Sub-Saharan Africa, however, expanding from 23 percentage points (20–25) in 2010 to 29 points (25–33) in 2019. A virtually stagnant access rate in rural areas of Sub-Saharan Africa is to blame, showing up in annualized increases of 0.1 percentage points per year, with uncertainty intervals that overlap 0 percentage points per year (-0.05–0.24), compared with 0.8 percentage points (0.35–1.26) per year in urban areas.

CHANGES IN THE FUEL MIX

Trends in the use of cooking fuels can inform important policy discussions, which can in turn be harnessed to make and review policies so they produce the intended outcomes. In low- and middle-income countries, the use of gaseous fuels[31] increased consistently from 36 percent (31–41) in 2000 (1.8 billion people) to 51 percent (45–58) in 2019 (3.3 billion people), overtaking unprocessed biomass fuels[32] as the dominant cooking fuel over the past decade (figures 2.13 and 2.14). Use of electricity for cooking has also risen, from 3 percent (2–4) in 2000 (140 million people) to 7 percent (4–12) in 2019 (450 million people), though the increase was far more notable in urban areas (figure 2.13). Between 2000 and 2010, increases in the use of clean fuels were accompanied by steep declines in the use of coal, particularly in rural areas where the use of coal dropped from 11 percent (6–17) in 2000 to 2 percent (1–6) in 2019, and kerosene, particularly in urban areas, where its use dropped from 9 percent (7–10) in 2000 to 2 percent (1–3) in 2019. But from around 2010 onwards, the use of unprocessed biomass fuels (wood, crop waste, and dung) has shown persistent declines, primarily in rural areas, where use of unprocessed biomass fuels dropped from 68 percent (63–73) in 2010 to 57 percent (49–65) in 2019.

FIGURE 2.13 • Percentage of people using each type of cooking fuel in low- and middle-income countries, in urban areas, rural areas, and overall



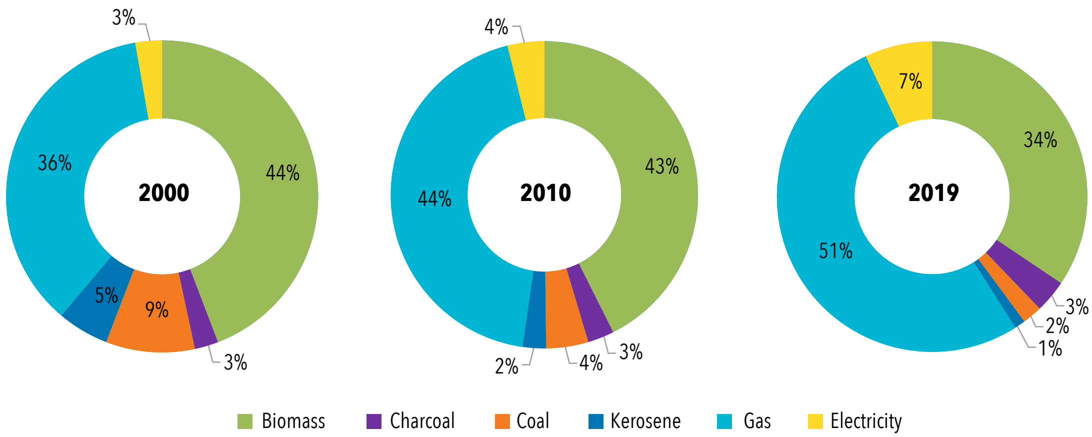
Source: Stoner and others 2021.

Although the use of kerosene has dwindled worldwide (figures 2.13 and 2.14), it remains prominent in urban areas of low- and middle-income countries in Oceania (16 percent [8–35] in 2018) and Sub-Saharan Africa (9 percent [6–11] in 2018). In 2018, globally, the proportion using charcoal was low (4 percent [3–4]), but in Sub-Saharan cities, charcoal has overtaken unprocessed biomass (29 percent [26–33]).

31 Gaseous fuels, or simply "gas," refer to liquefied petroleum gas (LPG), natural gas, and biogas.

32 Biomass fuels consist of raw/unprocessed biomass (wood, crop waste, and dung), but not charcoal, which is presented separately.

FIGURE 2.14 • Comparison of the percentage of people using each fuel type in low- and middle-income countries in 2000, 2010, and 2019



Source: Stoner and others 2021.

BOX 2.1 • RENEWABLE FUELS: BIOGAS AND SOLAR

Modern energy solutions for cooking are an important mechanism to achieve climate goals and zero net emissions. According to data from the WHO Household Energy Database, renewable energy cooking solutions are gradually being adopted by populations in some regions. From the database, surveys that report use of renewable fuels like solar and biogas are not yet available in sufficient numbers to derive globally representative estimates, but the available surveys can still inform more descriptive analyses of the current status of these energy sources, as well as how their use has changed over time.

A descriptive analysis of surveys in the WHO Household Energy database suggests that the use of biogas and solar for cooking purposes is increasing. Biogas is a viable alternative for households with livestock, which in some places can supply energy not only for cooking but also home lighting and heating. Because biogas has a carbon-neutral footprint, it contributes no greenhouse gas emissions, transforms organic waste into a high-quality fertilizer, and ultimately reduces the volume of disposed waste and improves sanitary conditions. Based on an analysis of survey data, biogas as the primary energy source for cooking has grown over the past decade, with some countries in Asia, Latin America, and Sub-Saharan Africa reporting as much as 4 percent of the population mainly using biogas for cooking—a notable increase compared with survey values reported prior to 2010, where the minimum and median values for these regions were 0 percent.

TABLE B2.1.1 • Analysis of survey data on the percentage of the population relying mainly on biogas for cooking

		BEFORE 2010	2010–19
Central Asia and Southern Asia	Countries reporting	11	8
	Minimum (%)	0	0.05
	Median (%)	0	0.32
	Maximum (%)	3.1	3.2
Eastern Asia and South-eastern Asia	Countries reporting	10	8
	Minimum (%)	0	0.02
	Median (%)	0	0.26
	Maximum (%)	0.3	1.28
Latin America and the Caribbean	Countries reporting	21	10
	Minimum (%)	0	0
	Median (%)	0	0.09
	Maximum (%)	1	2.8
Sub-Saharan Africa	Countries reporting	37	33
	Minimum (%)	0	0
	Median (%)	0	0.12
	Maximum (%)	2	4.23

Source: WHO Household Energy Database (2021).

Solar cookers are another carbon-neutral solution reported in household surveys. Solar cookers are an important complement to a clean cooking system. Some factors—like the time required for cooking, sunshine availability, etc.—will restrain the adoption of solar cookers as primary equipment; most countries report less than 0.05 percent of the population using them. The past decade has seen a marginal increase of less than half a percentage point in the population using them. Between 2015 and 2019, around 5 percent of surveys reported use of solar cookers above 0.5 percent, or approximately 6 in 1,000 people. Another renewable clean cooking solutions with promise of scalability are ethanol stoves and renewable electric cooking. Ethanol and other alcohol stoves are clean cooking solutions that have shown to be socially acceptable and growing in popularity in some regions. More efficient electric cooking devices (e.g., induction stoves and pressure cookers), expanded mini-grid systems, and more battery storage from solar home systems are all making renewable electric cooking a reality in some places. Such scalable clean and renewable cooking solutions are critical to expanding access, particularly in rural or remote areas where development of infrastructure may not be as readily available or planned in an environmentally sustainable way. They also offer the benefit of stimulating demand for off-grid installations, which are key to their viability and sustainability.

POLICY INSIGHTS

In 2019, the global population with access to clean cooking fuels and technologies stood at 66 percent (59–71). The remaining 34 percent rely on polluting fuels and technologies that produce high levels of household air pollution having a range of damaging effects. In addition to exacerbating gender inequities, household air pollution damages health, well-being, and the environment. Most of those affected by severe household air pollution are the poor, who also lack access to adequate health care. The inequitable distribution and burden of disease from polluting fuels and technologies make primary prevention via clean household energy interventions even more vital. This is because one consequence of polluting fuels and technologies is the copious emission of fine particulate matter and gases (mainly carbon monoxide) generated both in the home and throughout a neighborhood. Fine particulate matter is a leading risk factor for noncommunicable diseases[33] and increased co-morbidity with COVID-19 (van der Valk 2021). It has been shown that the effects of acute as well as long-term exposure to household air pollution are substantial, with long-term exposure exacerbating disease and its progression. According to pre-COVID-19 estimates (WHO 2021), the lack of access to clean fuels and technologies for cooking contributes to 3.8 million deaths each year in low- and middle-income countries.

Lack of access to clean fuels and technologies has been shown to be a greater health and development risk for women and children. In energy-poor households, it is usually the women and children who are responsible for collecting the fuels used for household activities like cooking, heating, and lighting, putting them at greater risk for injury and violence. Compared with men, they are also typically the household members exposed to the most pollution owing to greater time spent around the stove. Indeed, achieving universal clean cooking access would positively affect other SDGs, including better health and well-being (SDG 3), education (SDG 4), reduced gender inequalities (SDG 5), economic growth (SDG 8), sustainable cities and communities (SDG 11), and climate action (SDG 13).

An integral piece of the policies and strategies under implementation is the setting of clear benchmarks for achievement. WHO's guidelines for indoor air quality: household fuel combustion (WHO 2014) provide benchmarks, which are considered by most countries when setting goals for clean household air and for clean cooking fuels and technologies. The guidelines provide evidence of fuel use, emissions, and human exposure levels, as well as health risks. As part of the interventions and tools provided by WHO, the Clean Household Energy Solutions Toolkit is intended to help sector professionals and policy makers implement the recommendations found in the WHO Guidelines. In addition to a clear roadmap, this tool provides intermediate targets and transition stages and opening opportunities for assessment and regulation.

In order to achieve universal access to clean fuels and technologies, greater political will at the national level is essential, along with coordination among different actors. All household energy needs, including cooking energy and electricity access, should be integrated in a national energy plan. Integrated energy planning can help governments decide where to direct available resources, what solutions to support or leverage, and which communities to target. Governments should also promote policies that enable an environment conducive to widening access to clean cooking fuels and technologies. Given the status of such access presented in previous sections, it is not possible to overstate the urgency of action. This is particularly the case for the Sub-Saharan African region, where access is particularly low and where the population exposed to polluting cooking is growing rapidly.

33 Noncommunicable diseases including ischemic heart disease, stroke, chronic obstructive pulmonary disease, and cancers. Household air pollution is a cause of pneumonia in children and has been reported to have significant associations with lung function development, respiratory infections, and asthma in young children.

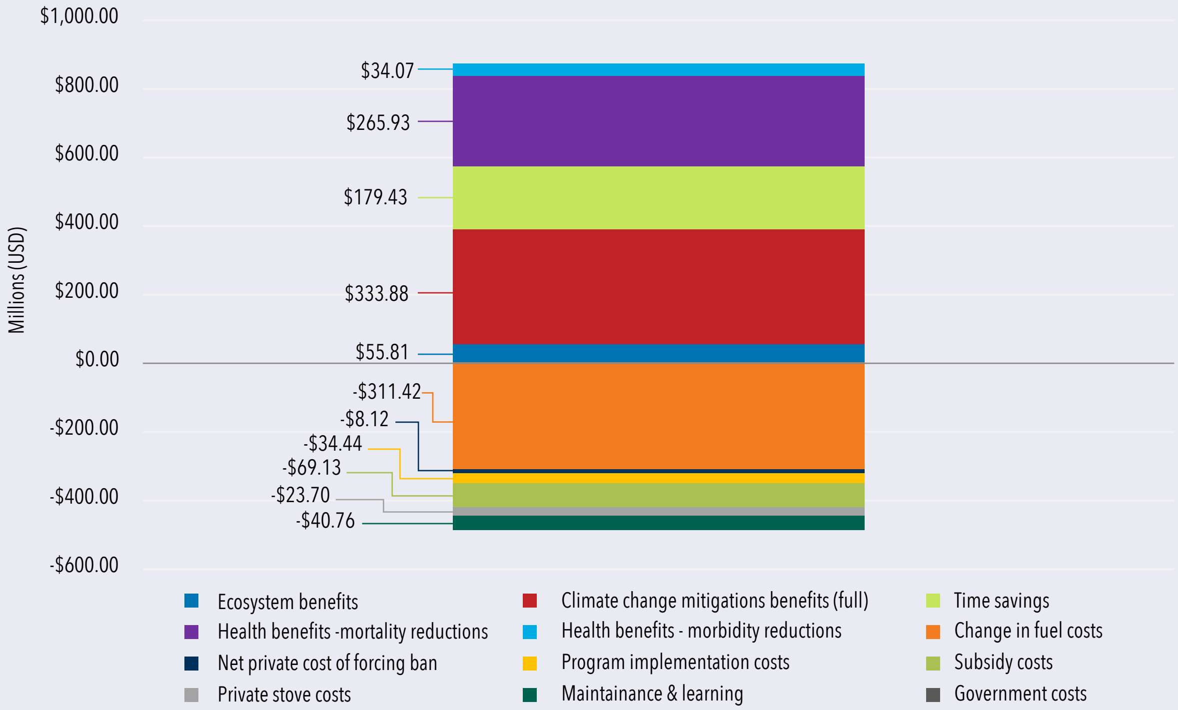
BOX 2.2 • WHO'S BAR-HAP TOOL FOR ANALYZING COSTS AND BENEFITS OF HOUSEHOLD ENERGY TRANSITIONS

Understanding the economic, health, and climate costs and benefits of different household energy interventions are critical elements that decision-makers must consider when designing and implementing household energy policies.

To better support evidence-based decision-making, WHO and researchers at Duke University developed a tool to inform policymakers about the costs and benefits of transitioning to cleaner fuels and technologies. The tool, Benefits of Action to Reduce Household Air Pollution (BAR-HAP), quantifies the net health and economic benefits of various policy actions and specific technology transitions. It contains 16 fuel and technology transitions from more polluting options (biomass, kerosene) to clean or transitional fuels and technologies including improved biomass, improved charcoal, biogas, LPG, ethanol, and electric stoves. Users can select from five policy instruments that could facilitate a transition to cleaner cooking: a subsidy for stoves, a subsidy for fuel (e.g., biomass pellets, LPG, electricity, and ethanol), stove financing (spreading payments for the new technology over time), a behavior change campaign, and a ban on polluting technology. Scenarios can be run to shift a portion of the population to various cleaner fuels and technologies, with different policy scenarios applied for each transition pathway. BAR-HAP calculates government and private costs, as well as mortality and morbidity reductions, accounting for health spillovers, time savings, climate-mitigation value, and other environmental benefits related to the sustainability of biomass harvesting. BAR-HAP is one of the critical elements of the WHO's Clean Household Energy Solutions Toolkit, which contains tools and resources that enable countries to develop policies for expanding clean household energy use.

The costs and benefits of transitioning all traditional firewood stoves to LPG stoves in Nepal provide a sample application of the tool. As seen in the figure below, climate mitigation is the largest category of benefits from this transition, followed by avoided mortality, household time savings, other ecosystem benefits, and avoided morbidity. The largest costs are stoves (borne by government and users), program implementation for stove distribution, and technology maintenance.

FIGURE B2.2.1 • Breakdown of total present value of costs and benefits with 70 percent stove subsidy for shift from traditional biomass stoves to LPG stoves in Nepal



Source: Das and others 2021.

OUTLOOK

The slow pace toward universal access to clean cooking fuels and technologies must not be overlooked. A continuation of business as usual is not sufficient or acceptable. Accelerating access must become a top political priority, accompanied by targeted policies. Moreover, the COVID-19 pandemic has exacerbated the vulnerability of people who lack access to clean fuels and technologies. The economic crisis caused by the pandemic will undoubtedly have consequences for household energy use; in some countries it threatens to reverse the progress made thus far (Shupler and others 2020). The same crisis provides an opportunity, however, to set new priorities; promote innovative policies, institutions, and businesses; and establish measures that guarantee universal clean cooking by 2030.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A household's choice of fuels and technology depends on multiple factors, including initial and recurrent costs, accessibility, household preferences for cooking practices (Shankar and others 2020), and the number of tasks (e.g., space heating and lighting in addition to supplemental cooking) that can be achieved with a given fuel and stove combination. Due to the lack of sufficient and comparable data on all household energy technologies, the clean cooking figures for SDG 7 reported here capture only the progress in transitioning households' primary fuel and technology for cooking and do not account for the full suite of fuels and technologies employed in the home for all cooking activities and related end uses like space heating and lighting.

Shankar and others (2020) confirm that the parallel use of multiple fuels and technologies, referred to as stove stacking, was observed in all 11 case study countries where fuel and cookstove programs had taken place. The case studies followed up on the clean cooking solution of LPG in Cameroon, Indonesia, Peru, and Ecuador; ethanol/methanol in Ethiopia and Nigeria; biogas in Cambodia, Kenya, Tanzania, and Uganda; and compressed biomass pellets and briquettes in Rwanda and China. The study reveals that everyone stacks. Even in places where programs are more established, as in Jakarta (Indonesia) and Carchi (Ecuador), reported rates of exclusive use of clean fuel are as low as 10 percent and 19 percent, respectively. Stacking information obtained through improved surveys, like WHO's core household energy survey questions or the World Bank's Multi-Tier Framework (MTF) surveys, are essential to better design and policy implementation that adapt to the reality of clean household energy transitions and the ubiquitous practice of stacking. A suggested approach to the problem of stacking is to implement policies to promote clean stacking of stoves and fuels—for example, the use of electricity from mini-grid or off-grid systems paired with LPG to meet household energy needs. Clean stacking is a critical practice that ensures healthy home and community environments for the most vulnerable populations.

In light of the acknowledged challenges of securing a rapid adoption of clean fuels and technologies, particularly in more rural and poorer areas where affordability and the lack of infrastructure are major obstacles, the switch to clean cooking may be more gradual, and intermediate solutions required. In these cases, transitional fuels and technologies—like low-emission biomass cookstoves that are more energy efficient and substantially reduce emissions, yielding benefits for health, climate, and the environment—should be prioritized (Anenberg 2013). In identifying such transitional technologies, policy and programmatic decision-makers should use available evidence of performance (e.g., emissions rates), health risks, safety, and user acceptability) to secure the widespread and sustained use of such improved technologies (Rehfuess 2014; Puzzolo 2013). Advanced cookstoves can also be the instrument that facilitates the exploration of cleaner fuel and stove stacking. Over time, users realize the benefits of the cleaner options, which can influence their decision-making.

The low rate of access to clean cooking fuels and technologies, along with the common practice of stove stacking, call for an innovative approach by policy makers to find solutions to current challenges. So far, public investments have focused on "improved" cooking stoves, while little private investment has been made in alternate solutions like biogas, ethanol, solar, or electric cooking (SEforAll 2020). Both private investments and use of renewable energy for cooking show a promising trend (box 2.1). Establishing partnerships and cooperation platforms, such as the West and Central Africa Alliance for the Promotion of Biodigesters, can also play a catalytic role in aligning government, development funding, and the private sector behind alternative clean cooking solutions and should be leveraged to scale up such solutions where viable. It has been shown (Couture and Jacobs 2019) that the cost of cooking with electricity in mini-grid contexts or via solar energy is competitive with the costs of other cooking fuels. Overcoming cost challenges, however, is only part of the problem; adapting to the way of life of users is key for a lasting integration (Goodwin 2015).

Strategic policies and financial incentives will be essential in recovering from setbacks to clean cooking caused by COVID-19. The participation of national governments—in the form of targeted policies and subsidy support for both demand and supply— will be necessary to accelerate progress toward universal access, in particular in Sub-Saharan Africa. Policy solutions should include results-based incentives to finance scale-ups of proven business models and behavioral-change campaigns. Policy solutions should also leverage grid expansion and modernization, as well as decentralized electric solutions to address clean cooking gaps. Although some advancement has been made in Sub-Saharan Africa, it is limited to a few countries. Countries with small populations, the majority of which are without access, have not benefited from the programs and support that large countries have received, and as a consequence struggle to capture the attention of investors.

BOX 2.3 • COVID-19 AND ENERGY ACCESS: PROTECTING THE MOST VULNERABLE THROUGH CLEAN COOKING

Lockdowns imposed as a result of the pandemic have likely affected household fuel use. A full picture of the impact of the pandemic will not be available until further down the line, but preliminary studies and reports show the danger it presents to the progress achieved so far in expanding access to clean cooking.

Households that were able to afford clean fuels are affected by the financial backlash caused by lockdowns. With lost wages, poor households are being forced to make spending choices; in looking to cut costs, they often revert to polluting cooking solutions as cheaper alternatives. That is the case in areas of Kenya where studies have shown that households that were relying on LPG before the pandemic have returned to kerosene or wood for household activities (Shupler and others 2020).

Switching back to polluting alternatives puts the health of household members at greater risk of disease from household air pollution, particularly during a pandemic, when people are spending more time indoors breathing in the high levels of health-damaging pollutants. Air pollution is also known to weaken the immune system, compromising the ability to fight off infections including COVID-19 (van der Valk 2021). Poor communities are also likely to have unreliable or inadequate health-care infrastructure, making disease prevention even more critical to fighting the pandemic.

The impact of the pandemic on clean cooking progress extends beyond its effects on household members. An early assessment by the Clean Cooking Alliance of the outcomes of lockdowns on the clean cooking market suggests severe disruptions in the value chain, with nearly one-third of business respondents temporarily ceasing all operations early in the lockdown, and two-thirds expecting long-term consequences.

By contrast, another study also carried out in Kenya (Shupler and others 2021) showed the benefits of access to LPG in combination with payment flexibility and fuel delivery. The study showed that people with access to the pay-as-you-go LPG program (whereby consumers purchase LPG credits in small increments) were less likely to stop using LPG during the COVID-19 lockdowns. The study reports that 95 percent of pay-as-you-go LPG users continued to use the clean fuel during lockdown, despite a complete cessation of income in 88 percent of the community members. The same study points out that users of traditional LPG cylinders had a "drop rate" (that is, the rate of reverting to kerosene or fuel wood) between 22 percent and 67 percent, depending on changes in the number of household members during lockdown.

In light of the many challenges brought about by the pandemic, a green recovery presents an opportunity for clean cooking, as long as it is given full consideration as an essential element of the post-COVID-19 recovery. Sector policies and programs should be ambitious, forward-looking, and smart in design, integrating long-term financial assistance and resources.

HIGH-LEVEL FINANCIAL COMMITMENTS TO DATE

As previously noted, the lack of access to clean cooking costs on the order of USD 2 trillion per year—USD 1.4 trillion for negative health effects, USD 0.8 for lost productivity among women, and USD 0.2 trillion for environmental degradation (ESMAP 2020b).[34]

Finance for clean cooking remains far below the amount needed to achieve SDG 7 by 2030. To estimate the investments needed, different organizations report various figures, based on the scenario chosen. IEA (2020) reported that an annual investment of USD 4.5 billion would be needed to achieve universal access for cooking. Of that, USD 2.4 billion is needed in Sub-Saharan Africa, while South Asia and South-eastern Asia need USD 2.1 billion. Under the ESMAP-MECS scenario, the amount needed to transition to improved cooking solutions (Tier 2) rises to USD 10 billion annually, and it rises further to USD 156 billion annually for the Modern Energy Cooking Services scenario (Tier 4).[35] In 2018, USD 131 million of annual investment was made, accounting for less than 3 percent of the annual investment required in the IEA scenario. Of the amount invested, 60 percent is public finance. Although meager, this figure is still three times the USD 48 million allocated to clean cooking in the previous year. Nonetheless, both amounts remain much less than the amount needed (SEforAll 2020).

Furthermore, although many financial commitments have been made, resources are not reaching the countries that need it the most. A total of 18 countries are home to 2.2 billion people without access to clean cooking attracted only 25 percent of the investment tracked. Countries like Ethiopia or Democratic Republic of the Congo received less than 1 percent of the annual investment needed (SEforAll 2020).

The RISE report (ESMAP 2020a) provides an analysis of financial incentives for universal access to clean cooking for the period 2010–19 (box 2.4). For consumers, the incentives take the form of financing; for suppliers, the incentives include subsidies, tax benefits, and duty exemptions. Among the 55 economies surveyed, China, India, Nigeria, and South Africa implemented all 4 financial incentives. Thirteen economies (Bangladesh, Cambodia, Cameroon, Ethiopia, Lao PDR, Mauritania, Mongolia, Nepal, Niger, Rwanda, Togo, Uganda, Zimbabwe) had implemented 3 of the 4 financial incentives. Of these, India, Nigeria, Cambodia, and Mongolia are among the 20 countries with the fastest-rising population shares enjoying access to clean cooking fuels and technologies for the period 2015–19 (see figure 2.10).

BOX 2.4 • CLEAN COOKING POLICY FROM RISE 2020

Out of the four target areas for SDG 7 (access, efficiency, renewables, international cooperation), access to clean cooking is the most often overlooked by policy makers. In the latest edition of the World Bank's Regulatory Indicators for Sustainable Energy index (RISE), policy frameworks for SDG 7.1.2—universal access to clean fuels and technologies for cooking by 2030—were evaluated. The review of clean cooking in the RISE report included information on 55 countries that account for more than 93 percent of the world's population with low access scores. Four indicators measure the clean cooking pillar's policy frameworks: planning, inclusiveness, standards and labeling, and incentives to increase uptake.

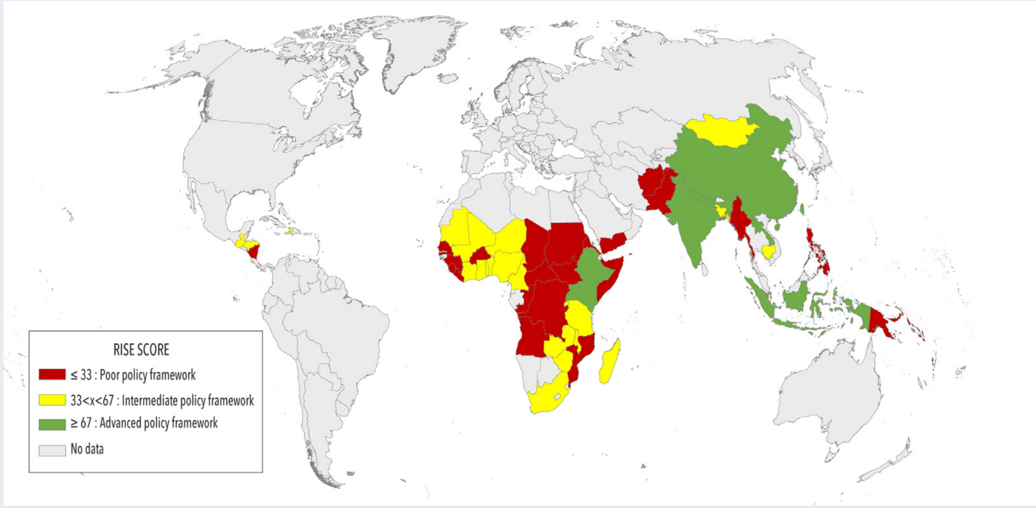
When evaluating policy frameworks for clean cooking dating back to 2010, RISE scores across all 55 access-deficit countries have improved consistently. The number of countries with advanced policy frameworks (RISE scores in the green zone on the map in figure B2.4.1) rose from none in 2010 to eight in 2019. Among these green zone countries, China, Ethiopia, India, Indonesia, and Kenya made great strides toward better access—especially India, which was the only country to score above 90 on a scale of 1 to 100. Of the remaining 47 countries that did not reach the green zone (scores below 67/100), 22 made moderate progress; in 25, the policy apparatus remains in its early stages. Yet looking at sheer numbers, the current situation is more encouraging (figure B2.4.2).

Although less than a quarter of the access-deficit countries have advanced policy frameworks, these countries are home to 1.4 billion people who still lack access, accounting for close to half the population lacking access.

34 When the costs of death and disability (measured in adjusted life years) are combined with the hours women spend on fuel collection, cooking, and stove cleaning, and with the costs of climate change and environmental degradation the economic impact is severe indeed.

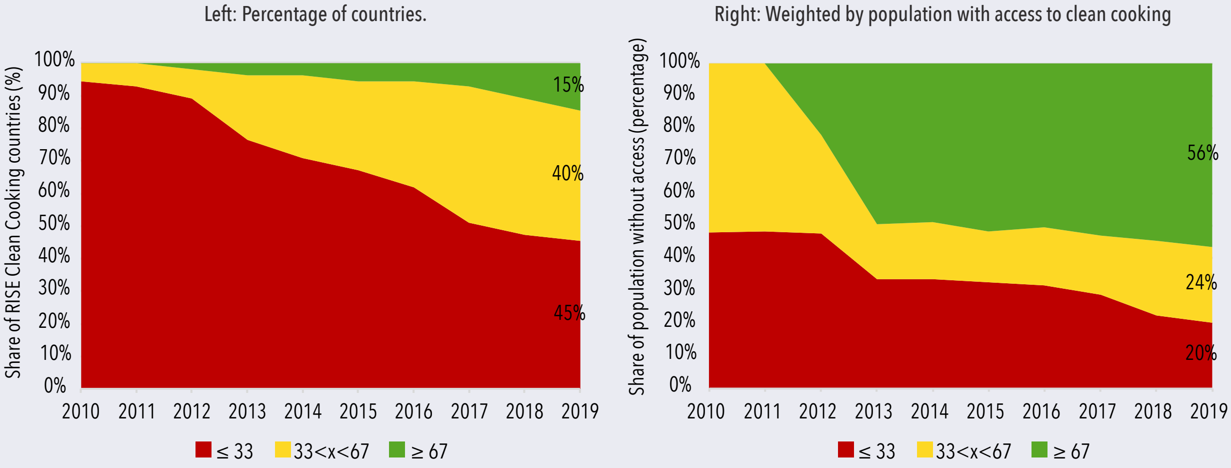
35 MECS is more stringent than the binary clean cooking indicator. The investment estimated by MECS includes, in addition to household spending for a two-burner stove and fuel, fuel and stove subsidies to fill in the affordability gap, as well as downstream infrastructure essential to the functioning of clean cooking market. The ESMAP-MECS Multi-Tier Framework considers scores (0–5) for convenience, fuel availability, safety, affordability, efficiency, and exposure.

FIGURE B2.4.1 • Placement on RISE index of 55 access-deficit countries, 2019



Note/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 on any map in this work 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.*

FIGURE B2.4.2 • RISE Clean Cooking pillar score, 2010–19



Source: ESMAP 2020a.

Several trends can be discerned from the RISE report. Overall, although this trend is not universal, performance on the clean cooking index soars as income rises. Most lower-income countries are in the red zone, suggesting that they have not yet developed policy frameworks for clean cooking. Some low-income nations (like Ethiopia, Malawi, and Uganda) have robust policy frameworks that have boosted them into the green zone. The 2010–17 period was notable for pushing several countries out of the red zone. This was particularly true for upper- and lower-middle-income countries in Asia (most notably India) and Latin America (most notably Guatemala). The period between 2017 and 2019 saw large gains for poorer Sub-Saharan countries like Benin, Kenya, Nigeria, and Tanzania.

But the presence of low-access countries among top RISE performers shows that a focus on the policy agenda is not enough. Scaling up access on the ground depends on the finer aspects of allocating resources and planning implementation. In low-income countries like Uganda and Ethiopia, scale-up will require stepping away from artisanal production of biomass stoves toward clean solutions (LPG, biogas, and electricity). As this transition will occur over a longer period of time, interim solutions (such as quality-assured biomass stoves) will mitigate the worst health and environmental outcomes caused by the use of charcoal and firewood.

Source: ESMAP 2020a.

MONITORING THE TRANSITION TO CLEAN FUEL AND CLEAN TECHNOLOGIES

A key component to accelerating global action on household air pollution is to raise awareness of the benefits of clean fuels for household activities. Action plans should rely on data and estimates that quantify progress in the transition to clean fuels. Information on major cooking fuels is collected at the urban, rural, and national levels whenever available. The information obtained includes the principal fuel households use for cooking, which has a decisive effect on the air quality in the home and in the community. The progress reported in this chapter relies on this information, which enables projections that quantify progress made toward the SDG 7.1.2 goal. As access expands and pilot programs are implemented, a fuller, more nuanced picture of successful transitions to clean fuels will become possible.

In 2020, a collaboration between WHO and the World Bank produced new household survey questions for national surveys and censuses. These questions complement the information presently gathered on the principal cooking fuel, expanding it to include information on secondary fuel use and cooking technologies. Detailed new questions will enable surveys to gather information on all household fuel uses (for cooking, heating, and lighting), as well as technology and stacking practices. This information, which has just begun to be gathered, will also permit more reliable projections of the burden of disease.

POLICY RECOMMENDATIONS

Universal access to clean fuels and technologies must be prioritized, and action is most urgently needed in Sub-Saharan Africa, which is dominated by low access rates. Progress must be achieved through a just and equitable energy transition that leaves no one behind. Affordable solutions must be offered to poor and vulnerable populations.

Greater political will at the national level, along with cooperation among actors, is essential to coordinate and align policies (ESMAP 2020b). To strengthen policies and create an enabling environment, governments are encouraged to establish intergovernmental clean cooking "delivery teams" to work across government agencies (ESMAP 2020b).

Governments should consider embedding policies in stimulus packages to support energy service providers and minimize market disruptions (ESMAP 2020a). Possible financial incentives include favorable and stable taxes and duties to sustain business growth—for example, a five-year VAT exemption on all clean cooking fuels and technologies. Incentives and policies focusing on clean fuels and efficient technologies should also embed gender strategies at national levels. Placing women in the clean cooking energy value chain, from production to consumption, ensures that local cooking practices, affordability, and end-user preferences will be honored (Energia 2020).

Major initiatives are needed to drive progress. Key actions needed for large-scale public and private investment include the following:

- Increase investment in public infrastructure to reduce the transactional costs and make the ecosystem more credible for financing mechanisms, such as results-based financing and carbon finance.
- A "results-based financing accelerator" to standardize methodologies and create aggregate or warehouse structures would allow for investment in many small projects at once.
- Smart and equitable strategies for reform of fossil fuel subsidies to help reallocate funding and boost sustainable energy access.
- A subsidy toolkit that profiles effective programs and structures and provides guidance on how to design subsidies could be a first step toward quantifying the benefits of transitions to clean cooking fuels. For example, WHO's Clean Household Energy Solutions Toolkit describes the costs and benefits of various household energy interventions.

A strong market for clean cooking would benefit from the following key actions:

- Creating an open-platform "user insight lab" to generate and integrate insights on the user experience into innovative business models, technologies, and policies.
- Supporting international standards for clean cooking and building national implementation capacity.
- Supporting technology-specific innovation accelerators to drive rapid, evidence-based, market-ready research and development of clean cooking fuels and practices, related to ethanol and biomass, in particular.
- Providing gender-focused technical assistance to enterprises to ensure that gender equity is mainstreamed across the clean cooking ecosystem.
- Fostering mechanisms for knowledge exchange among peers.

METHODOLOGY

DATA SOURCES

The WHO Household Energy Database[36] contains regularly updated, nationally representative household survey data. It relies on a number of sources (table 2.1) and serves in this report as the basis for all modeling efforts (Bonjour and others 2014; Stoner and others 2020). The database is built from 1,440 surveys taken in 170 countries (including high-income countries) between 1960 and 2020; 21 percent of the surveys cover the years 2014–19; 88 new surveys cover 2017–19. Modeled estimates for low- and middle-income countries are provided only if there is underlying survey data on cooking fuels, so there are no estimates for Bulgaria, Cuba, Lebanon, or Libya.

Population data are from the United Nations Population Division.

MODEL

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

- Unprocessed biomass (e.g., fuel wood, dung, crop waste)
- Charcoal
- Coal
- Kerosene
- Gaseous fuels (e.g., LPG)
- Electricity

Trends in the proportion of the population using each fuel type draw on country-level survey data and are estimated using a Bayesian hierarchical model, with urban and rural disaggregation. Smooth functions of time were the only covariate. Estimates for overall "polluting" fuels (unprocessed biomass, charcoal, coal, and kerosene) and "clean" fuels (gaseous fuels, electricity, as well as an aggregation of any 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

36 https://www.who.int/airpollution/data/household-energy-database/en/.

modeling with Markov Chain Monte Carlo Summaries can be taken 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" and "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 (60 countries) in the 2019 fiscal year were assumed to have transitioned to clean household energy. They are therefore reported as having 100 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, Cuba, Lebanon, and Libya). Modeled specific-fuel estimates were reported for 132 low- and middle-income countries, plus 2 countries with no World Bank income classification (Niue and Cook Islands); estimates of overall clean fuel use were reported for 190 countries.

UNCERTAINTY INTERVALS

Many of the point estimates provided 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 the number of households relying on different fuels between years. The uncertainty intervals should therefore be taken into account when assessing changes in the access rate, or in the use of specific fuels, year to year.

GLOBAL AND REGIONAL AGGREGATIONS

Population data from the United Nations Population Division (2018 revision) 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.

ANNUALIZED GROWTH RATES AND FUTURE PROJECTIONS

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.

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

Projections are hypothetical scenarios in which no new policies or interventions (positive or otherwise) take place, and as such are useful as baseline scenarios for comparing the effect of interventions.

Data sources are summarized in table 2.1.

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

NAME	ENTITY	NUMBER OF UNIQUE COUNTRIES	DISTRIBUTION OF DATA SOURCES (IN %)	QUESTION
Census	National statistical agencies	109	17.8	What is the main source of cooking fuel in your household?
Demographic and Health Survey (DHS)	Funded by USAID; implemented by ICF International	81	16.7	What type of fuel does your household mainly use for cooking?
Living Standard Measurement Survey, income expenditure survey, or other national surveys	National statistical agencies, supported by the World Bank	48	6.8	Which is the main source of energy for cooking?
Multi-indicator cluster survey	UNICEF	87	11.3	What type of fuel does your household mainly use for cooking?
Survey on global AGEING (SAGE)	WHO	7	0.6	
World Health Survey	WHO	50	3.5	
National survey		107	33.6	
Other		80	9.7	

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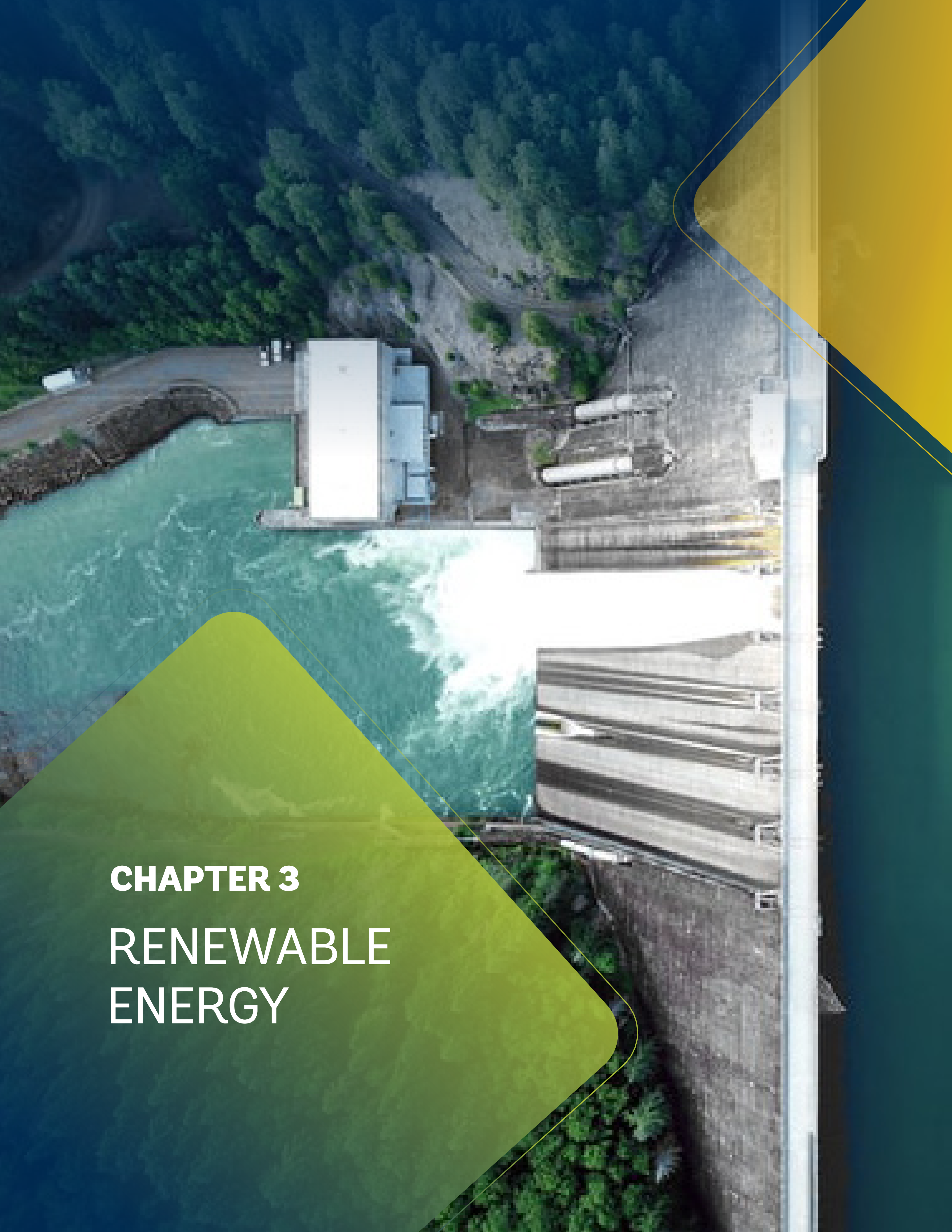


CHAPTER 3

RENEWABLE ENERGY

MAIN MESSAGES

- **Global trend:** Overall, renewable energy has seen unprecedented development over the past decade, with growth outpacing projections on a yearly basis. Despite great progress, however, the share of renewables in total final energy consumption (TFEC) has remained steady over the period. In 2018, the share of renewable energy sources (including biomass) in TFEC was 17.1 percent, very close to its share in the preceding year. This is due to the fact that TFEC increased at the same rate as renewable energy consumption (+2.1 percent). The share of renewable sources in TFEC, excluding traditional uses of biomass, increased by 2.5 percentage points over the past decade. The global picture points to the importance of further scaling up renewable energy while containing energy consumption through energy efficiency and sufficiency. Across end uses, electricity continued to see the greatest increase in its share of renewables, while transport and heat saw much slower or no progress.
- **Target for 2030:** Ensuring access to affordable, reliable, sustainable, and modern energy for all implies an accelerated deployment of renewable energy sources across three main end uses: electricity, heat and transport. Thus, the main indicator used to assess progress toward Sustainable Development Goal (SDG) target 7.2—to "increase substantially the share of renewable energy in the global energy mix by 2030"—is renewable energy's share of total final energy consumption (TFEC). While there is no quantitative milestone set for 7.2, custodian agencies of this target have indicated that current efforts need to accelerate significantly to scale uptake in line with SDG 7.
- **Electricity:** Renewable electricity use grew 7 percent year-on-year in 2018, bringing the share of renewables in global electricity consumption to 25.4 percent, up from 24.7 percent in 2017. This is the highest renewable share of all end-use categories. To meet the growing global electricity demand (+4 percent in 2018), nonrenewable electricity consumption continues to grow as well (+3 percent in 2018), although at a lower growth rate than renewables. Hydropower remains by far the largest source of renewable electricity globally, followed by wind and solar PV which are recording the fastest growth rates. Together, wind and solar PV are responsible for more than half of the increase in renewable electricity consumption observed over the past 10 years.
- **Heat:** Renewable heat consumption increased 1.2 percent to 16.2 EJ in 2018, excluding traditional uses of biomass. It should be noted that this calculation does not account for electricity used for heating, including via heat pumps. Traditional uses of biomass in 2018 declined 2 percent globally, still accounting for 14 percent (24 EJ) of global heat consumption. Overall, as global heat demand continued to increase (+1.1 percent year-on-year) the share of modern renewables in global heat consumption remained at 9.2 percent, as two years prior and only 1 percentage point higher than a decade earlier.
- **Transport:** In 2018, renewable energy used in transport grew by 7 percent, the fifth largest increase on record since 1990, and the largest since 2012. This brings the total share of renewable energy to 3.4 percent, up from 3.3 percent in 2017. Biofuels, primarily crop-based ethanol and biodiesel, supplied 91 percent of renewable energy. Nevertheless, renewable electricity expansion and electric vehicle sales are leading to record increases in renewable electricity use in transport, which grew by 0.03 EJ in 2018, the largest increase in a single year.
- **Regional highlights:** Sub-Saharan Africa has the largest share of renewable sources in its energy supply, and traditional uses of biomass represent more than 85 percent of this. Excluding traditional uses of biomass, Latin America and the Caribbean have the largest share of modern renewable energy uses in TFEC, owing to significant hydropower generation, and to the consumption of bioenergy in industrial processes and biofuels for transport. In 2018, more than a third of the global year-on-year increase in modern renewable energy consumption took place in Eastern Asia—essentially in China—where wind and solar photovoltaic (PV) dominate the growth.
- **Top 20 countries:** The share of renewable energy in TFEC varies widely across countries. Between 2000 and 2018, the share of modern renewables in TFEC declined in six of the top 20 energy consumer countries, despite the expansion of modern renewable energy use in each. This was mostly due to simultaneous increases in nonrenewable energy use. In 2018, the largest progression in the share of modern renewables was observed for Spain (+1.7 percentage points), due to higher hydropower generation, followed by Indonesia (+1.4 percentage points), where a rapid uptake of bioenergy for power generation played a leading role.

- **Installed renewable electricity-generating capacity in developing countries:** Beyond SDG target 7.2, this report for the first time tracks progress toward SDG indicator 7.B.1. It thus considers installed renewable electricity-generating capacity per capita in developing countries, using the most recent available data, from 2019 (see box 3.3). In 2019, developing countries had 219 watts per capita of renewable energy installed capacity. That year's 7 percent year-on-year growth rate signals a slight slowdown from 2018, driven primarily by decreased uptake of hydropower and solar PV per capita, while wind remained stable. Although the majority of new capacity installations in 2018–19 were made in developing countries, in 2019 developed countries still had around four times more capacity per capita.
- **Recent trends:** Beyond the immediate impact on health, the COVID-19 pandemic has major implications for economic activity and therefore energy consumption. To slow the spread of the virus, governments across the world have imposed restrictions on most social and economic activities, curtailing transport, industrial production and services, and causing a major energy demand shock. While this demand shock resulted in declining renewable energy use for transport and heat in 2020, renewable electricity generation expanded at an estimated 7 percent year-on-year, supported by long-term contracts, low marginal costs, priority access to grids, and installation of new renewable capacity. According to early estimates, in 2020, the share of renewables in final energy consumption increased significantly for electricity and minimally for transport and heat.

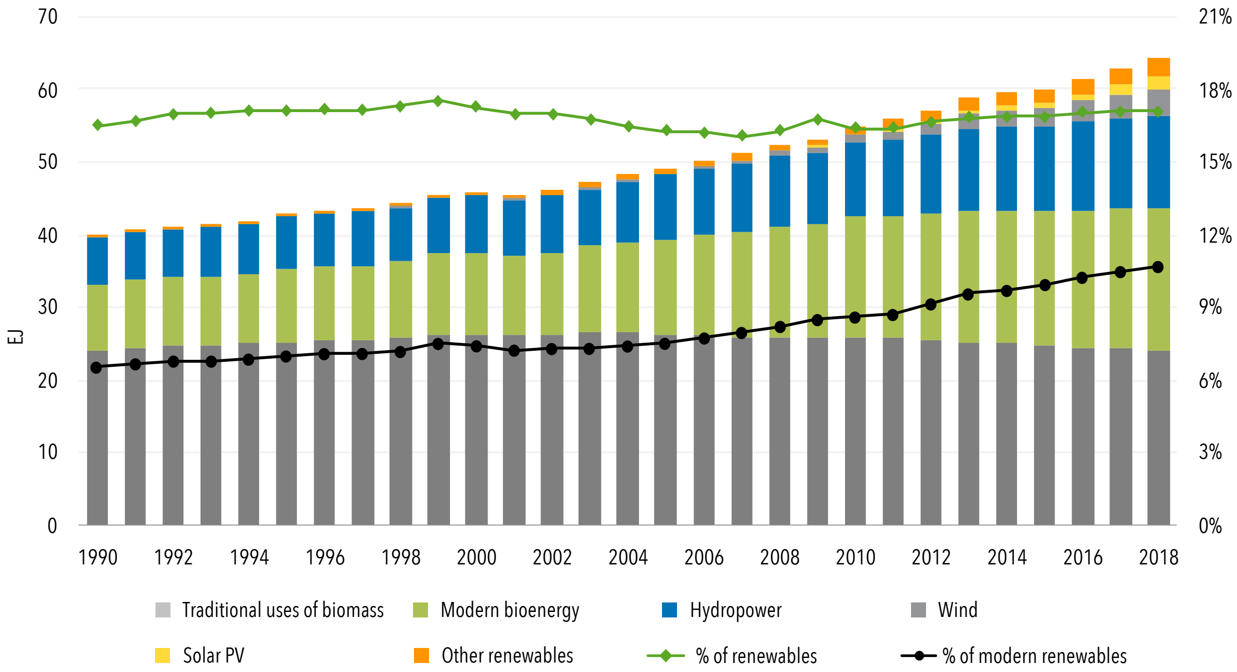
ARE WE ON TRACK?

In 2018, global renewable energy consumption, including traditional uses of biomass, amounted to 64.2 exajoules (EJ), following a 2.1 percent year-on-year increase (figure 3.1). This mirrors the increase in nonrenewable final energy consumption over the same period. As a result, the share of renewables in total final energy consumption remained flat at 17.1 percent, which is still below the 17.5 percent level achieved in 1999—the highest point on record over the past three decades. From 2017 to 2018, hydropower, solar PV, wind, and modern bioenergy contributed equally to the growth of renewable energy, while the consumption of traditional uses of biomass declined.

Since 1990, the share of renewable energy in total final energy consumption (TFEC) has remained relatively steady despite global renewable energy consumption expanding more than 60 percent (figure 3.2). Two simultaneous trends can be observed over the past decade: traditional uses of biomass have been slowly declining (-7 percent in 2008–18), while the share of modern renewables in TFEC—excluding traditional uses of biomass (box 1)—progressively increased from 8.2 percent in 2008 to 10.7 percent in 2018. To achieve SDG 7 and provide access to affordable, reliable, and sustainable energy for all, the uptake of modern renewables and the transition to more efficient uses of biomass need to accelerate.

Over the last decade, wind and solar PV saw the fastest growth rate and accounted for more than a third of the increase in modern renewable energy consumption. Overall, bioenergy, including traditional uses of biomass, remains the largest renewable source of energy, accounting for almost 70 percent of global renewable energy consumption, followed by hydropower, wind, and solar PV.

FIGURE 3.1 • Renewable energy consumption by technology and share of total energy consumption, 1990–2018



Source: IEA 2020b; UNSD 2020.

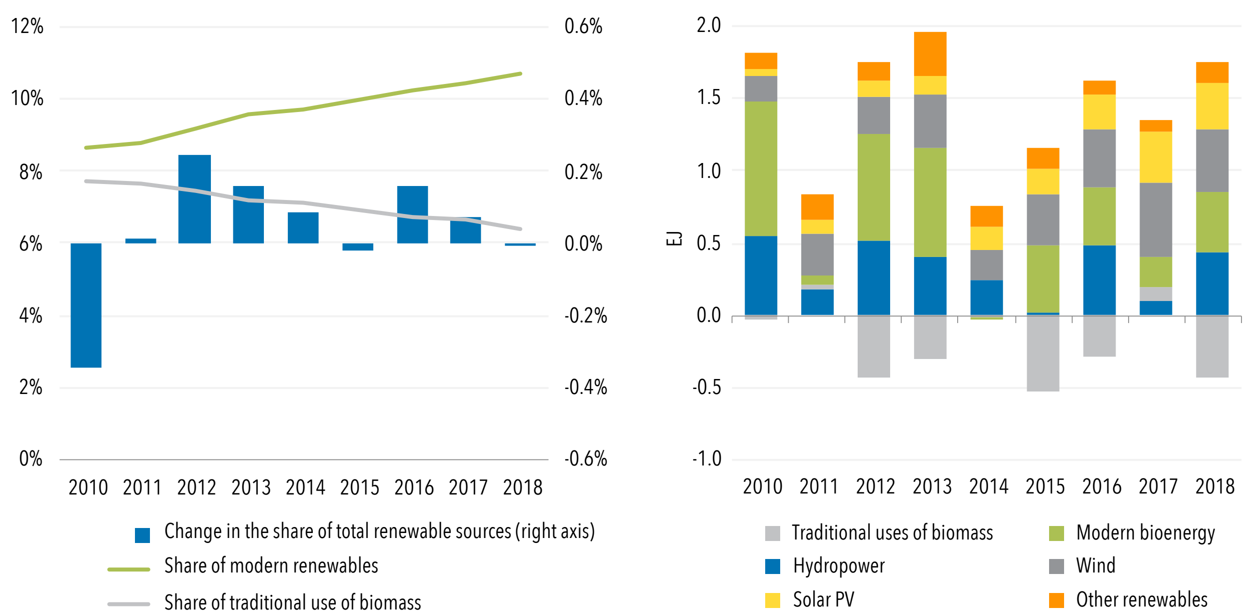
BOX 3.1 • DEFINITIONS OF TRADITIONAL USES OF BIOMASS AND MODERN RENEWABLES

Traditional uses of biomass refer to local solid biofuels (wood, charcoal, agricultural residues, and animal dung) being burned via basic techniques using, for example, traditional open cookstoves and fireplaces. Owing to their informal and non-commercial nature, it is difficult to estimate the energy consumed by such practices, which remain widespread in households in the developing world. For purposes of this report, the phrase "traditional uses of biomass" refers to the residential consumption of primary solid biofuels and charcoal in countries outside the Organisation for Economic Co-operation and Development (OECD) excluding Eurasia. Although biomass is used with low efficiency in OECD countries as well—for example, in fireplaces burning split logs—such use is not included in the traditional uses of biomass cited in this report.

Traditional uses of biomass tend to have very low conversion efficiency (5–15 percent). This can result in high local demand, potentially exceeding sustainable supply, and leading to negative environmental impacts, notably deforestation. In addition, emissions of particulate matter and other air pollutants are produced. When combined with poor ventilation, such pollutants create indoor air pollution in households, which is responsible for a range of severe health conditions and a leading cause of premature death. Even though biomass as it is traditionally used is, in principle, renewable, policy attention should focus on encouraging the adoption of more efficient renewable heating and cooking technologies (see chapter 2).

"Modern bioenergy" can be used efficiently for electricity generation, industrial applications, cooking in efficient wood and pellet stoves and boilers, and the production of biofuels for transport. Modern bioenergy—along with solar PV, solar thermal, geothermal, wind, hydropower and tidal energy—is one of the modern renewable sources analyzed in this report.

FIGURE 3.2 • Share of modern renewable energy and traditional uses of biomass in total final energy consumption (left) and renewable energy consumption growth by technology (right), 2010–18



Source: IEA 2020b; UNSD 2020.

This report includes minor revisions to the data presented in last year's edition. In particular, traditional uses of bioenergy for heat have been revised down by 0.7 EJ (-3 percent) for the year 2017, mostly due to changes in data from the Eastern Asia and South-eastern Asia regions. Modern uses of biomass have also been revised down by 0.2 EJ (-1 percent), with the largest changes in Sub-Saharan Africa, Northern America and Europe, and Western Asia and Northern Africa.

LOOKING BEYOND THE MAIN INDICATORS

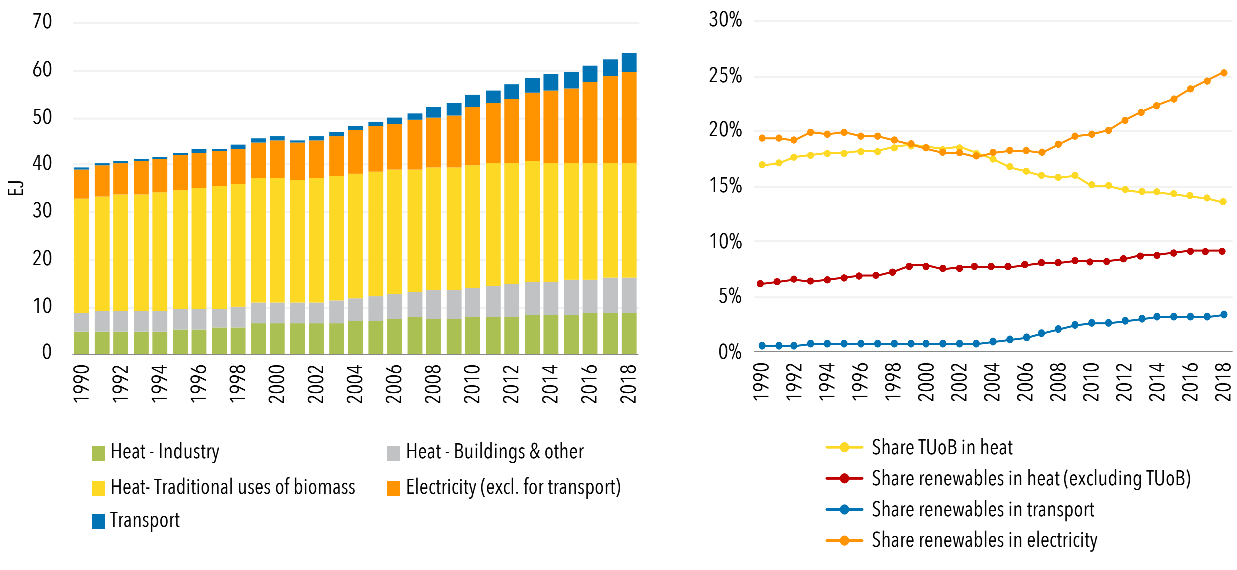
Ensuring access to affordable, reliable, sustainable, and modern energy for all implies a substantial increase in the share of renewable energy in all three main end-use categories: electricity, transport and heat, which, in 2018, accounted respectively for 21 percent, 32 percent, and 47 percent of all TFEC.

The share of renewables in final consumption is the largest and most dynamic for **electricity**, rising from 24.7 percent in 2017 to 25.4 percent in 2018 (figure 3.3). Renewable electricity accounts for almost half of global modern renewable energy consumption and three-quarters of its year-on-year increase. Going beyond the indicator (share of TFEC) and considering instead new electricity capacity installations, renewables have seen strong progress, growing 7.9 percent in 2018 and 7.4 percent in 2019 (box 3.3). This far outpaces new capacity installations in conventional, fossil fuel–based electricity (IRENA 2019a; IRENA 2020a).

In the **heat** sector, renewable sources account for 22.8 percent of energy used, most of which (13.6 percent) corresponds to traditional uses of biomass, down about 2 percent from the previous year. Excluding traditional uses of biomass, the consumption of modern renewables for heat increased just over 1 percent year-on-year, at a similar rate as global heat demand, resulting in a constant share of modern renewables in final heat consumption. Overall, nonrenewable energy used for heat increased almost 2 percent year-on-year.

