TRACKING SDG 7

THE ENERGY PROGRESS REPORT 2020

A joint report of the custodian agencies

International Energy Agency

IRENA
International Renewable Energy Agency

United Nations
Statistics Division

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

World Health Organization

Report designed by: Duina Reyes
Cover photo: Vincent Tremeau/World Bank

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PARTNERS

The development of the Energy Progress Report was made possible by the exceptional collaboration between the five SDG 7 custodian agencies, specially constituted in a Steering Group:

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

The Steering Group was supported by a Technical Advisory Group composed as follows:

- African Development Bank (AfDB)
- Clean Cooking Alliance
- Denmark (Ministry of Foreign Affairs)
- ENERGIA
- European Commission
- FIA Foundation
- Food and Agricultural Organization (FAO)
- Germany (Federal Ministry for Economic Cooperation and Development)
- Hivos
- International Institute for Applied Systems Analysis
- International Labour Organization (ILO)
- Islamic Development Bank
- Kenya (Ministry of Energy & Petroleum)
- Latin American Energy Organization (OLADE)
- Norway (Ministry of Foreign Affairs)
- Pakistan (Ministry of Foreign Affairs)
- Renewable Energy Policy Network for the 21ST Century (REN 21)
- Sustainable Energy for All (SEforALL)
- TERI School of Advanced Studies
- The Netherlands (Ministry of Foreign Affairs)
- The United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN -OHRLLS)
- UAE (Ministry of Foreign Affairs)
- United Nations Association of China
- United Nations Children's Fund (UNICEF)
- United Nations Department of Economics and Social Affairs (UN DESA)
- United Nations Development Programme (UNDP)
- United Nations Economic Commission for Africa (UNECA)
- United Nations Economic Commission for Asia and the Pacific (ESCAP)
- United Nations Economic Commission for Latin America and the Caribbean (ECLAC)
- United Nations Economic Commission for Western Asia (ESCWA)
- United Nations Economic Programme for Europe (UNECE)
- United Nations Environment Programme (UNEP)
- United Nations Framework Convention on Climate Change (UNFCCC)
- United Nations Human Settlements Programme (UN-Habitat)
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The Steering Group's work for the 2020 edition of the report was chaired by IRENA and made possible by agreement among the senior management of the member agencies. Fatih Birol (IEA), Francesco La Camera (IRENA), Stefan Schweinfest (UNSD), Riccardo Puliti (World Bank), and Maria Neira (WHO) with Rohit Khanna (ESMAP) oversaw the development of the Energy Progress Report in collaboration with Minoru Takada (UNDESA). The technical co-leadership of the project by the custodian agencies was the responsibility of Laura Cozzi (IEA), Rabia Ferroukhi (IRENA), Leonardo Souza (UNSD), Elisa Portale (World Bank), and Heather Adair-Rohani (World Health Organization).

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CONTENTS

EXECUTIVE SUMMARY

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The 2020 edition of *Tracking SDG 7: The Energy Progress Report* monitors and assesses attainments in the global quest for universal access to affordable, reliable, sustainable, and modern energy by 2030. The latest available data and select energy scenarios are set forth in this year's report, which finds that although the world continues to advance toward SDG 7, its efforts fall well short of the scale required to reach the goal by 2030.

The data and analyses presented in these pages were prepared before the covid-19 pandemic and must be viewed in the light of this unprecedented crisis. Like most grave crises, the covid-19 pandemic shows how an unforeseen global calamity can disrupt trends and policies of long standing, with outcomes both expected and unpredictable, dire and surprising. With its widespread impact on societies and economies at all levels, including plummeting oil prices, disrupted supply chains, and the limited ability of many households and businesses to pay for electricity services, the pandemic is certain to affect the energy transition and progress toward SDG 7. At the same time, the crisis is pointing to the urgent need for access to reliable, affordable, sustainable, and modern energy—for hospitals and health facilities to treat patients, for schools to prepare children for the digital economy, for communities to pump clean water, and for people to gain access to information. The full impact of the covid-19 pandemic on energy access, energy efficiency, renewable energy deployment, and the full energy transition remains to be seen.

In response to the pandemic, countries around the world will have to take exceptional measures to bring the health emergency under control, limit its human toll, and avoid deep recession. Under such circumstances, countries have an opportunity to consider options for economic stimulus that not only respond to the immediate crisis, but also ensure longer-term social, economic, and environmental sustainability. At the heart of such objectives is access to modern energy, with its immense potential to spur the achievement also of other Sustainable Development Goals and global climate objectives. The SDG 7 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)—therefore urge the international community and policy-makers to safeguard the gains already attained for SDG 7 and not lose sight of the need to continue action on affordable, reliable, sustainable, and modern energy for all.

According to the custodian agencies, the latest data on progress toward SDG 7, before the onset of the pandemic, demonstrated that stepped-up efforts toward all targets were urgently required if SDG 7 was to be met within the coming decade. Even greater efforts will be needed to meet the SDG 7 targets in a post covid-19 world.

Universal access. SDG target 7.1 is universal access to affordable, reliable, sustainable, and modern energy services; with 7.1.1 focusing on access to electricity and 7.1.2 focusing on access to clean cooking solutions. Recent years have seen rapid growth in access to electricity after an accelerated deployment of affordable electrification options, including on- and off-grid solutions. As a result, the global population lacking access to electricity dropped to 789 million in 2018, from 1.2 billion in 2010 (Figure ES.1). By contrast, the global population without access to clean cooking solutions remained largely unchanged during the same period, standing at close to 3 billion. The rate of increase in access to clean cooking has even decelerated since 2012, falling behind population growth in some countries. Increased efforts are needed to ensure universal access to both electricity and clean cooking, consistent with SDG target 7.1.

Renewable energy. Target 7.2 aims to increase substantially the share of renewable energy in the global energy mix. That share continued to increase in 2017 (+ 0.1 percentage points), although at a slower pace than the year before (+ 0.2 percentage points), reaching 17.3 percent of total final energy consumption (TFEC) in 2017, up from 17.2 percent in 2016 and 16.3 percent in 2010. Solar PV and wind are key drivers behind the fast-growing share of renewables in the generation of electricity. But renewables' share in the heating and transportation sectors lags far behind its potential. An acceleration of renewables in all sectors will be needed to achieve target 7.2.

FIGURE ES.1 • **Latest data on primary indicators of global progress toward SDG 7 targets**

2010	Latest year
1.2 billion people without access to electricity	**789 million** people without access to electricity (2018)
3 billion people without access to clean cooking	**2.8 billion** people without access to clean cooking (2018)
16.3% share of total final energy consumption from renewables	**17.3%** share of total final energy consumption from renewables (2017)
5.9 MJ/USD primary energy intensity	**5.0 MJ/USD** primary energy intensity (2017)
10.1 USD billion international financial flows to developing countries in support of clean energy	**21.4 USD billion** international financial flows to developing countries in support of clean energy (2017)

Energy efficiency. SDG target 7.3 is to double the global rate of improvement in energy efficiency by 2030, over the trend observed between 1990 and 2010, which was 1.3 percent. Global primary energy intensity, defined as total primary energy supply per unit of GDP, reached 5.0 megajoules per USD dollar in 2017, equivalent to a 1.7 percent rate of improvement from 2016—the lowest since 2010. Preliminary estimates for 2018 (1.3 percent) and 2019 (2 percent) suggest that the improvement rate would reach approximately 2.1 percent between 2010-2019 which is lower than the required 2.6 percent annual target rate for the years between 2010 and 2030. Consequently, achieving the goal will require an energy intensity improvement rate of at least 3 percent per year from now through to 2030—a challenging proposition.

International public finance. Finally, target 7.A is to promote access to technology and investments in clean energy, with 7.A.1 focusing on international public financial flows to developing countries in support of clean and renewable energy. Total flows reached USD 21.4 billion in 2017, double the level of 2010. Although this is a promising increase, only 12 percent of financial flows in 2017 reached the least-developed countries, which are the furthest from achieving the various SDG 7 targets. Increased efforts are needed to make sure finance reaches the countries most in need.

* * *

In addition to reviewing progress toward SDG 7 targets, this report identifies best practices, policies, and measures to accelerate progress while supporting the achievement of other SDGs. The chapters that follow include boxes that identify the linkages between SDG 7 and other SDGs. The report also describes the results of global modeling exercises conducted by IEA and IRENA to determine whether current—which is to say, pre-covid-19—policy ambitions are sufficient to meet the SDG 7 targets and, if they are not, what additional actions are needed for success. The final chapter of the report contains an overview of indicators and suggests ways to further improve the underlying data and the tracking of advances.

ACCESS TO ELECTRICITY

The share of the global population with access to electricity increased from 83 percent in 2010 to 90 percent in 2018, enabling more than a billion people to gain access during the period. The population still without access to electricity was 789 million in 2018, down from 1.2 billion in 2010.

The global advance of electrification accelerated slightly in recent years, rising from an average of 0.77 percentage points annually between 2010 and 2016 (127 million people/year) to 0.82 percentage points between 2016 and 2018 (136 million people/year). These numbers nevertheless fall short of the gains needed to achieve the goal of universal access to electricity by 2030. Annual increases of at least 0.87 percentage points would be required to meet the target. Under current and planned policies before the start of the COVID-19 crisis, it is estimated that about 620 million people will remain without access in 2030, 85 percent of them in Sub-Saharan Africa.

The global advance in access to electricity since 2010 masks unequal progress across regions (Figure ES.2). Latin America and the Caribbean and Eastern Asia and South-eastern Asia approached universal access, exceeding 98 percent access to electricity by 2018. In Central Asia and Southern Asia, more than 92 percent of the population had gained access to electricity by 2018. The world's access deficit is increasingly concentrated in Sub-Saharan Africa, where the access rate climbed from 34 percent in 2010 to 47 percent in 2018. After 2010, access advances in Sub-Saharan Africa outpaced population growth, but the trend reversed recently. Between 2016 and 2018, the number of people in the region lacking access remained almost stable.

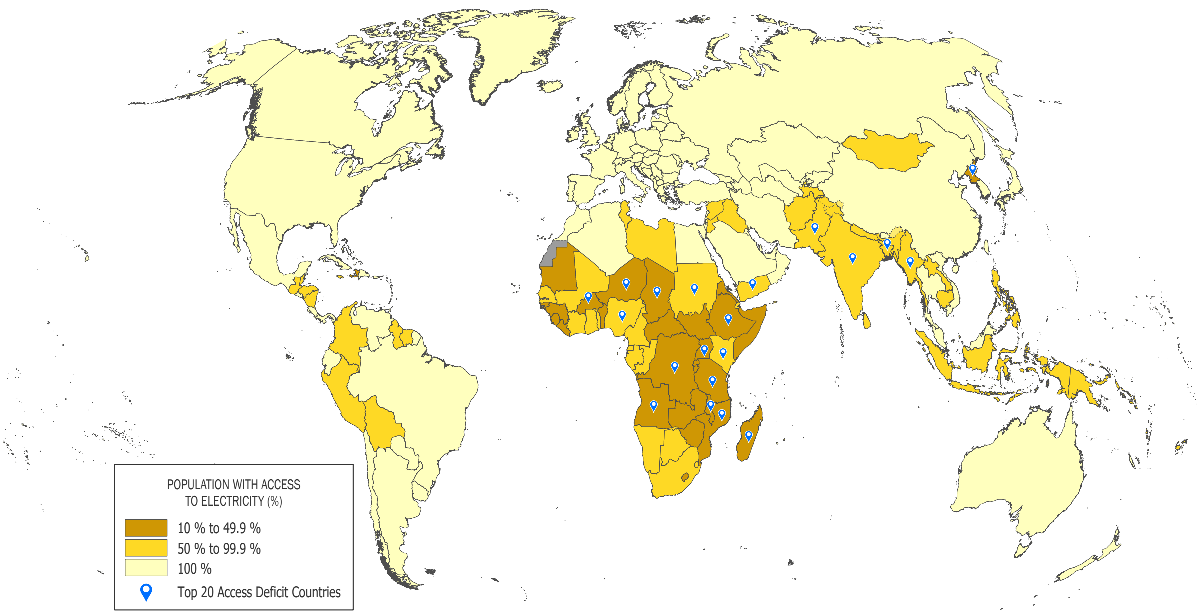
At the country level, the 20 countries with the largest access deficits accounted for 78 percent of the total population without access to electricity in 2018 (Figure ES.3). Nigeria, the Democratic Republic of Congo (DRC), and India had the three largest deficits: 85 million, 68 million, and 64 million people, respectively. Among the 20 countries with the largest access deficits, Bangladesh, Kenya, and Uganda showed the greatest improvement since 2010, thanks to average annual electrification growth rates in excess of 3.5 percentage points. These three countries were among eight of the 20 countries where the expansion of access to electricity kept pace with population growth between 2010 and 2018. The other five were India, Democratic People's Republic of Korea, Myanmar, Sudan, and Tanzania.

Major disparities in access to electricity are also seen between urban and rural areas. In 2018, the unserved rural population of 668 million made up 85 percent of the global access deficit. Between 2010 and 2018, access to electricity in rural areas grew from 70 percent to 80 percent. In urban areas, access is already close to universal (97 percent in 2018), but growth in access barely kept up with population growth.

In several countries, expanded off-grid solutions have brought improved access to rural areas. By 2018, renewable off-grid technologies were providing below Tier 1 electricity services to 136 million people around the world, compared with about 1 million people in 2010. These services were provided primarily through standalone home systems and solar lighting, with mini grids having grown from a niche solution to being widely deployed in off-grid areas that offer sufficient demand.

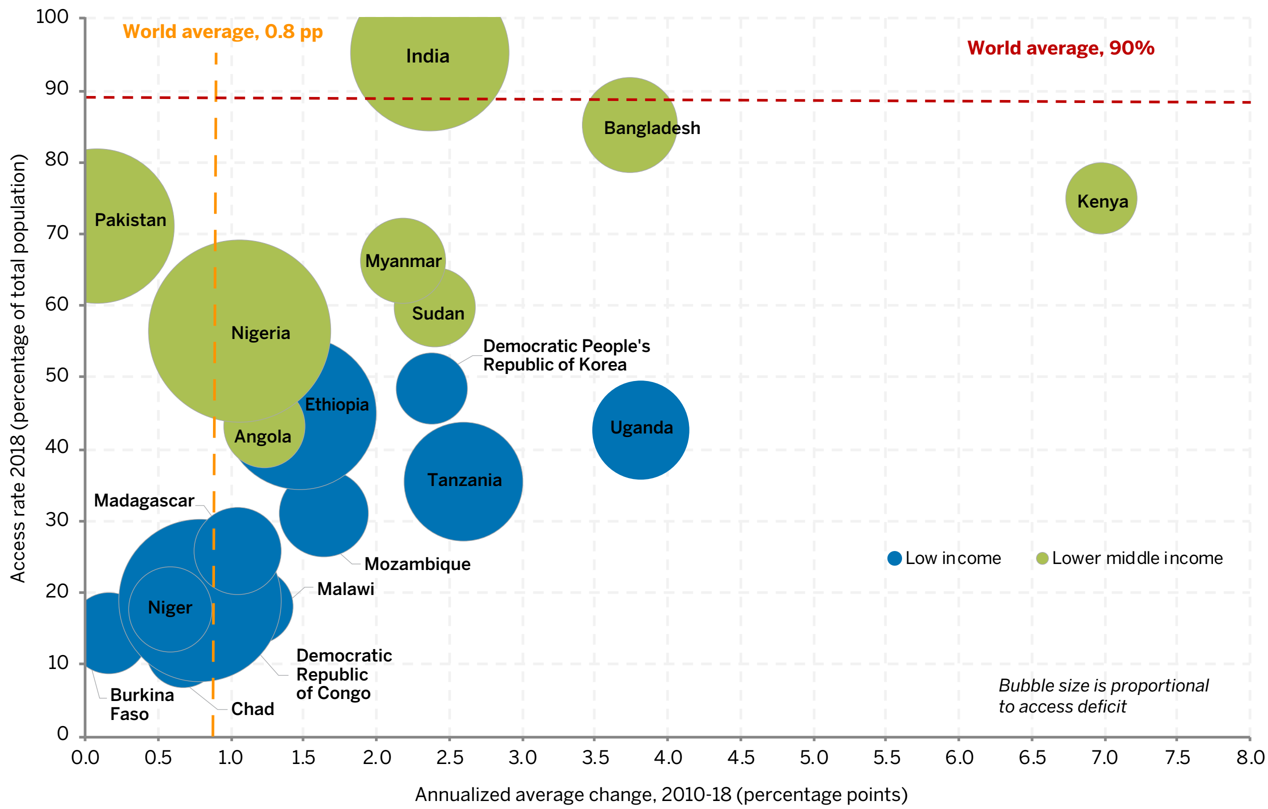
Closing the access gap, particularly in Sub-Saharan Africa, will require concerted efforts. Policy frameworks will require consistent updates and enforcement to support innovation, such as off-grid solutions and newer business models. Geospatial analysis undertaken to determine how universal access can be achieved at the least cost show the need for integrated policies embracing both centralized and decentralized solutions. With significant potential to advance on other SDGs—such as on gender, health, and education—access strategies will succeed only if the technical elements outlined above take an inclusive approach that leaves no one behind and maximizes the socioeconomic benefits of electricity. While the world is coping with the covid-19 pandemic, it is critical to ensure that past gains in electrification are safeguarded. It might require collective support for utilities, mini grid and off-grid service providers to continue serving their current clients and allow for future expansion.

FIGURE ES.2 • Share of population with access to electricity in 2018



Source: World Bank.

FIGURE ES.3 • The 20 countries with the largest access deficit, 2010–18



Source: World Bank.
Note: A country's "access deficit" is the number of people in the country who lack access to electricity.

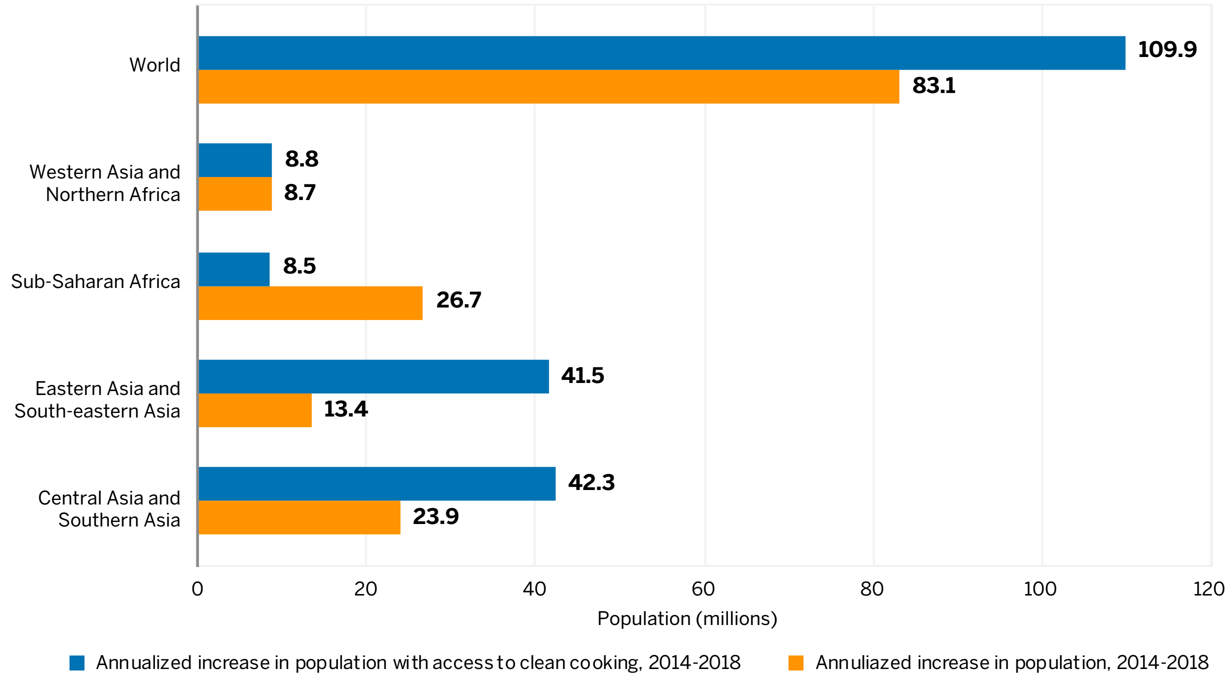
ACCESS TO CLEAN COOKING SOLUTIONS

The share of the global population with access to clean fuels and technologies for cooking increased from 56 percent in 2010 (uncertainty interval 52–61 percent) to 63 percent in 2018 (56–68), leaving approximately 2.8 billion people without access.[1] That number has been largely unchanged over the past two decades owing to population growth outpacing the number of people gaining access to clean cooking solutions.

To achieve the goal of universal access to clean fuels and technologies for cooking, increases of at least 3 percentage points annually would have been needed between 2010 and 2030. Between 2010 and 2018, however, access expanded at an annualized average of just 0.8 percentage points (–0.2, 1.7) and has steadily slowed since 2012 (to 0.7 percentage points in 2017 and 2018)—far from the numbers needed to reach the target.

The stagnation in the number of people lacking access to clean cooking globally masks regional trends (Figure ES.4). Promising improvements were made in Eastern Asia and South-eastern Asia, and in Central Asia and Southern Asia, but Sub-Saharan Africa moved in the opposite direction, as population growth between 2014 and 2018 outstripped growth in access by an average of 18 million people a year.

FIGURE ES.4 • Annualized increase in population and in the number of people having access to clean cooking over the period 2014–18, by region



Source: WHO; UN population estimates were used.

The top 20 countries with the largest populations lacking access to clean cooking fuel and technologies accounted for 82 percent of the global population without access between 2014 and 2018.[2] Nineteen of the top 20 countries with the lowest access shares are among the world's least-developed countries, and most of them are in Africa. These countries increased access by less than 0.1 percentage points annually; in some, access shrank. These trends have combined to cause access to stagnate in Sub-Saharan Africa, with annualized increases of just 0.4 percentage points for the

1 Fuels and technologies considered clean are determined based on the 2014 WHO guidelines for indoor air pollution from household fuel combustion. These include electricity, liquefied petroleum gas (LPG), natural gas, biogas, solar, and alcohol fuel stoves.

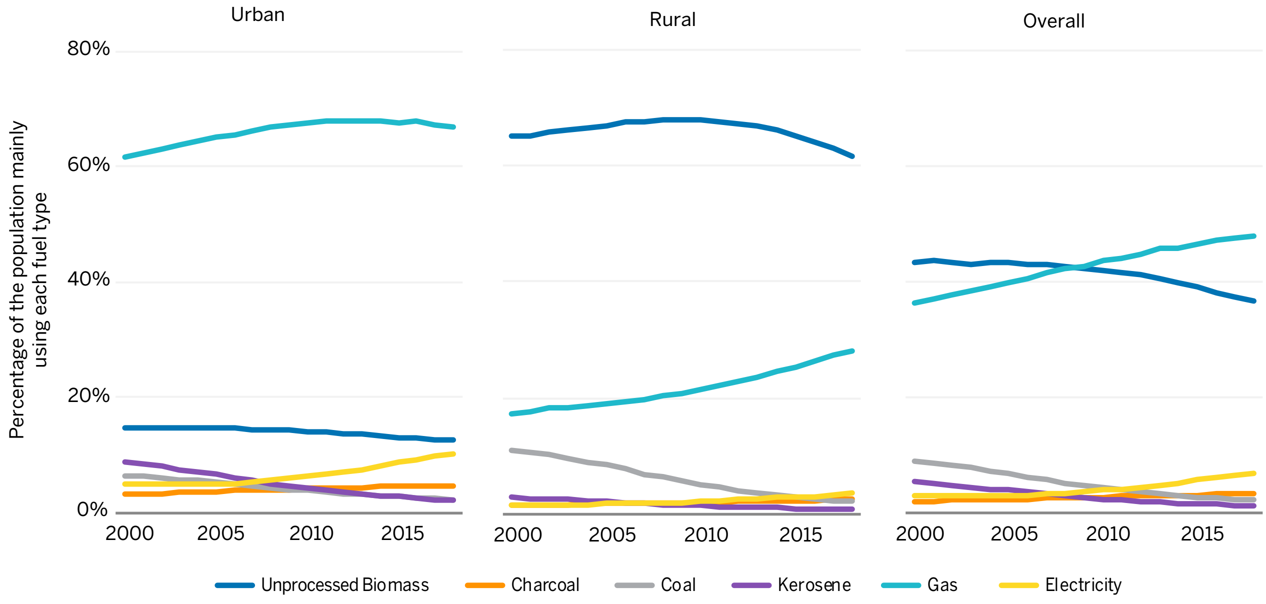
2 The top 20 access-deficit countries are the 20 countries with the highest access-deficit population: Afghanistan, Bangladesh, China, Democratic People's Republic of Korea, Democratic Republic of the Congo, Ethiopia, Ghana, India, Indonesia, Kenya, Madagascar, Mozambique, Myanmar, Nigeria, Pakistan, Philippines, Sudan, Uganda, United Republic of Tanzania, and Viet Nam.

region between 2010 and 2018. Comparatively, the most significant progress in access to clean cooking fuels was seen in Asia, where annualized increases stood at 1.6 percentage points for Eastern Asia and South-eastern Asia, and 1.5 percentage points for Central Asia and Southern Asia.

Significant variations in access to clean cooking also exist between urban and rural areas owing to disparities in infrastructure and in availability of clean fuels and technologies. In 2018, access to clean cooking solutions stood at 83 percent (76–87) in urban areas, and at 37 percent (30–45) for rural areas. A slight convergence has been observed, with disparity falling from 52 percentage points in 2010 to 46 percentage points in 2018. This can be attributed to accelerated progress in access in rural areas (in particular in Asia), in conjunction with population growth outpacing access growth in urban areas, particularly in Africa).

As illustrated in Figure ES.5, in low- and middle-income countries, gas (LPG, natural gas, and biogas) has overtaken unprocessed biomass as the dominant fuel since 2010, reflecting its predominance in urban areas. In urban areas, the use of electricity for cooking has also risen. In rural areas, unprocessed biomass remains dominant, though its share is falling.

FIGURE ES.5 • Percentage of people using each cooking fuel type in low- and middle- income countries, for urban areas, rural areas, and overall, 2000–18



Source: WHO Global Household Energy Model.

Among all the SDG 7 targets, slow progress toward clean cooking perhaps presents the greatest cause for concern. Under current and planned policies, 2.3 billion people would still be deprived of access to clean cooking fuels and technologies in 2030, relying instead on traditional uses of biomass, kerosene, or coal as their primary cooking fuel. This means that nearly a third of the world's population will continue to be exposed to harmful household air pollution, and many will still be spending many hours gathering fuel. As cooks and fuel gatherers, women and their children are disproportionately susceptible to these negative effects.

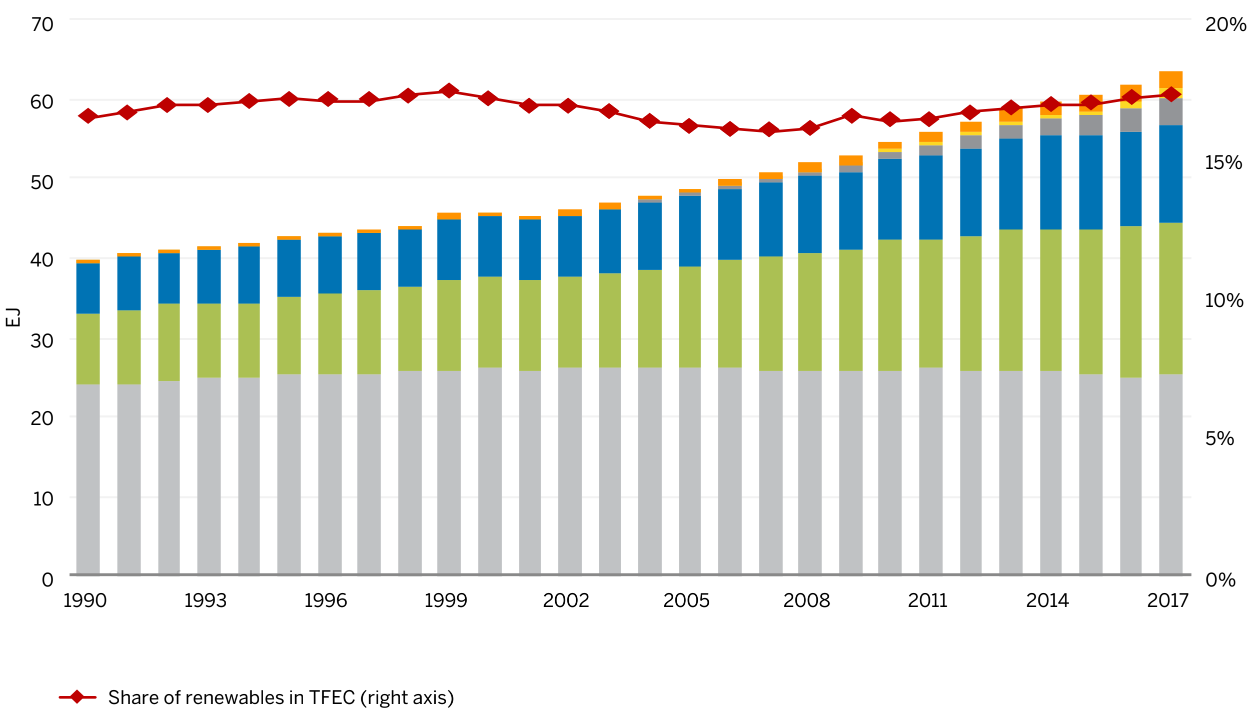
Acceleration of access to clean cooking solutions will require high-level political commitment, ambitious national and subnational strategies, and an urgent mobilization of investment. Designing and implementing successful commitments and strategies in turn requires a detailed understanding of the current state and patterns of household energy use. To achieve this, household surveys must become more comprehensive. In addition to gathering data on grid connectivity, they should cover off-grid options, impacts on children and women, and all the household fuels and technologies in use for cooking, space heating, and lighting. In recognition of these shortcomings, and to support countries in this process, WHO and ESMAP at the World Bank have developed a new set of household survey questions. Designed and tested, these survey questions are available for countries to use to better assess the attributes and impacts of household energy use for evidence-based decision-making and effective monitoring of household energy use.

RENEWABLE ENERGY

The share of renewable energy in TFEC reached 17.3 percent in 2017, up from 17.2 percent in 2016 and 16.3 percent in 2010 (Figure ES.6).[3] This indicates that global use of renewables has grown faster (at 2.5 percent in 2017) than overall global energy consumption (1.8 percent in 2017), extending a trend seen since 2011. The growth of renewables is driven primarily by increased consumption of modern renewables (that is, renewables other than traditional uses of biomass). Modern renewables commanded a 10.5 percent share of TFEC in 2017, up from 10.3 percent in 2016 and 8.6 percent in 2010.

The largest increase in the use of renewables has come in the power sector, where their share of global electricity consumption reached 24.7 percent in 2017, surpassing the share of renewables in the heating sector for the first time. The growth rate of almost 6 percent year-on-year was driven primarily by solar PV and wind energy. Lower hydropower output (and other factors) slowed the growth rate in 2017, sending it below the record 8 percent growth reached in 2016. The share of renewables in the heating sector reached 23.5 percent of total final heat consumption in 2017. This growth can be primarily attributed to uses of modern renewable energy; traditional uses of biomass remained relatively unchanged in 2017, still accounting for around 14 percent of global heat consumption. In the transport sector, the share of renewables remained at 3.3 percent in 2017, the majority of which was consumed in the form of liquid biofuels, predominantly crop-based ethanol and biodiesel. In 2017, the consumption of renewable electricity in the transport sector represented only 0.3 percent of the sector's total energy consumption worldwide.

FIGURE ES.6 • Renewable energy consumption by technology and share in total final energy consumption (TFEC), 1990–2017



Source: International Energy Agency (https://www.iea.org/data-and-statistics) and United Nations Statistics Division (https://unstats.un.org/unsd/energystats/).

3 The share of renewables in TFEC was previously previously stated as 17.5 percent in 2016. This has been amended to 17.2 percent in this report. Data revisions by countries in 2020 reflected a fall in solid biomass and charcoal consumption between 2000 to 2016, resulting in a decline in the share of renewables globally in the historical time series.

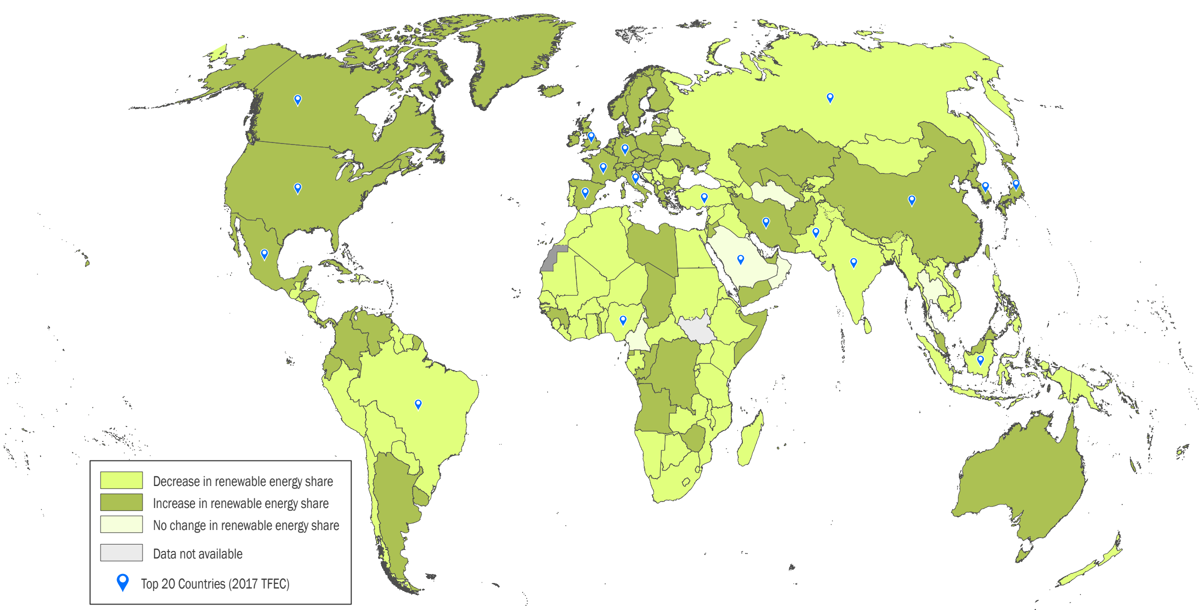
Important regional differences should be noted. Sub-Saharan Africa had by far the highest share of renewable energy in TFEC for 2017. However, reliance on traditional uses of biomass in the region accounts for almost 85 percent of its renewable energy consumption and, as already observed, is associated with adverse health and environmental effects. Owing to the extensive use of modern bioenergy across the power, heat, and transport sectors, in addition to the region's reliance on hydropower to generate electricity, Latin America and the Caribbean had the largest share of modern renewables among all regions.

At the national level, the share of renewable consumption in TFEC varies widely, depending on resource availability, policy support, and the impact of energy efficiency on growth in energy demand. Between 2010 and 2017, 13 of the world's 20 largest energy consumers expanded their share of renewables (including traditional uses of biomass) (Figure ES.7). The United Kingdom tripled its renewable share in its TFEC. Among the largest 20 energy consuming countries, Brazil was the leader, with a 45 percent share of modern renewables, followed by Canada at 23 percent. China remains by far the largest consumer of renewables in absolute terms; its share in 2017 stood at 13 percent. In several countries, the decrease in total renewable energy share was also driven by reduced traditional uses of biomass.

To boost the share of renewables in energy consumption to a level sufficient to achieve SDG 7 by 2030 and to meet global climate objectives, most long-term energy scenarios point toward decarbonization of all end uses, particularly through increased electrification of the heat and transport sectors. With the right policy support, IEA's Sustainable Development Scenario shows that modern renewables could reach a share of 23 percent of TFEC by 2030, supplying 50 percent of electricity generation. IRENA's Transforming Energy Scenario for 2030 lays out a path toward even higher shares of modern renewables: 28 percent overall and 57 percent of electricity generation.

Policies and measures to support the deployment of renewable energy are becoming increasingly common around the world. In particular, the use of auctions to set electricity tariffs competitively has gained popularity since 2014, owing chiefly to the ability of well-designed auctions to procure renewables-based electricity at the lowest price while also fulfilling other social and economic aims of the sponsoring country such as job creation and development of a local industry. By 2018, more than 106 countries had held a renewable energy auction at some point in time. With the right policies in place, a hike in renewables would be instrumental in advancing not only SDG 7 but also other SDGs, such as SDG 8 on decent jobs. IRENA's analysis shows that the number of renewable energy jobs worldwide expanded from 7.3 million in 2012 to 11 million in 2018; and may further triple by 2030.

FIGURE ES.7 • Change in share of renewable energy in total final energy consumption between 2010 and 2017



TFEC = Total final energy consumption.

Source: International Energy Agency (https://www.iea.org/data-and-statistics) and United Nations Statistics Division (https://unstats.un.org/unsd/energystats/).

ENERGY EFFICIENCY

Rates of improvement in global primary energy intensity (total primary energy supply per unit of gross domestic product) have fallen in the past few years, following a period of relative steady growth. Global primary energy intensity in 2017 was 5.01 megajoules per USD dollar, equivalent to a 1.7 percent rate of improvement since 2016, the lowest rate since 2010. Nevertheless, recent progress has been greater than historical trends, thanks in part to a range of energy efficiency policies adopted around the world. The average annual rate of improvement in global primary energy intensity between 2010 and 2017 was 2.2 percent, more than the historical rate of 1.3 percent between 1990 and 2010. To reach the SDG 7.3 target (by doubling the historic improvement trend), the annual improvement to 2030 would need to average 3 percent in the years between 2017 and 2030.