Including renewable electricity use, the **transport** sector represents only 10 percent of global modern renewable energy consumption. It is the end-use sector with the lowest renewable energy penetration, at only 3.4 percent of final energy consumption in 2018. Biofuels supply the large majority of renewable consumption in transport, but renewable electricity use is also slowly emerging thanks to the uptake of electric rail and electric vehicles.

FIGURE 3.3 • Renewable energy consumption and share by end use, 1990–2018



Source: IEA 2020b; UNSD 2020.

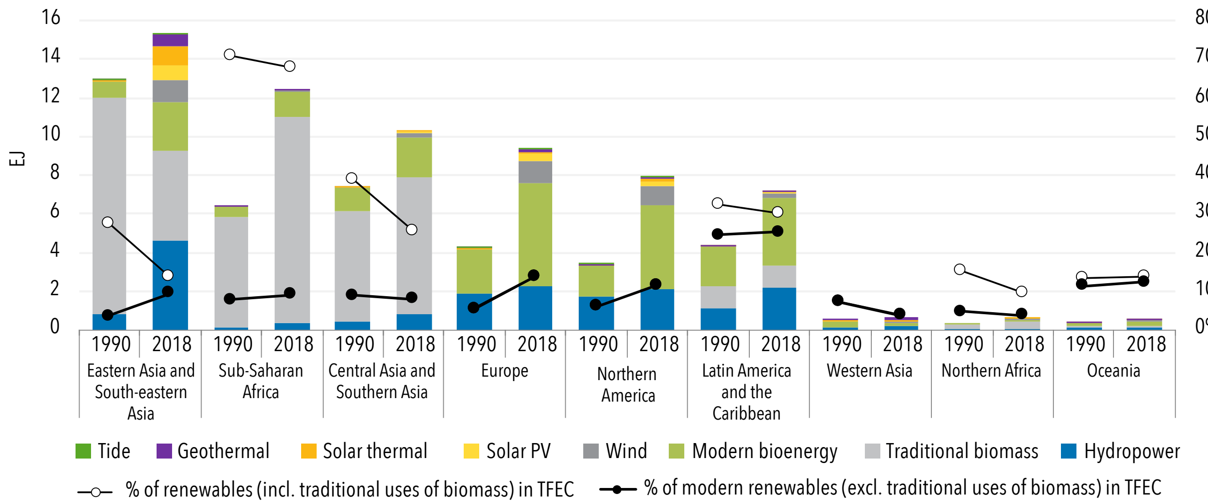
Note: "Transport" includes electricity used for transport.

This global figure hides regional disparities (figure 3.4). Sub-Saharan Africa has the largest share of renewable sources in its energy supply, with traditional uses of biomass representing more than 85 percent of the renewable energy consumed in this region. Excluding traditional uses of biomass, Latin America and the Caribbean have the largest share of modern renewable energy consumption, owing to the significant share of hydropower in electricity generation, and to the consumption of bioenergy for industrial processes (in particular in the sugar and ethanol industry) and biofuels for transport.

In 2018, more than a third of the global year-on-year increase in modern renewable energy consumption took place in Eastern and South-eastern Asia (figure 3.5), which saw the fastest progression of the share of renewables in TFEC (+0.5 percentage point), due primarily to the deployment of wind and then solar PV. Europe and Northern America together accounted for 43 percent of the year-on-year growth in modern renewable energy use, owing to modern bioenergy consumption for heat, good conditions for hydropower in Europe, as well as growing contributions from wind and solar PV.

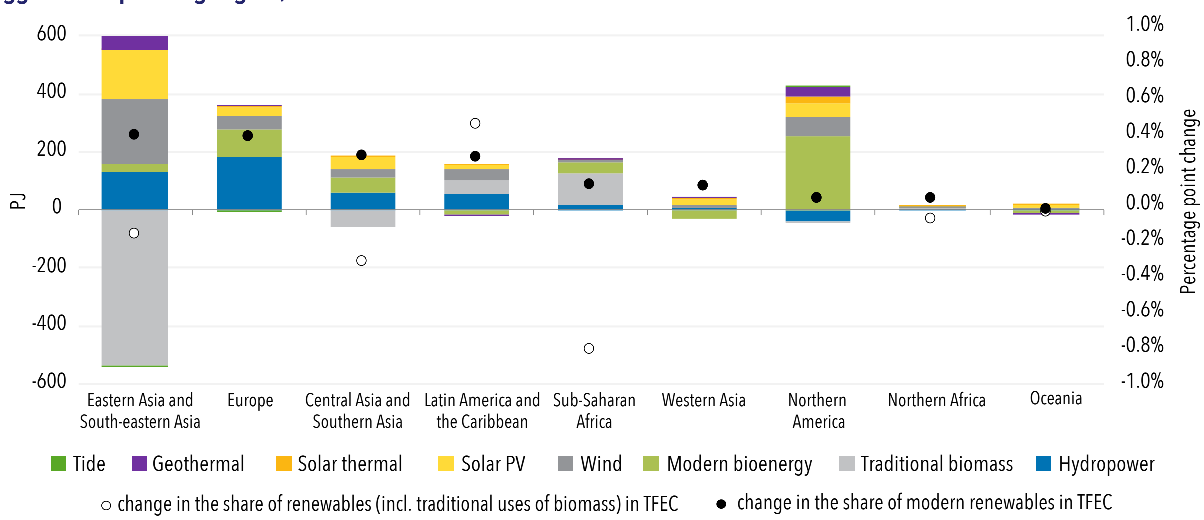
At a national level, the share of renewable sources in energy consumption varies widely depending on resource availability, policy support, and the impact of energy efficiency and consumption patterns on total energy demand. Among the top 20 energy-consuming countries, Brazil and Canada had the largest shares of modern renewables in 2018 (figure 3.6), owing to heavy reliance on hydro for electricity and bioenergy for heat and transport. China alone accounted for almost a fifth of global modern renewable energy consumption, yet this represented less than 10 percent of its TFEC. Germany, Italy, and the United Kingdom achieved the greatest progression in the share of modern renewables in TFEC between 2000 and 2018, mostly through the deployment of bioenergy (in particular for heat), wind and solar PV, and thanks to the stabilization or decline of TFEC (figure 3.7). In 2018, the greatest growth in the share of modern renewables was observed for Spain (+1.7 percentage point), due to higher hydropower generation, followed by Indonesia (+1.4 percentage point), where a rapid uptake of bioenergy for power generation played a leading role.

FIGURE 3.4 • Renewable energy consumption and share in total final energy consumption by region, 1990 and 2018



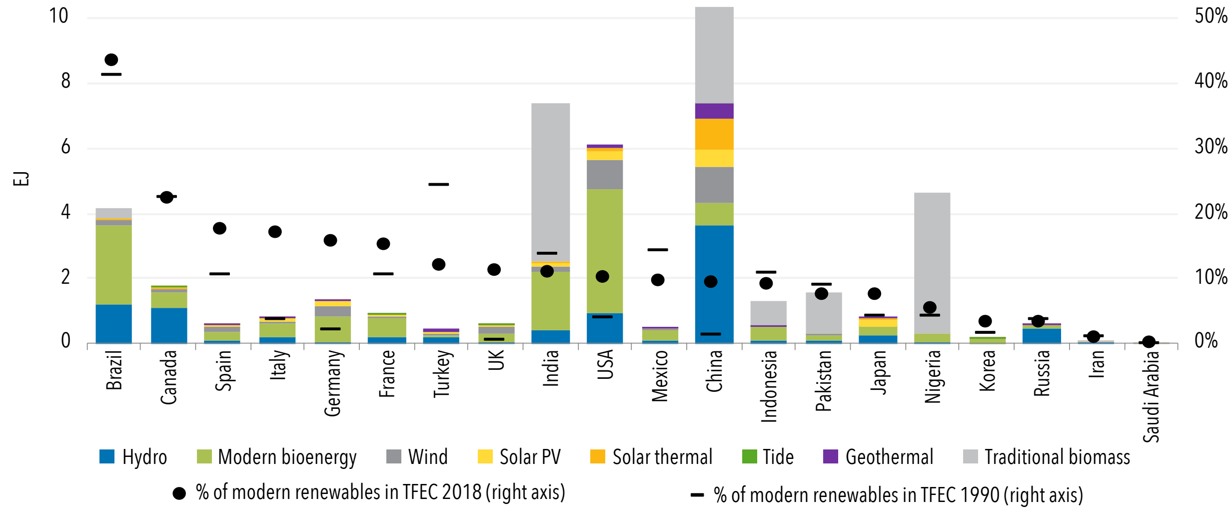
Source: IEA 2020b; UNSD 2020.

FIGURE 3.5 • Year-on-year change in renewable energy consumption and in the share of renewables in total final energy consumption by region, 2018



Source: IEA 2020b; UNSD 2020.

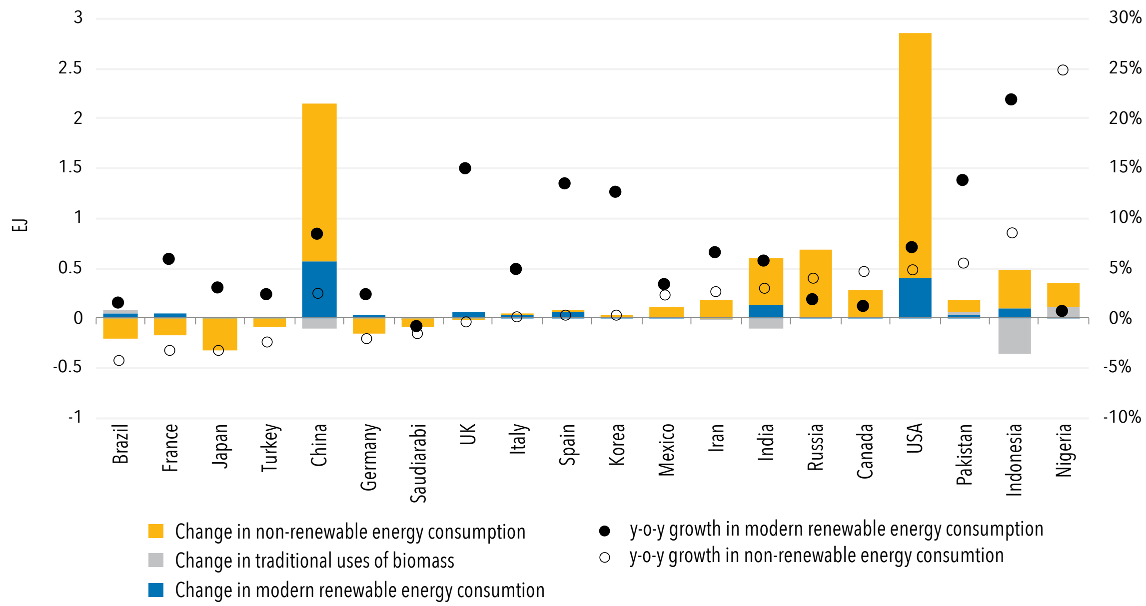
FIGURE 3.6 • Renewable energy consumption, 2018, and share of renewables in TFEC, 1990 and 2018, top 20 countries with the largest energy consumption



Source: IEA 2020b; UNSD 2020.

Between 2000 and 2018, the share of modern renewables in TFEC declined in 6 out of the 20 largest energy-consuming countries, despite growing consumption of modern renewable energy in all of them. In the same period, the consumption of nonrenewable energy increased in 13 such countries. This highlights the importance of containing overall consumption through energy efficiency and sufficiency,[37] and phasing out the use of fossil fuels, to achieve larger shares of renewables in the energy mix.

FIGURE 3.7 • Annual change in renewable and nonrenewable energy consumption, top 20 countries with the largest energy consumption, 2018



Source: IEA 2020b; UNSD 2020.

37 Energy sufficiency corresponds to the action of tailoring and scaling energy-related infrastructure, technology choices, and behaviors to fundamental needs while selectively avoiding nonessential energy-intensive services and consumption patterns. This is to allow affordable access to energy to meet everyone's needs and fair access to meet their energy wants, while keeping the impacts of energy use within environmental limits (Darby and Fawcett 2018; Marignac 2019).

BOX 3.2 • RENEWABLE ENERGY IN A PANDEMIC: HOW THE COVID-19 CRISIS IS AFFECTING RENEWABLE ENERGY DEVELOPMENT

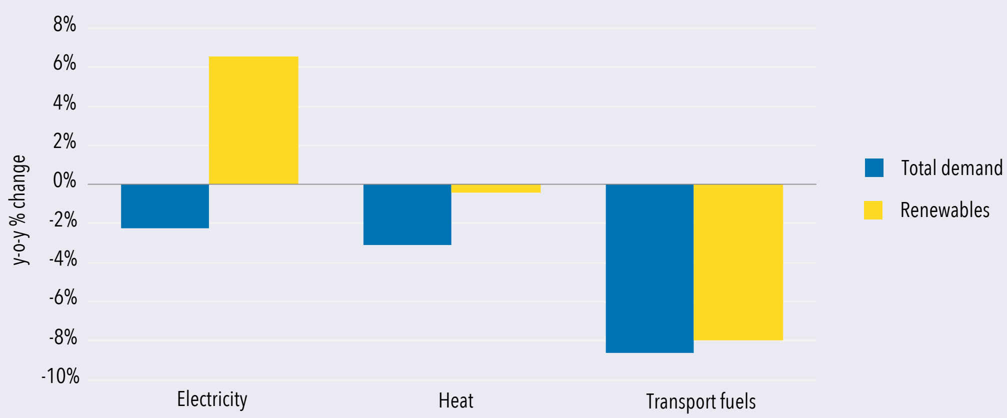
Beyond the immediate impact on health, the COVID-19 pandemic has had major implications for economic activity and therefore energy consumption. To slow the spread of the virus, governments across the world imposed restrictions on most social and economic activities, curtailing transport, industrial production, and services, causing a major energy demand shock.

The implications of the COVID-19 pandemic for renewable energy development vary across end-use sectors. According to preliminary estimates from the International Energy Agency, global electricity demand declined 2 percent in 2020 compared to 2019, but renewables' use for power generation increased by almost 7 percent year-on-year. Long-term contracts, low marginal costs, priority access to grids, and the ongoing installation of new renewable capacity all contributed to expanding renewable electricity generation while output from all other fuels declined. The most recent data from IRENA show 260 GW of renewable energy capacity additions in 2020, signaling growth of 10.3 percent and exceeding the expansion in 2019 by almost 50 percent despite the COVID-19 pandemic (IRENA 2021).

This growth more than compensated for declines in bioenergy demand for industry and biofuels for transport. Indeed, lower economic activity has led to an estimated 3 percent year-on-year decline in global heat demand, which also affected renewable energy consumption, albeit in a smaller proportion (less than 1 percent decline). Reduced commercial, industrial, and construction activity has translated into lower bioenergy and waste use in several energy-intensive industries such as paper and pulp and cement; the use of renewables in the residential sector was less affected.

Biofuel for transport is the most diminished of all renewable energy sources, with an estimated 8 percent decline in consumption in 2020 compared with 2019. This is the first reduction in annual production in two decades, driven by both lower transport fuel demand and lower fossil fuel prices diminishing the economic attractiveness of biofuels. The biggest year-on-year drops in output are for U.S. and Brazilian ethanol and European biodiesel.

FIGURE B3.2.1 • Change in energy demand and renewables' output in electricity, heat and transport, 2019–20



Source: IEA 2020a.

Overall, these factors led to renewables' increased share for electricity, and only slightly increased share for heat and transport, as total renewable energy consumption grew by an estimated 1 percent in 2020. Despite looming economic uncertainty, investors' appetite for renewable energy remains strong, thanks in particular to support from government-led green stimulus plans, especially for renewable electricity. Global renewable energy auction results reached record-high volumes in 2020. If geared toward renewable energy, the recent policy momentum to support economic recovery has the potential to accelerate further renewable energy growth.

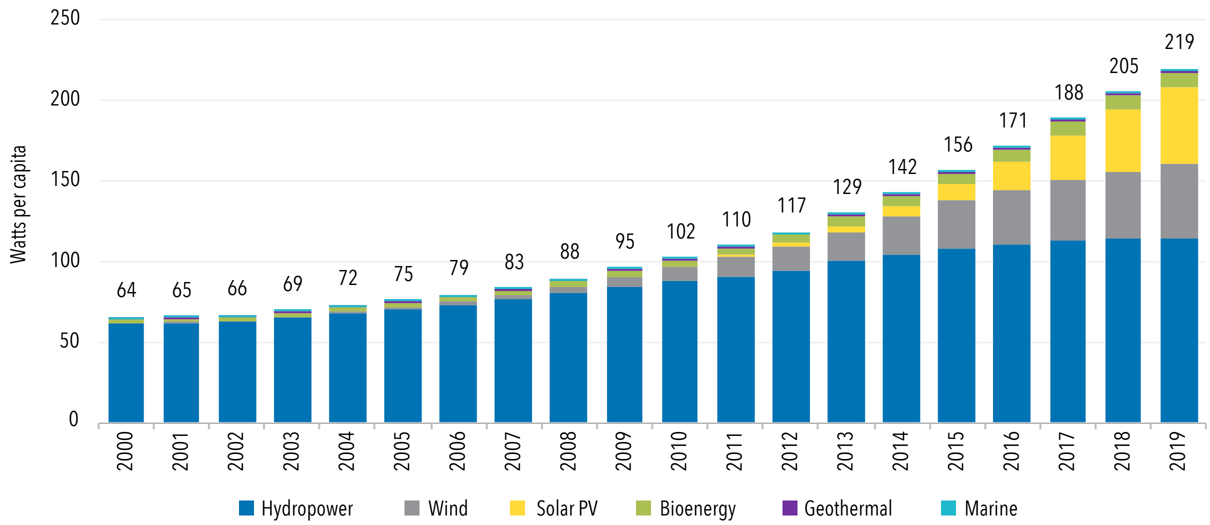
ELECTRICITY

Electricity accounted for 21 percent of TFEC globally in 2018 and is the fastest growing end use. Electricity consumption doubled over the past 23 years and saw a 33 percent increase in the past decade.[38]

In 2018, global renewable electricity consumption increased by almost 7 percent (+1.3 EJ) year-on-year, while nonrenewable electricity consumption grew 3 percent (+1.7 EJ). As a result, the share of renewables in electricity generation increased by 0.7 percentage point to 25.4 percent in 2018—making its share the largest among all end uses.

In 2018, hydropower and wind each contributed a third of the annual increase in renewable power generation, followed by solar PV, which accounted for another quarter (figure 3.8). Hydropower's increase is partly due to better hydrological conditions than in 2017, especially in Europe (e.g., in Spain, Italy, and France). Global solar PV and wind electricity generation expanded by 25 percent and 13 percent respectively, year-on-year. In 2018, solar PV surpassed bioenergy to become the third largest source of renewable electricity globally. Accounting for 63 percent of renewable power generation and 16 percent of total electricity generation, hydropower remained the largest renewable source of electricity globally and for each region.

FIGURE 3.8 • Global renewable electricity consumption by technology, 1990–2018

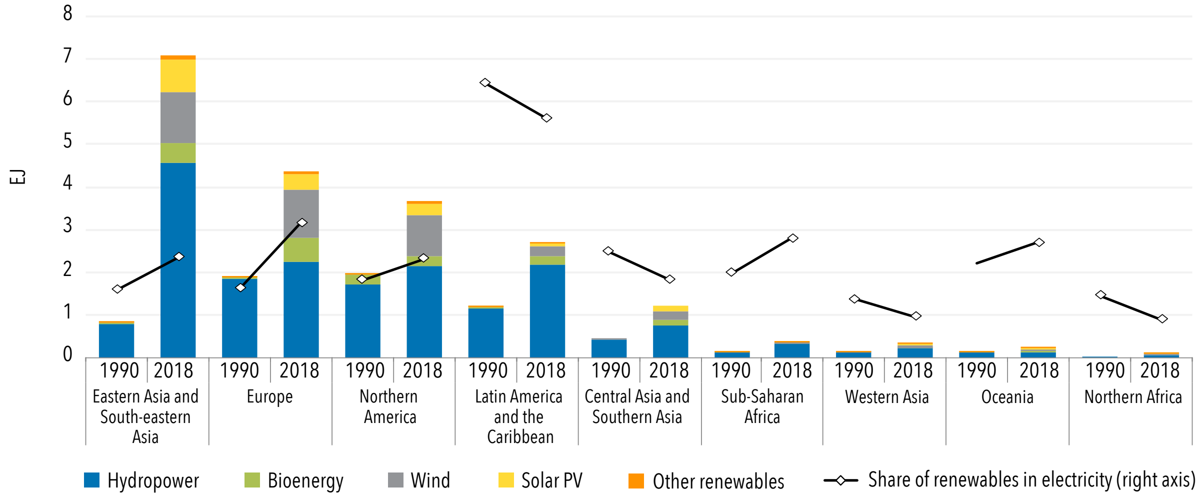


Source: IEA 2020b; UNSD 2020

In 2018, the share of renewables in electricity increased in all regions but Northern America, compared with 2017 (figure 3.9). This is mainly due to lower bioenergy output in Canada and lower hydropower generation in the United States. The Latin America and Caribbean region had the largest share of renewable sources in power generation, with hydropower alone representing 45 percent of regional electricity generation in 2018. The share of renewables in power generation increased the fastest in Europe, where it rose by almost 2 percentage points year-on-year to 32 percent of total generation. This was mostly driven by the flattening of electricity consumption, better hydrological conditions, and the rapid growth of new wind and solar PV capacity. Thanks to rapidly declining costs and policy support, wind and solar PV together accounted for more than 70 percent of the increase in renewable electricity consumption over the past decade both in Europe and Oceania, and up to 83 percent in Northern America.

38 Among the key 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 global electricity consumption in 2018 (IEA 2018).

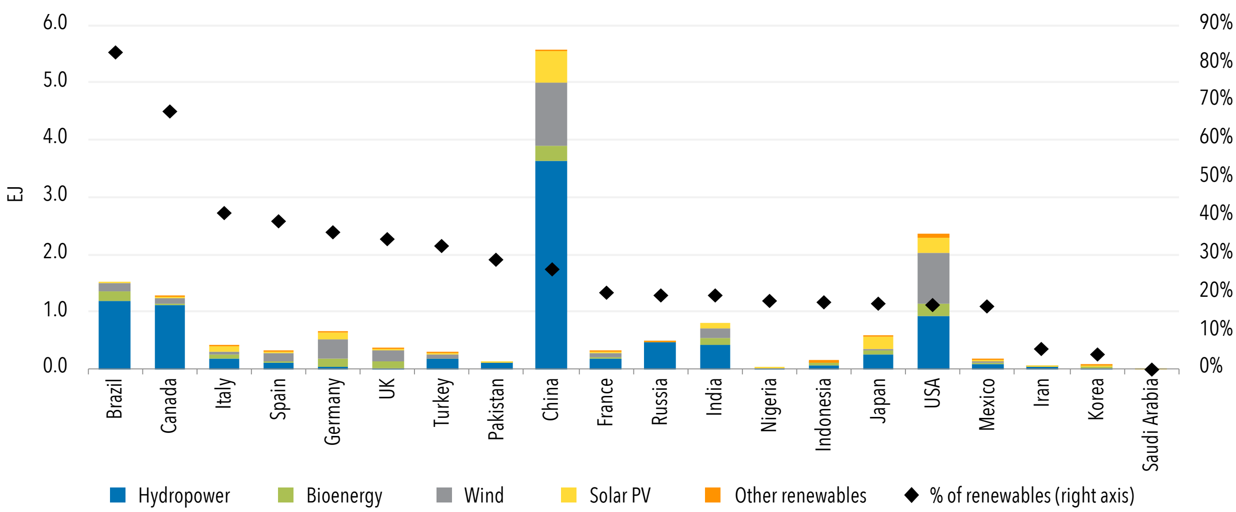
FIGURE 3.9 • Renewable electricity consumption and share of renewables in electricity by region, 1990 and 2018



Source: IEA 2020b; UNSD 2020.

The top 20 energy-consuming countries show contrasting trends, with the share of renewables in electricity generation varying from near 0 percent to more than 80 percent (figure 3.10). Brazil and Canada have the largest shares by far, owing to large hydropower capacities. Wind and solar PV together—that is, non-dispatchable renewables—are the largest renewable electricity sources in Germany, the United Kingdom, Spain, and the United States. Their combined share in renewable power generation ranged from 43 percent to 70 percent in those countries. Between 2017 and 2018, Indonesia's renewable electricity consumption recorded the largest growth rate among the top 20 energy-consuming countries, rising by almost 60 percent, due primarily to a strong increase in bioenergy use.

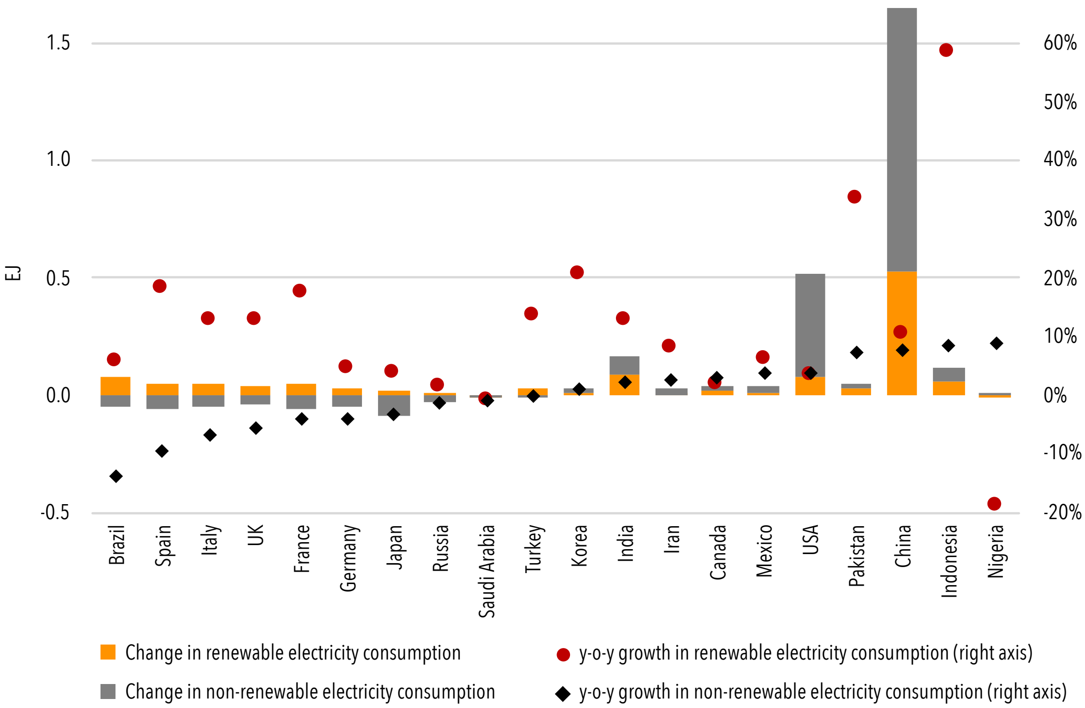
FIGURE 3.10 • Renewable energy consumption in electricity by source and country, top 20 final energy users, 2018



Source: IEA 2020b; UNSD 2020.

In 2018, China alone contributed 40 percent of the global annual increase in renewable electricity generation, of which wind and solar PV together accounted for two-thirds (figure 3.11). India, Brazil, and the United States were the next largest contributors to this growth, together contributing about one-fifth of it. In the same period, China was also responsible for the largest increase in nonrenewable electricity consumption, followed by the United States. These two countries together were responsible for more than 70 percent of the annual growth in total electricity consumption, and more than 90 percent of the growth in nonrenewable electricity consumption.

FIGURE 3.11 • Year-on-year change in renewable and nonrenewable electricity consumption by country, top 20 final energy users, 2018



Source: IEA 2020b; UNSD 2020.

This chapter tracks progress toward SDG indicator 7.B.1,[39] which points to the importance of increasing installed renewable energy-generating capacity in developing countries (in watts per capita). The overall trend in renewable electricity capacity installations over the past decade shows remarkable progress, further outlined in box 3.3.

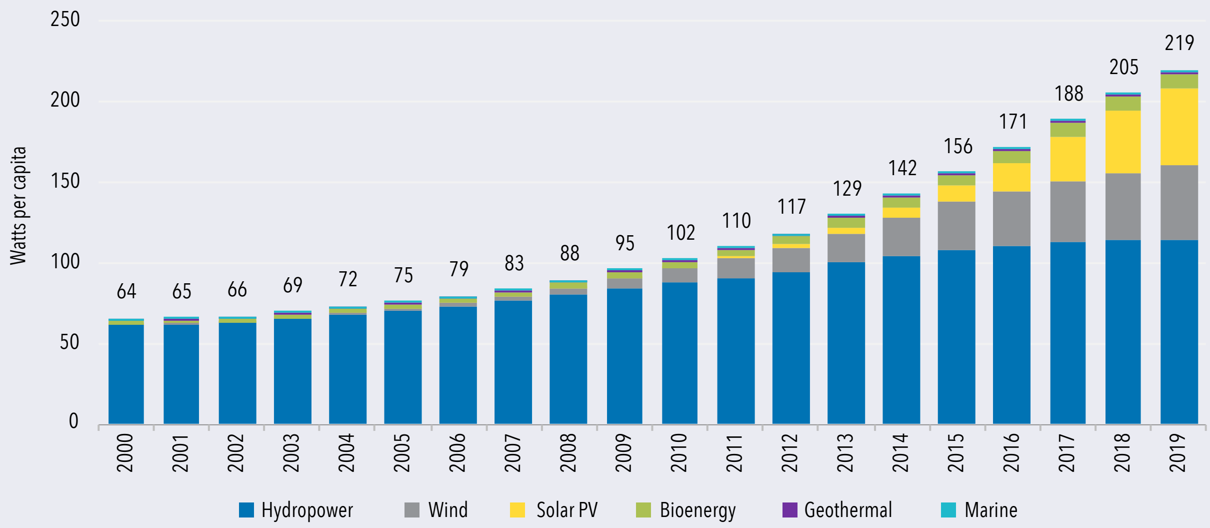
39 This indicator is part of SDG target 7.B, which envisions an expansion of modern and sustainable energy services for all in developing countries.

BOX 3.3 • INSTALLED RENEWABLE ELECTRICITY CAPACITY IN DEVELOPING COUNTRIES

On a global level, new renewable electricity capacity installations witnessed remarkable development over the past decade, outpacing installations in nonrenewable electricity capacity since 2012 and consistently since 2015. In 2019, renewable electricity capacity (on- and off-grid) grew by 7.4 percent, accounting for 72 percent of overall new electricity capacity installations (IRENA 2020a).

In 2018, for the first time, a majority of new renewable electricity capacity was installed in developing countries (IRENA 2019a). The significant increase in renewable electricity installations in these countries can primarily be attributed to the large uptake of new solar and wind capacity, increasing by a compound annual growth rate of 72 percent and 22 percent respectively over the 2010–19 period. The most recent data from IRENA show that renewable energy capacity continued to grew at an even higher level in 2020 despite COVID-19.

FIGURE B3.3.1 • Installed renewable electricity generating capacity in developing countries (in watts per capita), 2000–19



Source: IRENA, 2020b.

In 2019, developing countries had 219 watts per capita of installed renewable electricity capacity (1.4 TW across 6.4 billion people). The 7 percent year-on-year growth rate of 2019 was lower than the 8.8 percent of 2018, signaling a slight slowdown compared to the compound annual growth rate of 8.9 percent during the period 2010–19. The slight slowdown in 2019 can be explained by technology trends in capacity additions. Hydropower capacity per capita almost stabilized with population growth, with year-on-year growth of 0.4 percent in 2019 compared to 1.5 percent in 2018. Solar capacity per capita dropped to a year-on-year growth of 22.2 percent in 2019 compared to 35.5 percent in 2018. Wind remained at 11.3 percent year-on-year.

Renewable electricity capacity installations in 2019 were highly concentrated in Latin America and the Caribbean, with 405 watts per capita, closely followed by Eastern and South-eastern Asia at 391 watts per capita. While Latin America and the Caribbean had considerable renewable electricity capacity installed per capita already in 2010, primarily in hydropower, the largest increase—191 percent—was witnessed in Eastern and South-eastern Asia, driven primarily by solar and wind energy deployment. Sub-Saharan Africa had 34 watts per capita in 2019, up from 24 in 2010.

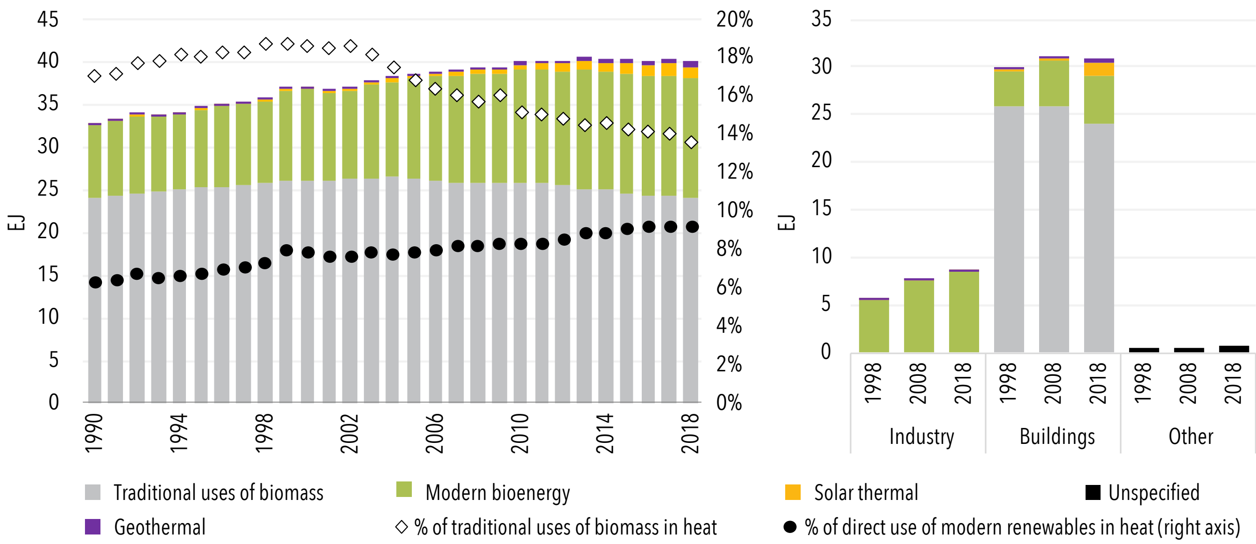
While the past decade has seen positive development, there remains significant untapped potential for developing countries to expand their renewable electricity capacity. Although a majority of new capacity installations have been made in developing countries in the past two years, developed countries had around four times more capacity per capita (at 880 watts per capita) than developing countries in 2019 - this follows more or less the per capita differental between developed and developing countries for overall installed electricity-generating capacity. The population growth rate for developing countries decreased slowly, from 1.52 percent in 2001 to 1.25 percent in 2019. To continue with increased levels of capacity per capita, installations of renewable electricity must continue outpacing population growth.

HEAT

Heat is the largest energy end use worldwide, accounting for half of global TFEC (177 EJ). Total heat consumption grew by an estimated 1.1 percent in 2018 compared with 2017. With coal, gas, and oil meeting more than three-quarters of global heat demand, the sector remains heavily fossil-fuel dependent. The traditional uses of biomass slightly decreased (-1.8 percent) in 2018 compared to 2017, while still accounting for almost 14 percent (24 EJ) of global heat consumption (figure 3.12). Excluding these traditional uses of biomass, as well as ambient heat harnessed by heat pumps[40] (for which available data are limited), renewable heat consumption increased 1.2 percent year-on-year to 16.2 EJ in 2018. This represented only 9.2 percent of total heat consumption, same as the two years before, and only one percentage point higher than ten years earlier.

Despite its dominant share in final energy consumption, the heat sector receives limited policy attention and support. Greater ambition and stronger policy support are needed to progress toward SDG 7.1 and SDG 7.2 targets (See policy insights below). Doing so requires combining strong improvements in energy efficiency with fast deployment of renewable heat technologies in order to transition away from fossil fuels and inefficient and unsustainable uses of biomass.

FIGURE 3.12 • Renewable heat consumption by source and sector, 1990-2018



Source: IEA 2020b; UNSD 2020.

Note: Indirect consumption of renewable heat through renewable electricity is not represented on this figure.

Bioenergy accounts for about 87 percent (14.1 EJ) of direct modern uses of renewables for heat[41] globally, following a year-on-year 0.5 percent increase in 2018, mostly in the buildings sector. Industry is responsible for a little less than two-thirds of modern bioenergy use, most of it concentrated in subsectors producing biomass residues on site, such as wood, pulp, and paper industries, as well as the sugar and ethanol industries.

Global solar thermal consumption increased by 3.7 percent in 2018, accounting for 8.5 percent (1.4 EJ) of modern uses of renewables for heat; yet it still met less than 1 percent of total final heat demand. The large majority of solar thermal consumption corresponds to small domestic solar water heaters, although significant untapped potential remains for large-scale systems for district heating and industrial applications,

40 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 this dearth of data, this report does not account for it, although ambient heat can be credited as a renewable source.

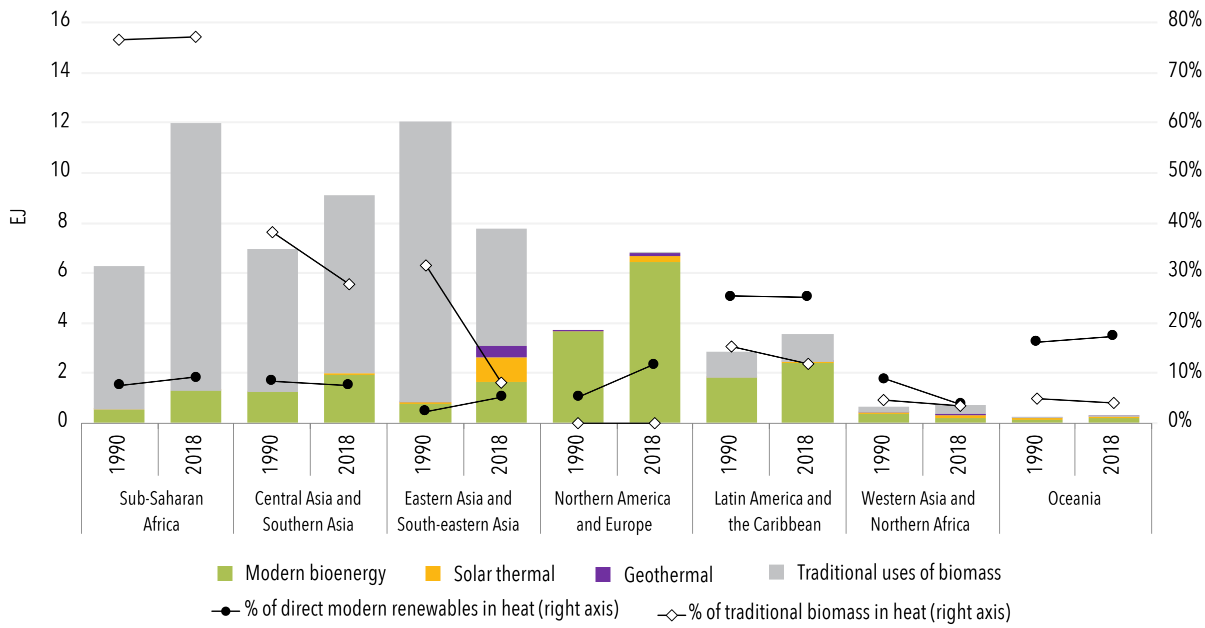
41 Renewables also contribute to heat supply indirectly through renewable electricity used for heating and district heat networks. Accounting for these indirect uses, and excluding ambient heat, renewable electricity is actually the second largest modern renewable heat source after bioenergy, and the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

which continue to develop as a niche market. China continued to lead solar thermal developments by far, accounting for 70 percent of global cumulative solar thermal capacity and 74 percent of newly installed capacity in 2018. However, China's market for solar thermal has been continuously declining since 2014, due to reduced construction activities, the phasing out of incentives, and market competition with other technologies such as heat pumps, as well as solar PV for rooftop space. 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, it is still a niche technology.

Geothermal heat consumption grew almost 14 percent in 2018, representing 4.2 percent (0.7 EJ) of modern uses of renewables for heat. Almost 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 two-thirds of global geothermal heat consumption, followed by Turkey and the United States, which together account for another 18 percent. China and the United States together represented almost 90 percent of the growth in geothermal heat consumption in 2018.

Traditional uses of biomass are primarily concentrated in Sub-Saharan Africa and Asia (figure 3.13), with—in descending order—India, Nigeria, China, Ethiopia, Pakistan, Indonesia, and the Democratic Republic of Congo together accounting for more than two-thirds of global consumption. Despite a slightly declining trend since 2004, traditional uses of biomass in 2018 were still at a greater level than in 1990 at a global scale. Contrasting trends were observed across regions and countries over the past decade, with particularly significant declines in Eastern Asia, especially China, as well as in Indonesia, India. and Vietnam. These were partly compensated by strong population-driven increases in Sub-Saharan Africa—especially in Nigeria, Ethiopia, and the Democratic Republic of Congo—as well as in Pakistan.

FIGURE 3.13 • Renewable heat consumption by region, 1990 and 2018

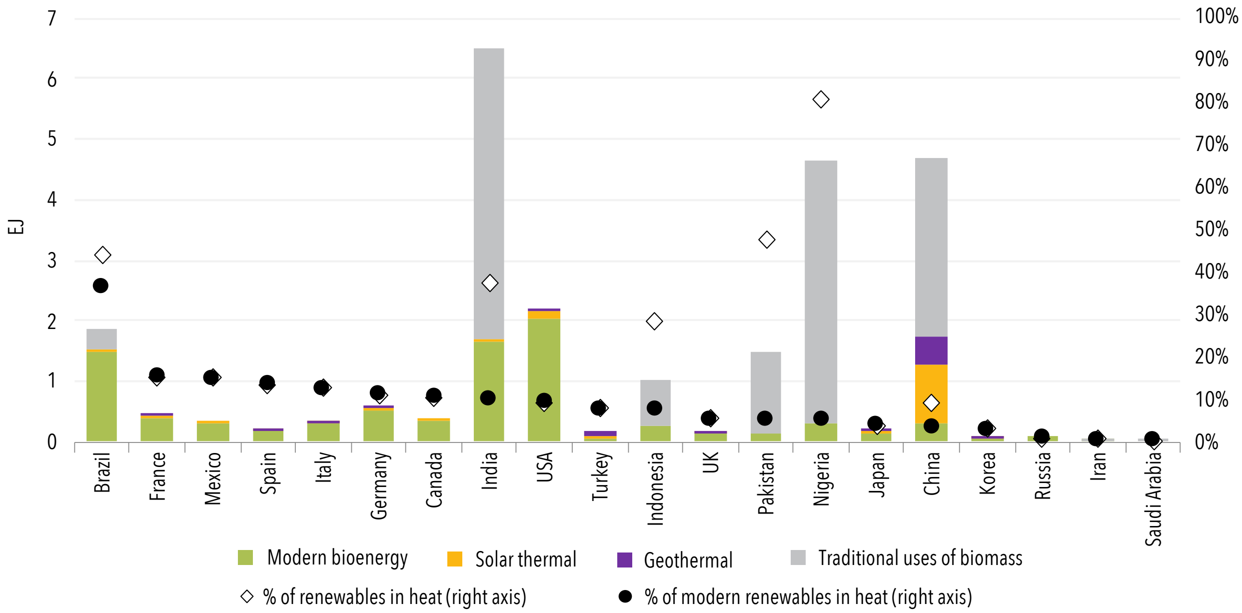


Source: IEA 2020b; UNSD 2020.

Note: Indirect consumption of renewable energy through electricity for heat is not included in this figure.

The United States, China, and India together represented two-thirds of the global increase in renewable heat consumption from 2010 to 2018 (figure 3.14). Together with Brazil, they were responsible for 46 percent of total heat demand and accounted for 44 percent of modern renewable heat consumption globally in 2018. 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 sugar and ethanol industry in Brazil and India, and notable deployment of solar thermal water heaters and geothermal heat in China. Europe is responsible for more than another one-quarter of global modern renewable heat consumption, owing to the deployment of residential wood and pellet stoves and boilers (e.g., in France, Germany, and Italy) and the use of biomass in district heating (e.g., in Nordic and Baltic countries, Germany, France, and Austria). In addition, albeit not quantified in this report, the growing consumption of renewable electricity through electric heaters and heat pumps, especially in China, the United States, and the European Union contributed indirectly to renewable heat consumption (IEA 2019).

FIGURE 3.14 • Renewable heat consumption and share of renewables in total heat consumption, by country, 2018



Source: IEA 2020b; UNSD 2020.

Note: Indirect consumption of renewable energy through electricity for heat is not included in this figure.

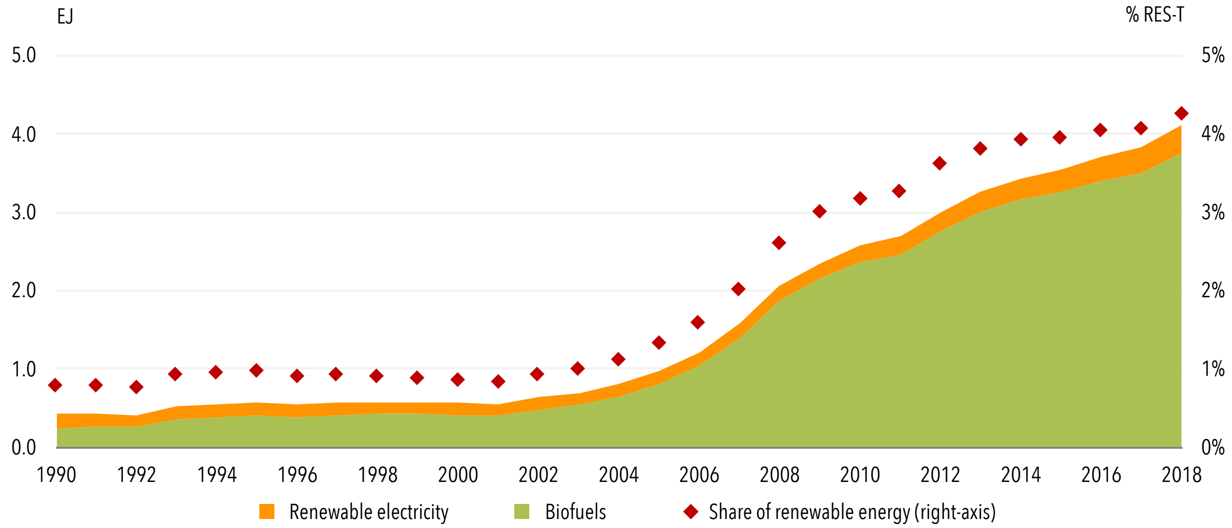
TRANSPORT

Renewable energy in transport grew by 0.28 EJ in 2018, the fifth largest year-on-year absolute growth since 1990 and the largest since 2012 (figure 3.15). Renewable electricity expanded by 0.03 EJ, the single largest expansion since 1990, and biofuels expanded by 0.25 EJ. This led to a slight increase in the share of renewable energy in transport, which reached 3.4 percent in 2018, up from 3.3 percent in 2017. The majority of renewable energy consumed came in the form of liquid biofuels (91 percent), mainly crop-based ethanol and biodiesel blended with fossil transport fuels. Most of the remainder was from renewable electricity.

Country-level policies drove the 0.25 EJ growth in biofuels in 2018. This is the largest annual increase since 2013. The growth in biofuels was split almost equally between ethanol and biodiesel. Nearly 75 percent of this growth occurred in Brazil, primarily due to ethanol growth, and Europe, primarily from biodiesel growth. In Brazil, ethanol demand grew by 15 percent from 2017 levels because of two key factors. First, sugar processors invested in ethanol equipment and storage facilities, which made it easier for sugar mills to switch between sugar and ethanol production. These changes combined with low international sugar prices drove sugar mills to maximize ethanol production. Second, there was higher domestic demand for ethanol because fiscal incentives for ethanol and high oil prices meant ethanol was relatively less expensive than gasoline at the pump. Brazil has a large flex-fuel vehicle fleet and so owners of these vehicles can decide whether to fill up with ethanol or a gasoline-ethanol blend, depending on prices. In Europe, country-level policies to meet the Renewable Energy Directive pushed up demand, while the removal of anti-dumping duties on imports from Indonesia and Argentina expanded the supply of biodiesel and hydrotreated vegetable oil.

Renewable electricity used in vehicles and trains grew by a record 0.03 EJ in 2018 but still accounted for only 9 percent of renewable energy use in transport. Part of this growth is thanks to an expanding electric vehicle fleet. In 2017 there were 3.1 million electric vehicles on the road, which grew to 5.1 million in 2018. The electricity powering these vehicles is also increasingly coming from renewable sources. Renewable electricity's share of total electricity use in transport climbed from 22 percent to 25 percent between 2013 and 2018.

FIGURE 3.15 • Global renewable fuel share in transportation and totals for renewable electricity and biofuels from 1990 to 2018



Source: IEA 2020b; UNSD 2020.

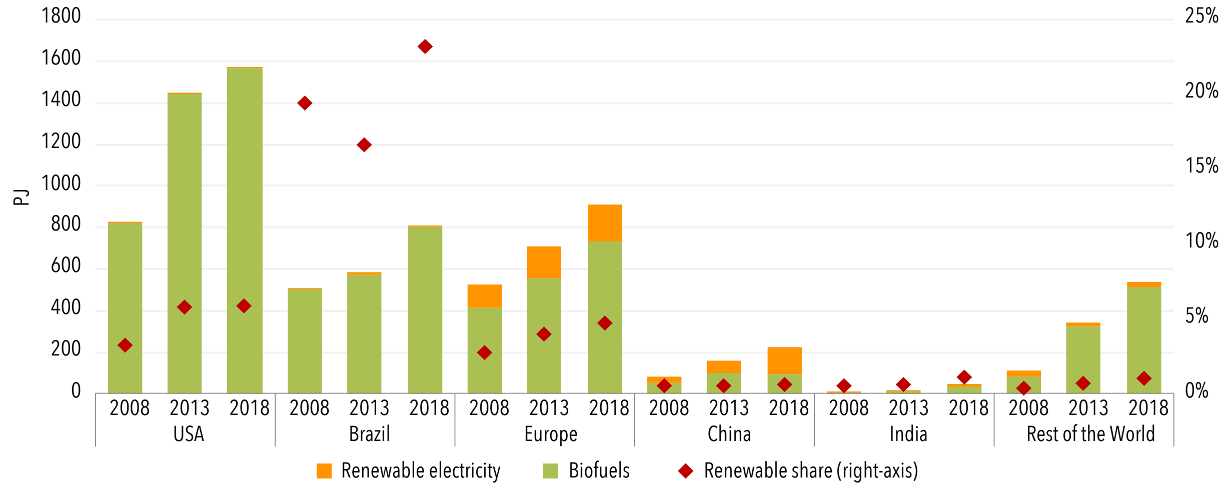
Over the past decade, renewable energy in transport has nearly doubled, but its share has only increased by 1.3 percentage points. The growth is thanks to country-level policies to expand biofuels, electrify transport, and increase renewable energy generation. Biofuel policies have driven the largest growth in renewable energy, while renewable electricity has played a smaller, but growing role. Despite many successes at the country level, these policies have only marginally kept ahead of growing fossil fuel demand, leading to only a small share increase.

The United States, Brazil, and Europe account for 80 percent of renewable energy used in transport, but shares are growing in other countries and regions as well (figure 3.16). In the United States and Brazil, biofuels, primarily cropped-based ethanol and biodiesel, provide the majority of renewable energy use in transport. Biofuels provide most of the renewable energy used in transport in Europe as well, but renewable electricity contributes 20 percent of the total. In China, renewable energy in transport grew by 40 percent between 2013 and 2018 with most growth occurring in renewable electricity. Renewable electricity represents more than 50 percent of renewable energy use in transport in China, thanks to renewable electricity expansion and electrification of transport, accompanied by only modest efforts to boost biofuels. In 2018, 45 percent of the global light-duty electric vehicle fleet was in China as well as over 250 million two- and three-wheel vehicles and 400,000 electric buses. In India, biofuel support policies have more than doubled renewable energy use in transport since 2013.

Expanding the renewable share of transport energy will require a combination of policies that support biofuels, electric vehicles, renewable electricity generation, and active mobility and the phasing out of fossil fuels for transport. These policies must be steadily strengthened in countries that already have them and expanded to those countries that do not.

Support for biofuels should be accompanied by measures to ensure the sustainability of feedstock supplies and use.

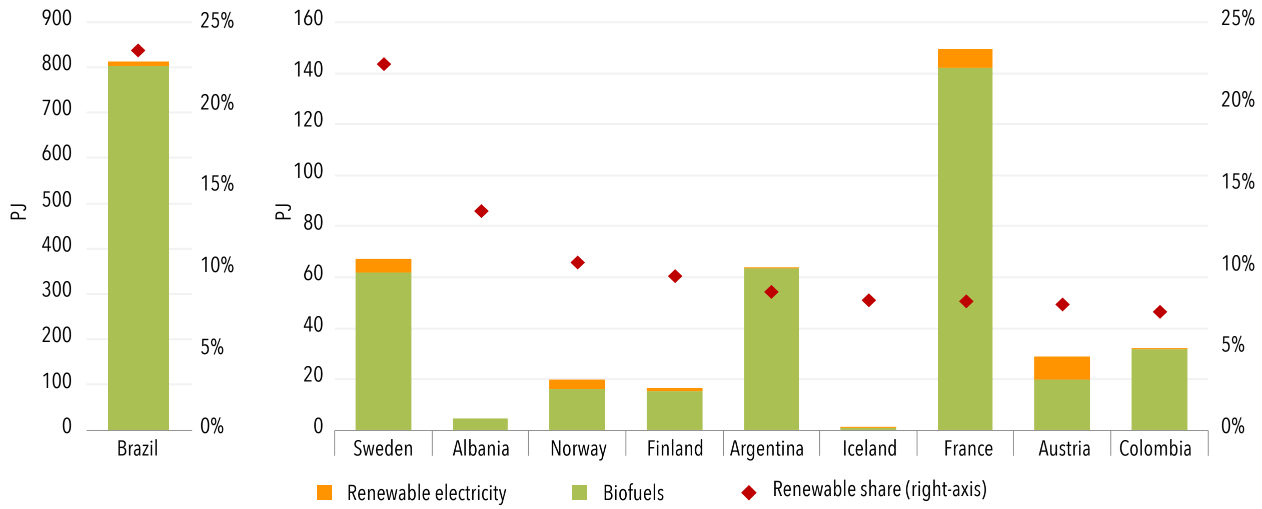
FIGURE 3.16 • Selected countries' renewable energy share in transportation and total renewable energy for 2008, 2013, and 2018



Source: IEA 2020b; UNSD 2020.

More than 70 countries have biofuel support policies in place, and most large markets support electric vehicle adoption and renewable energy generation that have driven growth in renewable energy shares. Brazil, Sweden, Norway, Finland and Albania all achieved renewable energy shares above 10 percent in 2018 (figure 3.17). Share increases in other jurisdictions were more modest. Policies in the United States drove renewable shares up from 3.3 percent in 2008 to 6 percent in 2018 and policies in Europe drove shares up from 2.7 percent to 4.7 percent. Another 130 countries have no policies to drive renewable energy use in transport and had no measurable increase in the renewable energy used for transport in 2018.

FIGURE 3.17 • Top ten countries by renewable energy share in transport, 2018



Source: IEA 2020b; UNSD 2020.

POLICY INSIGHTS: A FOCUS ON HEATING AND COOLING

As demonstrated in this chapter, the adoption of renewable energy in the power sector has seen significant progress in the last decade, while much more effort is needed in other end uses.

Heating and cooling accounts for almost half of global energy consumption, of which industrial processes account for close to 50 percent and another 46 percent is used in residential and commercial buildings—predominantly for space and water heating and, to a lesser extent, for cooking. The remainder of heating is used in agricultural activities, such as heating greenhouses, soil, and farm buildings; drying harvested products; and maintaining temperatures for aquaculture. As developing countries continue to develop their industries and as climate change increases the frequency and severity of heat waves and other weather events, the demand for heating and cooling will grow (IEA 2019).

POLICY ATTENTION GIVEN TO HEATING AND COOLING TO DATE

Despite the urgency of decarbonizing heating and cooling, some barriers persist. Chief among them are high up-front costs, regulatory and institutional frameworks based on fossil fuels, consumer inertia, and technical hurdles.

These barriers can be overcome with support policies. But so far, policy makers have given scant attention to transitioning heating and cooling to renewables. At the end of 2019, only 49 countries had national targets for renewable heating and cooling (compared with 166 countries having goals for renewable power generation). This number has been almost steady since 2016, when 47 countries had renewable heating and cooling targets (REN21 2020; REN21 2018). Decarbonizing and modernizing the energy used for heating and cooling requires that governments implement comprehensive policy packages that combine efficiency and renewables while phasing out the use of fossil fuels. Such policies can span the range of decarbonization options including electrification, renewable gases, sustainable biomass, and the direct use of geothermal and solar thermal energy.

POLICIES FOR RENEWABLE HEATING AND COOLING IN THE KEY TRANSFORMATIVE PATHWAYS

Five pathways are possible to decarbonize heating and cooling with renewables. Policies to support them are presented below.

Renewables-based electrification

Greenhouse gas emissions can be reduced by switching to efficient renewable-energy-powered electric technologies, such as heat pumps and electric appliances for buildings, electrified heating and cooling for industry, and decentralized technologies for productive uses in areas that lack access to clean and reliable energy. Such a transition must be coordinated with the deployment of renewables in the power sector.

Renewables-based electrification is particularly important for cooling needs, not least in developing countries and low-income communities, many of which are in areas at risk of increased average temperatures and heat waves due to climate change. Policies that can effectively accelerate uptake of new equipment include fiscal and financial measures such as loans, grants, and subsidies. In China, government subsidies supported the switch from coal-fired boilers in buildings, resulting in the purchase of more than half a million heat pumps in 2018 (CHPA 2019; Zhao, Gao, and Song 2017). Industrial facilities also present large opportunities for electrification, with competitive applications already available in the food and beverage and textile industries. Heat pumps can also be combined with solar thermal preheating or waste-heat recovery to further raise efficiency and cut operating costs (IRENA Coalition for Action 2021). Additional reductions could come from homes and businesses switching to efficient appliances, notably cookstoves.

Although widespread electrification of heating and cooling will significantly increase overall demand for electricity, it also holds out the promise of adding flexibility to the electricity system through improvements in demand response, thereby facilitating the integration of higher shares of variable renewable energy into the power generation mix. Thermal storage can also enhance system flexibility (IRENA 2020b).

Exploiting this potential requires proactive policies favoring demand response, including measures to upgrade power networks through the deployment of remote monitoring and control technologies and to establish aggregators and dedicated flexibility products in the power market. Time-of-use tariffs can incentivize users match their demand to system needs (IRENA 2019b).

In off-grid and weak-grid contexts, there is a need to coordinate planning for decentralized heating and cooling with planning for rural electrification. Above all, coordination measures must ensure that the deployment of technologies supports broad socioeconomic development goals. Among possible measures are regulations, fiscal incentives, donor-sponsored research and development, roll-out programs to increase economies of scale, energy performance standards, appliance labels, public awareness campaigns, user education, and financing models for manufacturers, installers, and consumers (IRENA, IEA, and REN21 2020).

Renewable gases

Not all heating and cooling systems can be electrified at a competitive cost, so there is a role for renewable gases such as green hydrogen, biogas, and biomethane to replace fossil gases. Renewable gases can often use networks and infrastructure built for fossil gas, reducing the costs of the transition. With due attention to safety and feasibility, many countries are already injecting biomethane into their gas grids.

Renewable gases offer advantages beyond reducing carbon emissions from fossil fuel use and methane emissions from the decomposition of organic waste. Ambitious, long-term frameworks for the development of a renewable gas industry and related markets will depend on roadmaps, industrial strategies, and specific targets. France, for example, has set a target of 10 percent of the gas consumed in the country being renewable by 2030 (IRENA, IEA, and REN21 2020).

Other policies to help create markets for renewable gas products include: low-carbon fuel standards; direct investment support and subsidies to lower high production costs; assessments of gas transmission pipelines to confirm they can be safely used; new regulatory frameworks; and mechanisms for certifying emissions reductions from renewable gas.

Sustainable use of biomass

Bioenergy is presently the largest renewable source of energy for heating, with the majority being in the form of inefficient uses of biomass (e.g., wood, crop residues, and animal dung) for cooking and heating as outlined above.

The transition to a more efficient use of biomass would include the adoption of improved cookstoves and modern biofuels. Many countries already implement policies to this end, including in Sub-Saharan Africa through national cookstove programs supported by development finance. Data collection and analysis to understand local cooking needs, cultural cooking preferences, and local fuel supply are important first steps toward effective policy making. Standards, certification, and testing play a key role in ensuring that clean cooking solutions satisfy users' needs, meet air quality standards, and are backed by sustainable fuel supply chains (see chapter 2).

Certification schemes are also important where bioenergy can be used for heat in buildings, district heating systems, and for industrial processes. Such supportive policy and regulatory regimes are essential to ensure reliable and consistent supplies of biomass feedstock and avoid possible negative environmental consequences from increasing biomass exploitation.

Financial incentives can help builders and property owners overcome the higher capital costs of efficient biomass boilers compared with gas or oil boilers. The scaling up of financing solutions is also needed to support greater deployment of clean cooking solutions in developing countries (SEforAll and CPI 2020).

Direct use of solar thermal heat

Energy from the sun can be used directly for space and water heating, industrial processes, food drying, and wastewater treatment, among other uses. When solar collectors are paired with absorption or adsorption chillers, solar energy also can be used for cooling.

Solar water heating systems in single-family houses and multifamily dwellings represent the largest use of solar thermal heat—almost 90 percent of installed capacity in 2018—whereas district heating networks, industrial processes, and space heating and cooling represent only 4 percent (Weiss and Spörk-Dür 2020). Solar water heaters can substantially reduce energy bills while creating local jobs and industries (IRENA, IEA, and REN21 2020). Solar thermal also has vast potential for air conditioning, since the greatest demand for cooling coincides with the highest solar potential. But the use of solar thermal for such purposes requires support for research and demonstration projects to overcome technical barriers.

While highly cost-competitive on a life-cycle basis, depending on the region and application, most solar thermal systems come with high up-front costs. Effective supporting policies include fiscal and financial incentives such as loans, grants, tax credits, or subsidies, combined with targets, mandates, and building codes to increase the size of the market, as well as public awareness efforts to increase interest and demand. Denmark, for example, has used tax incentives to help build large-scale solar thermal district heating plants (Perlin 2017). In Rwanda, grants and loans provided by the SolaRwanda program led to more than 3,000 solar water heaters being installed in homes by 2018 (Solar Thermal World 2018).

Direct use of geothermal heat

The thermal energy stored in rocks and in water trapped under the surface of the earth can be tapped for a wide range of uses, from space heating and cooling to aquaculture, agriculture (e.g., grain drying), and other commercial and industrial processes. Much of the potential of thermal energy has yet to be tapped, however. It is currently the smallest renewable heat source.

Among obstacles to expanding geothermal heat are high up-front investment costs, uncertainties about finding and capturing the energy, and inadequate policy and regulatory frameworks.

Government initiatives and plans to encourage the collection, updating, and sharing of data on geothermal resources' mapping could help attract investors, as could loan guarantees, grants, and direct support for demonstration projects (IRENA, IEA, and REN21 2020). Use of geothermal energy in agriculture can bring important socioeconomic benefits. Some European countries, including France, Germany, Iceland, the Netherlands, and Switzerland, have set up risk insurance funds to ease the drilling risk of geothermal projects (Dumas and Angelino 2015).

Policies that cut across all pathways

Cross-cutting policies are needed to address long-standing barriers and speed up decarbonization in all contexts. Nationally determined contributions that are aligned with renewable heating and cooling targets can improve policy certainty and guide investment. Only 25 of nearly 200 countries have formulated commitments on renewable heating and cooling in their nationally determined contributions (REN21 2020). The effectiveness of targets relies on comprehensive long-term planning for decarbonization.

Integrated long-term plans, including energy efficiency plans and the development of needed infrastructure (e.g., district heating and cooling networks), can avoid conflicts among pathways and stranded assets. District heating and cooling networks, for example, can enable the large-scale penetration of renewables and be more efficient than decentralized systems, especially in densely populated areas. This makes them an essential component of the wider energy transition. While most district heating networks still run on fossil fuels (often linked to power plants), a growing number are integrating some renewable energy such as biomass, especially in Northern Europe. Policies to promote the deployment of new district infrastructure and the greater use of renewable energy in existing networks include resource mapping, mandated connections, city-level targets, as well as mechanisms to offset high capital costs and reduce risks. Amsterdam (the Netherlands) requires all new developments to connect to district heating systems (C40 and UNEP 2016). Helsingborg (Sweden) and Munich (Germany) have both set targets for 100 percent renewable district heating by 2034 and 2040, respectively (IRENA, IEA, and REN21 2020).

The energy transition also requires leveling the playing field with fossil fuels, for which phasing out fossil fuel subsidies and redirecting resources toward the energy transition are key. Where possible, policy makers can also consider adjusting or implementing policies such as carbon pricing to internalize any negative impacts. However, those policies require careful design to avoid harming low-income populations (IRENA, IEA, and REN21 2020).

Finally, coordinating intersectoral exchanges (e.g., among energy, agriculture, forestry), streamlining permitting procedures, and reinforcing relevant data collection can improve supportive governance and institutional structures crucial for the implementation of plans.

THE WAY FORWARD

Looking ahead, measures to scale up renewable heating and cooling can and must be aligned with broad socioeconomic policies and objectives, such as improving conditions for vulnerable segments of the population, developing key economic sectors, setting long-term energy plans, and pursuing international climate and sustainability goals. A coherent, consistent, long-term policy approach to renewable energy and the decarbonization of the energy system will inspire confidence in investors and project developers. Importantly, international cooperation is going to be vital for introducing and implementing energy transition policies globally, in order to address climate change, economic inequality, and social injustice.

APPENDIX: METHODOLOGY

TABLE 3A.1 • Definitions

Renewable energy sources (RES)	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 plus the amount of electricity and heat consumption estimated from renewable energy sources
Direct renewables	Final consumption of bioenergy, solar thermal, and geothermal energy.
Total final energy consumption (TFEC)	The sum of the final energy consumption in the transport, industry, and other sectors (also equivalent to the total final consumption minus non-energy use)
Traditional uses of biomass	Final consumption of traditional uses of biomass. Biomass uses are considered traditional when biomass is consumed in the residential sector in non–Organisation for Economic Co-operation and Development (OECD) countries excluding Eurasia. It includes the following categories in International Energy Agency statistics: primary solid biomass, charcoal and non-specified primary biomass, and waste. Note: This is a convention, and traditional consumption/use of biomass is estimated rather than measured directly.
Modern renewable energy consumption	Total renewable energy consumption minus traditional consumption/use of biomass.

METHODOLOGY FOR MAIN INDICATOR

The indicator used in this report to track progress toward SDG target 7.2 is the share of renewable energy in total final energy consumption. Data from the International Energy Agency and United Nations Statistics Division energy balances are used to calculate the indicator according to the 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 the energy balance flows (TFEC = total final energy consumption as defined in table 3A.1, ELE = gross electricity production, HEAT = gross heat production) and their subscripts correspond to the energy balance products.

The denominator is the total final energy consumption of all energy products (as defined in table 3A.1) while the numerator, renewable energy consumption, is a series of calculations defined as: the direct consumption of renewable energy sources plus the final consumption of gross electricity and heat that is estimated to have come from renewable sources. This estimation allocates the amount of electricity and heat consumption to renewable sources based on the share of renewables in gross production in order to perform the calculation at the final energy level.

METHODOLOGY FOR ADDITIONAL METRICS BEYOND THE MAIN INDICATOR

The amount of renewable energy consumption can be divided into three end uses to refer to the energy service for which the energy is consumed: electricity, heat, and transport. They are calculated from the energy balance and are defined as follows.

Electricity refers to the amounts of electricity consumed in the industry and other sectors. Electricity used in the transport sector is excluded from this aggregation. Electricity used for heat-raising purposes is included because official data on final energy service are unavailable.

Heat refers to the amount of energy consumed for heat-raising purposes in industry and other sectors. It is not equivalent to the final energy end use service. It is also important to note that when used in the context of an end use, it does not refer to the same quantity as the energy product "Heat" in the energy balance, as used in the formula above.

Transport refers to the amounts of energy consumed in the transport sector. Most of this is used by railways and roads (and in some cases, pipeline transport). The amount of renewable electricity consumed in the transport sector is estimated based on the national annual shares of renewable electricity in gross production.

Methodology for indicator 7.b.1

Indicator 7.b.1 measures the installed renewable energy generating capacity in developing countries (in watts per capita) by dividing the maximum installed capacity of power plants that generate electricity from renewable energy sources at the year-end by the total population of a country at the mid-year. Data from IRENA are used to calculate the indicator.

IRENA's electricity capacity database contains information about the electricity generating capacity installed at year-end, measured in MW. The data set covers all countries and areas from the year 2000 onwards. The data set also records whether the capacity is on-grid or off-grid and is split into 36 different renewable energy types that can be aggregated into the six main sources of renewable energy. For the population part of this indicator, IRENA uses population data from the United Nations World Population Prospects.

More detail on the methodology 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

MAIN MESSAGES

- **Global trend:** The rate of global primary energy intensity improvement—defined as the percentage decrease in the ratio of global total energy supply per unit of gross domestic product—has slowed in recent years. Global primary energy intensity was 4.75 megajoules (MJ) per U.S. dollar[42] in 2018, a 1.1 percent improvement from 2017. This was the lowest annual rate of improvement[43] since 2010.
- **2030 target:** Energy intensity improvements are moving further away from the target set under the United Nations' Sustainable Development Goals (SDGs) for 2030. Between 2010 and 2018 the average annual rate of improvement in global primary energy intensity was 2 percent. Although better than the rate of 1.2 percent between 1990 and 2010, this is well below the 2.6 percent set in SDG target 7.3.[44] Annual improvement until 2030 will now need to average 3 percent to meet the SDG target. While 2019 saw a slight rebound, with an estimated improvement rate of 2 percent, early estimates for 2020 suggested even less progress than in 2018, at only 0.8 percent, as a result of the COVID-19 crisis.
- **Regional highlights:** More robust, continuous improvements in energy intensity are seen in Asia than in any other world region. Between 2010 and 2018, primary energy intensity in Eastern Asia and South-eastern Asia improved by an annual average rate of 3.1 percent, driven by strong economic growth. Similarly, in Central Asia and Southern Asia and Oceania, the average annual improvement rate of 2.6 percent between 2010 and 2018 was above the global average (2.0 percent) and an improvement on historic trends. Rates of improvement were just below the global average in Northern America and Europe (1.9 percent), with the lowest rates of improvement in Western Asia, Northern Africa, Latin America and the Caribbean (0.8 percent), and Sub-Saharan Africa (1.4 percent). Data on absolute energy intensity reveal wide regional differences: energy intensity in Sub-Saharan Africa is almost double the level in Latin America and the Caribbean. These variations rather mirror differences in economic structure, energy supply, and access than in energy efficiency.
- **Top 20 countries in energy intensity:** Comparing the periods 2000–10 and 2010–18, the average annual rate of improvement in primary energy intensity increased in 14 of the 20 countries with the largest total energy supply in the world. However, only half of the top energy-consuming countries performed better than the global average. China continued to improve primary energy intensity at the fastest rate, at an annual average of 4.3 percent between 2010 and 2018. Other emerging economies with average energy intensity rates that are at or above that set by SDG target 7.3 include India and Indonesia. The United Kingdom, Japan, and Germany continue to improve their energy intensity at rates beyond SDG target 7.3, thanks to decades of concerted effort toward energy efficiency and a shift in their economies toward producing high-value, low-energy goods and services.
- **End-use trends:** Although global primary energy intensity improved across all sectors during the period 2010–18, the rate differed by sector. Using different intensity metrics, the rate of improvement slowed compared with the period 1990–2010 in all sectors except for transport, where fuel efficiency standards drove energy intensity improvements. The decline in the rate of improvement from one period to the other is most noticeable in services, where energy intensity has worsened since 2010, but also in agriculture and, to a lesser extent, industry. All three of these sectors were significantly influenced by emerging economies, which experienced rapid improvements in energy intensity during the period 1990–2010 as they mechanized production and shifted to higher-value goods and services.
- **Electricity supply trends:** The mounting share of renewables in electricity supply also improves the efficiency of supply by eliminating the losses that are accounted for in the conversion of primary (nonrenewable) fuels into electricity. This relationship between efficient primary renewable electricity[45] and a decrease in primary energy intensity highlights the synergies between SDG target 7.2 and SDG target 7.3. In addition, the average efficiency of fossil fuel electricity generation increased from 36 percent in 2000 to 40 percent in 2018 due to relatively more efficient gas-fired generation and the construction of more efficient coal-fired generation in China and India. Major producing countries are seeing declines in electricity transmission and distribution losses, which indicates higher rates of electrification and a modernized supply infrastructure.

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42 Based on 2017 purchasing power parity.

43 Calculated as a compound average annual growth rate.

44 Revisions of underlying statistical data and methodological improvements explain the slight changes in historical growth rates from previous editions. Yet the target of improving energy intensity by 2.6 percent per year across the period 2010–30 remains the same.

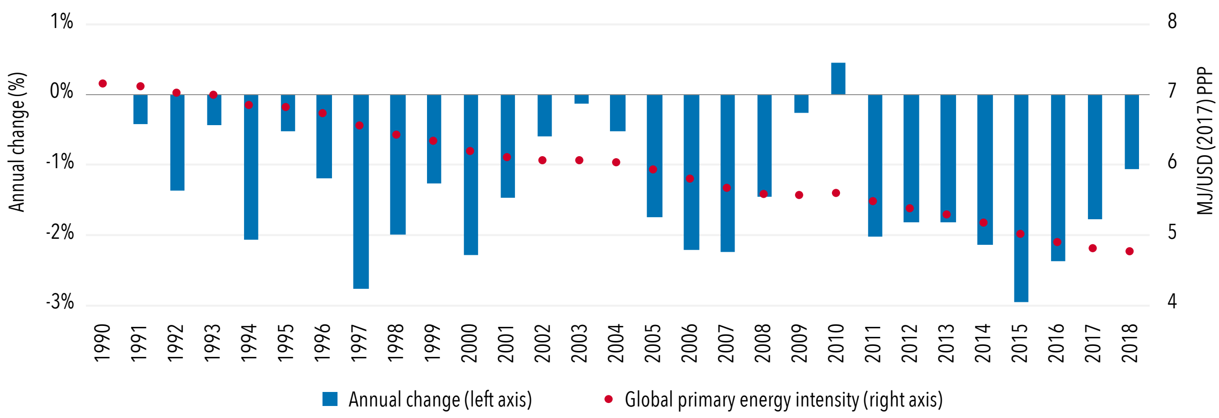
45 Primary renewable electricity such as hydropower, solar PV, wind, and ocean energy is captured directly from natural resources. Electricity from geothermal, solar thermal, and biomass sources is renewable but it is not treated as 100 percent efficient in energy statistics due to conversion losses.

ARE WE ON TRACK?

Sustainable Development Goal (SDG) 7 commits the world to ensure universal access to affordable, reliable, sustainable, and modern energy. Achieving SDG target 7.3—doubling the global rate of energy intensity improvement by 2030—is key as it also supports the other targets under SDG 7. Energy intensity is the ratio of total energy supply to the annual gross domestic product (GDP) created—in essence, the amount of energy used per unit of wealth created. By using this measure of energy intensity to understand efficiency, we can observe how energy use rises or falls while also looking for the development factors (social and economic) that may affect those rates. 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, an annual improvement rate of 2.6 percent per year was recommended by the United Nations to achieve the target, but since global progress has been slower than necessary in recent years, the annual average improvement rate now required to achieve SDG target 7.3 by 2030 is 3 percent (figure 4.2). Nevertheless, global primary energy intensity has shown gradual improvement since 1990[46] (figure 4.1). Recent numbers show that global primary energy intensity improved by 1.1 percent in 2018 to 4.75 MJ/U.S. dollar (2017 purchasing power parity [PPP]) (figure 4.2). This is the lowest rate of improvement since 2010, though the trend has been slowing since 2015.

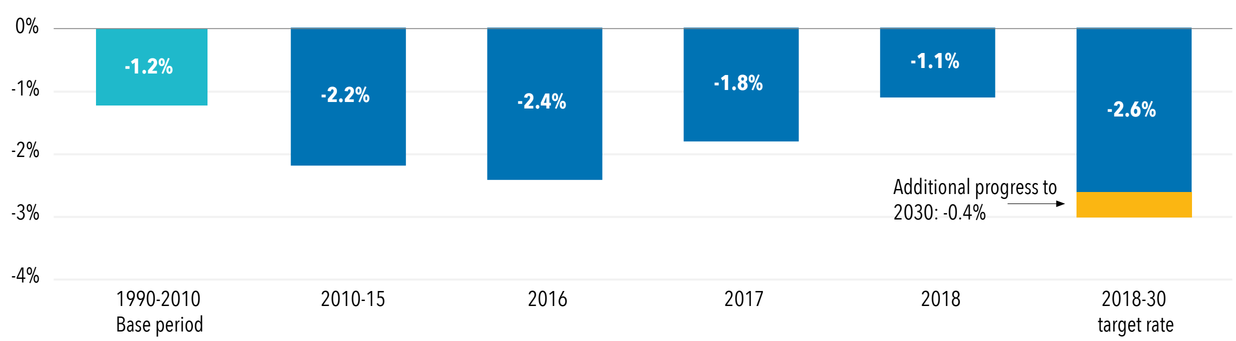
FIGURE 4.1 • Global primary energy intensity and its annual change, 1990–2018



Sources: IEA, UN, and World Bank (see footnote 46).

MJ = megajoule; PPP = purchasing power parity.

FIGURE 4.2 • Growth rate of primary energy intensity, by period and target rate, 2018–30



Source: IEA, UN, and World Bank (see footnote 46).

46 Most of the energy data in this chapter 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/).

LOOKING BEYOND THE MAIN INDICATORS

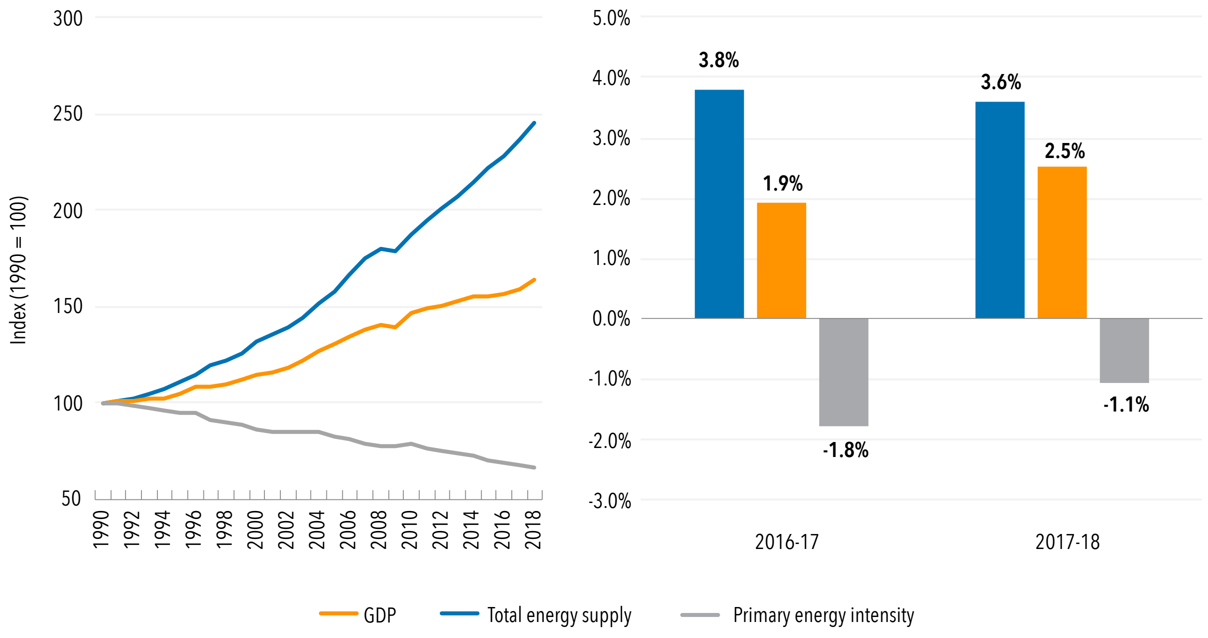
COMPONENT TRENDS

The impact of improvements in primary energy intensity (the global proxy for improvements in energy efficiency) is revealed by trends in its underlying components (figure 4.3, left). Between 1990 and 2018, global GDP increased by a factor of 2.5 while global total energy supply[47] grew by less than 65 percent. Growth in energy supply picked up in 2017, and continued to increase in 2018, growing 2.5 percent.

The difference in growth rates for global GDP and total energy supply is reflected by consistent improvements in global primary energy intensity, which fell by a third between 1990 and 2018, signaling trends in the decoupling of energy use and economic growth. In the period 2010–18, global primary energy intensity fell by nearly 15 percent, one and a half times more than the percentage fall observed between 2000 and 2010.

While GDP growth slowed slightly between 2016 and 2018, the growth rate for energy supply increased, resulting in a further slowdown in the improvement rate for energy intensity—from 1.8 percent in 2017 to 1.1 percent in 2018 (figure 4.3, right).

FIGURE 4.3 • Trends in underlying components of global primary energy intensity, 1990–2018 (left); and growth rates of GDP, total energy supply, and primary energy intensity, 2016–18 (right)



Sources: IEA, UN, and World Bank (see footnote 46).

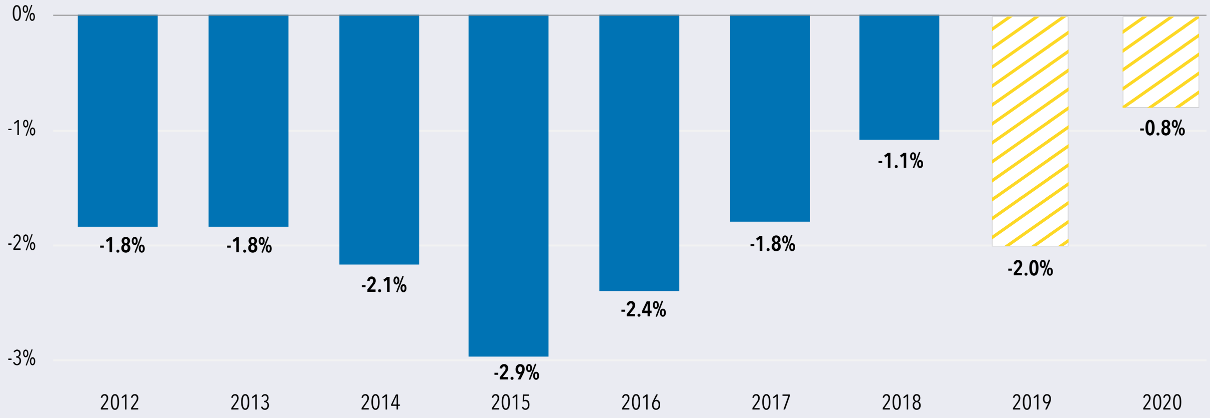
GDP = gross domestic product.

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

BOX 4.1 • COVID-19 AND ENERGY EFFICIENCY

The COVID-19 crisis has had a major impact on energy intensity. Lockdowns and travel restrictions cut global economic activity dramatically, leading to an expected 4.6 percent fall in global gross domestic product and a 5.3 percent fall in global total energy supply in 2020. Consequently, primary energy intensity improved by only 0.8 percent, the lowest rate since just after the last global economic crisis in 2010 (figure B4.1.1).

FIGURE B4.1.1 • Growth rate of global primary energy intensity, 2012–20



Source: IEA 2020a.

While primary energy intensity represents a number of factors—including the effects of changes in the composition of economic activity during the COVID-19 crisis—it also includes the impact of technical energy efficiency improvements, which is likely to be weaker, due to the economic uncertainty created by the pandemic.

In the immediate term, some energy efficiency improvements are expected to have continued thanks to investments already in the pipeline. There is also evidence from some countries that lockdowns provided businesses and households with opportunities to improve the energy efficiency of commercial and residential buildings. In some cases, however, job uncertainty and lower incomes associated with extended lockdown measures have led to lower adoption of energy efficient appliances. Government support programs that subsidized household energy bills may have insulated consumers from absorbing energy costs that otherwise would have served as incentive for purchasing more energy efficient appliances. An overall decrease in travel has also had mixed outcomes for the share of energy efficient modes in transport activity. For example, the share of active modes such as walking and biking has increased, while public transport use has decreased. Efficient electric vehicles sales appear to have remained healthy, spurred partly by government support programs (IEA 2020a).

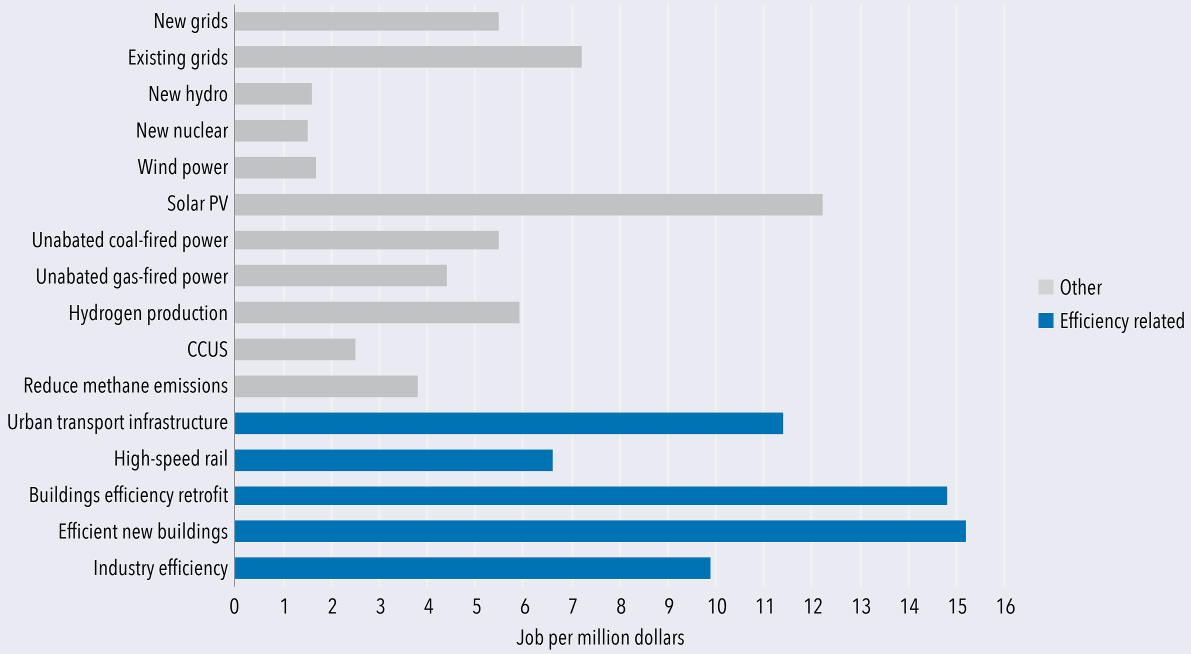
Particularly in industry, investments in new energy efficient technologies and practices are likely to have weakened, as economic uncertainty led businesses to reprioritize their investments. Overall, however, the International Energy Agency estimates energy efficiency investments remained relatively stable in 2020.

There is some evidence to suggest that following an economic crisis, a larger share of energy inefficient investments tends to flow to low-income countries, especially those dependent on foreign direct investment (Mimouni and Temimi 2018). As these countries start attracting investment to support jobs after the crisis, ideally this would not come at the expense of locking in energy-inefficient capital stock, which could ultimately cost more and lock in lower productivity in the medium to long term.

While medium- and high-income economies will have more resources available to stimulate economic growth following the crisis, they also face the challenge of ensuring stimulus investments to create jobs also support energy-efficient, rather than inefficient, technologies and practices. Therefore, strong policies for energy efficiency should be a shared goal of governments throughout the world.

Thankfully, as energy efficiency delivers a range of benefits, and supports the achievement of several SDGs beyond SDG 7 (from decent work and economic growth to sustainable cities and communities), it is an obvious choice of government support. The high labor intensity of energy efficiency makes it a particularly attractive investment during a recession. For example, International Energy Agency analysis has found that a million dollars spent on building energy efficiency can deliver around 15 jobs, one the highest factors in the energy sector (figure B4.1.2). In its post-COVID-19 recovery agenda, the International Renewable Energy Agency estimates that employment in energy efficiency would expand from just under 10 million jobs in 2017 to 29 million in 2030 (IRENA, 2020).

FIGURE B4.1.2 • Construction and manufacturing jobs created per USD 1 million of capital investment in the International Energy Agency's Sustainable Recovery Plan



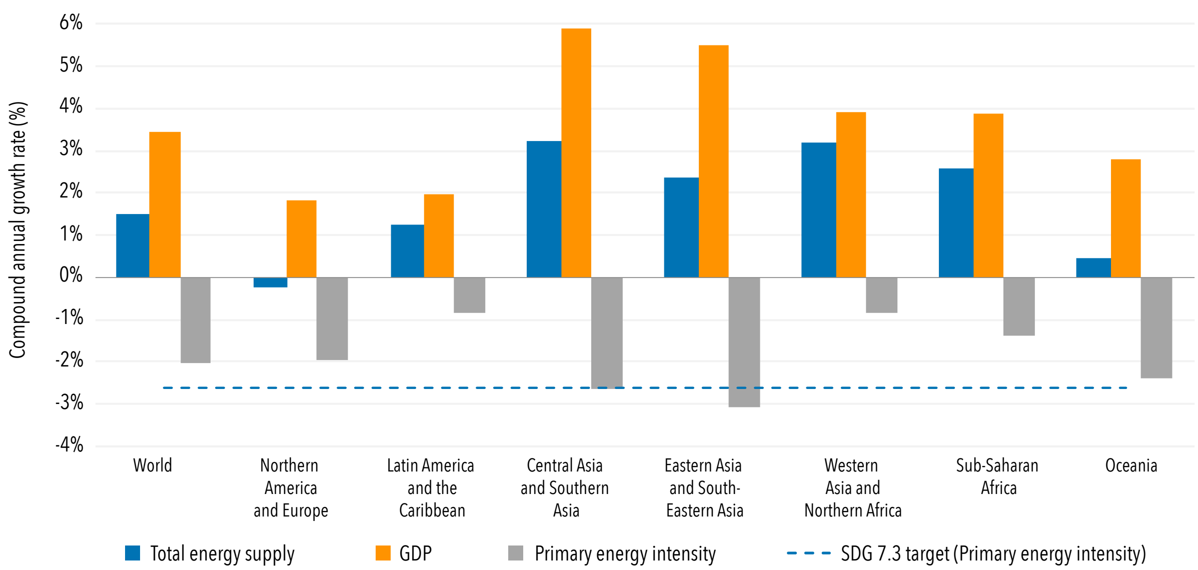
Note: Further information available from IEA (2020f); CCUS = carbon capture and storage.

REGIONAL TRENDS

Overall, since 2010, primary energy intensity has improved across the world, but significant differences in trends are observed across regions (figure 4.4). Emerging economies in Central, Southern, Eastern, and South-eastern Asia have seen a rapid increase in economic activity; however, the rise in total energy supply associated with such growth has been mitigated in part by significant improvements in energy efficiency, which have put downward pressure on the global average. Over the same period, mature 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 accomplishment was made possible by a continued shift toward less energy-intensive industrial activities (such as services) and improved energy efficiency one observes when mature policies are in place, particularly in buildings (Northern America) and industry (Europe). In these economies, energy intensity improved at a rate slightly below global trends, leading to an absolute level of energy intensity slightly below the global average (figure 4.5). Similar trends and absolute levels of energy intensity have been observed for Oceania, where total energy supply increased modestly, while GDP grew faster than in Northern America and Europe.

Western Asia and Northern Africa, Latin America and the Caribbean, and Sub-Saharan Africa recorded the smallest average gains in energy intensity improvement over the period 2010–18 (less than 1.4 percent per year). However, trends differed across these regions. In Latin America and the Caribbean, both growth in total energy supply and GDP were among the lowest worldwide, but it is also the least energy intensive region in the world, at 3.3 MJ/U.S. dollar (2017 PPP) (figure 4.5). In Western Asia, Northern Africa, and Sub-Saharan Africa, both growth in total energy supply and GDP were among the highest worldwide. In absolute terms, economic output in Sub-Saharan Africa is highly energy intensive, at nearly 6.5 MJ/U.S. dollar (2017 PPP), reflecting the low value of economic output and the widespread use of inefficient solid biomass for cooking in this region, compared to 4.3 MJ/U.S. dollar (2017 PPP) in Northern Africa and Western Asia (figure 4.5).

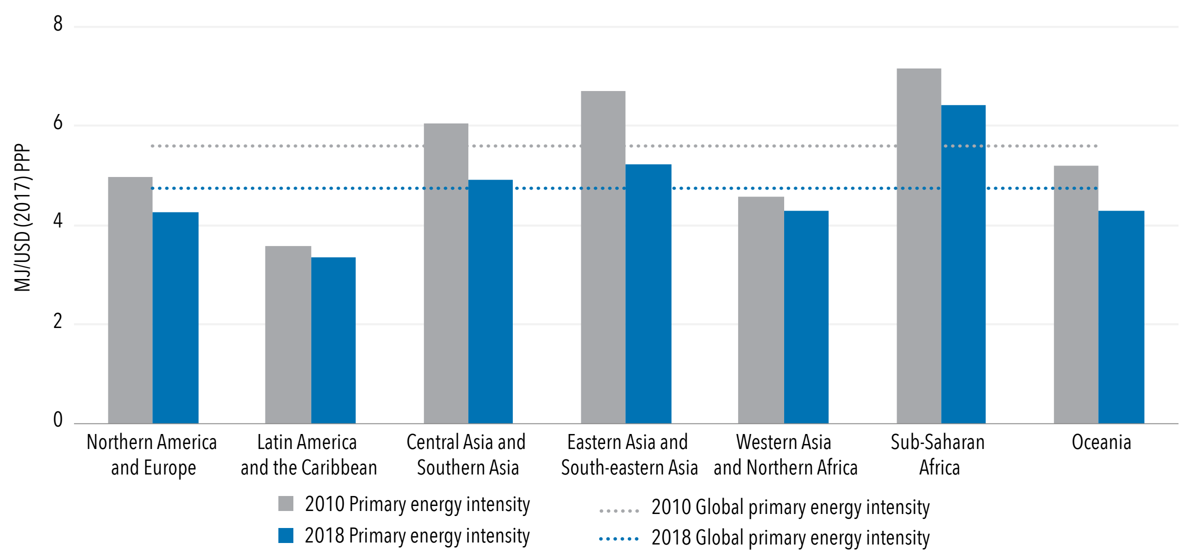
FIGURE 4.4 • Growth rate of total energy supply, GDP and primary energy intensity at a regional level, 2010–18



Sources: IEA, UN, and World Bank (see footnote 46).

GDP = gross domes6tic product.

FIGURE 4.5 • Primary energy intensity at a regional level, 2010 and 2018



Sources: IEA, UN, and World Bank (see footnote 46).

MJ = megajoule; PPP = purchasing power parity.

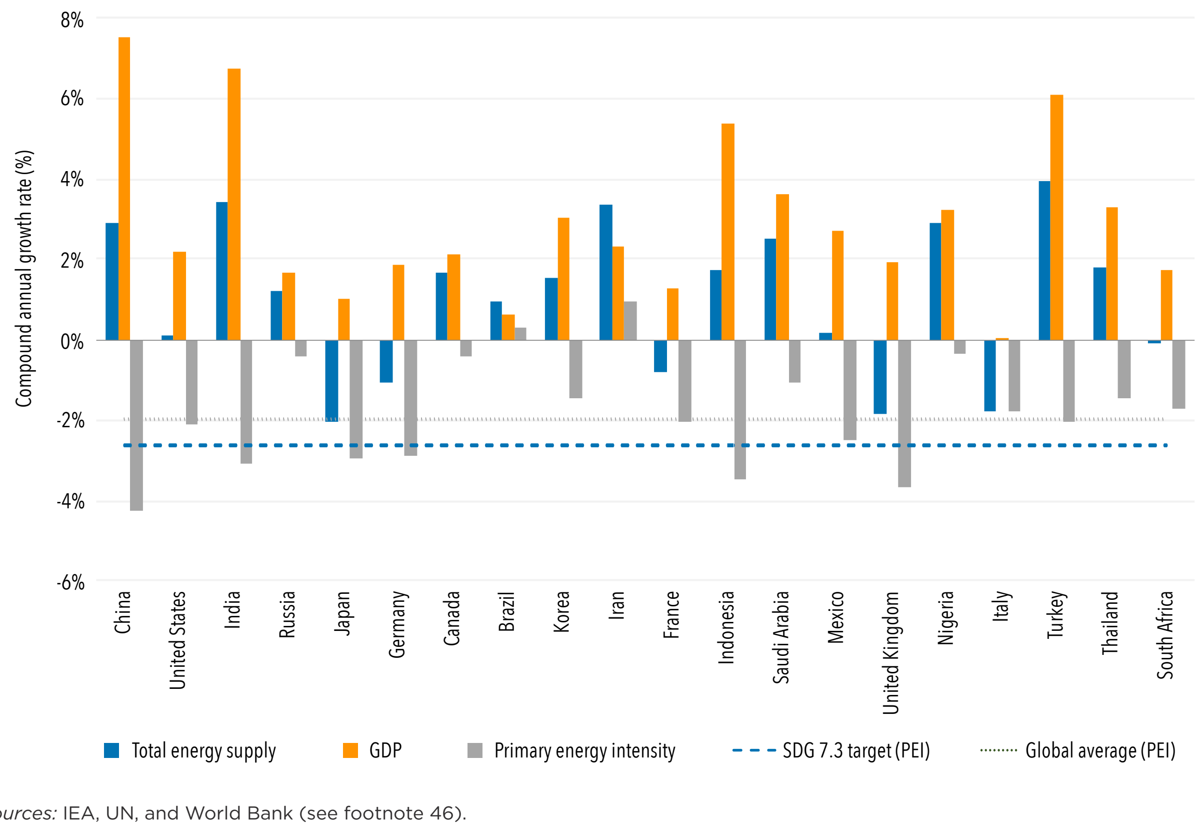
MAJOR COUNTRY TRENDS

Rates of improvement for primary energy intensity in the 20 countries with the largest total energy supply would be central to realizing SDG target 7.3, as they account for around three-quarters of global GDP and energy consumption. Over the period 2010 to 2018, 14 of these countries increased their rate of improvement, but only half of the top energy-consuming countries performed better than the global average, with six (China, United Kingdom, Indonesia, India, Japan, and Germany) exceeding the level required by SDG target 7.3 (figure 4.6).

Of these six countries, three—China, Indonesia, and India—are major emerging economies. These countries have seen rapid structural changes in their economies, changes that have moved them toward higher-value activities that create more GDP for every unit of energy consumed. In these countries—particularly China and India—concerted efforts to introduce energy efficiency policies over the period have quickened the pace of energy intensity improvements, beyond the pace set by structural economic changes alone.

The economies in the United Kingdom, Japan, Germany, and France have expanded as their energy use declined. In Italy, primary energy intensity improved as total energy supply dropped while GDP remained constant. These trends suggest that economic growth is being decoupled from energy use, as economic activity has largely shifted to high-value, service-related activities that are less energy intensive. In addition, the economies in these countries all have strong, decades-long records of policy action on energy efficiency.

FIGURE 4.6 • Growth rate of total energy supply, GDP, and intensity in the 20 countries with the largest total energy supply, 2010–18

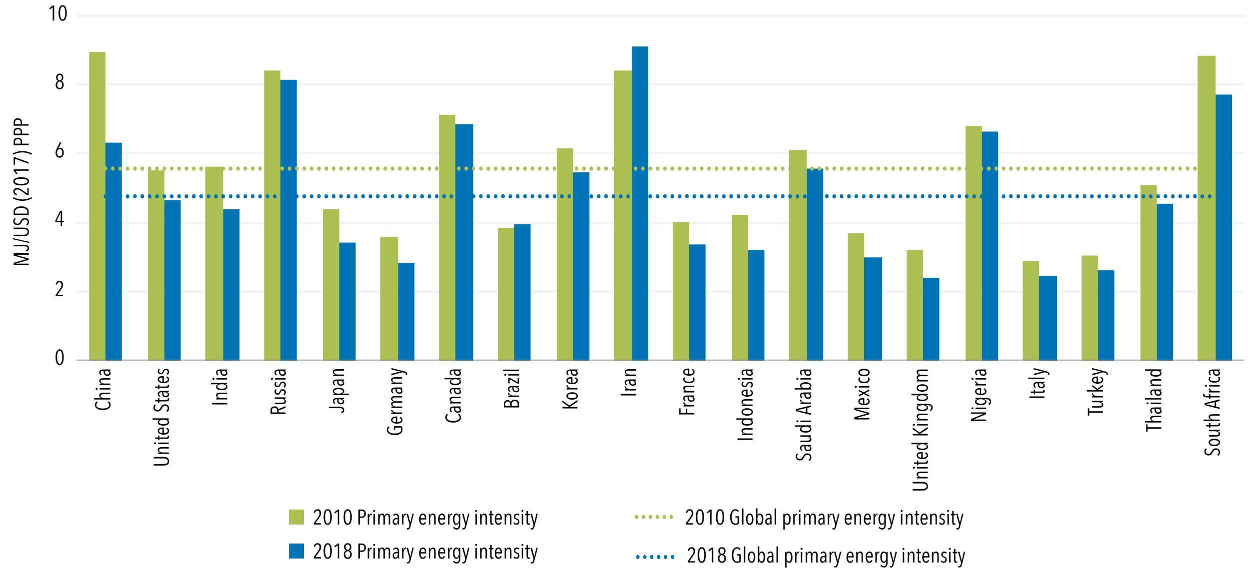


Sources: IEA, UN, and World Bank (see footnote 46).

Note: Countries along x-axis ordered by total energy supply.

GDP = gross domestic product; SDG = Sustainable Development Goal.

FIGURE 4.7 • Primary energy intensity in the 20 countries with the largest total energy supply, 2010 and 2018



Sources: IEA, UN, and World Bank (see footnote 46).

Note: Countries along x-axis ordered by total energy supply.

MJ = megajoule; PPP = purchasing power parity.

In absolute terms, the energy intensity of 8 of the top 20 energy-consuming countries remain above the global average, a minor improvement from 9 in 2010 (figure 4.7). Iran, Russia, and South Africa are the countries with the highest energy intensities and maintained levels of energy intensity exceeding global averages in 2010 and 2018. Since 2010, however, average global primary energy intensity fell by nearly USD 1/MJ (2017 PPP).

Certain countries have made progress by moving further below global average energy intensity, including India, Indonesia, Japan, the United States, and the United Kingdom. Others—such as China and South Africa—despite remaining more energy intensive than the global average, are improving and shifting toward the global average. Countries where progress has been slowest include those where energy-intensive fossil fuel extraction represents a major segment of economic activity—namely, Iran, Brazil, Nigeria, Canada, and Russia.

BOX 4.2 • DIGITALIZATION KEY TO ACCELERATING ENERGY EFFICIENCY ACROSS SECTORS AND SYSTEMS

Digitalization is transforming the energy sector, and, if harnessed, will accelerate progress toward the achievement of Sustainable Development Goal target 7.3. With the proliferation of digital devices and low-cost sensors, a wealth of granular and continuously up-to-date data is now available to optimize energy supply and use. Digitalization provides new insights to strategically direct energy efficiency measures to where they can be most impactful and have the greatest benefit.

Digitalization is a critical catalyst for decarbonization and decentralization: smart grids are vital for accommodating growing shares of variable and distributed renewables (IEA 2020j), and, together with digital platforms, allow for full, efficient utilization of a range of flexibility options, including behind-the-meter connected devices. The International Energy Agency estimates that 3,070 terawatt-hours (TWh) of current electricity consumption is technically available for digitally enabled demand response, and this is expected to almost double by 2040 to about 6,220 TWh, or around a quarter of electricity consumption worldwide (IEA 2020g).

The COVID-19 pandemic has had a major impact on energy intensity, as described in box 4.1, but it has also shown the importance of electricity systems, which have ensured continuity of critical infrastructure, enabled remote working and home-schooling (IEA 2020f), and of energy-efficient information and communication technology systems, which have allowed network electricity usage to remain flat despite a spike of 50 percent or more (GSMA 2020). Following this crisis, there is an opportunity to stimulate economic recovery based on more efficient, sustainable, and resilient electricity systems, where digitalization can play a key role.

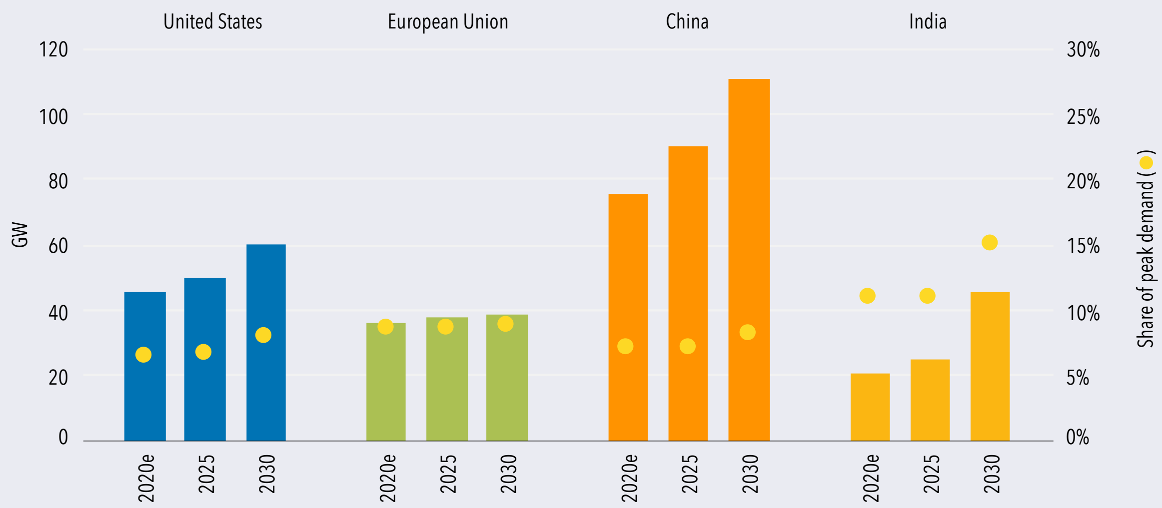
Digital technologies can help achieve significant energy efficiency outcomes across sectors. For example, in the buildings sector, digitalization could cut total energy use by 10 percent by 2040, creating cumulative energy savings of 234 exajoules—equivalent to more than half the final demand consumed globally per year (IEA 2019a).

Digitalization also offers systemwide benefits, including active participation of consumers and behavioral change, reliability and resilience, operational efficiency, cost reductions, and investment optimization. It also has the potential to produce positive economic and social outcomes. For example, the International Energy Agency estimated that projects' job creation potential is higher per unit of investment for those projects that include the modernization or digitalization of existing grids (IEA 2020f).

Cities in particular hold the key to implement many of the solutions that deeply decarbonized systems need to operate securely and efficiently. By 2040, flexibility in electricity networks will need to double to accommodate rising shares of wind, solar, and new uses of electricity like electric vehicles, or electric heating and cooling (IEA 2020j).

Deploying digitally enabled platforms in dense urban areas could unlock much of the flexibility needed. The International Energy Agency estimates that vehicle-to-grid applications during peak times could provide over 600 gigawatts of flexibility globally by 2030 across China, the United States, the European Union, and India (IEA 2020b). The vast majority of this potential—equivalent to the world's total wind power capacity in 2020 (IEA 2020e)—lays in urban and peri-urban areas, where charging of large numbers of electric vehicles in residential areas, offices, or public charging facilities could be aggregated to provide flexibility services to the grid. Four times as much potential to provide flexibility could be technically tapped in the future by smartly managing electricity equipment inside residential, commercial, and industrial buildings (IEA 2020g).

FIGURE B4.2.1 • Power system flexibility needs in selected regions in the Stated Policies Scenario, 2020–30



Source: IEA 2020j.

Note: 2020e = estimated values for 2020. Flexibility needs are represented by the average of the highest 100 hour-to-hour ramping requirements after removing wind and solar production from electricity demand.

GW = gigawatt.

END-USE TRENDS

Using different energy intensity metrics, it is possible to examine the impact across different sectors: compared with the period 1990–2010, the rate of improvement slowed across all sectors, with the exception of transport (figure 4.8).

In the industry sector, which comprises highly energy-intensive economic activities such as the production of cement, iron, and steel, the annual rate of energy intensity reductions dropped by roughly a quarter: from 3.4 percent to 2.6 percent. This slower rate of energy intensity improvement can be largely attributed to increased industrial production in China and the United States, particularly the steel and petrochemical sectors, respectively (IEA 2019a). In spite of this slowdown, industry energy intensity improved at the highest rate of all the sectors over the 2010–18 period, reflecting continued gains in productivity. This is largely driven by emerging Asian economies such as China and India through, for example, more efficient manufacturing processes for steel, cement, and chemicals (IEA 2017). The share in global cement production in China and India (where energy intensities are among the lowest in the world) rose from 42 percent to 63 percent between 2004 and 2018 (USGS 2021). Furthermore, the policy framework for industry energy efficiency tends to be more developed than for other sectors across countries worldwide (IEA 2018).

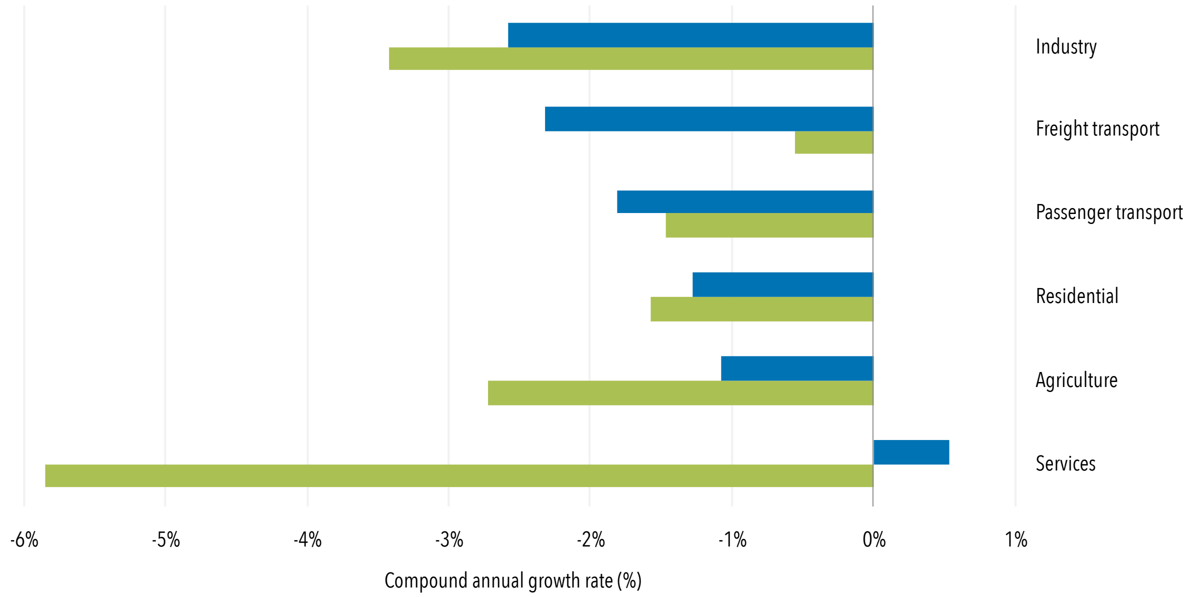
Between 2010 and 2018, the freight transport sector experienced the second-highest rate of energy intensity improvement, after the industry sector, at 2.3 percent a year. This drop in intensity is steeper than the 0.5 percent annual reduction seen in the period 1990–2010. Similarly, energy intensity for passenger transport improved at a faster rate of 1.8 percent a year compared with the previous period (1.5 percent). The transport sector is a primary source of global emissions. As people travel more frequently and over longer distances, and consume more imported goods, the sector is growing rapidly. Although stronger fuel efficiency standards in major markets are improving energy efficiency, these are offset by behavioral changes. For example, consumer demand for new and larger private road vehicles—comparatively energy-intensive forms of transport—remains strong, particularly as living standards rise in emerging economies (IEA 2019a; 2019b).

The residential sector, which is responsible for more than a quarter of electricity consumption worldwide, has seen a minor slowdown in the rate of energy intensity improvement, from 1.6 percent in the previous period to 1.3 percent annually between 2010 and 2018. Demand for new construction continues to grow alongside populations, and recent years have seen increasing demand for cooling and larger living spaces. Mitigating some of these effects would require increased ambition in the enforcement of building energy codes, especially in emerging economies, where a large share of new dwellings is being built. In addition, exceptional weather events in 2018 caused an increase in demand for heating and cooling, exacerbating the slowdown in energy intensity improvement.

Between 2010 and 2018, the services sector experienced the greatest slowdown across all sectors in the rate of energy intensity improvement. While showing the highest rate of improvement in the previous period at 5.8 percent a year, energy intensity in the sector increased over the period 2010–18 at an annual rate of 0.5 percent. There are two likely reasons for this. First, the productivity gains brought about by the widespread computerization of this sector in emerging economies had reached a saturation point. Second, services had become increasingly focused on higher-end products.

Similarly, the improvement rate for agriculture's energy intensity more than halved—from 2.7 percent a year in 1990–2010 to just 1.1 percent between 2010 and 2018. As with the services sector, this is explained by a natural slowdown in the rate of improvement in emerging economies with the advent of modern farming techniques following a period of rapid mechanization that brought large gains in output for each unit of energy consumed.

FIGURE 4.8 • Compound annual growth rate of energy intensity by sector, 1990–2010 and 2010–18



Sources: IEA, UN, and World Bank (see footnote 46).

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 final energy use per 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 services, industry, and agriculture sectors, energy intensity is defined as final energy use per unit of gross value added (in 2017 U.S. dollar purchasing power parity). It would be desirable, over time, to develop more refined sectoral and end-use-level energy intensity indicators that make it possible to look at 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 the relevant energy-consuming sectors.

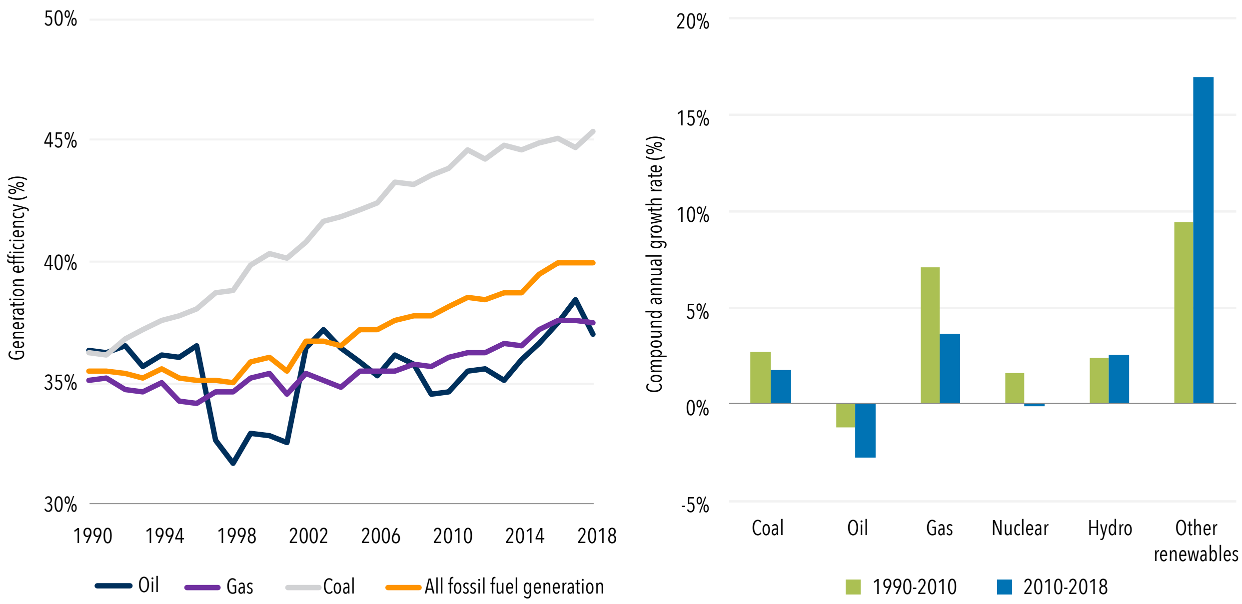
TRENDS IN ELECTRICITY SUPPLY EFFICIENCY

In addition to improvements in end-use efficiency, the rate of global primary energy intensity improvement is also influenced by changes in the efficiency of electricity supply. These include improvements in the efficiency of fossil fuel generation and reductions in transmission and distribution losses. The efficiency of fossil fuel electricity generation steadily improved from 2000, after showing flat rates of improvement during the preceding decade, to reach 40 percent in 2018 (figure 4.9).

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 because no losses are accounted for in the conversion of resources such as sunlight and wind into electricity. So, generally speaking, having more renewable energy in the mix boosts the efficiency of electricity supply.

In 2018, renewable energy comprised 29.2 percent of global electricity consumption, making a notable contribution to energy efficiency. Between 2010 and 2018, renewable electricity sources other than hydropower grew at an annual average rate of 16.9 percent, up from 9.4 percent in the period 1990–2010 (figure 4.9). Hydropower electricity also grew at a slightly faster rate than in the preceding period. Conversely, growth rates for fossil fuel generation were all lower in 2010–18 than in the 1990–2010 period. The combined effect of these growth rates has been to improve the overall efficiency of electricity supply by reducing losses experienced when converting energy supply into electricity. Trends showing that increasing the share of renewable electricity helps to reduce energy intensity point to a synergistic relationship between SDG targets 7.2 and 7.3.