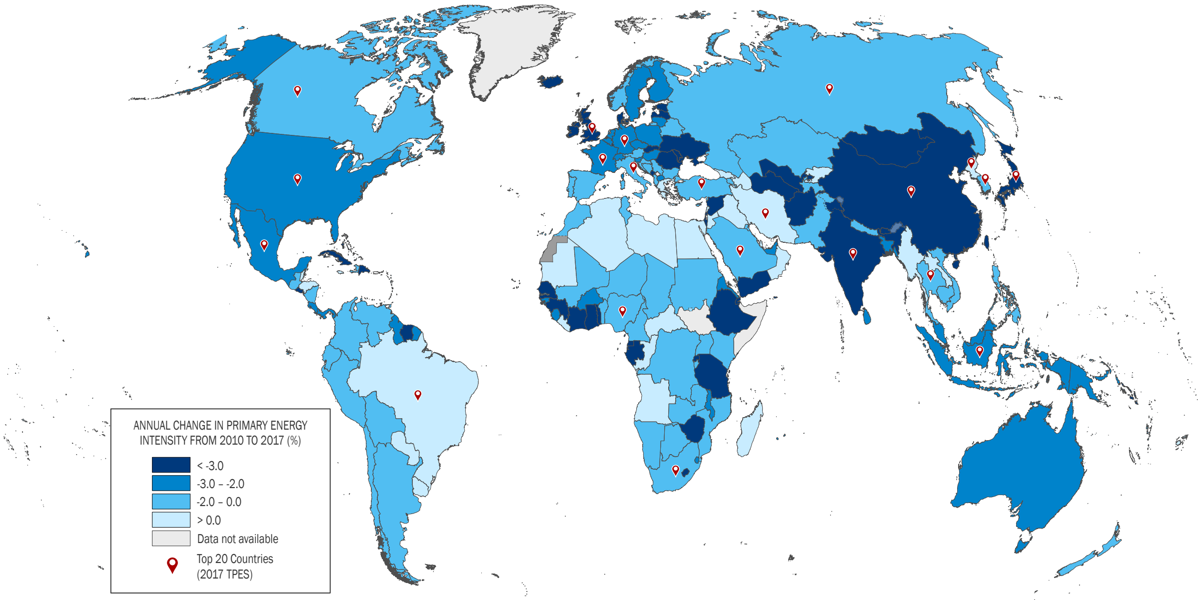
Although energy intensity across all end-use sectors improved in aggregate over the 2010–17 period, improvement rates varied by sector. It is possible to examine the intensity of the sectors using other intensity metrics. These intensity figures show that transport (freight and passenger) improved during 2010–17, whereas the other sectors show a decrease in intensity improvement over the previous period (1990–2010). The decline in the rate of improvement is most noticeable in the services and agriculture sectors, where the rate of improvement in energy intensity more than halved. The industrial sector's rate of improvement dropped by about a third. Driving this pattern are the substantial improvements in energy intensity recorded in emerging economies between 1990 and 2010, which slipped between 2010 and 2017.

Significant geographical differences also exist in energy intensity and recent improvements. Sub-Saharan Africa is the most energy-intensive region; Latin America and the Caribbean the least. Between 2010 and 2017, energy-intensity improvements continued to be highest in Asia; most countries in the region saw rates of improvement in energy intensity that were higher than during 1990–2010 and well above the global average (e.g., 3.3 percent in Eastern Asia and South-eastern Asia). The lowest rates of improvement were found in Latin America and the Caribbean (0.5%), Northern Africa (0.4 percent) and the Middle East (0.3 percent) (Figure ES.8).

With the recent slowdown in the rate of improvement of energy intensity, the world is slackening the pace required to meet the SDG 7.3 target, which is to double the global rate of improvement in energy efficiency by 2030. As such, it is forgoing various benefits. For example, if the world had stayed on track for the target, it could have consumed less energy or generated more economic value. And if the world had achieved the target level of intensity for the energy consumed between 2011 and 2017, global GDP would have been USD 2 trillion per year higher.

By making energy-efficiency measures a policy and investment priority, governments can help the world achieve SDG 7.3 by 2030. There are numerous examples around the world of successfully implemented policies, ranging from minimum energy-efficiency standards, financial incentives, market-based mechanisms, capacity-building initiatives, and regulatory instruments. All of these encourage investment in efficiency measures and help to rebalance energy markets in favor of cleaner, more efficient operations. Analysis shows that regulatory measures that mandate energy savings cover only about a third of global energy use. Furthermore, effort will be be needed to harness new digital technologies so that they increase energy efficiency rather than just add to global energy demand. With the right policies in place—ones that maximize the potential of energy efficiency—IEA's Sustainable Development Scenario shows that an annual average rate of improvement in energy intensity of 3.6 percent between 2017 and 2030 is indeed possible (Figure ES.9).

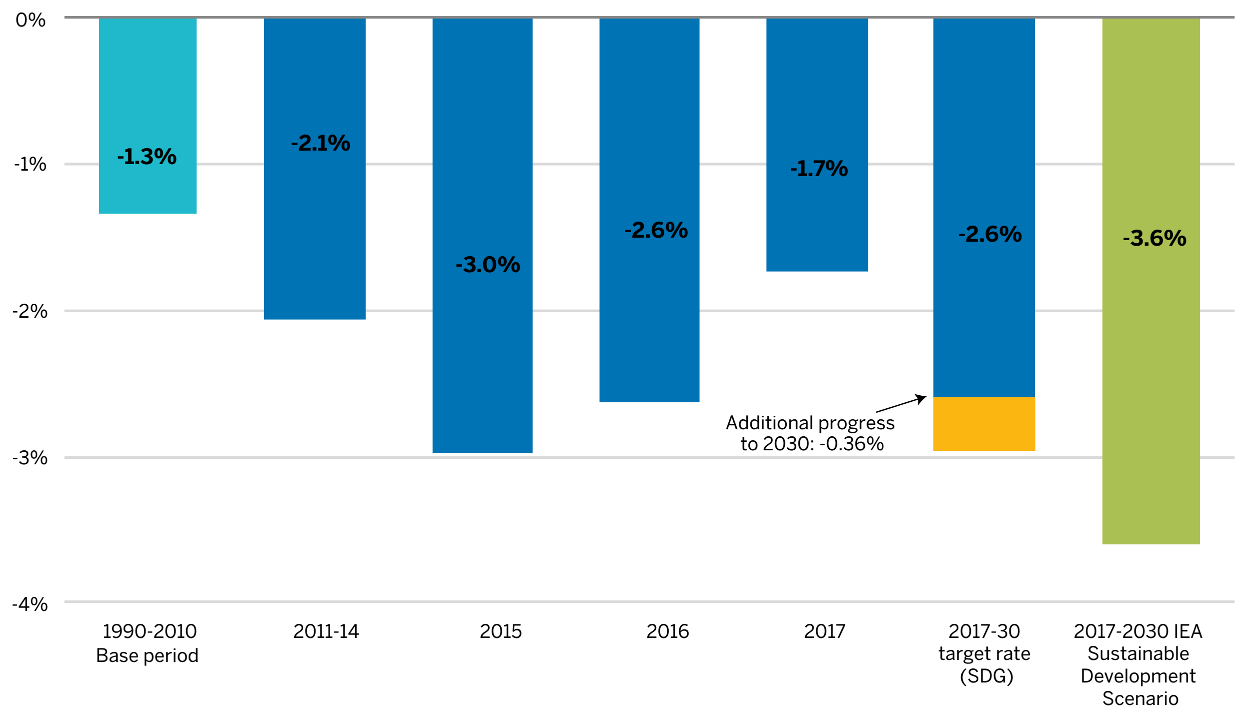
FIGURE ES.8 • Compound annual average growth rate of primary energy intensity, 2010–17



TPES = Total primary energy supply.

Source: International Energy Agency (https://www.iea.org/data-and-statistics) and United Nations Statistics Division (https://unstats.un.org/unsd/energystats/).

FIGURE ES.9 • Annual growth rate of primary energy intensity by period, target rate for 2017–30, and potential for 2017–30 in IEA Sustainable Development Scenario



Source: International Energy Agency (https://www.iea.org/data-and-statistics) and United Nations Statistics Division (https://unstats.un.org/unsd/energystats/).

TRACKING PROGRESS ACROSS TARGETS: INDICATORS AND DATA

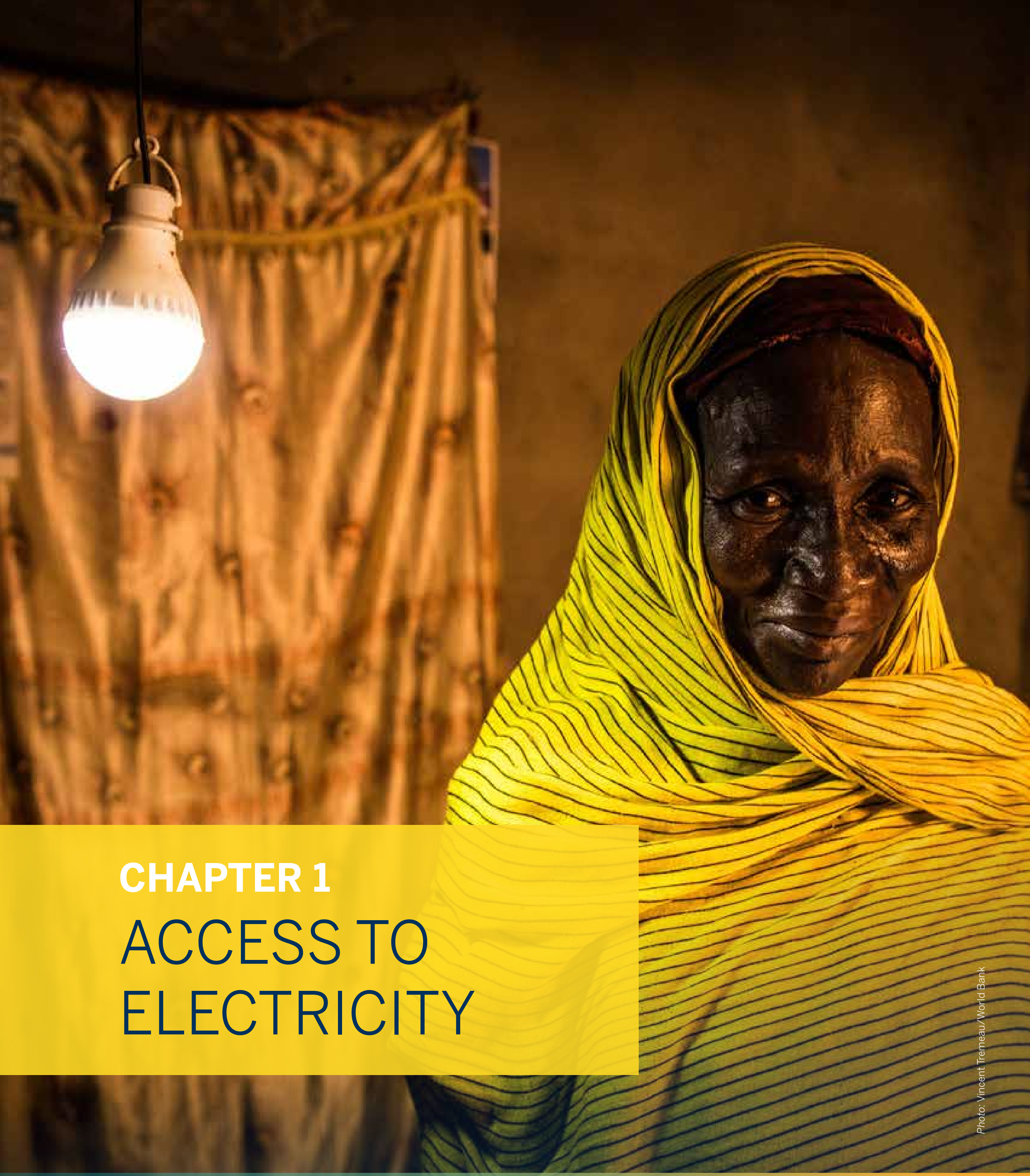
Each target is monitored using one or more proxy indicators, in line with the SDG framework devised by the UNSD.[4] For example, progress in access is monitored both through the proportion of the population having access to electricity and the proportion relying primarily on clean fuels and technologies. Similarly, progress in energy efficiency is monitored through the energy intensity of the economy, measured in terms of primary energy and GDP.

Chapter 6 provides the set of global SDG 7 tracking indicators by country for selected years, preceded by a brief description of the underlying data work of the custodian agencies. International organizations typically collect and validate data from national administrations; they then further elaborate the data into indicators, adopting consistent methodologies that ensure comparability across countries. (Indicators derived according to international methodologies represent global benchmark compilations and are not intended to replace national indicators.)

The work of tracking SDG 7 highlights once more the need for quality data to inform policy at the national, regional, and international levels, as well as the opportunity to enhance data quality through international cooperation to further strengthen national capacities. Through a variety of projects worldwide, the custodian agencies actively promote the development of statistical capacity across countries.

Finally, authors from the custodian agencies would like to acknowledge the work and dedication of all their colleagues working to collect energy data across national administrations worldwide. It is they who make possible the international tracking work reflected in this report.

4 The latest full list of targets, indicators, and custodian agencies is available at: https://unstats.un.org/sdgs/files/Tier-Classification-of-SDG-Indicators-11-December-2019-web.pdf



CHAPTER 1
ACCESS TO ELECTRICITY

Photo: Vincent Tremeau/World Bank

MAIN MESSAGES

- **The global trend:** The world has made striking progress over the past decade—far more than in previous decades—in increasing access to electricity. The share of the world's population having access to electricity grew from 83 percent in 2010 to 90 percent in 2018,[5] an increase of more than a billion people. During this period, the number of people without access to electricity fell from about 1.2 billion to 789 million, outpacing the overall increase in population. Trends from 2016 to 2018 show accelerated electrification (with the average annual rate of electrification increasing to 0.82 percentage points) compared with 2010–16 (0.77 points).[6]
- **Target for 2030:** Despite accelerated progress in recent years, the world will fall short of SDG indicator 7.1.1, which aims for 100 percent access to electricity by 2030, if the current rate is maintained. Due to the many challenges facing access-deficit countries, the latest projection shows that about 620 million people would still lack access to electricity in 2030 (IEA 2019b). To close the gap, the annual rate of electrification would have to rise from the current 0.82 percentage points to 0.87 percentage points for the years 2019 to 2030. Moreover, this projection does not account for the disruptions of covid-19. These have not yet been quantified, but they will likely affect electrification, slowing and in some cases even reversing advances (e.g., as utilities and off-grid service providers face financial difficulties). Governments, hand in hand with the international community, should be prepared to mitigate these adverse effects to safeguard the gains in access.
- **Regional highlights:** The global advance in access to electricity since 2010 masks unequal progress across regions, with attention now focusing on Sub-Saharan Africa.[7] Latin America and the Caribbean and Eastern Asia and South-eastern Asia approached universal access, exceeding 98 percent access to electricity by 2018. In Central Asia and Southern Asia, more than 92 percent of the population had access by 2018. The world's access deficit is increasingly concentrated in Sub-Saharan Africa, which, in 2018, was home to about 548 million people who lacked access—more than half of the region's population and nearly 70 percent of the global population without access. After 2010, access advances in Sub-Saharan Africa outpaced population growth, but the trend has reversed recently. Between 2016 and 2018, the number of people in the region lacking access remained almost stable.
- **Urban-rural distribution in access:** Rural populations made up about 85 percent (668 million people) of the global access deficit in 2018. But, since 2010, they have seen more progress than the urban deficit populations. Globally, the access rate in rural areas grew from about 70 percent in 2010 to 80 percent in 2018. During the same period, the rate of urban electrification grew from 95 to 97 percent. While approaching universal access, urban electrification nevertheless faces policy and technical challenges. The obstacles to supplying electricity to surging urban populations have slowed gains since 2010. Unstable distribution networks have made it difficult to connect pockets of people in urban cores and in sprawling settlements that ring large cities. In the coming years, the access rate is more likely to advance in rural areas than in cities.

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5 Access to electricity (also referred to as "electrification" or "electrification rate" in the report) refers to the share of the population with access to electricity out of the total population in the 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 have been conducted (about 20 countries), access to electricity service at the equivalent of Tier 1 and above (Tier 1+) is considered (ESMAP 2015). Otherwise, electricity access is calculated through binary measurements in existing household surveys, such as the DHS and LSMS (World Bank and IEA 2017). The number of people who gained access between 2010 and 2018 is 1.037 billion.

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

7 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/); in chapter 5, the report uses IEA's World Energy Outlook classifications.

- **The top 20 countries with access deficits:** In 2018, 20 countries accounted for 617 million people without access—78 percent of the worldwide deficit in that year. Achieving universal access will require sustained efforts to bridge electrification gaps in these countries. Nigeria and the Democratic Republic of Congo had the world's largest access deficits in 2018, with 85 and 68 million people, respectively, lacking access. India was third with about 64 million people. Over the 2010–18 period, electrification efforts in Nigeria and the Democratic Republic of Congo (DRC) lost ground to population growth, leading to net increases of 3 million and 12 million people, respectively, lacking access to electricity by 2018. Among the 20 largest access-deficit countries, Bangladesh, Kenya, and Uganda showed the most improvement since 2010. Expansion of access kept pace with population growth in just 8 of the 20 countries during the period; in addition to the three just mentioned, those countries were India, Democratic People's Republic of Korea, Myanmar, Sudan, and Tanzania.
- **Decentralized renewable energy:** By 2018, about 35 million people had access to off-grid sources of electricity at Tier 1 and above (Tier 1+); close to 136 million people had access to solutions below Tier 1[8] (IRENA 2019a; GOGLA 2019). The Tier 1+ sources were mostly standalone home systems and solar lighting, with mini grids becoming a growing source. By 2018, the adoption of off-grid energy sources had tripled worldwide from 2010 levels. Overall, the two major access-deficit regions (Sub-Saharan Africa and Central Asia and Southern Asia) are embracing off-grid technologies as least-cost alternatives to the grid.

8 Under the MTF classification, households with access below Tier 1 have electricity for less than 4 hours per day, supplemented by off-grid solar devices or rechargeable batteries.

ARE WE ON TRACK?

As of 2018, 90 percent of the world's population had access to electricity (Figure 1.1). From 2010 to 2018, the global population without access to electricity shrank from almost 1.2 billion to 789 million. Between 2016 and 2018, an average of 136 million people gained access to electricity each year, substantially more than the average annual population growth of 84 million for the same period. The progress between 2016 and 2018 also represented an acceleration from the annual increase in electrification of 127 million people seen between 2010 and 2016. Yet global progress hides glaring disparities among countries and regions. For instance, the least-developed countries fall well behind the global average.[9] By 2030 (before accounting for covid-19 effects), about 94 percent of the global population are projected to have access to electricity; this means that close to 620 million people would lack it (IEA 2019b). The shortfall in meeting the target reflects the complexities involved in bringing electricity to unserved populations—complexities that extend to affordability, reliability, and the cost of deploying last-mile solutions, especially in low-income, remote, or conflict-affected countries. As of 2018, 57 percent of those without access lived in low-income countries, 30 percent in fragile and conflict-affected areas.[10]

FIGURE 1.1 • Percentage of population with access to electricity

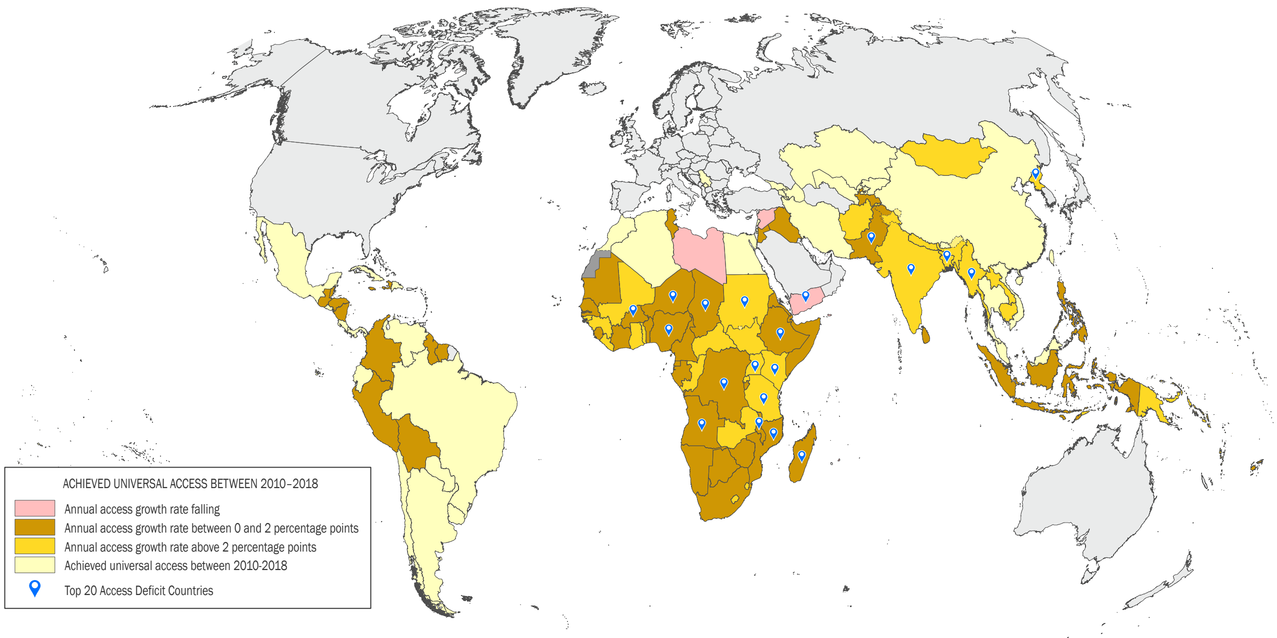
Source: World Bank, IEA.

Since 2010, 52 countries—most of them in Latin America and the Caribbean—have reached universal access, whereas another 88—concentrated in Sub-Saharan Africa, Central Asia, and Southern Asia—were still short of the goal in 2018. Fewer than half of the latter accelerated their annual electrification rates by more than 2 percentage points between 2010 and 2018, including just 8 of the top 20 access-deficit countries (Figure 1.2). On a more positive note, nearly 75 percent of the 88 countries still short of universal access managed electrification rates in excess of population growth. In Sub-Saharan Africa, an annual average of more than 26 million people gained access each year after 2010, improving the regional rate to 47 percent in 2018. In Central Asia and Southern Asia, 1.8 billion people, making up more than 92 percent of the region's population, had gained access by 2018.

9 The list of least-developed countries for 2018 can be found here: https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/ldc_list.pdf.

10 Countries with a per capita GNI of less than USD 1,025 are classified as low-income (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups). Countries affected by violent conflict are identified based on a threshold number of conflict-related deaths relative to the population (https://www.worldbank.org/en/topic/fragilityconflictviolence/brief/harmonized-list-of-fragile-situations). The two categories are not mutually exclusive.

FIGURE 1.2 • Annual increase in access to electricity rate in access-deficit countries, 2010-18 (percentage points)



Source: World Bank.

LOOKING BEYOND THE MAIN INDICATORS

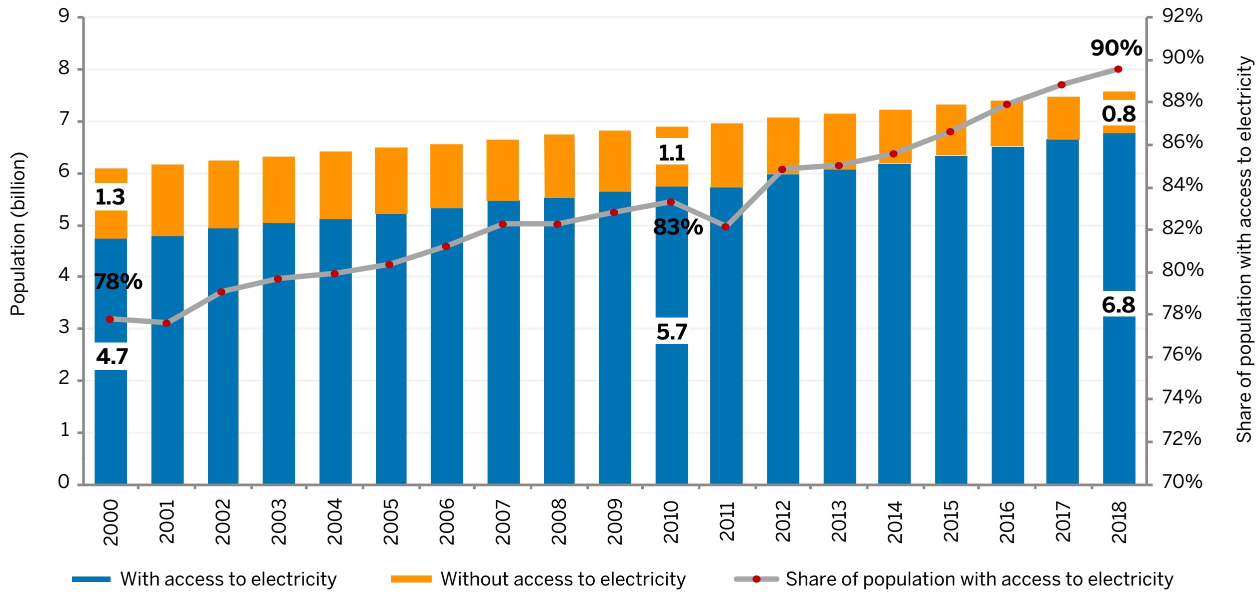
This chapter explores changes in access to electricity between 2000 and 2018, comparing progress across socioeconomic and geographical contexts in response to electrification efforts. The aim of the analysis is to inform efforts to achieve the 2030 target and to sustain gains in access.

After analyzing access trends using data for the 2000-2018 period, the chapter provides policy insights based on a literature review and country case studies.[11] The methodology employed is explained at the end of the chapter.

ACCESS AND POPULATION

Despite major progress since 2010, the current pace of electrification is still not fast enough to meet the 2030 target. The global electrification rate has progressed steadily, rising from 83 percent of the world's population in 2010 to 90 percent in 2018 (Figure 1.3). During this same period, the population without access to electricity fell from 1.2 billion to 789 million. Compared with previous decades, the pace of electrification has accelerated since 2010. Between 2016 and 2018, however, electrification grew by just 0.82 percentage points per year, lower than the average annual increase believed necessary (before the onset of covid-19) to achieve universal access by 2030 (0.87 percentage points; Figure 1.4). The last mile of the road to universal access will be especially challenging in view of the difficulty of reaching the populations that remain unserved. In addition, affordability and reliability remain salient issues for many countries moving toward the target. According to the 2018 Regulatory Indicators for Sustainable Energy (RISE), the poorest 40 percent of households in half of the access deficit countries spent more than 5 percent of their monthly household expenditure on 30 kilowatt-hours (kWh) of electricity[12] (ESMAP 2018). One-third of the access-deficit countries face more than one disruption per week in electricity supply, with disruptions lasting more than four minutes on average.

FIGURE 1.3 • Gains in electricity access, 2000–18 (billions of people and share of population with access)

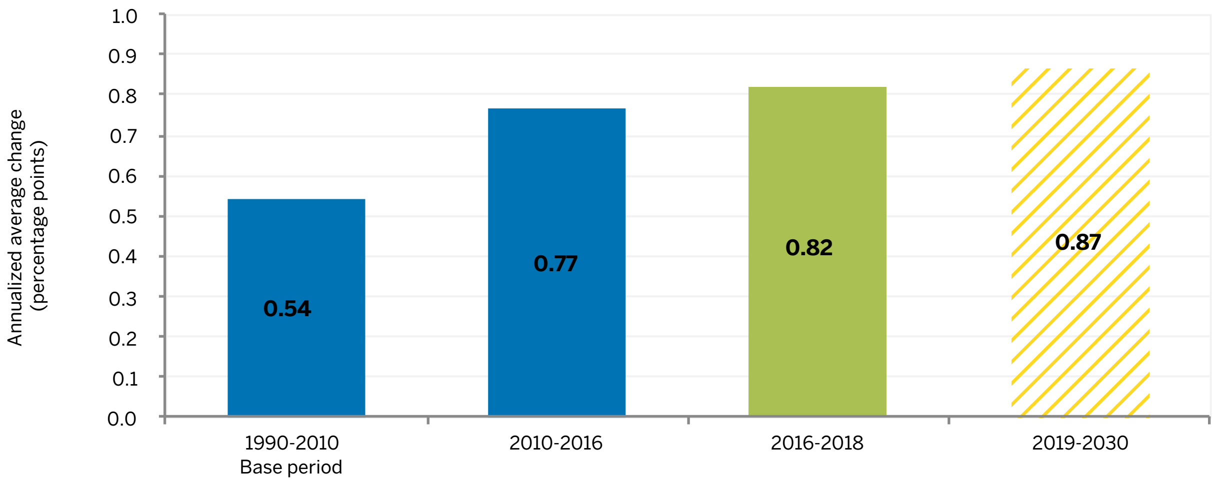


Source: World Bank.

11 Access to electricity data in this chapter mostly comes from the World Bank's Global Electrification Database: https://databank.worldbank.org/source/world-development-indicators.

12 The World Bank's Regulatory Indicators for Sustainable Energy can be found at https://www.worldbank.org/en/topic/energy/publication/rise---regulatory-indicators-for-sustainable-energy. Electricity is considered affordable if a household does not have to spend more than 5 percent of its total monthly income to purchase it (World Bank and IEA 2015). The definition of subsistence consumption varies by region but has been defined in the range of 30 kWh per month (Kojima and Trimble 2016).

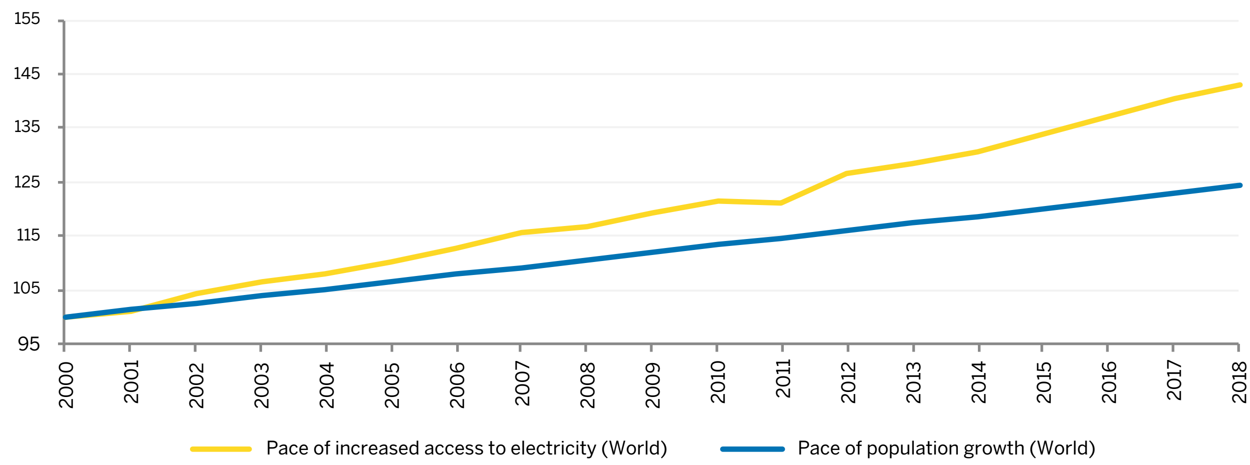
FIGURE 1.4 • Average annual increase in access to electricity (in percentage points) required to reach universal access by 2030



Source: World Bank.
Note: The 2019–30 annual increase required to achieve the target does not include potential impacts from the covid-19 pandemic.

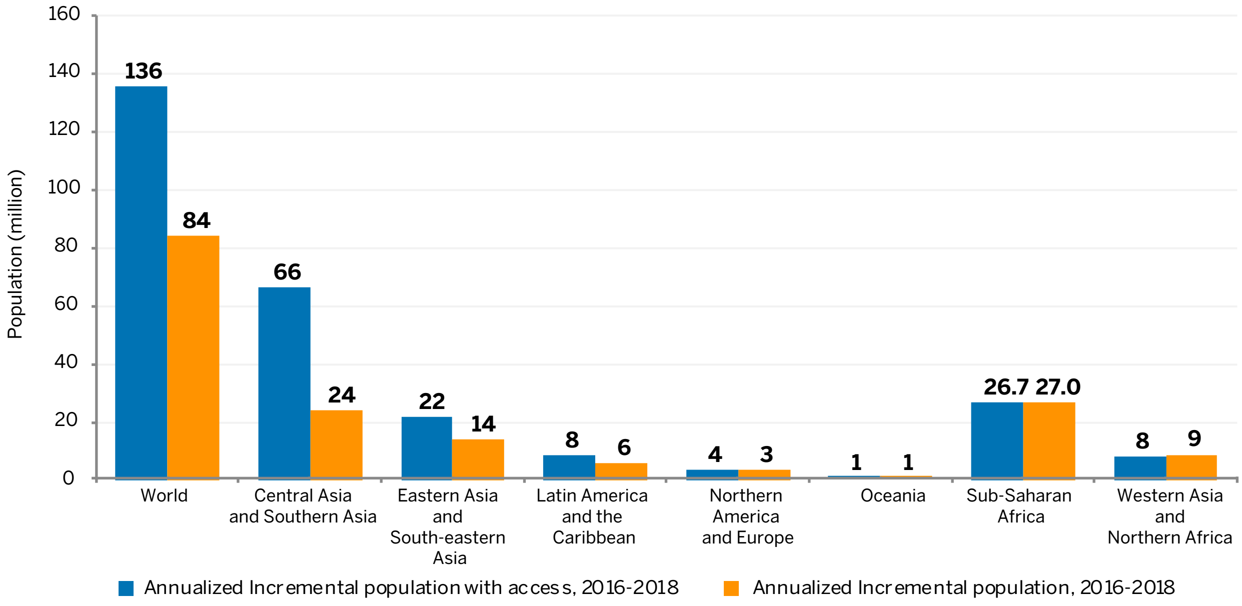
Between 2010 and 2018, electrification accelerated faster than demographic growth worldwide (Figure 1.5). This trend was confirmed between 2016 and 2018, as electricity reached 136 million new people on average annually, while the world population grew by 84 million (Figure 1.6). The increase in population with access is traceable chiefly to electrification efforts in Central Asia and Southern Asia, where an annual average of 66 million people gained access to electricity between 2010 and 2018. For Sub-Saharan Africa, even though electrification outpaced population growth for the period, recent growth in access (2016 to 2018) fell below population growth. This resulted in a net annual increase of almost 0.3 million people without access to electricity in the region between 2016 and 2018, driven largely by a slowdown in two large access-deficit countries: DRC and Nigeria.

FIGURE 1.5 • Pace of increased electricity access vs. pace of global population growth, 2000–18 (index, 2000 = 100)



Source: World Bank.

FIGURE 1.6 • Annual incremental increases in electrification and population, 2016–18, by region



Source: World Bank.

Low-income countries and those affected by fragility, conflict, and violence are lagging behind. Within the group of low-income countries, the population share with access to electricity grew from 30 percent in 2010 to 43 percent in 2018. Between 2016 and 2018, population growth slightly outpaced growth in access to electricity. Globally, more than half of the unserved population live in low-income countries. The global access deficit has been increasingly concentrated in those countries, with their share in the unserved population growing from 37 percent in 2010 to 53 percent of the global population without access in 2018 (420 million). In fragile and conflict-affected countries, the access rate increased from 48 percent in 2010 to 62 percent in 2018. Yet, over the short-term (2016 to 2018) in these countries, the population grew faster than electrification, with a net increase of almost 2 million annually in the unconnected population. In 2018, almost one-third of unserved people lived in fragile and conflict-affected contexts (233 million). These results reflect a major push toward electrification in middle-income countries, with modest progress in low-income countries and fragile and conflict-affected settings. They also show that the push to reach the remaining unserved population is becoming even more challenging. Access to more and better data would help to inform policy in fragile and low-income environments that present the most complex challenges (box 1.1).

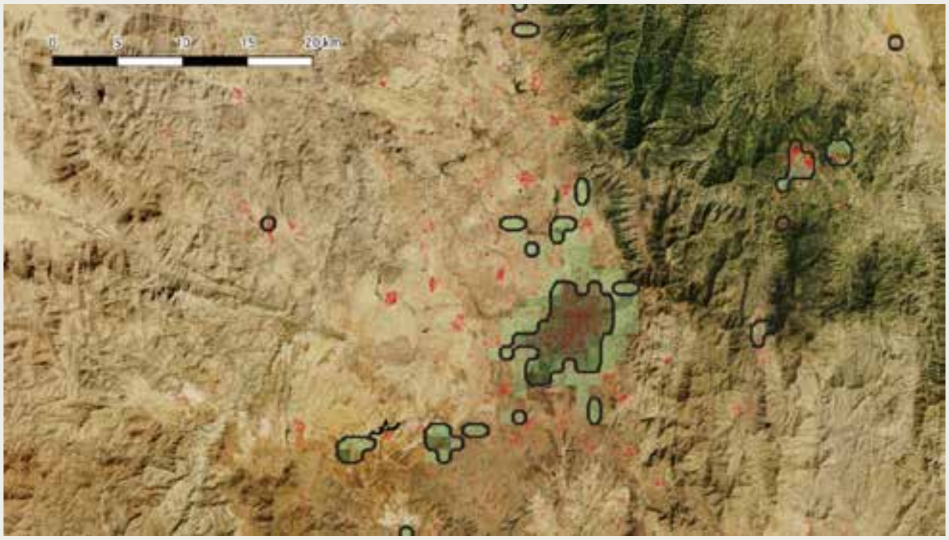
BOX 1.1 • MEASURING ACCESS TO ELECTRICITY FROM THE NIGHT SKY

Satellite images captured at night are proving to be a promising source of data for measuring access to electricity. The images show the emission of light around the globe, providing a record dating back to 1992 (between the DMSP-OLS and VIIRS platforms). Nonhuman sources of light, such as lunar reflections and fires, can be removed, producing satellite data with compelling images of urbanization and access to electricity. Analysis of satellite imaging can reduce the lag in tracking the progress of electrification, particularly in fragile and conflict-affected countries where household surveys and censuses are conducted infrequently and irregularly, leaving substantial data gaps.