FIGURE 4.9 • Trends in global fossil fuel electricity generation efficiency (left) and growth in electricity generation by fuel type (right), 1990–2018



Source: IEA 2020h.

POLICY RECOMMENDATIONS AND CONCLUSIONS

Recent shortfalls in energy intensity improvement—below rates that would meet SDG target 7.3—will require strengthened government policies on energy efficiency. Well-designed and well-implemented energy efficiency policies can deliver a range of benefits beyond energy and emissions savings.

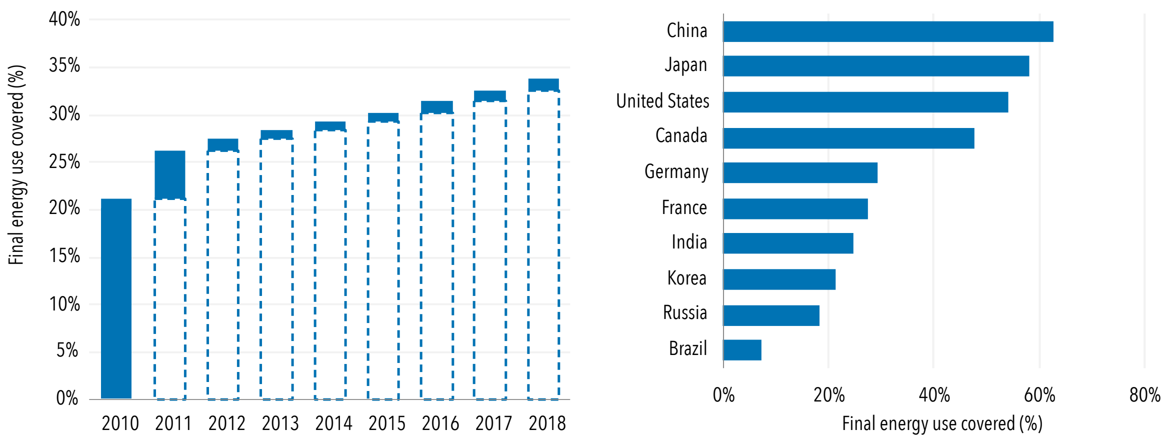
Strong policy action is also vital for signaling to investors that energy efficiency is a long-term priority, helping to create more certainty for investors and to catalyze the transformative investments needed to return the world to a path to meet SDG target 7.3.

ENERGY EFFICIENCY POLICY

Governments have several policy tools for increasing energy efficiency, including regulatory instruments that mandate minimum efficiency levels in buildings, appliances, vehicles, and industry; fiscal or financial incentives to increase the financial viability of installing energy-efficient equipment; and information programs to help energy users make informed decisions. The following section describes some options and policies.[48]

Analysis of energy use covered by regulatory instruments[49] shows that only about one-third of use is covered by measures that mandate energy savings (figure 4.10, left). Not coincidentally, policy coverage is highest in countries that have made the most progress in lessening their energy intensity since 2010, such as China, Japan, and the United States.

FIGURE 4.10 • Growth in energy use covered by mandatory efficiency policies globally, 2010–18 (left), and 2018 coverage in the 10 countries with the highest total energy supply (right)



Source: Based on analysis for IEA (2019a).

Note: Methodological improvements explain the slight changes in historical policy coverage rates from previous editions. The country with the tenth largest total energy supply is Iran. However, since there is no mandatory efficiency policy coverage indicator for Iran, the figure includes the policy coverage for France (rank 11).

48 More information and examples can be found in the IEA's Global Policies Database (https://www.iea.org/policies), the World Bank's Regulatory Indicators for Sustainable Energy (RISE) (https://www.worldbank.org/en/topic/energy/publication/rise---regulatory-indicators-for-sustainable-energy), the Global Status Report of Renewable Energy Policy Network for the 21st Century (REN21), or the recommendations of IEA's Global Commission for Urgent Action on Energy Efficiency.

49 This metric reflects: the energy use of appliances, equipment, and vehicles required to comply with minimum energy performance standards (MEPS) before being sold; the energy use of buildings that were constructed or renovated in accordance with a mandatory building energy code; and the energy use of industrial firms or sectors that are required by law to meet energy efficiency improvement targets.

Minimum energy performance standards (MEPS) are a proven tool in policy making. Introducing MEPS would be one way to expand mandatory policies covering more products in more sectors globally. Mandatory MEPS have proven to be cost-effective; evaluations show that benefits outweigh any additional costs by a factor of 3 to 1.[50] To date, nearly 100 countries have adopted MEPS, covering more than 80 different types of technologies across economic sectors; yet despite their benefits, MEPS are still absent in many jurisdictions.

Well-designed MEPS programs can include features that encourage energy efficiency well beyond the minimum standards and drive innovation among equipment manufacturers to improve the competitiveness of industries and economies.

In the European Union (EU), for example, MEPS have been introduced in an EU-wide manner since 2005 as part of the Ecodesign framework directive, which currently covers over 24 technologies, from residential equipment, such as refrigerators and heating equipment, through to nonresidential equipment, such as motors. These efficiency requirements are periodically updated according to technology developments and have expanded to address the aspect of resource efficiency in product design, central to the European Union's circular economy strategy. The Ecodesign framework directive is estimated to be delivering nearly 20 percent of EU energy savings, over 300 million tons fewer greenhouse gas emissions, and net savings of EUR 63 billion in consumer expenditure (EC, 2018).

Government actions to reduce the cost of energy-efficient equipment or retrofits include economic incentives such as grants or loans. In New Zealand, for example, a series of energy efficiency programs have combined government and third-party funding (and, in some phases, homeowner contributions) to provide insulation retrofits, and sometimes heating, in older houses. Warmer Kiwi Homes (launched in 2018) provides subsidized insulation and heating retrofits for low-income homeowners. A 2011 cost-benefit analysis of a previous iteration of the insulation grants program found that it delivered health benefits well over NZD 1 billion (USD 610 million) (Gimes et al. 2012).

Bulk procurement policies are another effective tool for easing the cost of energy efficiency investments, as governments can leverage their considerable purchasing power to procure efficiency services or products. In India, for example, more than 350 million LED lamps have been distributed though the Unnat Jyoti by Affordable LEDs for All (UJALA) program. The program's economies of scale have helped reduce the price of a LED lamp by a factor of ten (EESL 2017).

BOX 4.5 • RECOMMENDATIONS OF THE GLOBAL COMMISSION FOR URGENT ACTION ON ENERGY EFFICIENCY

In response to a global slowdown in energy efficiency improvement, the International Energy Agency's executive director convened an independent high-level commission in June 2018 to examine how progress on energy efficiency could be accelerated through new and stronger policy action. The 23-member Global Commission for Urgent Action on Energy Efficiency was composed of current and former national leaders, ministers, chief executives, and global thought leaders. Members of the commission worked together to produce a set of 10 recommendations—finalized during the COVID-19 crisis—to encourage governments to implement more ambitious energy efficiency actions (IEA 2020d). Several of the recommendations were intended to encourage governments to deploy energy efficiency measures for their short-term economic stimulus benefits and their contribution to achieving long-term clean energy transitions.

A range of governments are taking action to make policy consistent with the recommendations. Germany's stimulus policy package shows a strong focus on building renovation, expanding a preexisting mechanism—the CO_2 Building Renovation Program—by an additional EUR 1 billion. This step will help to unlock the job creation potential of energy efficiency in the buildings sector (Recommendation 2), a sector that tends to be particularly labor-intensive. Similarly, Italy has supercharged the Eco Bonus program to provide 110 percent tax incentives from July 1, 2020, to December 31, 2021, for energy efficiency building renovations, installation of rooftop solar PV, and electric vehicle charging stations.

50 As in the Technology Collaboration Programme on Energy Efficient End-Use Equipment, 4E-TCP (IEA 2016).

Spain's Law on Climate Change and the Energy Transition, approved in May 2020, sets out a long-term vision and policy framework to achieve carbon neutrality by 2050. The law puts energy efficiency at the heart of Spain's cross-governmental climate action, committing to improve efficiency and reduce primary energy consumption by at least 35 percent by 2030 (Recommendations 1 and 10). It focuses strongly on building renovation, adding to Spain's existing long-term strategy for energy rehabilitation in the buildings sector (Recommendation 2). Under the law, the national government will closely collaborate with municipalities to expand more efficient and clean modes of transport in key urban areas, including by establishing low-emission zones no later than 2023 and investing in alternative mobility infrastructure (Recommendation 7).

Canada's recent announcement that it will step up its Community Efficiency Financing Initiative creates more opportunities for municipalities and subnational partners to take stronger action toward efficiency (Recommendation 7). The new USD 300 million fund supports municipalities' financing programs for home energy performance upgrades, which have proven effective in overcoming barriers such as access to capital or uncertainty about the cost and quality of retrofits, while creating local jobs and reducing emissions.

China's new policy for supporting private energy conservation, announced in July 2020, focuses on scaling up private sector efficiency investment through a range of financial instruments (Recommendations 3 and 4). Preferential tax incentives create opportunities for more efficient use of energy and water resources among businesses, while the policy strongly encourages financial institutions to incorporate efficiency criteria in their finance services. Subnational governments play a key role in implementing and monitoring these measures (Recommendation 7).

POLICIES FOR LEVERAGING DIGITAL TECHNOLOGIES TO SCALE UP EFFICIENCY

In order to take advantage of the multiple benefits that energy efficiency and digitalization can offer, national and subnational governments need to:

- Develop strategies or roadmaps to chart steps needed to progress.
- Systematically address barriers to data access, sharing, and use and ensure robust mechanisms for data protection.
- Build capacity to enable the use of digital tools for data management and analysis.
- Take measures to enable investments and encourage the development of innovative business models.

ENERGY EFFICIENCY INVESTMENT

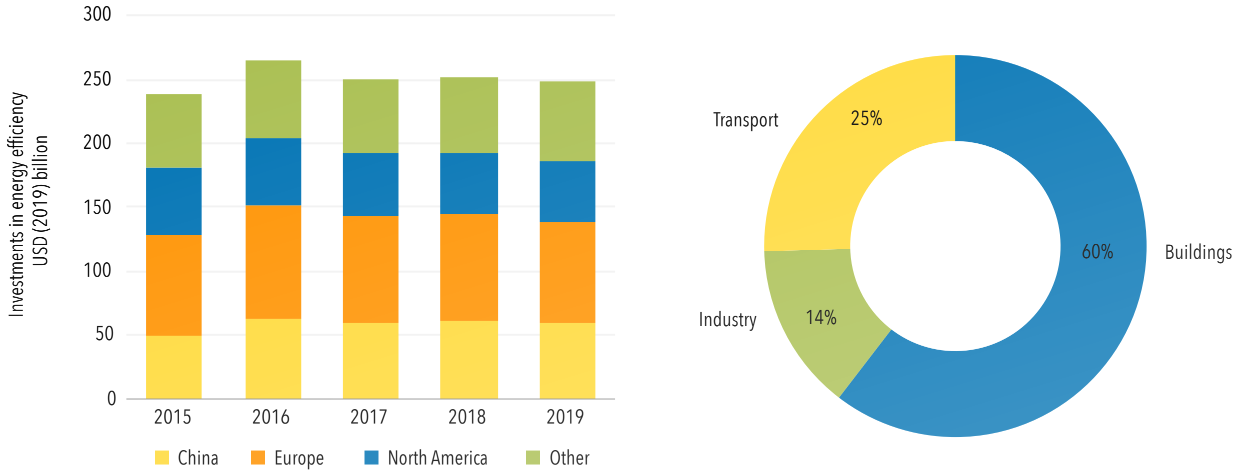
Investments in energy efficiency typically fall into one of the following four key areas:

- Incremental spending on more efficient technologies
- Project investments by energy service companies
- Green mortgages, green bonds, and property-based repayment schemes
- Climate mitigation investments by international financial institutions

Annual global investments in energy efficiency have remained largely unchanged since 2017 (figure 4.11). In 2019, incremental efficiency investments across the buildings, transport, and industry sectors stood at USD 249 billion, with the buildings sector consistently receiving the largest share of total investments—around 60 percent. Total investments declined slightly in 2019, driven by declines in industry (-6 percent) and transport (-4 percent) due to falling global car sales and the most efficient cars trailing the wider market (IEA 2020i). Global investments in the energy efficiency of buildings increased modestly, driven by strong growth in China.

Deploying readily available efficiency technologies is one of the most cost-effective means of saving energy while reducing emissions and achieving wider SDG targets. At current levels, however, the world is not investing enough in efficiency, suggesting a major missed opportunity.

FIGURE 4.11 • Energy efficiency investment by region, 2015–19 (left) and sector (right), 2019



Source: IEA 2020i.

CONCLUSIONS

The improvement rate for energy intensity has slowed over the past few years, falling well below the annual 2.6 percent initially projected as a prerequisite to reaching SDG target 7.3. The year 2018 saw a 1.1 percent improvement from 2017; this was the slowest rate of improvement seen since 2010. The average rate over that eight-year period, 2 percent, was better than the 1.2 percent annual average of the previous decade, but still low enough to require an average rate of 3 percent every year through 2030 in order to meet SDG target 7.3, doubling the global rate of energy intensity improvement by 2030. While early estimates for 2019 indicated an upward trend with an improvement rate of 2 percent, the outlook for 2020 suggests even lower levels of improvement at only 0.8 percent as a result of the COVID-19 crisis.

Nonetheless, the 3 percent target remains well within reach, provided there is significant and systematic investment in cost-effective energy efficiency improvements on a large scale. Given the multiple benefits of energy efficiency, it is an obvious choice of government support. This has been reflected in a range of recent stimulus packages throughout the world. The focus on cross-sector energy efficiency programs observed within global stimulus packages also reflects an opportunity for continued investment beyond these recovery efforts.

One of these benefits is that improved efficiency at scale would be a key factor in achieving affordable, sustainable energy access for all. The recent slowdown of intensity improvements, the significant potential opportunities for investment and economic recovery, and the pressing need for expanded access all point to the need for urgent action by governments to enact policies that would foster rapid progress toward a 3 percent annual improvement.

The decoupling of their economy from their energy use has been key to the progress some countries are making toward energy efficiency. In Japan, for example, minimally energy-intensive sectors (e.g., services) play a more prominent role in the economy than high-intensity sectors like heavy manufacturing. Still, some developing economies are seeing similar trends as their economies grow and their services and low-intensity manufacturing sectors pick up steam.

Every sector displays the trend toward slowing rates of intensity improvement, with the notable exception of transport, where efficiency rates improved faster than before. Passenger transport, for one, has seen increased demand as the world's growing middle class accelerates demand for personal vehicles and long-distance travel. This increase in demand has been offset, however, thanks to the strengthened efficiency standards many countries have implemented since 2010.

Digitalization has also been an emerging trend reshaping the energy landscape and facilitating progress toward improved energy efficiency. Wide-ranging data collection, analysis, and utilization can help to optimize demand and consumption at scale, to improve energy efficiency and to leverage flexibility opportunities at a systems level. Sector-specific digitalization solutions are also having a marked effect on energy efficiency. Some applications for the buildings sector, for example, could cut total energy use by 10 percent by 2040, creating cumulative energy savings of 234 exajoules. In addition to the opportunities to optimize efficiency, digitalization can also support deep decarbonization, particularly in cities. It would be essential for governments to seriously consider this trend when developing policies to ensure that the more optimistic scenarios end up dominating the landscape.

National and subnational governments have an array of policies to help them meet their energy efficiency goals. A number of successful, implemented policies exist in various forms around the world, including energy efficiency standards, financial incentives, market-based mechanisms, capacity-building initiatives, and regulatory changes. All of them encourage investment in efficiency measures and rebalance energy markets in favor of cleaner, more efficient operations.

The world has all of the technology and resources necessary to improve energy efficiency by 50 percent by 2030. The slowing rates of improvement and investment point to a major missed opportunity for the global community. Making energy efficiency measures a priority in policy and investment over the coming years can help the world achieve SDG target 7.3, improve economic development, and ensure universal access to clean, efficient energy.

METHODOLOGY

Total energy supply (TES) in megajoules (MJ)	This represents the amount of energy that is available in the national territory during the reference period. It is calculated as follows: Total energy supply = Primary energy production + Import of primary and secondary energy - Export of primary and secondary energy - International (aviation and marine) bunkers - Stock changes. (Definition coherent with International Recommendations for Energy Statistics). *Data sources:* Energy balances from the International Energy Agency (IEA), supplemented by the United Nations Statistics Division (UNSD) for countries not covered by IEA as of 2017.
Gross domestic product (GDP) in 2017 U.S. dollars (USD) at purchasing power parity (PPP)	Sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. GDP is measured in constant 2017 USD PPP. *Data source:* World Development Indicators (WDI database, http://datatopics.worldbank.org/world-development-indicators/).
Primary energy intensity in MJ/2017 USD PPP	$Primary\ energy\ intensity = \frac{TES\ (MJ)}{GDP\ (USD\ 2017\ PPP)}$ Ratio between TES and GDP is measured in MJ per 2017 USD PPP. Energy intensity (EI) 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 as changes are affected by other factors other than energy efficiency, particularly changes in the structure of economic activity.
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 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), while positive numbers 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 energy consumption by the 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 up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or 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/2017 USD PPP	$Industrial\ energy\ intensity = \frac{Industrial\ TFEC\ (MJ)}{Industrial\ value\ added\ (USD\ 2017\ PPP)}$ Ratio between industry TFEC and industry value added, measured in MJ per 2017 USD PPP. *Data sources:* Energy balances from IEA and value added from WDI.
Services energy intensity in MJ/2017 USD PPP	$Services\ energy\ intensity = \frac{Services\ TFEC\ (MJ)}{Services\ value\ added\ (USD\ 2017\ PPP)}$ Ratio between services TFEC and services value added measured in MJ per 2017 USD PPP. *Data sources:* Energy balances from IEA and value added from WDI.

Agriculture energy intensity in MJ/2017 USD PPP	$Agriculture\ energy\ intensity = \frac{Agriculture\ TFEC\ (MJ)}{Agriculture\ value\ added\ (USD\ 2017\ PPP)}$ Ratio between agriculture TFEC and agriculture value added measured in MJ per 2017 USD 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 between passenger transport final energy consumption and passenger transport activity measured in MJ per passenger-kilometers. *Data source:* IEA Mobility Model.
Freight transport energy intensity in MJ/ton-km	$Freight\ transport\ energy\ intensity = \frac{Freight\ transport\ TFEC\ (MJ)}{Ton\text{-}kilometers}$ Ratio between freight transport final energy consumption and activity measured in MJ per ton-kilometers. *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 between residential TFEC and square meters of residential building floor area. *Data source:* IEA Mobility Model.
Fossil fuel electricity generation efficiency (%)	$Generation\ efficiency = \frac{Electricity\ output\ from\ coal, oil, and\ natural\ gas}{Coal, oil, and\ natural\ gas\ input}\ (\%)$ Ratio of the electricity output from fossil fuel (coal, oil, and gas) fired power generation and the fossil fuel TES input to power generation. *Data source:* IEA Energy Balances.
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 from main activity producer electricity plants; and Electricity output CHP is electricity output from combined heat and power plants. *Data source:* IEA Energy Balances.

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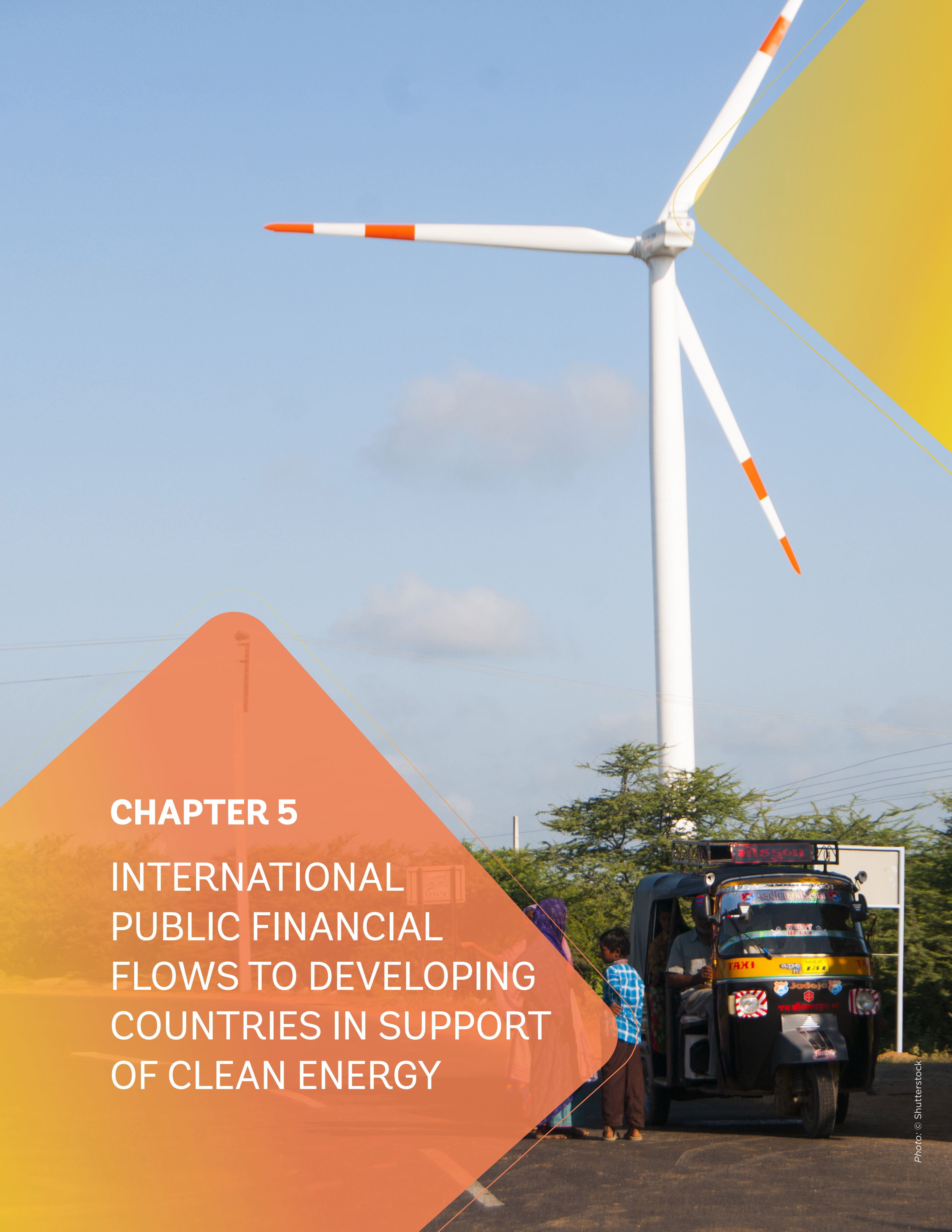

CHAPTER 5

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

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MAIN MESSAGES

- **Global trends:** Although renewable energy investments continue to be sourced primarily from the private sector, the public sector remains a major source of financing and is central in leveraging private capital, particularly in developing countries. Tracking of SDG indicator 7.a.1 by the custodian agencies shows that international public financial flows to developing countries in support of clean energy amounted to USD 14 billion in 2018, a 35 percent decrease from an all-time high of USD 21.9 billion in 2017 (box 5.1). Overall, however, the trend in international public financial flows has been positive over the past decade, with a threefold increase in the 2010–18 period when considering a five-year moving average. Combined with a 59 percent increase in active donors between 2010 and 2018, this trend demonstrates growing support from international donors for renewable energy in developing countries. Yet the level of financing remains below what is needed to reach SDG 7, in particular for the least developed countries (LDCs) and in a post-pandemic context.
- **The target for 2030:** Although there is no quantitative target for international public financial flows to developing countries under indicator 7.a.1, the overarching target of SDG 7.a points to the importance of enhancing international cooperation. In light of the pandemic and the urgent need to scale up overall investment in renewable energy, financial flows to developing countries must surge, especially toward those countries falling farthest behind—notably the LDCs. The pandemic has exacerbated the existing vulnerabilities of these countries, including: declining investments, growing debt burdens, and severely reduced fiscal space. In 2020, donors deployed sizeable capital for emergency responses, focusing first on protecting lives and livelihoods while reducing debt loads. In the post-COVID recovery phase, aligning public financial flows with low-carbon and climate-resilient development will be critical to accelerate progress toward SDG 7 while simultaneously stimulating economic development and employment. Several development finance institutions (DFIs) and governments have issued promising announcements in support of such efforts—but more is needed.
- **Technology highlights:** International public financial flows plummeted across all renewable energy technologies between 2017 and 2018, with the largest declines in hydropower and wind, which both fell by 61 percent. While hydropower has received the largest share of commitments over the period 2010–18, recent years have seen public financial flows redirected toward solar energy, which received 20–25 percent of commitments in 2016–18. A larger share of commitments has also been targeted toward "multiple/other renewables," including non-technology-specific support for multipurpose green funds and supporting infrastructure, such as grids and storage, among others. Altogether, these have amounted to some 20 percent of total commitments in recent years.
- **Regional highlights:** Except for Eastern and South-eastern Asia, international financial flows to all regions slowed between 2017 and 2018. Over the period 2010–18, however, flows to all regions followed a positive trend. The steepest rises were observed in Central and Southern Asia and Oceania—which saw six- and fourfold increases, respectively, during the period 2010–18 (using a five-year moving average). Although flows doubled from 2010 to 2018, Sub-Saharan Africa saw less growth than other regions in public financial flows. Nevertheless, the region has attracted more commitments to off-grid renewable energy, and targeted efforts have been launched during the pandemic to protect this important sector (box 5.2).

- **Country highlights and distribution:** Public financial flows continue to be concentrated in a few countries, although distribution by population improved between 2010 and 2018. Top receiving countries in absolute terms over the period 2010–18 were emerging economies and some of the countries with the largest access deficits—including India, Pakistan, Nigeria, Argentina, and Turkey. Together, these five countries received 30 percent of total commitments. In 2018 the 46 LDCs received 20 percent of commitments, the same level as in 2017 in absolute terms but less than in 2016 and 2015. On a per capita basis, most LDCs received less than the average across developing countries —most of these are in Sub-Saharan Africa, home to several of the world's top access-deficit countries.
- **Financing instruments highlights:** The most commonly used financial instruments were concessional loans, representing on average 65 percent of annual financial commitments over the 2010–18 period. A rising trend in use of risk-mitigation instruments (including guarantees and insurance) began in 2010, particularly for wind and solar projects. These instruments can help mobilize private capital as they effectively reduce actual and perceived risks and the cost of capital. Growing use of risk-mitigation instruments will also be critical in the post-pandemic phase, given that recent market uncertainty, including increased off-taker risk and volatility in financial markets, have made investors more risk averse.

BOX 5.1 • IN THIS EDITION, A NEW CHAPTER ON SDG INDICATOR 7.A.1

The 2021 edition of the report for the first time features a full chapter on SDG indicator 7.a.1. Designed to enhance international collaboration, this indicator measures the amount of international public finance being deployed to support clean energy in developing countries under SDG 7.a. For purposes of the indicator, clean energy is understood to mean renewable energy, including bioenergy, geothermal, hydropower, ocean, solar, and wind energy, as well as hybrid systems.

The indicator covers official loans, grants, and equity investments received by countries on the Development Assistance Committee's (DAC) list of recipients of official development assistance (ODA), as well as any additional developing countries that are recipients of assistance in support of clean energy from foreign governments, multilateral agencies, and other development finance institutions. The indicator does not track private finance leveraged through these international public financial flows, although such finance is certainly relevant.

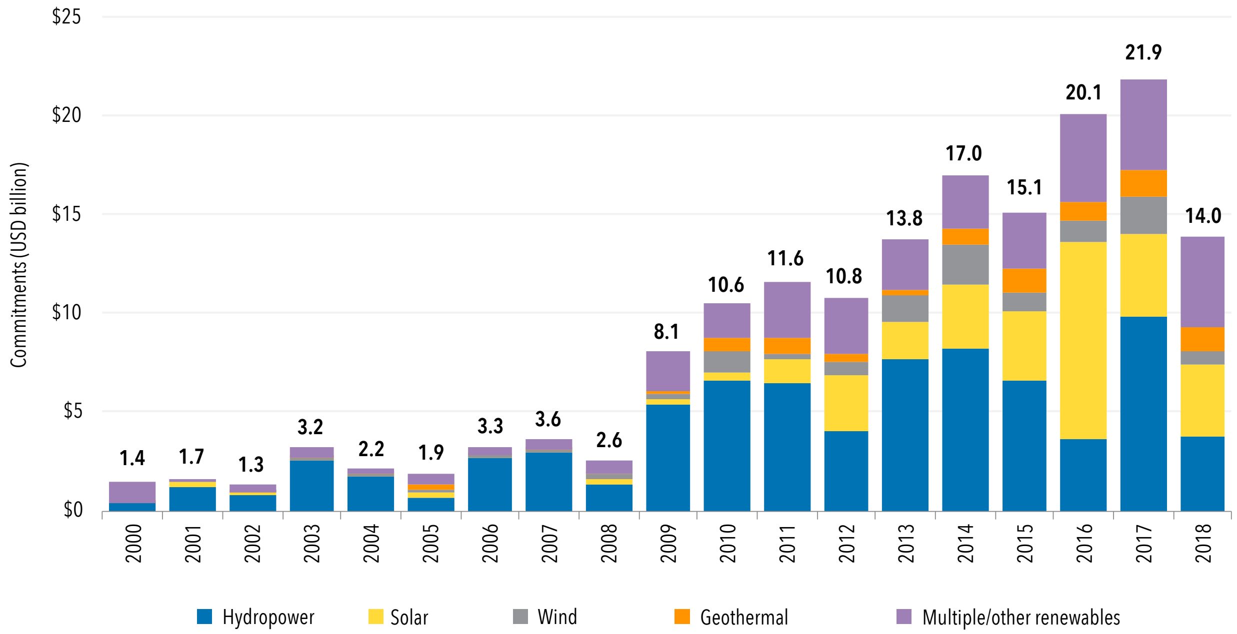
For this indicator, international public financial flows are recorded as the financial commitments made by donors, irrespective of the time required to complete disbursements. It should be noted that financial disbursements may spool out over weeks, months, or years. The focus on commitments allows for a more comprehensive and granular analysis of financial flows and ensures methodological consistency across data sources.

More details about the scope of the data and data limitations can be found in the methodology section at the end of this chapter.

ARE WE ON TRACK?

Findings suggest that important progress was made over 2010–18 in enhancing international financial flows to developing countries for clean energy, although commitments dropped from an all-time high of USD 21.9 billion in 2017 to USD 14.0 billion in 2018 (figure 5.1).[51] This decrease is primarily explained by the fluctuating nature of annual commitments[52] and to a few large outlier projects. The decline in 2018 was attributable chiefly to a 61 percent drop in hydropower commitments (from USD 9.8 billion in 2017 to USD 3.8 billion in 2018), following a large single-project commitment in 2017 of USD 5.2 billion to fund the Mambilla hydroelectric plant in Nigeria. The decline in financial flows in 2018 could partly also reflect the turbulence of this particular year for global economies (Jones 2018) and the trend of falling global investments in renewable energy technologies (box 5.4).

FIGURE 5.1 • Annual international public financial flows (commitments) to developing countries in support of clean energy research and development and renewable energy production, by technology (USD; 2000-18).



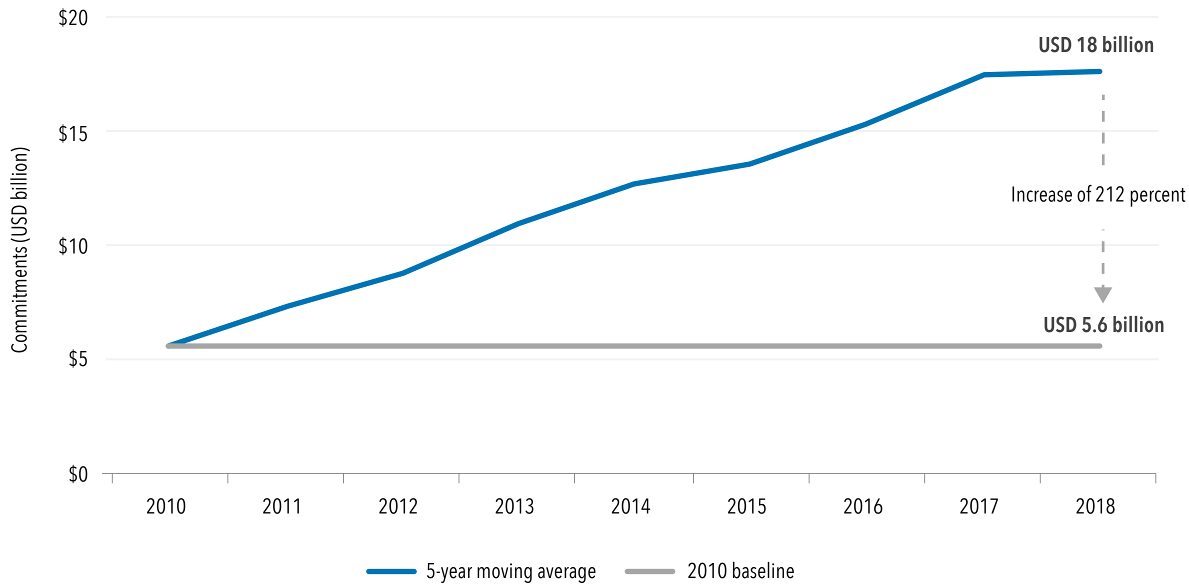
Source: IRENA and OECD 2021.

To better reflect the trend in financial flows, the analysis in this chapter also considers a five-year moving average showing that financial flows grew threefold between 2010 and 2018, from USD 5.6 billion to USD 17.6 billion (figure 5.2). While remaining stable in 2018, average financial flows rose steadily each year between 2010 and 2017, demonstrating progressively growing support from international donors for clean energy in developing countries. This growing support is further confirmed by the increase in active donors making financial commitments to clean energy, although flows continue to be heavily dominated by a handful of capital providers. The effects on the trend of the disruptions of the pandemic and changing priorities of DFIs and donor countries remain to be seen.

51 Except as otherwise indicated, the data underlying the figures and graphs in this chapter were drawn from the IRENA Renewable Energy Public Investments Database, a database based on OECD and IRENA data on international financial flows to developing countries in support of clean energy (https://www.irena.org/Statistics/View-Data-by-Topic/ Finance-and-Investment/Renewable-Energy-Finance-Flows). All USD amounts have been adjusted to constant prices and 2018 exchange rates.

52 Indicator 7.a.1 tracks international financial flows as annual commitments as opposed to disbursements. The methodology section at the end of the chapter offers further details.

FIGURE 5.2 • Commitments based on five-year moving average against 2010 baseline (USD; 2020-18).



Source: IRENA and OECD 2021.

Although there is no quantitative target under SDG indicator 7.a.1 on international financial flows to developing countries, it is clear that financial commitments to developing countries will have to increase, in light of the COVID-19 crisis and the need to boost renewable energy investment—from global levels of around USD 300 billion per year in the power sector alone, to USD 550-850 billion a year throughout 2019-30 (IEA 2020; IRENA 2020c).[53] Furthermore, the need to bolster financial support to developing countries has been identified as a central commitment under both the Paris Agreement and the Addis Ababa Action Agenda. Most important are efforts to direct financial flows toward those countries trailing farthest behind.

International financial flows to developing countries in support of clean energy advanced over 2010–18 and achieved a more even distribution across the population. But the overall numbers mask the disproportionate weight of a few countries and a few large commitments. Top receiving countries—namely, India, Pakistan, Nigeria, Argentina, and Turkey—accounted for 30 percent of total commitments in absolute terms over the period. Several of these top receiving countries have become donors themselves in recent years.

The 46 LDCs lie at the lower end of the recipient scale. LDCs received around 20 percent of commitments over the 2010–18 period and a total of USD 2.8 billion in 2018, the same level as in 2017 yet lower than in 2016 and 2015. Over half of LDCs (24 out of 46) received less than USD 2.5 per capita—lower than the average—leaving plenty of room for scaling up support. Many LDCs are in Sub-Saharan Africa, which is home to some of the top energy access-deficit countries in the world. Often underserved by the private sector, these countries are gravely in need of international support, as also demonstrated by other studies (e.g., SEforAll and CPI 2020).

53 See chapter 6 on investment levels needed to reach SDG 7.

LOOKING BEYOND THE MAIN INDICATOR

This section further explores the 2010–18 trends for public financial flows to developing countries in support of clean energy research and development and renewable energy production. It analyses trends across technologies, geographical contexts, and financial instruments. While international public financial flows are important to renewable energy finance, they represent only a portion of global renewable energy finance, which is further described in this section (box 5.4).

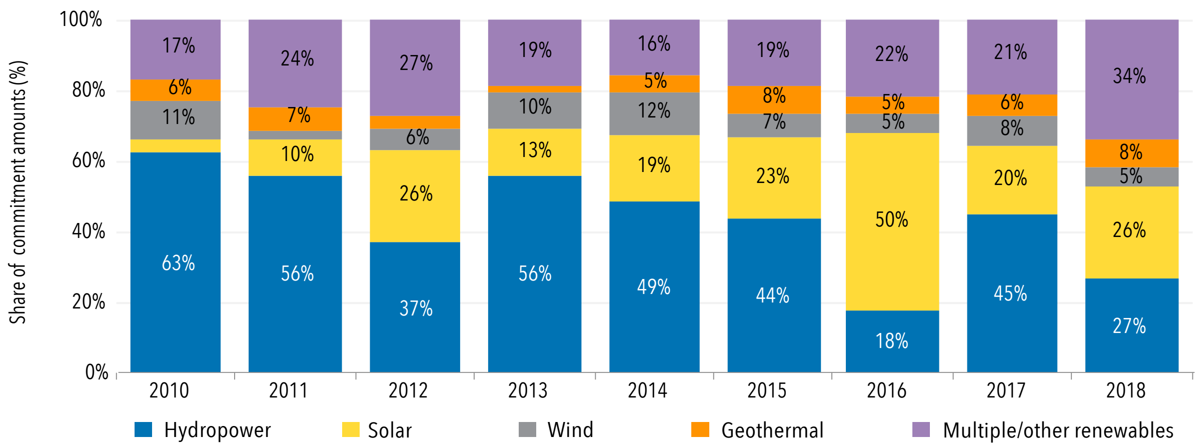
TECHNOLOGY TRENDS

The great majority of international financial flows to developing countries in support of clean energy is technology-specific, meaning that the donor has allocated the support (regardless of its type) to a specific renewable energy technology. Such technology-specific support may include, but is not limited to, project-level financing for feasibility studies, project development and production, supporting infrastructure, as well as research and technical assistance.

Between 2017 and 2018, international commitments decreased across all technologies under the SDG 7.a.1 indicator.[54] The largest drops were in flows for hydropower and wind, which each fell 61 percent—from USD 9.8 billion to USD 3.8 billion for hydropower and from USD 1.8 billion to USD 0.7 billion for wind. Meanwhile, financial commitments to geothermal and solar energy dropped, respectively, by 19 and 16 percent—from USD 1.4 billion to USD 1.1 billion for geothermal and from USD 4.3 billion to USD 3.6 billion for solar. The category “multiple/other renewables,” including support not specific to any particular technology (e.g., dedicated to multipurpose green funds or underlying infrastructure) grew 3.9 percent, from USD 4.5 billion to USD 4.7 billion.

Of the USD 134.8 billion in total financial flows over the period 2010–18, hydropower attracted the largest share (42.2 percent on average) despite declines in 2016 and 2018 (figure 5.3). These commitments in support of hydropower were mainly concentrated in India (USD 10.7 billion), Pakistan (USD 9.9 billion) and Nigeria (USD 6.6 billion). Support for hydropower was followed by solar, multiple/other renewables, and wind, which attracted averages of 22.9 percent, 21.7 percent, and 7.6 percent, respectively, for the 2010–18 period.

FIGURE 5.3 • Share of annual commitments by technology (2010-18).



Source: IRENA and OECD 2021.

Note: “Multiple/other renewables” includes commitments that could not be categorized as support for a specific technology for various reasons: unclear commitment description; commitments directed to support more than one technology; technologies receiving insignificant commitments such as bioenergy; or multipurpose financial instruments such as green funds, renewable energy and electrification programs, technical assistance activities, and infrastructure supporting renewable energy.

54 Clean energy for this indicator takes into consideration support for renewable energy, including bioenergy, geothermal, hydropower, ocean, solar, and wind energy, as well as hybrid systems.

Disregarding the peak in commitments in 2017 (USD 21.9 billion), the share of financial flows going to support hydropower has declined since 2015 (sinking in 2016 to 18 percent of commitments and in 2018 to 27 percent) in favor of other technologies, such as solar, wind, and multiple/other renewables, including renewable energy infrastructure.

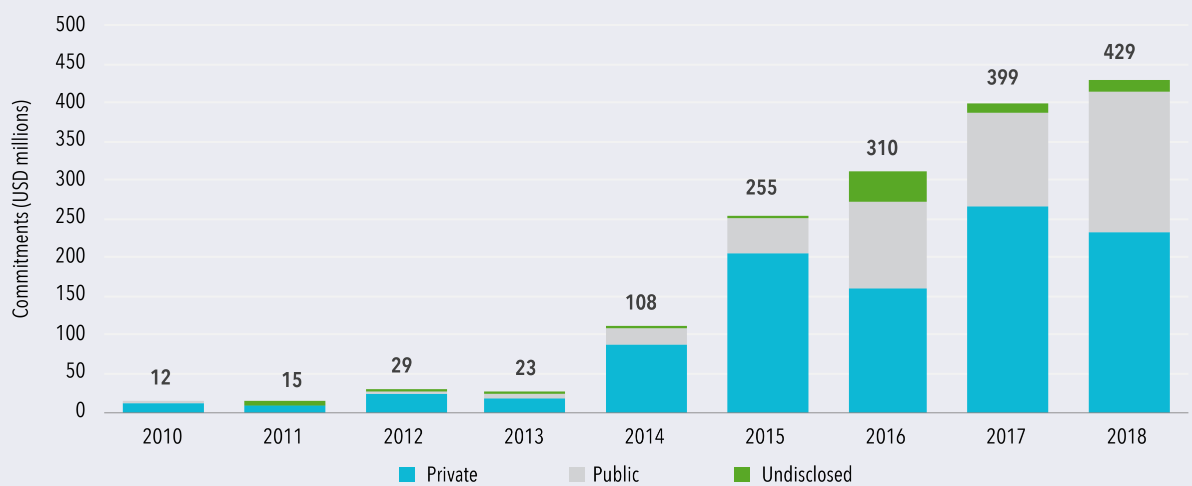
Since 2010, financial flows to developing countries have increasingly targeted solar energy, growing from shares of around 4 percent in 2010 to 20-50 percent in 2016–18. The increased interest of international donors in solar energy reflects a global trend. Solar installed capacity has undergone unprecedented growth over the past decade, partly because of technology cost reductions and market maturity (IRENA and CPI 2020). In addition, international donors have recently shown more interest in applications of solar technology in the off-grid renewable energy sector (for example, solar home systems and mini-grids), a key component to accelerate access to energy in developing countries (box 5.2 provides an overview of off-grid renewable energy financing trends).

From 2010 to 2018, international donors increased their financial commitments to what is categorized in this chapter as multiple/other renewables, attracting around 22 percent of yearly average commitments—a share comparable to that of solar. This category includes multipurpose green funds, which have multiplied in recent years, providing a convenient option for resource allocation for donors and financial institutions (United Nations 2020). These funds can be pooled to support smaller projects, which for some of the individual donors and other development partners might otherwise be difficult to support. The category further includes commitments to support infrastructure not specific to any particular technology, such as grids and battery storage. Multilateral development banks are moving increasingly towards supporting renewables by financing infrastructure, since investments in renewable power-generation assets can come directly from the private sector in many countries.

BOX 5.2 • OFF-GRID RENEWABLE ENERGY INVESTMENTS

Financing for off-grid renewable energy solutions in developing countries—both stand-alone systems and mini-grids—has grown considerably over time, albeit from a small base, from just USD 12 million in 2010 to nearly USD 430 million in 2018 (IRENA, based on Wood Mackenzie 2020) (figure B.5.2.1). During this period, off-grid renewables attracted more than USD 1.6 billion in commitments from private and public investors focused on solar home systems (accounting for 66 percent of the total), mini-grids (15 percent), and solar lights (12 percent).

FIGURE B.5.2.1. Annual public and private investments to off-grid renewable energy in developing countries, (USD; 2020-18)



Source: IRENA analysis based on Wood Mackenzie (2020).

Public financing has played a pivotal role in financing off-grid renewables, providing, on average, 32 percent of commitments during 2013–18—as compared to an average public share in total renewable energy investments of 14 percent (IRENA and CPI 2020). In the off-grid space, the role of public financing has also swelled over time—with shares growing from just 1–2 percent in 2010–11 to 30–42 percent in 2017–18—reflecting the increasing importance that public investors have attributed to these solutions for the provision of affordable, reliable, and sustainable energy services, as well as associated socioeconomic development. Meanwhile, the magnitude of private financing has also expanded, reflecting growing maturity and activity in the sector. Sub-Saharan Africa attracted the majority of public financial flows to off-grid renewable energy solutions in 2010–18 (69 percent). Public finance in the region was provided for the most part by international donors, including DFIs and government agencies, which provided 85 percent of total public commitments to off-grid renewables over the period. But the fact that finance is concentrated in a few countries (for example, Nigeria, the United Republic of Tanzania, and Rwanda) remains a key challenge, since many other countries are in need as well (IRENA, based on Wood Mackenzie 2020).

Even as investment in the off-grid renewable energy sector has grown, it still represents only about 1 percent of the total investment in energy access in deficit countries (IRENA and CPI 2020). Bankable business models are a key requirement for scaling up private sector participation. They would need appropriate risk-allocation frameworks and risk-mitigation instruments. An off-grid/mini-grid project is often perceived as nontraditional and risky, with the expected energy demand and associated ability to pay in the initial stages likely to produce uncertainty, in addition to other notable risks (such as licensing and permitting issues, lack of a track record, among others). As a result, access to affordable debt and project financing with appropriate tenors for off-grid projects remains challenging, leading most projects in the market to rely almost exclusively on grants or equity financing. Through the Solar Risk Mitigation Initiative (SRMI), the World Bank is proposing, in partnership with the Green Climate Fund, an innovative mechanism. It will mitigate minimum revenue payment risks, alleviating the demand risk and enhancing financial sustainability in the initial years of mini-grid projects. Also explored are additional coverage for financial risks, breach of contract, and provisions allocating risk if a law changes.

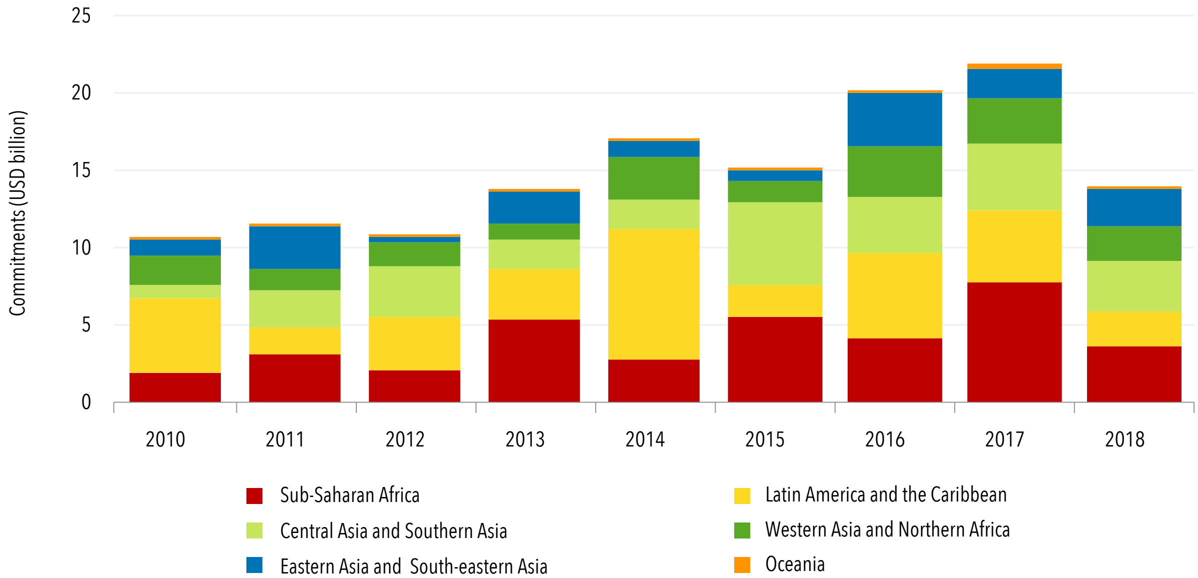
The COVID-19 pandemic has hit rural communities in developing countries especially hard, curtailing investments in energy access. Off-grid renewable energy solutions are key to the socioeconomic development and recovery of these communities, with stand-alone systems providing energy services to more than 420 million people globally (GOGLA 2020). Governments and donors have a key role to play in ensuring the survival and sustainable recovery of the sector. Some initiatives led by DFIs have been put in place in response to COVID-19.

For instance, the African Development Bank established the COVID-19 Off-Grid Recovery Platform to provide relief to energy access companies selling and deploying decentralized renewable energy solutions. As part of the initiative, the bank approved USD 20 million in concessional funding, which is expected to leverage USD 30–40 million in additional commercial investments (AfDB 2021). Similarly, under its Building Back Better approach, the World Bank is supporting the multistakeholder COVID-19 Energy Access Relief Fund. Established with USD 100 million in funding, it will provide concessional financing to small to medium-size enterprises in the energy-access sector (SIMA 2020). The World Bank has been scaling up electrification of health-care facilities (for example in Haiti), where a combined facility of USD 7.4 million from the Scaling-up Renewable Energy Program, the International Development Association, and the Energy Sector Management Assistance Program will electrify prioritized regional and district hospitals that lack reliable electricity and that currently have to rely on diesel. Countries such as Nigeria have also integrated investment plans in off-grid renewable energy solutions as part of their COVID-19 economic recovery plan (SEforAll 2020).

REGIONAL TRENDS

In 2018, international public financial flows in support of clean energy to developing countries not only dropped across all technologies but also across all regions, with the exception of Eastern and South-eastern Asia, where commitments grew by 43 percent over 2017 (figure 5.5).

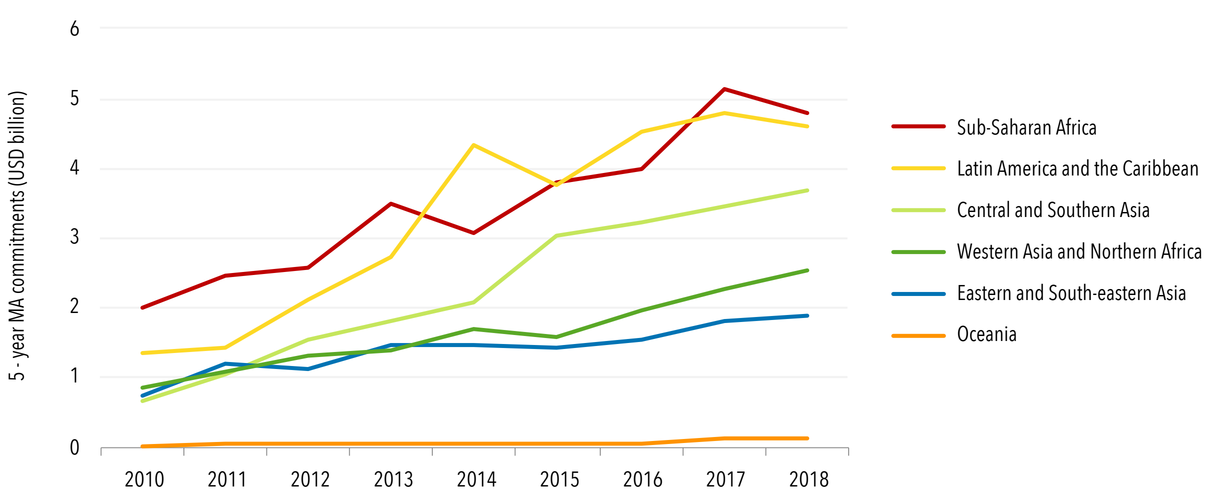
FIGURE 5.5 • Annual commitments by region, (USD, 2010-18)



Source: IRENA and OECD 2021.

Despite the decline in 2018, financial flows to all regions have grown steadily over the period 2010–18. The five-year moving average shows that Central and Southern Asia saw the largest average annual increase between 2010 and 2018, followed by Oceania, Latin America and the Caribbean, Western Asia and Northern Africa, and Eastern and South-eastern Asia (figure 5.6). Compared to other regions, Sub-Saharan Africa saw less growth in commitments when considering a five-year moving average. Nevertheless, the region attracted the highest total amount of public commitments over the period 2010-18, as well as the majority of public and private commitments in off-grid renewable energy. (box 5.2).

FIGURE 5.6 • Annual commitments by region based on a five-year moving average, (USD; 2020-18)



Source: IRENA and OECD 2021.

Central and Southern Asia saw a decrease in international financial flows, landing at USD 3.1 billion in 2018—down from USD 4.3 billion in 2017. Nevertheless, over the period 2010–18, financial commitments to the region grew steadily; in fact, Central and Southern Asia is the region that has seen the largest growth in annual average financial flows, with a close to sixfold increase according to the five-year moving average. In total, Central and Southern Asia received USD 26.9 billion in international public financial flows over the period 2010–18. Increased commitments in solar and wind energy starting in 2011 drove the growth—particularly in **India**, **Pakistan**, and **Bangladesh**—along with occasional large commitments to hydropower. The drop in 2018 may be ascribed to the fact that hydropower commitments reached only USD 492 million—the lowest value recorded in the region since 2010—down from USD 2.2 billion in 2017.

Financial flows to **Eastern and South-eastern Asia** reached a total of USD 2.5 billion in 2018, up from 1.8 billion in 2017. In total, the region received USD 15.8 billion in international public financial flows over the period 2010–18. The five-year moving average confirms a positive trend in the region, with average annual commitments more than doubling between 2010 and 2018. From a focus on hydropower projects prior to 2010, the region has seen increased commitments to various technologies—including wind, geothermal and solar—reaching shares of 28-48 percent between 2016 and 2018. The year 2018 was characterized by a rise in geothermal energy commitments, totaling USD 924 million and spread out among projects in **Indonesia**, **Philippines**, and **China**.

Latin America and the Caribbean saw international public financial flows fall to USD 2.3 billion in 2018—half of the USD 4.7 billion in 2017 commitments. In total, Latin America and the Caribbean received USD 36.2 billion in international public financial flows over the period 2010–18. While the trend based on the five-year moving average shows annual commitments tripling in 2018 compared with 2010, these annual commitments have stabilized since 2016. The technology mix of commitments has changed in the region from predominantly hydropower prior to 2010, to greater shares of solar and geothermal in recent years. Solar energy commitments, in particular, grew from a share of 1 percent in 2010 to between 25 and 50 percent in the 2016–18 period. Over time, the region has also seen increasing commitments to multi-technology projects and programs, which accounted for more than half of commitments in 2018.

For **Oceania**, financial flows amounted to USD 79 million in 2018—a significant drop from an all time high of USD 323 million in 2017. In total, Oceania received USD 800 million in international public financial flows over the period 2010–18. While commitments fluctuated greatly over the period 2010–18, the trend when looking at a five-year moving average shows an increase of almost four times in annual average investments between 2010 and 2018. Because the region attracts relatively small investments per commitment compared with other regions, any single year may vary considerably in the technology mix of commitments. Solar energy predominated in earlier years, with investments directed to small solar PV projects like rural electrification programs. The most substantial commitments were in hydropower projects. The drop in financial flows in 2018 followed a considerable commitment of USD 122 million to the Tina River Hydropower Development project in the **Solomon Islands** in 2017.

A drop in financial flows was seen in **Sub-Saharan Africa**, where commitments landed at a total of USD 3.7 billion in 2018—less than half of the record-high financial flows of USD 7.8 billion in 2017. In total, Sub-Saharan Africa received USD 36.5 billion over the period 2010-18, the highest total amount of all regions. There is a clear trend of increasing financial flows to the region—although lower growth than in the other regions—with average annual commitments doubling when looking at the five-year moving average. These flows have been channeled primarily to hydropower, which attracted less than 40 percent of financial commitments in 2010 but 72 percent in 2017 and 57 percent in 2018. The drop in financial flows in 2018 followed a record-high commitment of USD 5.2 billion to fund the Mambilla Hydroelectric Plant in **Nigeria**.

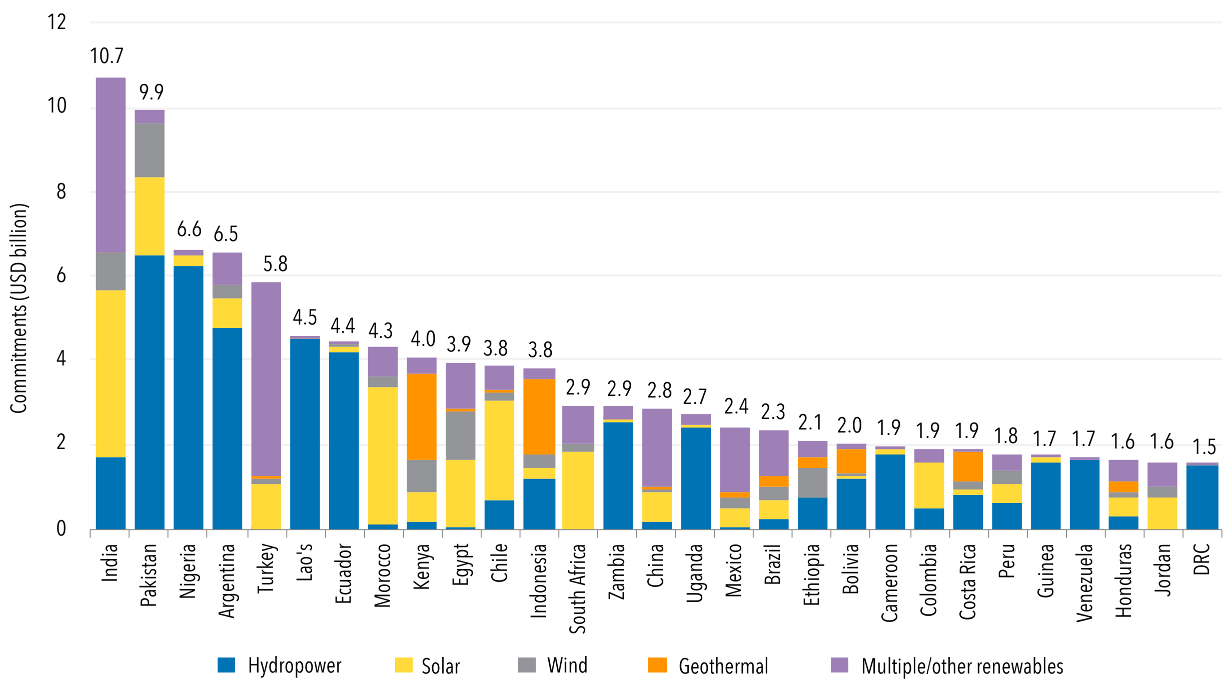
Financial flows to **Western Asia and Northern Africa** declined to USD 2.3 billion in 2018 from USD 3 billion in 2017. In total, Western Asia and Northern Africa received USD 18.5 billion in international public financial flows over the period 2010–18. The trend since 2010 has been positive, with average annual financial flows more than doubling between 2010 and 2018 when viewed through a five-year moving average. In recent years, the region saw an increase in solar energy investments, particularly in solar PV farms and distributed generation installations for buildings. In 2018, a considerable single-project commitment of USD 708 million was made to the 580 MW Noor Midelt I solar hybrid farm in **Morocco**.

COUNTRY TRENDS

While international financial flows to developing countries in support of clean energy increased over the period 2010–18 across all regions, a closer look at the data reveals that investments were concentrated in a small number of countries,[55] although the distribution across population has improved since 2010. Over the period 2010–18, 29 developing countries—representing 73 percent of the population in developing countries—attracted 80 percent of total financial flows (or USD 104 billion) (figure 5.7).

This concentration of flows largely reflects the operational policies and lending criteria of DFIs and donor countries. It should be noted that some of the recipient countries, having received very low financial flows, may not be eligible for or reliant on international public funding for clean energy investments. More and more developing countries are able to attract large amounts of private financing—especially some of the more mature clean energy markets or high-income developing countries. With that said, many developing countries continue to be underserved by the private sector as well as international public finance and are therefore in need of greater financial inflows to develop their clean energy sources.

FIGURE 5.7 • Total commitments by top recipients, (USD; 2020-18)



Source: IRENA and OECD 2021.

DRC = Democratic Republic of Congo.

Top receiving countries

India, Guinea, Indonesia, Turkey, and Morocco were the top receiving countries in 2018, accounting for close to 50 percent of total financial commitments that year. Guinea stands out in this group of emerging economies, based on a single commitment of USD 1.2 billion to a hydropower project, an amount that represents the great majority of what the country has received in financial commitments since 2010. The other four countries were steadily among the top receiving countries over the period 2010–18. Considering total commitments over the period 2010–18, top receiving countries were **India, Pakistan, Nigeria, Argentina,** and **Turkey**, together receiving 30 percent of total financial flows.

On the other end of the scale are developing countries that did not receive any international public financial flows in the entire 2010–18 period. Many of these are small territories or high-income economies such as **Bahrain, Singapore,** and the **United Arab Emirates**.[56]

55 "Country" as used in this chapter also refers, as appropriate, to territories or areas.

56 Countries with a per capita GNI of USD 12,536 or more are classified as high-income economies (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups).

India attracted the highest investment volumes, receiving USD 10.7 billion during the 2010–18 period. In 2018 alone, the country was the top recipient, at USD 2.1 billion (representing 15 percent of the total financial flows for the year). This is an increase of USD 1.3 billion from the USD 834 million received in 2017. Over time, commitments in India have transitioned from focusing on hydropower to solar energy, which reached an all-time peak investment of USD 1.5 billion in 2016. As one of the top top energy access-deficit countries in the world, India is receiving public financial flows from European institutions and governments, several multinational donors, and region-specific donors.

Pakistan was the second-largest recipient country, attracting USD 9.9 billion between 2010 and 2018—mostly in hydropower (USD 6.5 billion). In 2018, Pakistan saw a 95 percent drop in financial flows, sinking to USD 101 million from a high of nearly USD 2.1 billion in 2017. The decrease was due to a substantial drop in hydropower and wind energy commitments. Since 2013, wind and solar energy technologies have become more attractive to funders. While the steadiest donors in Pakistan are international development banks and European institutions and governments, the largest donors over 2010–18 were China Development Bank and the Ex-Im Bank of China focusing on large-project funding.

As the third-largest recipient country, **Nigeria** attracted USD 6.6 billion in 2010–18. Following the record-high financial flows in 2017, commitments decreased to USD 97 million in 2018. These year-on-year fluctuations are explained by commitments to hydropower plants—representing 94 percent of total investments in 2010–18. These commitments overshadow the trend of increasing solar energy commitments in the country, which has increased from a total of less than USD 10 million in 2015 to almost USD 100 million in 2018. Most of these financial commitments came from the Ex-Im Bank of China.

Argentina attracted USD 6.5 billion of total investments during the 2010–18 period. In 2018, commitments dropped to USD 498 million from USD 516 million in 2017. Throughout the 2010–18 period, Argentina received several investments to large solar PV plants and wind power. In many cases projects were backed up by renewable energy auctions such as the RenovAr rounds. Significant investors in the country are China Development Bank, the International Finance Corporation, the U.S. International Development Finance Corporation, and the Development Bank of Latin America.

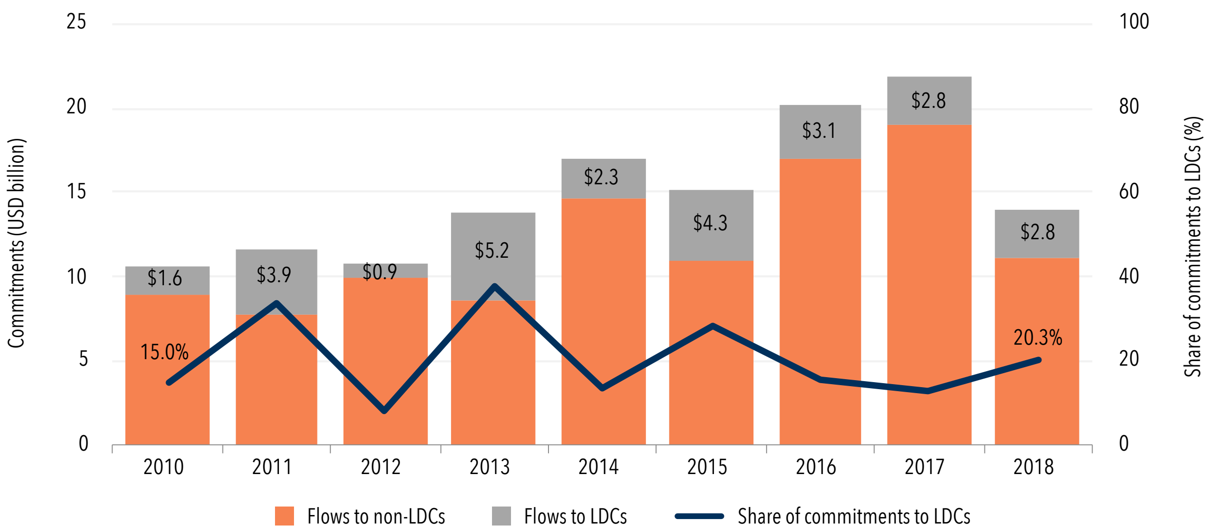
Turkey received USD 5.8 billion in public financial flows to clean energy in 2010–18. Commitments increased from USD 400 million in 2017 to USD 1 billion in 2018, mostly driven by investments to multi-technology projects and programs. In fact, these attracted most (77 percent) of the total investment in the 2010–18 period. Various donors targeted their commitments to Turkey, particularly the International Bank for Reconstruction and Development, the International Finance Corporation, institutions of the European Union (EU), the Islamic Development Bank, and KfW. For the first time in 2018, Turkey was also on the list of donor countries committing international public financial flows to clean energy.

Reaching those furthest behind

In 2020, the United Nations categorized 46 countries as LDCs - home to 1.06 billion people. Many of them are among the countries with the largest energy-access gaps and with limited progress toward attaining SDG 7. Lower levels of economic development, a less mature renewable energy sector, relatively weak financial markets, and political uncertainty make these countries particularly dependent on international public finance.

Over the period 2010–18, LDCs attracted 20 percent of total financial flows (USD 26.8 billion). That share has remained relatively stable. In 2018, they received a total of USD 2.8 billion, the same as in 2017, but lower than in 2016 and 2015 (figure 5.8). Decreased financial flows to LDCs risk leaving these countries even further behind on reaching SDG 7, but also on goals related to affordable, reliable, and modern energy (OECD 2019). This is even more relevant in light of the pandemic, which has hit these countries hard. The pandemic-induced recession may return millions of people to extreme poverty.

FIGURE 5.8 • Annual commitments to LDCs and non-LDCs in support of clean energy (USD; 2010-18)



Source: IRENA and OECD 2021.

On the positive side, all LDCs received financial flows at some point over the 2010–18 period and the number of LDCs receiving commitments annually increased from 33 countries in 2010 to 42 in 2018. Nevertheless, financial commitments are still concentrated in a few countries. The top receiving LDCs were **Lao People's Democratic Republic, Zambia, Uganda, Ethiopia,** and **Guinea,** which together attracted more than half of all commitments made in 2010–18. In 2018, **Guinea** and **Lao People's Democratic Republic** alone received 56 percent of commitments to LDCs. Those attracting the lowest financial commitments over this period were **São Tomé and Principe**, **Somalia,** and **Guinea-Bissau**.

Another group of vulnerable countries include the 53 small island developing states (SIDS), which face special circumstances and needs arising from the adverse impacts of climate change. In 2018, SIDS received a total of USD 220 million, down from an all-time high of USD 555 million in 2017. Over the period 2010–18, financial flows to SIDS more than tripled using a five-year moving average. Over this period, SIDS received a total of USD 2.2 billion—around 2 percent of total commitments to developing countries. The top receiving SIDS were **Cuba, Jamaica,** and **Solomon Islands,** which together attracted more than 31 percent of all commitments made to SIDS from 2010 to 2018. As further highlighted in the analysis below, many of the least-populated SIDS are among the top receivers per capita. Other SIDS—primarily high-income economies—received no commitments over the period.

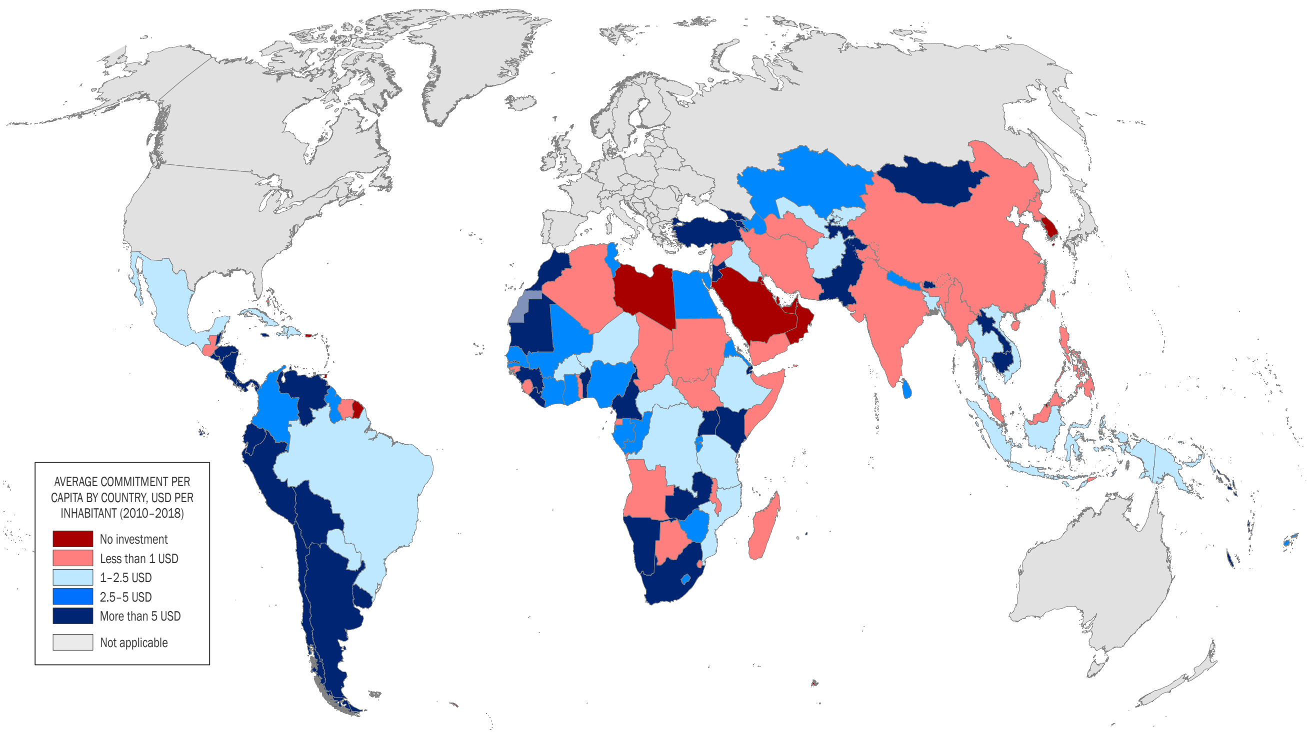
Special attention should also be directed to the 32 land-locked developing countries (LLDCs) facing trade and development challenges caused by their lack of sea access and their geographical remoteness[57]. In 2018, LLDCs received a total of USD 1.7 billion—a reduction of almost half compared with the USD 3.2 billion received in 2017. Over the 2010–18 period, LLDCs saw a 53 percent increase in commitments using a five-year moving average, a modest rise if compared with the tripling of financial flows to all developing countries. Still, LLDCs attracted commitments totaling USD 21.3 billion during the period, representing 16 percent of total commitments to developing countries. The top-receiving LLDCs were **Lao People's Democratic Republic, Zambia,** and **Uganda,** which together attracted almost half (47 percent) of total commitments made to LLDCs in 2010–18. The LLDCs that received the lowest commitments in the period were **Botswana, Turkmenistan**, and **Eswatini**.

57 While categorized as LLDCs, the Republic of North Macedonia and the Republic of Moldova are not considered "developing" by the United Nations and thus are excluded from the scope of the indicator and this analysis.

Distribution of financial flows to developing countries

The foregoing analysis of total financial flows showed that a large majority of total flows were concentrated in a small share of the developing countries. This section offers additional insights into the distribution of financial flows across population and how this has developed over the period 2010–18.

FIGURE 5.9 • Average commitment per capita by developing country (USD; 2020-18)



Source: IRENA and OECD 2021.

Note: The data on international public financial flows to developing countries in support of clean energy underlying this map were drawn from the IRENA Renewable Energy Public Investments Database, a database based on OECD and IRENA data (https://www.irena.org/Statistics/View-Data-by-Topic/Finance-and-Investment/Renewable-Energy-Finance-Flows). All USD amounts have been adjusted to constant prices and 2018 exchange rates.

Note/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 on any map in this work 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.

On a per capita basis, public financial flows reached an average of USD 2.4 over the period 2010–18. This number hides important disparities across countries, as shown in figure 5.9. Most notable from the map is that the majority of LDCs (24 of 46) received less than the average per capita in developing countries—most of which can be found in Sub-Saharan Africa, where the world's top access-deficit countries are found. Thirteen of these countries were in the lowest bracket, receiving, on average, less than USD 1 per capita each year over the period 2010–18.

Among those countries that received more than the average of USD 2.4 per capita can be found the majority of lower- and upper-middle-income economies. Of the 61 countries that received more than USD 5 per capita, a majority were upper-middle or high-income economies (figure 5.9).

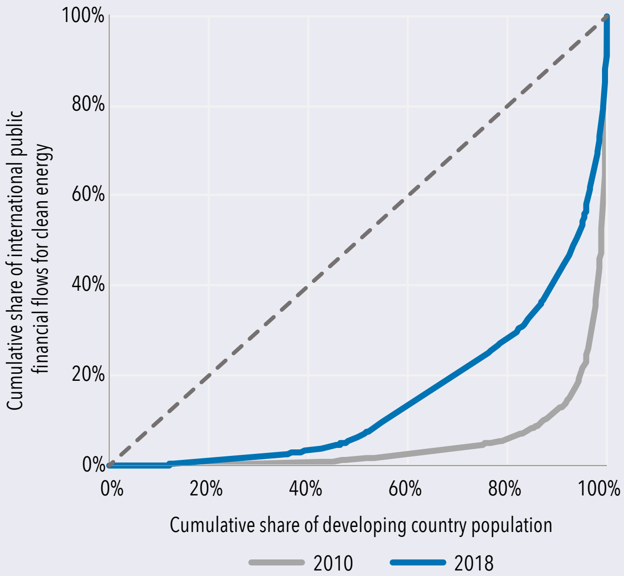
In addition to the operational and lending criteria of DFIs and donor countries, per capita numbers to some extent reflect country populations, with many of the least populous countries, for example, SIDS, receiving generous commitments per capita, while populous countries tend to attract lower levels. Although financial flows are concentrated in a few developing countries, commitments were more evenly distributed between developing countries in 2018 than in 2010—at least on a per capita basis (box 5.3).

BOX 5.3 • UNDERSTANDING THE DISTRIBUTION OF PUBLIC FINANCIAL FLOWS ACROSS DEVELOPING COUNTRIES, 2010–18

Public investments were more evenly distributed across populations in 2018 than in 2010, but there is still plenty of room for improvement.

The two curves in the figure show the amount of funding going to different countries (using population as a measure of country size to scale the need for investments in clean energy). Countries are ranked along the horizontal axis from those receiving the least funding to those receiving the most (in USD per capita). This type of chart is a standard indicator of distribution across a population that is used to calculate measures such as the Gini coefficient of income distribution. The 45-degree line would indicate a perfectly even distribution of financial flows (with each country receiving a share of total financial flows proportional to its population). The farther the distribution is from the 45-degree line, the more uneven the distribution of investment funding.

FIGURE B.5.3.1 • Distribution of commitments across developing countries, 2010 and 2018



At the lower end of the distribution, about 100 countries accounting for 50 percent of the population in developing countries received only 1 percent of public financial flows in 2010. By 2018, their share of total funding had increased to 5 percent. While still a small share with plenty of room for improvement, it has jumped in size.

At the other end of the scale, half of all commitments in 2010 went to just eight countries accounting for less than 1 percent of the population living in developing countries. By 2018, the group of well-funded countries had expanded, with half of all commitments going to 35 countries accounting for 6 percent of the developing-country population. Again, the population of well-funded countries is still low, but the number of countries increased, and their share of population grew somewhat, suggesting that funding is not as narrowly focused on a few countries as it was in 2010.

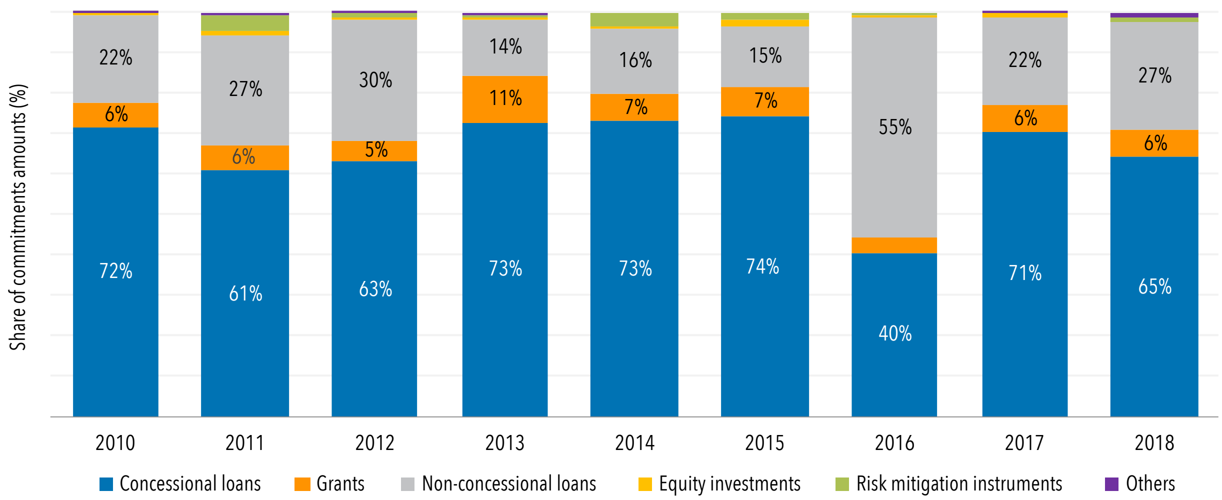
Apart from changes at the ends of the distribution, the most interesting development is in the middle of the distribution. The 2010 distribution shows a sudden change from poorly funded to well-funded countries at the 90th percentile of cumulative population, whereas, in 2018, the group of countries from the 50th to 90th population percentiles received about 40 percent of total funding. This is why the curve for 2018 appears much closer to the 45-degree line, indicating a more equal distribution of funding. With about 40 percent of total funding and 40 percent of developing-country population, this group of 25 countries may also be considered to be relatively well funded. Along with the 35 countries receiving the highest levels of funding, this group of 70 countries is much larger and more populous than the few countries that were in this position in 2010. Thus, it is reasonable to say that international public financial flows for clean energy are now reaching many more people than they were in 2010.

SOURCES OF FINANCING

International public financial flows to developing counties in support of clean energy came from 56 active donors in 2018, up from 36 in 2010, representing a surge of donor interest. In 2018, 14 of these donors committed 80 percent of the international public financial flows, led by Germany (USD 2.1 billion), the Ex-Im Bank of China (USD 1.8 billion), the International Finance Corporation (USD 1.4 billion), and the Asian Development Bank (USD 0.9 billion). New donors in 2018 included the governments of Turkey and Hungary.

These donors use a range of financial instruments to support clean energy in developing countries.[58] By far the most commonly used were **concessional loans**, which accounted on average for 65 percent of annual financial commitments from 2010 to 2018 (figure 5.10). Together with **grants**—which accounted for an average of 6 percent of commitments each year—concessional loans have an important role to play in renewable energy markets, with their pronounced benefits in emerging markets (IRENA 2016). By providing project developers with more favorable financing terms than those available in the commercial market (lower interest rates and extended grace periods) concessional loans can enhance the affordability of renewable energy finance in LDCs (IRENA and CPI 2020; IRENA 2016). Over time, international public donors have expanded their focus, including toward non-concessional instruments and mechanisms designed specifically to leverage public funds to mobilize private investors.

FIGURE 5.10 • Shares of annual commitments by financial instrument, (2010-18)



Source: IRENA and OECD 2021.

During the 2010–18 period, an average of 26 percent of annual commitments made to developing countries came in the form of **non-concessional loans.** The majority of non-concessional loans during the 2010–18 period was concentrated in eight relatively mature and large developing markets for renewables: India (USD 3.9 billion), Turkey (USD 3.8 billion), Pakistan (USD 2.3 billion), Egypt (USD 1.9 billion), China (USD 1.8 billion), Indonesia (USD 1.7 billion), Colombia (USD 1.6 billion), and Morocco (USD 1.6 billion). Non-concessional loans flows chiefly targeted solar energy and hydropower projects, with total commitments amounting to USD 13.5 billion and USD 7.9 billion, respectively, during 2010–18. For solar, this represented as much as 45 percent of total investments. The World Bank alone accounted for more than half of the non-concessional loans commitments to developing countries over the period 2010–18 (or USD 18.2 billion). **Equity investments** remained limited over the period, with shares below 1 percent per year. The use of equity was concentrated in Sub-Saharan Africa, which attracted USD 479 million during the period, and Central and Southern Asia, receiving a total of USD 326 million, more than 60 percent of which went to India.

An increased use of **risk-mitigation instruments** (including guarantees and insurance) was observed after 2010, in particular for wind and solar projects. During 2010–18, international donors committed a total of USD 1.7 billion in the form of risk-mitigation instruments (1.2 percent), of which 49 percent (or USD 872 million) went to wind projects (mainly in Kenya, Mexico, Pakistan, and Senegal), while 43 percent (or USD

58 The methodology section provides further information on these financial instruments.

725 million) went to solar projects (mainly in Thailand, South Africa, and Peru). These instruments have an important role to play in developing markets with limited track records on renewable energy projects, as they can reduce the risk perception and cost of capital while limiting capital requirements on international donors (IRENA 2020b). This approach allows these institutions to free up part of their financial resources for other renewable energy projects. In the context of risk mitigation, it is important not to de-risk specific transactions but rather to work with a country over a medium-term horizon to improve the viability of the energy sector through various risk-mitigation efforts. The following section on policy insights offers examples in this vein. The disruptions of the pandemic have made investors more risk averse, so risk-mitigation instruments will be of critical importance to attract investment in the hard-hit developing and emerging markets.

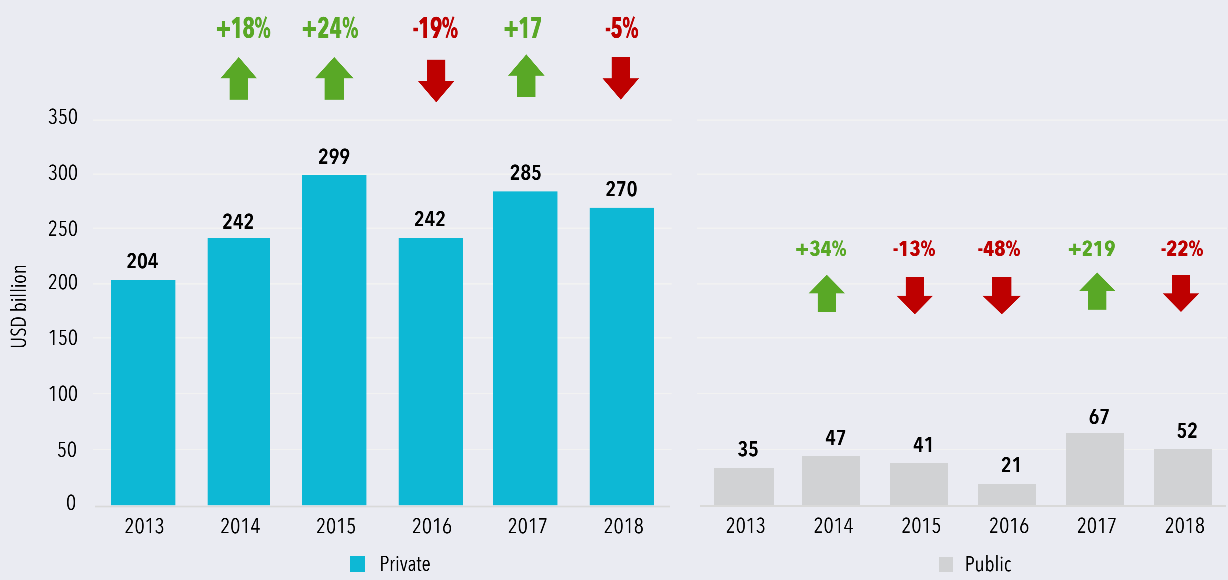
BOX 5.4 • GLOBAL RENEWABLE ENERGY INVESTMENTS AT A GLANCE

Going beyond the SDG 7.a.1 indicator on international public financial flows, this box provides an overview of global renewable energy investments, both public and private (IRENA and CPI 2020).

Global renewable energy investments have jumped from just USD 40 billion in 2004 to around USD 300 billion in recent years (Frankfurt School–UNEP Centre/BNEF 2020). Between 2013 and 2018, investments increased steadily, peaking at USD 351 billion in 2017, before dipping in 2018, albeit less than the decline in public renewable energy investments (IRENA and CPI 2018). Despite the impacts of the COVID pandemic on the global economy in 2020, data suggest that global investments in renewable energy resumed their growth in both 2019 and 2020 (BNEF 2021).

The private sector remained the main capital provider for renewables throughout the 2013–18 period, accounting for 86 percent of investments in the sector. Within the private sector, project developers provided 46 percent of investments, followed by commercial financial institutions at 22 percent. Public finance—including all domestic and international public financing flows—provided on average 14 percent of total investments from 2013 to 2018. Development finance institutions (domestic, bilateral, and multilateral) consistently provided the majority of public investment, or, on average, 85 percent between 2013 and 2018 (IRENA and CPI 2020) (figure B.5.4.1). It should be noted that these are global averages and that public finance plays a more important role in some markets than in others.

FIGURE B5.4.1 • Global annual public and private investments in renewable energy (USD; 2013-18)

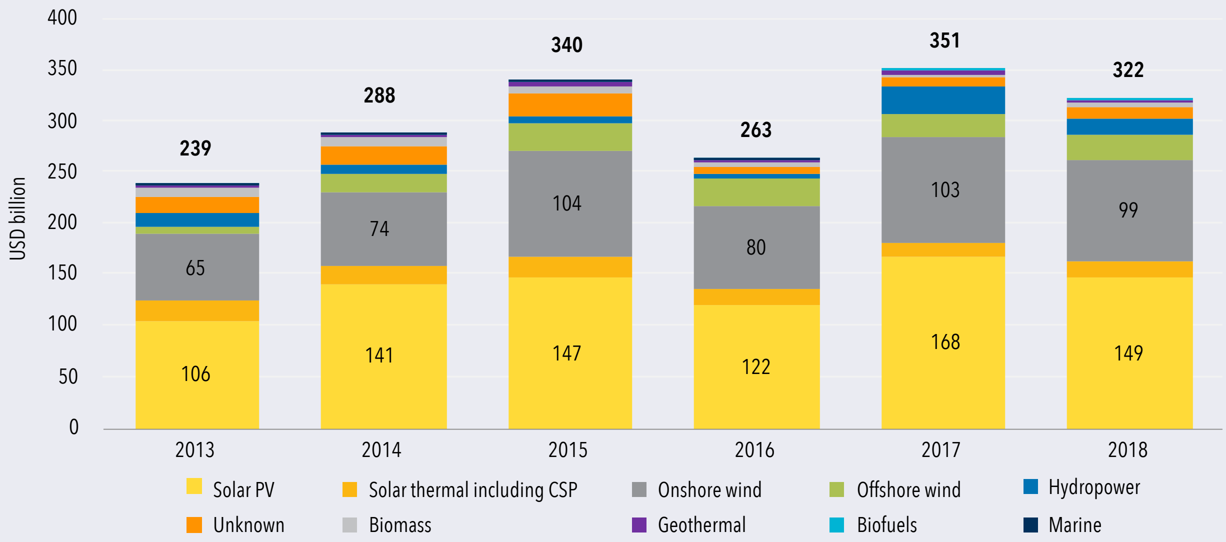


Source: IRENA and CPI 2020.

Note: investment figures are expressed in nominal (current) United States dollars (USD). Hence, they do not account for inflation or changes in exchange rates over time.

The majority of renewable energy investments in 2013–18 went to solar PV and onshore wind, which together attracted, on average, 75 percent of the total, reflecting these technologies' increasing appeal to investors. Other technologies accounted for minor shares of investments, including offshore wind (7 percent), solar thermal (6 percent) (figure B5.4.2). Hydropower investments represented only a small share (4 percent) of global renewable energy investments, a significant difference from its much larger share of public financial flows.

FIGURE B5.4.2 • Global annual public and private investments in renewable energy, by technology (USD; 2013-18)



Source: IRENA and CPI 2020.

Note: investment figures are expressed in nominal (current) United States dollars (USD). Hence, they do not account for inflation or changes in exchange rates over time.

Like public capital, total renewable energy investments were also concentrated in a handful of regions. East Asia and Pacific, led by China, attracted the largest share of renewable energy investments (32 percent) over 2013–18. Western Europe and OECD Americas followed, with 19 percent and 18 percent of the total, respectively. Regions dominated by developing economies remained consistently under-represented, attracting together only 15 percent of global investments in renewables in 2013–18.

POLICY INSIGHTS

This section draws on the analysis of international financial flows in support of clean energy in developing countries and provides insights into the role of public finance, international donors, and renewable energy policies to accelerate investments at scale.

SCALING UP PUBLIC FINANCE FOR RENEWABLES IN DEVELOPING COUNTRIES

Achieving international climate and development goals will require a massive scale-up of renewable energy investments, both in developed and developing countries. Investment in the power sector alone, would need to grow from around USD 300 billion to USD 550-850 billion a year throughout 2019-30. This would need to be supported by additional investments to an expanded and modernized electricity network and grid battery storage (IEA 2020; IRENA 2020c). Closing investment gaps in developing countries will require substantial and coordinated efforts from a variety of stakeholders.

At the global level, renewables have been financed primarily through private capital. Between 2013 and 2018, the public sector accounted for only 14 percent of global renewable energy investments (IRENA and CPI 2020) (box 5.4). While it is reasonable to assume that the bulk of global investments needed in renewable energy will continue to come from private sources, public finance institutions and international donors will have a key role to play to help mobilize private capital at scale. Especially in developing countries, where real or perceived risks result in a high cost of financing, public finance remains key to cover early-stage project development risks, to address barriers to attracting private capital, and to bring new markets to maturity. That said, it is critical that public finance be carefully used and targeted toward unlocking private investments in renewables.

The pandemic has intensified debt pressures in many developing countries, straining their financial resources. At the same time, market uncertainty and volatility due to the crisis have made investors more risk averse, reducing the capital available for renewables in developing countries. Hence, in a post-pandemic recovery period, international public finance flows in support of clean energy are key to developing the sector in these markets (box 5.5). Given their socioeconomic benefits (for example, on jobs and economic growth) and applications (for example, in health care and other critical infrastructure), renewables represent farsighted investments that can support developing countries in their post-pandemic recovery (IRENA 2020c).

BOX 5.5 • COVID-19 AND INTERNATIONAL PUBLIC FINANCIAL FLOWS TO DEVELOPING COUNTRIES IN SUPPORT OF RENEWABLE ENERGY

The COVID-19 pandemic has hit the world's low-income economies hard, causing a recession that could push more than 100 million people into extreme poverty and reverse progress made to date toward SDG 7. Public finance institutions—and international donors, in particular—have a key role to play in supporting the post-COVID economic recovery of developing countries.

In March 2020, the International Monetary Fund (IMF) and the World Bank Group called on bilateral creditors to suspend debt service payments by the poorest countries. The G20 responded to this call, agreeing to suspend repayment of official bilateral credit from the poorest countries until late June 2021 (IMF 2021). The Fund has also announced that in the immediate crisis-containment phase the scope for implementing green recovery plans may be limited, given the overriding priority of providing urgent relief to households and firms. However, as countries move from containment and stabilization to recovery, green recovery plans will likely be reflected in IMF-supported programs.

Beyond immediate relief measures, numerous financing institutions have announced actions centered on a green economic recovery with renewables at the core. Some initiatives include:

- **Public Development Banks for Green Recovery:** Some 450 public development banks joined a declaration delivered at the Finance in Common conference in November 2020 on a post-COVID "green recovery." Through this declaration, development banks—including the Asian Development Bank, the African Development Bank, the European Bank for Reconstruction and Development, and the World Bank—committed to shifting their investment strategies and activities toward renewable energy, energy efficiency, and clean technologies to accelerate progress toward universal access to clean energy and the energy transition. Notably, the banks also agreed to work together to foster the uptake of renewable energy in countries where there is little or no such development (Finance in Common 2020).

- **World Bank Group Green Recovery Initiative:** Together with the governments of Germany, the United Kingdom, and Austria, the World Bank Group launched the Green Recovery Initiative, which aims to help countries build a low-carbon, climate-resilient recovery from COVID-19. Funding will be provided through a new trust fund, the Climate Support Facility, which was launched in December 2020 with an initial investment of USD 52 million from the German Federal Ministry of Economic Cooperation and Development, the UK's Foreign, Commonwealth, and Development Office, and the Austrian Federal Ministry of Finance. One of the pillars of the fund is to improve conditions for renewable energy (World Bank 2020).

- **AfDB COVID-19 Off-Grid Recovery Platform:** In December 2020, the African Development Bank approved a USD 20 million concessional investment from the Sustainable Energy Fund for Africa to establish the COVID-19 Off-Grid Recovery Platform. The USD 50 million blended finance initiative will provide relief and recovery capital to energy access businesses, supporting them through and beyond the pandemic (AFDB 2021).

- **The European Commission post-pandemic recovery in Africa and EU neighboring countries:** In November 2020, the European Commission signed ten financial guarantee agreements with partner financial institutions to stimulate private investments (around EUR 10 billion) and a post-pandemic recovery in Africa and EU neighboring countries in November 2020. Among the agreements are a EUR 20 million guarantee provided by the Spanish development finance institution, COFIDES, for off-grid and mini-grid projects in Sub-Saharan Africa, and a EUR 62 million guarantee provided by the Agence Française de Développement and the Italian Cassa Depositi e Prestiti to reduce off-taker risk in energy projects (European Commission 2020).

On a country level, the trend for official development assistance post-COVID and its impact on public financial flows for clean energy are still not clear. While some countries (such as the United Kingdom) may reduce their aid commitments and focus on domestic recovery, others may increase the assistance they provide (for example, Sweden and France) and expand their green post-COVID recovery policies (Donor-tracker 2021).

According to a preliminary analysis conducted by the OECD Secretariat in August 2020, at least 30 OECD and key partner countries have included measures directed at supporting the transition to greener economies as part of their recovery programs or strategies. Such measures include grants, loans, and tax relief directed toward green transport; the circular economy; and clean energy research, development, and deployment (OECD 2020). These OECD countries, to some extent, may extend their green policies into their international assistance actions. For instance, the Republic of Korea's midterm aid strategy for 2021–25 has twelve priority goals, including promoting the country's Green New Deal, diversifying development finance, and strengthening partnerships with civil society. Korea will double its aid budget between 2019 and 2030 (Donor tracker 2021).

Among developing countries, the Indonesian government announced its post-COVID recovery plan, which includes USD 1 billion for the installation of solar rooftop panels over the next five years, a move that is expected to generate over 20,000 jobs in renewables (Ho 2020). Similarly, Nigeria's stimulus plan foresees the installation of 5 million solar home systems and mini-grids (Government of Nigeria 2020). Colombia plans to invest USD 4 billion in renewable energy and energy transmission projects to accelerate economic recovery (ISSD 2020). International donors can support the implementation of these recovery packages in developing countries by ensuring that financial flows for clean energy are maintained and ultimately increased.

Disruptions during the COVID-19 pandemic have led to greater interest in sustainable assets among private financiers. A pronounced relocation of capital is to be expected, with significant implications for financial markets. How this will affect international public financial flows for clean energy remains to be seen.

USING INTERNATIONAL PUBLIC FINANCE TO ATTRACT PRIVATE CAPITAL

When public resources are limited, they should be used strategically to crowd in additional private capital, especially in sectors and regions that private investors perceive as too risky to invest in. In less-mature renewable energy markets, **direct financing** for renewable energy projects from DFIs can pave the way for private commercial investors, establish a track record for investments, and support the development of a pipeline of bankable projects. In those markets where generating capacity can be financed directly by the private sector, many multilateral development banks are electing to finance supporting infrastructure such as grid integration and energy storage. Examples include public investments in solar and wind farm infrastructure to mitigate risks (particularly those associated with acquiring land and consent); to shorten the private sector's development timeline (so as to save costs and lower tariffs in power purchase agreements); and to provide comprehensive de-risking.

In order to further stimulate private demand and the creation of local renewable markets, DFIs can partner with international and local financial institutions to **co-finance** renewable energy projects, including supporting infrastructure such as grids or batteries. The participation of DFIs often reduces the perceived risk for third-party investors and therefore lowers the cost of financing (Climate Finance Leadership Initiative 2019). It can also result in an important skill transfers from DFIs to local private financiers.

On-lending structures allow international donors, particularly DFIs, to use their high credit rating and market access to borrow capital at low rates and on-lend such funds via credit lines to local financial institutions or public entities. The local financial institutions can access consultancy services and training to develop bankable renewable energy projects, thus **building capacity** and a track record. On-lending reduces the risk for local lenders in developing countries and can increase the availability of financing for project developers, usually on better terms than can be found in the local market (IRENA 2016). For example, in 2019 the Asian Infrastructure Investment Bank launched on-lending facilities for USD 300 million to support renewable energy projects in India and Turkey (AIIB 2019a; AIIB 2019b).

International public donors can also focus on **attracting large-scale investors** in renewable energy projects. These include, for example, institutional investors—pension funds, insurance companies, sovereign wealth funds, endowments, and foundations. While they represent one of the largest capital pools in the world, so far they have played a limited role in financing renewable energy (IRENA 2020d). Institutional investors are looking for post-pandemic investments offering good environmental, social, and governance performance. This trend is likely to boost their capital allocation to renewable energy infrastructure as a way to hedge their climate exposure. However, as many of these investors are new to renewables, especially in developing countries, support from DFIs through co-financing initiatives can expand know-how on financial and legal structuring and improve the risk/return profile for institutional investors.

DFIs can further address specific risks through the provision of **risk-mitigation instruments**, such as guarantees, currency-hedging instruments, and liquidity reserve facilities.[59] These can be particularly effective in mobilizing private investments while reducing capital requirements for public finance institutions (IRENA 2020b). Such instruments can cover a variety of risks. For example, in January 2020, Germany' KfW joined the African Energy Guarantee Facility launched by the European Investment Bank and the African Trade Insurance Agency to provide guarantees to reinsurers covering political and credit risk for energy projects in Africa (EIB 2020). In the context of the pandemic, risk mitigation has become even more important, as investors have become more risk averse, especially in developing countries.

In risk mitigation it is important to work with a country on a medium-term horizon to improve the viability of its energy sector. The World Bank—in partnership with the Agence Française de Développement, the International Solar Alliance, and the International Renewable Energy Agency—launched the Sustainable Renewables Risk Mitigation Initiative (previously known as Solar Risk Mitigation Initiative), which supports governments as they develop sustainable renewable energy programs. The initiative uses an a one-stop-shop approach to integrated risk mitigation that extends from upstream technical assistance to operationalization of bankable programs. The process ensures funding for the studies needed upfront, when countries are prioritizing scarce resources amid the emergency response to the pandemic. It also provides technical assistance to finance the critical public investments and the risk-mitigation coverage needed to enable private investments at scale.

59 Guarantees are contracts that transfer agreed risks to reduce the risk of nonpayment of outstanding principal, interest, or other contractual payments to investors. Currency-hedging instruments are financial contracts that protect investors from negative financial impacts resulting from adverse changes in currency exchange rates. Liquidity reserve facilities are tools provided by third parties, usually banks, that offer a credit line from which special purpose vehicles can draw in the event of a cashflow shortfall (IRENA 2016).

In addition to directly providing risk-mitigation instruments, international institutions can support clean energy investments by **addressing specific barriers** for investors and project developers. An example of this is the Climate Investment Platform, a joint initiative of the United Nations Development Programme, the International Renewable Energy Agency (IRENA), and Sustainable Energy for All, developed in coordination with the Green Climate Fund. Specifically, the Climate Investment Platform facilitates access to risk-mitigation instruments and ensures bankable projects, matching project developers with investors and facilitating deals (CIP 2021).

Finally, the **standardization of project documentation** can can further attract investors by reducing transaction costs, simplifying the due diligence process, and reducing the time for projects to reach financial close. Standardized contracts can also facilitate the **aggregation of small-scale projects**, further reducing transaction and due diligence costs for large-scale investors (IRENA and CPI 2020). Efforts in this direction have already been made with regional and country initiatives. For example, standardized contracts are at the core of the World Bank's Scaling Solar program in Africa (World Bank 2018). In this context, IRENA and the Terrawatt Initiative have teamed up under the Open Solar Contracts initiative to standardize contract documentation for solar PV projects, streamline project development, accelerate finance processes, and reduce costs and barriers to entry for small-scale developers.

SUPPORTING THE ESTABLISHMENT OF AN EFFECTIVE POLICY FRAMEWORK TO ATTRACT FURTHER INVESTMENTS

While this chapter focuses on the need to scale up international public financial flows to developing countries, the ultimate objective should be to bring these markets to a level of maturity that attracts private capital at scale while helping to maximize local development. To this end, international public donors can play a key role in supporting developing countries by establishing a sustainable private capital market that encourages a just energy transition. This can be achieved if stable and coherent policy and regulatory frameworks for renewable energy are in place. The predictability and reliability of policies and regulations are vital for attracting private investors, as they reduce the risks of policy reversals or renegotiations.

Governments can signal their political will and long-term commitment to investors by establishing **ambitious renewable energy targets** that are both credible and in line with broader national energy and climate strategies. Establishing ambitious targets alone, however, is not enough to build confidence among investors. Targets need to be accompanied by clear and stable policy and regulatory frameworks in support of renewable energy deployment and integration, as well as by governments' capability to implement these targets and to ensure that the benefits of the energy transition are widely shared across society.

Any **deployment policies** used to accelerate the uptake of renewables ("push" policies such as quotas and mandates; "pull" policies such as feed-in tariffs and auctions; and fiscal and financial policies such as tax incentives, grants, and subsidies), must go hand-in-hand with enabling and integrating policies. **Enabling policies** strengthen coordination between the energy sector and the rest of the economy by leveling the playing field for renewables (for example, phasing out fossil fuel subsidies, introducing carbon pricing policies), building the skills and capabilities needed for renewables (education and training policies), and facilitating a just transition through labor mobility and job security (labor market and social protection policies). Finally, **integrating policies** promote the integration of renewables into the wider energy and economic system by, for example, improving transmission and distribution networks, building electric vehicle charging stations, and enhancing system flexibility (IRENA, IEA, REN21 2020; 2018).

Some examples of support programs that help establish coherent national policy frameworks include: the Climate Investment Platform and the GET FiT Program in Zambia. The first provides direct support to governments, helps set ambitious targets (including nationally determined contributions), and clean energy policies and regulations (CIP 2021). The second is implemented by KfW and aims to bolster institutional capacity and the policy and regulatory framework for independent power producers using renewable energy (GET FiT Zambia 2020).

To summarize, we need holistic policy frameworks, tailored to specific country contexts and objectives, in order to attract further investments that maximize socioeconomic benefits and opportunities along the renewable energy value chain. These policy frameworks need to link short-term measures, including recent stimulus packages for a post-pandemic recovery, to medium- and long-term objectives such as achieving SDG 7. To ensure a just transition, one that leaves no one behind, policy and regulatory frameworks for renewables should extend well beyond the energy sector. They should also attend to the transformative impacts that energy transitions will have on society, institutions, financing, ownership structures, and the wider economy.

METHODOLOGY

The 7.a.1 indicator focuses on public financial flows to developing countries in support of clean energy research and development and renewable energy production, including in hybrid systems. The indicator measures public financial flows (“public” here referring to the source of funds and not the recipients) in the form of financial commitments, and includes three categories of financial flows based on data extracted from IRENA and OECD databases.

DATABASES

From the OECD, official development assistance (ODA) and other official flows (OOF) to developing countries together comprise the public financial support that donors provide to developing countries for renewable energy. These flows are defined as the sum of official loans, grants, and equity investments that “DAC countries” (ODA recipients listed by the Development Assistance Committee) receive from foreign governments and multilateral agencies for clean energy research to develop and produce renewable energy (including in hybrid systems). The OECD consolidates and categorizes these figures as self-reported by donors; these figures are extracted from the OECD/DAC Creditor Reporting System (CRS) as bulk downloads starting in the year 2000 and then filtered to reflect public investments in clean energy by excluding commitments with blanks or zeroes. Then, purpose codes are filtered to include clean energy investments: energy generation, renewable sources (multiple technologies, hydroelectric power plants, solar energy for centralized grids, solar energy for isolated grids and stand-alone systems, solar energy), thermal applications, wind energy, marine energy, geothermal energy, and biofuel-fired power plants (between 23210 and 23290). Finally, private donor flows (mostly philanthropic organizations) are removed from the data (https://stats.oecd.org/Index.aspx?DataSetCode=crs1).

Data from IRENA capture additional flows to non-ODA recipients in developing regions and flows from countries and other public institutions not currently reporting to DAC. These flows are defined as all additional loans, grants, and equity investments that developing countries (defined as countries in developing regions, as listed in the United Nations’ M49 composition of regions) receive from all foreign governments, multilateral agencies, and other DFIs for the purpose of clean energy research and development and renewable energy production (including in hybrid systems). These additional flows cover the same technologies and other activities (research and development, technical assistance, renewable electricity distribution infrastructure, and so forth) as listed above and, to avoid duplication of data, exclude all flows extracted from the CRS.

DEFLATING NOMINAL USD PRICES TO CONSTANT PRICES AND EXCHANGE RATES

International finance flows expressed in nominal terms have been 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 United States dollar in a recent year (2018 in this report). This is done using a combination of the OECD DAC deflators for the DAC donors and deflators calculated by IRENA for other international donors not included in the CRS database. The formula below converts the nominal investment amounts in current USD to USD at constant prices and exchange rates.

$$USD_{constant\ ,n,m} = \frac{USD_{Current\ ,n}}{DAC\ Deflator_{n,m}}$$

n – current year (nominal)
m – constant year (2018)

The OECD publishes DAC deflators for each donor. More information can be found at https://www.oecd.org/dac/financing-sustainable-development/development-finance-standards/informationnoteonthedacdeflators.htm.

MEASURING FINANCIAL FLOWS THROUGH COMMITMENTS

Financial flows in this context 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 in the full amount 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 several weeks, months or years. Tracking financial commitments can yield very different results compared with approaches that consider financial disbursements. Although disbursement information would provide a more accurate picture of the actual financial flows to renewable energy each year, consistent 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, canceled, or altered. Any changes must be reflected in annual values.

FLUCTUATIONS IN FINANCIAL FLOWS AND METRICS TO ANALYZE TRENDS (FIVE-YEAR MOVING AVERAGE)

Given the fluctuating nature of commitments as outlined above, the analysis in this chapter uses a five-year moving average to capture the trend in financial flows. A five-year moving average may smooth peaks and valleys in annual commitments as well as deviations from an underlying trend, including in the business cycles of donor countries.

FINANCIAL INSTRUMENTS

The analysis in this chapter captures financial commitments made through the following financial instruments:

- **Concessional loans:** loans extended at terms more favorable than those prevailing on the market, either in terms of lower interest rates or grace periods.
- **Non-concessional loans:** loans extended under prevailing market terms and conditions.
- **Grants:** transfers made in cash, goods, or services for which no repayment is required.
- **Equity investments:** money invested in a company through the purchase of shares of that company, conferring upon the owner the right to be compensated according to his ownership percentage.
- **Risk-mitigation instruments,** such as guarantees and insurance products: contracts transferring agreed risks to reduce the risk of nonpayment of outstanding principal, interest, or other contractual payments to investors).
- **Investment funds;** supplies of capital belonging to numerous investors used to collectively purchase securities while each investor retains ownership and control of his own shares.
- **Bonds:** fixed-income instruments representing a loan made by an investor to a borrower (typically corporations or governments).

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CHAPTER 6

THE OUTLOOK FOR SDG 7

MAIN MESSAGES

- **Outlook for progress toward 2030 goals:** At today's rate of progress, the world is not on track to achieve Sustainable Development Goal 7 (SDG 7). In this chapter, forward-looking scenarios are used to outline how the energy system could further support the achievement of global climate and sustainable development goals. The Stated Policies Scenario of the International Energy Agency (IEA) shows that current and planned policies are not enough to meet the goals; in fact, under this scenario, none of the targets can be achieved by 2030 (IEA 2019). In contrast, IEA's Sustainable Development Scenario lays out ways to bridge the gap and put the world's energy system on track to achieve the SDG targets most closely related to energy (e.g., SDG 3.9, SDG 7, and SDG 13).[60] The Transforming Energy Scenario developed by the International Renewable Energy Agency (IRENA) presents a path toward the goal of boosting renewable energy while maximizing socioeconomic benefits—including during a post-COVID-19 recovery period.
- **Outlook for access to electricity:** Recent progress has been mixed, as is the outlook for 2030: IEA's Stated Policies Scenario projects that 660 million people will still lack access to electricity in 2030. Nonetheless, these numbers mask some positive outcomes. Thanks to well-designed policies and strong implementation measures, 98 percent of the population of Developing Asia will have access to electricity by 2030. The COVID-19 crisis, however, threatens progress elsewhere the world. In Sub-Saharan Africa, the number of people without access to electricity actually increased in 2020. In the IEA's Sustainable Development Scenario, the connection rate more than triples from previous levels, as 85 million people each year between now and 2030 electrify in sub-Saharan Africa, most notably in the Democratic Republic of Congo, Niger, Nigeria, Sudan, and Uganda. These countries have the largest population shares without access.
- **Outlook for access to clean cooking solutions:** If clean cooking fails to find a lasting place on the global political agenda, 2.4 billion people will remain without access in 2030, according to IEA's Stated Policies Scenario. Their continued reliance on polluting fuels and technologies will have dramatic consequences for the environment, economic development, and most notably, the health of women and children. The challenge in Developing Asia and Sub-Saharan Africa is to understand how cultural, economic, and social factors combine to slow progress. Affordable solutions are available: liquefied petroleum gas (LPG) and improved cookstoves, for example, offer obtainable and scalable solutions in many regions today. Alternative fuels, such as biogas or bioethanol, could also play a role, depending on local circumstances. Ultra-efficient electric appliances, such as electric pressure cookers, powered by the grid or by solar photovoltaic (PV) and a battery, also represent clean, stand-alone, and cost-effective ways to improve access.
- **Outlook for renewable energy:** Despite the impact of the COVID-19 pandemic, the outlook for renewables under IEA's Stated Policies Scenario is resilient in all regions with supportive policies and falling technology costs. In the power sector, IEA and IRENA scenarios both conclude that solar PV and wind will account for most renewables-based electricity generation by 2030. IEA's Sustainable Development Scenario further shows that intensified policy support and cost reductions could push the share of modern renewables in total final energy consumption (TFEC) to more than 25 percent, in which case renewables would account for just over half of all electricity supply. IRENA's Transforming Energy Scenario also shows how the rapid growth in renewable energy could continue over the coming decade, with renewables' share in TFEC reaching 28 percent by 2030 and 57 percent in power generation. The outlook for the use of renewables in transport and heating and cooling is not as strong. Despite its large share of final energy consumption, heat receives limited policy attention globally compared with other end-use sectors.[61] The number of countries with national targets for renewable heat is less than one-third of those with targets for renewable electricity. Policy support is also critical for the outlook in transport, particularly in an environment of lower prices for oil and gas.

60 Most of this chapter is based on results from IEA's World Energy Model (IEA 2020a) and from analysis in the *World Energy Outlook* (IEA 2020b). Some of the geographical groupings in this chapter, unlike foregoing chapters, are those used in the *World Energy Outlook*. "Developing Asia" refers to non-OECD Asia.

61 "Heat" in this chapter refers to energy consumed to produce heat for industry, buildings, and other sectors. All of these will be referred to hereafter simply as "heat." They are not equivalent to heat as a final energy service, which refers to the energy available to end users to satisfy their needs.

- **Outlook for energy efficiency:** The rate of global primary energy intensity improvement—the percentage decrease in the ratio of global total primary energy supply per unit of gross domestic product—has slowed in recent years. In IEA's Stated Policies Scenario, lower fuel prices are a key reason for a further slowing of the rate at which the energy intensity of the global economy improves. The annual rate of improvement falls to 2 percent annually for 2019–25 before rising slightly in subsequent years. In contrast, in the Sustainable Development Scenario, the average rate of improvement required to meet the SDG 7.3 target has risen to 3 percent per year between 2018 and 2030, a difference of 0.4 percent from the 2.6 percent initially estimated when the SDGs were developed.
- **Investment needs:** IEA and IRENA project that renewables investment needs to increase considerably — in the power sector alone, investment would need to grow from USD 300 billion to USD 550-850 billion a year throughout 2019-30. This would need to be supported by additional flows to an expanded and modernized electricity network and grid battery storage (IEA 2020a; IRENA 2020b). Furthermore, according to the IEA scenario, annual investment for universal energy access in the period to 2030 totals USD 30 billion for electricity and USD 5 billion for clean cooking. Investment of USD 545 billion a year will be needed for energy efficiency, with transport and buildings accounting for the largest share of efficiency spending (IEA 2020a). Historically, the finance available for expansion and upgrades of access to electricity and clean cooking has been inadequate for achieving SDG 7. As a result of the COVID-19 disruptions, the perceived risk of lending money to developing countries has increased, making mitigation mechanisms more important than ever to maintain and accelerate progress on energy access.

PRESENTATION OF SCENARIOS

This chapter describes the results of global modeling exercises undertaken to determine, first, if current policy ambitions are sufficient to meet the SDG 7 targets, and second, to identify what additional actions might be needed. It also examines the investments required to achieve the goals. Scenarios for the various targets are taken from IEA's flagship publication, *World Energy Outlook* (IEA 2020b), which considers the estimated effects of the COVID-19 pandemic, assessed at the time of publication. With respect to developments in renewable energy, scenarios are also taken from IRENA's Global Renewables Outlook: Energy Transformation 2050 (IRENA 2020a).

IEA's Stated Policies Scenario (which, in earlier IEA publications, is called the New Policies Scenario) reflects the impact of existing policy frameworks and announced policy intentions. Its utility is to hold up a mirror to the plans of today's policy makers and elucidate their consequences for energy use, emissions, and energy security. The scenario spans a broad range of policies, starting with Nationally Determined Contributions under the Paris Agreement. In practice, the bottom-up modeling implied by the scenario involves a great deal of sector-level detail, including pricing policies, efficiency standards and schemes, electrification programs, and specific infrastructure projects.

IEA's normative Sustainable Development Scenario[62] describes an integrated, least-cost pathway that would deliver on the energy-related SDGs: to ensure universal access to affordable, reliable, sustainable, and modern energy services by 2030 (SDG 7); to curb the air pollution that causes deaths and illness (SDG 3.9); and to take effective action to address climate change (SDG 13). This scenario takes the SDG outcomes as its point of departure, working backward to set out what would be needed to achieve those outcomes in a cost-effective way. By 2030, under this scenario, universal access to both electricity and clean cooking is achieved; modern renewables reach 25 percent of TFEC, almost two and a half times their 2018 share; the energy efficiency aims of SDG target 7.3 are exceeded (with average annual improvements in global energy intensity accelerating to 3.8 percent annually between 2020 and 2030); and the global temperature rise over pre-industrial levels is held below 2°C.

The International Renewable Energy Agency's scenarios in its Global Renewables Outlook (IRENA 2020a) explores global energy development pathways to 2030 and beyond from two perspectives. The first is an energy pathway shaped by current and planned policies (the Planned Energy Scenario); the second is a cleaner, climate-resilient pathway based on a more ambitious, yet achievable, uptake of renewable energy and energy efficiency measures—the Transforming Energy Scenario.