To create the image in Figure B1.1, a year's worth of night-time lights imagery is processed to create a single indicator of the likelihood of electrification (shown by the shaded green squares), with a resolution of around 500 meters. The images are further filtered to find points significantly brighter than their surroundings, producing regions of access (black outlines). By overlaying this with population data (red pixels), it is possible to create disaggregated estimates of access. It is also possible to go further, using additional data to quantify not only access but also the percentage of connections within each area. Satellite imagery can therefore complement the end-user data available from household surveys such as the Multi-Tier Framework.[a]

The approach has several limitations, however, such as coarse resolution and large regional differences, which must be overcome through further research. Granularity is limited by the amount of light that can be picked up from space. Industrial complexes and streetlights are bright, whereas satellite sensors may not be able to pick up light emitted from houses or offices. Off-grid sources may be particularly hard to capture because of dimmer light.

FIGURE B1.1 • Night-light areas around Asmara, Eritrea



Source: World Bank; MapBox Satellite; Facebook HRSL; NOAA VIIRS.

a. The Multi-Tier Framework (https://www.worldbank.org/en/topic/energy/publication/energy-access-redefined) looks at the multiple dimensions of access to capture information about the quantity and quality of services. It also captures the multiple modes of delivering energy access from grid to off-grid and the range of cooking methods and fuels people use.

THE ACCESS DEFICIT

While the number of people worldwide without access to electricity fell steadily from 1.2 billion to 789 million between 2010 and 2018, the overall trend hides important regional disparities. The decline was most significant in Central Asia and Southern Asia, where the deficit shrank from 441 million in 2010 to 152 million in 2018 (Figure 1.7). During the same period, the global deficit became increasingly concentrated in Sub-Saharan Africa. That region's share grew from 48 percent of the overall global deficit in 2010 to almost 70 percent in 2018; within the region, 548 million people lacked access in 2018. The region's deficit increased slightly between 2016 and 2018 (Figure 1.8), as electrification efforts fell behind population growth, particularly in Burkina Faso, DRC, Niger, and Nigeria.

FIGURE 1.7 • Evolution of the access deficit (millions of people), 2000–18

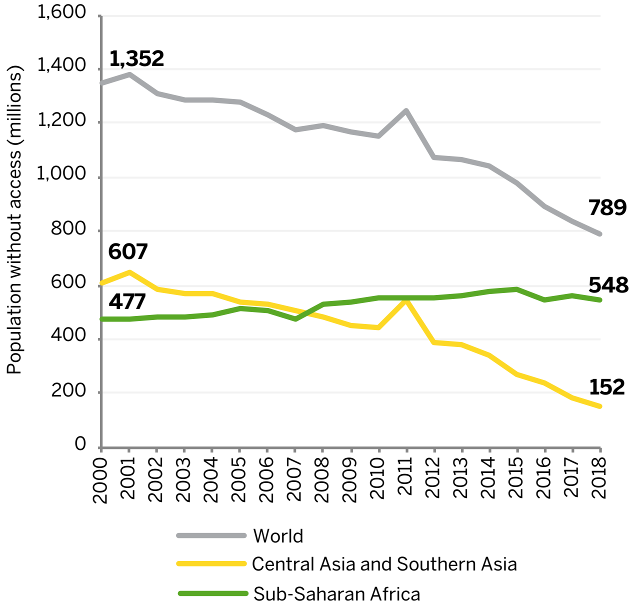
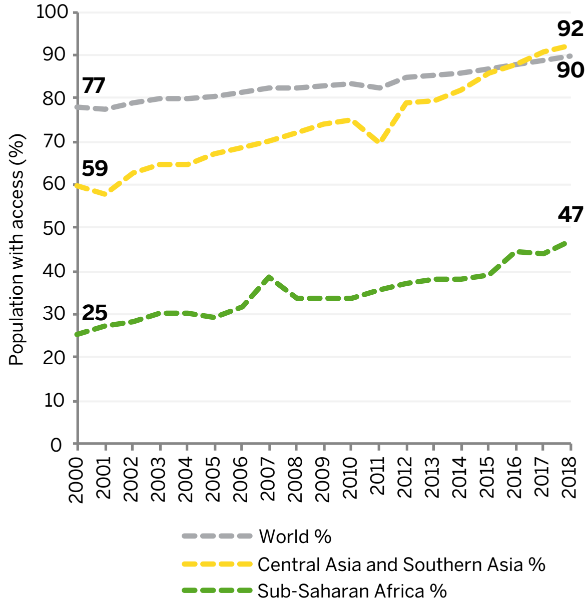


FIGURE 1.8 • Evolution of electricity access (percentage of population with access), 2000–18



Source: World Bank.

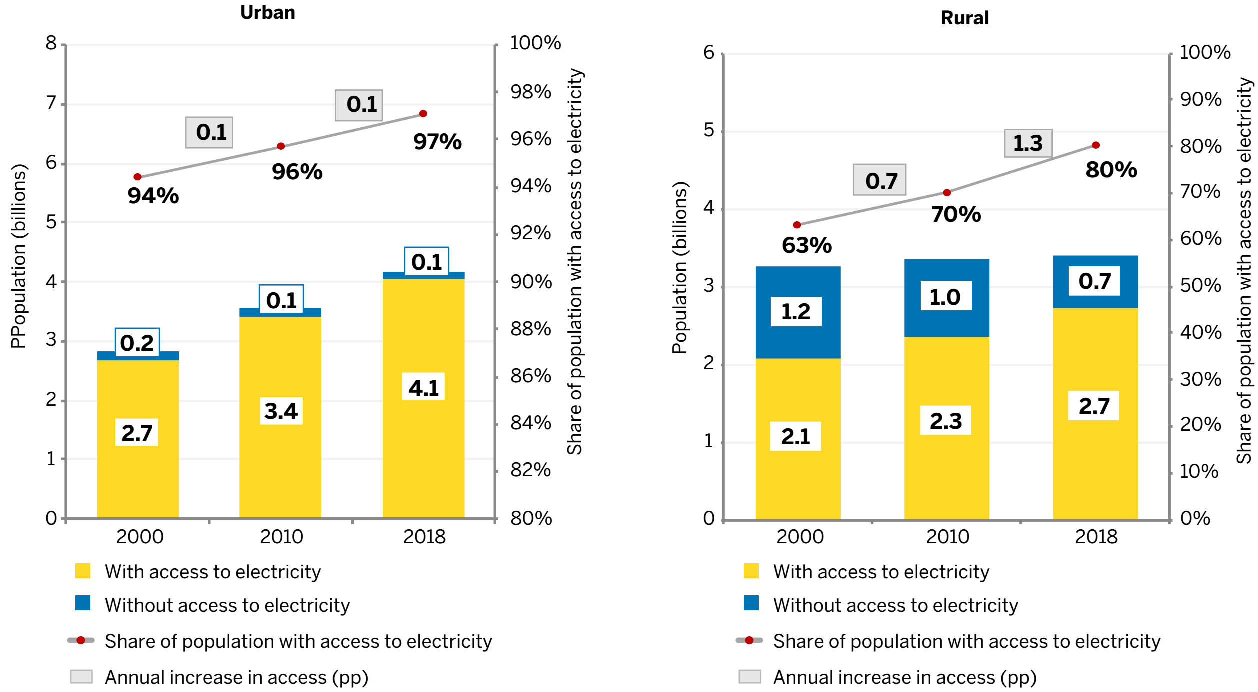
Latin America and the Caribbean is approaching universal access; in 2018, the level of access to electricity there was 98 percent, leaving just 11 million of the region's people without access, most of them in Haiti, Peru, Guatemala, Honduras, and Nicaragua. Eastern Asia and South-eastern Asia also showed improvement, exceeding 98 percent access in 2018. These regions are expected to reach universal access ahead of the 2030 schedule, provided they surmount the hurdle of last-mile connectivity posed by affordability and cost of supply.

THE URBAN-RURAL DIVIDE

In 2018, the world's rural areas continued to have lower levels of access to electricity (80 percent, with 668 million people unserved) than urban areas (97 percent; 121 million). The pace of electrification picked up in rural areas between 2010 and 2018, whereas it remained steady in urban areas (Figure 1.9). Between 2016 and 2018, the focus on electrifying the countryside brought power to over 52 million new residents on average each year, far outpacing rural population growth over the same period. Rural electrification accelerated at a pace more than six times that of rural population growth in Central Asia and Southern Asia between 2016 and 2018. In Sub-Saharan Africa, the pace of rural electrification matched that of rural population growth (Figure 1.10), although about 70 percent of the world's unelectrified rural population lived in Sub-Saharan Africa.

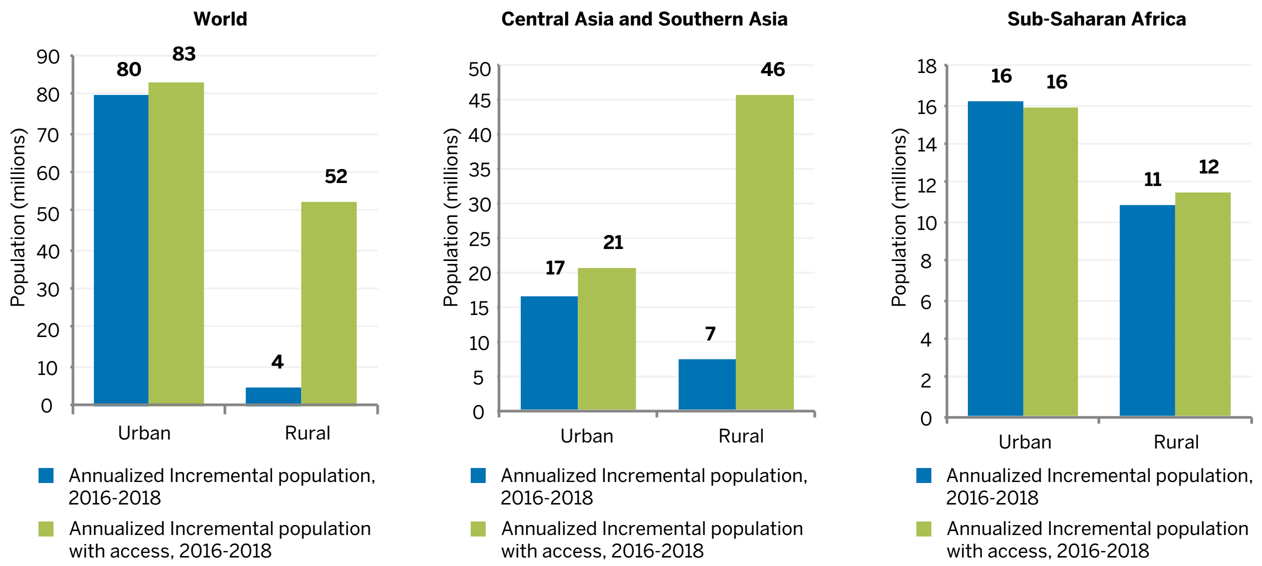
Globally, despite slower growth in access, urban electrification brought access to more than 83 million urban residents on average each year between 2016 and 2018 (compared with population growth of 80 million). In Sub-Saharan Africa, electrification in urban areas dipped below population growth. As a result, in 2018, most of the world's unelectrified urban population lived in Sub-Saharan Africa (76 percent in 2018) (Figure 1.11). A vast majority of this unserved urban population in Sub-Saharan Africa lived in low-income and fragile and conflict-affected countries (62 percent and 75 percent, respectively). The last-mile issues for large cities are posed by populations residing in vast informal settlements that are unlikely to be attractive customers for utilities, as they present thorny barriers pertaining to legality, ownership, low demand, and housing type. Electrifying new areas is generally more newsworthy than densifying existing areas already connected. Additionally, donors have tended to push for rural electrification.

FIGURE 1.9 • Gains in electricity access in urban and rural areas, 2000, 2010, and 2018 (billions of people and share of population with access)



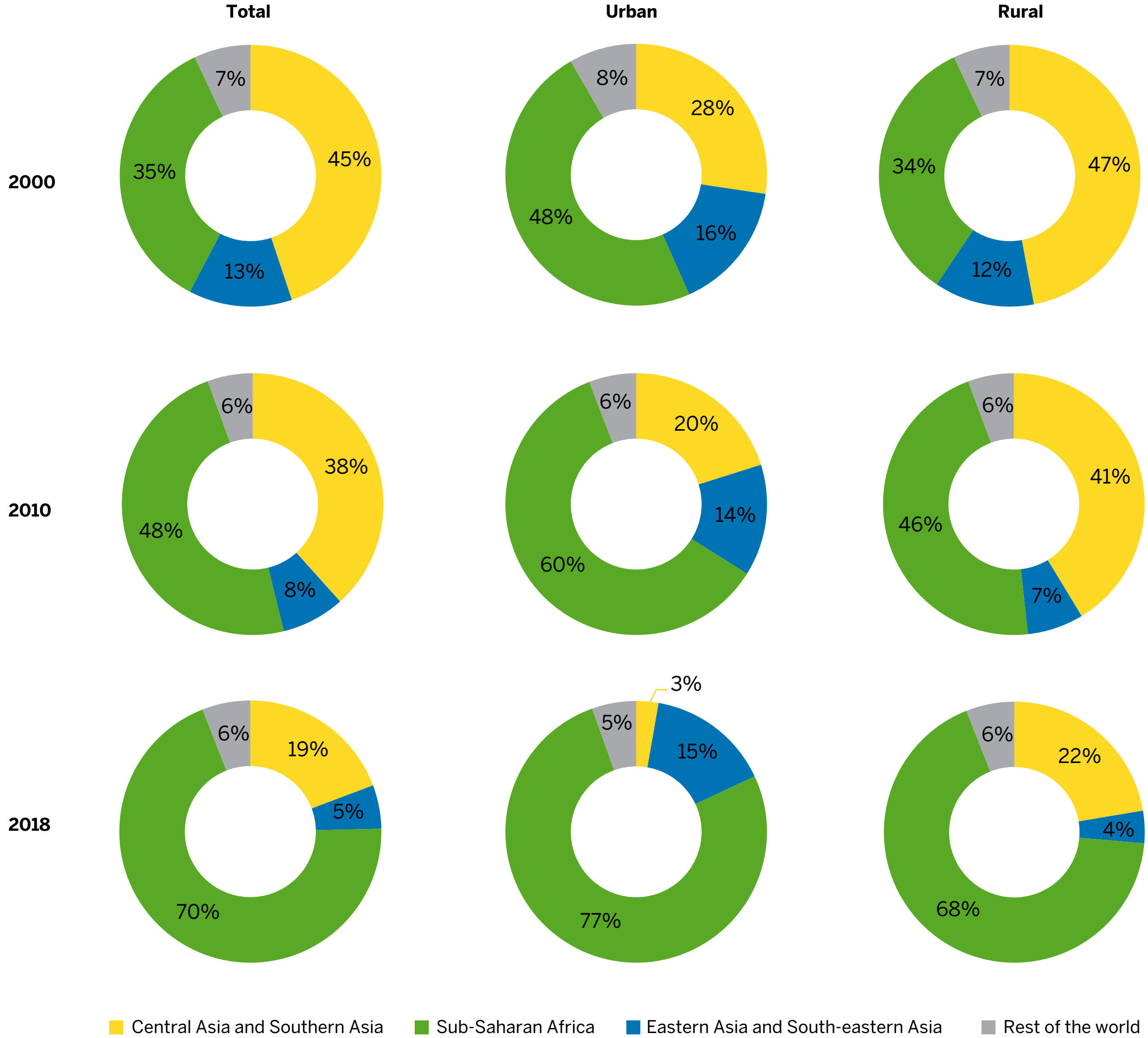
Source: World Bank.

FIGURE 1.10 • Annual incremental growth in access and population in urban and rural areas of Sub-Saharan Africa and Central Asia and Southern Asia, 2016–18



Source: World Bank.

FIGURE 1.11 • Regional shares of the global access deficit, in total and along the urban-rural divide, 2000, 2010, and 2018



Source: World Bank.

OFF-GRID ELECTRIFICATION

Progress is being made to improve the accuracy of data on off-grid electrification. As of today, supply-side data is available in databases maintained by the International Renewable Energy Agency (IRENA) and the association of producers of off-grid solar energy (GOGLA), in addition to demand-side figures made available through the Multi-Tier Framework.

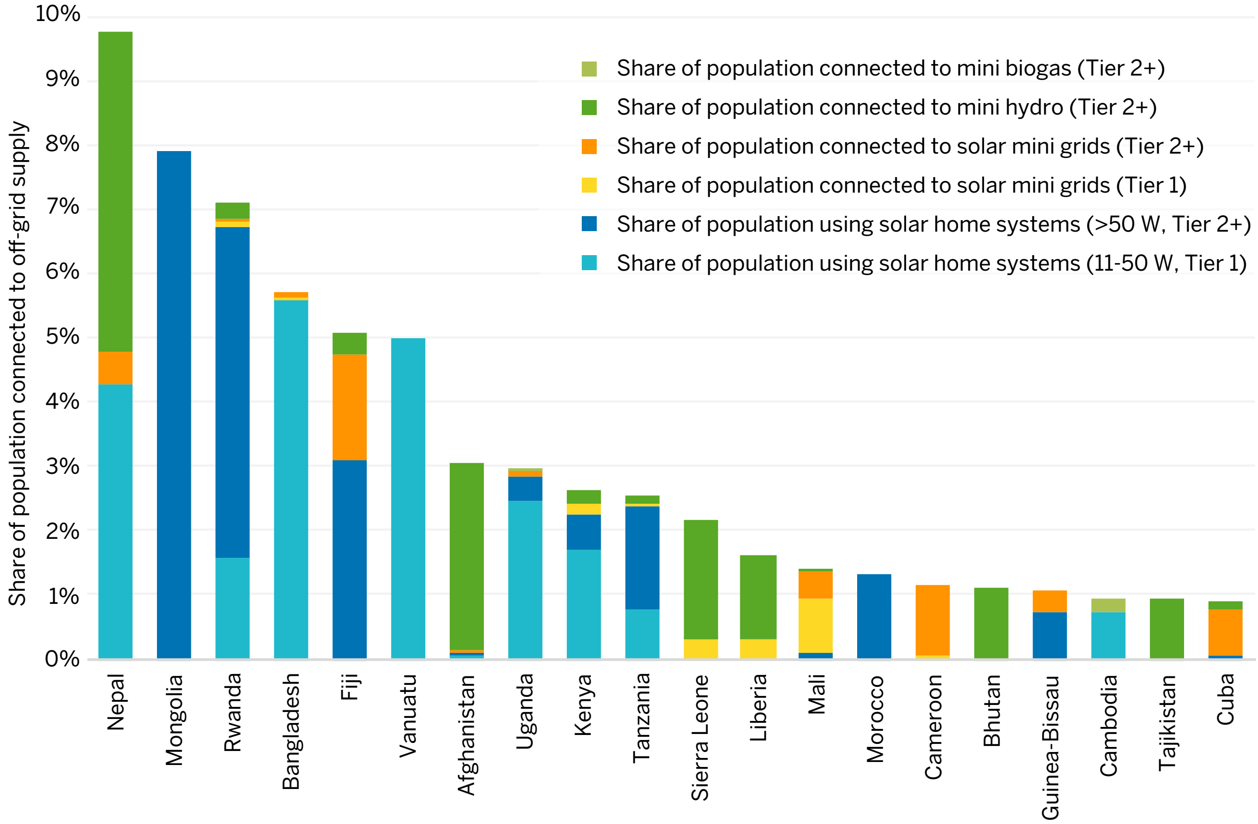
As of 2018, more than 35 million people had Tier 1+ electricity service access through standalone home systems or renewable-based mini grids (IRENA 2019a; GOGLA 2019). The population with access to standalone systems providing Tier 1+ service increased almost four times between 2010 and 2018; although it started from a low basis, the population with access to solar mini grids providing Tier 1+ access quintupled between 2010 and 2018. In 2018, standalone systems producing 11–50W and above made up 72 percent of Tier 1+ off-grid access; the rest came from mini grids.

The number of people gaining Tier 1+ access through mini grids exceeded 3 million in 2018. mini grids have grown from a niche solution to widespread deployment in off-grid areas that offer sufficient demand to sustain a mini grid business. Leading developers are leveraging transformative technologies and economic trends to build portfolios of "third-generation" mini grids at unprecedented scale that provide high-quality, affordable electricity (ESMAP 2019). In the off-grid solar sector, new markets and a shift toward higher-priced and larger pay-as-you-go–enabled products have driven the rapid growth in the sector's sales (ESMAP 2020).

As of 2018, about half of the 20 countries with the highest levels of Tier 1+ off-grid access were in Sub-Saharan Africa, whereas only four were from Central Asia and Southern Asia. In 2018, Bangladesh, Fiji, Mongolia, Nepal, and Rwanda saw more than 5 percent of their population gain Tier 1+ access from off-grid sources (Figure 1.12).

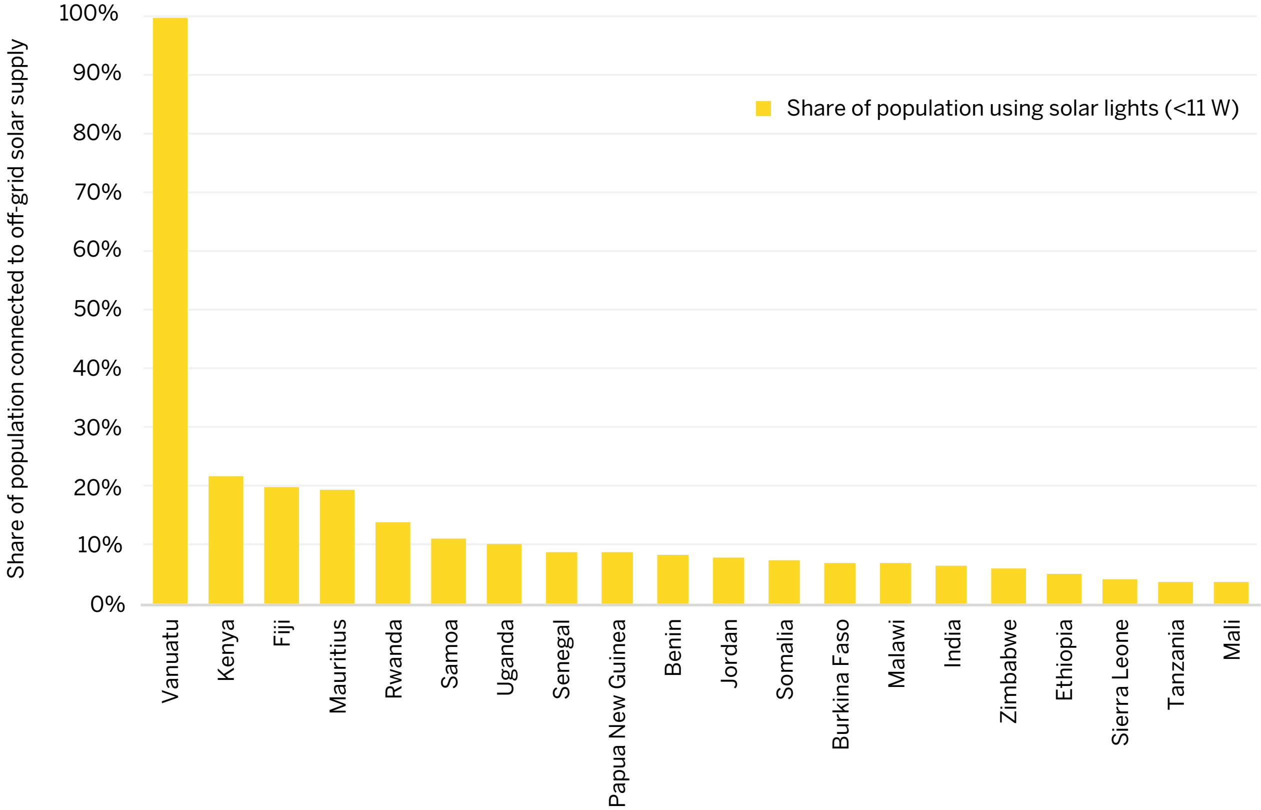
By 2018, below–Tier 1 solutions were providing basic electricity services to 136 million people globally, compared with about 1 million people in 2010. Some of the access-deficit countries that provided more than 10 percent of their population with such access were Kenya, Rwanda, Somalia, Uganda, and Vanuatu (Figure 1.13). Below–Tier 1 solutions are an important pre-electrification step enabling people can gain access to basic electricity for which they would otherwise have to wait for years.

FIGURE 1.12 • Top 20 countries with the highest rates of access to off-grid supply (Tier 1 or higher), 2018



Source: IRENA, GOGLA.

FIGURE 1.13 • Top 20 countries with the largest share of solar lighting systems (below Tier 1), 2018



Source: IRENA, GOGLA.

COUNTRY TRENDS

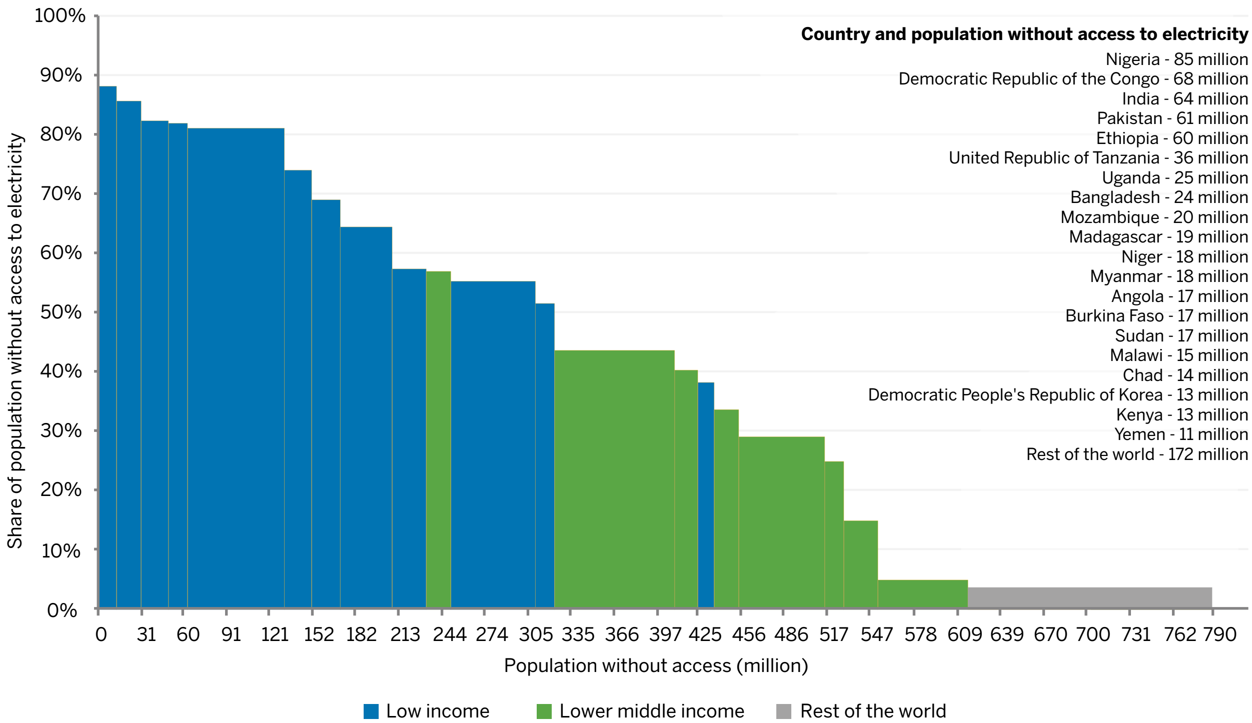
Of the unserved population at the end of 2018, more than 617 million people (78 percent) lived in the 20 largest access-deficit countries (as determined by the number of people lacking access), also called "high-impact countries" (Figure 1.14). For that reason, closing the access deficit globally will depend on efforts focused on these countries.

In 2018, Nigeria replaced India as the country with the largest population without access. For the first time since tracking began, the top two deficit countries (Nigeria and the Democratic Republic of Congo) are in Sub-Saharan Africa. The pace of electrification in Nigeria (+1.1 percentage points annually since 2010, reaching 57 percent access in 2018) was not enough to keep up with population growth (+3 percentage points annually). The access deficit increased by almost 3 million people since 2010, bringing to 85 million the number of people lacking access to electricity in 2018. The DRC, too, struggled to keep its electrification efforts on par with population growth. Between 2010 and 2018, access rates in the country rose only by 6 percentage points, with the result that the access deficit grew by almost 12 million from 2010 to reach a total of 68 million people in 2018. By contrast, India made major progress between 2010 and 2018 by accelerating its efforts to achieve universal access. Despite an access rate of 95 percent, 64 million Indians were still without access. In another change, Yemen replaced Mali on the list of top 20 access-deficit countries.

Almost three-quarters of the 20 major access-deficit countries expanded electrification at a rate of more than one percentage point each year since 2010. Only eight of them, however, electrified rapidly enough to outpace population growth. These were Bangladesh, India, Kenya, Democratic People's Republic of Korea, Myanmar, Sudan, Tanzania, and Uganda. Twelve countries, mainly in Sub-Saharan Africa, could not outpace population growth: Angola, Burkina Faso, Chad, Democratic Republic of Congo, Ethiopia, Madagascar, Malawi, Mozambique, Niger, Nigeria, Pakistan, and Yemen.

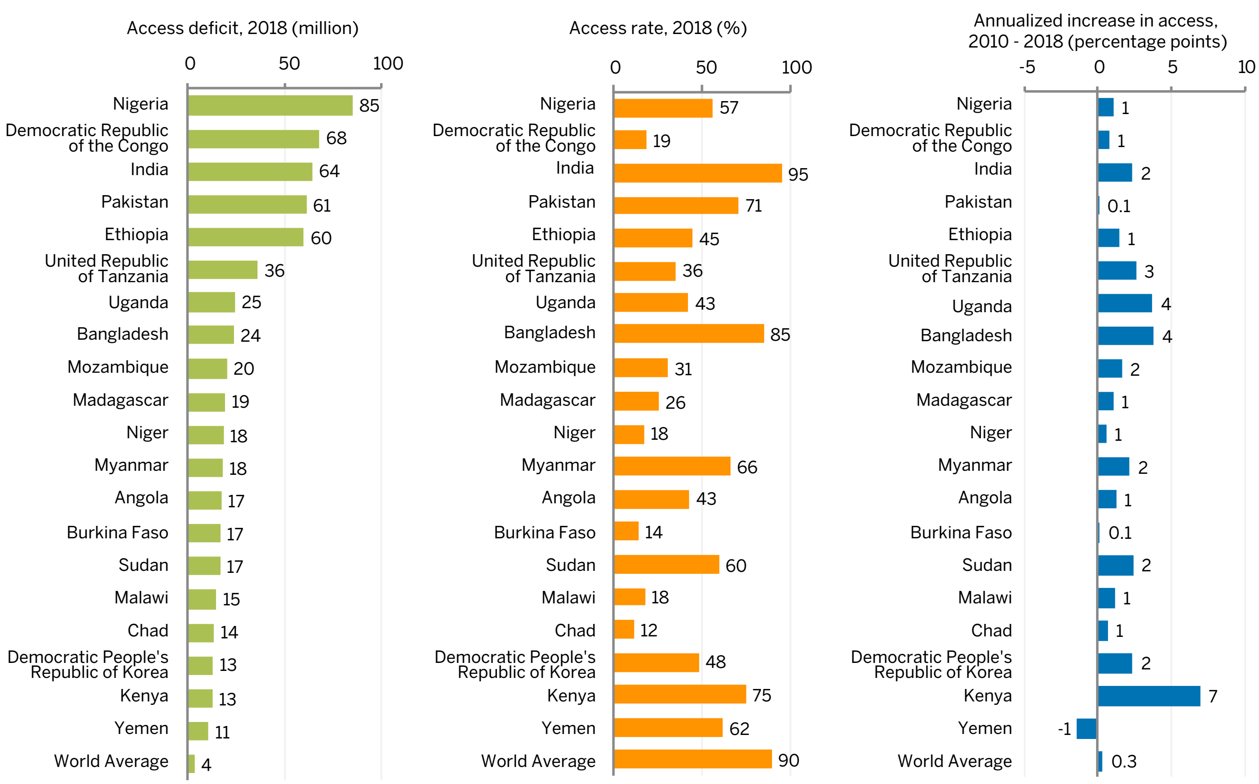
Some larger countries with unserved populations of more than 50 million in 2018—such as Pakistan—have electrified at rates of less than one percentage point per year since 2010, resulting in increased access deficits (Figure 1.15). As a result of conflict, Yemen has seen its access rate shrink since 2010.

FIGURE 1.14 • Share of population and total population without access, top 20 access-deficit countries and rest of the world, 2018



Source: World Bank.

FIGURE 1.15 • Electricity access in the top 20 access-deficit countries by population, 2010–18

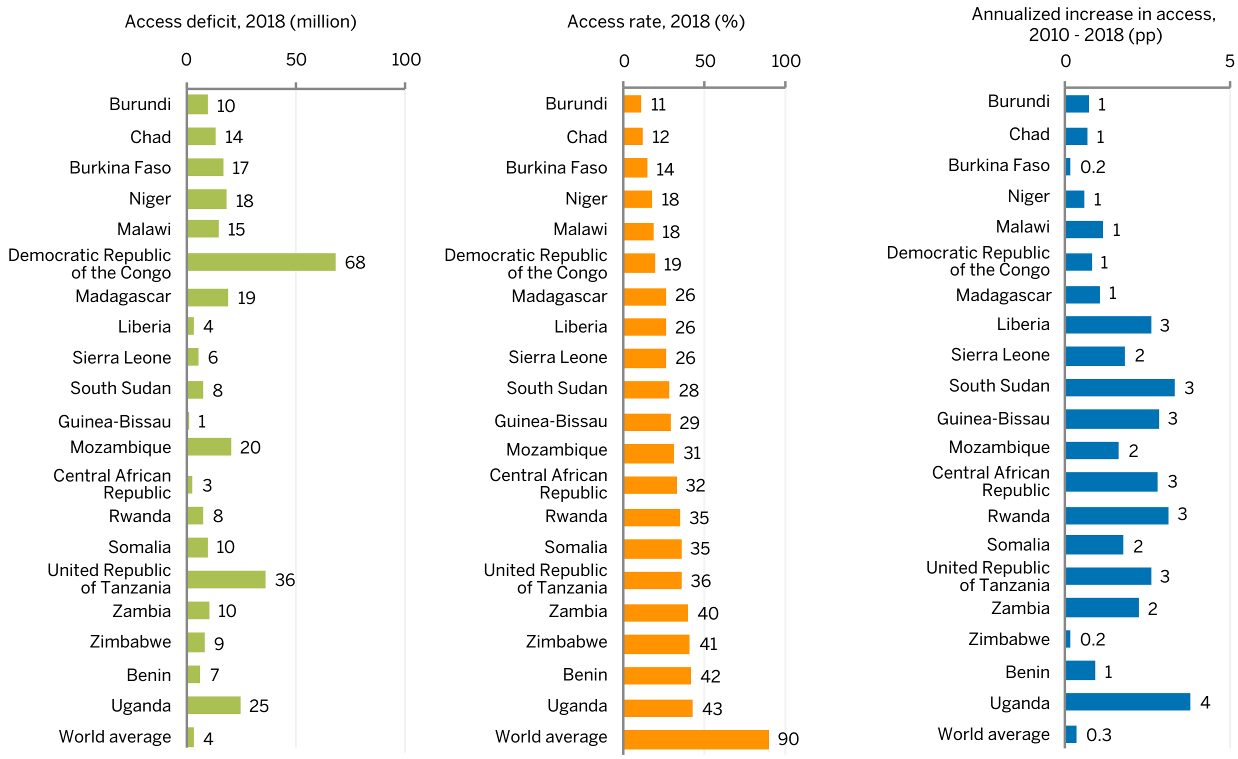


	Access deficit, 2018 (million)	Access rate, 2018 (%)	Annualized increase in access, 2010 - 2018 (percentage points)
Nigeria	85	57	1
Democratic Republic of the Congo	68	19	1
India	64	95	2
Pakistan	61	71	0.1
Ethiopia	60	45	1
United Republic of Tanzania	36	36	3
Uganda	25	43	4
Bangladesh	24	85	4
Mozambique	20	31	2
Madagascar	19	26	1
Niger	18	18	1
Myanmar	18	66	2
Angola	17	43	1
Burkina Faso	17	14	0.1
Sudan	17	60	2
Malawi	15	18	1
Chad	14	12	1
Democratic People's Republic of Korea	13	48	2
Kenya	13	75	7
Yemen	11	62	-1
World Average	4	90	0.3

Source: World Bank.

The least-electrified countries are all in Sub-Saharan Africa; almost all are among the least-developed countries (Figure 1.16). Burundi and Chad had the lowest access rates in 2018: 11 percent and 12 percent, respectively, and limited improvement since 2010. In Sub-Saharan Africa, Benin, Burkina Faso, Burundi, Chad, the DRC, Niger, and Zimbabwe have had annual electrification rates of less than one percentage point since 2010. On the other hand, Uganda's annual increase in electrification was almost four percentage points, enabling the country to shrink its deficit.

FIGURE 1.16 • Electricity access in the 20 least-electrified countries, 2010–18



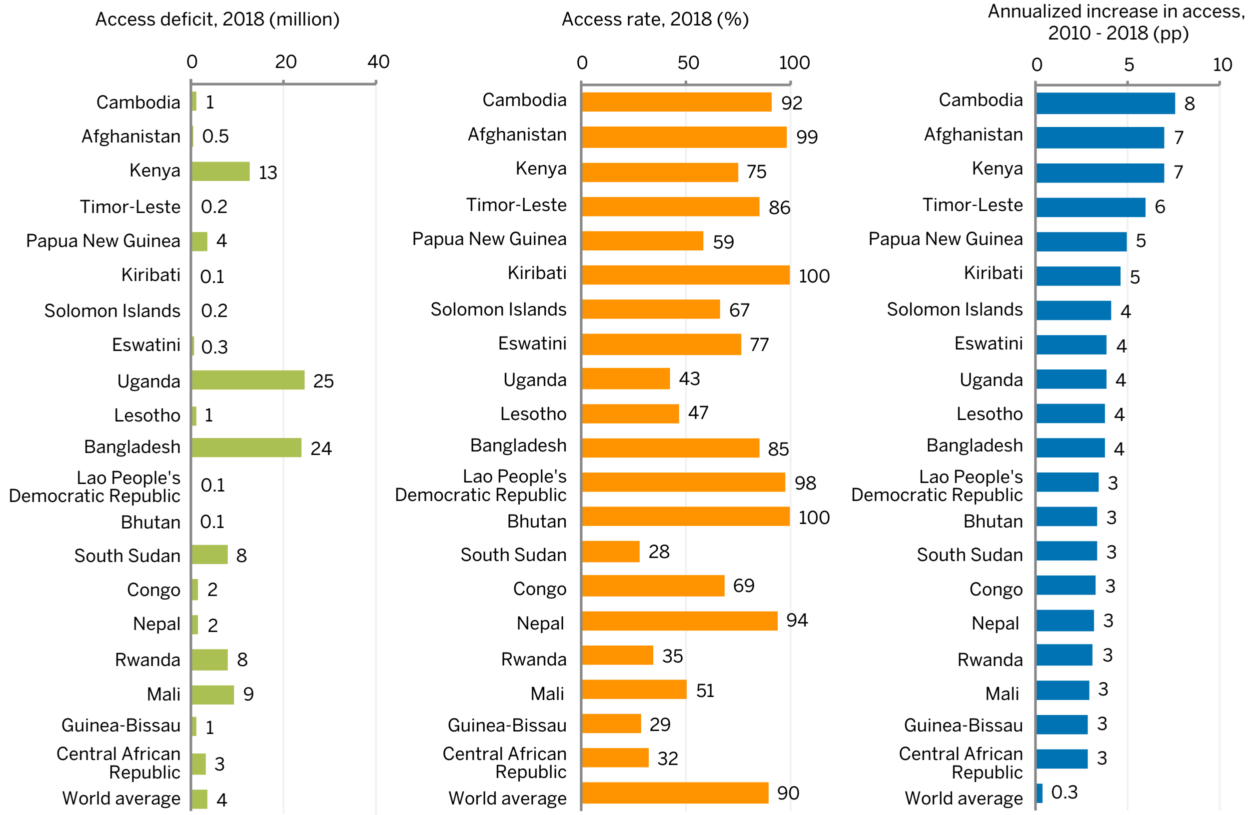
Source: World Bank.

Three countries (Afghanistan, Cambodia, and Kenya) have electrified at rates exceeding 7 percentage points annually since 2010 (Figure 1.17). The three followed different strategies. In Afghanistan, electrification has been driven principally by humanitarian groups, whose efforts have transformed it into the country with the most mini grids in addition to impressive off-grid solar penetration (ESMAP 2019). Cambodia and Kenya relied more on integrated planning that combined grid and off-grid electrification, public financing, and incentives for the private sector. RISE suggests that, since 2010, programs supporting mini grids and standalone systems have benefited from a strong regulatory push, more so than grid electrification. Cambodia's off-grid expansion proved significant in improving access in rural regions (ESMAP 2018).[13]

These experiences show that, regardless of a country's stage in the process, rapid electrification is possible, even in a fragile context; an enabling environment is key. This lesson is borne out in countries with low access rates, such as Rwanda and Liberia, as well as in countries with high rates, such as India and the Lao People's Democratic Republic.

13 According to the World Bank's 2018 Regulatory Indicators for Sustainable Energy, found at https://www.worldbank.org/en/topic/energy/publication/rise---regulatory-indicators-for-sustainable-energy.

FIGURE 1.17 • Electricity access in the 20 fastest-electrifying countries by annualized increase, 2010–18



Source: World Bank.

POLICY INSIGHTS

The world has a decade to meet the SDG 7 call for universal access to electricity. Now more than ever, efforts must be made to accelerate electrification in access-deficit countries. The covid-19 crisis has further accentuated the need for reliable, affordable access—in health institutions in particular (box 1.3), but also for water pumping, schools, and community resilience. Recent trends have shown, however, that it is hard to sustain the pace of electrification through to the last mile, or even the last few miles. Doing so requires commitment. In countries where the level of electrification remains low (e.g., the Sahel countries, Figure 1.16), the question is how to deliver affordable and reliable service at scale. In countries approaching universal access (e.g., India, Peru), the question is how to connect those hardest to reach.

The quantitative analysis above provides rich data for mapping the journey toward universal electricity access. But data alone cannot chart the course over the next decade. It will be imperative to look beyond the data into the latest innovations in policy and regulation, public and private investment, and business models for electrification. National authorities and the international community have identified good practices. Their insights are summarized below.

INTEGRATED ELECTRIFICATION STRATEGIES AND PLANNING TO DRIVE POLICY MAKING AND INVESTMENT DECISIONS

The most successful national strategies integrate grid improvements, mini grids, and off-grid technologies—presenting credible paths to universal access. As in Myanmar and Togo, the strategy must span the power sector value chain and all population segments to support economic and social development goals. National ownership, coherence, inclusivity, capacity, robustness, and data transparency/accessibility are key principles in developing effective initiatives to be undertaken by local authorities and their development partners.[14] Comprehensive data from the Multi-Tier Framework and new electricity-access planning techniques (e.g., geospatial least-cost algorithms based on satellite imaging) and tools such as the Global Electrification Platform[15] are critical for informed decision-making. Better quality and fewer gaps in data will make these tools more practical. These tools also need to capture more information about how electricity is actually used so that communities can realize its full benefits.

POLICY FRAMEWORKS, WORKABLE REGULATIONS, AND STRONG INSTITUTIONAL ARRANGEMENTS TO CREATE ENABLING ENVIRONMENTS

A quarter of the access-deficit countries now have comprehensive policies to improve access—the culmination of a broader trend of steady policy improvements in those countries (ESMAP 2018). Yet regulatory frameworks that support mini grids and off-grid systems have improved faster than those governing grid electrification. Most access-deficit countries still have a way to go to make their utilities transparent, operationally efficient, and financially viable. Many countries with the right policies and regulations struggle to implement, monitor, and enforce them. This is because power sector reform efforts are shaped by a country's political and economic context and are more likely to gain traction when led by champions enjoying broad stakeholder support. Also, reform efforts should be driven by and tailored to desired policy outcomes, rather than attempting to follow a predetermined process. This warrants a pluralism of approaches going forward (Foster and Rana 2019). Given the rapid evolution of mini grids and large off-grid sector growth, it is important to update enabling frameworks to capture the nuances of these new sectors. In the instance of pay-as-you-go, the enabling policy and regulatory framework must go beyond the energy sector and also cover aspects of digital development and financial inclusion. Fostering gender equality would help improve sector governance and sustainability in industry practices (USAID 2018).

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14 The Roundtable Initiative has embraced these principles. It also seeks to improve coordination among development partners and practitioners on energy system modeling and planning in developing countries, based on a code of conduct aligned with the 2005 Paris Declaration on Aid Effectiveness (https://energyeconomicgrowth.org/publication/key-principles-improving-support-strategic-energy-planning-developing-and-emerging).

15 See https://electrifynow.energydata.info/.

INNOVATIONS IN TECHNOLOGY AND BUSINESS MODELS TO REACH THE REMAINING UNSERVED POPULATION

Encouraging rapid development of markets and promoting private sector participation (as Kenya and Nigeria have done) is essential to drive down the cost of electrification and to ensure that efforts are consistent with consumers' needs. New areas of private sector development include: (i) greater use of distributed renewable energy systems as battery storage costs decline; (ii) high-efficiency appliances for residential and productive uses and in public institutions; (iii) institutional and business delivery models tailored to poor, remote, fragile, and conflict-ridden countries (e.g., Haiti, Yemen); and (iv) digital technologies, such as the use of Internet of Things technologies, especially for off-grid households and micro, small, and medium enterprises, integrated with digital payment and financial services. Technological and business model synergies between clean cooking and electrification (e.g., electric cooking, pay-as-you-go, and results-based financing) are also creating opportunities for integrated approaches that can grow the market.

LEVERAGED PUBLIC AND PRIVATE FINANCING TO FUND ELECTRIFICATION AT SCALE

Expanding access to electricity—especially for clean technologies like renewable energy mini grids and off-grid electrification—remains underfunded, especially in Sub-Saharan Africa. Financing for off-grid electrification represented just 1.2 percent of total funding for energy access in 2017. It is concentrated in a few countries; Kenya, Tanzania, and Uganda account for more than half of this financing (SEforAll and CPI 2019). As public financing will likely remain limited over the next few years, universal access will not be achieved by 2030 without unlocking private financing. Available public resources are best spent on measures likely to attract private sector finance and on extending access to populations living in areas unlikely to attract private financing, as well as on subsidizing service for those who simply cannot afford it. Mini grid and off-grid solutions that are likely to serve much of the unelectrified population (ESMAP 2019, IEA 2019c), are often considered high-risk investments by commercial financiers. Therefore, one of the imperatives identified in the latest off-grid market trends report is to unlock financing from local commercial banks (ESMAP 2020). So-called results-based financing—where flows are tied to delivery of services—ensures that electrification reaches the intended population. Further private efforts may depend on additional risk mitigation by public authorities and new approaches to encourage local entrepreneurs and foster access to finance. Public resources in the form of credit lines, guarantees, and working capital facilities should be used to leverage the needed private capital and mitigate risk.

LEAVING NO ONE BEHIND

Electrification strategies will succeed only when the technical elements cited above are combined with inclusive approaches for electrifying remote populations. As universal access to electricity draws near, the unelectrified population will be poorer and more rural, living in fragile regions affected by conflict and violence. Both demand and supply subsidies will be required to reach these populations. They will have to be better targeted and designed to ensure sustainability, minimize distortions, and enable (rather than displace) private-sector service delivery and financing. Energy safety nets integrated with social assistance programs could supply vulnerable households with access to essential services (SEforAll 2020).

It will be equally important to shift thinking about the humanitarian challenge of displaced people and host communities toward development of solutions that address the effects of crises on local infrastructure and institutions (box 1.2). Factors to consider when providing such households with energy services include increased awareness about cyclical incomes (which make it hard to pay upfront connection costs), the lack of land titles, and the need for mobile energy services (e.g., off-grid technology). In addition, access is not the same as use. It is therefore important to look at the link between usage and affordability. Using appliances could boost livelihoods and incomes. Specific approaches suitable for fragile and conflict-affected contexts include greater reliance on and collaboration with local government and businesses, nonprofit partners, and United Nations agencies.

BOX 1.2 • PROVIDING ELECTRICITY TO RECORD NUMBERS OF FORCIBLY DISPLACED PEOPLE

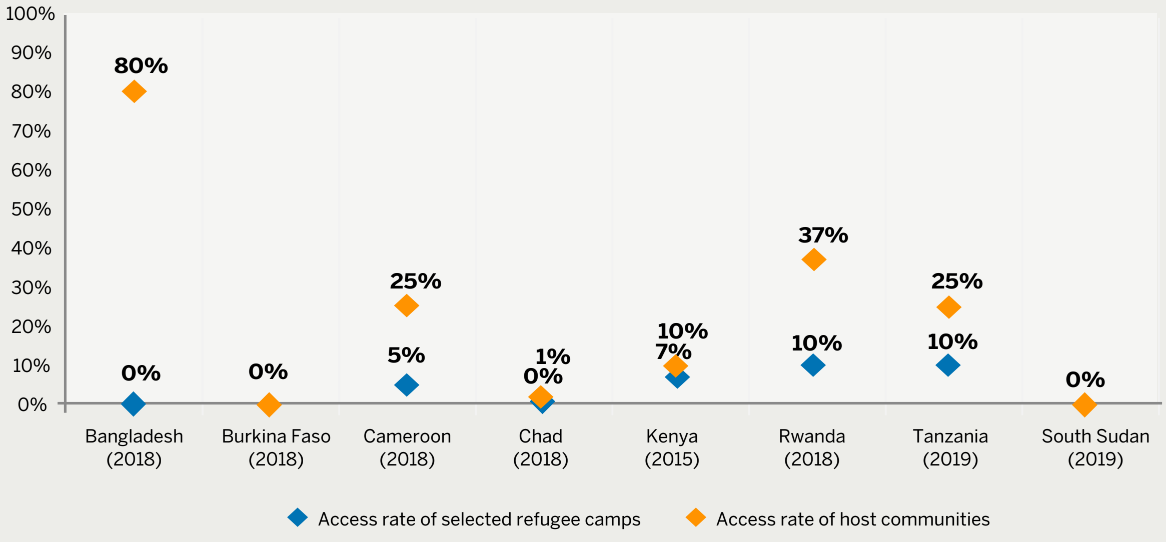
Today, forcible displacement affects a record number of 75 million people around the world, including almost 24 million refugees and asylum seekers. Of the 75 million forcibly displaced people at the end of 2018, about 20 million were refugees and over 3.5 million were asylum seekers (UNHCR 2019).

Historically, humanitarian and development actors do not provide access to electricity among refugee households. They lack the expertise and funding to do so, for a start. Some host governments are reluctant to authorize long-term infrastructure for refugee settlements that are optimistically considered temporary.

Electricity access for displaced populations is now receiving growing attention, though reliable information and monitoring are scarce. The best globally comparable data presently available come from the Integrated Refugee and Forcibly Displaced Energy Information System of the United Nations High Commissioner for Refugees (UNHCR). The system is a global monitoring toolkit accessible at https://eis.unhcr.org/about.

Existing data shows that refugees have disproportionately lower access to grid electricity than their surrounding host communities. According to the UNHCR findings (Figure B1.2.1), the most striking cases were in Rwanda (Gihembe, Kigeme, Mugombwa, Nyabiheke) and Tanzania (Nyarugusu), where just 10 percent of refugees had access to the electricity grid in 2018, compared with 25–37 percent in the host communities.[a] In Cameroon (Douala, Gbiti, Kette, Meiganga, Minawao), only 5 percent of the refugees had access to the grid in 2018, compared with 25 percent in the host communities. In Bangladesh, the gap between the refugees in 10 camps in Cox's Bazar and the host community was particularly stark: no refugees had access to grid power, whereas up to 80 percent of the host community had access. In other countries, including Burkina Faso (Gandafabou, Goudebo, Mentao), Chad (Aradib, Djabal, Goz Amer), and South Sudan (Doro, Ezo, Gendrassa, Kaya, Lasu, Yusuf Batil), neither refugees nor the host communities had access, underlining the poverty of areas hosting refugees in many countries.

FIGURE B1.2.1 • Percentage of refugee households having access to on-grid electricity in selected communities



Source: Integrated Refugee and Forcibly Displaced Energy Information System (https://eis.unhcr.org/home).

Limited data suggest that refugees do have somewhat better access to off-grid electricity. A study conducted among 600 sample households in three refugee camps (Gihembe, Kigeme, Nyabiheke) in Rwanda in 2018 found that 41–51 percent of the refugees had access to electricity for lighting from an off-grid power source (Sandwell and others 2019).[b] Another study conducted among 500 sample households in Nyarugusu in Tanzania in 2017 found a similar situation, with 43 percent of refugees having access through off-grid electricity (Rivoal and Haselip 2017). This indicates the potential for market-based approaches to off-grid electricity solutions in refugee settings. One estimate has refugees and internally displaced people spending USD 223 million on off-grid lighting technologies alone, of which USD 121 million is attributed to refugees living in camps (Moving Energy Initiative 2018).

In order to chart a strategy for achieving SDG 7, more work is needed to gauge the differences in access to and demand for energy among refugees and hosts.

Source: Integrated Refugee and Forcibly Displaced Energy Information System (https://eis.unhcr.org/home).

a. The country data presented in this paragraph can be found at https://eis.unhcr.org/home.

b. On average across all three camps, 58 percent reported no access to electricity, while 41 percent reported either access to electricity through solar lanterns (21 percent), solar home systems (16 percent), mini grids (2 percent), or rechargeable batteries (2 percent).

ENERGIZING WOMEN

Access to electricity plays a critical role in poverty reduction for women and girls. Women's employment and leisure will improve with increased access to electricity. Poor electricity supply was pinpointed as the biggest obstacle to growth by 25 percent of female-headed enterprises surveyed in Tanzania and 19 percent in Ghana. Statistical data from these countries show a positive relationship between the productive use of electricity and women's economic empowerment. Use of electrical appliances allowed for diversification in products for sale and helped female entrepreneurs attract more customers (Wilson 2020). The provision of electric light amplifies time savings by increasing efficiency and adding flexibility in the scheduling of household tasks. Freeing up women's time is a prerequisite for investments in their education and life choices, encouraging them to seize economic opportunities and participate in economic, political, and social life (World Bank 2012).

Electrification projects can promote gender equality in several ways. For example, ensuring that the upfront cost of electricity provision and electric appliances is affordable to women and women-led businesses—who are less likely to have access to finance—would facilitate grid and off-grid connections and the use of energy services. Also, gender disparities can be ameliorated with approaches that ensure women have the same opportunity as men to benefit from improved income-generating activities. With a focus on closing gender gaps in employment and skills development, projects can also address women's underrepresentation in the energy sector workforce. IRENA's online gender survey from 2018 highlighted access to training and skills development programs. In fact, these were seen as a key measure to improve women's engagement in deploying renewables for energy access (IRENA 2019b).To ensure that gender is factored into energy projects, specific actions throughout the project cycle are required: a gender-gap assessment, a plan of action for interventions, and a focus on monitoring and evaluation that tracks the narrowing of gender gaps. An in-country example from Ethiopia—where the government has launched a reform of its energy sector to reach universal electrification by 2025—aims to create more equitable institutions and equal benefits for women. A first-of-its-kind approach, the NEP and NEP 2.0 initiatives established new ways of looking at gender, focusing on constraints in employment, child care, sexual harassment, female entrepreneurship, and consumer-level affordability (World Bank 2020).

GOING BEYOND CONNECTIONS: IMPROVING LIVELIHOODS AND HUMAN CAPITAL

Electrification programs must be grounded in a broader agenda of social transformation. Countries with universal electricity access built their programs as part of a transformative agenda of social and economic development (e.g., China, Tunisia, United States of America, Viet Nam). Electricity access programs should be designed to support countries' sustainable development initiatives. There is growing evidence that demand-side factors are impeding the scale-up of electrification, particularly in Sub-Saharan Africa, where electrified households often remain at minimum consumption levels, not making full use of electricity's socioeconomic benefits. Persistent lack of household demand, inability to pay, or unwillingness to pay makes service providers reluctant to serve low-income users and threatens the sustainability of efforts across all technologies—grid, mini grid, and off-grid. That so many rural schools and health facilities remain without reliable access to electricity (box 1.3) likewise limits the impact of electrification because the objectives of human capital development remain unrealized.

Well-targeted demand-side interventions can unlock the potential of electrification and lead to broader social and economic development effects. Programs that emphasize productive uses of electricity, raise awareness, increase the availability and affordability of energy-efficient appliances, provide financial support, and offer extension services for the development of enterprises or better farming can scale up the consumption of electricity and stimulate a virtuous circle of productive use. In Bangladesh, the government-owned Infrastructure Development Company Limited launched intensive customer-awareness campaigns to address load-uptake challenges in mini grids. The campaigns brought in new customers and raised electricity utilization. Furthermore, the range of off-grid solutions to promote productive uses of solar energy, such as solar water pumps, cold storage, and solar milling, as well as products servicing public institutions, is rapidly expanding, with a market of USD 11.3 billion in 2018 in Sub-Saharan Africa alone (Lighting Global 2019).

BOX 1.3 • SUPPORTING OTHER SDGS BY SUPPLYING POWER TO EDUCATION FACILITIES AND HEALTH CENTERS

Providing electricity to schools and health centers offers broad benefits that will assist in reaching objectives codified in a range of SDGs, most directly SDG 3 (health) and 4 (education) but also SDG 5 (gender) and SDG 8 (work and economic growth). The MTF team collected information from public institutions including health and education facilities as a part of the household survey.[a]

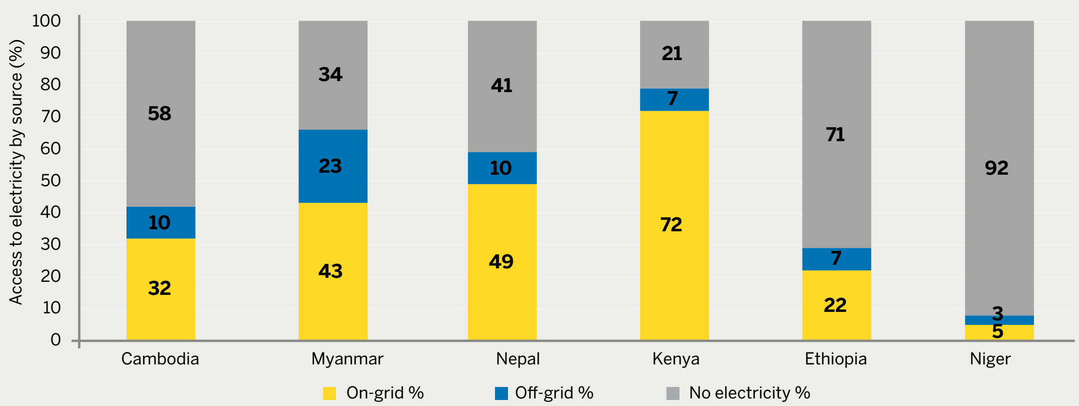
Education facilities[b]

In 2018, the Multi-Tier Framework (MTF) survey compiled data in public institutions in Cambodia, Ethiopia, Kenya, Myanmar, Nepal, and Niger. The data were collected at the facility level by interviewing officers best positioned to respond at the institutions.

In the surveyed countries, 31 percent of educational facilities are electrified through an on-grid source of electricity and 9 percent through off-grid systems; 60 percent have no access to electricity.

The national public grid is the primary source of electricity for educational facilities with access to power. More specifically, 49 percent of schools in Nepal are electrified through the public grid, 72 percent in Kenya, and only 22 percent in Ethiopia. An exception to this trend is Niger, where solar energy sources, including solar home/lighting systems, mini grids, and batteries, are primary providers of electricity for 3 percent of schools. Education facilities also rely on solar as backup power to cover urgent energy demand. This is the case for 86 percent of facilities in Cambodia and 15 percent of schools in Kenya.

FIGURE B1.3.1 • Electrification of schools in selected MTF countries, by source



Schools and other educational facilities use electricity for lighting (72 percent), computers and printers (36 percent), and fans or evaporative air-cooling systems (32 percent). A lack of electricity to power appliances, however, is a major constraint for 40 percent of educational facilities. This is especially true for schools in Myanmar

(56 percent) and Cambodia (28 percent). Other relevant obstacles are the lack of appliances in the market and the high cost of electric-powered items, which reduces the full benefits of access to electricity.

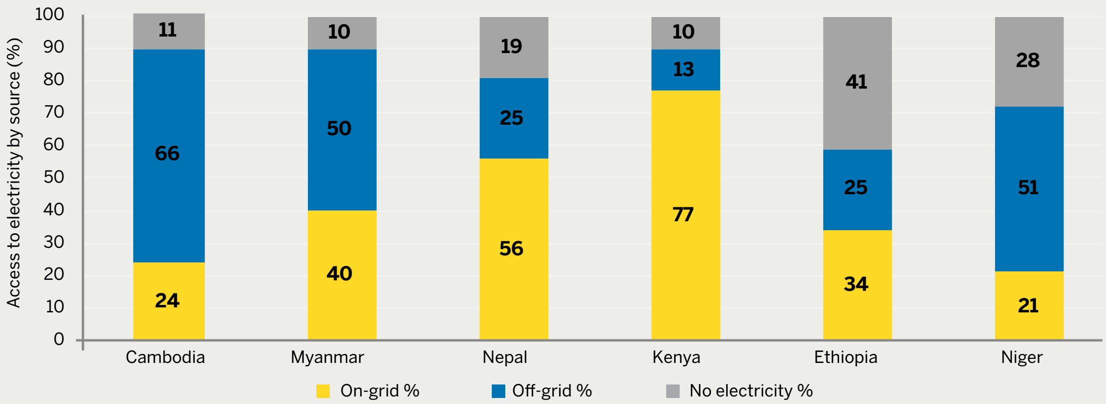
Beyond access, the poor quality of electricity service affects the functioning of educational facilities. At the aggregate level, only 16 percent of schools report enjoying 24 hours of electricity each day. Unscheduled interruptions hinder the functioning of more than 25 percent of educational centers. About 28 percent of schools report damage to equipment from frequent voltage fluctuations.

Health centers[c]

The covid-19 pandemic highlights the need for reliable and affordable electricity to health centers. MTF collected data across 730 health centers, including clinics and hospitals in Cambodia, Ethiopia, Kenya, Myanmar, Nepal, and Niger.

Across the surveyed countries, around 75 percent of health facilities have access to a primary source of electricity (42 percent through grid access, 33 percent through off-grid solutions), while 25 percent remain unelectrified. These aggregate results mask large discrepancies at the country level, as well as quality and reliability of supply. In Kenya, 77 percent of health centers rely on the public national grid to cover their primary electricity needs. At the same time, 66 percent of health centers in Cambodia use off-grid solutions to cover their primary electricity demand, and 83 percent of them use solar systems as a backup power source.

FIGURE B1.3.2 • Electrification of health institutions in selected MTF countries, by source



The health centers use electricity mainly for lighting (57 percent), refrigerators for vaccines (40 percent), and fans or evaporative air-cooling systems (28 percent). They also reported, however, that the use of electric-powered medical appliances is limited owing to no availability, high cost, and insufficient energy.

In every country analyzed, the power supply is compromised by unscheduled interruptions and voltage fluctuations. Twenty-five percent of health facilities reported that unscheduled outages affect the capacity to deliver essential health services. Damage to equipment caused by poor-quality connections and frequent voltage fluctuations are also constraints for 28 percent of health centers.

The electrification of educational and health centers should be designed to promote their long-term sustainability. Advances in off-grid electrification—including remote monitoring and private sector delivery—could be important elements of sustainability. It is possible that even off-grid facilities are being overlooked while planning grid expansion. The cost of extending access is high, but the cost of continued lack of electricity access is higher (UN DESA 2014).

a Within the selected human settlement areas or enumeration areas, field teams identified all public institutions that households in the community could reach out to. Then, the field teams interviewed all (or largest) public institutions identified within and nearby the community.

b The sample of education facilities include data from 179 facilities in Cambodia, 217 in Myanmar, 368 in Nepal, 482 in Kenya, 221 in Ethiopia and 92 in Niger. Definition of education facilities include primary, secondary, vocational/technical schools and universities.

c The sample of health facilities include data from 25 facilities in Cambodia, 67 in Myanmar, 282 in Nepal, 153 in Kenya, 180 in Ethiopia and 23 in Niger. Definition of health facilities include health centers, private clinics, hospitals and referral hospitals.

Source: Multi-Tier Framework, World Bank (https://mtfenergyaccess.esmap.org/).

METHODOLOGY

DATABASE

The World Bank's Global Electrification Database (https://databank.worldbank.org/source/world-development-indicators) compiles nationally representative household survey data as well as census data from 1990 to 2018. 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 1,133 surveys from 144 countries, excluding surveys from high-income countries as classified by the United Nations. In general, about 25 percent of the countries publish or update their electricity data each year, thus permitting global data collection since 2010. Greater investment in data collection and capacity building is needed in order to gain 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 was adapted to predict electricity access and used to fill in the missing data points for the time period between 1990 and 2018. 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 real 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 present report, to avoid having electrification trends from 1990 to 2010 overshadow efforts since 2010, the model was run twice:

- With survey data + assumptions from 1990 to 2018 for model estimates from 1990 to 2018
- With survey data + assumptions from 2010 to 2018 for model estimates from 2010 to 2018

MEASURING ACCESS TO ELECTRICITY THROUGH OFF-GRID SOURCES

GOGLA Global Off-Grid Solar Market Database 2020 is updated through a semi-annual data collection run in partnership with the World Bank Group's Lighting Global program and the Efficiency for Access Coalition. The database contains sales volumes of off-grid solar lighting products that include at least one light point, a panel, and a battery, excluding products sold as components. Sales volumes are collected for every country in the world; however, data on a specific country are included only when it has satisfied the three-data-point rule. This means that at least three separate product manufacturers need to have reported sales for any single data point to be reflected in the figures throughout the report. Where there are fewer than three responses for a region, country, or product category, no results are shown to protect the proprietary interests of the companies that have supplied data in support of this industry report. More information can be found at https://www.gogla.org/global-off-grid-solar-market-report.

IRENA's 2018 off-grid database builds on GOGLA's data, adding mini grid data, data from national rural electrification programs, and data from international development projects, commercial vendors, and nongovernmental organizations. The database covers only developing countries. Its 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 off-grid sector. During the merging of data from these different sources, care is taken not to double count the observations from different sources and to ensure that planned projects and programs have been implemented. To account for the limited lifetime of small solar devices, the number of lights sold or distributed in the last three years is taken as the current number of these devices in operation. It is assumed that solar home systems last for five years (i.e., a five-year total is used) unless there is evidence that a long-term maintenance and replacement program is in place. More details of the methodology used to compile this data can be found in IRENA (2018).

The tier-wise data are presented by technology as:

- Below Tier 1: Lighting (<11W)
- Tier 1: Small solar home systems (11–50W); large solar home systems (>50W); small PV mini grid access
- Tier 2+: Larger PV mini grid access and non-PV mini grids.

In the GOGLA database, the tier-wise data are calculated differently than highlighted above. Tier 1 includes systems with a wattage of less than 11W and multiple lights; Tier 2+ includes solar home systems with a wattage greater than 40W. A reconciliation of the different tier-wise methodologies will be attempted in future reports.

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 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 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. This ensures that demand-side data are being collected. The IEA Energy Access Database sources data, where possible, from government-reported values for household electrification (usually based on utility connections), which focuses 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 (IEA 2019a, 2019c). The World Bank utilizes a similar access structure to determine energy access called the Multi-Tier Framework, ranging in a tiered spectrum, from Tier 0 (no access) to Tier 5 (highest level of access).

These two different approaches can sometimes lead to differing 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 different 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 mostly 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 service provider data.

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 implementing surveys in the field. Household surveys (particularly those taken in remote and rural areas) may suffer from sampling errors that may lead to underestimates of the access deficit.

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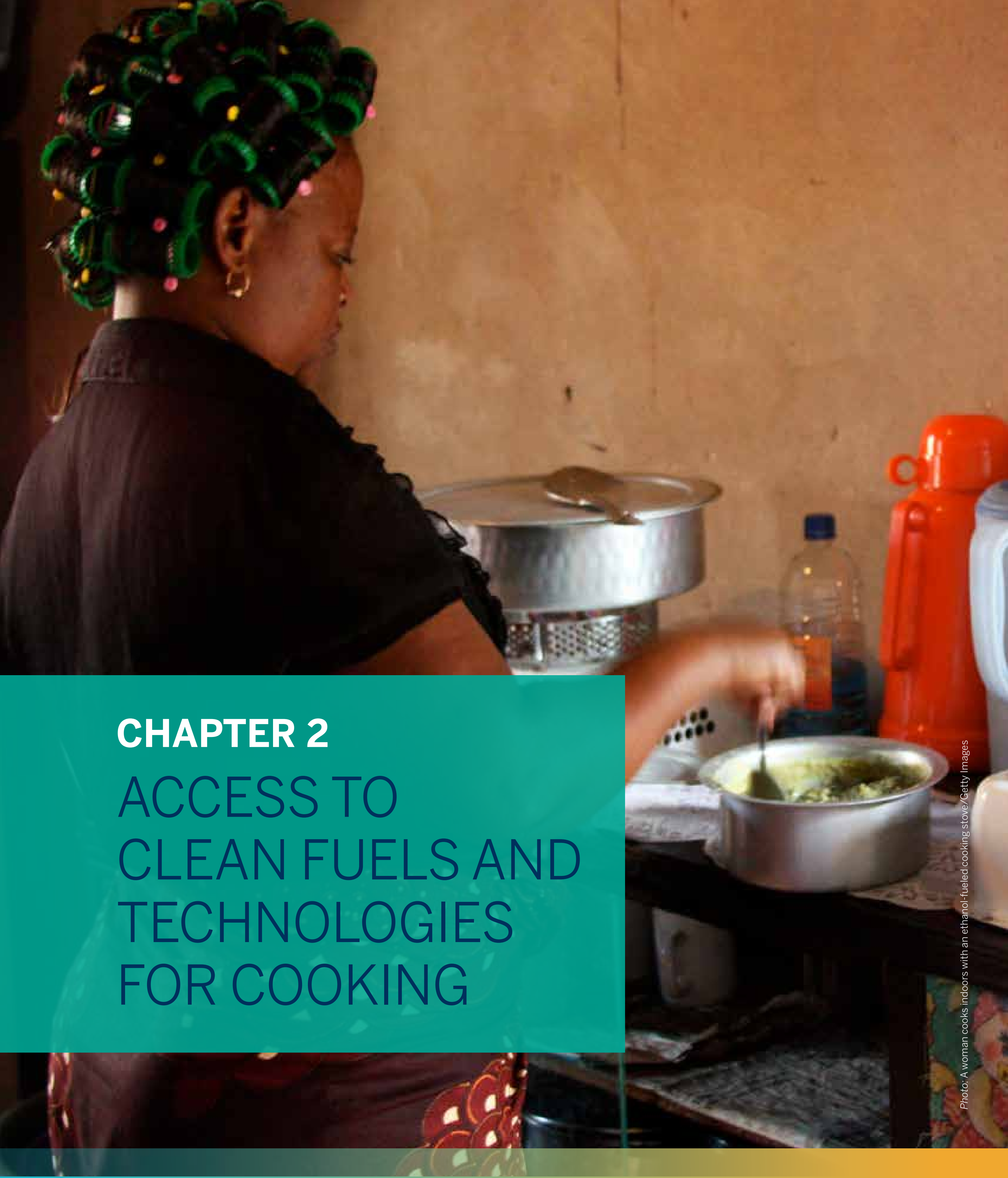

CHAPTER 2

ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

Photo: A woman cooks indoors with an ethanol-fueled cooking stove/Getty Images

MAIN MESSAGES

- **Status of access:** In 2018, 63 percent (56–68 percent[16]) of the global population had access to clean cooking fuels and technologies; the global population without access was 2.8 billion (2.4–3.3) people. Without prompt action, universal access will fall short of SDG goals by almost 30 percent. Meanwhile, exposure to household air pollution will continue to contribute to millions of deaths from noncommunicable diseases (including heart disease, stroke, and cancer) and pneumonia. Household air pollution will continue to worsen climate change.
- **Access and the 2030 target:** The annual rate of access to clean cooking fuels and technologies from 2010 to 2018 increased by less than one percentage point (pp) as population growth outpaced the number of those with access. In the decade leading up to 2030, increases in excess of 3pp per year are required to achieve the goal of universal access to clean fuels and technologies by 2030.
- **Regional highlights:** Greater access to clean cooking was achieved largely in two regions of Asia. From 2010 to 2018, Eastern Asia and South-eastern Asia saw annualized increases in access of 1.6pp—while the numbers of people lacking access fell from 1.0 billion (0.8–1.2) to 0.8 billion (0.5–1.1). Central Asia and Southern Asia also saw improved access to clean cooking, with annualized increases of 1.5pp. The 1.11 billion (0.9–1.3) people without access dropped to 1.0 (0.7–1.3) billion. In Sub-Saharan Africa, meanwhile, a stagnant access rate (annualized increase of 0.4pp) combined with rapid population growth have meant that the numbers of people without access have risen from 750 million (730–750) people to 890 million (870–910) people.
- **Urban-rural divide:** There are urban-rural discrepancies worldwide in access to clean cooking fuels and technologies: 83 percent of urban dwellers have access to clean fuels and technologies, compared with 37 percent of those living in the countryside. These discrepancies have been shrinking since 2010 owing, first, to increased access in rural areas, and, second, to population growth in the cities that is beginning to outpace access.
- **The top 20 countries with access deficits:** From 2014 to 2018, 20 countries accounted for more than 80 percent of the global population without access to clean cooking fuel.[17] In terms of the percentage of the national population lacking access, 19 of the 20 countries with the lowest percentage of the population having access were least-developed countries in Africa. Of these, 15 had annualized increases in access over the same period of less than 0.1pp, with some of these displaying potential decreases in access.
- **Fuel trends:** In low- and middle-income countries of Central Asia and Southern Asia, Eastern and South-eastern Asia, Latin America and the Caribbean, Oceania, Sub-Saharan Africa, and Western Asia and Northern Africa, the use of gaseous fuels (liquefied petroleum gas [LPG], natural gas, and biogas) continues to increase. Since 2010, gas has overtaken unprocessed biomass fuels as the dominant fuel worldwide. (Unprocessed biomass, charcoal, coal, and kerosene are considered polluting fuels.) In urban areas, the use of electricity for cooking has risen, but gas remains the most common fuel. In rural areas, meanwhile, a decline in the use of polluting fuel, particularly raw coal, has been accompanied by increased use of gas, though unprocessed biomass fuels remain dominant. Finally, the global proportion using charcoal is low, but charcoal has overtaken unprocessed biomass in Sub-Saharan cities.