62 More information on IEA's Sustainable Development Scenario can be found at: https://www.iea.org/reports/world-energy-model/sustainable-development-scenario

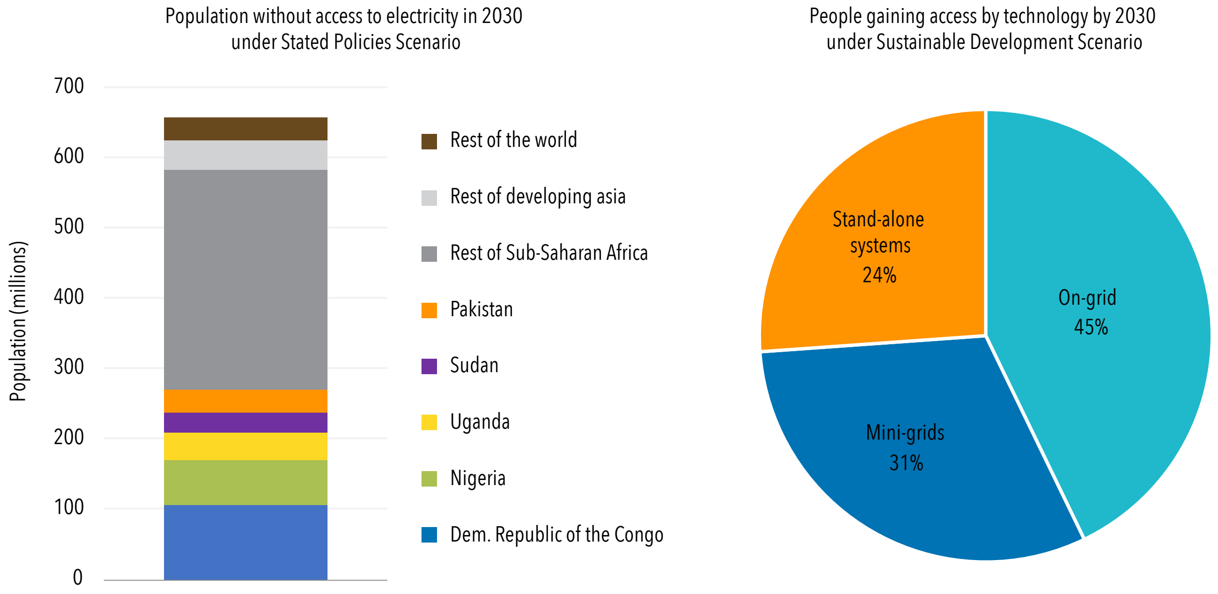
OUTLOOK FOR ACCESS TO ELECTRICITY

Despite the disruption caused by the COVID-19 pandemic in the early part of the decade, the outlook for access to electricity indicates continued progress to 2030 but without achieving the goal of universal access. The number of people remaining without access to electricity in 2030 is expected to decline under the policies set out in IEA's Stated Policies Scenario to 660 million (8 percent of the global population), of whom some 555 million (or 85 percent) reside in Sub-Saharan Africa (figure 6.1). SDG target 7.1 remains within reach, and policies implemented in several countries have put them on track to achieve universal access. The same cannot be said for many Sub-Saharan countries.

Developing Asia remains on track to reach an access rate of 98 percent by 2030, an improvement of close to 20 percentage points since 2010. The very populous countries of Bangladesh, India, Indonesia, and the Philippines are on a pathway to reach full access before 2030; a few million people remain without access in countries such as Pakistan. The region of Central and South America is projected to continue its steady progress, moving to 99 percent in 2030, with most of those remaining without access living in rural areas. Haiti remains the only major country in the region to have a substantial nonelectrified population.

In many less well-off regions, the economic downturn caused by COVID-19 is compounding the difficulties faced by governments as they seek to alleviate energy poverty and expand access. Past progress on energy access in many parts of Africa is being reversed: the number of people without access to electricity is set to increase in 2020, while basic electricity services have become unaffordable for up to 30 million people who previously had access. The COVID-19 crisis has brought into stark relief the sizeable global inequalities in access to reliable energy and health-care services, especially in rural and peri-urban areas, highlighting the need to expand access to help populations mitigate the effects of the pandemic (IEA 2020a).

FIGURE 6.1 • Population without access to electricity in 2030, and delivery of electricity connections by technology and region in IEA scenarios



Source: IEA 2020b.

Low-income countries are facing more stress because of the pandemic. Lack of access to sanitation and public health infrastructure, high household occupancy rates, and poorly paid, often informal jobs that cannot be done remotely make social distancing impossible and immediate health risks hard to avoid. In 27 Sub-Saharan African countries, close to 60 percent of health centers have no access to reliable electricity, in addition to the hundred million people lacking access in their homes, which severely limits their ability to store medicines and food, charge phones, access digital information, maintain remote access to education, and light buildings effectively (IEA 2019).

Those countries with the greatest need for better access to electricity may find that available finance diminishes, impeding their capacity to recover. The finance available for funding expansion and upgrades of electricity access in the past has never risen to the level of what is needed to achieve SDG 7. Between 2013 and 2017, USD 8 billion was spent each year to improve electricity access in 20 countries that house 70 percent of the world's population without access to electricity. The majority of this financing came in the form of debt from international public institutions, with most of the remainder funded privately (SEforAll 2019). The impact of the COVID-19 pandemic is likely to reduce the level of finance available, as evidenced by the withdrawal of USD 100 billion of capital from emerging economies during the first quarter of 2020, an amount greater than the total outflows during the 2008 crisis (IMF 2020). SDG target 7.1 can remain within reach only if governments and donors put access at the heart of their recovery plans and programs.

To bridge the gap and connect the remaining 660 million people without access by 2030, the connection rate would have to triple from its current level—to 85 million a year between 2020 and 2030. Most of the acceleration would have to occur in Sub-Saharan Africa, notably in Democratic Republic of Congo, Niger, Nigeria, Sudan, and Uganda, which together are home to half the region's population that would still lack access in 2030 under the Stated Policies Scenario. The delivery technology varies by region under the Sustainable Development Scenario: in Sub-Saharan Africa, 43 percent of connections are directly to the grid, 31 percent are mini-grids, and the remainder (26 percent) stand-alone systems. In Developing Asia, just over half the connections are directly to the grid, a third are mini-grids, and the remainder are stand-alone systems.

Under the Sustainable Development Scenario, governments and donors put access at the heart of recovery plans and programs to achieve universal access by 2030. This involves, for example, measures to support the emerging private solar sector and action-based targets to boost progress at the pace needed. Where finance is constrained, access projects will need to be smart (e.g., linked with agriculture to unlock related benefits), effective, and easy to jumpstart. Decentralized energy solutions will have to play an important role, particularly in reaching remote households far from a grid.

Some countries are already moving ahead. Integrated national electricity access plans using both centralized and decentralized solutions, adapted to the local context, are already showing benefits in Ghana, Senegal, Ethiopia, Nigeria, and Rwanda (IEA 2019). Many of these plans aim to maximize the benefits of energy access by focusing on health services, schools, agricultural enterprises, and similar organizations, along with households. In its economic stimulus plan, Nigeria emphasized the role of both decentralized solar PV systems and LPG in providing modern fuel, while stimulus measures in Indonesia include a commitment to provide 1 gigawatt's (GW) worth of solar panels each year to poor households. Under the Sustainable Development Scenario, universal access to electricity by 2030 requires investing USD 30 billion annually from 2020 to 2030 in smart, efficient, and integrated generation and delivery programs along with full use of decentralized solutions.

BOX 6.1 • IEA'S SUSTAINABLE RECOVERY PLAN

The economic damage wrought by the COVID-19 pandemic has renewed the opportunity to support economic growth and jobs while boosting investment in clean energy technologies. It is in this context that IEA's Sustainable Recovery Plan was formulated (IEA 2020a). If the Sustainable Recovery Plan were to be implemented in full, it would increase annual investment in clean energy infrastructure by USD 1 trillion above historic levels in the three years from 2021 to 2023, kickstarting an accelerated program of spending on clean energy technologies under the Sustainable Development Scenario that would extend beyond the plan's initial three-year period.

The Sustainable Recovery Plan, which is fully embedded in the Sustainable Development Scenario, takes account of the circumstances of individual countries as well as existing energy project pipelines and prevailing market conditions. The plan would also accelerate the achievement of the Sustainable Development Goals: 420 million people would gain access to clean cooking solutions in low-income countries, and nearly 270 million people would gain access to electricity.

Around 40 percent of spending would be for efficiency measures across the transport, building, and industry sectors. A further one-third would support the growth of low-carbon electricity generation, expand and modernize electricity grids, and bring electricity to people who currently lack it. Full implementation of the Sustainable Recovery Plan in the Sustainable Development Scenario leads to an upsurge in investment in all low-emissions forms of electricity generation over the coming three years.

The remainder would be spent to:

- Electrify end uses (especially passenger cars and building heat)
- Make the production and use of fuels more sustainable
- Improve urban infrastructure by installing or expanding EV charging networks, public transport, and walking and cycling infrastructure
- Improve access to clean cooking in low-income countries
- Boost innovation in critical technology areas such as hydrogen, batteries, carbon capture, utilization, and storage, in addition to small modular nuclear reactors.

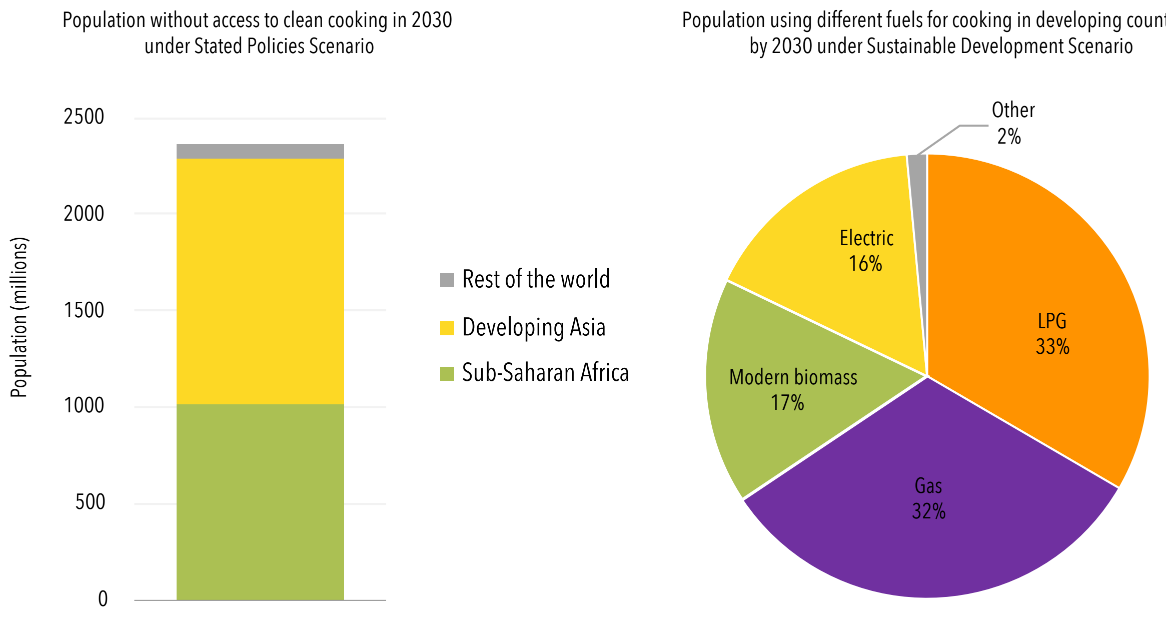
Full implementation of the Sustainable Recovery Plan would also raise global gross domestic product to 3.5 percent higher in 2023 than it otherwise would be; save or create 9 million jobs a year over the next three years; and lower annual energy-related greenhouse gas emissions to 4.5 Gt and air pollutant emissions by 5 percentage points.

THE OUTLOOK FOR ACCESS TO CLEAN COOKING FUELS AND TECHNOLOGIES

The global population without access to clean cooking shrank in recent decades in response to efforts to reduce the reliance of vulnerable populations on traditional uses of biomass. Interventions aimed to improve indoor air quality, reduce the amount of time spent gathering fuel, and curb deforestation and emissions from incomplete combustion of biomass. Progress has been uneven, however. The population without access to clean cooking continued to increase in Africa, while, elsewhere, mostly in Developing Asia, countries benefited from dedicated policies promoting LPG use. But the modest advances have been stalled by the COVID-19 pandemic. While some countries such as Uganda and India have implemented policies to counter this trend (removal of value-added tax on LPG in Uganda; free LPG refills for a limited period for the poorest in India), Sub-Saharan Africa appears destined to revert for the time being to traditional uses of biomass.

The outlook for clean cooking remains a serious concern, and the world has strayed far from the pathway to universal access to clean cooking solutions by 2030. The economic difficulties and risks arising from the COVID-19 crisis are moving some regions and countries further from the goal of universal access. According to IEA's Stated Policies Scenario, delayed progress in 2020 and 2021 means that by 2030 2.4 billion people will lack access to clean cooking—or 60 million more than projected in last year's report (figure 6.2).

FIGURE 6.2 • Clean cooking access in 2030 (left) and cooking fuel use in 2030 (right), in percentages



Source: IEA 2020b.

Note: In the figure above, "gas" is natural gas, while "modern biomass" is biomass consumed through improved or advanced biomass cookstoves. See https://www.iea.org/articles/defining-energy-access-2020-methodology for further information.

In the Stated Policies Scenario, the global population without access to clean cooking solutions in 2030 is split between Developing Asia and Sub-Saharan Africa. In Developing Asia, the projected access rate in 2030 is 70 percent, leaving nearly 1.3 billion people without access. In Sub-Saharan Africa, the rate is only 30 percent, leaving just over 1 billion people without access. Conversely, further progress is projected in India, which is projected to shrink the number of those without access from 655 million today to 500 million in 2030, thereby achieving a 67 percent access rate.

Under IEA's Sustainable Development Scenario, every household in the world would have access to clean cooking by 2030, an achievement that would require providing access to 2.8 billion people. Access to clean cooking solutions brings many health, economic, and social benefits, including reductions in household air pollution, improved health outcomes, and more time for productive activities, particularly for women and children.

In the Sustainable Development Scenario, as previously noted, access programs have a prominent place in recovery plans designed to achieve universal access by 2030. In the case of clean cooking, this worthy objective calls for a statement of clear ambitions and effective programs to support affordable access for the poorest households and the deployment of effective infrastructure (IEA 2020a). LPG and improved cookstoves, for example, offer readily available and scalable solutions in many regions. But alternative fuels, such as biogas or bioethanol, should also be part of clean cooking in many regions, depending on local circumstances. Other technologies could also boost the use of clean cooking fuels and solutions. Electric pressure cookers, for example, powered by solar PV and a battery, could be a clean, stand-alone, and cost-effective cooking solution without overburdening distribution or micro-grids, while creating synergies with newly gained access to electricity. In certain areas, renewable LPG could provide a locally produced, sustainable fuel source.

OUTLOOK FOR RENEWABLE ENERGY

SDG target 7.2 foresees a steep rise in the share of renewable energy in the energy mix. Although a quantitative objective is not specified, long-term scenarios charting various paths for the energy sector can help benchmark progress. IEA's Stated Policies Scenario and IRENA's Planned Energy Scenario both plot energy use under existing policy frameworks and stated policy plans.

Despite the impact of the COVID-19 pandemic, the global outlook for renewables under IEA's Stated Policies Scenario remains positive, helped by supportive policies and falling technology costs. The share of all renewables (including traditional uses of biomass) is projected to rise to 21.5 percent of TFEC by 2030, from 17 percent in 2018, while that of modern renewables would increase to 16 percent in 2030, up from 10.5 percent in 2018. IRENA's Planned Energy Scenario, by contrast, shows the total share of renewables in TFEC (including traditional uses of biomass) remaining largely flat until 2030, rising only slightly to 17.5 percent. The replacement of traditional uses of bioenergy with modern forms largely offsets growth in the renewable share over the period. The modern renewable energy share in TFEC increases from 10.5 percent in 2018 to 16.5 percent by 2030 (IRENA 2020a).

The use of renewables to generate electricity has grown the fastest in recent years, and the various scenarios project that this trend will continue. Renewable sources of electricity have been resilient during the COVID-19 crisis and are set for strong growth, rising by two-thirds from 2020 to 2030, with PV and wind driving growth. Over the decade, renewables overtake coal as the primary means of generating electricity. Solar PV is the strongest performer, meeting almost a third of electricity demand growth over the period thanks to widely available resources, declining costs, and policy support in more than 130 countries. Nonetheless, hydropower remains the largest low-emissions source of electricity globally through to 2030, while also providing flexibility and other power system services.

Expansion in the direct use of renewables in end-use sectors such as buildings and transport has remained slow but steady. Modern bioenergy accounts for the lion's share of growth through to 2030. In the transport sector, biofuels see strong growth, while the use of renewables for heat also grows, with modern bioenergy accounting for the largest share of the growth. Biogas and modern biomass for heating also see demand grow, driven by industry growth (IEA 2020b).

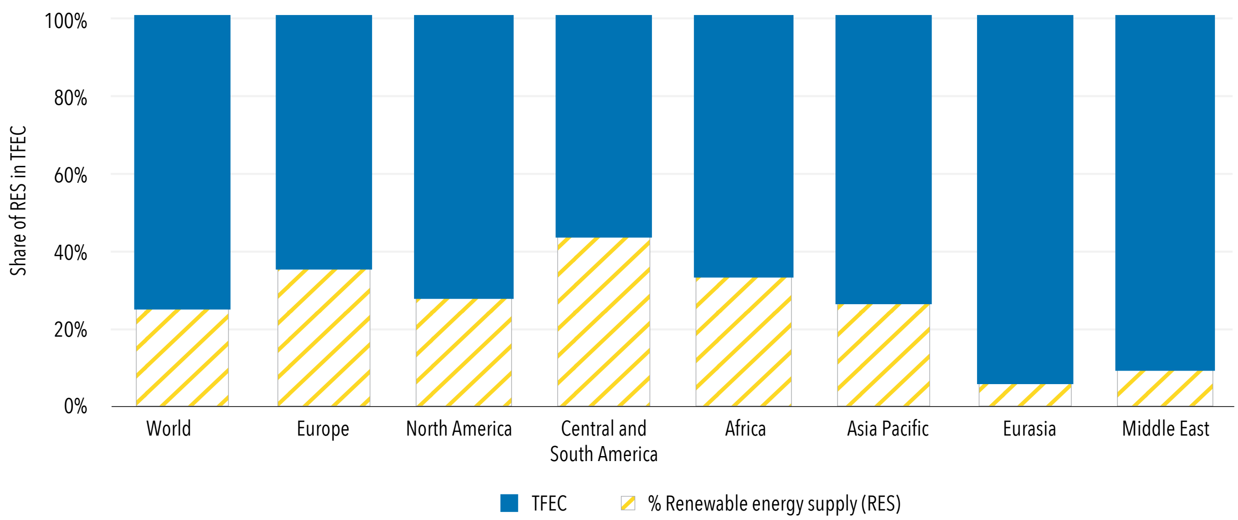
The outlook for end-use renewables depends largely on policy actions taken at a time of economic difficulty and competing budgetary pressures. Furthermore, there is a risk that some targets may not be enforced, or that implementation dates may be delayed as a result of pressures arising from the COVID-19 pandemic. Supportive policies may, however, play a major role in recovery packages, especially transport biofuels on the grounds that they would provide support for agricultural production while also reducing emissions.

How can we bridge the gap? Some insights follow.

INSIGHTS FROM IEA'S SUSTAINABLE DEVELOPMENT SCENARIO

Once again, the projected increases in the use of renewable energy under Stated Policies Scenario fall short of global goals for climate protection and sustainable development. In IEA's Sustainable Development Scenario, which charts a more-ambitious path toward these goals, renewables play a greater role, with their use growing twice as fast as under the Stated Policies Scenario. Under the more-ambitious scenario, modern renewables would reach just over 25 percent of TFEC in 2030 (figure 6.3).

FIGURE 6.3 • Share of renewables in total final energy consumption (TFEC), Sustainable Development Scenario, 2030



Source: IEA 2020b.

RES = renewable energy sources; TFEC = total final energy

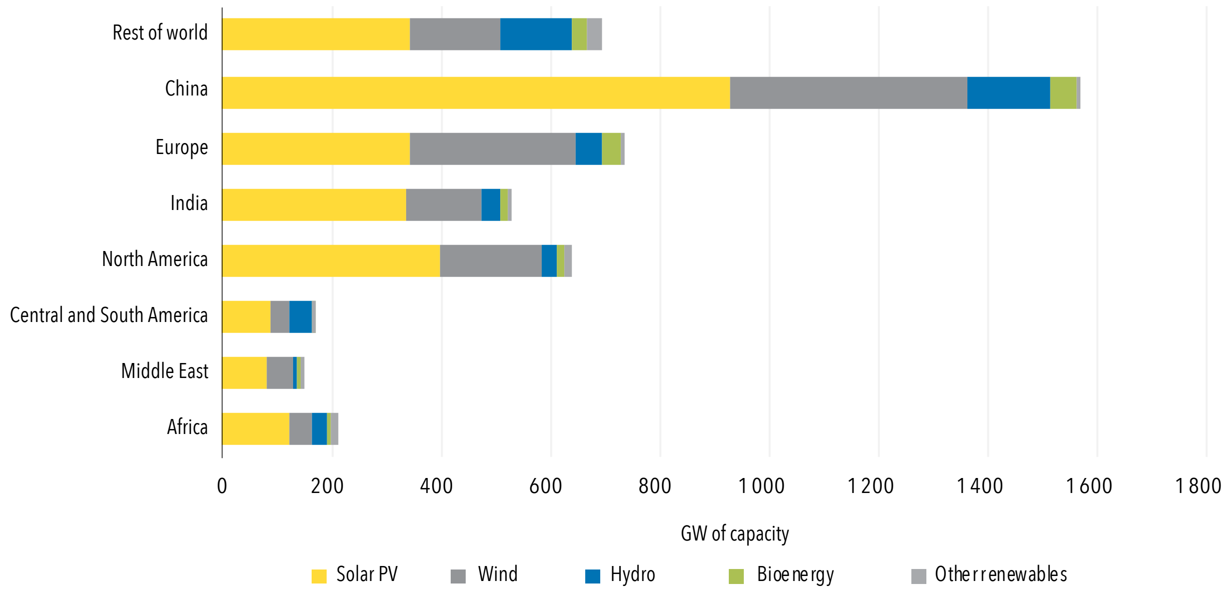
In IEA's Sustainable Development Scenario, the share of renewables-based electricity generation increases rapidly, expanding its current share to just over 50 percent by 2030, or almost 14 percentage points (3,800 TWh) higher than under the Stated Policies Scenario. At the global level, renewables-based electricity generation increases by 8 percent per year to almost 16,400 terawatt-hours (TWh) by 2030, or more than four times the amount of electricity generated in the United States today from all sources.

Increased electrification of energy end uses under the Sustainable Development Scenario means that the share of electricity in final energy demand rises to 24 percent by 2030 compared with a little over 21 percent under the Stated Policies Scenario. The electrification of transport and heat is indirectly increasing demand for renewables in end-use sectors and complements the direct use of renewables in efforts to decarbonize energy use. So-called direct renewables, principally biofuels, increase their share in demand for transport-related energy to 11 percent. Combined with growing electrification, renewables' share in transport rises to around 13 percent. Although light-duty vehicles are on a pathway to decarbonization by 2030, renewable fuels still account for just 4 percent of total fuel consumed by ships in 2030 and just 10 percent of fuel use in the aviation sector (IEA 2020b).

The use of renewables for heat applies to space and water heating, cooking, industrial processes, and other uses (figure 6.4). It can be provided directly by bioenergy, solar thermal, or geothermal energy, or indirectly through electricity and district heat produced from renewable sources. Fuel switching to the direct use of renewables can also reduce the use of fossil fuels—for example, through the use of solar thermal water heating, biomass, and low-carbon gases. In 2020, renewables accounted for 8 percent of total energy consumed for commercial heat production worldwide. By 2030, this increases to 18 percent under the

Sustainable Development Scenario. The share of traditional uses of biomass falls to 5 percent of TFEC by 2030 under the Stated Policies Scenario, whereas under the Sustainable Development Scenario, traditional uses of biomass are phased out entirely, as developing countries replace them with more modern and efficient fuels and technologies.

FIGURE 6.4 • Cumulative renewable power generation capacity additions, by technology and region, in the Sustainable Development Scenario, 2019–30



Source: IEA 2020b.

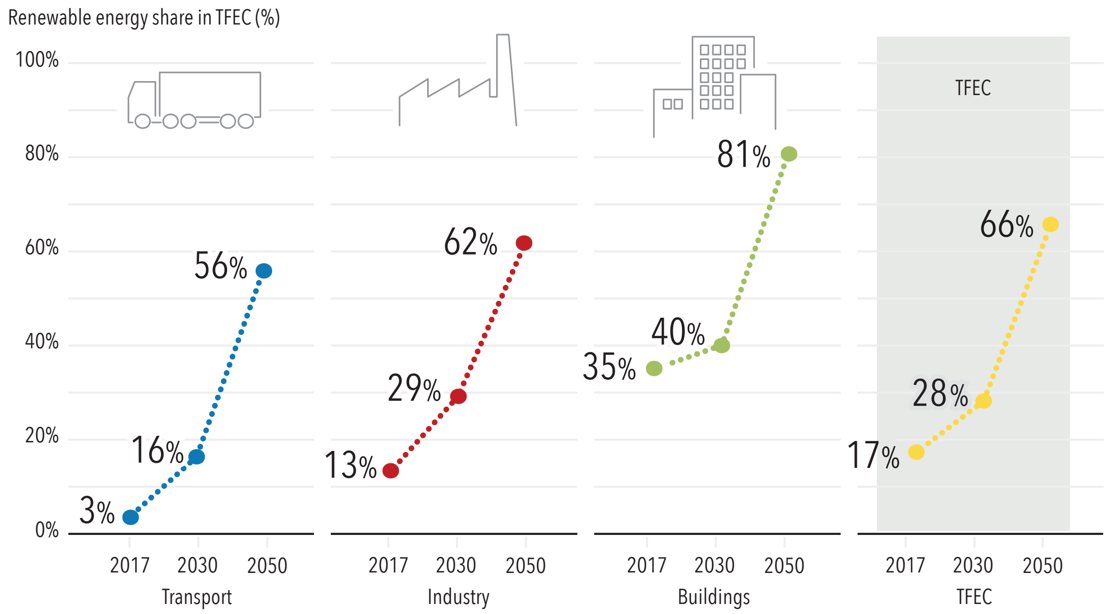
Across regions, variations in energy policy, socioeconomic trends, and natural-resource endowments result in differing growth trajectories for renewables. Developing economies account for around 85 percent of the growth in renewable electricity generation through 2030 under both the Stated Policies and Sustainable Development scenarios, with developing economies in Asia, led by China and India, representing half the increase. Under the Stated Policies Scenario, the outlook for electricity generation from renewable sources ranges from 10 percent in the Middle East and 18 percent in North Africa, at the low end, to more than 70 percent in Central and South America, where hydropower dominates the power mix. Under the Sustainable Development Scenario, the share of renewable electricity generation increases in every region, approaching or surpassing half of all electricity generated by 2030 in many regions.

INSIGHTS FROM IRENA'S TRANSFORMING ENERGY SCENARIO

IRENA's Planned Energy Scenario describes a path set by current and planned policies for modern renewables, whereby its share would reach only 17.5 percent in 2030—far short of the global climate objectives and SDG 7. The agency's Transforming Energy Scenario, by contrast, presents a cleaner, climate-resilient pathway based on a more ambitious, yet achievable, uptake of renewable energy and energy efficiency measures. In it, the share of modern renewable energy in TFEC would rise steeply from 10.5 percent in 2018 to 28 percent by 2030. Several factors would be responsible: growth in renewable electricity generation, electrification of end uses, more direct use of renewable energy, and improved energy efficiency.

The developments vary based on sector (figure 6.5). At just 3 percent, the transport sector has the lowest renewables share, but it would see the most growth year on year, to 16 percent of renewables in the sector's final energy consumption by 2030—five times more growth over ten years. The industry sector sees the renewables share increase from 13 percent to 29 percent by 2030. The buildings sector would have the highest share of renewable energy in the end-use sectors, just like today, but with a marked shift in fuels away from traditional forms of bioenergy to modern direct uses and renewable electricity. In the sector, the overall renewables share would ramp up from 35 percent (when including traditional use of biofuels) or 13 percent (excluding traditional uses of biofuels) in 2017 to 40 percent by 2030. The upward trajectory in renewables share would accelerate toward 2050, with shares increasing to 56 percent in transport, 62 percent in industry, 81 percent in buildings—while overall in TFEC the share would reach two-thirds.

FIGURE 6.5 • Share of renewable energy in TFEC by end use under the Transforming Energy Scenario

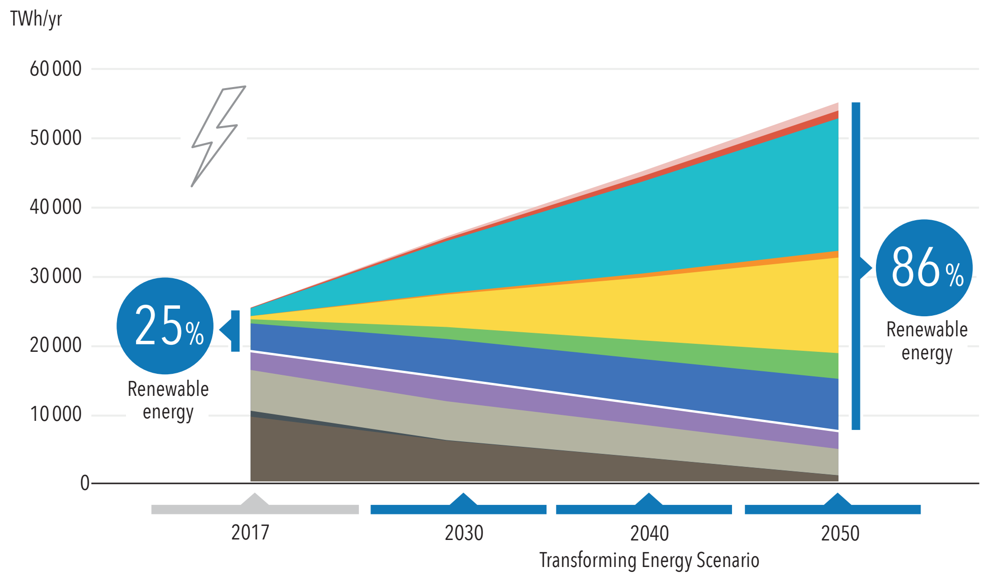


Source: IRENA 2020a.

Note: 2017 includes traditional uses of biofuels in the buildings sector and TFEC. By 2030 most traditional forms of biofuels are phased out of energy supply.

Electricity will increasingly become the crucial energy carrier as the world moves toward decarbonization of the energy system. In recent years renewable electricity has come to dominate new capacity expansion, and over the coming decades it will be the single largest driver for change in the global energy transformation. Over the next ten years, electricity would grow under the Transforming Energy Scenario from a 20 percent share of final energy consumption to a 29 percent share by 2030, with gross electricity consumption increasing 50 percent from 25,570 TWh in 2017 to 35,850 TWh in 2030 (figure 6.6). The share of renewable electricity generation will subsequently rise, with most new capacity provided through new renewables capacity, as the renewables share more than doubles to 57 percent by 2030, up from 25 percent in 2017. This trend would continue toward 2050, when renewable electricity would make up 86 percent of a total gross electricity generation of almost 55,000 TWh.

FIGURE 6.6 • Electricity generation mix (TWh/year) under IRENA's Transforming Energy Scenario



Source: IRENA 2020a.

Wind and solar PV would dominate global electricity generation and capacity additions under the Transforming Energy Scenario. By 2030, more than a third of the world's electricity would come from solar and wind power, a trend that would increase over the succeeding decades, amounting to over 60 percent by 2050. Total installed wind and solar capacity would exceed 6,000 GW in 2030 and 8,800 GW by 2050, respectively. This can be achieved, however, only if power systems adapt and become more flexible. The Transforming Energy Scenario also requires widespread investment in enabling infrastructure, including grid expansion, flexible generation, demand-response, storage, and more.

Despite this transformation occurring in the power sector, it leaves the other half of final energy consumption unelectrified. To address this, the Transforming Energy Scenario takes several approaches.

First is energy efficiency, which includes improved technical efficiency and behavior changes. Energy efficiency would also contribute (together with use of renewables and electrification) to energy intensity improvements, which, under the Transforming Energy Scenario, amount to 3.2 percent per year through 2050.

Second, direct use of renewables is scaled up considerably. Sustainable uses of bioenergy would remain a pillar of a renewables-based energy system, used to provide heat in industry and as a biofuel. Heat produced from solar thermal energy plays an important role in residential, commercial, and some light industry; while geothermal is an important source in countries with the necessary resources.

Third, fossil fuels would still have a role in 2050, providing one-third of the energy supply. They would, however, be far below today's levels of production. Oil would largely be used in industry for some subsectors, and in aviation and shipping. Coal would be used only in industry, mostly for steel production. Natural gas would see production increase and peak in the mid-2020s, but then fall to two-thirds of 2017 levels by 2050, by which time it would have become the most widely used fossil fuel.

Fourth: indirect electrification via hydrogen (and synthetic fuels). Hydrogen is a promising energy carrier, which by 2030, under the Transforming Energy Scenario, has the potential to supply 11 EJ of global energy demand, of which 3.2 EJ would come from renewable sources. By 2050 nearly 29 EJ will be consumed, two-thirds of which will come from renewable sources.

BOX 6.2 • IRENA'S POST-COVID-19 RECOVERY AGENDA

COVID-19 has intensified the urgency of decarbonizing our societies and meeting the Sustainable Development Goals. By making the energy transition an integral part of the wider recovery, governments can accelerate the pursuit of a healthy, inclusive, prosperous, just, and resilient future.

The onset of the crisis upended economic trends and dynamics around the world, including in the energy sector. To date, renewable energy as a whole has fared better than fossil fuels. Renewables remain predominant in new electric power capacity and have proven flexible, cost-effective, and resilient in the face of the 2020 health and economic crisis.

IRENA's post-COVID-19 agenda links short-term recovery with medium- and long-term scenarios targeting 2030 and 2050. Annual investment in energy transition–related technologies would more than double from the 2019 level of USD 824 billion to nearly USD 2 trillion in the 2021–23 recovery phase, before reaching an annual average of USD 4.5 trillion in the decade to 2030 (IRENA 2020b).

With the added investment stimulus under IRENA's Transforming Energy Scenario, energy transition-related technologies would add 5.5 million more jobs by 2023 than would be possible under the less ambitious Planned Energy Scenario, while boosting GDP by an additional 1 percent on average. In the medium-term through 2030, 19 million more jobs would be created compared with the Planned Energy Scenario; GDP would be boosted an additional 1.3 percent per year.

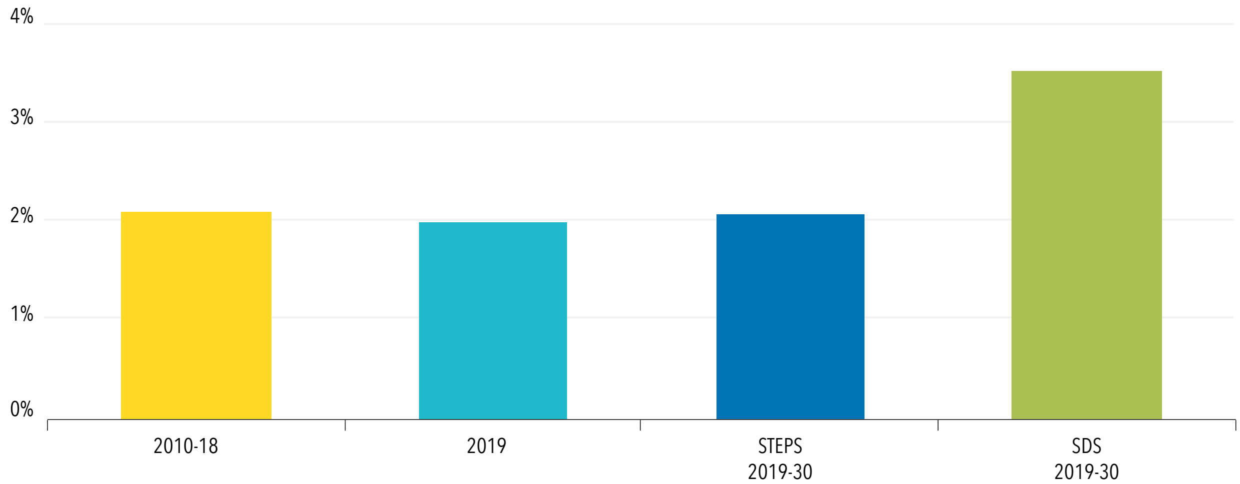
In 2019, jobs in the renewable energy sector worldwide reached an estimated 11.5 million, continuing a long-term growth trend (IRENA 2020c). By 2030, the absolute number of renewable energy jobs is expected to increase to 30 million. By 2050, IRENA's Transforming Energy Scenario foresees the renewable energy workforce numbering as much as 42 million. Additionally, 21 million jobs will be in energy efficiency and almost 15 million in power grid and energy flexibility. The overall energy sector will account for 100 million workers, including the conventional technologies.

This outcome is the result not only of shifting investment priorities within the energy sector, but also of the greater labor intensity of renewables compared with fossil fuels. Gains in energy transition–related fields would far outweigh the loss of jobs in fossil fuels (IRENA 2020b).

THE OUTLOOK FOR ENERGY EFFICIENCY

Global energy intensity, measured by the ratio of total energy supply to GDP, is the key indicator of global progress on energy efficiency. Global primary energy intensity in 2018 improved by just 1.1 percent over 2017. Annual improvement through 2030 will now need to average 3 percent if the world is to meet the target set by SDG 7.3. While early estimates for 2019 indicated a slight recovery, with an improvement rate of 2 percent, the outlook for 2020 suggests even lower levels of improvement than in 2018, at only 0.8 percent because of the COVID-19 disruptions. The slowdown likely reflects weaker implementation of energy efficiency policy and strong demand in energy-intensive economies and sectors.

FIGURE 6.7 • Average annual primary energy-intensity improvement in the Stated Policies and Sustainable Development scenarios, 2010–30, percent



Source: IEA 2020b; e for estimate.

SPS = Stated Policies Scenario; SDS = Sustainable Development Scenario.

The COVID-19 crisis has altered previously held assumptions about the development of the world's energy systems. In the Stated Policies Scenario, which assumes an annual efficiency improvement of 2 percent between 2019 and 2030, the improvement is accompanied by a rise in global final energy consumption to around 11,270 million tonnes of oil equivalent by 2030, lagging 2.5 years behind IEA's *World Energy Outlook* projections because of COVID-19 (IEA 2020b). In 2025, TFEC is predicted to remain below pre-crisis trajectories, before returning to annual growth rates of 1.2 percent for the remainder of the decade, consistent with growth rates anticipated in pre-pandemic projections.

Low fuel prices are an important reason in the Stated Policies Scenario for a slowing of the rate at which the energy intensity of the global economy improves. In this scenario, the annual rate of improvement falls to 2 percent annually for 2019–25 before rising slightly in subsequent years. This is much lower than pre-crisis projections of 2.4 percent per year and far short of the improvement required to meet the goals of the Sustainable Development Scenario. Lower fuel prices have implications for measures to improve efficiency. Payback periods for investments to improve efficiency, for example, are extended by 20–40 percent for buildings and by 20–30 percent for transport, compared with last year's projections. Enhanced energy efficiency mandates and incentives may be needed to compensate for weakened price incentives, and the extent to which these measures are built into COVID-19 recovery strategies may help to determine the uptake of more efficient goods.

In contrast, energy efficiency is one of IEA's building blocks for its Sustainable Development Scenario. The COVID-19 lockdowns and disruptions saw TFEC fall in 2020 and 2021—before a predicted recovery, peaking in 2024. The accelerated improvements in energy efficiency across all energy end uses under this scenario would cause global energy demand to decline after 2024 . The adoption of the measures outlined in the scenario translates to energy savings of 1,600 million tonnes of oil equivalent in 2030 annual consumption over the Stated Policies Scenario, overshooting SDG target 7.3. The annual 3.5 percent improvement in energy intensity under the Sustainable Development Scenario between 2019 and 2030 is obtained through a combination of well-implemented policies and regulations.

In the Sustainable Development Scenario, total energy supply declines by 7 percent between 2019 and 2030, with demand in advanced economies falling by more than 15 percent over this period. This drop occurs despite strong economic growth, itself a reflection of two developments, the first of which is the widespread deployment of both demand- and supply-side efficiency measures. The second development is the increased electrification of end-use sectors. The primary energy intensity of the global economy under the Sustainable Development Scenario falls by 3.4 percent on average each year in the 2019–30 period, compared with a decline of 2 percent on average each year between 2010 and 2019.

Early implementation of efficiency improvements across all sectors is essential to move toward a more sustainable trajectory. In the transport sector, efficiency improvements under the Sustainable Development Scenario mean that the average conventional passenger car sold in 2030 consumes 50 percent less energy than those sold in 2019, while new trucks consume 26 percent less fuel. There are also substantial reductions in indirect emissions from appliances and air conditioners. By 2030, household appliances and air conditioners in the Sustainable Development Scenario are on average 10 percent more efficient than 2019. In industry, efficient industrial facilities improve with the deployment of better electric motors, heat pumps, and irrigation pumps, and the wider implementation of energy management systems.

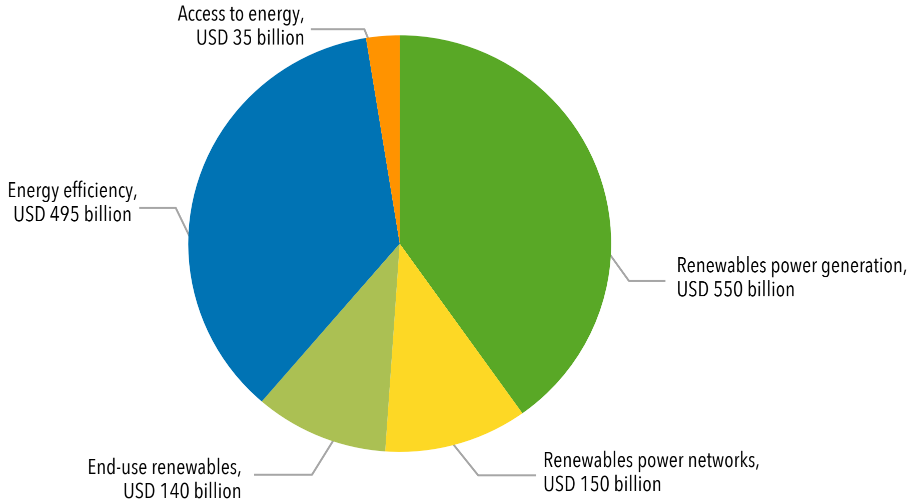
The Sustainable Development Scenario also contains a suite of measures to speed up programs to improve the energy efficiency of new and existing buildings; it also provides assistance to manufacturers to accelerate upgrades to production lines to produce higher-efficiency equipment. Improvements in efficiency across all end uses in the building sector, and achievement of universal access to clean cooking, will produce declines in total energy demand in residential buildings by almost 15 percent over the 2019–30 period, despite a 25 percent increase in the provision of energy services reflecting population and economic growth. In the existing building stock, deep energy retrofits can reduce energy use by more than 60 percent. Around 30 percent of the worldwide building stock that will exist in 2030 has yet to be built, and in some countries, including India, the figure is over 50 percent. Nearly three-quarters of countries today do not, however, have mandatory energy codes for new buildings. In the Sustainable Development Scenario, mandatory energy-related building codes are introduced in all countries, and existing codes become more rigorous. These measures reduce the average energy intensity of new buildings by nearly 50 percent over the 2019–30 period (IEA 2020b).

INVESTMENTS NEEDED TO ACHIEVE SDG 7

The economic damage brought about by the pandemic has created an opportunity to support economic growth and jobs while boosting investment in renewable energy technologies. In the Sustainable Development Scenario, total energy sector investments needed to achieve all targets of SDG 7 are estimated to average USD 1.4 trillion per year between 2019 and 2030 (figure 6.8). As part of post-COVID-19 economic stimulus packages, the Sustainable Development Scenario sees USD 35 billion average annual investment toward energy access from 2021 to 2030 (three-times more than in the Stated Policies Scenario), with universal access by 2030. This is predicated on strong policy support and international co-operation, particularly in Sub-Saharan Africa.

The finance available for funding expansion and upgrades of electricity and clean cooking access in the past has been much less than what is needed to achieve full access in line with SDG 7. Between 2013 and 2017, USD 8 billion was spent on average each year to improve electricity access in 20 countries, with 70 percent of the world's population lacking access to electricity; in the same period, USD 70 million was spent each year on clean cooking in the 20 countries that have the highest numbers of people lacking access (SEforAll 2019).

FIGURE 6.8 • Average annual investment in selected technologies, Sustainable Development Scenario, 2020–30



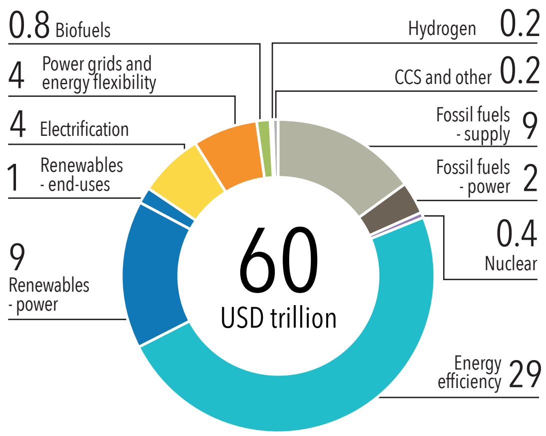
Source: IEA 2020b.

In the Sustainable Development Scenario, USD 30 billion is the average annual investment required from 2020 to 2030 in order to reach full electricity access in emerging market and developing economies; and around USD 5 billion, or more the six times the present level, for clean cooking access, with more than half this investment occurring in Sub-Saharan Africa (IEA 2020b). It is critical that clean cooking remains on the political agenda during the present crisis. Even modest investments in this sector can deliver sizable social and environmental improvements, while boosting resilience and public health.

The majority of the investment required to meet SDG 7 in the Sustainable Development Scenario is directed toward renewable electricity generation (incl. batteries) and end-use efficiency, which account for USD 550 billion and USD 495 billion average investment each year, respectively. Renewables-based power investment needs to be supported by additional spending on expanding and modernizing electricity networks of USD 150 billion on average each year. Finally, investments on end-use renewables account for the remaining USD 140 billion that makes up the USD 1.4 trillion annual investments necessary to achieve SDG 7, according to the Sustainable Development Scenario.

IRENA's Transforming Energy Scenario shows that cumulative investments into the energy system over the period from 2016 to 2030, including infrastructure, supply, efficiency, and electrification, would reach USD 60 trillion. Compared to the Planned Energy Scenario, investments of nearly USD 10 trillion would need to be redirected from fossil fuels and related infrastructure to low-carbon technologies by 2030. Of the total investments, the largest investment need is energy efficiency, with USD 29 trillion, or roughly half the investment. This is followed by USD 9 trillion of cumulative investments needed to scale up renewable power generation capacity through 2030 (on an annual basis between 2019-30, this would mean around USD 850 billion as referred to in the main messages). To enable the broad shift to electricity, and renewable power, USD 8 trillion needed to be invested in power grids, energy flexibility, and enabling electrification infrastructure. Fossil fuel supply and nuclear would see investments of more than USD 11 trillion; while renewable direct use and supply (including hydrogen) would require USD 2 trillion in investment. In line with the Transforming Energy Scenario, IRENA's post-COVID-19 agenda for the 2021–23 recovery phase states that annual investment in energy-transition-related technologies should reach USD 2 trillion to maximize socioeconomic benefits (box 6.2).

FIGURE 6.9 • Transforming Energy Scenario investments from 2016 to 2030 (USD trillion)



Source: IRENA 2020a.

Closing investment gaps will require substantial and coordinated efforts from a variety of stakeholders. While the bulk of investments will continue to come from private sources, public finance institutions and international donors will play a key role in mobilizing private capital at scale, in particular in developing countries.

CONCLUSION

While innovative policies and technologies continue to bring benefits to the energy sector, the impact of the COVID-19 pandemic has left us in a far different place from that foreseen in early 2020. Not only is the world not on track to meet SDG 7 under current and planned policies, some goals are even more elusive than ever. For example, recent successes on energy access in Africa are being reversed, while the number of people without access to electricity rose in 2020 after falling the previous six years. Meanwhile, basic electricity services are now too costly for up to 30 million people, people who could previously afford access.

The perceived risk of lending money to a number of developing countries has increased dramatically, making it more expensive for them to raise debt finance for energy technologies and energy access. In IEA's Stated Policies Scenario, the economic fallout from COVID-19 adds to the difficulties that governments and other agents face in expanding access. These obstacles will leave 660 million people without access to electricity in 2030 (most of them in Sub-Saharan Africa) and close to 2.4 billion people worldwide lacking access to clean cooking. If we are to achieve our 2030 goals, expanding access must be at the center of recovery plans and programs. This involves, for example, measures to support the emerging private solar sector, setting action-based targets to boost progress at the required pace. In a world where finance is constrained, access projects will need to be smart (e.g., linked with agriculture to unlock related benefits), effective, and capable of being kickstarted. Decentralized energy solutions will also play an important role, in particular, in reaching remote households far from a grid.

The impact of the pandemic on meeting SDG 7 goes beyond access. Low oil and gas prices could act as a barrier to the uptake of clean energy technologies for some end uses. The payback period for many energy efficiency retrofits in buildings, for example, is longer when fossil fuel prices are lower. In some sectors, the ongoing decline in economic activity and lingering economic uncertainty are likely to bring slower turnover of capital stock—meaning that more carbon-intensive and inefficient capital stock may operate for longer.

Yet the pandemic could also have positive outcomes. In a number of advanced economies, a decline in interest rates and accommodative monetary policy by central banks means that base lending rates will stay lower for longer. Given the capital-intensive nature of many clean energy technologies, this could translate into lower deployment costs. Recovery plans designed to kickstart economic growth, protect workers, and create jobs could provide a substantial boost to the deployment of clean energy technologies, for example, by developing strategies that harness existing skills in the energy sector to support clean energy transitions. Lower fossil fuel prices could make it easier for governments to reform fossil fuel subsidies. Part of how we get on track toward meeting SDG 7 depends on how governments respond to the economic crisis and what role recovery packages play in shaping a more sustainable future.

METHODOLOGY

IEA METHODOLOGY AND SCENARIOS

The analysis presented in this chapter is based on results from the World Energy Model (WEM) and IEA analysis in the *World Energy Outlook* (IEA 2019). Detailed documentation of the WEM methodology can be found at https://www.iea.org/reports/world-energy-model/documentation#abstract.

The analyses shown above are built on two scenarios described below.

Stated Policies Scenario

The Stated Policies Scenario provides decision-makers with feedback about their current course, based on stated policy ambitions. This scenario assumes that the COVID-19 pandemic is brought under control over the course of 2021. It incorporates IEA assessments 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 reflect progress on implementation of corporate sustainability commitments.

Sustainable Development Scenario

The Sustainable Development Scenario is designed so the energy-related United Nations Sustainable Development Goals might achieve universal access to affordable, reliable, and modern energy services by 2030; substantial reductions in air pollution, and craft effective actions to address climate change. The Sustainable Development Scenario is fully aligned with the Paris Agreement to hold the rise in global average temperature to “well below 2 °C … [while] pursuing efforts to limit [it] to 1.5 °C.” The Sustainable Development Scenario assesses what combination of actions would be required to achieve these objectives. In this Outlook, investments in the 2021–23 period are fully aligned with those in “Sustainable Recovery: World Energy Outlook Special Report” (IEA 2020). In the Sustainable Development Scenario, many of the world’s advanced economies reach net-zero emissions by 2050, or earlier in some scenarios, and global carbon dioxide (CO_2) emissions are on course to fall to net zero by 2070.

Methodology for access to electricity and access to clean cooking

The projections presented in the WEO, and this chapter, focus on two elements of energy access: electricity and clean cooking facilities at the household level. These elements are measured separately. The IEA maintains databases on national, urban, and rural electrification rates; for the proportion of the population without clean cooking access, the main sources are the World Health Organization (WHO) 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 shown in the Stated Policies Scenario take into account current and planned policies, recent progress, as well as population growth, economic growth, urbanization rate, and the availability and prices of different fuels. In the Sustainable Development Scenario, we identify least-cost technologies and fuels to reach universal access to both electricity and clean cooking facilities. For electricity access, this is done by incorporating 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 has been developed in collaboration with the KTH Royal Institute of Technology, Division of Energy Systems Analysis (KTH-dESA) in Stockholm. Further details about IEA methodology for energy access projections are in this document.

Methodology for renewable energy projections

The annual updates to WEO projections reflect the broadening and strengthening of policies over time, including for renewables. The projections of renewable electricity generation are derived in the renewables submodule of the World Energy Model, which projects the future deployment of renewable sources for electricity generation and the investment needed. The deployment of renewables is based on an assessment of the potential and costs for each source (bioenergy, hydropower, photovoltaics, concentrating 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, which affects costs. By including financial incentives for the use of renewables and nonfinancial barriers in each market, technical and social constraints as well as the value each technology brings to system in terms of energy, capacity, and flexibility, the model calculates deployment as well as the resulting investment needs on a yearly basis for each renewable source in each region.

Methodology for energy efficiency projections

The key energy efficiency indicator refers to GDP and total final energy demand.

Economic growth assumptions for the short to medium term are based largely on those prepared by the OECD, the International Monetary Fund, and the World Bank. Over the long term, growth in each WEM region is assumed to converge to an annual long-term rate. This is dependent on demographic and productivity trends, macroeconomic conditions, and the pace of technological change.

Total final energy demand is the sum of energy consumption for each end use in each final demand sector. In each subsector or end use, at least six types of energy are shown: coal, oil, gas, electricity, heat, and renewables. The main oil products—liquefied petroleum gas (LPG), naphtha, gasoline, kerosene, diesel, heavy fuel oil, and ethane—are modeled separately for each final demand sector.

In most of the equations, energy demand is a function of activity variables, which again are driven by:

- Socioeconomic variables: In all end-use sectors, GDP and population are important drivers of sectoral activity variables that determine energy demand for each end use within each sector.
- End-user prices: 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. End-user prices are then used as an explanatory variable influencing the demand for energy services.
- Technological parameters—e.g., recycling in industry, or material efficiency.

All 25 WEM regions for energy demand are modeled in considerable sectoral and end-use detail. Specifically:

- Industry is separated into six subsectors (with the chemicals sector disaggregated into six subcategories).
- Building energy demand is separated into residential and services buildings, which are then differentiated into six end uses. Within the residential sector, appliances energy demand is separated into four appliance types.
- Transport demand is separated into nine modes, with considerable detail for road transport.

IRENA methodology and scenarios

IRENA's scenarios referenced in this report were developed by the Renewable Energy Roadmaps (REmap) team at IRENA's Innovation and Technology Centre in Bonn. Since 2014, REmap has produced roadmaps that provide ambitious, yet feasible pathways for deploying low-carbon technologies to create a clean, sustainable energy future at global, regional, and country levels.

The findings presented in this report are based on IRENA's 2020 flagship publication, *Global Renewables Outlook: Energy Transformation 2050*. It presents two scenarios:

- The Planned Energy Scenario is the primary reference case in IRENA's *Global Renewables Outlook*, providing a perspective on energy system developments based on governments' energy plans and other ca. 2019 targets and policies, including Nationally Determined Contributions under the Paris Agreement, unless the country has more recent climate and energy targets or plans.
- The Transforming Energy Scenario describes an ambitious energy transformation pathway based largely on renewable energy sources and steadily improved energy efficiency (though not limited exclusively to these technologies). This scenario would set the energy system on the path needed to keep the rise in global temperatures to well below 2 degrees Celsius (°C) and toward 1.5°C during this century.

More information can be found on the IRENA website www.irena.org/remap

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CHAPTER 7

TRACKING SDG 7 PROGRESS ACROSS TARGETS: INDICATORS AND DATA

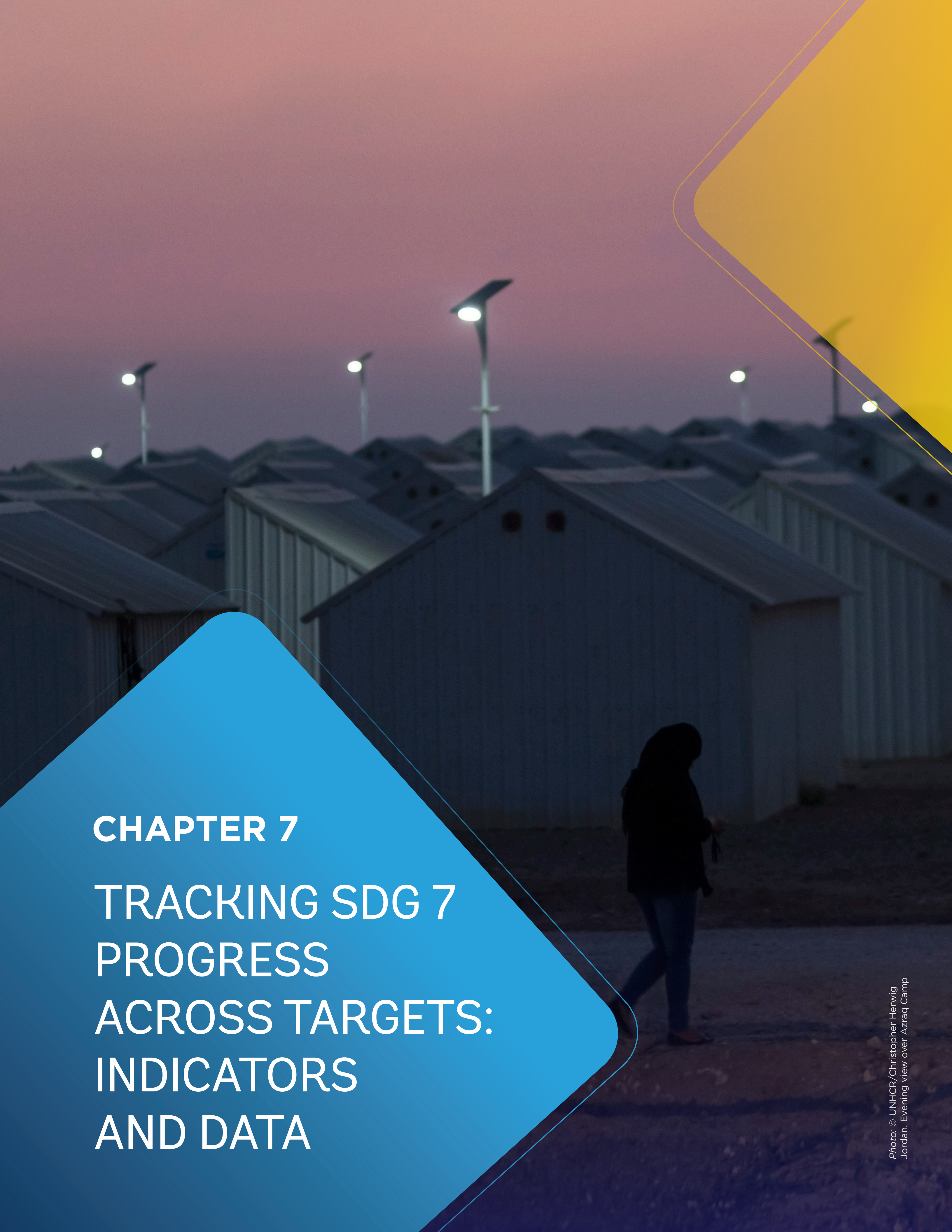

Photo: © UNHCR/Christopher Herwig
Jordan. Evening view over Azraq Camp

Comprehensive and accurate data are essential for countries intent on making evidence-based decisions. In developed and developing countries alike, this focus on accurate data provides transparency with respect to trends and helps track progress toward policy goals. Well-designed and appropriately resourced data collection on national energy statistics and trends plays a fundamental role in how countries monitor their own progress toward achieving Sustainable Development Goal 7.