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

17 The top 20 access-deficit countries are the 20 countries with the highest access-deficit population. Among them are Afghanistan, Bangladesh, China, Democratic People's Republic of Korea, Democratic Republic of Congo, Ethiopia, Ghana, India, Indonesia, Kenya, Madagascar, Mozambique, Myanmar, Nigeria, Pakistan, Philippines, Sudan, Uganda, United Republic of Tanzania, and Viet Nam.

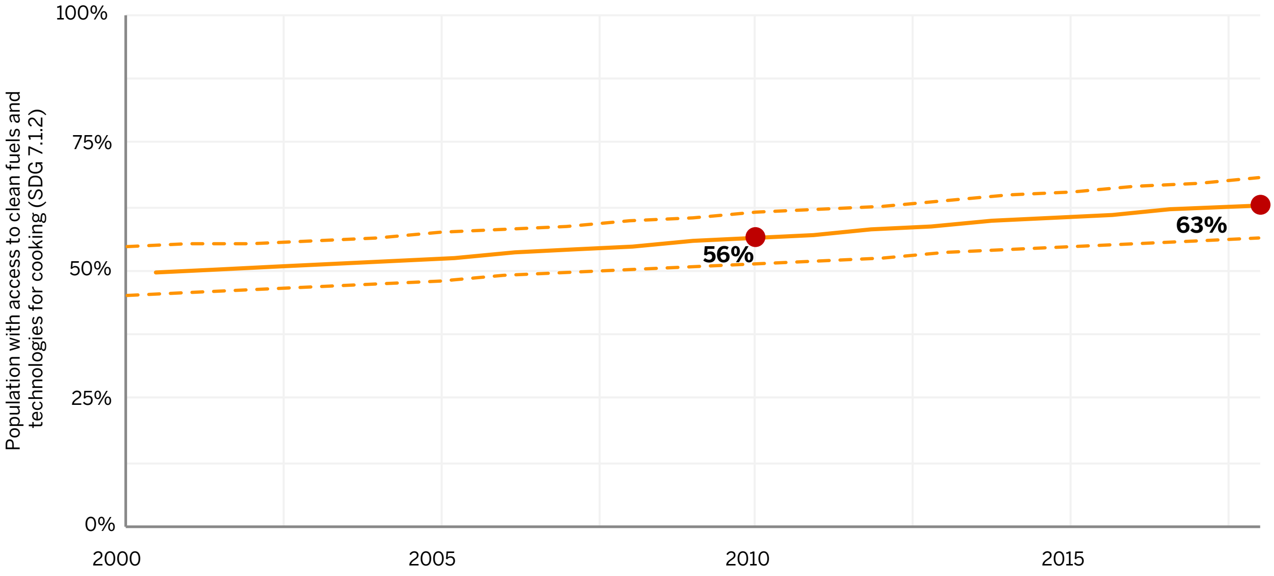
- **Survey harmonization:** Current data collection on household fuel use from national surveys offers a clear picture of access to clean cooking. Historically, however, these surveys typically ask only about the primary cooking fuel, eliciting little information on secondary household stoves or sources of air pollution (i.e., fuels and technologies used for lighting and heating). Improved survey questions regarding household fuel use will allow for a fuller understanding of the health, climate, and social impacts of household energy use, and attributes leading to more sustained adoption of clean cooking.
- **Outlook:** Since 2010, only small improvements in access to clean fuels and technologies for cooking have been realized. Although Asia has made notable gains, stagnant growth in access, combined with rapid population growth, have brought progress in Sub-Saharan Africa to a standstill. If this trend continues, any hope of achieving universal access rates by 2030 will be quashed, leaving a third of the global population vulnerable not only to adverse health effects but also to social and economic disadvantages. The latter is especially true for women and children, who shoulder time-consuming household tasks of gathering fuel and tending smoky stoves. These tasks take them away from remunerative work on the one hand while on the other subject them to adverse environmental conditions. That said, universal access remains achievable if serious efforts were made toward accelerating the transition to clean cooking worldwide, and particularly in Sub-Saharan Africa.

ARE WE ON TRACK?

In 2018, 63 percent (56–68) 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 what can be considered "clean" fuels and technologies are set out in WHO guidelines for indoor air quality: household fuel combustion (WHO 2014). Yet there remain some 2. 8 billion (2.4, 3.3) people who rely on polluting fuels and technologies for cooking, including traditional stoves paired with 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 primarily on clean cooking fuels and technologies. The global access rate has been improving over the past few decades, albeit slowly (Figure 2.1).[18] By 2030, if trends continue, only around 70 percent of the population worldwide will have access to clean cooking fuels and technologies (IEA 2019).This means nearly a third of the global population will be exposed to harmful household air pollution from cooking with polluting fuels and devices, and many will still devote huge amounts of time to gathering fuel instead of on remunerative work, schooling, and other productive or leisure activities.

FIGURE 2.1 • The global population with access to clean cooking (in percentages)



Labels represent access-rate point estimates for 2010 (left) and 2018 (right)

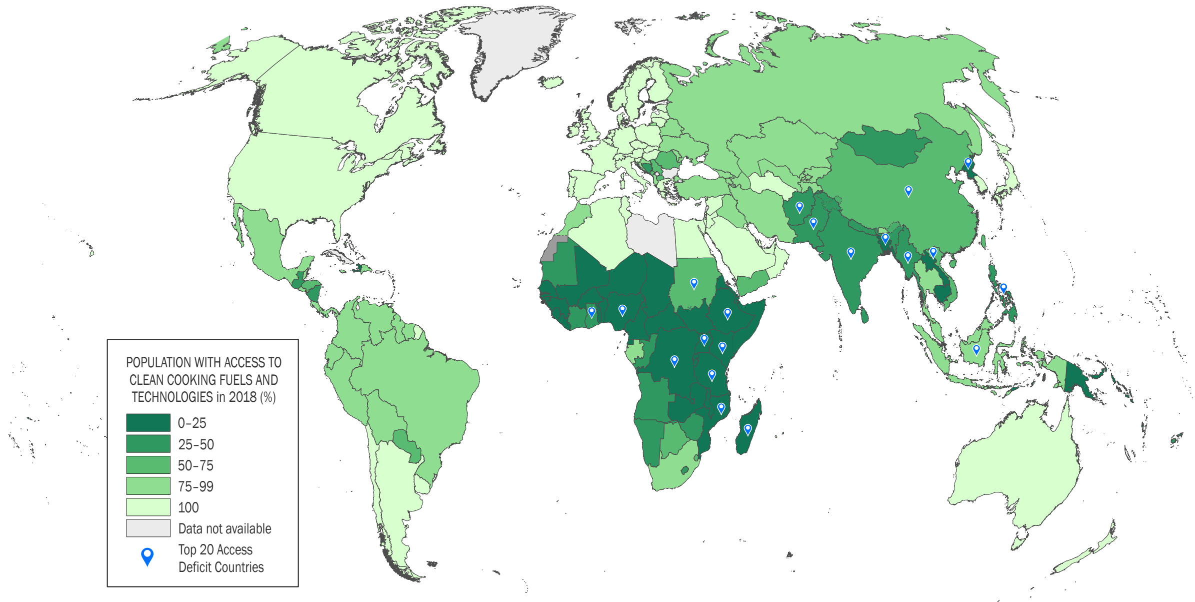
Source: WHO.

Note: The estimates published this year rely on statistical modeling and are in accordance with previous estimates published within the confidence intervals. Progress through 2018 was estimated by modeling survey data and UN population estimates (see methodology section at the end of the chapter).

SDG = Sustainable Development Goal.

18 Except as otherwise indicated, the data underlying the figures in this chapter were drawn in January 2020 from WHO's Household Energy Database, https://www.who.int/airpollution/data/household-energy-database/en/.

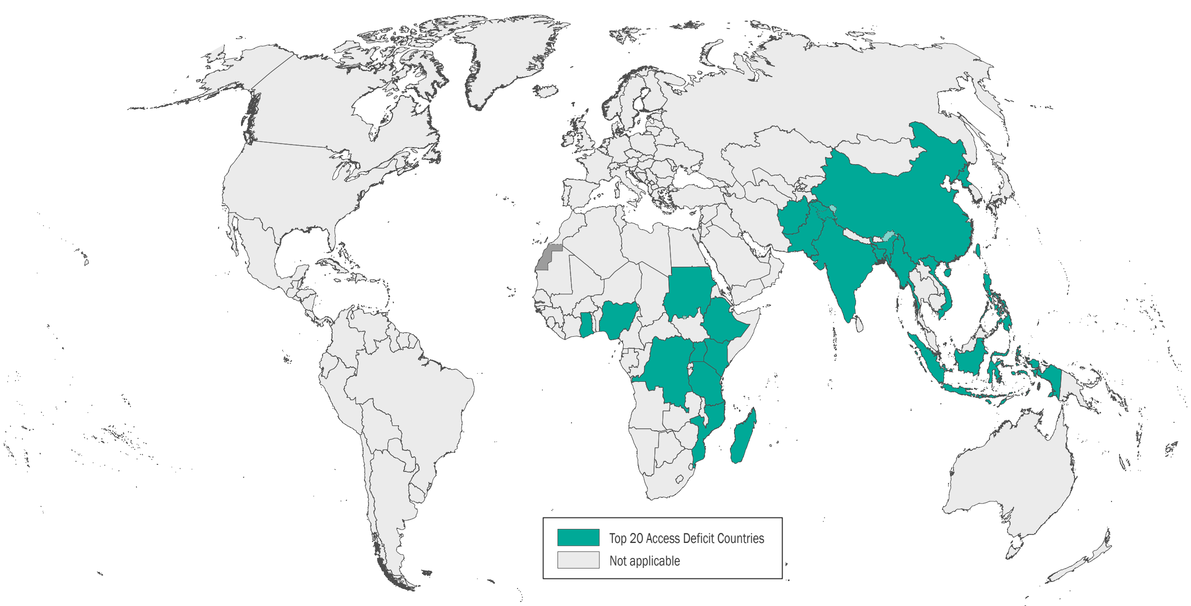
FIGURE 2.2 • Regional populations, by rate of access to clean cooking fuels and technologies, 2018



Source: WHO.

Deficient access rates dominate in the developing countries of Sub-Saharan Africa and Asia (figure 2.2). When considering the average access-deficit for the five-year period between 2014 and 2018, the 20 countries with the largest populations lacking access to clean fuels and technologies are concentrated in these regions (Figure 2.3).

FIGURE 2.3 • Top 20 access-deficit countries, 2014–18

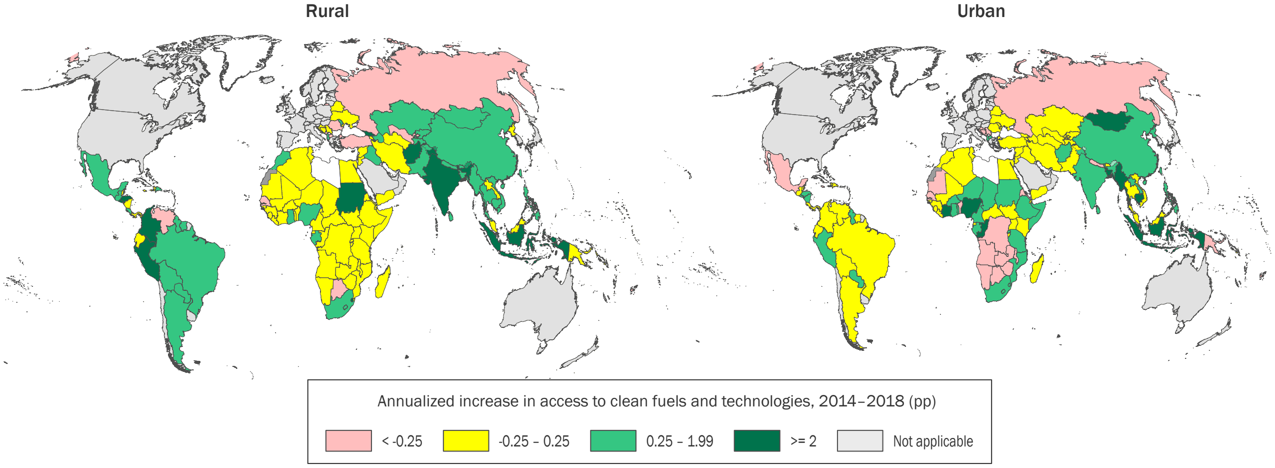


Source: WHO.

Between 2010 and 2018, the regions with the greatest progress in access to clean cooking were Eastern Asia and South-eastern Asia, with annualized increases of 1.6pp, and Central Asia and Southern Asia, with annualized increases of 1.5pp. In Sub-Saharan Africa, however, the access rate was stagnant, with annualized increases of only 0.4pp over this period.

Over the five-year period from 2014 to 2018, rural areas in Latin America, Central Asia and Southern Asia, and Eastern Asia and South-eastern Asia broadly benefited from modest increases in the access rate (Figure 2.4). Meanwhile, Latin American cities saw little change. Urban areas in many Asian countries displayed slower increases in access than their rural counterparts. With a few exceptions, most countries in Sub-Saharan Africa saw little change in rural areas, while country performance in urban areas showed a clear split between countries that improved access over this period and those that did not.

FIGURE 2.4 • Average annual increase (percentage points) in the clean cooking access rate, by urban/rural classification, over the period 2014–18



Source: WHO.
pp = percentage points.

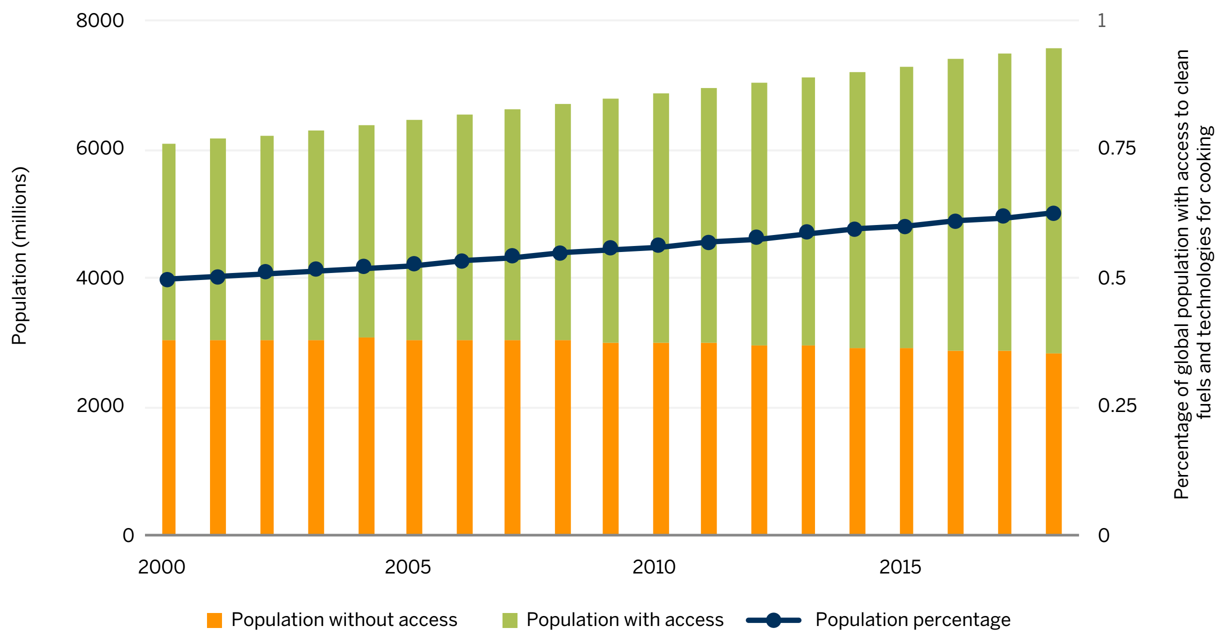
LOOKING BEYOND THE MAIN INDICATORS

ACCESS AND POPULATION

The global access rate to clean cooking fuels and technologies reached 63 percent (56–68) in 2018. As seen in Figure 2.5, the access rate has been steadily rising between 2000 and 2018, with an annualized increase in access to clean cooking of 0.8pp (−0.2, 1.7) between 2010 and 2018. As shown in Figure 2.6, progress in access has decelerated since 2012, dropping from just below 0.8pp per year between 2000 and 2015 to 0.7pp from 2017 to 2018. Even discounting potential slowing of progress, such increases are not enough to reach SDG target 7.1.2 by 2030. Moreover, as seen in previous years, population growth continues to outpace the annual increase in the number of people with access to clean fuel and technologies in Sub-Saharan Africa: Figure 2.7 shows the annualized increase in the number of people with access to clean fuels and technologies (orange), compared to the annualized population increase (green), by region, over the period 2014–18.

Over this period, population growth in 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.

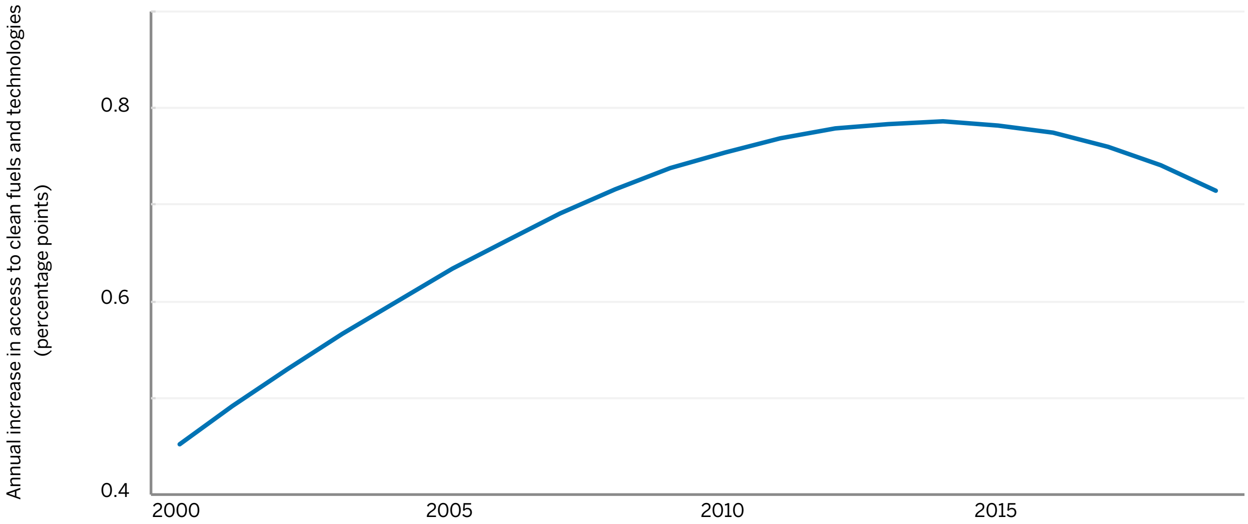
FIGURE 2.5 • Change over time in the absolute number of people (left axis) and percentage of the global population (right axis) with access to clean cooking



Source: WHO.

As a result, in 2018, around 3 billion people lacked access to clean fuels and technologies for cooking. Furthermore, if trends continue without changes in policy, the access deficit will shrink from 2.8 to 2.7 billion people (2.0–3.5) by 2030, about half of them in Sub-Saharan Africa and a quarter of them in Central Asia and Southern Asia. Using IEA's Stated Policies Scenario, 2.3 billion people will still lack access in 2030 under current and planned policies (IEA 2019). Action is urgently needed.

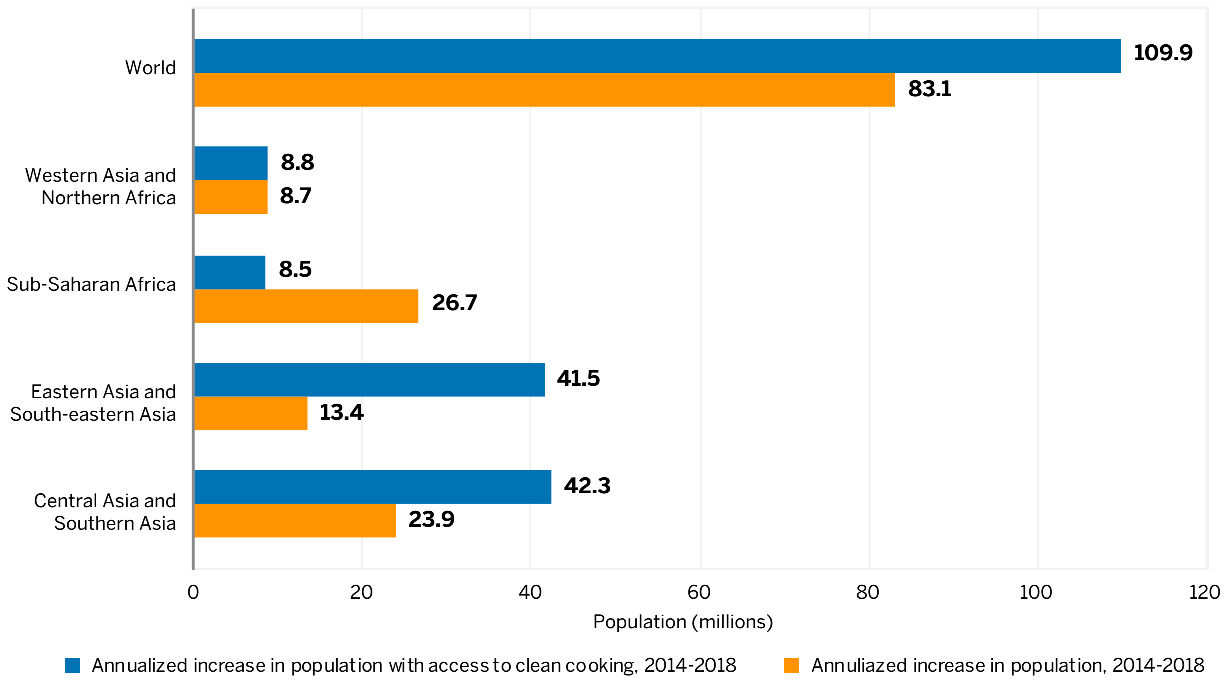
FIGURE 2.6 • Average annual increase (percentage points) in the global clean cooking access rate (the percentage of people with access)



Source: WHO.

In 2010, we estimated that average annual increases of 2pp would be necessary to achieve the goal of universal access to clean cooking. To make up for lax progress over the period 2010–18, however, the necessary annual increases in access rate now exceeds 3pp, nearly four times higher than the 0.8pp seen in the period 2010–18. The longer only marginal improvements are made, the more challenging the goal of universal access by 2030.

FIGURE 2.7 • Annualized increase in population and in the number of people with access to clean cooking over the period 2014–18, by region



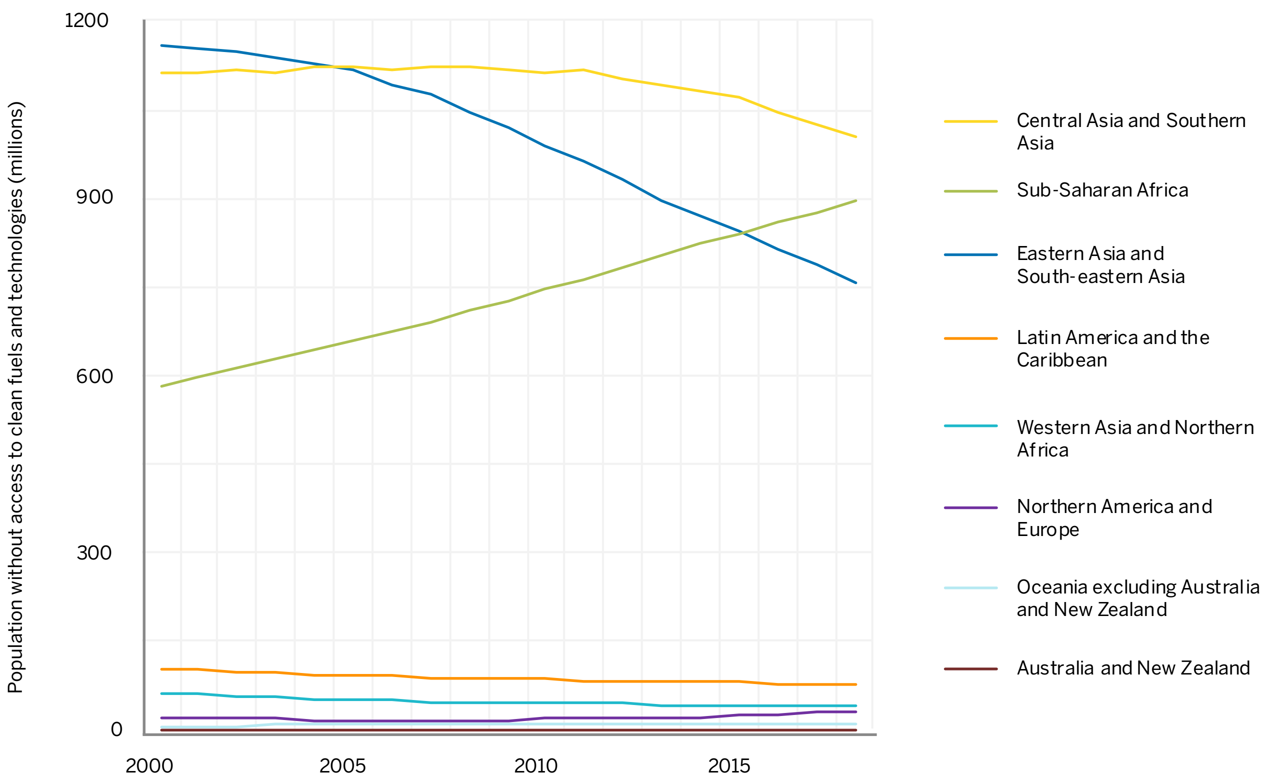
Source: WHO; UN population estimates.

THE ACCESS DEFICIT

While the human cost from polluting cooking is gradually easing in most regions, the trend is being overtaken by alarming population increases in Sub-Saharan Africa: On a global scale, gains in the percentage of population having access to clean cooking have been matched by population growth. These developments have caused a decades-long stagnation in the numbers of people without access to clean cooking, referred to here as the "access deficit." Estimates suggest this number has hardly deviated from 3 billion people in any year since 2000, as illustrated in Figure 2.1, with the 2018 estimate of 2.8 billion people (2.4, 3.3) being equal to the 1990 value of 2.8 billion people (2.4, 3.1).

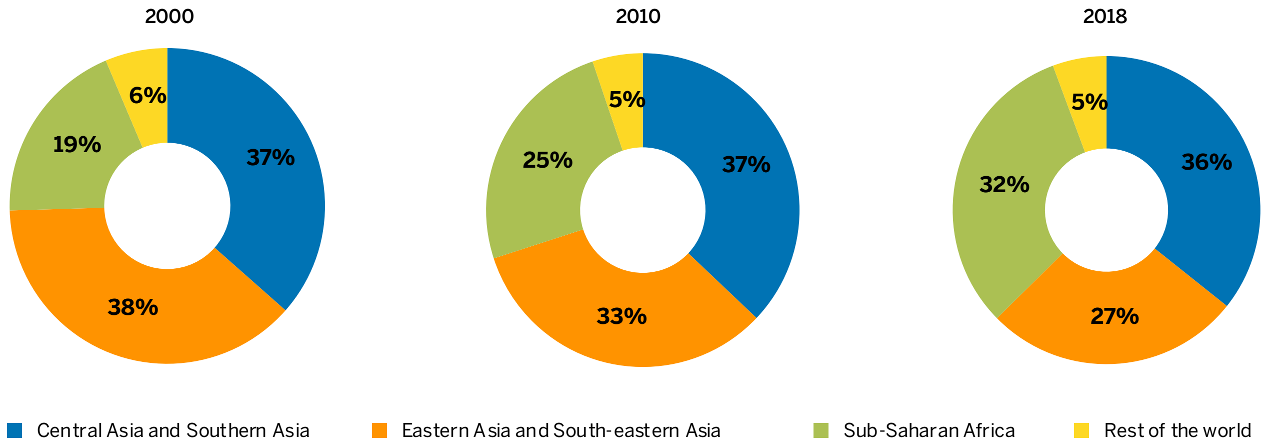
Stagnation in the global access deficit disguises key regional trends. As illustrated in Figure 2.8, the access deficit has decreased consistently in Eastern and South-eastern Asia since 2000 and in the regions of Central Asia and Southern Asia since 2010. In Sub-Saharan Africa, meanwhile, the access deficit is growing and has risen by around a factor of 50 percent since 2000.

FIGURE 2.8 • Access deficits by region (population without access to clean fuels and technologies), 2000–18



Source: WHO.

FIGURE 2.9 • Proportion of the total global access deficit in the three largest deficit regions and the rest of the world, 2000, 2010, and 2018



Source: WHO.

As illustrated in Figure 2.9, from 2000 to 2018, the proportion of the global access-deficit population residing in Central Asia and Southern Asia has shown minimal change, remaining at just over a third lacking access. But the proportion living in Sub-Saharan Africa has increased from approximately one-fifth to one-third of the total; meanwhile, the proportion residing in Eastern Asia and South-eastern Asia has decreased 11 percentage points. As a result, in 2018 more people without access to clean fuels and technologies reside in Sub-Saharan Africa than in Eastern Asia and South-eastern Asia. If observed trends in access and population continue, it can be estimated that in 2030 Sub-Saharan Africa will have the greatest access deficit, at around 44 percent of the region's total population. 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

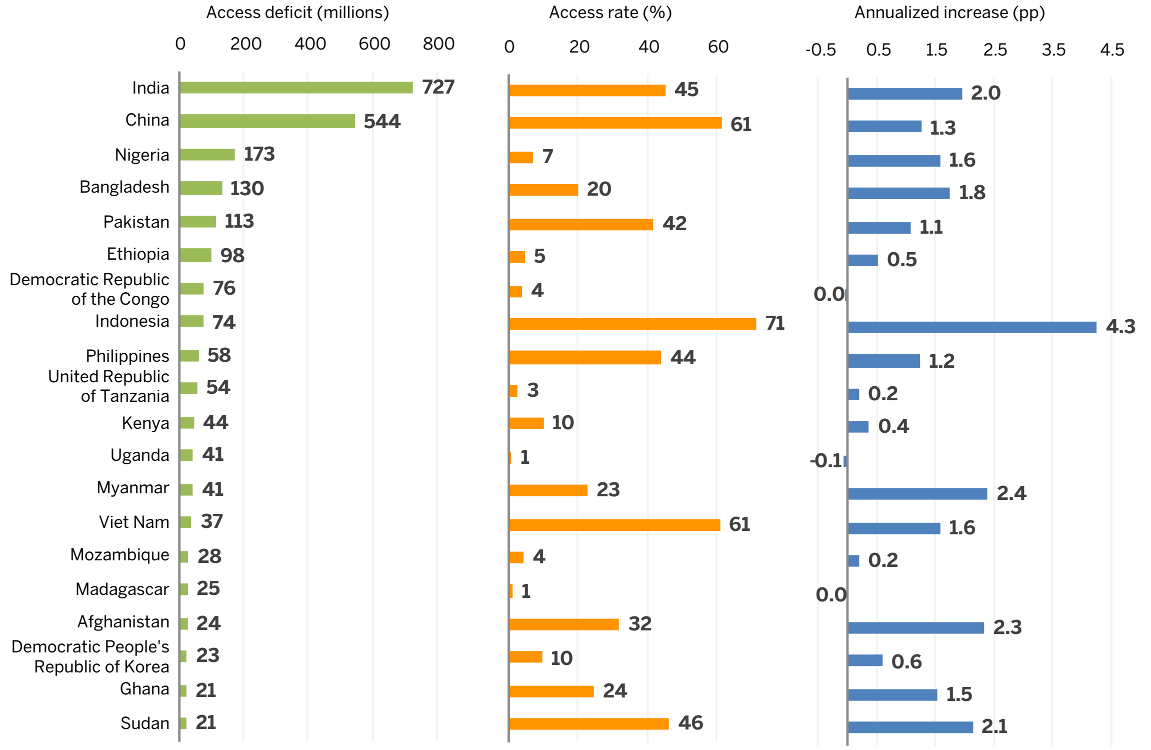
The top 20 access-deficit countries (Figure 2.10) accounted for 82 percent of the global population (2014–18 average) lacking access to clean cooking.[19] India alone still accounts for the largest share of the access deficit at 25 percent, followed by China at 19 percent.

Six out of the 20 countries have proportions of their respective populations with access to clean fuels less than or equal to 5 percent, including Democratic Republic of Congo, Ethiopia, Madagascar, Mozambique, Uganda, and Tanzania. Seventeen out of the 20 countries have access rates under 50 percent.

The 20 countries with the lowest access rates have shown little to no sign of improvement, represented by near-zero annualized increases (2014–18). Rapid annual gains in access (more than 2 percentage points) can, however, be seen in several countries between 2014 and 2018, including Indonesia (4.3 points), Myanmar (2.4 points), Afghanistan (2.2 points), Congo, and Sudan (both at 2.1 points, see Figure 2.13).

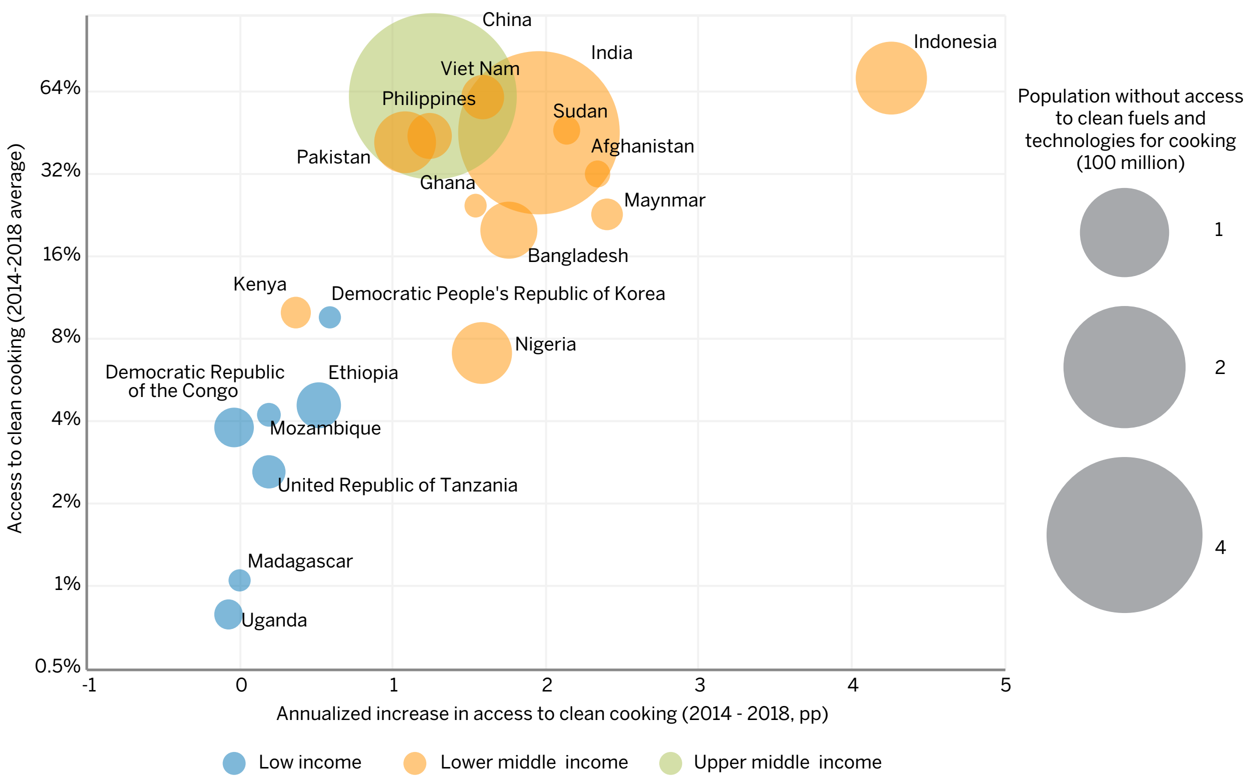
19 The top 20 access-deficit countries are the 20 countries with the highest access-deficit populations. These are Afghanistan, Bangladesh, China, Democratic People's Republic of Korea, Democratic Republic of Congo, Ethiopia, Ghana, India, Indonesia, Kenya, Madagascar, Mozambique, Myanmar, Nigeria, Pakistan, Philippines, Sudan, Uganda, United Republic of Tanzania, and Viet Nam.