Working with national data across regions, several custodian agencies collaborated on this account of progress on SDG 7.[63]

Global tracking certainly benefits from continuous improvements of national data systems—as countries set up legal frameworks and institutional arrangements;[64] gather accurate supply-and-demand data and balance equations;[65] implement end-user surveys (e.g., of households, businesses, and others); and establish quality-assurance frameworks consistent with the United Nations' *International Recommendations for Energy Statistics.*[66] Global progress toward SDG 7 makes a number of energy policies relevant, so tracking them is an opportunity to strengthen data collection.

This chapter compiles the indicators used to track progress across the SDG 7 targets, as set out in table 7.1; it also describes the work done at national and international levels to obtain the underlying data. For further information on the methodologies behind indicators, please refer to the individual chapters or to the United Nations' metadata repository for SDGs.[67]

TABLE 7.1 • Targets and indicators for SDG 7

TARGET	INDICATOR
7.1—By 2030, ensure universal access to affordable, reliable and modern energy services	7.1.1—Proportion of population with access to electricity
	7.1.2—Proportion of population with primary reliance on clean fuels and technology
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
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
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
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)

63 This report is based on the work of the several custodian agencies in tracking progress across the SDG 7 targets: 7.1—access (World Bank, WHO); 7.2—renewables (IEA, IRENA, UNSD); 7.3—energy efficiency (IEA, UNSD); 7.a—international cooperation (OECD, IRENA); 7.b—public financial flows (IRENA).

64 Institutional arrangements are made to optimize data production, exchange, and governance across organizations, mainly statistical offices and government agencies (energy ministries) responsible for implementing energy polices.

65 Energy balances are comprehensive accounts of all the energy entering, exiting, and consumed in the territory of a given country, typically covering production, import, and export of primary energy sources, in addition to its transformation into fuels for final consumption and consumption within each major end-use sector. Examples are available at https://www.iea.org/data-and-statistics/data-tables?country=WORLD and https://unstats.un.org/unsd/energystats/dataPortal/.

66 Under IRES (United Nations 2018) data quality is marked by relevance, accuracy, and reliability; timeliness and punctuality; coherence and comparability; and accessibility and clarity. For quality-assurance frameworks, please refer to IRES, chapter IX.

67 https://unstats.un.org/sdgs/metadata/

ACCESS TO ELECTRICITY

Tracking progress on electrification requires a universally applicable and transparent approach. This complex process tracks cumulative progress across interventions carried out by a number of national and international players—including governments, energy utilities, private sector companies, funding agencies, and developmental organizations. Given the rise of decentralized energy solutions and the socioeconomic complexity of access-deficit countries, the tracking process also encompasses a mix of technologies such as grids, mini-grids, and self-generation solutions like solar home systems. Finally, assessments must tally the numbers of people benefiting from these interventions and describe the nature and magnitude of improvements. It is critical, however, to help governments and practitioners understand their current access status and identify any bottlenecks to rapid electrification so they can make informed decisions and achieve their universal access goals in more efficient ways.

In order to set goals for investment priorities and track progress, a multi-tier framework (MTF) based on household surveys has been established through a multiagency effort.[68] Defining and measuring access to electricity should focus not only on the number of users with access but also on the nature and degree of access across a number of attributes—capacity (adequacy), availability, reliability, affordability, quality, legality, health impact, safety, and convenience, among others. The MTF has been deployed by national statistical offices and the World Bank since 2016, and data collection has been completed for 16 first-round countries. New MTF surveys are being implemented in seven countries.

For the purposes of global measurement, however, given the paucity of data for multi-tier metrics, standardized country-level surveys (and supply-side data from governments or utilities) complement the MTF approach for now.

Some methods to track electricity access include:

- Conducting workshops (e.g., on geospatial planning) to develop the capacity of national statistical offices in data collection, arranged through development partners.
- Improving the usability of datasets for energy practitioners by helping governments adopt emerging technology and data analytics. Survey design can be hampered by outdated or nonexistent censuses.
- Exploring the use of large-scale open databases, such as satellite data.

Most microdata found in household, enterprise, and agriculture surveys are useful for energy practitioners and ministries. It takes significant time and effort, however, to extract data on energy access, including socioeconomic status, electrification status, and village-level information. Data harmonization and standardization could help more end users access and use such datasets, for example, to design projects and formulate policy.

ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

For the purposes of monitoring SDG 7 on access to clean cooking (and SDG 3 on health), a nonparametric statistical model is used to estimate country and regional access[69]. "Clean cooking" is determined by the emission levels of a particular fuel-and-technology combination. The analysis for SDG 7.1.2 presently centers on cooking fuels, using them as surrogates to estimate reliance on clean cooking.[70]

In the future, it will be essential to have information on the many types of cooking fuels and technologies, as well as their frequency and duration of use, in order to design, implement, and monitor the effectiveness

68 Participants in the MTF process were the Energizing Development Program (EnDev), the Energy Sector Management Assistance Program (ESMAP), the Global Alliance for Clean Cookstoves (the Alliance), the International Energy Agency (IEA), Practical Action Consulting (PAC), the UN Development Program (UNDP), the UN Foundation, the UN Industrial Development Organization (UNIDO), the World Bank, and the World Health Organization (WHO).

69 See methodology section of chapter 2.

70 This approach is rooted in the lack of globally representative data on household-level cooking technologies. Households considered to have access to clean cooking for SDG 7.1.2 are those primarily relying on electricity, biogas, solar, alcohol fuels, natural gas, and liquefied petroleum gas (LPG) for household cooking.

and outcomes of clean cooking policies and programs. The wording, and number, of survey questions is important. Country-level estimates of clean cooking access are also used to gauge the burden of disease and ultimately the "mortality rate from the joint effects of ambient and household air pollution," which is one of the indicators used to monitor the environmental health impacts under SDG 3 (SDG 3.9.1). By improving data collection on "stove stacking" (the parallel use of different cooking fuels in the home, a common practice in low- and middle-income countries), surveys can produce more accurate appraisals of household exposure to air pollution and of resultant disease burdens.

Simple improvements to surveys enable a better job of monitoring the trends and outcomes of clean cooking. For example, with more robust data collection on the fuels households use, the clean cooking estimates presented here have been able to employ more advanced modeling techniques. Doing so has allowed analysts to estimate the percentage of households mainly using biomass, charcoal, coal, kerosene, gaseous fuels, or electricity, and to arrive at such estimates for each country in every region. With specific estimates, decision-makers can more readily monitor the trends and outcomes of policy changes, such as subsidies or tariffs.

As refinements in household surveys and censuses are made, countries should begin gathering a more complete picture of household energy use, including heating and lighting fuels and technologies (which affect household air pollution as well as stove stacking). Steps have already been taken to develop a harmonized and robust set of questions for national household surveys and censuses.[71] More information on such initiatives by WHO and the World Bank can be found in the 2020 edition of this report (chapter 2, box 2.2).

RENEWABLE ENERGY

Renewable energy progress is tracked for SDG 7 as the share of renewables in total final energy consumption (TFEC).[72] The tracking effort requires comprehensive data across all energy sources (renewable and non-renewable) and across supply, transformation, and final consumption sectors. In terms of data, computation of this indicator relies on the availability of a full supply-demand energy balance,[73] as well as some assumptions regarding electricity and heat.

Specific challenges to accurately tracking renewables include the need to monitor the swift development of geographically distributed sources[74] and to improve the capacity across countries to measure traditional use of biomass for energy (solid biofuels) by households—the largest component of renewable energy in the developing world.

Developing better estimates of solid biofuel use in households requires dedicated effort, for example, through surveys—either enhancing existing surveys with an energy module or establishing new energy surveys. Survey-based results are valuable, and they not infrequently initiate significant revisions of previous estimates, in such cases affecting SDG 7.2 tracking.

A broader question to be addressed for biomass is how much of its use can be considered sustainable—as, for example, traditional fuel wood harvesting is associated with deforestation.

ENERGY EFFICIENCY

Energy efficiency is tracked for SDG 7 through energy intensity, which is the ratio of total energy supply[75] to economic output. Defining the total energy supply requires robust information on primary energy production across all sources, as well as trade in all energy products, among other things. The supply information

71 The WHO/World Bank Core questions on household energy use are available here: https://www.who.int/tools/core-questions-for-household-energy-use

72 Please refer to IRES for the methodology to derive the TFEC.

73 Please refer to IRES for methodology to derive an energy balance.

74 Solar PV, wind, etc.; including off-grid and micro-grid.

75 Please refer to IRES for the methodology to derive the total energy supply (TES).

may be collected from administrative sources[76] or through surveys of higher-level players, such as energy suppliers; the information is available for most commercially traded energy sources[77] and in most countries is of reasonably good quality.

Tracking energy intensity is best done in conjunction with analysis of demand drivers across sectors, such as industry, transport, and building—both residential and services. Given the diverse nature of end users, demand-side data collection is inherently more complex, time-consuming, and costly than supply-side collection. Direct consumer surveys may be necessary, especially when suppliers cannot provide detailed information on how much energy is being delivered to the various types of users.

To analyze sectoral energy efficiency, countries are encouraged to monitor intensities at the end-use level,[78] at least for priority sectors. Apart from the greater data disaggregation required, such indicators require more coordination across entities concerning activities beyond the energy sector, such as building records, vehicle registrations, and so on. Many countries have started to collect end-use data so they can compile energy efficiency indicators to support their policy making and planning.[79]

INTERNATIONAL FINANCIAL FLOWS TO DEVELOPING COUNTRIES IN SUPPORT OF CLEAN AND RENEWABLE ENERGY

SDG indicator 7.a.1 focuses on public financial flows to developing countries in support of clean energy research and development and renewable energy production, including in hybrid systems. The indicator measures public financial flows based on data extracted from IRENA and OECD databases. Public international financial flows data are susceptible to multiple changes and adjustments that call for increased attention to detail, standardized data collection and management cycles, and constant revision of the existing commitment values.

Information on public investment flows to support SDG 7.a.1 could be improved in the following four areas:

- Tracking investments
- Standardizing commitment details
- Centralizing data collection
- Presenting constant flows.

Improved investment tracking should reveal how recipients use international public financial commitments for end-use projects or programs. It is also useful for estimating the amount of private capital leveraged by public funds. End-to-end flow tracking would require commitment identification numbers assigned to end-use organizations and projects by public investors. International flows are often disbursed in multiple phases as they pass through local governments, ventures, or funds. If and when reporting institutions revise financial investment figures, these should be extended to include several years of information to account for commitment cancelations or modifications in amounts.

Standardizing commitment details could be achieved by sharing best practices among public donors and investors, refining reporting directives, and encouraging public donors and investors to provide energy details according to international standards. Standardization would increase reporting accuracy regarding progress toward SDG 7.a.1 and enhance the level of detail concerning commitments—such as

76 Data collected by various agencies in response to legislation and/or regulation, not necessarily for statistical purposes, may be used to compile energy statistics by ensuring quality and addressing limitations related to their different purposes.

77 Difficulties remain in estimating the supply of solid biofuels in several countries, implying uncertainties about TES if solid biofuel use is significant in the overall energy mix.

78 Examples of energy efficiency indicators include energy per passenger-kilometer (or tonne-km for freight), by vehicle type, for transport; energy for space heating/cooling per area, for buildings; energy per amount of physical production of a good, for industry. IEA's Energy Efficiency Indicators: Fundamentals on Statistics (https://www.iea.org/reports/energy-efficiency-indicators-fundamentals-on-statistics) includes a methodological framework for energy efficiency indicators, as well as experiences from countries to produce relevant data.

79 Examples of projects include: the IEA energy efficiency indicators, https://www.iea.org/reports/energy-efficiency-indicators for IEA member countries and beyond; and the Odyssée database for Europe, https://www.indicators.odyssee-mure.eu/energy-efficiency-database.html.

on technology, type of finance (e.g., project-level finance, infrastructure, research, or technical assistance), type of financial mechanism, and so forth. Data collection on investments have an inherently financial focus and are commonly missing the details mentioned above. Centralizing data collection efforts could be encouraged with preformatted questionnaires and online data-entry portals to improve flow comparability across public donors. The OECD's CRS database is exemplary in this regard—public donors and investors fill out questionnaires with data about their commitments. But data collection for public investments in clean energy and renewables at a global scale is mostly decentralized, making commitments data less uniform.

Correcting international commitments for currency exchange rates and inflation is key to making flows comparable across countries and over time. To account for currency exchange rate changes and inflation, it is important that countries and other institutions tracking these flows deflate them properly. Sustainable Development Goal target 7.a.1 uses the OECD methodology to deflate international flows, first by adjusting for inflation from the year the flows occurred to a baseline year (2018) and, second, by converting those local-currency values to United States dollars using the exchange rates from the baseline year (2018).

INSTALLED RENEWABLE ELECTRICITY-GENERATING CAPACITY IN DEVELOPING COUNTRIES

Indicator 7.b.1 is defined as the installed capacity of power plants that generate electricity from renewable energy sources divided by the total population of a country. *Capacity* is defined as the net maximum electrical capacity installed at year end, following IRES. Renewable energy sources are defined in the IRENA statute as hydropower, marine (ocean, tidal, and wave), wind, solar (photovoltaic and thermal), bioenergy, and geothermal.

The capacity data are collected as part of IRENA's annual questionnaire cycle. Questionnaires are sent to countries at the start of each year. They ask for renewable energy data over the previous two years. The data are then validated and checked with countries. IRENA's *Renewable Energy Statistics Yearbook* publishes them in late June.

Population data come from the *World Population Prospects*, published by the United Nations Population Division. These figures represent total population of a country as of midyear (July 1).

For each country and year, the renewable-electricity-generating capacity at year end is divided by the population at midyear to produce a measure of watts per capita. This division scales the capacity data to account for the enormous variations in country needs. It uses population rather than GDP to scale the data, because population is the most basic indicator of country demand for modern and sustainable energy services.

The focus of this indicator on electricity capacity does not capture any trends in the modernization of technologies used to produce heat or provide energy for transport.

With the trend toward electrification of end uses, however, the focus here on electricity may become less of a drawback in the future, serving instead only as a general indicator of progress on electrification in developing countries.

Furthermore, as reflected in numerous national policies, plans, and targets, many countries regard increased production of electricity (in particular, renewable electricity) as a top priority in their transition to delivering more modern and sustainable energy services. Thus, this indicator is a useful first step toward measuring progress on this target in a way that reflects country priorities. It can also be used until other additional or better indicators are developed.

CONCLUSION

We know from efforts to track SDG 7 that good-quality data are vital for informed policy making at country, regional, and international levels. Improved data quality worldwide is made possible through cooperation, at national and international levels, and through strengthened statistical capacity.

At the national level, cooperation among statistical offices and institutions across policy domains is key to optimizing the use of data-collection resources. For example, household surveys could be designed to support tracking across SDG 7 targets, such as clean cooking and energy efficiency at end-use levels[80] and also with targets beyond SDG 7, such as quality of life, cleaner air, and better health.

International cooperation strengthens the effort to track progress toward achieving SDG 7 by raising awareness about the need for good-quality data. Good data underpin good policy. In addition, standardized methodologies for indicators are needed, along with common frameworks for surveys. International databases need to be compiled. And more support is needed for developing statistical capacity in countries and regions. As the custodian agencies work together to track progress toward SDG 7, they have found ways to refine their collaboration on data—with each other and among countries.

Finally, the custodian agencies would like to acknowledge the work and dedication of all the colleagues working on energy data collection across national administrations worldwide. It is they who make possible the international work without which this tracking report would be impossible.

80 For example, clean cooking and space heating are linked for rural households in colder climates. More broadly, all end uses of energy within a household (lighting, appliances, cooking, heating, cooling) can and should be addressed by surveys.

SDG 7.1.1 - ACCESS TO ELECTRICITY

Data provided by the World Bank

Country/region	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%)	
	2000		2005		2010		2015		2019		2019		2019	
Afghanistan			22		43	*d*	72	*d*	98	*g*	100		97	
Albania	100	*m*	100	*m*	100	*m*	100	*k*	100	*m*	100	*m*	100	*m*
Algeria					99		99		100	*c*	100	*c*	99	
American Samoa														
Andorra	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Angola			30		35		42	*d*	46		72			
Anguilla	95		96		98		100		100					
Antigua and Barbuda	97		92	*d*	99		100	*m*	100	*m*	100	*m*	100	*m*
Argentina	95		97		99	*e*	100		100		100		100	
Armenia	99	*d*	100	*d*	100	*d*	100	*d*	100	*g*	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		92	*c*	98	*c*	89	
Barbados	100	*m*	100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Belarus	100	*m*	100	*m*	100	*m*	100	*m*	100	*c*	100	*c*	100	*m*
Belgium	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Belize	79	*e*	84		90	*e*	92	*c*	93	*e*	98	*e*	88	
Benin	22		26		34	*g*	30	*k*	40		65		17	
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*	96		100		88	
Bosnia and Herzegovina	100	*m*	100	*m*	100	*m*	100	*k*	100	*m*	100	*m*	100	*m*
Botswana	27		38		52		62	*k*	70		88		28	
Brazil	94		97	*h*	99		100	*h*	100	*g*	100		98	

Country/region	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%)	
	2000		2005		2010		2015		2019		2019		2019	
British Virgin Islands	97		98		99		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	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Burkina Faso	9		11		13	*d*	16		18		65			
Burundi	2		3	*c*	5	*d*	8		11		63		3	
Cabo Verde			67	*d*	81	*e*	87		96		95		96	
Cambodia	17	*d*	21	*d*	31	*d*	69		93		100		91	
Cameroon	41	*c*	47		53		59		63		93		24	
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*	8		10	*c*	13		14	*c*	32	*c*	2	
Chad	3		5		6	*c*	8	*d*	8	*c*	37	*c*		
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		99	
Comoros	40		51		70		74		84		98		78	
Congo			34	*d*	40		44		48		66		13	
Cook Islands					99		100		100		100			
Costa Rica	97	*k*	99	*h*	99	*h*	99	*h*	100	*g*	100	*g*	99	
Côte d'Ivoire	49		59	*d*	58		63	*k*	69		94		42	
Croatia	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Cuba	97	*k*	97		98		99		100	*c*	100	*c*	99	
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	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*

Country/region	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%)	
	2000		2005		2010		2015		2019		2019		2019	
Democratic People's Republic of Korea					29		40		49		42		61	
Democratic Republic of the Congo	7	*c*	6	*g*	13		16		19	*k*	41		1	
Denmark	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Djibouti	56		56		56		58		61		72		25	
Dominica	81		88		94		100		100				100	
Dominican Republic	89	*h*	90	*h*	98	*h*	99	*h*	100		100		100	
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*	100		99		100	
Equatorial Guinea							66		67		91		2	
Eritrea	29		35		40		46		50		76		37	
Estonia	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Eswatini			34		46	*c*	64		77		91		73	
Ethiopia	13	*d*	14	*d*	33		29	*d*	48		93		36	
Faroe Islands	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Fiji	76		82		89		95		100		100		100	
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		91		98		24	
Gambia	34	*c*	30	*c*	47		54		60		80		28	
Georgia			98	*c*	100	*k*	100	*k*	100		100		100	
Germany	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Ghana	44	*e*	41	*k*	64	*e*	74		84	*d*	94	*d*	70	
Gibraltar	100	*m*	100	*m*	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		90		92		95					

Country/region	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%)	
	2000		2005		2010		2015		2019		2019		2019	
Guam	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Guatemala	73	*h*	78		84		90		96		97		94	
Guinea	15		20	*d*	28		34		42		88		16	
Guinea-Bissau					6	*g*	20		31		54		13	
Guyana	74		78	*d*	83		88		92		97		90	
Haiti	34	*d*	35		37		41		45		80		1	
Honduras	67		69	*h*	81	*h*	90	*h*	93		100		83	
Hungary	100	*m*	100	*m*	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	59		67		76	*g*	88	*d*	98		100		97	
Indonesia	86	*g*	85		94	*g*	98	*g*	99	*g*	100	*g*	98	
Iran (Islamic Republic of)	98	*d*	99		100		100	*k*	100		100		100	
Iraq					98		99		100		100		100	
Ireland	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Isle of Man	100	*m*	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*	99		100		99	
Japan	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Jordan	99		99		100	*k*	100		100		100		100	
Kazakhstan	99		100	*k*	100	*k*	100	*c*	100		100		100	
Kenya	15		25		19	*d*	42	*d*	70	*e*	91	*e*	62	
Kiribati			70	*e*	63	*e*	91	*e*	100		89		100	
Kosovo	100	*m*	100	*m*	99		100	*k*	100	*c*	100	*c*	100	*m*
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	42		57	*e*	70		90	*e*	100		100		100	
Latvia	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*

Country/region	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%)	
	2000		2005		2010		2015		2019		2019		2019	
Lebanon			100		100		100		100		100		100	
Lesotho	4	*c*	10		17	*g*	32		45		76		32	
Liberia					5		16		28		46		8	
Libya	100	*k*	90		82		73		69		100			
Liechtenstein	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Lithuania	100	*m*	100	*m*	100	*m*	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		15		12	*g*	21		27		79			
Malawi	5	*d*	7		9	*d*	11	*d*	11	*f*	46	*f*	4	
Malaysia					99		100		100		100		100	
Maldives	84	*e*	91		99		100		100		100		100	
Mali	10		18		27		38	*d*	48		91		15	
Malta	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Marshall Islands	69		76		89		93		97		96		100	
Mauritania			18	*f*	34		40	*c*	46		86			
Mauritius	99	*e*	99		100		99		100	*m*	100	*m*	100	*m*
Mexico	98	*h*	99	*h*	99	*h*	99	*d*	100		100		100	
Micronesia (Federated States of)	46	*e*	55		65	*e*	74		82		96		78	
Monaco	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Mongolia	67	*e*	86	*g*	79	*c*	88		99		100		97	
Montenegro	100	*m*	100	*c*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Morocco	70		78		93		97	*g*	100	*g*	100		99	
Mozambique	6		12		19		24	*d*	30		73		5	
Myanmar			47		49	*g*	61	*g*	68		93		58	
Namibia	37	*d*	40		45		52	*g*	55		75		35	
Nauru	99		99		99		99	*g*	100	*m*	100	*m*	100	*m*
Nepal	29		47		69	*k*	84		90	*c*	94	*c*	89	
Netherlands	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*

Country/region	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%)	
	2000		2005		2010		2015		2019		2019		2019	
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*	78		83		88		100		71	
Niger	6	*c*	7	*g*	13		17	*g*	19		50		13	
Nigeria	43		47		48	*d*	53	*d*	55	*f*	84	*f*	26	
Niue							100		100		100			
North Macedonia	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
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	70		71		71		71		74		100		59	
Palau	98		99	*e*	99		99		100	*m*	100	*m*	100	*m*
Panama	81	*e*	84		87	*e*	92		96		100		88	
Papua New Guinea	9		19		20	*g*	44		63		83		60	
Paraguay	89		95	*h*	97	*h*	99	*h*	100		100		100	
Peru	72	*h*	77	*h*	88	*h*	94	*h*	98		100		92	
Philippines	75		80		85		89	*f*	96		98		94	
Poland	100	*m*	100	*m*	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*
Republic of Korea	100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Republic of Moldova	100	*m*	99	*d*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Romania	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Russian Federation	100	*m*	100	*m*	100	*m*	96	*k*	100	*m*	100	*m*	100	*m*
Rwanda	6	*d*	5	*d*	10	*d*	23	*d*	38		93		26	
Saint Kitts and Nevis	95		96		100		100	*m*	100	*m*	100	*m*	100	*m*
Saint Lucia			92		94	*e*	97		100		97		100	
Saint Martin (French Part)	100		100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*

Country/region	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%)	
	2000		2005		2010		2015		2019		2019		2019	
Saint Vincent and the Grenadines	80		86		93		100		100		99		100	
Samoa	88		92		96		99		99	*c*	100		99	
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		75		78		69	
Saudi Arabia	100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Senegal	38	*c*	47	*d*	57	*g*	61	*d*	70	*d*	95	*d*	48	
Serbia	100	*m*	100	*c*	100	*c*	100	*k*	100	*c*	100	*c*	100	*m*
Seychelles	94		96		97	*e*	100	*m*	100	*m*	100	*m*	100	*m*
Sierra Leone			11	*c*	11	*c*	20		23	*d*	51	*d*	2	
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	*m*	100	*m*	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		34		55	*d*	70		77		68	
Somalia			13		21		29		36		66		11	
South Africa	72		81	*g*	83	*g*	85	*g*	85	*g*	88		79	
South Sudan					2	*e*	5		7		13		5	
Spain	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Sri Lanka			78		85	*g*	94		100		100		100	
State of Palestine	100	*g*	100	*k*	100	*g*	100	*k*	100	*c*	100	*c*	100	
Sudan	23	*c*	33		38		47		54		81		39	
Suriname	95		95		91	*c*	95		98		99		96	
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			92		93	*g*	90		89		100		76	
Tajikistan	98	*c*	99	*c*	99		98	*k*	100		99		100	
Thailand	82	*d*	93		100	*f*	100	*c*	100	*c*	100	*c*	100	
Timor-Leste			34		38	*d*	67	*e*	95		100		92	

Country/region	Total electricity access rate (%)					Urban electricity access rate (%)	Rural electricity access rate (%)
	2000	2005	2010	2015	2019	2019	2019
Togo	17 *c*	27	31 *c*	45	52	92	24
Tonga	86	89	93	100 *k*	98 *c*	100	98
Trinidad and Tobago	91 *e*	98	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Tunisia	95 *g*	99 *g*	100 *j*	100 *k*	100	100	100
Turkey			100 *i*	100 *e*	100	100	100
Turkmenistan	100 *d*	100	100 *i*	100 *c*	100 *c*	100 *c*	100
Turks and Caicos Islands	96 *e*	96	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Tuvalu		96	97	99	100	100	100
Uganda	7	9 *d*	12 *g*	19 *d*	41 *d*	71 *d*	32
Ukraine	100 *m*	100 *c*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
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	38 *g*	73 *g*	19
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 *g*	100 *g*	100 *m*
Uzbekistan	100	100	100	100	100	100	100
Vanuatu	22	31	44 *k*	52	65	95	54
Venezuela (Bolivarian Republic of)	99 *h*	99	99	100 *g*	100	100	100
Viet Nam	88	96 *d*	97 *k*	100	99 *e*	100	99
Yemen	49	55	61	67	73	93	61
Zambia	17 *e*	23	22 *e*	31 *g*	43	80	14
Zimbabwe	34	36	40	34 *d*	41	85	20
World	75	78	83	87	90	97	81
Northern America and Europe	100	100	100	99	100	100	100

Country/region	Total electricity access rate (%)					Urban electricity access rate (%)	Rural electricity access rate (%)
	2000	2005	2010	2015	2019	2019	2019
Latin America and the Caribbean	92	94	96	97	98	100	93
Central Asia and Southern Asia	59	67	75	86	95	100	92
Eastern Asia and South-eastern Asia	89	92	96	97	98	99	97
Western Asia and Northern Africa	48	57	91	93	94	99	86
Sub-Saharan Africa	24	29	33	38	46	78	25
Oceania	80	82	82	87	92	99	76

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 and are not based on a statistical model.

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. Data from assumption: Countries considered "developed" by the UN are assumed to have an electrification rate of 100%. Countries that are classified as High Income Countries (HIC) are also assumed to have an electrification rate of 100% from the time the country first became a HIC, unless survey data was collected.

SDG 7.1.2 ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

Source: World Health Organization

Country or region	Clean cooking access rate (%)											
	2000			2010			2015			2019		
	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural
Afghanistan	6	31	1	20	70	6	29	80	12	36	85	20
Albania	38	66	18	66	86	46	76	90	57	81	92	63
Algeria	97	100	92	99	100	98	99	100	98	99	100	99
American Samoa												
Andorra	100	100	100	100	100	100	100	100	100	100	100	100
Angola	41	81	8	44	78	7	47	78	8	50	77	8
Anguilla												
Antigua and Barbuda	100	100	100	100	100	100	100	100	100	100	100	100
Argentina	95	98	70	99	100	91	100	100	95	100	100	97
Armenia	79	94	54	96	99	92	98	100	95	98	100	96
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	96	44	93	99	86	96	99	92	97	99	94
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	35	1	13	42	2	18	51	5	23	57	8
Barbados	100	100	100	100	100	100	100	100	100	100	100	100
Belarus	95	99	88	98	100	96	99	100	97	99	99	98
Belgium	100	100	100	100	100	100	100	100	100	100	100	100
Belize	80	94	67	83	96	73	83	96	73	82	95	73
Benin	1	1	0	4	8	1	4	8	1	4	7	1
Bermuda												
Bhutan	28	87	10	64	96	48	74	97	60	79	97	66
Bolivia (Plurinational State of)	63	92	18	76	97	39	83	98	52	86	99	57
Bosnia and Herzegovina	52	80	32	45	69	22	44	67	19	46	67	18

Country or region	Clean cooking access rate (%)											
	2000			2010			2015			2019		
	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural
Botswana	45	71	19	56	78	29	55	74	28	53	69	26
Brazil	89	97	55	94	99	70	96	99	76	96	99	79
British Virgin Islands												
Brunei Darussalam	100	100	100	100	100	100	100	100	100	100	100	100
Bulgaria												
Burkina Faso	3	12	1	6	21	1	8	28	1	10	34	1
Burundi	0	1	0	0	0	0	0	0	0	0	0	0
Cabo Verde	63	90	31	70	91	33	75	93	40	78	93	44
Cambodia	4	15	1	11	45	4	19	60	9	31	70	20
Cameroon	10	22	1	20	37	2	22	40	2	22	38	2
Canada	100	100	100	100	100	100	100	100	100	100	100	100
Cayman Islands												
Central African Republic	1	1	0	0	1	0	0	1	0	0	1	0
Chad	3	5	3	2	10	0	3	13	0	4	15	0
Channel Islands												
Chile	100	100	100	100	100	100	100	100	100	100	100	100
China	43	68	25	54	78	28	60	81	32	64	83	37
China, Hong Kong Special Administrative Region												
China, Macao Special Administrative Region												
Colombia	78	93	33	87	97	42	91	98	55	94	99	67
Comoros	0	1	0	3	7	1	6	13	2	8	16	2
Congo	9	15	1	17	26	2	26	37	3	34	47	3
Cook Islands	79	98	25	81	99	20	79	99	16	78	99	12
Costa Rica	89	97	78	92	98	80	94	98	84	96	98	87
Côte d'Ivoire	18	37	3	18	36	1	23	47	1	30	60	1
Croatia	100	100	100	100	100	100	100	100	100	100	100	100
Cuba												

Country or region	Clean cooking access rate (%)											
	2000			2010			2015			2019		
	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural
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
Democratic People's Republic of Korea	2	3	1	6	9	1	8	13	1	11	17	1
Democratic Republic of the Congo	1	3	0	3	10	0	4	11	0	4	10	0
Denmark	100	100	100	100	100	100	100	100	100	100	100	100
Djibouti	4	4	1	7	8	1	8	11	0	10	12	0
Dominica	81	94	59	84	95	67	84	94	69	83	94	69
Dominican Republic	84	95	67	87	95	69	89	95	71	91	96	76
Ecuador	89	99	74	94	99	84	94	99	85	94	99	84
Egypt	84	96	74	99	100	99	100	100	100	100	100	100
El Salvador	58	82	25	77	94	48	85	96	63	89	96	74
Equatorial Guinea	19	32	4	23	34	5	24	33	5	24	32	5
Eritrea	4	11	0	8	20	1	9	21	1	9	19	1
Estonia	100	100	100	100	100	100	100	100	100	100	100	100
Eswatini	24	60	10	39	80	23	48	86	32	55	89	40
Ethiopia	1	3	0	2	10	0	4	18	0	7	27	0
Faroe Islands												
Fiji	28	49	8	32	49	13	40	58	18	50	68	26
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	65	80	15	80	90	30	86	93	39	88	94	45
Gambia	4	7	1	3	4	1	2	2	0	1	2	0
Georgia	48	86	10	66	93	35	79	96	60	88	97	77
Germany	100	100	100	100	100	100	100	100	100	100	100	100
Ghana	6	13	1	16	30	4	21	36	6	23	36	8
Gibraltar												

Country or region	Clean cooking access rate (%)											
	2000			2010			2015			2019		
	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural
Greece	100	100	100	100	100	100	100	100	100	100	100	100
Greenland												
Grenada	92	94	92	93	95	92	91	95	90	89	95	88
Guam												
Guatemala	41	68	17	38	62	11	43	68	12	49	74	14
Guinea	1	1	0	1	1	0	1	2	0	2	4	0
Guinea-Bissau	1	4	0	1	3	0	1	2	0	1	2	0
Guyana	36	56	28	61	75	56	71	81	68	77	84	75
Haiti	3	6	1	4	7	1	4	7	1	4	7	1
Honduras	31	56	8	43	71	15	45	71	17	45	69	18
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	50	6	35	70	14	48	82	27	64	90	48
Indonesia	6	13	2	42	62	24	68	85	51	82	92	72
Iran (Islamic Republic of)	93	98	86	96	99	92	97	99	92	96	99	92
Iraq	74	83	58	95	98	90	98	99	96	99	99	98
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	76	98	54	86	96	75	85	93	78	83	90	78
Japan	100	100	100	100	100	100	100	100	100	100	100	100
Jordan	100	100	99	100	100	100	100	100	100	100	100	100
Kazakhstan	84	96	68	93	98	86	96	99	93	98	99	96
Kenya	2	5	1	7	20	2	11	28	3	17	38	5
Kiribati	1	2	0	3	6	1	6	11	1	10	17	1
Kosovo												
Kuwait	100	100	100	100	100	100	100	100	100	100	100	100
Kyrgyzstan	53	86	34	72	93	60	76	94	66	77	95	66

Country or region	Clean cooking access rate (%)											
	2000			2010			2015			2019		
	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural
Lao People's Democratic Republic	1	3	1	4	10	1	6	15	1	8	18	2
Latvia	100	100	100	100	100	100	100	100	100	100	100	100
Lebanon												
Lesotho	16	46	8	31	73	16	36	78	18	39	79	19
Liberia	1	1	0	0	0	0	0	0	0	0	0	0
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
Madagascar	1	3	1	1	2	1	1	2	0	1	2	0
Malawi	2	12	0	2	11	1	2	11	1	2	8	0
Malaysia	98	99	95	98	99	95	97	99	94	96	98	93
Maldives	53	96	39	93	99	90	98	100	97	99	100	99
Mali	1	2	0	1	2	0	1	2	0	1	2	0
Malta	100	100	100	100	100	100	100	100	100	100	100	100
Marshall Islands	13	18	2	53	71	2	63	83	1	65	86	1
Mauritania	30	53	13	42	68	18	44	68	19	43	65	18
Mauritius	100	100	100	100	100	100	100	100	100	100	100	100
Mexico	83	98	47	85	95	52	85	93	53	85	92	57
Micronesia (Federated States of)	11	25	4	12	30	4	12	33	4	12	33	3
Monaco	100	100	100	100	100	100	100	100	100	100	100	100
Mongolia	23	41	2	35	50	7	44	62	11	52	70	14
Montenegro	67	83	44	63	75	41	62	72	41	62	72	44
Morocco	90	100	80	96	100	92	98	100	95	98	100	96
Mozambique	2	5	1	3	9	0	4	11	0	5	13	0
Myanmar	3	6	1	10	26	3	20	53	6	30	73	9
Namibia	34	76	11	41	76	11	44	74	12	46	72	13
Nauru	100	100	100	100	100	100	100	100	100	100	100	100

Country or region	Clean cooking access rate (%)											
	2000			2010			2015			2019		
	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural
Nepal	6	24	3	21	65	11	28	67	14	31	65	16
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	55	7	45	70	8	50	78	8	55	83	9
Niger	1	4	0	1	6	0	2	9	0	2	12	0
Nigeria	1	2	0	2	4	1	5	11	2	13	26	4
Niue	75	90	68	93	97	91	97	98	95	98	99	97
North Macedonia	57	70	40	67	85	43	72	89	49	76	90	56
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	66	4	36	83	11	43	87	18	49	88	26
Palau	100	100	100	100	100	100	100	100	100	100	100	100
Panama	100	100	100	100	100	100	100	100	100	100	100	100
Papua New Guinea	5	39	0	8	40	3	9	39	4	9	38	4
Paraguay	49	72	17	58	78	28	65	84	36	68	86	40
Peru	43	61	5	66	84	14	76	91	26	83	95	40
Philippines	38	56	20	40	61	21	42	64	23	47	69	27
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
Korea, Republic of	100	100	100	100	100	100	100	100	100	100	100	100
Moldova, Republic of	64	96	40	91	98	86	95	99	92	96	99	94
Romania	100	100	100	100	100	100	100	100	100	100	100	100
Russian Federation	100	100	100	97	98	97	94	96	93	90	93	90
Rwanda	0	1	0	0	1	0	1	2	0	2	6	0
Saint Kitts and Nevis	100	100	100	100	100	100	100	100	100	100	100	100

Country or region	Clean cooking access rate (%)											
	2000			2010			2015			2019		
	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural
Saint Lucia	86	79	91	96	94	96	96	96	97	97	97	97
Saint Martin (French Part)												
Saint Vincent and the Grenadines	96	95	98	96	96	97	95	95	97	94	95	96
Samoa	19	49	9	27	56	18	32	61	23	36	65	28
San Marino	100	100	100	100	100	100	100	100	100	100	100	100
Sao Tome and Principe	0	1	0	1	2	0	2	3	1	3	4	1
Saudi Arabia	100	100	100	100	100	100	100	100	100	100	100	100
Senegal	35	69	7	34	64	7	27	52	5	24	46	4
Serbia	59	84	32	67	86	44	67	85	45	66	83	44
Seychelles	100	100	100	100	100	100	100	100	100	100	100	100
Sierra Leone	0	0	0	0	0	0	0	1	0	1	1	0
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	8	38	3	8	37	2	8	37	2	9	37	1
Somalia	0	0	0	1	2	0	2	3	0	3	5	0
South Africa	56	77	29	77	89	56	84	93	63	86	95	65
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
Sri Lanka	17	53	10	22	57	14	26	64	18	31	69	22
State of Palestine												
Sudan	8	18	6	33	55	23	46	64	36	53	67	45
Suriname	78	89	60	88	94	76	92	96	84	94	97	89
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	99	100	98	99	100	98	98	100	97	97	100	96

Country or region	Clean cooking access rate (%)											
	2000			2010			2015			2019		
	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural
Tajikistan	36	79	20	70	95	60	77	97	70	82	97	76
Thailand	58	86	45	74	88	64	78	87	70	80	86	73
Timor-Leste	2	5	0	5	12	1	8	21	3	13	29	4
Togo	0	1	0	3	8	0	7	15	1	9	20	1
Tonga	36	79	24	60	88	51	69	91	62	76	93	71
Trinidad and Tobago	100	100	100	100	100	100	100	100	100	100	100	100
Tunisia	94	96	91	99	100	99	100	100	99	100	100	100
Turkey	90	99	78	94	99	83	95	100	84	95	100	84
Turkmenistan	99	100	99	100	100	100	100	100	100	100	100	100
Turks and Caicos Islands												
Tuvalu	20	26	14	50	69	29	63	86	35	69	92	36
Uganda	1	4	0	1	3	0	1	2	0	0	1	0
Ukraine	92	95	86	94	98	87	95	98	88	95	99	88
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
Tanzania, United Republic of	1	2	0	1	4	0	3	8	1	4	11	1
United States of America	100	100	100	100	100	100	100	100	100	100	100	100
United States Virgin Islands												
Uruguay	100	100	100	100	100	100	100	100	100	100	100	100
Uzbekistan	83	98	71	86	99	74	86	99	75	85	98	74
Vanuatu	16	60	4	12	39	3	9	29	2	8	22	2
Venezuela (Bolivarian Republic of)	95	99	71	97	99	82	97	99	86	97	99	87
Viet Nam	14	41	5	49	78	36	60	82	48	65	82	55
Yemen	56	94	42	60	94	44	61	94	43	61	93	42
Zambia	14	38	1	16	37	2	16	34	2	16	32	2

Country or region	Clean cooking access rate (%)											
	2000			2010			2015			2019		
	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural
Zimbabwe	34	87	6	30	81	5	30	80	5	30	79	6
Australia and New Zealand	100	100	100	100	100	100	100	100	100	100	100	100
Central Asia and Southern Asia	26	57	9	37	73	16	48	82	26	60	87	43
Eastern Asia and South-eastern Asia	42	65	24	55	77	29	62	82	37	68	84	43
Latin America and the Caribbean	80	93	44	85	95	52	87	95	56	88	95	60
Northern America and Europe	98	99	96	99	99	96	98	99	96	98	99	96
Oceania excluding Australia and New Zealand	10	43	2	12	44	4	13	46	6	15	47	6
Sub-Saharan Africa	9	24	3	12	26	4	14	29	4	16	33	4
Western Asia and Northern Africa	81	92	66	89	97	79	91	97	82	92	97	83
World	50	76	25	57	81	29	61	83	35	66	84	42

Note:
Data source: Household Energy Database, WHO, January 2021.

Source: World Health Organization

SDG 7.2 – RENEWABLE ENERGY

Data provided by the IEA and UNSD

Country / region	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	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	
Afghanistan	54.2	14.9	20.3	21.4	10.4	0	0	11	0	0	0	0	0	14.4	13.5	0	130.1	a
Albania	41.4	37.1	38.6	38.3	7.5	5.3	0	24.8	0	0	0.6	0	0	21.9	7.2	4.7	88.2	b
Algeria	0.4	0.3	0.1	0.2	0.1	0	0	0	0	0	0.1	0	0	2.1	0.9	0	1583	b
American Samoa	0.0	0.0	1.5	2.9	0	0	0	0	0	0	2.9	0	0	0	0	0	0.5	a
Andorra	14.5	18.7	19.3	18.5	0.4	0	0	16.7	0	0	0	0	1.4	1.6	0	0	9	a
Angola	73.4	50.8	47.8	56.8	50.1	0	0	6.7	0	0	0	0	0	27.1	202.3	0	403.9	b
Anguilla	0.2	0.1	0.2	0.2	0.1	0	0	0	0	0	0.1	0	0	0	0	0	1.5	a
Antigua and Barbuda	0.0	0.0	0.5	0.9	0	0	0	0	0	0	0.9	0	0	0	0	0	4.1	a
Argentina	9.8	8.8	9.4	10.5	2.9	2.8	0	4.6	0	0.2	0	0	0	110.8	60.5	64	2236.7	b
Armenia	7.2	9.4	10.7	11.1	4.4	0	0	6.4	0	0	0.3	0	0	5.7	4.2	0.1	90	b
Aruba	0.2	5.5	6.7	8.0	0.3	0	0	0	0	7.7	0	0	0	0.5	0	0	6.8	a
Australia	8.4	8.2	9.3	9.6	5.1	0.2	0.2	1.4	0	1.4	1.4	0	0	127.2	178.5	8.7	3259.6	b
Austria	26.4	31.1	34.9	33.8	15.9	1.9	0.4	12.2	0	1.9	1.2	0.1	0.3	165.7	171.6	28.8	1081.7	b
Azerbaijan	2.1	4.4	2.3	2.0	0.5	0	0	1.3	0	0.1	0	0	0.1	4.9	1.7	0.1	338.8	b
Bahamas	0.0	1.7	1.5	1.0	1	0	0	0	0	0	0	0	0	0	0.3	0	27.6	a
Bahrain	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	201.7	b
Bangladesh	59.0	41.1	34.2	30.7	30.4	0	0	0.3	0	0	0.1	0	0	4.5	395.8	0	1303.4	b
Barbados	14.3	9.1	3.2	5.8	4.7	0	0	0	0	0	1.2	0	0	0.2	0.5	0	12	a
Belarus	5.6	7.3	6.8	7.2	6.9	0.1	0	0.1	0	0	0.1	0	0	2.1	48.8	0.2	707.8	b
Belgium	1.4	5.8	9.4	10.7	4.8	1.5	0.6	0.1	0	2.1	1.2	0	0.3	67.6	60.5	21.4	1402.7	b
Belize	34.6	32.9	32.7	40.1	32.4	0	0	7.7	0	0	0	0	0	2.5	3.1	0	14	a
Benin	70.3	47.2	49.9	44.0	43.9	0	0	0	0	0	0.1	0	0	0.1	80.9	0	184.2	b
Bermuda	0.0	0.4	0.5	0.4	0	0	0	0	0	0	0	0	0.3	0	0	0	5.9	a
Bhutan	91.4	90.8	86.7	81.1	69.6	0	0	11.5	0	0	0	0	0	7.9	47.4	0	68.2	a

Country / region	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	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	
Bolivia (Plurinational State of)	29.7	15.6	8.2	7.6	4.4	0	0	3	0	0.1	0.1	0	0	9.2	11.2	0	269.7	b
Bonaire, Sint Eustatius and Saba	0.0	0.0	3.0	3.2	0.1	0	0	0	0	2.8	0.3	0	0	0.1	0	0	4	a
Bosnia and Herzegovina	19.4	19.6	25.3	35.4	27.4	0	0	7.9	0	0.1	0	0	0	14.1	48.1	0.1	176	b
Botswana	36.6	30.3	28.2	28.2	28.2	0	0	0	0	0	0	0	0	0	23.9	0	84.8	b
Brazil	42.8	46.9	43.7	47.1	22	9.4	0	13.4	0	1.7	0.5	0	0	1495.8	1851.1	811.9	8836.9	b
British Virgin Islands	1.0	0.7	1.0	1.4	1.1	0	0	0	0	0.1	0.1	0	0	0	0	0	1.2	a
Brunei Darussalam	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	39.1	b
Bulgaria	8.0	14.2	17.8	19.5	12.1	1.7	0.2	2.9	0	0.8	1	0.4	0.4	21.3	50.7	7.1	404.8	b
Burkina Faso	85.4	81.5	72.7	67.0	66.5	0	0	0.3	0	0	0.2	0	0	0.8	111.6	0	167.9	a
Burundi	93.2	92.6	91.2	85.5	84.6	0	0	0.9	0	0	0	0	0	0.6	48.5	0	57.3	a
Cabo Verde	38.5	21.2	26.3	23.0	19.3	0	0	0	0	3.3	0.4	0	0	0.3	1.4	0	7.2	a
Cambodia	81.1	68.5	64.9	61.8	56	0	0	5.8	0	0	0	0	0	17.4	165.4	0	295.7	b
Cameroon	84.5	78.6	78.0	80.6	76.2	0	0	4.4	0	0	0	0	0	14	236.6	0	310.8	b
Canada	22.0	21.9	22.6	22.2	5	1.2	0.1	14.5	0	1.2	0.2	0	0	1231.7	367	109.1	7698.9	b
Cayman Islands	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	5.3	a
Central African Republic	85.1	86.6	84.2	80.9	78	0	0	3	0	0	0	0	0	0.5	12.8	0	16.4	a
Chad	88.7	81.6	85.3	85.3	85.3	0	0	0	0	0	0	0	0	0	61.2	0	71.8	a
Chile	31.4	27.0	25.1	25.5	16.2	0	0.1	6.5	0	1	1.7	0.1	0	119.7	170.1	1.9	1145.7	b
China	29.6	12.3	12.2	13.1	4.1	0.1	0.4	4.6	0	1.4	1.9	0.6	0	5417.4	4680.8	227.1	78676.8	b
China, Hong Kong Special Administrative Region	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0	0	0	0	0	0	0.3	0.2	0.2	371.3	b
China, Macao Special Administrative Region	0.2	5.4	7.4	14.0	0.1	0	0	0	0	0	0	0	13.9	4.5	0	0	32.3	a
Colombia	28.0	29.7	31.6	30.7	13.8	2.7	0	14.2	0	0	0	0	0	170.8	158.6	32.3	1177.4	b
Comoros	49.0	46.6	64.2	55.0	55	0	0	0	0	0	0	0	0	0	3.8	0	6.9	a

Country / region	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	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	
Congo	64.9	54.8	64.2	69.9	67.4	0	0	2.5	0	0	0	0	0	2	55	0	81.6	b
Cook Islands	0.0	0.0	1.5	4.4	0	0	0	0	0	0	4.4	0	0	0	0	0	0.8	a
Costa Rica	32.9	40.4	38.3	35.7	14.2	0	0	16.1	0	3.5	0.1	1.9	0	35.5	22.5	0	162.2	b
Côte d'Ivoire	63.7	75.3	64.8	63.5	61.1	0	0	2.5	0	0	0	0	0	7.5	182.1	0	298.5	b
Croatia	26.8	29.8	33.1	32.8	17.4	0.4	0.7	11.9	0	2.1	0.3	0.1	0	41.3	48.4	1.9	278.7	b
Cuba	34.4	14.6	20.1	20.9	17.6	3	0	0.1	0	0	0.1	0	0	2	61.8	0	306	b
Curaçao	0.1	0.5	1.6	3.0	0	0	0	0	0	2.8	0.2	0	0	0.8	0	0	24.9	b
Cyprus	3.1	6.6	10.5	12.1	2.1	0.6	0.7	0	0	1.1	5.7	0.1	1.8	1.6	5.8	0.4	64	b
Czechia	5.9	11.0	14.8	14.7	10.7	1.3	1.3	0.4	0	0.1	0.7	0	0.2	21.9	112.2	13.6	1003.5	b
Democratic People's Republic of Korea	8.7	13.5	23.1	33.7	17.5	0	0	16.2	0	0	0	0	0	34.5	37.2	0	212.9	b
Democratic Republic of the Congo	97.9	96.8	95.8	96.4	93	0	0	3.4	0	0	0	0	0	27.4	754.7	0	811.4	b
Denmark	10.7	21.2	33.0	35.3	20.2	1.6	0.8	0	0	8.8	1	0	2.9	75.5	119	9.9	578.9	b
Djibouti	31.4	32.5	28.2	27.8	27.8	0	0	0	0	0	0	0	0	0	2.1	0	7.7	a
Dominica	11.0	10.1	8.6	8.2	3.5	0	0	4.6	0	0	0	0	0	0.1	0.1	0	1.7	a
Dominican Republic	19.1	17.0	15.0	16.1	13	0	0	2.1	0	0.6	0.4	0	0	8.1	33.3	0	257.8	b
Ecuador	19.4	11.8	13.1	16.3	3.8	0.1	0	12.3	0	0	0	0	0	65.1	18.5	0.7	516	b
Egypt	7.8	5.3	5.1	4.7	2.7	0	0	1.7	0	0.3	0.1	0	0	47.4	60.7	0.1	2282.3	b
El Salvador	33.5	32.6	21.0	23.2	9.8	0	0.1	6.3	0	0	1.1	5.9	0	17.4	7.6	0	108	b
Equatorial Guinea	45.8	5.7	4.5	4.9	4.2	0	0	0.7	0	0	0	0	0	0.6	3.8	0	90.1	a
Eritrea	76.6	81.1	77.1	73.2	72.6	0	0	0	0	0	0.6	0	0	0.1	15.6	0	21.6	b
Estonia	19.8	25.4	27.6	28.8	25.8	0.6	0.4	0	0	1.1	0.1	0	0.8	4.3	29.9	0.7	121.2	b
Eswatini	62.2	63.7	66.6	66.1	61.3	0	0	4.8	0	0	0	0	0	4.7	21.8	0	40.1	a
Ethiopia	95.6	94.1	91.6	89.9	88	0	0	1.8	0	0.1	0	0	0	32.7	1496.5	0.2	1700.8	b
Falkland Islands (Malvinas)	1.5	4.6	4.7	5.0	1.2	0	0	0	0	3.7	0	0	0	0	0	0	0.5	a
Faroe Islands	2.8	3.4	7.5	5.9	0	0	0	3.7	0	2.2	0	0	0	0.6	0	0	9.6	a

Country / region	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	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	
Fiji	52.2	28.0	32.7	27.9	19.6	0	0	8.1	0	0	0.1	0	0	1.8	4.3	0	22	a
Finland	31.7	33.6	43.2	44.2	33.1	1.5	0.6	5.5	0	2.4	0	0	1.1	134.9	303.3	16.7	1028.9	b
France	9.3	12.0	13.5	15.3	6.8	2.5	0.3	3.1	0	1.4	0.6	0.1	0.4	304.4	427.4	149.4	5777.2	b
French Guiana	23.8	29.4	0.0	0.0	..	..	..	..	..	..	..	..	..	..	..	..	..	a
French Polynesia	9.9	8.3	8.0	7.6	0.4	0	0	5.8	0	0	1.3	0	0	0.6	0	0	8.9	a
Gabon	72.8	85.8	81.9	89.9	88.1	0	0	1.8	0	0	0	0	0	3.2	154.9	0	175.8	b
Gambia	62.9	56.0	52.9	52.4	52.3	0	0	0	0	0	0.1	0	0	0	5.2	0	10	a
Georgia	47.3	39.1	28.1	27.9	6.6	0	0	20.7	0	0.2	0.1	0.4	0	34.4	12.1	1.1	170.4	b
Germany	3.7	11.6	14.6	15.8	5.1	1.4	2	0.6	0	3.8	2	0.1	0.8	636.2	564.1	128.4	8412.5	b
Ghana	71.6	51.9	44.0	42.0	34.8	0	0	7.1	0	0	0	0	0	23.4	114	0	327.4	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	17.9	6	1.1	0.3	3.1	0	3.4	3.9	0.1	0	53.8	50.2	6.9	620.9	b
Greenland	9.2	10.1	13.1	11.5	0	0	0	11.2	0	0	0	0	0.3	0.9	0	0	8.1	a
Grenada	10.5	10.5	12.3	10.4	10.4	0	0	0	0	0	0	0	0	0	0.3	0	3.3	a
Guadeloupe	2.6	3.0	0.0	0.0	..	..	..	..	..	..	..	..	..	..	..	..	..	a
Guam	0.0	0.0	1.3	3.0	0	0	0	0	0	0	3	0	0	0.2	0	0	5.6	a
Guatemala	62.7	67.2	63.4	64.1	60.8	0	0	2.9	0	0.2	0.1	0.2	0	22.8	286.8	0	483.1	b
Guernsey	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	1.3	a
Guinea	85.5	75.7	76.2	69.9	67.6	0	0	2.3	0	0	0	0	0	3.5	103	0	152.4	a
Guinea-Bissau	91.2	87.8	87.2	86.8	86.7	0	0	0	0	0	0.1	0	0	0	24.5	0	28.2	a
Guyana	29.8	30.3	24.9	16.8	16.7	0	0	0	0	0	0.1	0	0	0.1	4.7	0	28.4	a
Haiti	80.8	79.0	76.1	76.2	75.9	0.2	0	0.2	0	0	0	0	0	0.3	108.4	0	142.6	b
Honduras	55.2	52.1	52.7	50.1	42.3	0	0	4.6	0	1.3	1.4	0.4	0	16.6	75.8	0	184.7	b
Hungary	5.2	13.5	15.6	13.5	10.4	1.1	0.3	0.1	0	0.4	0.4	0.6	0.2	16.1	76.3	8.6	746.6	b
Iceland	60.7	75.4	77.1	78.2	0.7	0.6	0.1	34.7	0	0	0	42.2	0	66.2	37.1	1.2	133.7	b
India	51.6	41.1	34.4	31.7	28.3	0.2	0	1.8	0	0.8	0.6	0	0	806.5	6518.1	49.2	23269.1	b

Country / region	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	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	
Indonesia	45.6	34.8	27.0	20.9	16.9	2	0	1.1	0	0	0	0.7	0	159.5	1010.8	118.7	6178.2	b
Iran (Islamic Republic of)	0.4	0.9	0.9	1.0	0.3	0	0	0.7	0	0	0	0	0	49.2	21.1	0.1	7073.7	b
Iraq	0.3	1.7	0.8	0.5	0.1	0	0	0.4	0	0	0	0	0	3.5	0.9	0	922.5	b
Ireland	2.0	5.2	9.1	10.7	2	1.4	0.2	0.5	0	5.9	0.1	0	0.6	32.2	11.1	6.5	463.6	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	2.3	a
Israel	6.0	8.6	3.7	3.7	0.2	0	..	..	0	0.1	3.5	0	0	5.3	16	0	571.7	b
Italy	5.1	12.8	16.6	17.1	6.7	1.5	0.8	3.8	0	1.4	2	0.6	0.3	402.7	328.5	68.8	4685.5	b
Jamaica	9.4	9.0	11.8	8.7	5.6	1.6	0	0.5	0	0.8	0.1	0	0	1.4	5.3	1.5	94.7	b
Japan	3.8	4.8	6.3	7.4	2.2	0.2	0	2.5	0	0.2	2	0.1	0.1	562.7	178.5	28.5	10420.2	b
Jersey	0.0	7.4	15.9	17.4	0	0	0	0	0	0	0	0	17.4	1.1	0	0	6.3	a
Jordan	2.1	3.0	3.2	7.2	1.2	0	0	0	0	0.9	5.2	0	0	6.7	12	0	259.6	b
Kazakhstan	2.5	1.4	1.7	1.9	0.1	0	0	1.6	0	0.1	0.1	0	0	29	2.1	1.2	1741.5	b
Kenya	78.9	76.5	72.0	72.3	68.7	0	0	1.5	0	0.1	0	2	0	26.1	489.2	0	713	b
Kiribati	56.5	48.5	45.8	41.1	40.1	0	0	0	0	0	1	0	0	0	0.5	0	1.3	a
Kuwait	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0.2	0	0	594.1	b
Kyrgyzstan	35.2	25.6	23.3	23.2	0.1	0	0	23.2	0	0	0	0	0	39.2	0.1	0.1	170.1	b
Lao People's Democratic Republic	81.5	64.9	53.9	41.9	34	0	0	7.8	0	0	0	0	0	11.8	51.1	0	150	a
Latvia	35.8	33.1	38.1	41.3	32.5	1	1.4	5.1	0	0.3	0	0	0.9	12.3	55.5	1.8	168.6	b
Lebanon	4.9	5.7	4.2	4.7	2.9	0	0	0.5	0	0	1.3	0	0	1.4	8.9	0	217.4	b
Lesotho	56.7	53.0	44.9	38.4	32.1	0	0	6.3	0	0	0	0	0	2.9	14.8	0	46.1	a
Liberia	90.8	88.6	84.0	87.2	86.9	0	0	0.3	0	0	0	0	0	0.3	75.8	0	87.3	a
Libya	2.0	2.4	2.9	2.6	2.6	0	0	0	0	0	0	0	0	0	10.8	0	412	b
Liechtenstein	53.9	52.3	55.5	56.8	7.4	0	0.8	33.7	0	0	14.9	0	0	1.4	0.3	0	3	a
Lithuania	17.2	21.5	29.0	33.5	21.5	1.4	1	2.4	0	6.3	0.5	0	0.4	27.5	45	3.5	226.6	b
Luxembourg	6.8	3.7	9.1	16.0	3.4	3.3	1.4	1.4	0	3.9	1.9	0	0.7	16.2	3.4	5.5	156.8	b
Madagascar	83.4	86.7	80.0	81.6	80.2	0	0	1.3	0	0	0	0	0	3.3	193.3	0	241	a

Country / region	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	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	
Malawi	82.6	81.2	80.8	73.2	65.9	0	0	7.3	0	0	0	0	0	5.1	44.9	0	68.3	a
Malaysia	4.4	2.0	3.4	5.3	0.1	0.9	0.1	4.1	0	0	0.1	0	0	91	0	18.5	2062.7	b
Maldives	2.3	1.4	1.4	1.1	0.8	0	0	0	0	0	0.3	0	0	0.1	0.2	0	18.5	a
Mali	83.5	79.2	79.9	76.6	74.4	0	0	2.2	0	0	0	0	0	3.3	107.9	0	145.3	a
Malta	0.0	1.2	6.0	7.5	0.3	1.9	0.3	0	0	0	4.9	0	0	0.9	0.3	0.4	21.1	b
Marshall Islands	19.6	13.3	11.3	11.7	11.4	0	0	0	0	0	0.4	0	0	0	0.2	0	1.7	a
Martinique	1.7	2.5	0.0	0.0	..	..	..	..	..	..	..	..	..	..	..	..	..	a
Mauritania	44.4	34.0	28.6	25.1	23.8	0	0	0	0	0.6	0.8	0	0	0.8	14.1	0	59.3	a
Mauritius	20.4	13.6	11.5	9.2	7.2	0	0.2	1.2	0	0.1	0.5	0	0	2.2	1	0	34.7	b
Mayotte	16.2	10.0	0.0	0.0	..	..	..	..	..	..	..	..	..	..	..	..	..	a
Mexico	12.2	9.4	9.2	9.6	6.2	0	0	2	0	0.8	0.4	0.3	0	165.7	316.8	0.6	5018.8	b
Micronesia (Federated States of)	2.0	1.8	1.4	1.8	1.1	0	0	0	0	0.2	0.5	0	0	0	0	0	1.4	a
Mongolia	5.7	4.5	3.6	3.4	2.4	0	0	0.2	0	0.7	0.1	0	0	1.6	3.8	0	162.8	b
Montenegro	0.0	49.1	43.0	40.6	20.7	0	0	18.6	0	1.3	0	0	0	6	6.3	0	30.5	b
Montserrat	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	0.3	a
Morocco	15.3	13.9	11.2	10.8	7.6	0	0	0.8	0	1.9	0.5	0	0	21.2	50.5	0.2	663.5	b
Mozambique	93.6	84.3	80.7	65.9	48	0	0	18	0	0	0	0	0	38.3	102.1	0	212.9	b
Myanmar	80.2	84.9	70.7	60.1	55.4	0	0	4.7	0	0	0	0	0	38.4	457	0	824.2	b
Namibia	34.7	31.0	28.8	30.3	10.9	0	0	18.7	0	0.1	0.6	0	0	14.8	8.5	0	76.7	b
Nauru	0.0	0.1	0.1	0.7	0	0	0	0	0	0	0.7	0	0	0	0	0	0.5	a
Nepal	88.3	87.3	85.0	75.0	69	0	2.1	4	0	0	0	0	0	23.4	415.6	0	585	b
Netherlands	1.7	3.9	5.7	7.4	2	1.3	0.4	0	0	1.9	0.7	0.2	0.8	62.9	54.7	22.6	1897.9	b
New Caledonia	7.5	4.8	5.1	4.4	0.3	0	0	2.9	0	0.4	0.8	0	0	1.4	0.2	0	38.1	a
New Zealand	29.0	31.7	31.2	31.0	8.3	0	0.2	15.1	0	1.2	0.1	6.1	0	116.4	53.1	0.3	547	b
Nicaragua	58.4	54.4	50.0	50.2	44.8	0	0	1.1	0	2.1	0.1	2.1	0	7.9	46.4	0	108.2	b
Niger	87.6	80.7	78.9	78.0	77.8	0	0	0	0	0	0.2	0	0	0.2	100.2	0	128.8	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	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	
Nigeria	86.2	86.5	82.3	79.7	79.4	0	0	0.3	0	0	0	0	0	16.9	4631.2	0	5835.4	b
Niue	0.6	26.7	22.4	23.3	0.4	0	0	0	0	0	22.9	0	0	0	0	0	0.1	a
North Macedonia	19.4	22.4	24.0	20.9	10.5	0	0.3	9.2	0	0.5	0.1	0.2	0	7.7	8.2	0	76.3	b
Northern Mariana Islands	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	1.1	a
Norway	60.2	56.4	58.1	60.8	4.6	2.1	0.2	51.8	0	1.4	0	0	0.8	404.1	41.6	19.8	765.5	b
Oman	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	829.9	b
Pakistan	51.1	47.4	45.9	41.7	38.6	0	0	2.9	0	0.2	0.1	0	0	124.5	1474	0	3829.5	b
Palau	0.0	0.0	0.0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	2.1	a
Panama	27.7	20.6	21.9	24.4	6.7	0	0	16	0	1.2	0.5	0	0	25.9	9.8	0	146.3	b
Papua New Guinea	66.4	55.3	50.7	49.6	46.2	0	0	2.3	0	0	0	1.1	0	4.1	56.2	0	121.8	a
Paraguay	70.4	63.6	60.5	59.2	40.2	2.5	0	16.5	0	0	0	0	0	45	109.3	6.9	272.2	b
Peru	38.6	32.2	27.4	27.9	13.2	2	0	11.7	0	0.6	0.5	0	0	105.5	111	14.8	829	b
Philippines	34.8	28.8	25.9	23.2	16.7	1.6	0	2.1	0	0.3	0.3	2.3	0	68.1	228.4	20	1363.4	b
Poland	6.9	9.5	11.9	11.3	8	1.3	0.3	0.2	0	1.3	0.1	0	0.1	62.9	228.4	39.8	2939.3	b
Portugal	20.1	27.8	27.2	27.6	12.9	1.8	0.2	5.7	0	5.8	1.1	0.1	0.1	86	81.1	11.9	648.3	b
Puerto Rico	0.7	0.6	1.8	1.4	0	0	0	0.2	0	0.6	0.5	0	0	0.7	0	0	49.2	a
Qatar	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0	0	0	680.7	b
Republic of Korea	0.7	1.3	2.7	3.2	1.2	0.6	0.1	0.2	0	0.1	0.6	0.2	0.3	74.7	73.2	27.3	5500.8	b
Republic of Moldova	5.7	19.8	24.7	25.7	24.9	0	0.1	0.7	0	0.1	0	0	0	1.1	32.3	0	130.1	b
Réunion	11.7	16.4	0.0	0.0	..	..	..	..	..	..	..	..	..	..	..	..	..	a
Romania	16.4	24.1	23.7	23.0	14.8	1.3	0.1	4.6	0	1.7	0.5	0.1	0	65.1	144.5	14	970.2	b
Russian Federation	3.5	3.3	3.2	3.2	0.6	0	0	2.6	0	0	0	0	0	422	106	51.1	18206.4	b
Rwanda	86.8	90.7	86.7	85.7	84.2	0	0	1.4	0	0	0.1	0	0	1.2	68.8	0	81.7	a
Saint Helena	7.1	9.2	13.2	13.1	3.7	0	0	0	0	5.7	3.7	0	0	0	0	0	0.1	a
Saint Kitts and Nevis	26.6	1.0	1.7	1.7	0	0	0	0	0	1.2	0.4	0	0	0	0	0	1.9	a
Saint Lucia	24.1	13.2	11.5	10.2	9.9	0	0	0	0	0	0.3	0	0	0	0.5	0	5.5	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	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	
Saint Pierre and Miquelon	0.6	1.6	1.0	1.1	1.1	0	0	0	0	0	0	0	0	0	0	0	0.5	a
Saint Vincent and the Grenadines	8.5	5.1	4.3	4.9	2	0	0	2.7	0	0	0.2	0	0	0.1	0.1	0	2.8	a
Samoa	59.7	41.3	37.5	36.6	32.1	0	0	3	0	0	1.5	0	0	0.2	1.5	0	4.5	a
Sao Tome and Principe	54.7	43.8	40.2	37.8	37	0	0	0.8	0	0	0.1	0	0	0	0.8	0	2.1	a
Saudi Arabia	0.0	0.0	0.0	0.0	0	0	0	0	0	0	0	0	0	0.5	0.3	0	4947.2	b
Senegal	47.5	50.3	39.9	36.6	35.4	0	0	1	0	0	0.2	0	0	1.6	37.5	0	106.6	b
Serbia	22.1	20.6	21.3	21.1	12.4	0	0.2	8.3	0	0.1	0	0.1	0	29.6	44.3	0.4	351.3	b
Seychelles	1.5	0.7	1.3	1.2	0.5	0	0	0	0	0.5	0.2	0	0	0	0	0	5.3	a
Sierra Leone	91.3	84.9	78.5	79.6	79.3	0	0	0.3	0	0	0	0	0	0.2	42.7	0	53.8	a
Singapore	0.3	0.5	0.6	0.7	0.2	0	0	0	0	0	0.2	0	0.4	3.5	0	0.2	510.5	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	7.6	a
Slovakia	3.7	10.3	13.4	12.4	6.4	1.5	0.9	3	0	0	0.6	0	0	19.9	25.4	6.7	418.8	b
Slovenia	15.9	19.5	20.8	21.0	10.6	1.5	0.3	7	0	0	0.6	1	0	15.7	24.3	3.4	206.9	b
Solomon Islands	55.3	45.1	48.6	48.5	48.3	0	0	0	0	0	0.1	0	0	0	3.2	0	6.7	a
Somalia	93.3	93.6	94.5	94.9	94.9	0	0	0	0	0	0	0	0	0	109.8	0	115.7	a
South Africa	16.3	11.8	10.3	10.3	8.9	0	0	0.1	0	0.7	0.6	0	0	35.5	252.2	0.5	2786.5	b
South Sudan	0.0	0.0	26.7	33.2	33.1	0	0	0	0	0	0.1	0	0	0	5.5	0	16.7	b
Spain	7.9	14.4	16.3	17.4	5.5	2.1	0.2	3.2	0	4.7	1.6	0	0.1	322.3	191.3	76	3390.4	b
Sri Lanka	64.2	61.8	52.9	51.4	46	0	0	5.1	0	0.3	0.1	0	0	22.8	191.4	0	416.8	b
State of Palestine	17.5	14.1	11.0	12.7	3.8	0	0	0	0	0	8.9	0	0	2.9	5.3	0	64.4	a
Sudan	80.4	61.3	63.0	61.4	55.9	0	0	5.6	0	0	0	0	0	29.3	294.1	0	526.6	b
Suriname	23.6	22.1	11.6	19.2	5.1	0	0	14	0	0	0.1	0	0	3.1	1.1	0	22.2	b
Sweden	40.0	45.8	52.9	52.5	26.8	5.6	0.5	13.7	0	3.7	0.1	0	2.1	251.1	352.7	67.2	1278.6	b
Switzerland	18.2	20.6	24.0	24.2	5.3	0.9	0.4	14.8	0	0.1	1.2	0	1.5	115.2	50.4	13.5	740.1	b
Syrian Arab Republic	2.0	1.4	0.6	0.9	0.1	0	0	0.8	0	0	0	0	0	2	0.2	0	231.8	b
Tajikistan	62.4	61.8	48.1	39.5	0	0	0	39.5	0	0	0	0	0	47.7	0	0	121	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	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	
Thailand	22.0	22.7	22.7	23.7	18.3	2.6	1.1	0.9	0	0.2	0.5	0	0.2	111.5	557.8	81.5	3165	b
Timor-Leste	0.0	34.8	18.4	18.4	18.2	0	0	0.1	0	0	0.1	0	0	0	0.8	0	4.3	a
Togo	77.1	65.8	81.0	75.1	75	0	0	0.1	0	0	0	0	0	0.1	64.7	0	86.3	b
Tonga	2.5	1.0	1.9	1.7	0.9	0	0	0	0	0	0.8	0	0	0	0	0	1.5	a
Trinidad and Tobago	0.8	0.4	0.4	0.5	0.4	0	0	0	0	0	0	0	0	0	0.5	0	105.4	b
Tunisia	14.2	12.6	12.5	11.9	10.6	0	0	0	0	0.4	0.9	0	0	1.8	38.5	0	339.5	b
Turkey	17.3	14.2	13.3	11.9	1.7	0.2	0.2	4.4	0	1.5	1.5	2.5	0	292.9	188.1	7.8	4116.4	b
Turkmenistan	0.1	0.1	0.1	0.1	0.1	0	0	0	0	0	0	0	0	0	0.4	0	756	b
Turks and Caicos Islands	0.7	0.5	0.6	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	1.4	a
Tuvalu	0.0	0.0	5.3	9.9	0	0	0	0	0	0	9.9	0	0	0	0	0	0.1	a
Uganda	95.0	93.2	91.1	90.3	89	0	0	1.3	0	0	0	0	0	10.5	656	0	737.8	a
Ukraine	1.3	2.9	4.1	6.9	5.1	0.1	0.1	1.4	0	0.2	0.1	0	0	33.1	104.5	3.6	2043.7	b
United Arab Emirates	0.1	0.1	0.1	0.3	0.1	0	0	0	0	0	0.2	0	0	4.2	1.9	0	2353.1	b
United Kingdom of Great Britain and Northern Ireland	1.0	3.7	8.6	11.0	4.1	1.1	0.7	0.4	0	3.7	0.9	0	0.3	355.3	143.5	59.9	5058.3	b
United Republic of Tanzania	93.7	88.6	83.5	83.7	82.7	0	0	0.9	0	0	0	0	0	7.6	626.6	0	758.1	b
United States of America	5.4	7.4	9.0	10.1	3.5	2.7	0.1	1.5	0	1.4	0.6	0.2	0.1	2346.4	2192.5	1574.6	60487.2	b
United States Virgin Islands	0.0	0.0	4.1	3.4	0	0	0	0	0	0	3.4	0	0	0.1	0	0	1.9	a
Uruguay	38.7	53.2	59.4	60.7	42.2	1.6	0	9.5	0	6.9	0.6	0	0	40.3	75.3	2.7	195	b
Uzbekistan	0.7	1.3	1.7	1.5	0	0	0	1.5	0	0	0	0	0	17.6	0.2	0.5	1224.9	b
Vanuatu	48.7	38.4	35.5	30.8	28.6	0.3	0	0.8	0	0.5	0.6	0	0	0.1	0.8	0	2.9	a
Venezuela (Bolivarian Republic of)	15.3	13.8	15.3	14.6	1.9	0	0	12.6	0	0	0	0	0	137.8	21.1	0	1091.1	b
Viet Nam	58.0	34.8	30.7	23.5	13.8	0	0	9.7	0	0.1	0	0	0	239.9	338.4	0	2461.6	b
Wallis and Futuna Islands	0.0	0.4	0.6	0.7	0	0	0	0.5	0	0	0.2	0	0	0	0	0	0.2	a
Yemen	1.2	1.0	2.4	4.3	3.1	0	0	0	0	0	1.2	0	0	1	2.6	0	85.5	b
Zambia	89.9	89.9	85.5	85.1	75.4	0	0	9.7	0	0	0	0	0	39.3	305.4	0.1	405.2	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	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	
Zimbabwe	69.3	82.1	81.4	81.4	77.2	0.4	0	3.8	0	0	0	0	0	17	334.2	1.7	433.7	b
World	17.2	16.4	16.9	17.1	10.3	1	0.2	3.4	0	1	0.8	0.3	0.1	19820.7	40247.7	4108	375053.4	c
Northern America (M49) and Europe (M49)	7.4	10.1	12.0	12.7	4.8	1.8	0.3	3.2	0	1.5	0.6	0.2	0.2	7928.2	6765.7	2564	135678.3	c
Northern America (M49)	7.3	9.1	10.8	11.6	3.6	2.5	0.1	3.1	0	1.4	0.6	0.2	0.1	3668.4	2557.6	1674.2	68200.6	c
Europe (M49)	7.4	11.0	13.2	13.8	5.9	1.1	0.5	3.3	0	1.7	0.7	0.2	0.3	4204	4207.7	909.1	67477.7	c
Latin America and the Caribbean (MDG=M49)	28.5	29.2	28.5	30.1	15.4	4	0	9.1	..	1	0.4	0.1	..	2680.3	3572.4	937.8	23915.6	c
Central Asia (M49) and Southern Asia (MDG=M49)	37.5	30.6	27.2	25.4	22.5	0.1	0	1.9	0	0.5	0.4	0	0	1190.1	9079.7	52.2	40707.5	c
Central Asia (M49)	3.6	2.8	3.2	3.4	0.1	0	0	3.3	0	0	0	0	0	131.5	2.8	4	4013.4	c
Southern Asia (MDG=M49)	42.9	34.4	29.9	27.8	24.9	0.1	0	1.7	0	0.5	0.4	0	0	1057.4	9077	48.6	36694.1	c
Eastern Asia (M49) and South-eastern Asia (MDG=M49)	23.2	13.4	13.2	13.6	5.7	0.3	0.3	4.1	0	1	1.6	0.5	0	6956.4	7783.4	518	112431.7	c
Eastern Asia (M49)	19.8	10.5	11.0	12.0	3.7	0.2	0.3	4.2	0	1.2	1.8	0.5	0	6158.2	4973.7	276.4	95377	c
South-eastern Asia (MDG=M49)	38.4	29.9	25.8	22.6	16.8	1.4	0.2	3.5	0	0.1	0.1	0.4	0	798.4	2809.7	241.5	17054.7	c
Western Asia (M49) and Northern Africa (M49)	8.3	6.2	5.4	5.2	2.5	0	0	1.3	0	0.4	0.5	0.5	0	451.7	716.5	8.2	22546.3	c
Western Asia (M49)	6.1	4.5	3.9	3.7	0.6	0	0.1	1.4	0	0.4	0.7	0.6	0	356.9	261.4	7.4	16739.3	c
Northern Africa (M49)	14.8	11.1	9.9	9.5	7.8	0	0	1.2	0	0.3	0.2	0	0	95	455.6	0.7	5807	c
Sub-Saharan Africa (M49)	72.5	70.9	68.7	67.7	65.6	0	0	1.7	..	0.1	0.1	0.1	..	374.3	12003.3	5	18294.9	c
Oceania (M49)	13.2	12.8	13.6	13.8	6.9	0.1	0.2	3.3	0	1.3	1.2	0.8	0	245.5	298.7	10.9	4028.5	c
Oceania (M49) excluding Australia and New Zealand (M49)	48.3	38.4	36.1	34.2	30.2	0	0	2.9	0	0.1	0.4	0.6	0	8.7	67.1	0	221.9	c
Australia and New Zealand (M49)	11.4	11.4	12.3	12.6	5.6	0.1	0.2	3.3	0	1.3	1.2	0.8	0	236.5	231.6	10.9	3806.6	c

Country / region	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	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	
Least Developed Countries (LDCs)	84.0	76.0	73.4	70.5	66.9	0	0.1	3.4	0	0	0	0	0	387.1	7448.9	0.2	11116.8	c
Small island developing States (SIDS)	25.4	17.7	17.9	18.1	16	0.6	0	0.9	0	0.2	0.2	0.1	0.1	34.4	319.6	2.4	1966.8	c
Landlocked developing countries (LLDCs)	43.5	41.9	44.4	43.8	39.1	0.1	0.1	4.4	0	0	0	0	0	459.1	4115.1	17.5	10489.2	c
Africa (M49)	60.7	56.4	54.7	53.6	51.7	0	0	1.6	..	0.2	0.1	0.1	..	465.6	12458.8	5.5	24102	c
Asia (M49)	25.1	16.6	15.5	15.4	9.2	0.3	0.2	3.3	0	0.8	1.2	0.4	0	8473.5	17125.8	568	169878.6	c
Americas (m49)	11.8	14.3	15.6	16.5	6.7	2.9	0.1	4.8	0	1.3	0.5	0.1	0	6434.5	6129.8	2612.4	92116.2	c
Caribbean (M49)	25.4	18.0	20.3	21.3	19	1	..	0.7	..	0.4	0.2	..	..	14.8	211.1	1.6	1069.6	c
Central America (M49)	18.1	16.4	16.5	17.1	12.5	0	0	2.9	0	0.8	0.4	0.4	0	294.3	768.8	1	6225.2	c
Eastern Africa (M49)	88.1	87.4	84.5	83.6	80.2	0	0	3	..	0	0	0.3	..	190.5	4503.4	1.9	5618.3	c
Eastern Europe (M49)	4.3	5.7	6.3	6.4	3.4	0.3	0.1	2.2	0	0.2	0.1	0	0	674.8	932.4	144.1	27571.3	c
Melanesia (M49)	54.5	43.3	40.1	37.9	33.8	0	0	3.1	0	0.1	0.2	0.7	0	7.7	64.8	0	191.4	c
Micronesia (M49)	5.1	5.5	6.0	6.8	5.4	0	0	0	0	0	1.4	0	0	0.2	0.7	0	13.8	c
Middle Africa (M49)	88.0	78.3	76.0	79.2	75.5	0	0	3.8	0	0	0	0	0	74.4	1482	0	1964	c
Northern Europe (M49)	15.4	19.1	25.7	27.5	11.9	1.8	0.6	7.8	0	3.5	0.5	0.5	0.8	1383.4	1132	189	9843.3	c
Polynesia (M49)	25.5	14.8	15.1	14.6	9	0	0	3.9	0	0	1.6	0	0	0.9	1.5	0	16.7	c
South America (M49)	32.9	34.6	33.2	35.4	16.3	5.8	0	11.8	..	1	0.4	0	..	2350.7	2592.5	935.8	16620.8	c
Southern Africa (M49)	18.5	13.7	12.1	12.0	10.5	0	0	0.3	0	0.6	0.6	0	0	42.9	321.1	0.6	3034.2	c
Southern Europe (M49)	8.7	15.4	18.1	19.0	7.6	1.6	0.5	4.5	0	2.8	1.7	0.3	0.1	1002	838	174.4	10591.2	c
Western Africa (M49)	83.3	81.9	77.7	75.0	74.2	0	0	0.7	0	0	0	0	0	58.4	5696.8	0	7678.5	c
Western Europe (M49)	6.7	11.8	14.3	15.6	5.8	1.8	1.1	2.4	0	2.5	1.3	0.1	0.7	1348.1	1328.9	364	19471.9	c
Developing regions (MDG)	32.9	23.6	22.1	22.0	15.3	0.7	0.2	3.8	0	0.8	0.9	0.3	0	11067.6	33023.8	1500.1	207062.1	c
Developed regions (MDG)	7.2	9.7	11.6	12.3	4.6	1.7	0.3	3.2	0	1.5	0.8	0.2	0.2	8754.9	7197.8	2602.3	150540.8	c
Northern Africa (MDG)	7.1	5.3	4.6	4.3	3	0	0	0.8	0	0.4	0.2	0	0	67.3	161.5	0.5	5280.4	c
Sub-Saharan Africa (MDG)	72.7	70.6	68.5	67.5	65.3	0	0	1.8	..	0.1	0.1	0.1	..	403.1	12297.4	5.1	18821.6	c

Country / region	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	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	2018	
Eastern Asia (MDG)	25.4	11.5	11.6	12.5	3.9	0.2	0.4	4.4	0	1.3	1.8	0.6	0	5582.6	4795.1	248.3	84956.8	c
Western Asia (MDG)	5.7	3.9	3.6	3.5	0.6	0	0.1	1.2	0	0.4	0.6	0.7	0	308.5	221.2	6.8	15504.4	c
Oceania (MDG)	48.3	38.4	36.1	34.2	30.2	0	0	2.9	0	0.1	0.4	0.6	0	8.7	67.1	0	221.9	c
Caucasus and Central Asia (MDG)	4.7	3.9	4.1	4.3	0.4	0	0	3.7	0	0	0	0	0	170.4	20.8	5	4612.7	c

REFERENCE
a. Source: Energy Balances, UN Statistics Division (2020)
b. Source: IEA (2020), World Energy Balances
c. Sources: IEA (2020), World Energy Balances; Energy Balances, UN Statistics Division (2020)

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 – ENERGY EFFICIENCY

Data provided by the IEA and UNSD

Country / region	2000	2010	2015	2018	2000-2010	2010-2015	2015-2018	Source
Afghanistan	1.4	2.2	1.8	1.8	5.1%	-4.3%	-0.8%	*a*
Albania	4.0	2.8	2.6	2.5	-3.7%	-1.2%	-1.5%	*b*
Algeria	4.3	4.5	5.1	5.3	0.6%	2.7%	0.9%	*b*
American Samoa	..	..	..	..	..	..	..	*a*
Andorra	..	..	..	..	..	..	..	*a*
Angola	3.7	2.6	2.9	3.0	-3.4%	1.8%	1.8%	*b*
Anguilla	..	..	..	..	..	..	..	*a*
Antigua and Barbuda	3.1	4.1	4.0	3.6	2.7%	-0.4%	-3.7%	*a*
Argentina	3.7	3.3	3.4	3.3	-1.2%	0.6%	-0.5%	*b*
Armenia	6.8	3.9	4.0	3.4	-5.4%	0.5%	-4.8%	*b*
Aruba	14.4	16.2	3.3	3.1	1.2%	-27.4%	-2.2%	*a*
Australia	6.1	5.3	4.6	4.3	-1.4%	-2.6%	-2.3%	*b*
Austria	3.2	3.3	3.0	2.8	0.2%	-1.8%	-2.2%	*b*
Azerbaijan	14.5	3.7	4.2	4.3	-12.6%	2.3%	0.5%	*b*
Bahamas	2.3	2.1	2.3	2.8	-0.8%	1.7%	7.3%	*a*
Bahrain	10.2	9.5	8.9	8.2	-0.7%	-1.3%	-2.6%	*b*
Bangladesh	3.1	3.0	2.8	2.5	-0.6%	-1.4%	-3.9%	*b*
Barbados	3.8	4.6	3.8	3.8	1.8%	-3.4%	-0.7%	*a*
Belarus	12.9	7.0	6.1	6.3	-5.9%	-2.8%	1.2%	*b*
Belgium	5.5	4.8	3.9	3.8	-1.4%	-3.8%	-1.1%	*b*
Belize	6.8	5.5	6.0	5.9	-2.1%	1.7%	-0.8%	*a*
Benin	4.9	6.0	5.8	6.1	2.1%	-0.7%	1.4%	*b*
Bermuda	..	..	..	..	..	..	..	*a*
Bhutan	18.4	10.1	8.7	8.3	-5.8%	-3.0%	-1.6%	*a*
Bolivia (Plurinational State of)	3.5	4.1	4.1	4.0	1.4%	0.1%	-0.6%	*b*
Bonaire, Sint Eustatius and Saba	..	..	..	..	..	..	..	*a*
Bosnia and Herzegovina	6.7	6.6	5.9	6.5	-0.2%	-2.3%	3.4%	*b*

Country / region	2000	2010	2015	2018	2000-2010	2010-2015	2015-2018	Source
Botswana	4.0	3.2	3.2	3.0	-2.2%	-0.2%	-2.1%	*b*
Brazil	3.9	3.8	4.0	3.9	-0.1%	1.0%	-0.8%	*b*
British Virgin Islands	..	..	..	..	..	..	..	*a*
Brunei Darussalam	4.3	5.2	4.3	6.0	1.7%	-3.4%	11.2%	*b*
Bulgaria	9.4	5.8	5.5	5.0	-4.7%	-0.9%	-3.3%	*b*
Burkina Faso	5.5	5.4	4.9	4.6	-0.1%	-1.8%	-2.4%	*a*
Burundi	10.4	7.9	7.4	7.7	-2.6%	-1.4%	1.5%	*a*
Cabo Verde	2.6	3.0	2.6	2.7	1.6%	-2.7%	1.1%	*a*
Cambodia	7.9	5.7	5.4	5.1	-3.1%	-1.4%	-1.7%	*b*
Cameroon	6.2	4.7	4.7	4.5	-2.8%	0.4%	-2.1%	*b*
Canada	9.3	7.1	6.9	6.9	-2.6%	-0.5%	-0.3%	*b*
Cayman Islands	1.9	2.1	1.9	1.9	1.2%	-1.8%	-0.1%	*a*
Central African Republic	5.8	4.0	5.6	5.1	-3.6%	6.7%	-3.2%	*a*
Chad	8.2	3.8	3.0	3.5	-7.3%	-4.7%	5.3%	*a*
Chile	4.5	3.7	3.5	3.6	-2.1%	-1.0%	0.9%	*b*
China	10.9	8.9	7.2	6.3	-1.9%	-4.2%	-4.3%	*b*
China, Hong Kong Special Administrative Region	2.3	1.6	1.5	1.3	-3.8%	-1.0%	-4.8%	*b*
China, Macao Special Administrative Region	1.1	0.5	0.6	0.5	-7.3%	3.8%	-6.6%	*a*
Colombia	3.0	2.4	2.5	2.3	-2.2%	1.1%	-3.3%	*b*
Comoros	2.1	2.4	2.7	3.1	1.1%	2.3%	5.4%	*a*
Congo	3.1	4.6	6.4	6.9	4.1%	6.5%	3.0%	*b*
Cook Islands	..	..	..	..	..	..	..	*a*
Costa Rica	2.5	2.6	2.4	2.1	0.4%	-2.0%	-3.9%	*b*
Côte d'Ivoire	4.2	4.6	4.0	3.5	0.9%	-3.1%	-4.5%	*b*
Croatia	4.3	3.8	3.4	3.2	-1.3%	-2.0%	-2.6%	*b*
Cuba	..	..	..	..	..	..	..	*b*
Curaçao	22.2	20.2	22.3	13.9	-1.0%	2.0%	-14.5%	*b*
Cyprus	3.9	3.2	2.9	2.8	-1.9%	-2.1%	-1.5%	*b*
Czechia	6.7	5.4	4.6	4.3	-2.2%	-3.1%	-2.1%	*b*

Country / region	2000	2010	2015	2018	2000-2010	2010-2015	2015-2018	Source
Democratic People's Republic of Korea	..	..	..	..	..	..	..	*b*
Democratic Republic of the Congo	16.5	14.9	14.9	13.8	-1.0%	0.0%	-2.4%	*b*
Denmark	3.0	2.9	2.3	2.2	-0.3%	-4.8%	-1.0%	*b*
Djibouti	5.8	4.6	2.4	2.0	-2.4%	-11.9%	-5.8%	*a*
Dominica	2.5	3.0	3.1	2.9	1.9%	0.9%	-1.9%	*a*
Dominican Republic	3.9	2.6	2.2	2.1	-4.1%	-3.0%	-2.3%	*b*
Ecuador	3.3	3.5	3.3	3.1	0.6%	-1.3%	-1.6%	*b*
Egypt	3.2	3.6	3.5	3.6	1.2%	-0.9%	1.2%	*b*
El Salvador	3.5	3.9	3.4	3.3	1.2%	-2.8%	-1.2%	*b*
Equatorial Guinea	1.6	2.4	3.3	3.7	4.2%	6.8%	4.2%	*a*
Eritrea	..	..	..	..	..	..	..	*b*
Estonia	7.9	6.8	5.6	5.6	-1.6%	-3.8%	0.3%	*b*
Eswatini	7.3	5.4	4.8	4.5	-2.9%	-2.5%	-2.2%	*a*
Ethiopia	21.4	12.7	9.2	7.9	-5.1%	-6.2%	-5.0%	*b*
Falkland Islands (Malvinas)	..	..	..	..	..	..	..	*a*
Faroe Islands	..	..	..	..	..	..	..	*a*
Fiji	2.8	2.4	2.3	2.1	-1.6%	-0.9%	-3.4%	*a*
Finland	6.6	6.2	5.5	5.4	-0.5%	-2.5%	-0.9%	*b*
France	4.3	4.0	3.7	3.4	-0.8%	-1.8%	-2.5%	*b*
French Guiana	..	..	..	..	..	..	..	*a*
French Polynesia	..	..	..	..	..	..	..	*a*
Gabon	3.0	9.1	7.2	6.6	11.6%	-4.5%	-3.0%	*b*
Gambia	3.1	2.9	3.3	3.0	-0.6%	2.3%	-3.5%	*a*
Georgia	6.0	3.6	4.2	3.8	-5.1%	3.4%	-2.9%	*b*
Germany	4.0	3.6	3.1	2.8	-1.1%	-3.0%	-2.8%	*b*
Ghana	5.0	3.4	3.1	2.7	-3.7%	-2.4%	-4.4%	*b*
Gibraltar	..	..	..	..	..	..	..	*b*
Greece	3.6	3.1	3.2	3.0	-1.5%	0.6%	-2.0%	*b*
Greenland	..	..	..	..	..	..	..	*a*

Country / region	2000	2010	2015	2018	2000-2010	2010-2015	2015-2018	Source
Grenada	2.5	2.8	2.5	2.5	1.4%	-2.6%	0.8%	*a*
Guadeloupe	..	..	..	..	..	..	..	*a*
Guam	..	..	..	..	..	..	..	*a*
Guatemala	4.0	4.1	4.2	4.3	0.3%	0.1%	0.8%	*b*
Guernsey	..	..	..	..	..	..	..	*a*
Guinea	9.1	7.7	6.4	5.5	-1.6%	-3.8%	-4.6%	*a*
Guinea-Bissau	11.2	10.5	9.7	8.7	-0.6%	-1.6%	-3.6%	*a*
Guyana	8.0	6.5	5.3	5.2	-2.1%	-4.2%	-0.4%	*a*
Haiti	8.3	10.0	9.3	9.8	1.9%	-1.3%	1.6%	*b*
Honduras	4.7	4.9	5.0	4.6	0.5%	0.5%	-2.9%	*b*
Hungary	5.2	4.5	3.9	3.7	-1.4%	-3.0%	-1.8%	*b*
Iceland	11.4	15.2	13.7	13.0	2.9%	-2.1%	-1.7%	*b*
India	6.8	5.6	4.9	4.4	-1.9%	-2.8%	-3.6%	*b*
Indonesia	5.4	4.2	3.3	3.2	-2.5%	-5.0%	-0.8%	*b*
Iran (Islamic Republic of)	7.8	8.4	10.0	9.1	0.8%	3.6%	-3.2%	*b*
Iraq	5.5	5.7	5.4	6.6	0.4%	-1.3%	7.1%	*b*
Ireland	3.2	2.5	1.7	1.4	-2.4%	-7.7%	-5.2%	*b*
Isle of Man	..	..	..	..	..	..	..	*a*
Israel	3.9	3.7	2.9	2.7	-0.5%	-4.5%	-2.8%	*b*
Italy	2.9	2.9	2.6	2.5	-0.2%	-1.9%	-1.7%	*b*
Jamaica	5.9	3.8	3.9	4.1	-4.3%	0.6%	1.8%	*b*
Japan	4.8	4.4	3.6	3.4	-1.0%	-3.9%	-1.5%	*b*
Jersey	..	..	..	..	..	..	..	*a*
Jordan	4.6	3.7	3.9	3.9	-2.3%	1.2%	-0.2%	*b*
Kazakhstan	9.8	8.6	5.4	6.8	-1.3%	-8.7%	7.8%	*b*
Kenya	6.4	5.9	5.8	5.4	-0.8%	-0.3%	-2.5%	*b*
Kiribati	5.0	6.7	5.7	6.0	3.0%	-3.2%	1.5%	*a*
Kuwait	6.9	7.0	6.6	6.8	0.1%	-1.1%	1.2%	*b*
Kyrgyzstan	6.4	5.1	5.8	5.9	-2.3%	2.6%	0.3%	*b*
Lao People's Democratic Republic	3.8	3.3	3.8	5.8	-1.3%	2.9%	14.6%	*a*

Country / region	2000	2010	2015	2018	2000-2010	2010-2015	2015-2018	Source
Latvia	5.3	4.3	3.4	3.4	-2.0%	-4.5%	-0.5%	*b*
Lebanon	3.7	2.8	3.3	3.4	-2.9%	3.3%	0.9%	*b*
Lesotho	14.5	11.4	8.2	8.0	-2.4%	-6.4%	-0.7%	*a*
Liberia	10.1	13.5	13.0	13.6	3.0%	-0.8%	1.5%	*a*
Libya	7.4	6.1	11.1	7.5	-1.9%	12.7%	-12.4%	*b*
Liechtenstein	..	..	..	..	..	..	..	*a*
Lithuania	6.2	4.0	3.3	3.2	-4.3%	-3.7%	-0.9%	*b*
Luxembourg	3.3	3.2	2.5	2.4	-0.3%	-5.2%	-1.6%	*b*
Madagascar	6.0	6.1	6.7	7.8	0.1%	1.9%	5.4%	*a*
Malawi	7.4	5.4	4.7	4.7	-3.1%	-2.8%	0.0%	*a*
Malaysia	5.5	5.2	4.7	4.5	-0.4%	-2.1%	-1.5%	*b*
Maldives	1.7	2.3	2.4	2.6	2.6%	1.3%	2.7%	*a*
Mali	4.8	4.9	5.2	4.8	0.1%	1.4%	-3.1%	*a*
Malta	2.6	2.7	1.6	1.4	0.1%	-10.3%	-4.5%	*b*
Marshall Islands	9.1	10.4	10.6	10.1	1.3%	0.5%	-1.8%	*a*
Martinique	..	..	..	..	..	..	..	*a*
Mauritania	2.5	2.7	2.9	3.4	0.7%	1.9%	4.4%	*a*
Mauritius	3.0	2.6	2.4	2.2	-1.3%	-1.8%	-3.1%	*b*
Mayotte	..	..	..	..	..	..	..	*a*
Mexico	3.6	3.7	3.3	3.0	0.2%	-2.2%	-3.1%	*b*
Micronesia (Federated States of)	5.2	4.1	5.6	5.6	-2.4%	6.6%	-0.5%	*a*
Mongolia	9.2	8.1	5.9	6.4	-1.3%	-6.2%	2.6%	*b*
Montenegro	..	4.6	3.7	3.4	..	-4.1%	-2.3%	*b*
Montserrat	..	..	..	..	..	..	..	*a*
Morocco	3.6	3.5	3.3	3.2	-0.4%	-1.2%	-1.0%	*b*
Mozambique	26.8	12.5	13.3	11.5	-7.4%	1.2%	-4.7%	*b*
Myanmar	10.5	3.7	3.4	3.7	-10.0%	-1.4%	2.5%	*b*
Namibia	3.6	3.6	3.4	3.5	0.0%	-1.5%	1.5%	*b*
Nauru	16.2	8.7	5.4	5.1	-6.0%	-9.3%	-1.4%	*a*
Nepal	7.8	6.7	6.2	6.4	-1.5%	-1.5%	1.0%	*b*
Netherlands	4.1	4.0	3.4	3.1	-0.3%	-3.4%	-2.1%	*b*

Country / region	2000	2010	2015	2018	2000-2010	2010-2015	2015-2018	Source
New Caledonia	..	..	..	..	..	..	..	*a*
New Zealand	5.8	4.8	4.7	4.2	-1.9%	-0.5%	-3.7%	*b*
Nicaragua	5.2	4.7	4.5	4.5	-1.0%	-1.0%	0.2%	*b*
Niger	5.8	5.5	5.5	5.2	-0.6%	0.0%	-2.0%	*b*
Nigeria	10.0	6.8	6.1	6.6	-3.8%	-2.3%	2.9%	*b*
Niue	..	..	..	..	..	..	..	*a*
North Macedonia	5.4	4.4	3.6	3.3	-2.2%	-3.9%	-3.1%	*b*
Northern Mariana Islands	..	..	..	..	..	..	..	*a*
Norway	4.4	4.6	3.8	3.5	0.6%	-3.8%	-2.6%	*b*
Oman	4.1	7.3	8.2	7.8	6.0%	2.3%	-1.9%	*b*
Pakistan	5.8	5.1	4.7	4.6	-1.2%	-1.6%	-0.5%	*b*
Palau	11.1	10.7	8.6	9.2	-0.4%	-4.2%	2.1%	*a*
Panama	2.3	1.9	1.5	1.4	-2.0%	-3.7%	-3.2%	*b*
Papua New Guinea	5.9	5.6	4.9	4.6	-0.4%	-2.9%	-2.2%	*a*
Paraguay	3.6	3.1	3.0	3.4	-1.3%	-0.7%	4.0%	*b*
Peru	3.3	2.5	2.6	2.6	-2.7%	0.4%	0.3%	*b*
Philippines	4.8	3.0	2.9	2.8	-4.5%	-1.0%	-1.5%	*b*
Poland	6.0	4.6	3.8	3.7	-2.6%	-4.0%	-0.7%	*b*
Portugal	3.3	2.9	2.9	2.6	-1.2%	-0.5%	-2.6%	*b*
Puerto Rico	0.1	0.2	0.5	0.5	7.5%	14.8%	1.1%	*a*
Qatar	8.5	6.1	6.2	6.9	-3.3%	0.5%	3.6%	*b*
Republic of Korea	7.3	6.1	5.8	5.5	-1.7%	-1.3%	-1.7%	*b*
Republic of Moldova	8.1	6.4	5.3	5.1	-2.4%	-3.7%	-1.3%	*b*
Réunion	..	..	..	..	..	..	..	*a*
Romania	5.6	3.6	2.8	2.5	-4.4%	-4.7%	-3.5%	*b*
Russian Federation	12.1	8.4	7.8	8.1	-3.6%	-1.6%	1.6%	*b*
Rwanda	7.8	5.6	4.5	3.9	-3.3%	-3.9%	-4.7%	*a*
Saint Helena	..	..	..	..	..	..	..	*a*
Saint Kitts and Nevis	3.1	2.7	2.6	2.6	-1.2%	-1.3%	0.4%	*a*
Saint Lucia	3.1	3.2	3.0	2.9	0.4%	-0.9%	-1.9%	*a*

Country / region	2000	2010	2015	2018	2000-2010	2010-2015	2015-2018	Source
Saint Pierre and Miquelon	..	..	..	..	..	..	..	*a*
Saint Vincent and the Grenadines	2.4	2.7	2.7	2.7	1.1%	0.0%	-0.6%	*a*
Samoa	5.3	3.7	4.3	4.2	-3.4%	2.8%	-0.5%	*a*
Sao Tome and Principe	4.6	4.0	3.7	3.5	-1.4%	-1.8%	-1.1%	*a*
Saudi Arabia	4.7	6.1	5.8	5.6	2.6%	-0.8%	-1.5%	*b*
Senegal	4.3	4.8	4.2	3.6	1.1%	-2.5%	-4.6%	*b*
Serbia	8.5	6.2	5.6	5.3	-3.1%	-2.0%	-1.9%	*b*
Seychelles	2.9	3.3	2.8	2.9	1.2%	-2.9%	0.7%	*a*
Sierra Leone	11.1	6.6	6.0	5.4	-5.1%	-1.8%	-3.5%	*a*
Singapore	3.5	2.5	2.7	2.9	-3.3%	1.6%	2.2%	*b*
Sint Maarten (Dutch part)	..	..	8.3	9.5	..	..	4.4%	*a*
Slovakia	8.6	5.3	4.3	4.2	-4.7%	-4.2%	-1.1%	*b*
Slovenia	5.1	4.5	3.9	3.7	-1.3%	-2.6%	-2.1%	*b*
Solomon Islands	7.9	7.3	5.5	4.9	-0.7%	-5.7%	-3.7%	*a*
Somalia	..	..	..	..	..	..	..	*a*
South Africa	10.1	8.8	7.6	7.7	-1.3%	-3.0%	0.5%	*b*
South Sudan	..	..	..	..	..	..	..	*b*
Spain	3.6	3.1	2.9	2.8	-1.6%	-1.4%	-0.9%	*b*
Sri Lanka	3.1	2.2	1.9	1.8	-3.4%	-2.5%	-3.3%	*b*
State of Palestine	2.8	2.8	3.1	2.9	0.1%	1.4%	-2.3%	*a*
Sudan	7.3	4.6	4.7	4.5	-4.5%	0.5%	-1.8%	*b*
Suriname	4.6	3.3	4.0	4.1	-3.3%	3.7%	1.0%	*b*
Sweden	5.4	4.7	3.7	3.9	-1.5%	-4.8%	1.6%	*b*
Switzerland	2.5	2.2	1.9	1.7	-1.4%	-3.0%	-2.5%	*b*
Syrian Arab Republic	..	..	..	..	..	..	..	*b*
Tajikistan	11.6	5.4	4.8	5.0	-7.4%	-2.0%	1.1%	*b*
Thailand	4.9	5.1	5.1	4.5	0.4%	0.0%	-3.8%	*b*
Timor-Leste	..	1.4	2.0	2.0		7.8%	0.2%	*a*
Togo	14.0	16.6	12.2	11.3	1.7%	-6.0%	-2.5%	*b*
Tonga	3.0	2.9	2.8	3.0	-0.1%	-1.2%	2.9%	*a*

Country / region	2000	2010	2015	2018	2000-2010	2010-2015	2015-2018	Source
Trinidad and Tobago	19.5	21.6	19.8	19.5	1.0%	-1.7%	-0.6%	*b*
Tunisia	4.3	4.0	3.9	3.9	-0.7%	-0.7%	-0.1%	*b*
Turkey	3.3	3.1	2.6	2.6	-0.7%	-2.9%	-0.6%	*b*
Turkmenistan	29.9	21.7	16.0	13.3	-3.2%	-5.9%	-5.9%	*b*
Turks and Caicos Islands	2.1	3.4	3.3	3.3	4.8%	-0.4%	-0.1%	*a*
Tuvalu	3.4	3.9	2.7	3.0	1.3%	-7.3%	3.7%	*a*
Uganda	13.4	10.7	10.3	10.1	-2.2%	-0.8%	-0.5%	*a*
Ukraine	15.8	10.3	8.1	7.5	-4.2%	-4.7%	-2.4%	*b*
United Arab Emirates	4.1	5.5	5.3	4.4	2.9%	-0.8%	-5.8%	*b*
United Kingdom of Great Britain and Northern Ireland	4.2	3.2	2.6	2.4	-2.5%	-4.2%	-2.9%	*b*
United Republic of Tanzania	12.3	8.3	7.0	6.2	-3.8%	-3.3%	-4.1%	*b*
United States of America	6.7	5.5	4.9	4.7	-2.0%	-2.4%	-1.5%	*b*
United States Virgin Islands	..	..	..	..	..	..	..	*a*
Uruguay	2.9	2.9	3.0	3.0	-0.3%	0.9%	-0.3%	*b*
Uzbekistan	31.0	15.5	8.7	8.7	-6.7%	-10.9%	0.3%	*b*
Vanuatu	3.6	3.5	3.5	3.8	-0.3%	-0.2%	2.6%	*a*
Venezuela (Bolivarian Republic of)	..	..	..	..	..	..	..	*b*
Viet Nam	5.1	5.5	5.1	4.8	0.7%	-1.3%	-2.0%	*b*
Wallis and Futuna Islands	..	..	..	..	..	..	..	*a*
Yemen	..	..	..	..	..	..	..	*b*
Zambia	12.7	8.7	8.5	8.6	-3.7%	-0.5%	0.4%	*b*
Zimbabwe	10.2	14.1	11.6	11.0	3.3%	-3.8%	-1.6%	*b*
World	6.2	5.6	5.0	4.8	-1.0%	-2.2%	-1.7%	*c*
Northern America (M49) and Europe (M49)	5.9	5.0	4.4	4.3	-1.8%	-2.3%	-1.2%	*c*
Northern America (M49)	6.9	5.7	5.1	4.8	-2.0%	-2.2%	-1.4%	*c*
Europe (M49)	5.2	4.5	3.9	3.8	-1.5%	-2.6%	-1.1%	*c*
Latin America and the Caribbean (MDG=M49)	3.7	3.6	3.5	3.4	-0.4%	-0.4%	-1.6%	*c*

Country / region	2000	2010	2015	2018	2000-2010	2010-2015	2015-2018	Source
Central Asia (M49) and Southern Asia (MDG=M49)	7.1	6.1	5.3	4.9	-1.6%	-2.5%	-2.7%	c
Central Asia (M49)	16.7	11.0	7.3	7.9	-4.1%	-7.9%	2.7%	c
Southern Asia (MDG=M49)	6.5	5.7	5.2	4.7	-1.3%	-1.9%	-3.2%	c
Eastern Asia (M49) and South-eastern Asia (MDG=M49)	7.0	6.7	5.7	5.2	-0.5%	-3.1%	-3.0%	c
Eastern Asia (M49)	7.6	7.4	6.2	5.6	-0.3%	-3.2%	-3.3%	c
South-eastern Asia (MDG=M49)	5.2	4.3	3.8	3.7	-1.7%	-2.4%	-1.4%	c
Western Asia (M49) and Northern Africa (M49)	4.4	4.6	4.4	4.3	0.4%	-0.7%	-1.0%	c
Western Asia (M49)	4.5	4.8	4.5	4.3	0.7%	-1.3%	-1.1%	c
Northern Africa (M49)	4.2	4.1	4.2	4.1	-0.2%	0.6%	-0.5%	c
Sub-Saharan Africa (M49)	9.0	7.2	6.4	6.4	-2.3%	-2.1%	-0.1%	c
Oceania (M49)	6.0	5.2	4.6	4.3	-1.5%	-2.3%	-2.4%	c
Oceania (M49) excluding Australia and New Zealand (M49)	5.1	4.8	4.3	4.0	-0.4%	-2.2%	-2.3%	c
Australia and New Zealand (M49)	6.1	5.2	4.6	4.3	-1.5%	-2.3%	-2.5%	c
Least Developed Countries (LDCs)	7.7	5.6	5.3	5.0	-3.1%	-1.3%	-1.5%	c
Small island developing States (SIDS)	4.0	3.5	3.4	3.3	-1.1%	-0.7%	-0.6%	c
Landlocked developing countries (LLDCs)	11.5	8.1	6.4	6.5	-3.5%	-4.6%	0.9%	c
Africa (M49)	7.0	6.0	5.6	5.6	-1.6%	-1.1%	-0.3%	c
Asia (M49)	6.7	6.3	5.5	5.1	-0.6%	-2.8%	-2.7%	c
Americas (m49)	6.0	5.0	4.6	4.4	-1.8%	-1.8%	-1.4%	c
Caribbean (M49)	..	..	..	..	..	..	..	
Central America (M49)	3.6	3.6	3.3	3.0	0.2%	-2.1%	-2.8%	c
Eastern Africa (M49)	11.2	8.8	7.8	7.2	-2.4%	-2.2%	-2.6%	c
Eastern Europe (M49)	10.3	7.2	6.3	6.3	-3.5%	-2.6%	0.1%	c
Melanesia (M49)	5.0	4.8	4.3	4.0	-0.3%	-2.4%	-2.5%	c

Country / region	2000	2010	2015	2018	2000-2010	2010-2015	2015-2018	Source
Micronesia (M49)	8.0	7.6	7.2	7.4	-0.6%	-0.9%	0.5%	c
Middle Africa (M49)	6.5	5.2	5.6	5.7	-2.2%	1.4%	0.7%	c
Northern Europe (M49)	4.4	3.7	2.9	2.8	-1.8%	-4.3%	-2.0%	c
Polynesia (M49)	..	..	..	..	..	..	..	
South America (M49)	3.7	3.5	3.6	3.5	-0.7%	0.5%	-0.9%	c
Southern Africa (M49)	9.7	8.4	7.2	7.3	-1.4%	-3.1%	0.4%	c
Southern Europe (M49)	3.4	3.1	2.9	2.7	-0.8%	-1.5%	-1.4%	c
Western Africa (M49)	8.1	6.3	5.6	5.7	-2.5%	-2.3%	0.9%	c
Western Europe (M49)	4.1	3.7	3.3	3.0	-0.9%	-2.7%	-2.5%	c
Developing regions (MDG)	6.4	6.0	5.4	5.0	-0.6%	-2.2%	-2.4%	c
Developed regions (MDG)	5.8	4.9	4.3	4.2	-1.7%	-2.5%	-1.3%	c
Northern Africa (MDG)	3.9	4.0	4.2	4.1	0.2%	0.6%	-0.3%	c
Sub-Saharan Africa (MDG)	8.9	7.0	6.4	6.3	-2.4%	-2.0%	-0.2%	c
Eastern Asia (MDG)	9.8	8.4	6.9	6.1	-1.5%	-3.8%	-4.0%	c
Western Asia (MDG)	4.4	4.9	4.6	4.4	1.1%	-1.3%	-1.0%	c
Oceania (MDG)	5.1	4.8	4.3	4.0	-0.4%	-2.2%	-2.3%	c
Caucasus and Central Asia (MDG)	15.5	9.1	6.6	7.1	-5.1%	-6.4%	2.4%	c

REFERENCE
a. Source: Energy Balances, UN Statistics Division (2019)
b. Source: IEA (2019), World Energy Balances
c. Source: IEA (2019), World Energy Balances; Energy Balances, UN Statistics Division (2019)

DEFINITIONS
Energy intensity: Energy intensity is defined as the energy supplied to the economy per unit value of economic output.

SDG7.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 / region	International Commitments (2018 USD Millions)			
	2000	2010	2015	2018
Afghanistan	0.03	37.07	5.01	72.49
Algeria		0.41	0.89	0.05
Angola		0.02	0.02	0.12
Anguilla		0.05		
Antigua and Barbuda			7.29	
Argentina		1.07	111.67	497.82
Armenia		94.70	23.64	28.22
Azerbaijan	4.80	190.37	78.94	
Bahamas				0.11
Bangladesh	3.09	0.19	7.89	241.14
Barbados			0.08	0.05
Belize			0.02	16.54
Benin		0.17	583.81	1.92
Bhutan	5.10	23.25	128.23	0.12
Bolivia (Plurinational State of)	0.09	5.24	1.99	83.50
Botswana	0.03	10.07		0.01
Brazil	128.39	146.86	2.28	385.43
Burkina Faso	0.13	1.37	27.22	35.90
Burundi		13.39	2.51	10.00
Cabo Verde		71.19	3.28	
Cambodia		701.39	8.21	16.06
Cameroon		55.65	2.10	698.11
Central African Republic			9.62	3.80
Chad			0.02	
Chile	0.45	3.26	110.49	
China	247.45	78.65	93.54	325.50
Colombia		3.50	23.08	147.04
Comoros			1.00	
Congo	0.16			21.03
Cook Islands			18.41	

Country / region	International Commitments (2018 USD Millions)			
	2000	2010	2015	2018
Costa Rica	0.10	7.51	443.46	29.63
Côte d'Ivoire	14.19	0.91	0.84	31.98
Cuba	0.82	4.30	78.95	7.36
Democratic People's Republic of Korea			0.00	0.67
Democratic Republic of the Congo		0.42	0.62	0.08
Djibouti		12.69	0.92	31.00
Dominica				1.70
Dominican Republic	11.37	79.79	0.08	0.37
Ecuador	2.27	2,899.85	31.63	0.95
Egypt	10.61	1,031.20	245.03	107.86
El Salvador		57.31	78.09	59.49
Equatorial Guinea			0.02	
Eritrea		0.06	115.57	0.03
Eswatini			1.06	
Ethiopia	1.54	94.01	325.05	34.69
Fiji			1.71	6.00
Gabon		6.13	13.31	0.02
Gambia				129.23
Georgia		8.27	7.03	47.24
Ghana	4.23	24.98	62.57	28.54
Grenada			1.78	
Guatemala		9.45	0.02	11.72
Guinea	0.21		1.24	1,175.48
Guinea-Bissau		0.02		4.67
Guyana		1.20	1.49	31.05
Haiti	0.84	2.36	49.57	0.78
Honduras	34.04	131.12	373.74	85.43
India	493.09	315.53	929.76	2,133.78
Indonesia	2.31	46.92	387.78	1,076.35
Iran (Islamic Republic of)	61.11	0.00	0.20	0.07
Iraq		155.58		

Country / region	International Commitments (2018 USD Millions)			
	2000	2010	2015	2018
Jamaica	5.31	0.18	61.16	72.97
Jordan		6.77	169.58	92.06
Kazakhstan		1.39	49.28	334.02
Kenya	0.09	737.87	558.56	257.55
Kiribati		1.00		0.90
Kyrgyzstan	8.59	1.59	0.02	0.08
Lao People's Democratic Republic		10.65	87.41	401.83
Lebanon		1.72	38.04	6.44
Lesotho		0.04	0.04	69.90
Liberia			252.13	6.52
Madagascar			4.87	5.41
Malawi	6.96	14.93	62.38	16.84
Malaysia	138.61	0.14	0.18	0.05
Maldives	5.01	9.54	6.31	5.90
Mali	3.59	0.02	9.60	21.59
Marshall Islands			4.21	
Mauritania			0.12	0.01
Mauritius		2.07	9.76	
Mexico	2.41	47.98	211.11	387.84
Micronesia (Federated States of)			4.14	10.20
Mongolia	5.31	11.97	0.88	91.38
Montserrat			2.04	
Morocco	0.28	8.42	240.26	836.34
Mozambique	0.05	96.15	65.55	1.93
Myanmar		0.09	58.97	18.87
Namibia	0.11	48.33		43.70
Nauru			8.91	
Nepal	12.03	23.73	15.50	15.59
Nicaragua	0.03	134.67	68.56	20.14
Niger	0.19			29.20
Nigeria		0.58	46.76	96.64

Country / region	International Commitments (2018 USD Millions)			
	2000	2010	2015	2018
Niue			0.01	
Pakistan	0.04	268.77	4,192.78	101.09
Palau			5.27	
Panama		9.37	47.59	0.06
Papua New Guinea			8.62	0.14
Paraguay		0.09		133.00
Peru	1.11	7.96	86.23	70.94
Philippines	12.30	7.31	23.16	181.38
Residual/unallocated ODA: Central Asia and Southern Asia	3.57	17.13	53.83	23.96
Residual/unallocated ODA: Eastern and South-eastern Asia		7.12	0.56	2.77
Residual/unallocated ODA: Latin America and the Caribbean	2.34	10.34	114.53	242.85
Residual/unallocated ODA: Oceania excl. Aus. and N. Zealand		0.83	2.03	0.36
Residual/unallocated ODA: Sub-Saharan Africa	10.58	24.66	154.36	172.74
Residual/unallocated ODA: Western Asia and Northern Africa		7.48	37.90	14.43
Réunion			1.66	
Rwanda	0.15	2.19		16.14
Saint Helena			1.45	
Saint Lucia			0.01	
Samoa		0.21	0.01	
Sao Tome and Principe		0.13	0.37	
Senegal	0.16	1.11	33.14	52.95
Seychelles			0.04	
Sierra Leone		9.45		0.24
Solomon Islands			6.97	21.06
Somalia			0.33	3.47
South Africa	0.38	265.36	725.35	358.63
South Sudan			0.07	0.29
Sri Lanka	1.56	43.83	0.46	206.09
State of Palestine	0.04	1.41	23.35	37.50
Sudan		86.86	0.03	2.52
Suriname				0.29

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).

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