FIGURE 2.10 • The 20 countries with the largest populations lacking access to clean fuels and technologies, 2014–18 average



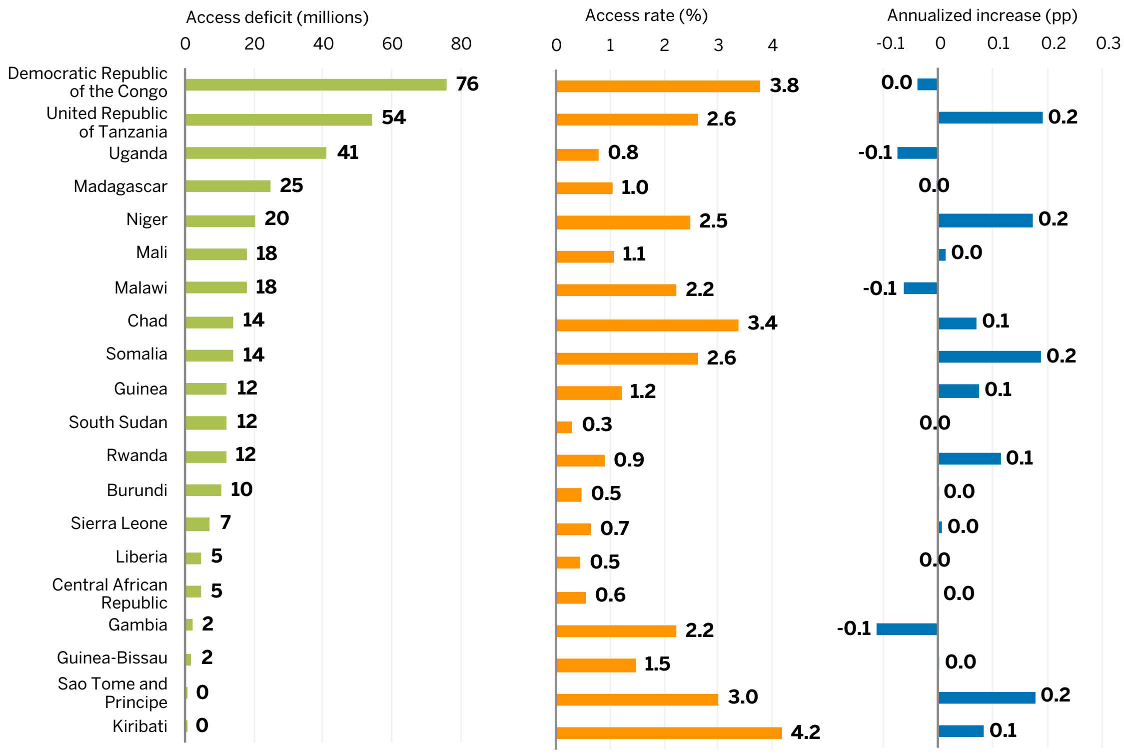
Source: WHO.

FIGURE 2.11 • The 20 countries with the largest access deficits to clean cooking, 2014–18



Source: WHO.
pp = percentage points.

FIGURE 2.12 • The 20 countries with lowest percentage of the population with access to clean fuels and technologies, 2014–18 average

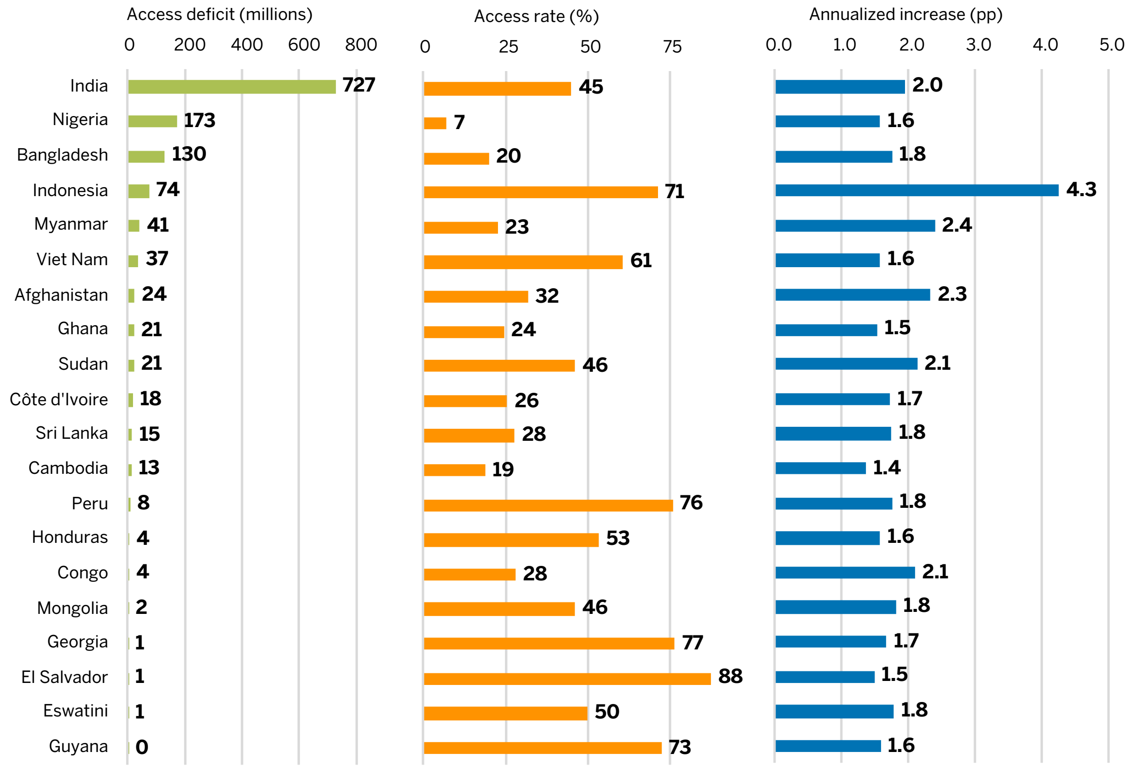


Source: WHO.

pp = percentage points.

Overall, in the 20 countries with lowest percentages of the population having access to clean fuels and technologies (Figure 2.12), the annualized access increase between 2014 and 2018 was small (always less than 0.3 percent); data suggests that a few countries experienced decreases in access to clean cooking fuels during the same period. These 20 countries are all least-developed countries and, with the exception of Kiribati, are all in Africa, highlighting the increasingly important need to address access deficits in Africa. Figure 2.13 shows the 20 countries with the fastest annualized increase (2014–18) in access to clean cooking. Despite relatively steep increases in access, the population lacking access is still significant in some of the larger countries. These countries with the largest deficits also receive disproportionately limited financing (SEforAll 2019) and thus face challenges for scaling up clean fuels and technologies.

FIGURE 2.13 • The 20 countries with the fastest increasing percentage of population with access to clean cooking fuels and technologies, 2014–18 average

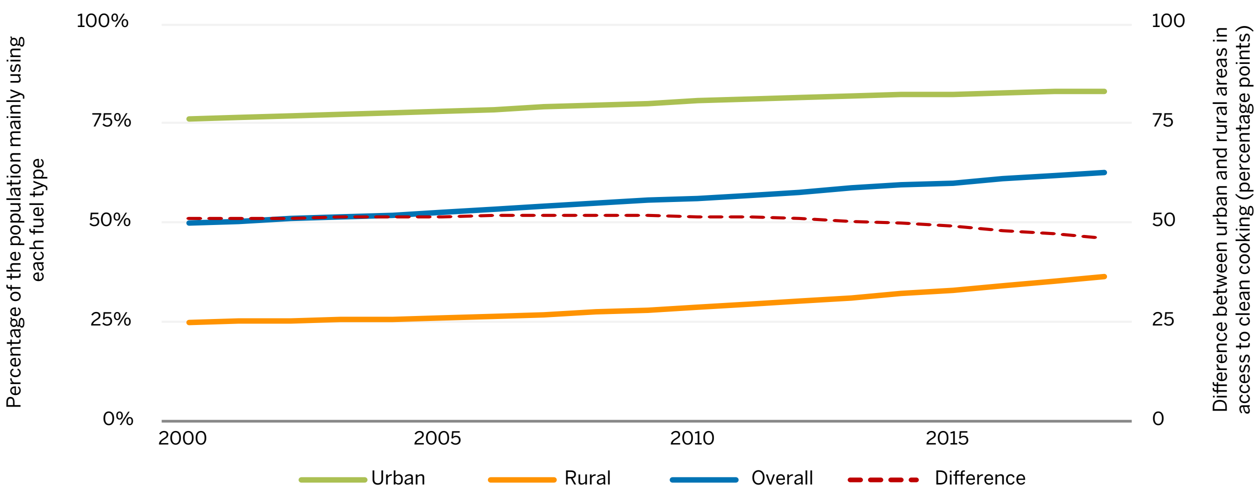


Source: WHO.

URBAN-RURAL DIVIDE

A vast urban-rural disparity persists in access to clean cooking solutions. Urban areas enjoy greater access because of infrastructure and availability of cleaner fuels and technologies. Figure 2.14 shows the percentage of the global population with access to clean fuels and technologies in urban areas, in rural areas, and overall from 2000 to 2018. In 2018, the access rate was 83 percent (76–87) in urban areas and 37 percent (30–45) in rural areas.

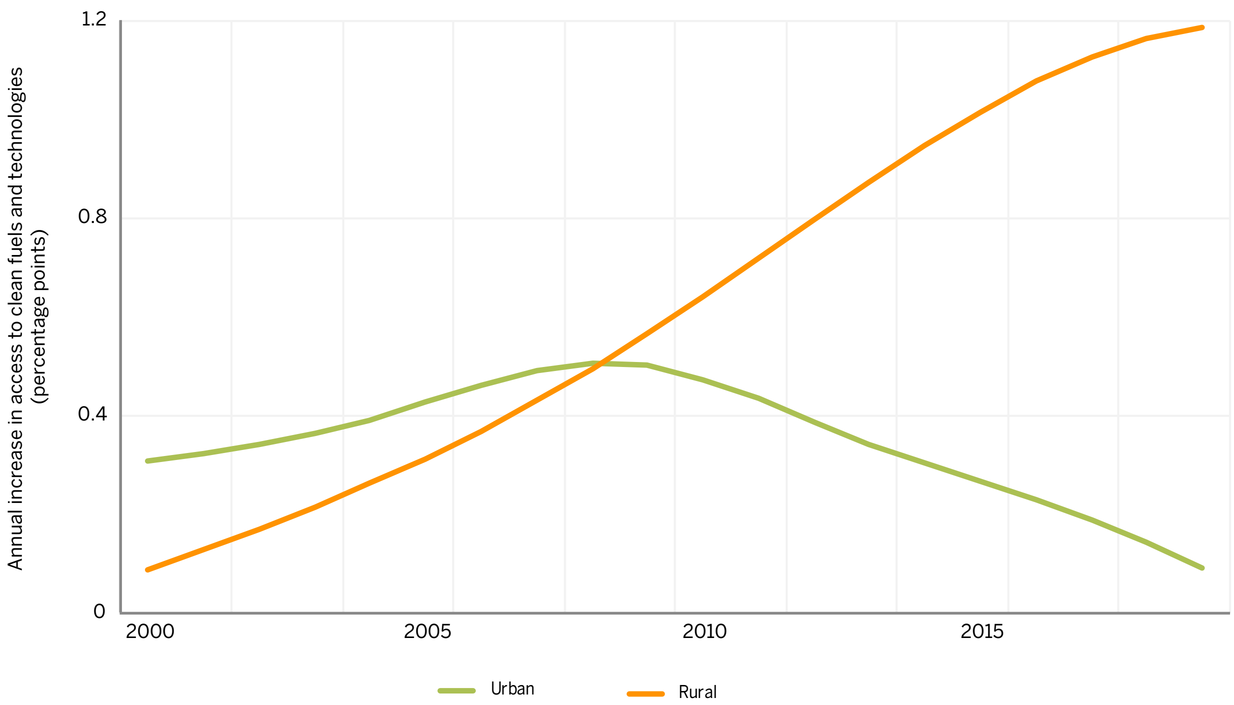
FIGURE 2.14 • Percentage of people with clean cooking access in urban areas, rural areas, and overall (solid lines), and discrepancy in access between urban and rural areas (dashed line)



Source: WHO.

Between 2000 and 2010 the disparity between urban areas and rural areas in access to clean cooking was fairly constant at just over 50 percentage points (52pp [45–57] in 2010), but this has steadily fallen over the past decade, as illustrated in Figure 2.14, to 46pp (36–55) in 2018. This is explained by trend changes in the annual increase in access to clean fuels and technologies for urban and rural areas (Figure 2.15). In rural areas, the annual increase has risen consistently, from only 0.2pp between 2000 and 2001 to 1.2pp between 2017 and 2018. In contrast, the annual increase in urban areas has fallen consistently over the past decade, from a high of 0.6pp between 2007 and 2008 to only 0.2pp between 2017 and 2018. This means that while access has accelerated in the countryside, it has been decelerating in urban areas. In fact, if observed trends continue and population growth outpaces access to clean fuels, the proportion with access to clean cooking is projected to decline in urban areas as the new decade begins. Meanwhile, some countries with rapid access growth will reach near-universal access, from which point increased access is no longer possible.

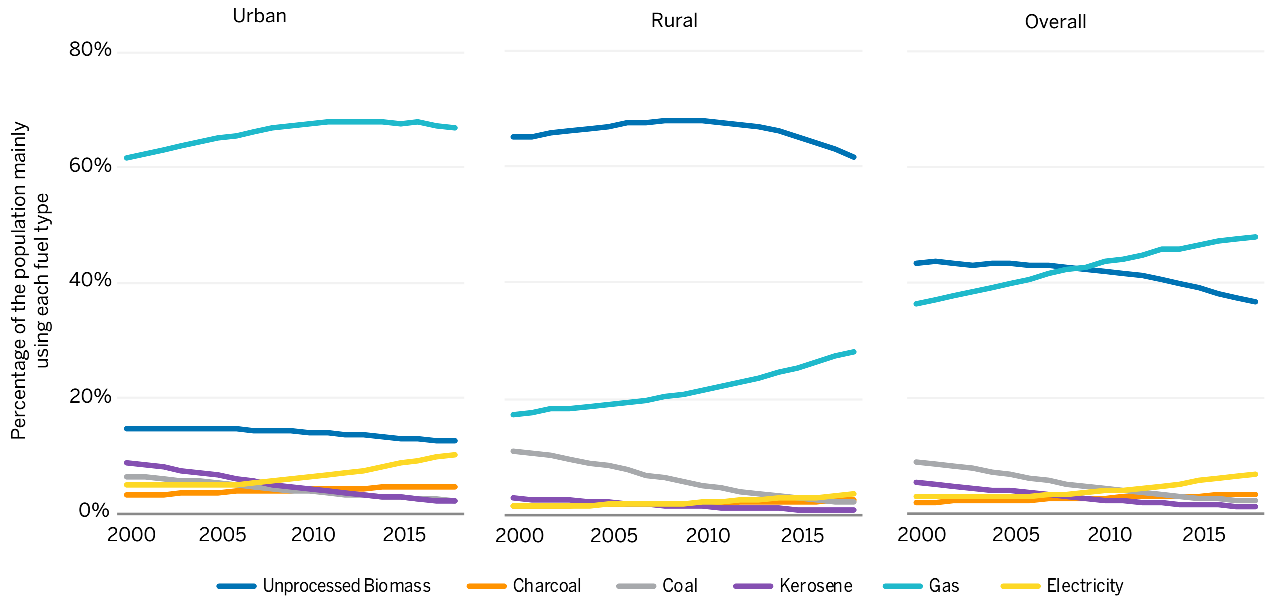
FIGURE 2.15 • Annual increase in access to clean fuels and technologies for urban and rural areas



Source: WHO Global Household Energy Model (Stoner and others 2019).

A deeper analysis of individual fuel access, at country and region levels, can help gauge the effects of current policies on household energy use and inform future policies and programs. Using estimates derived from household surveys and advanced modeling techniques, a few notable trends can be seen across regions and countries.

FIGURE 2.16 • Percentage of people using each cooking fuel type, for urban areas, rural areas and overall in low- and middle-income countries



Source: WHO Global Household Energy Model (Stoner and others 2019).

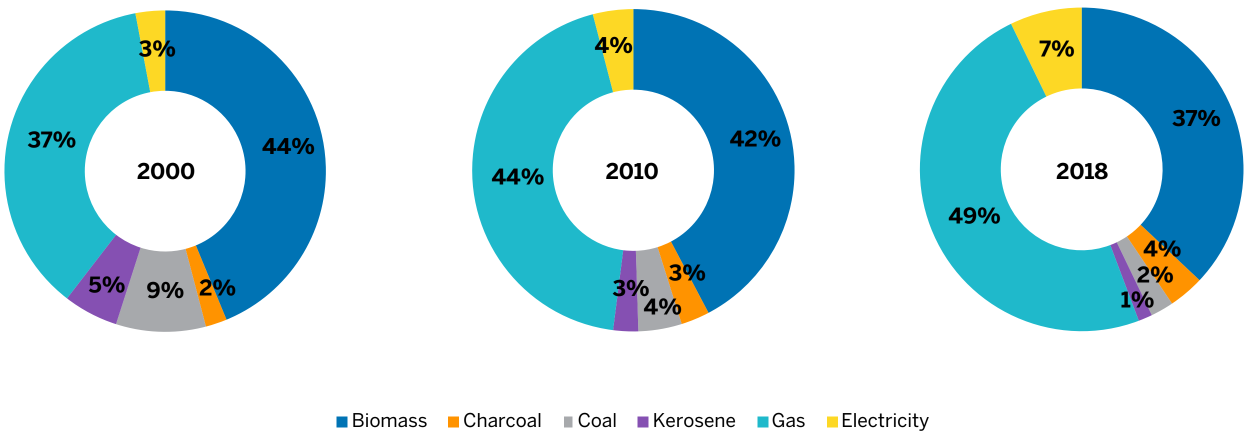
Among low- and middle-income countries, the use of gaseous fuels[20] increased consistently from 30 percent (23–40) in 1990 to 48 percent (42–56) in 2018, overtaking unprocessed biomass fuels[21] as the dominant type of cooking fuel over the past decade (figures 2.16 and 2.17). Use of electricity for cooking has also risen, from 3 percent (2–4) in 2000 to 7 percent (4–12) in 2018, though the increase was far more notable in urban areas (Figure 2.16). 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 the use of coal dropped from 11 percent (6–17) in 2000 to 2 percent (1–6) in 2018, and also in the use of kerosene, particularly in urban areas, where use dropped from 9 percent (7–10) in 2000 to 2 percent (1–3) in 2018. 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 (63–72) in 2010 to 62 percent (54–69) in 2018.

Although the use of kerosene has dwindled worldwide (figures 2.16 and 2.17), it remains prominent in urban areas of low- and middle-income countries in both Oceania (16 percent [8–35] in 2018) and in Sub–Saharan Africa (9 percent [6–11] in 2018). Globally the proportion using charcoal is low (4 percent [3–4] in 2018), but in Sub-Saharan urban areas its use has overtaken unprocessed biomass (29 percent [26–33] in 2018).

20 Gaseous fuels, or simply "gas," refer to liquefied petroleum gas, natural gas, or biogas.

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

FIGURE 2.17 • Comparison of the percentage of people using each fuel type among low- and middle-income countries in 2000, 2010, and 2018



Source: WHO Global Household Energy Model (Stoner and others 2019).

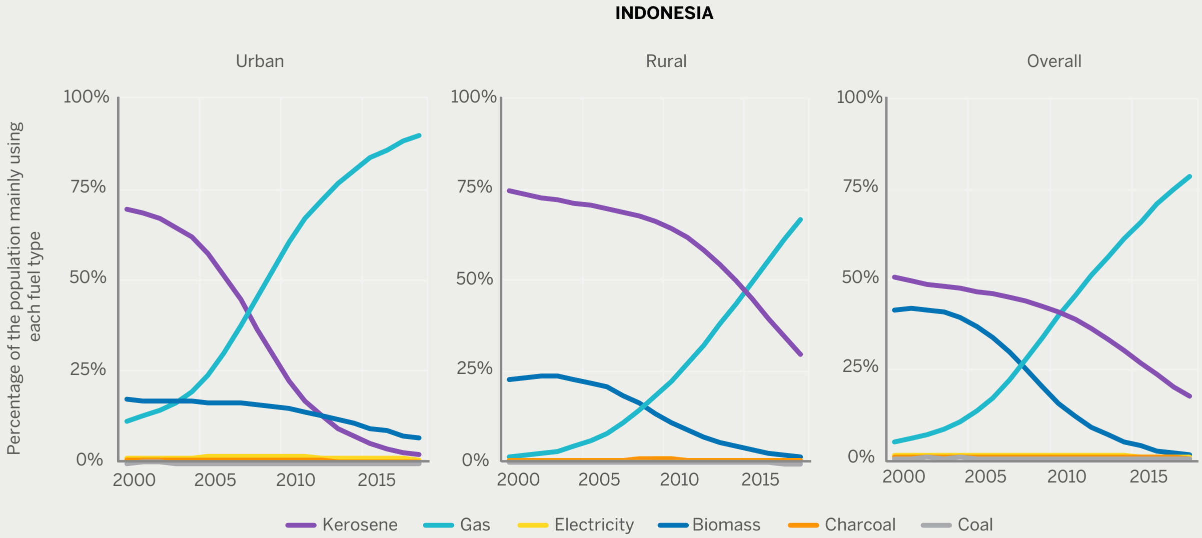
BOX 2.1 • SPECIFIC FUEL USE IN INDONESIA

Between 2000 and 2018, Indonesia saw the fastest growth in the percentage of people using clean fuels and technologies of any country, as illustrated in Figure B2.1.1. Here, the use of gaseous fuels—liquefied petroleum gas (LPG), natural gas, and clean biogas—rose considerably from 5 percent (1–13) in 2000 to 79 percent (65–88) in 2018.

In 2007, Indonesia launched an ambitious program to replace kerosene use with LPG in households and micro-businesses. The government had subsidized kerosene for decades, but the decline in domestic supply combined with rising oil prices (and the consequent increase in the subsidy) motivated an initiative to replace it. Indonesia planned and executed its transition to LPG in several SDG 7 efforts, including feasibility studies, field tests, distribution of conversion packages, strategic execution based on infrastructure readiness, and identification of areas of high consumption potential and follow-up surveys to assess user satisfaction. Continuity of the program is influenced by household income, infrastructure readiness, and access to sales points (Thoday and others 2018).

Consequently, in urban areas, the rise in LPG use has come overwhelmingly at the expense of kerosene, the use of which has dropped from 70 percent (53–83) in 2000 to 2 percent (0–11) in 2018. The use of kerosene also fell considerably in rural areas, from 22 percent (12–36) in 2000 to 1 percent (0–9) in 2018. However, the use of unprocessed biomass fuels also fell overall, dropping about 10pp between 2000 and 2010, after which the decrease accelerated considerably, dropping a further 35pp between 2010 and 2018.

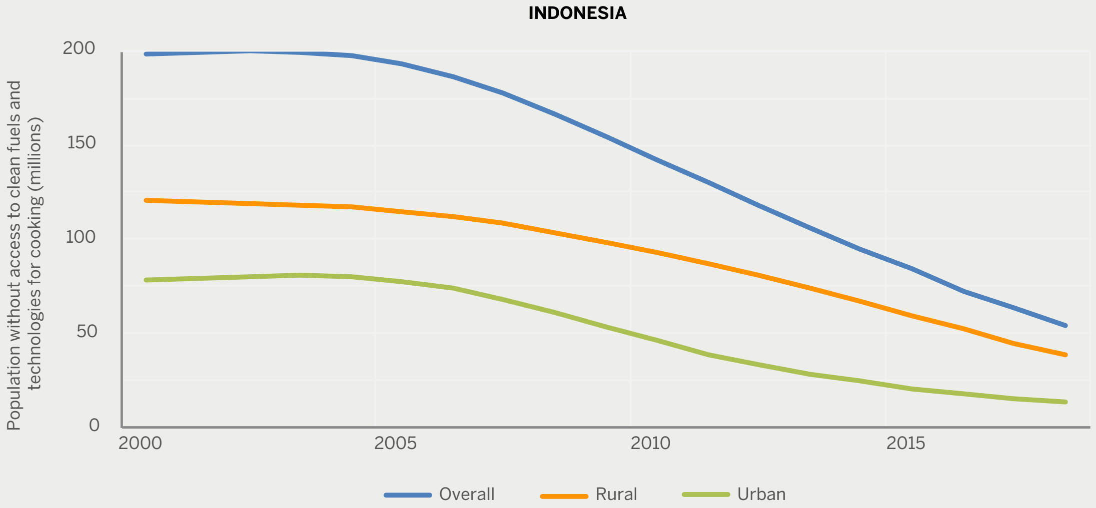
FIGURE B2.1.1 • Estimates of the population (percentages) in Indonesia relying on individual fuels for cooking (2000–18), with associated 95 percent confidence intervals



Source: WHO Global Household Energy Model (Stoner and others 2019).

The effect of these efforts is illustrated in Figure B2.1.2. In 2000, 199 million (179–208) Indonesians did not have access to clean fuels and technologies—78 million (64–86) in urban areas and 121 million (115–122) in rural areas. In 2018, about a quarter as many people did not have access to clean cooking—54 million (31–88), 13 million (4–32) of whom live in cities, and 38 million (23–57) in rural areas—leading to greatly diminished health outcomes and increased economic and social burdens for Indonesia.

FIGURE B2.1.2 • Population without access to clean fuels and technologies in Indonesia: urban, rural, and overall



Source: WHO Global Household Energy Model (Stoner and others 2019).

POLICY INSIGHTS

Lack of access to clean fuels and technologies for cooking contributes to 4 million deaths each year in low and middle-income countries. It has been linked to heart disease, stroke, chronic obstructive pulmonary disease, pneumonia, adverse pregnancy outcomes, and cancer. This pollution is not restricted, however, to the household environment alone, as it contributes as well to localized pollution, disrupting regional environments. Household air pollution affects climate change: cooking and heating account for some 25 percent of black carbon emissions worldwide (Bond and others 2013), and around 30 percent of the wood fuel harvested globally is unsustainable, which results in climate-damaging emissions equivalent to 2 percent of emissions worldwide (Bailis and others 2015).

These facts make a compelling case for policies on universal access to clean cooking fuels and technologies. These policies should be informed by data and integrated into the national agenda, while taking regional variations into consideration. More detailed national and regional data on cooking fuels will provide a more accurate picture of the situation and furnish policy makers with more information (box 2.2).

BOX 2.2 • ENHANCED MONITORING: CORE QUESTIONS ON ELECTRICITY ACCESS AND HOUSEHOLD ENERGY FOR HOUSEHOLD SURVEYS FINALIZED

National household surveys are an essential tool in monitoring household energy use and producing better understanding of the impacts on health and sustainable development. The data currently collected on household energy use offer us a snapshot of access. In the end, however, they provide insufficiently detailed information on patterns of household energy use and the diverse effects of these patterns on health and the environment across the globe. In recognition of these shortcomings, the World Health Organization and the World Bank's Energy Sector Management Assistance Program have developed a new set of household survey questions. These questions were refined through a collaborative process involving a diverse set of policy makers, researchers, and program implementation professionals through a series of expert consultations. These questions have also been extensively piloted in the field.

Shortcomings in previous surveys

Historically, national surveys and censuses often included only a single question: Was the household connected to a national electricity grid? This simplistic approach does not consider the quality and quantity of the service, such as potential breakdowns, voltage fluctuations, and hours of supply. To fully capture the varieties of household access, the survey must include questions about off-grid options.

Similarly, national surveys and censuses have historically asked only about the use of the primary fuel used for cooking. Other energy-intensive household activities (for example, heating and lighting or supplementary cooking) also produce emissions with adverse impacts. It is essential to collect data on all fuels and technologies used for household cooking, heating, and lighting to fully capture the exposure to health-damaging household air pollution. To account for fuel stacking and more accurately measure household exposure to air pollution, surveys need to ask about all types of fuel and stoves used for household activities—both main and supplemental fuels. Response options in the new core questions tie in directly to the WHO guidelines for indoor air quality: household fuel combustion (WHO 2014), so survey results will be able to classify households according to evidence-based and consistent definition of clean or polluting fuels and technologies.

New core questions

The new core questions on electricity access and household energy for household surveys capture national data on SDG 7, to "ensure access to affordable, reliable, sustainable, and modern energy for all," specifically indicator 7.1.1 on the proportion of the population with access to electricity, and indicator 7.1.2 on the proportion of the population with primary reliance on clean fuels and technologies.

The core questions are available for download: https://www.who.int/airpollution/household/survey-harmonization/en/. Supporting materials such as a guidebook for use by statistical offices are forthcoming.

Household exposure to air pollution and the household burden of fuel collection have been shown to disproportionately affect women and children. In order to assess the existence and magnitude of this trend on a global scale across diverse cultures and populations, the core questions capture data on the time burdens of collecting fuels and cooking, linked to identifying information on the age and sex of the primary cook and fuel collector.

Stronger data can lead to stronger policies

Designing and implementing successful national and subnational strategies to promote cleaner and safer household energy require a detailed understanding of current energy use. The questions presented in this guide have a central goal: to fill the data gaps enumerated above and, by standardizing survey questions, to enable cross-national comparison and validation of data. Better data will assist in the design of policies that encourage uptake and sustained use of clean household fuels and technologies.

GEOGRAPHIC VARIATIONS

The global transition from polluting to clean household energy use is proceeding too slowly. But more rapid progress is possible with the right mix of national policies, programs, and targeted interventions. For example, since 2001 Indonesia has prioritized the transition to clean cooking fuels, reducing the number of people using polluting fuels for cooking by almost 75 percent. In 2016, India launched Pradhan Mantri Ujjwala Yojana scheme, which prioritizes LPG connections to rural households to benefit women living below India's poverty line. Nigeria launched a campaign in Lagos and Abuja to disseminate information about LPG and encourage the switch to this fuel for cooking. In Bangladesh the government has worked to create awareness among users and promoted LPG as the cooking fuel for households; it has also reinforced monitoring systems to ensure safety and security. These countries, together with Myanmar, Viet Nam, and Afghanistan, were among the 20 countries with the largest populations lacking access to clean cooking during the period 2014–18. But because of efforts to transition, they were also among the 20 countries with the fastest-increasing access to clean fuels for the same period.

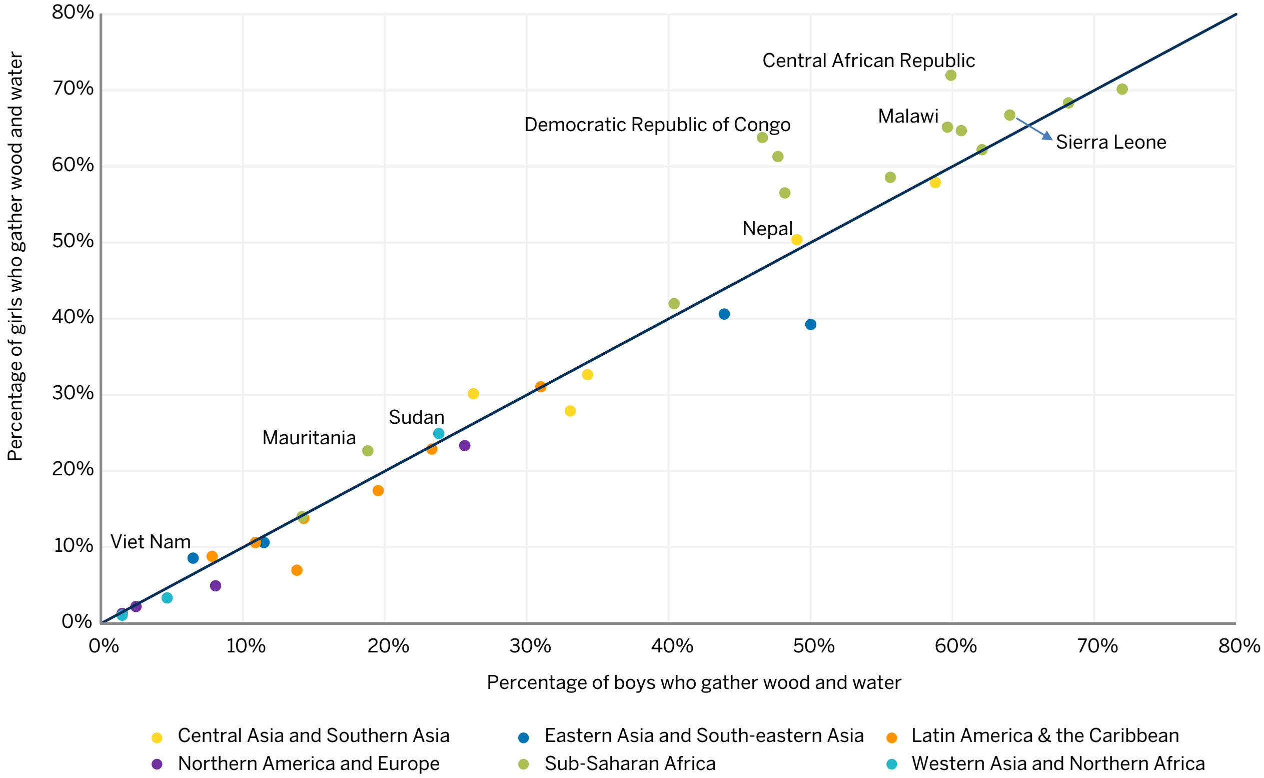
Rural areas across the globe have seen vast improvements: more than a quarter of a billion people have gained access to clean cooking fuels since 2010. Despite increasing rural access to clean cooking fuels, urbanization is outpacing the expansion of access. Furthermore, slum populations are often not captured in surveys. People living in densely populated settings, including humanitarian camps and slums, often rely on polluting fuels to meet their daily energy needs. Access to clean cooking fuels and technologies, while more readily available in urban areas, are still hindered in slums. Policymakers need to focus on this shortfall in access.

YOUTH, GENDER, AND HEALTH IMPLICATIONS

During 2018, 2.8 billion people were exposed to household air pollution. This exposure has been previously linked to high blood pressure and respiratory and cardiovascular disease (Ezzati and others 2007; McCracken and others 2007). The use of polluting fuels increases the risk of burns, injuries, poisoning, chronic headaches, and many other ills. The most vulnerable group thus exposed are women and children, as they are traditionally the procurers and users of polluting household fuels.

In access-deficit countries in Sub-Saharan Africa, a sizable percentage of children spend time gathering fuels. In addition, based on WHO statistics, the procurement of fuels is predominantly done by girls over boys (Figure 2.18). This imbalance creates a bias from an early age as girls spend more time procuring fuels instead of other activities, for example, receiving education.

FIGURE 2.18 • Percentages of girls and boys who gather wood and water[22] among all children in a given country, by WHO region, for the period 2010–17



Source: WHO.

Note: The World Health Organization categorizes the world into six regions: African Region (AFRO), Eastern Mediterranean (EMRO), European (EURO), The Americas (PAHO), South-East Asia (SEARO), and the Western Pacific (WPRO). A list of the countries in each region is available here: https://www.who.int/about/who-we-are/regional-offices

The degradation of household air quality because of polluting cooking fuels affects all household members. Some studies show, however, that the concentration of particles in the air increases drastically during meal preparation. This has an outsized effect on women and children because they are traditionally tasked with cooking.

Universal access to clean cooking fuels and technologies would also help attain other SDGs. The benefits of access to clean fuels and technologies include: better health and well-being (SDG 3), education (SDG 4), fewer gender inequalities (SDG 5), affordable and clean energy (SDG 7), economic growth (SDG8), sustainable cities and communities (SDG 11), and climate action (SDG 13).

22 Due to limitations in data collection methods, specific data on fuelwood collection cannot be disaggregated.

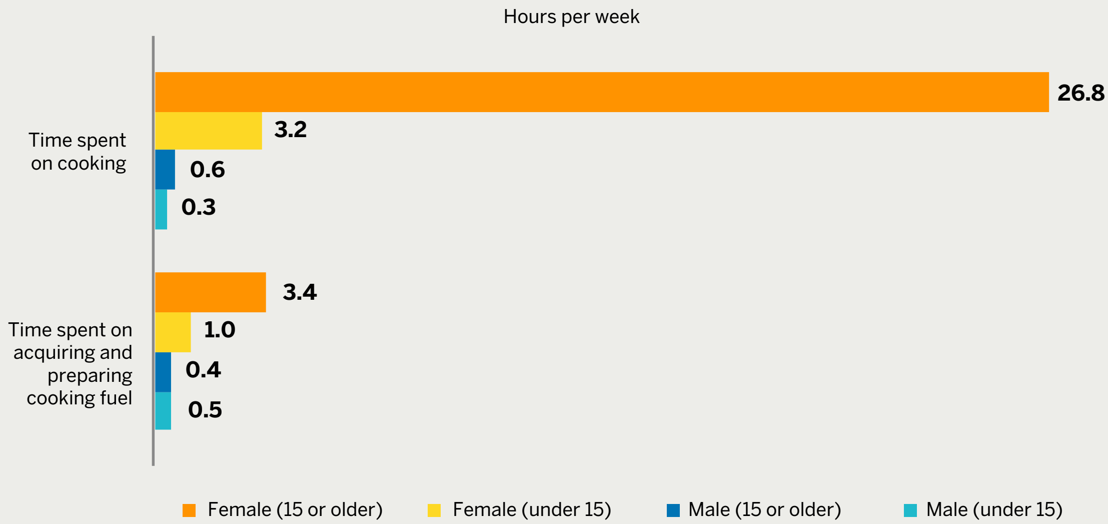
BOX 2.3 • CLEAN COOKING AND GENDER

In developing countries around the world, millions of women and girls live in energy poverty, risking their lives every day by working long, arduous hours to secure the energy needed by their households to cook their family's meals. The time spent cooking over inefficient stoves and procuring fuel restricts women's ability to partake in paid, as well as educational, political, and social activities, thereby perpetuating gender inequality, economic poverty, and a persistent drudgery trap. In addition to cooking, women also endure incredible hardships for fuel acquisition—walking long distances searching for fuel and carrying heavy loads of firewood and water. Displaced women have even worse burdens, in many cases having to walk for hours to find firewood, sometimes spending the night outside of camps set up for displaced people, and thus increasing their vulnerability to physical and sexual attack, dehydration, and other injuries. As the primary cooks in most developing-country households, women are more susceptible than men to household air pollution, as they are more likely to inhale toxic smoke from inefficient cooking fires.

Analyses of access to cooking fuels and technologies based on gender of head of household in Cambodia and Nepal show significant variability between countries and between urban and rural areas in-country. For example, the World Bank Multi-tier Tracking Framework (MTF) reports find that in Nepal (ESMAP 2018a), 43.6 percent of households run by women use clean-fuel stoves, compared to 36.1 percent of households headed by men. In Cambodia, meanwhile, no significant difference by gender exists in stove type for urban households (ESMAP 2018b); in the countryside, improved cooking stoves are less common among households headed by women (33.6 percent) than among households headed by men (41.7 percent). A common denominator in these countries: women are in charge of cooking, regardless of fuel and technology.

An in-depth analysis using data from Uganda shows that although female- and male-headed households show similar rates of access to clean cooking (at the country level, as well as in urban and rural areas), female-headed households tend to have better access to clean cooking than male-headed households as household expenditure level increases. Among the richest 40 percent of households, women have greater access to improved cookstoves (Bhojvaid and others 2014) and clean-fuel stoves (WLPGA 2014) than men. In terms of household time spent on cooking, women and girls spend much more time than men and boys. In Uganda, women (15 years and older) spend on average 3.8 hours per day cooking, and girls spend close to 30 minutes. In contrast, men and boys are virtually not involved in cooking. Similarly, female household members will often spend much more time acquiring and preparing fuel than men and boys. In Uganda, women spend 3.4 hours per week in cooking fuel acquisition and preparation—over 7.5 times more time than men (Figure B2.3.1).

FIGURE B2.3.1 • Time spent acquiring fuel and preparing food, by gender



Source: Multi-Tier Framework, World Bank (https://mtfenergyaccess.esmap.org/), accessed in March 2020.

The introduction of clean cooking fuels can drastically reduce the time women spend on unpaid household meal preparation; clean cooking also promotes more cost-efficient fuels and thus financial savings in the long term. The time and income recovered from these household activities free up space and opportunities for women and girls, helping to lift them out of energy poverty. Time spent collecting fuelwood can be intensive: in India, time spent collecting firewood ranges from three to ten hours per week (Jagoe and others 2014). Nigerian households spend an average of 1.7 hours per day gathering firewood (WHO 2019). In Kenya, households working with improved cookstoves saw the time spent collecting fuel drop from an average of 12 hours per week to 5 hours—and most participants reported using the time saved for economically productive tasks (WLPGA 2014).

Case studies have shown that when women receive empowerment training to sell stoves, they can dramatically increase sales. For example, in Nepal and Kenya women doubled sales after training. In a pilot project supported by the Clean Cooking Alliance with the Girl Guides in Ghana, 200 girls received training in empowerment, entrepreneurship, and cooking technologies and fuels. Afterwards, each household purchased efficient cookstoves. As a result, the girls reported a 50 percent reduction in cooking time, as well as two hours saved per firewood collection trip. In 2014, a research study commissioned by the Clean Cooking Alliance in Kenya found that women cookstove entrepreneurs sold three times as many cookstoves as their male peers when given the same training and support. Additionally, women's networks provide access to consumers in hard-to-reach markets, and women distributors better understand the needs of women and more easily approach their clients.

When women are positioned as the critical stakeholders they are—both as users who will benefit from cleaner, more efficient stoves and fuels, and as entrepreneurs and employees in the value chain—their efforts clearly spur widespread adoption. Women have a role to play in every segment of the cooking value chain, and their involvement can scale adoption of cooking products and services, while boosting their livelihoods. Women's involvement in the clean cooking sector can spur widespread distribution and delivery of cooking fuels and technologies that will contribute to a thriving global industry.

Sources: Clean Cooking Alliance; Multi-Tier Framework, World Bank (https://mtfenergyaccess.esmap.org/).

LOOKING AHEAD

Universal access to clean fuels and technologies remains feasible if serious policy efforts are made to expand access. Action is most urgently needed in Sub-Saharan Africa, given the stagnation of access levels in this region. All but one of the countries with the greatest deficit (people without access) are in Sub-Saharan Africa. In order to achieve universal access by 2030, efforts must include a focus in this area.

Cooking is multisectoral, and it demands multisectoral solutions. These include the Health and Energy Platform of Action (HEPA), a multisectoral platform launched in 2019. Aiming to strengthen the political and technical cooperation between the health and energy sectors at both global and country levels to accelerate the transition to clean energy, HEPA's initial focus is on clean cooking and electrification of health care facilities. To achieve universal access to clean fuels and technologies, governments, civil society organizations, private sector, academia, and the financial sector all must step up actions.

Major initiatives are needed to drive progress. Increased investment is key to encourage the uptake of clean cooking solutions. Encouraging progress includes the recent formation of the Clean Cooking Fund under ESMAP, and action by the Green Climate Fund and other bilateral programs promoting clean cooking. Governments need to set clear goals to transition away from polluting fuels such as unprocessed biomass and charcoal used in inefficient stoves.

In order to ensure that programs distributing new household energy technologies deliver the desired results, new programs should ensure that fuels and technologies are clean for health as defined by the WHO guidelines for indoor air quality: household fuel combustion. Some of the more-advanced biomass stoves do achieve the emission rate targets spelled out in the guidelines; if national programs intend to distribute these stoves, the adoption of national cookstove standards is valuable (WHO 2019). Standardization of cookstoves will support manufacturers, consumers, and policy makers by improving clarity about the benefits of clean cooking solutions.

To demonstrate the viability of clean and sustainable cooking solutions, governments and donors should consider providing supplemental funding for projects focused on electric stoves and biogas. Recent reports have highlighted the versatility and feasibility of mini grids and solar panels (Couture and Jacobs 2019). The cost of cooking with electricity, either via mini grids or solar panels has decreased significantly, putting this alternative well within the cost range of other cooking alternatives. This cost reduction is viable due to a combination of two effects: first, the cost of solar modules and batteries has decreased by 30 to 50 percent since 2016. Second, more energy-efficient cooking appliances, induction stoves, pressure cookers, and slow cookers decrease the electric power consumed per person. For example, over a one-hour period a pressure cooker uses approximately one-quarter of the electricity needed to operate an electric hot plate. In off-grid areas like slums, humanitarian camps, and rural areas, mini grids and solar panels can also provide electricity for cooking and other household activities.

There is encouraging progress in the promotion of clean fuels, including LPG. Stoves that rely on LPG and pay-as-you-go financing schemes are scaling up in Tanzania, Kenya, and Rwanda, with pilots in Nairobi; Uganda, India, and Guatemala have plans to expand. Biogas systems offer an advantageous solution to smallholders with ample access to agricultural and animal waste by integrating fertilizer supply, sanitation, and electricity, in addition to cooking fuel. Policy models that integrate stoves and fuel sales are gaining attention from the private sector (Clean Cooking Alliance 2019). In Rwanda and Zambia private initiatives combine biomass pellets with gasifier stoves to achieve high-quality combustion. Viable alternative fuels such as agricultural waste from local farms or neighboring countries could help reduce fuel costs.

Incentives to use clean fuels and efficient technologies must be both user-centered and suited to cooking practices in the community while featuring technical performance, practicality, and safety (Shan and others 2017). Failures here will likely defeat long-term adoption and exclusive use. Policies and programs tailored to surmount barriers are also needed. They need to focus on local cooking practices, affordability, and end-user preferences. As ever, women are an untapped resource for reaching the community. They also stand to benefit the most from transitions to clean cooking.

The WHO guidelines for indoor air quality: household fuel combustion (WHO 2014) include a good practice recommendation calling for governments to consider investing in clean household energy interventions to achieve climate change mitigation. Scaling up clean cooking is also a way for countries to achieve their nationally determined contributions while delivering meaningful health benefits.

METHODOLOGY

DATA SOURCES

The WHO Household Energy Database keeps regularly updated nationally representative household survey data (https://www.who.int/airpollution/data/household-energy-database/en/). It relies on a number of sources (see table 2.1) and serves in this report as the basis for all modeling efforts (Bonjour and others 2014; Stoner and others 2019). The database has 1,356 surveys taken in 170 countries (including high-income countries) between 1960 and 2018; 21 percent of the surveys cover the years 2013 to 2018 and 99 new surveys cover 2016 to 2018. Modeled estimates for low- and middle-income countries are provided only if there are underlying survey data on cooking fuels, so there are no estimates for Bulgaria, Cuba, Lebanon, and Libya.

Population data are from United Nations Population Division.

MODEL

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

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

Trends in fuel use by population proportions are identified through a Bayesian hierarchical modeling for each fuel type, both urban and rural, drawing on country survey data. 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 like 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.

The GHEM is implemented using the R programming language and the NIMBLE software package for Bayesian modeling with Markov chain Monte Carlo (MCMC). 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 fuel groupings and two specific clean fuel groupings for cooking, by country, for each year from 1990 to 2018. Further details on the modeling methodology and validation can be found in Stoner and others (2019).

Only survey data providing individual fuel breakdowns and with less than 15 percent of the population reporting "missing" and "no cooking" and "other fuels" were included in the analysis. Countries with no household fuel data but classified by the World Bank as high income (37 countries) were assumed to have transitioned to clean household energy. They are therefore reported as having greater than 95 percent access to clean technologies and fuels; no fuel-specific estimates were reported for high-income countries. In addition, no estimates were reported for low- and middle-income countries without data (Bulgaria, Cuba, Lebanon, and Libya). Modeled specific-fuel categories estimates were reported for 135 low- and middle-income countries and estimates of overall clean fuel use were reported for 190 countries.

UNCERTAINTY INTERVALS

Many of the point estimates we provide here are accompanied by 95 percent uncertainty intervals, which imply a 95 percent chance that the true value lies within the given range. Small annual changes in the point estimate may be statistical noise arising from either the modeling process or survey variability, and may therefore not reflect a real variation in the numbers 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, between years.

GLOBAL AND REGIONAL AGGREGATIONS

Population data from the United Nations Population Division 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 further 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.

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

TYPE OF DATA	RESPONSIBLE ENTITY	NUMBER OF UNIQUE COUNTRIES	DISTRIBUTION OF DATA SOURCES (IN %)	QUESTION
Census	National statistical agencies	108	18.40	What is the main source of cooking fuel in your household?
Demographic and Health Survey (DHS)	Funded by USAID; implemented by ICF International	81	17.20	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	26	3.00	Which is the main source of energy for cooking?
Multi-indicator cluster survey	UNICEF	80	10.90	What type of fuel does your household mainly use for cooking?
Survey on global AGEING (SAGE)	WHO	6	0.40	
World Health Survey	WHO	50	3.80	
National survey		106	35.80	
Other		79	10.30	

UNICEF = United Nations Children's Fund; USAID = United States Agency for International Development; WHO = World Health Organization.

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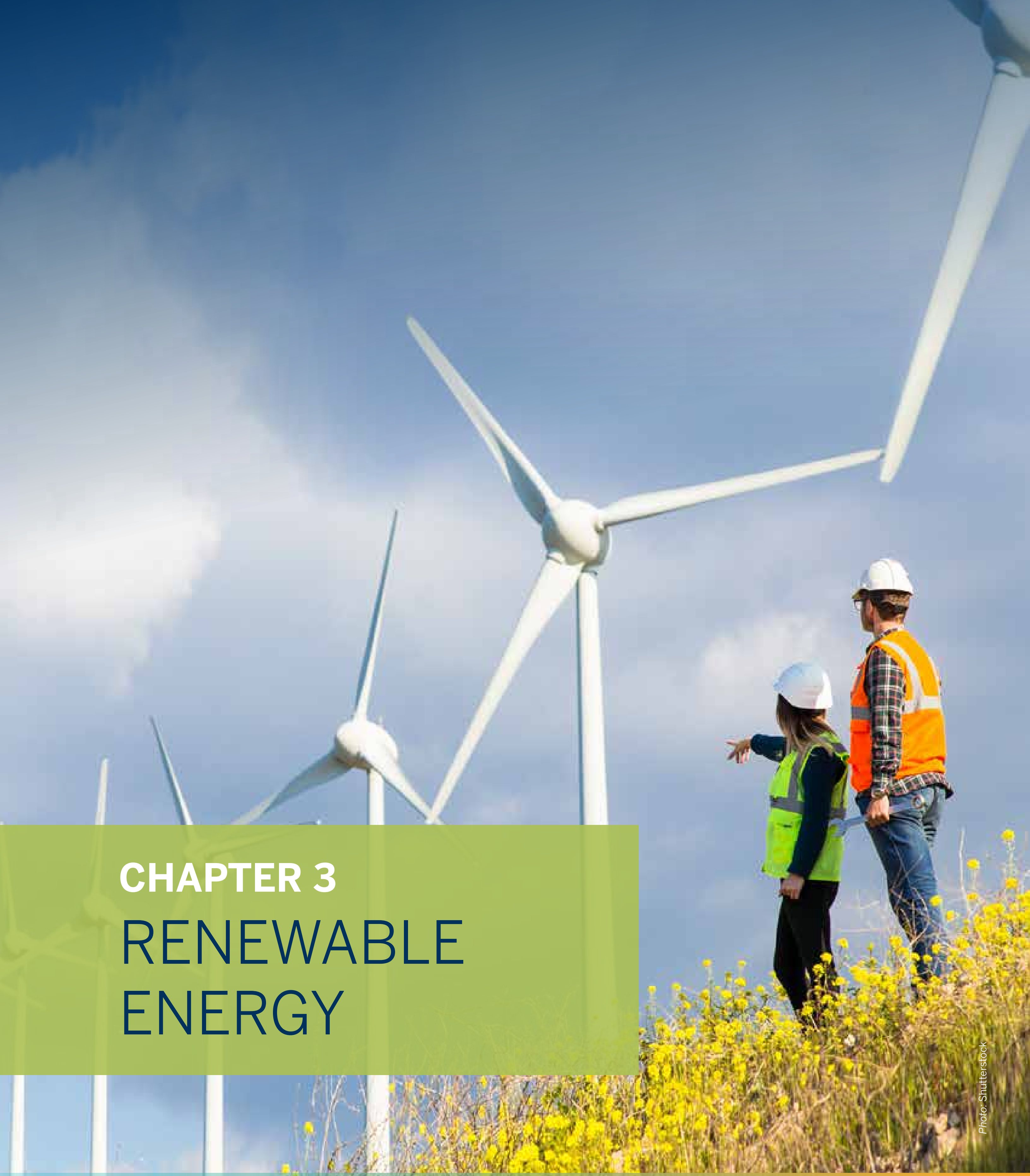

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CHAPTER 3
RENEWABLE ENERGY

MAIN MESSAGES

- **The global trend:** Sustainable Development Goal (SDG) 7.2 posits a substantial increase in the share of renewable energy in total final energy consumption (TFEC). Meeting this target will require the penetration of renewable energy to accelerate in all three end uses—electricity, heat, and transport. In 2017, the share of renewable energy in TFEC increased to 17.3 percent, up from 17.2 percent in 2016.[23] This rise reflects a more rapid growth in renewables (2.5 percent) compared with the overall growth of TFEC (+1.8 percent). Renewable energy consumption has grown fastest in the power sector; growth of renewables consumption in the heat and transport sectors has been much slower. Excluding the traditional uses of biomass (see box 3.1 for definitions), the share of renewables in TFEC rose to 10.5 percent in 2017, up from 10.3 percent in 2016.
- **The target for 2030:** Although there is no quantitative target for SDG 7.2, countries have agreed that the share of renewable energy would need to accelerate substantially to ensure access to affordable, reliable, sustainable, and modern energy for all. Despite impressive growth in renewable energy over the past decade, the world is not on track to meet the SDG 7.2 target.
- **Regional highlights:** At 69 percent of TFEC, Sub-Saharan Africa continues to show, by far, the highest share of renewable energy. The traditional uses of biomass, however, still account for almost 85 percent of renewable energy consumption in the region, while modern renewable energy is below the world average. Latin America and the Caribbean, on the other hand, had the largest share of modern renewables (29 percent) thanks to the extensive use of modern bioenergy and hydropower. In Asia, modern renewable energy shares remained below the global average at around 8 percent of the regional TFEC.
- **The top 20 energy-consuming countries:** The share of renewable consumption varies by country. Between 2010 to 2017, 13 out of the top 20 energy-consuming countries increased their share of renewables. The United Kingdom in particular saw the largest relative increase, led by wind energy. Yet in Brazil, India, Indonesia, Nigeria, Pakistan, and Turkey, renewables have grown more slowly than total energy consumption.
- **Electricity:** Renewable electricity consumption increased by almost 6 percent year-on-year in 2017. In relative terms, this meant that the share of renewables in global electricity consumption reached 24.7 percent, the highest of all end-use sectors. With this growth, the renewables share in electricity surpassed its share in heat for the first time in history. In terms of growth rate, however, this represents a deceleration compared with the record year-on-year growth recorded in 2016. Lower hydropower output was the main reason behind the slower increase in renewables.
- **Heat:** Renewables used for heating increased by 1.1 percent, reaching 23.5 percent of total final heat consumption in 2017, including traditional uses of biomass. The growth was led by modern renewable energy uses, which grew by 2.3 percent year-on-year in 2017. Overall, the share of modern renewables reached 9.2 percent of heat consumed globally, up from 9.1 percent in 2016. Consumption of biomass for its traditional uses remained almost unchanged (+0.3 percent year-on-year) in 2017 compared with 2016, still accounting for more than 14 percent of global heat consumption.
- **Transport:** The share of renewable energy in transport flattened in 2017, remaining at 3.3 percent in 2017. Most of the renewable energy consumed came in the form of liquid biofuels, mainly crop-based ethanol and biodiesel, thanks to policy support (among other factors) in Brazil, the European Union, and the United States. In 2017, consumption of electricity in the transport sector was 1.3 exajoules (EJ), of which 24 percent was renewable (0.3 EJ), representing 0.3 percent of global energy consumption in the transport sector.

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23 Revised historical data have altered the historical time series of renewable shares in this report; they now present lower values than the time series shown in previous editions. More details on this shift can be found in the section of this chapter entitled "Are We on Track?"

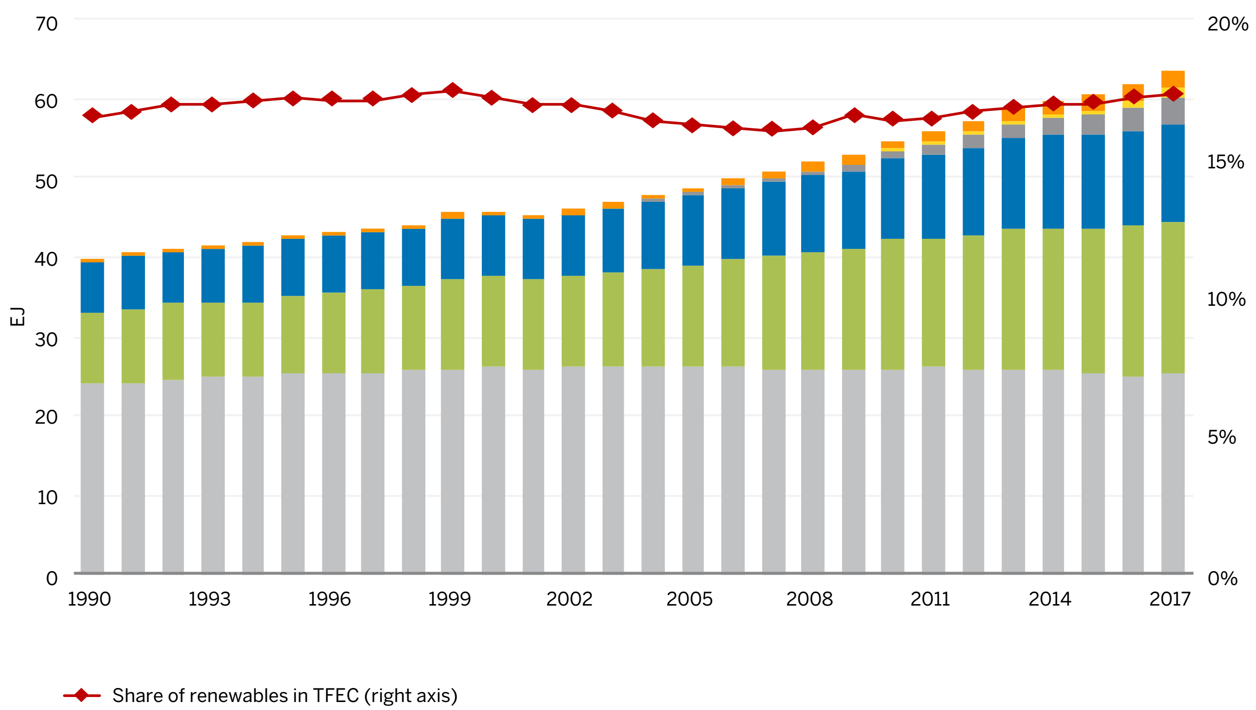
ARE WE ON TRACK?

In 2017, renewable energy consumption, including that of biomass for its traditional uses, increased by 2.5 percent year-on-year, a more rapid growth compared with global TFEC (+1.8 percent). As a result, the renewable energy share in TFEC increased from 17.2 percent in 2016 to 17.3 percent in 2017—still lower than the all-time record share of 17.5 percent, achieved in 1999 (Figure 3.1).[24]

Last year, SDG 7 reported that the 2016 share of renewables had reached 17.5 percent. New data submissions in 2018–19 indicate an important historical revision over published data from the previous year. Several African countries, as well as developing countries in Asia, revised downward historical data on solid biomass and charcoal consumption from 2000 to 2016. As a result, the share of renewables declined globally by 0.1–0.3 percentage points throughout the historical time series. On the one hand, this downward revision slightly increases the distance to target—i.e., the gap between the current status and the objective of achieving substantial increases in the share of renewables by 2030. The revision implies, however, that the consumption of biomass for traditional uses in developing (non-OECD) Asia and Africa was lower than previously estimated, suggesting that these regions are making better use of resources. The trend of rising shares of modern renewables was largely unaffected by the historical data revision.

Trends between 2000 and 2007 showed global declines in the share of renewables owing to faster growth from non-renewable sources to meet surging global demand, in particular coal consumption in some emerging economies. Since 2011, renewables have increased more rapidly than global energy consumption, leading to a steady increase in their share of TFEC. Overall, bioenergy, including traditional uses of biomass, remains the largest source, accounting for almost 70 percent of global renewable energy consumption, followed by hydropower, wind, and solar.

FIGURE 3.1 • Renewable energy consumption by technology, and share in total energy consumption, 1990–2017



Source: IEA and UNSD.

24 The data for figures 3.1–3.13 were obtained from the databases of the International Energy Agency and the United Nations Statistics Division. Those databases are accessible at https://www.iea.org/data-and-statistics and https://unstats.un.org/unsd/energystats/.

The share of renewable energy in TFEC continued to increase in 2017, albeit at a slower pace. This slowed growth is explained, first, by the surge in global energy consumption (1.8 percent in 2017, compared with 1.1 percent in 2016). Second, overall hydropower generation was lower, especially in Europe and China, more than offsetting the year-on-year increases seen in the Americas. Meanwhile, the absolute increase in generation from wind and solar doubled year-on-year, leading to an increase in the share of modern renewables (i.e., excluding traditional bioenergy), which reached 10.5 percent in 2017, up from 10.3 percent in 2016.

After declines in 2015 and 2016, traditional uses of biomass increased in 2017 in absolute terms because overall decreases in Asia could not offset additional consumption in Africa. Nevertheless, the share of such uses in TFEC continued to decline, falling below 7 percent for the first time. This trend needs to accelerate to ensure access to electricity through modern technologies. Despite progress, modern renewables must expand much more quickly to compensate for falling shares of traditional uses of biomass and to achieve the SDG 7.2 goal of substantially increasing the share of renewables by 2030 (Figure 3.2).

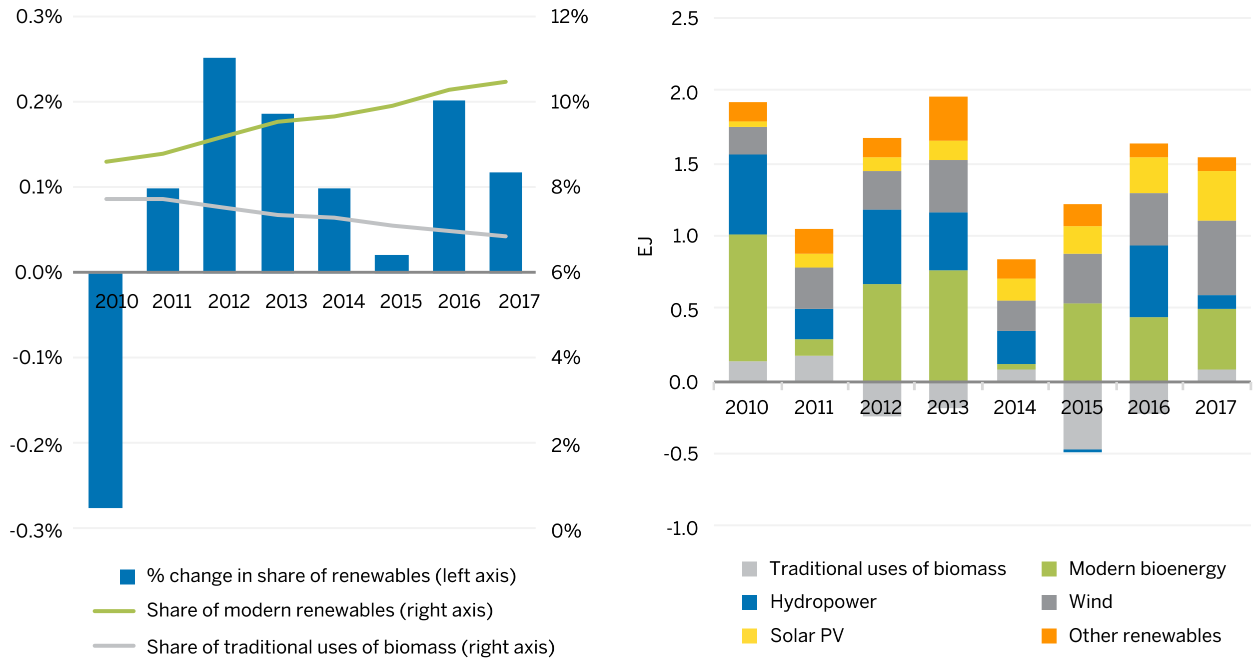
BOX 3.1 • "TRADITIONAL USES OF BIOMASS", DEFINED

The term "traditional uses of biomass" refers to the use of local solid biofuels (wood, charcoal, agricultural residues, and animal dung) burned with basic techniques, such as traditional open cookstoves and fireplaces. Owing to their informal and noncommercial nature, it is difficult to estimate the energy consumed in such practices, which remain widespread in households in the developing world. For purposes of this report, "traditional uses of biomass" refers to the residential consumption of primary solid biofuels and charcoal in non-OECD countries. Although biomass is used with low efficiency in OECD countries, as well—for example, in fireplaces burning split logs—such use is not covered by the traditional uses of biomass cited in this report.

Traditional uses of biomass tend to have very low conversion efficiency (5–15%) and, as local demand may also exceed sustainable supply, can often result in negative environmental impacts, notably deforestation. In addition, emissions of high particulate matter and other air pollutants are produced. When combined with poor ventilation, such pollutants create household indoor air pollution, 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 reducing it and encouraging the adoption of more modern renewable heating and cooking technologies.

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

FIGURE 3.2 • Share of renewable energy, modern renewable energy, and traditional uses of biomass, 2010–17 (left) and Renewable energy consumption growth by technology (right)

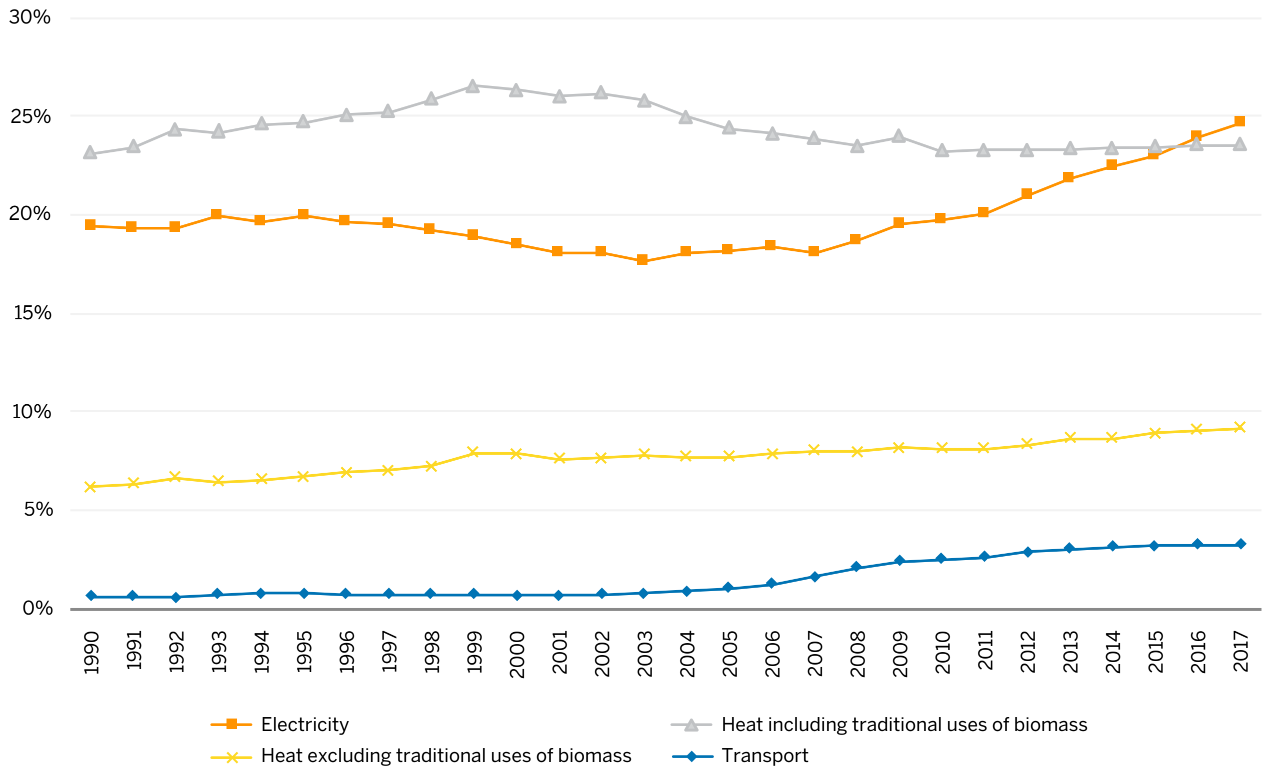


Source: IEA and UNSD.

LOOKING BEYOND THE MAIN INDICATORS

Renewable energy has three main end uses: electricity, transport, and heat.[25] The SDG 7.2 target calls for a "substantial increase" in the share of renewable energy, requiring an accelerated penetration of renewable energy in all three end uses. Electricity accounted for almost two-thirds of renewable energy consumption growth from 2016 to 2017, followed by heat (30 percent) and transport (6 percent). With this growth, renewables' share in electricity reached almost 25 percent and surpassed the renewable share in heat for the first time. The share of renewables (including traditional uses of biomass) in heat has been stable at around 23 percent since 2010 (Figure 3.3). The stability in shares stems from two concurrent drivers: first, slow declines in traditional uses of biomass for cooking and heating, and, second, greater use of modern renewable technologies. The year-on-year increase in the direct use of modern renewables for heat reached 2.3 percent in 2017. For the first time since 2001 the share of renewable energy in transport did not rise, remaining at 3.3 percent, which is the lowest share among end uses. Biofuels account for most of renewable consumption in transport, but renewable electricity use is also emerging thanks to the uptake of rail and electric vehicles.

FIGURE 3.3 • Renewable energy share by end use, 1990–2017



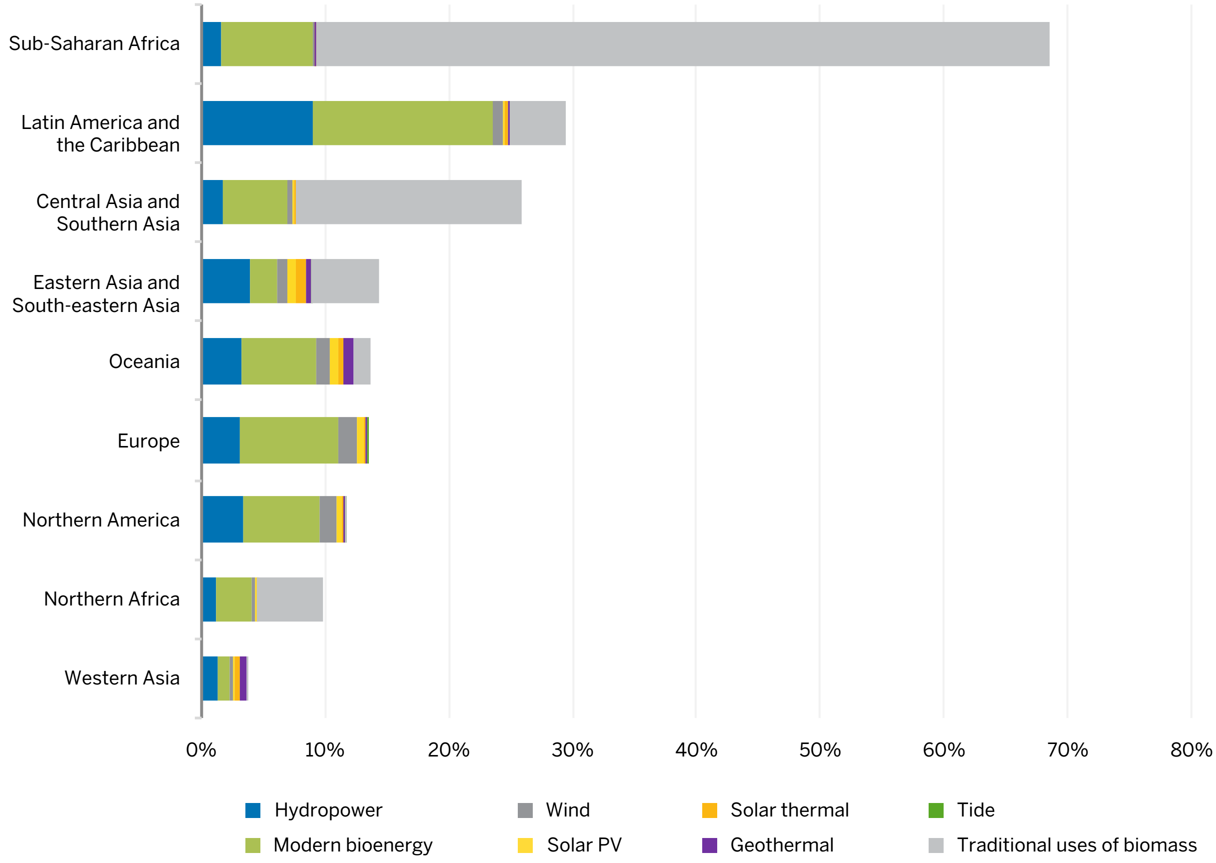
Source: IEA and UNSD.

The global figure on the share of renewables conceals regional disparities in the penetration of renewable energy and the role of traditional uses of biomass in country energy mixes (Figure 3.4). In 2017, Sub-Saharan Africa had by far the highest share of renewable energy in TFEC. But traditional uses of biomass account for almost 85 percent of

25 "End use" refers to the service for which energy is consumed. The services are classified into three categories: electricity end uses, transport end uses, and heating. For the sake of simplicity, the latter is referred to in this report as "heat." A fraction of electricity end uses overlaps with heat, as some electricity is consumed to produce heat. In this report, however, renewable electricity consumed to produce heat is accounted for under the electricity end use. Heat refers to the amount of non electric energy consumed for heating in industry and other sectors. It is not equivalent to the final energy end use.

total renewable energy consumption in the region. Latin America and the Caribbean had the largest share of modern renewables among all regions thanks to the extensive use of modern bioenergy in transport and industry, in addition to hydropower electricity generation. In Southern Asia as well as in Eastern Asia and South-eastern Asia, the penetration of modern renewables in TFEC remains below the global average at around 8 percent. Outside of Latin America, Middle Africa, Europe, Oceania, and Northern America had the highest share of modern renewables in final consumption in 2017, led by bioenergy and hydropower, with wind and solar PV making growing contributions.

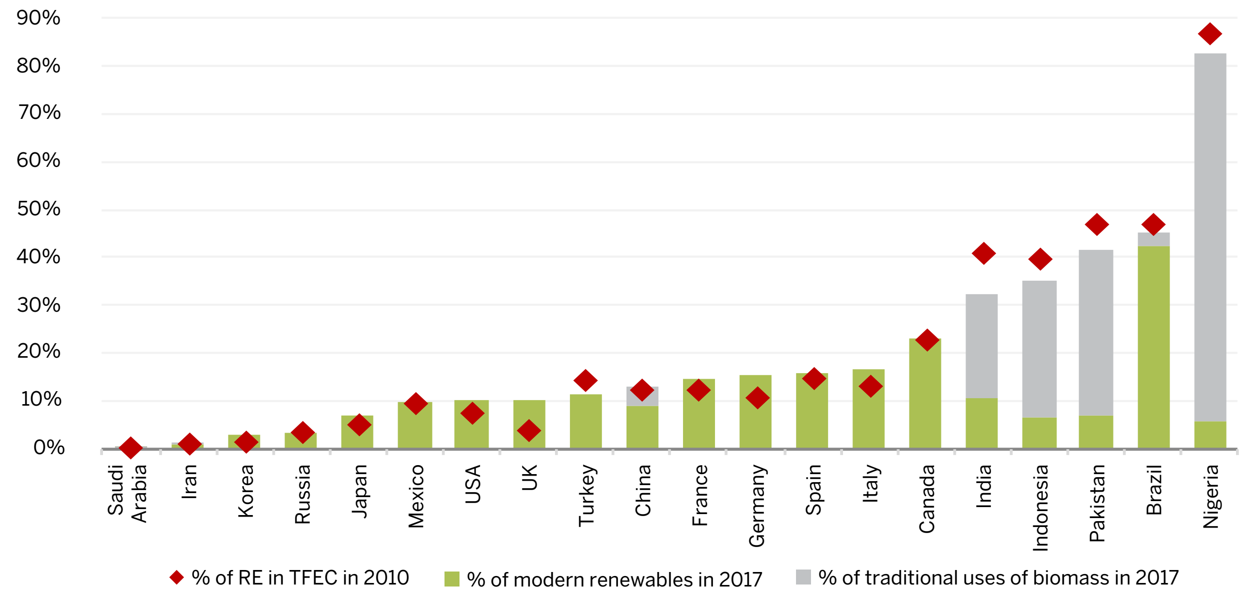
FIGURE 3.4 • Renewable share in total final energy consumption by region, 2017



Source: IEA and UNSD.

At the national level, the share of renewable consumption varies widely depending on resource availability, policy support, and the effect of energy efficiency on growth in demand for energy. Between 2010 and 2017, 13 of the 20 largest energy consumers increased the share of renewables (including traditional uses of biomass) in their consumption mix. The United Kingdom saw the largest relative increase, with its renewable share tripling between 2010 and 2017. Germany, Italy, France, and Japan also achieved remarkable growth, mostly in the power sector. In India, renewables penetration in TFEC has declined since 2010. Although wind, solar PV, and modern bioenergy grew, the upturn could not offset the welcome decline in the traditional uses of biomass and overall increases in energy consumption. In Indonesia, Pakistan, and Nigeria, modern renewables have grown far more slowly than non-renewable energy consumption (Figure 3.5). In absolute terms, China remains by far the largest consumer of all renewables, excluding bioenergy, while its share of renewables in TFEC—including traditional uses of biomass—was 13 percent in 2017. Among the 20 countries, Brazil was the absolute leader, with a 45 percent share of modern renewables, followed by Canada at 23 percent.

FIGURE 3.5 • Renewable energy share in TFEC, top 20 countries with the largest energy consumption, 2010 and 2017

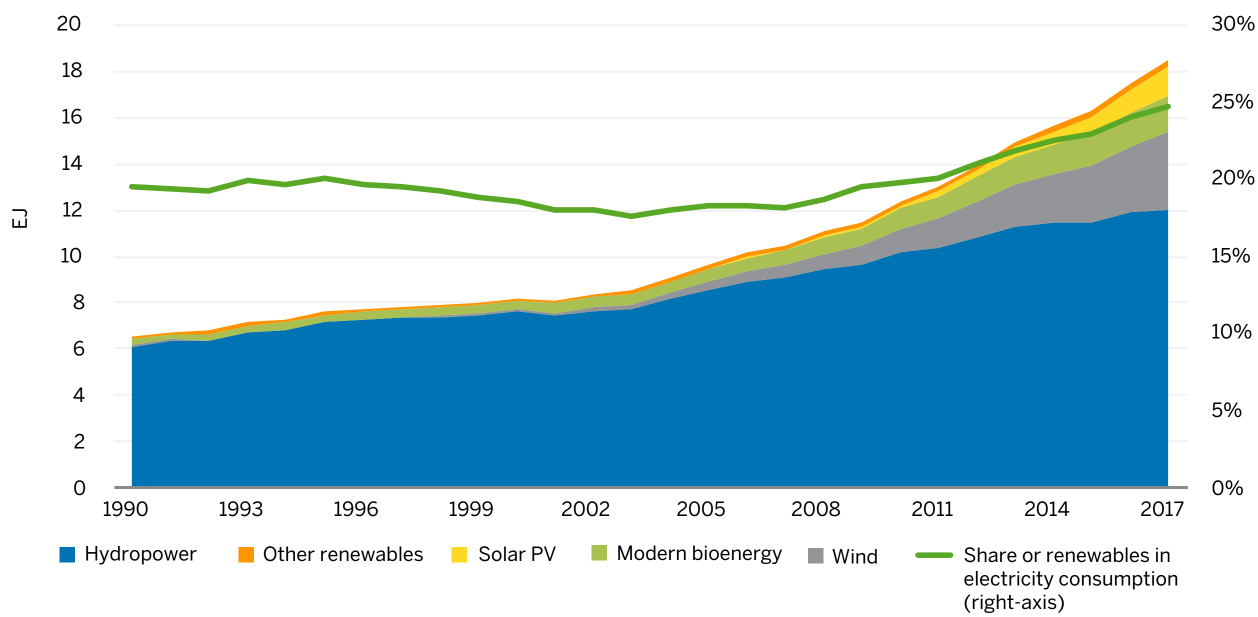


Source: IEA and UNSD.
RE = renewable energy, TFEC = total final energy consumption.

ELECTRICITY

In 2017, renewable electricity consumption grew by almost 6 percent. The share of renewables in global electricity consumption grew by 0.7 percentage points to reach 24.7 percent (Figure 3.6). The pace of growth slowed in comparison with 2016 despite slower overall growth in electricity demand. Lower hydropower output was the main reason behind the slowdown. From 2016 to 2017, hydropower generation declined in major hydropower-producing countries—Brazil, China, France, Italy, Spain, Pakistan, and Turkey—owing to low water availability. Nevertheless, hydropower remained the largest source of renewable electricity, accounting for two-thirds of all renewable power generation.

FIGURE 3.6 • Global renewable electricity consumption by technology, 1990–2017

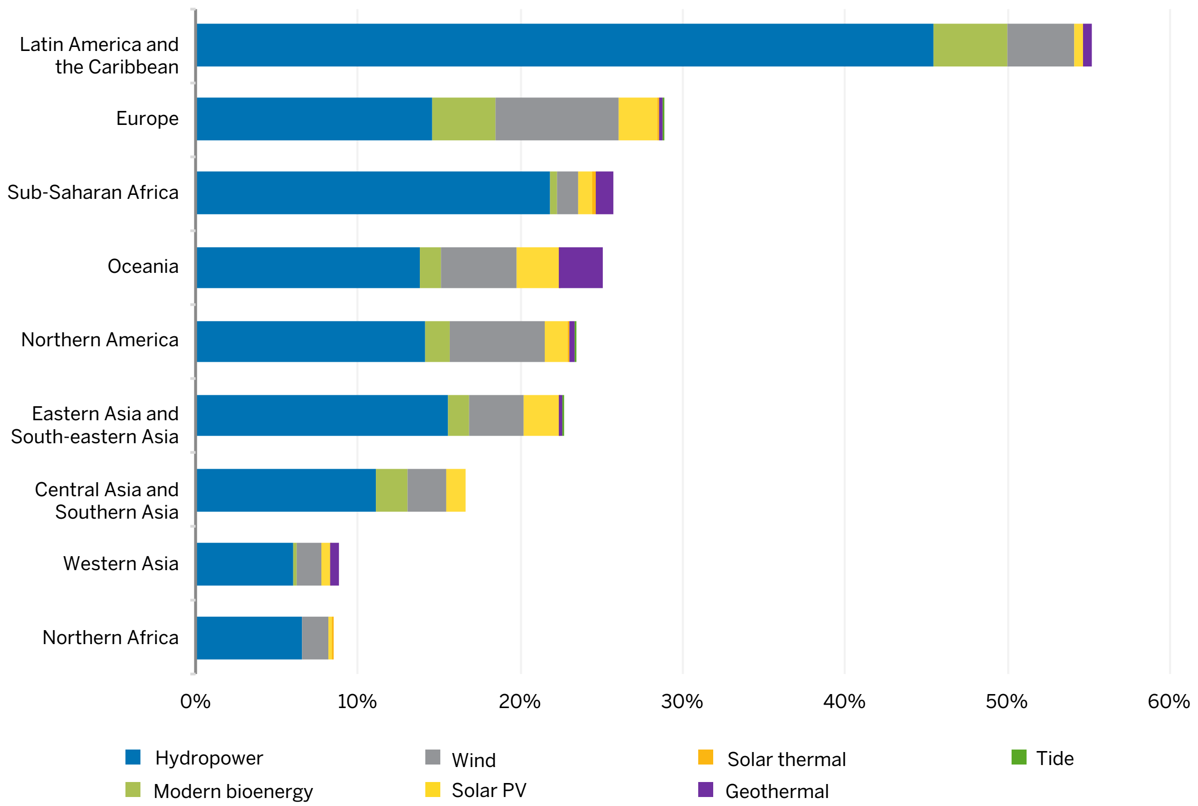


Source: IEA and UNSD.

In 2017, global solar PV and wind energy in electricity generation increased by 35 percent and 18 percent, respectively. Accordingly, wind and solar PV together were responsible for almost 85 percent of renewable electricity growth year-on-year.

In addition to policy support, resource availability explains regional differences in renewable electricity consumption. Latin America and the Caribbean commands the highest share of renewables in electricity consumption thanks to ample hydropower and bioenergy resources (Figure 3.7). In Europe, Northern America, and Oceania, hydropower remains the largest source of renewable generation, followed by wind and solar PV, which together provided on average 7–10 percent of total electricity generation in 2017. While hydropower remains the largest source of renewable electricity in Africa too, governments have been introducing policies to foster deployment of wind and solar technologies, which have benefitted from recent cost reductions.

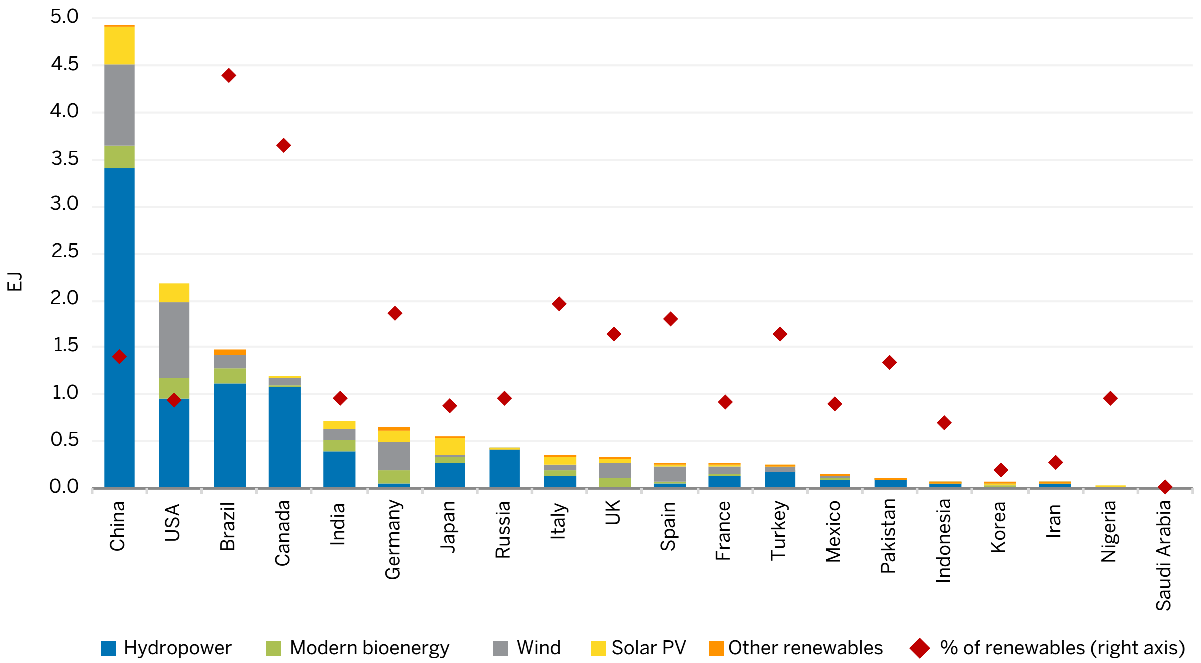
FIGURE 3.7 • Share of renewables in electricity consumption by region, 2017



Source: IEA and UNSD.

Among the top 20 energy consumers, the share of renewables in electricity ranges from less than 1 percent to 80 percent (Figure 3.8). In 2017, China consumed more renewable electricity than any other country globally in absolute terms, thanks to the country's hydropower generation. China was already the largest consumer of solar PV in 2016. As of 2017, the country also became the largest consumer of electricity from wind and bioenergy, surpassing the United States, which remained the second-largest consumer of renewable electricity in the world. Brazil and Canada have by far the highest share of renewables in electricity generation thanks to large hydropower capacities. In most European countries, wind and solar PV were the largest sources of renewable electricity, with their share ranging between 15–50 percent. Between 2016 and 2017, the United Kingdom's renewable electricity consumption increased by almost 20 percent, mostly thanks to offshore wind. With this growth, the country overtook Turkey, France, and Spain in just one year and became the tenth-largest renewable electricity consumer among the top 20 energy consuming countries.

FIGURE 3.8 • **Consumption of electricity generated from renewable sources, top 20 countries, 2017**

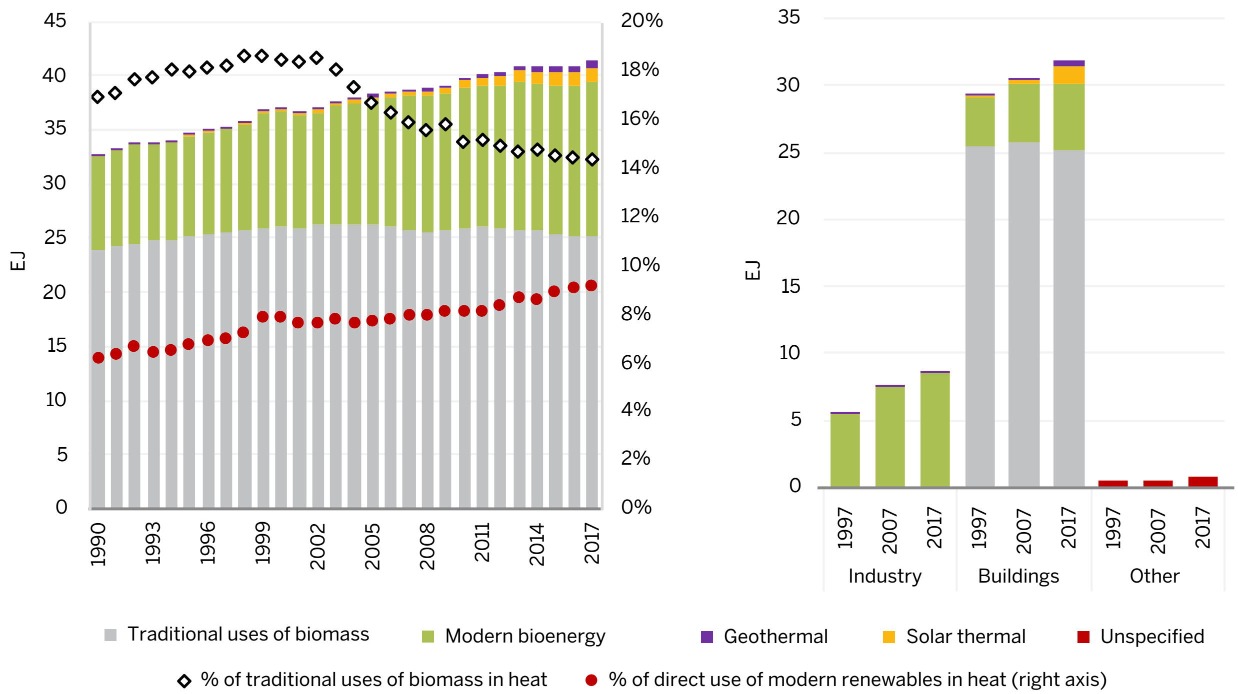


Source: IEA and UNSD.
RES = renewable energy sources, RES-E = renewable electricity

HEAT

Heat accounted for half of global final energy consumption in 2017, making it the largest energy end use worldwide (followed by transport and electricity generation). With coal, gas, and oil meeting more than three-quarters of global heat demand, the sector remains heavily dependent on fossil fuels. Traditional uses of biomass—which have low efficiency and generally result in adverse health and environmental effects—increased slightly (+0.3 percent) in 2017; such uses still account for more than 14 percent (25.2 EJ) of global heat consumption (Figure 3.9). Consumption of modern renewable energy for heat increased 2.3 percent in 2017, representing 9.2 percent of the heat consumed globally (up from 9.141 percent in 2016). A gradual transition away from the traditional uses of biomass to clean and modern cooking fuels, technologies, and services—mainly in developing countries, as indicated in the SDG 7.1 target—requires more policy attention. A faster deployment of modern renewables for heating, one that can replace traditional uses of biomass and fossil fuels, remains key to achieving both the SDG 7.2 and SDG 7.1 targets by 2030.

FIGURE 3.9 • Renewable heat consumption by source and sector



Source: IEA and UNSD.
Note: Indirect consumption of renewable heat through renewable electricity is not represented in this figure.

The consumption of modern bioenergy increased by 2 percent in 2017. Bioenergy makes up around 90 percent (14.2 EJ) of direct modern uses of renewables for heat and represents more than three-quarters of renewable district heat globally.[26] Industry is responsible for two-thirds of modern bioenergy use, most of which is concentrated in subsectors producing biomass residues on site, such as the wood, pulp, and paper industries, as well as the food and tobacco industries.

Global solar thermal consumption increased 3.3 percent in 2017, amounting to 1.3 EJ. The large majority corresponds to domestic solar water heaters, although large-scale systems for district heating and industrial applications continue to develop as a niche market. There is vast untapped potential for low-temperature industrial processes, but speeding deployment will require overcoming relatively high up-front costs and lack of awareness. China leads the solar thermal market, with 70 percent of global installed capacity in 2017, although capacity growth has slowed in recent years owing to reduced construction, market saturation, competition with other technologies, and the phaseout of incentives.

Meeting less than 0.5 percent of global heat demand, geothermal heat is the smallest renewable heat source. Bathing and space heating (via district heating) are the most prevalent applications globally. Development of geothermal systems remains limited to a few countries, with China and Turkey alone accounting for 84 percent of geothermal heat consumption worldwide. Direct use of geothermal heat increased 6.8 percent in 2017, contributing just over 0.6 EJ to the renewable heat supply.

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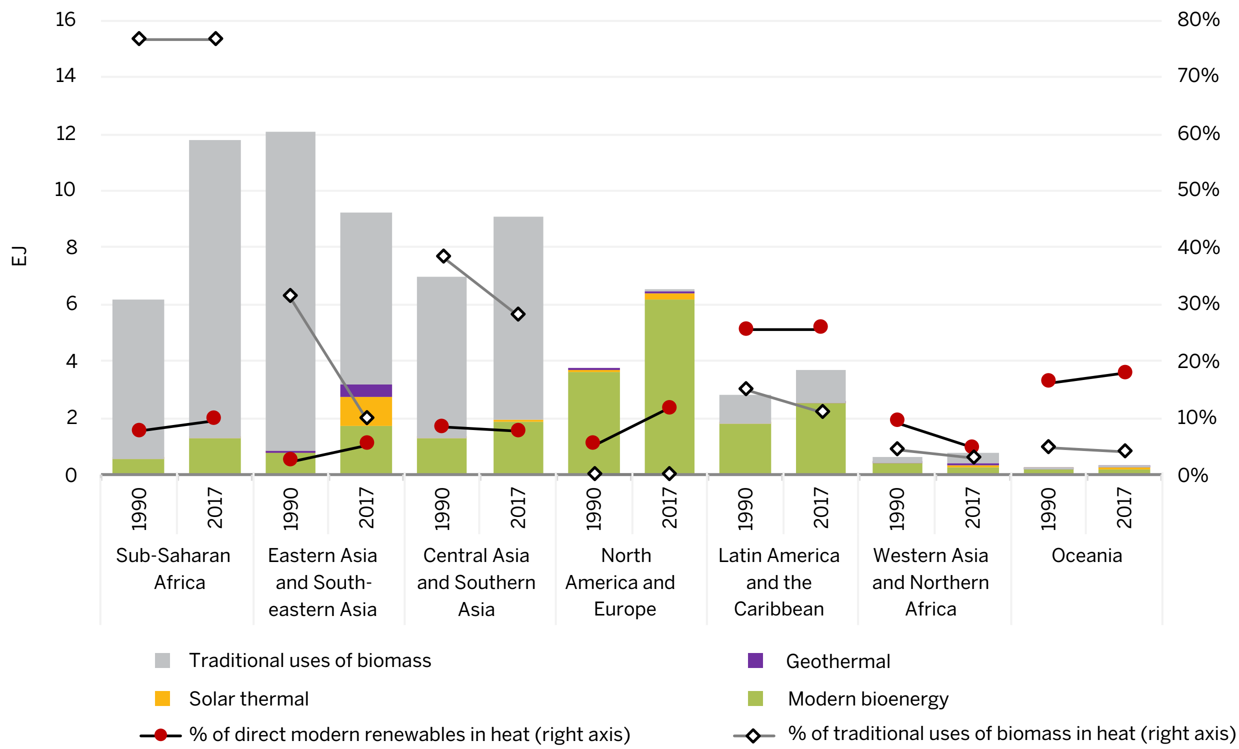
26 Renewables also contribute to heat supply indirectly through renewable electricity used for heating. Taking these indirect uses into account, renewable electricity, used chiefly in buildings, is the second-largest modern renewable heat source after bioenergy. It accounted for an estimated one-third of the increase in total (direct and indirect) modern renewable heat consumption in 2017, owing to the combination of increasing penetration of renewables in the power sector and electrification of heating through the use of electric heat pumps and boilers.

FIGURE 3.10 • Renewable heat consumption by region, 1990 and 2017

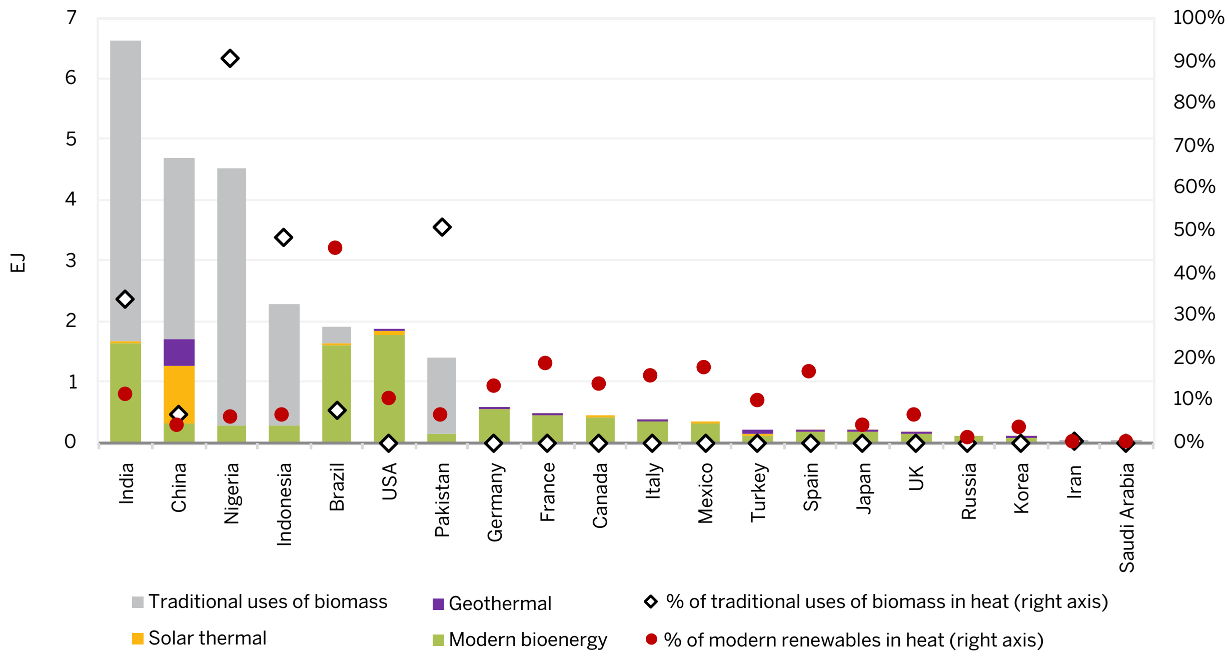


Source: IEA and UNSD.
Note: Indirect consumption of renewable energy through electricity for heat is not included in this figure.

The traditional uses of biomass are concentrated in Sub-Saharan Africa and Asia (Figure 3.10), with, in descending order, India, Nigeria, China, Indonesia, and Pakistan together accounting for more than 60 percent of global consumption. Stable traditional consumption of biomass at global scale hides disparate trends across regions: in Eastern Asia, consumption declined significantly over the past decade, especially in China, while in Sub-Saharan Africa consumption surged, driven by population increases.

Brazil, China, India, and the United States together accounted for more than 40 percent of global modern renewable heat consumption in 2017 (Figure 3.11). This results from the hefty consumption of bioenergy in the pulp and paper industry and for residential heating in the United States; the extensive use of bagasse in the sugar and ethanol industry in Brazil and India; and significant deployment of solar thermal water heaters in China. The European Union's Renewable Energy Directive, which promoted renewable heat consumption, was another factor, driving the expansion of residential wood and pellet stoves and boilers (e.g., in Italy, France, and Germany) and the use of biomass in district heating (e.g., Nordic and Baltic countries, Germany, France, and Austria). In addition, the growing consumption of renewable electricity through electric heaters and heat pumps in China, the United States, and the EU contributed indirectly to renewable heat consumption (IEA 2019b).

FIGURE 3.11 • Renewable heat consumption in top 20 countries, 2017

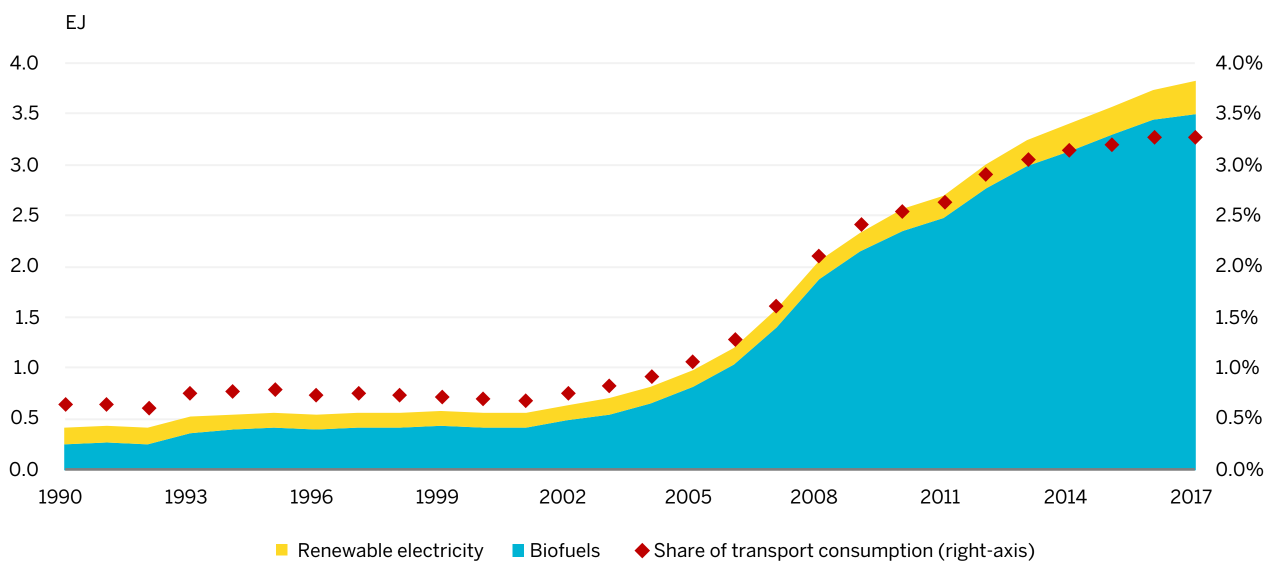


Source: IEA and UNSD.
Note: Indirect consumption of renewable energy through electricity for heat is not included in this figure.

TRANSPORT

The share of renewable energy in transport remained stable at 3.3 percent in 2017 year-on-year (Figure 3.12), the lowest of all end-use sectors. The majority of the renewable energy consumed came in the form of liquid biofuels, mainly crop-based ethanol and biodiesel blended with fossil transport fuels. Most of the remainder was from renewables-based electricity.

FIGURE 3.12 • Renewable energy consumption in transport, 1990–2017



Source: IEA and UNSD.

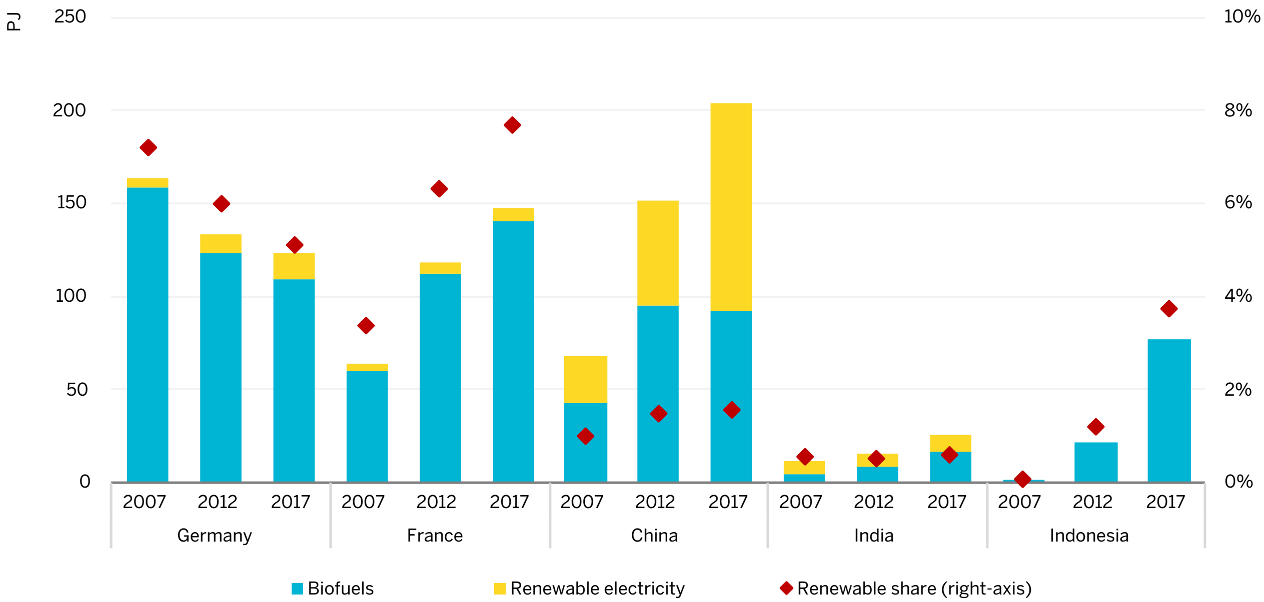
The share of renewable energy in transport is low (Figure 3.13). First, because biofuels are blended at low ratios with gasoline or diesel and, second, because the uptake of electric vehicles is still at an early stage. In addition, demand for fossil fuels for transport continues to grow. Petroleum-product consumption increased 15 percent from 2010 to 2017, with more than half of that growth occurring in the Asia-Pacific region. This has suppressed growth of the renewable energy share in China and India, even as renewable fuel consumption has grown.

Lack of broad policy support is also at work in the low uptake of renewable energy in transport. Around 130 countries consume no renewable energy in their transport sectors. Biofuel support policies exist in about 70 countries, and demand for electro-mobility is growing in China, Europe, and the United States. But many countries have no policies to support and stimulate low-carbon transport. As of 2017, only four countries had shares of renewable energy in transport that exceeded 10 percent: Brazil, Finland, Norway, and Sweden.

Furthermore, most of the transport-related renewable fuel consumption pertains to road vehicles, with minimal use in aviation and maritime transport. This is due to lower availability of economic and technically viable renewable fuels, compounded by even less policy support for their use in these long-haul sectors.

The United States and Brazil together accounted for 60 percent of renewable energy in transport in 2017. Shifting market dynamics in other key countries have produced variable growth in renewable energy consumption over the past ten years.

FIGURE 3.13 • Renewable fuel consumption in transport in selected countries



Source: IEA and UNSD.

In the transport sector, ethanol constitutes the largest share of renewable energy. But over 2013–17 the average annual increase in renewable energy consumption from ethanol was less than half that achieved in the previous five-year period. This is primarily because of the slowing expansion of ethanol consumption in the United States. Gasoline blended with ethanol at 10 percent covers almost all demand, while higher ethanol blends (such as 15 percent) is relatively minimal owing to limits in fuel-supply infrastructure and vehicle compatibility.

Europe has been a global leader in biodiesel consumption. But growth in demand has slowed. Consumption growth from 2013 to 2017 was a fifth of the levels reported for the preceding five years. A key factor was a decline in the German market, where consumption in 2017 was 20 percent lower than it was for 2008. In France and Spain, by contrast, markets continue to grow.

In 2017, global consumption of electricity in transport was 1.3 EJ, of which 24 percent was renewable (0.3 EJ). Rail consumed most renewable electricity in transport, with a smaller but growing share from road electric vehicles, a category that comprises cars, buses, and two- and three-wheel vehicles. The global electric car stock was around 3 million vehicles in 2017 and surpassed 5 million in 2018. China has significantly higher demand for renewables-based transport fuel. There, in 2017, over half of renewable energy in transport came from electricity, with the largest consumption coming from two- and three-wheeler vehicles.

New fuels with the potential to increase the renewable share in transport are entering the market. Consumption of hydrotreated vegetable oil, also known as renewable diesel, is on an upward trend, with demand growing in Europe and the United States. Technically a "drop-in" fuel, HVO can be used unblended in some diesel engines and offers the prospect of increasing the renewable share without changing vehicle fleets or modifying fueling infrastructure.

Biomethane (or biogas upgraded to the quality of natural gas) also offers a means of increasing renewable energy in transport. A like-for-like replacement for natural gas in suitable vehicles, it holds particular potential for road freight, where a strategic rollout of fueling infrastructure along key transport corridors could attract a relatively large share of demand, and for captive fleets, where vehicles operate on set routes and refuel at depots.

Progress is also evident in renewable aviation fuels. Flights using biofuel blends have surpassed 230,000; continuous biofuel supply is available at six airports; and there is policy support for their use in the United States and Europe. Nonetheless, aviation biofuels account for less than 0.1 percent of fuel demand. Renewable fuel consumption in marine transport remains nascent.

POLICY INSIGHTS: A FOCUS ON ELECTRICITY AND AUCTIONS

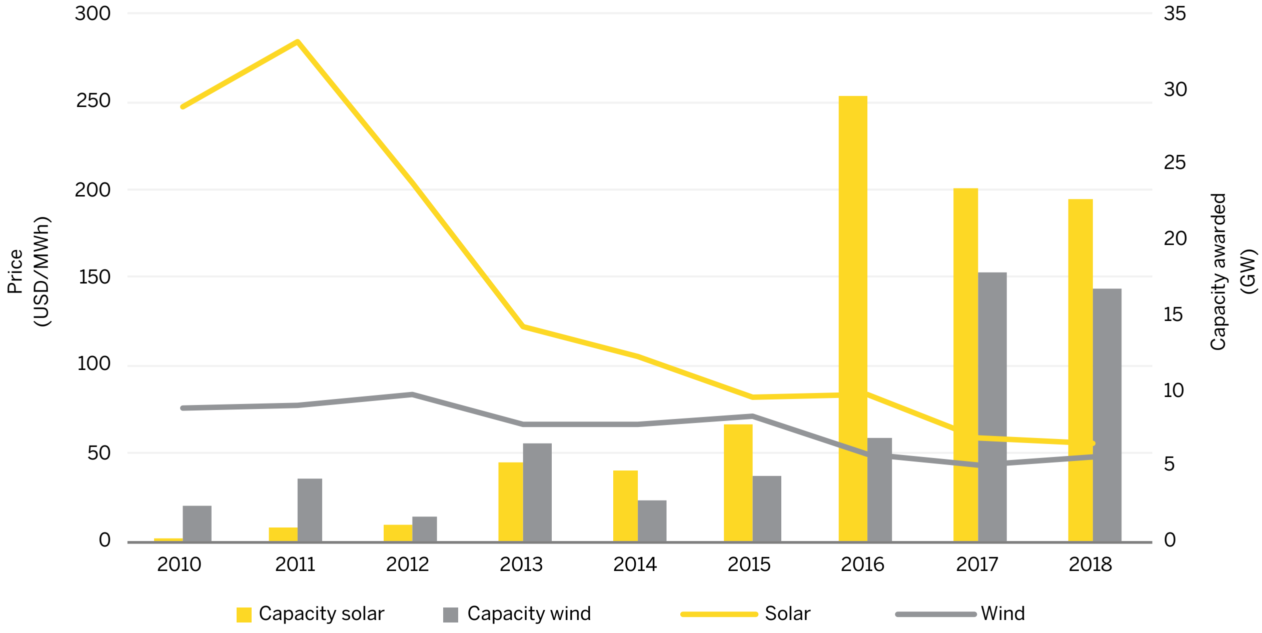
While modern renewable energy has seen robust growth in the past few years, deployment would need to accelerate much faster, especially in the heat and transport sectors, to ensure access to affordable, reliable, sustainable, and modern energy for all by 2030. Most scenarios for the energy transition point in the same direction. At the core of an energy transition thorough enough to reach the target of SDG 7 is increased electrification of all end uses, combined with a decarbonized power sector.

Various policies and measures adopted worldwide have supported renewable energy deployment in the power sector. The focus here is on the increasingly prominent role of auctions.

Between 2014 and 2018, instruments for competitively-set tariffs (auctions) have gained popularity, especially for utility-scale applications, owing chiefly to their ability to procure renewables-based electricity at the lowest price. By 2018, more than 106 countries had adopted auctions at some point in time (REN21 2019; IRENA 2019a), with at least 68 countries announcing auctions during the reporting period covered here (2010–18) (ESMAP 2018).

As illustrated in Figure 3.14, price results for solar and onshore wind auctions have decreased in the past decade. In 2017, solar energy was contracted at a global average price of almost USD 58/MWh, down from USD 250/MWh in 2010. Wind prices also fell during that period, albeit at a slower pace—from USD 75/MWh in 2010 to USD 43/MWh in 2017. Plunging technology costs have led policy makers to consider auctions as a way to track the price of renewable energy in their country. This downward trend continued for solar PV, though at a slower pace, reaching USD 56/MWh in 2018, while onshore wind prices rose slightly, reaching USD 48/MWh.

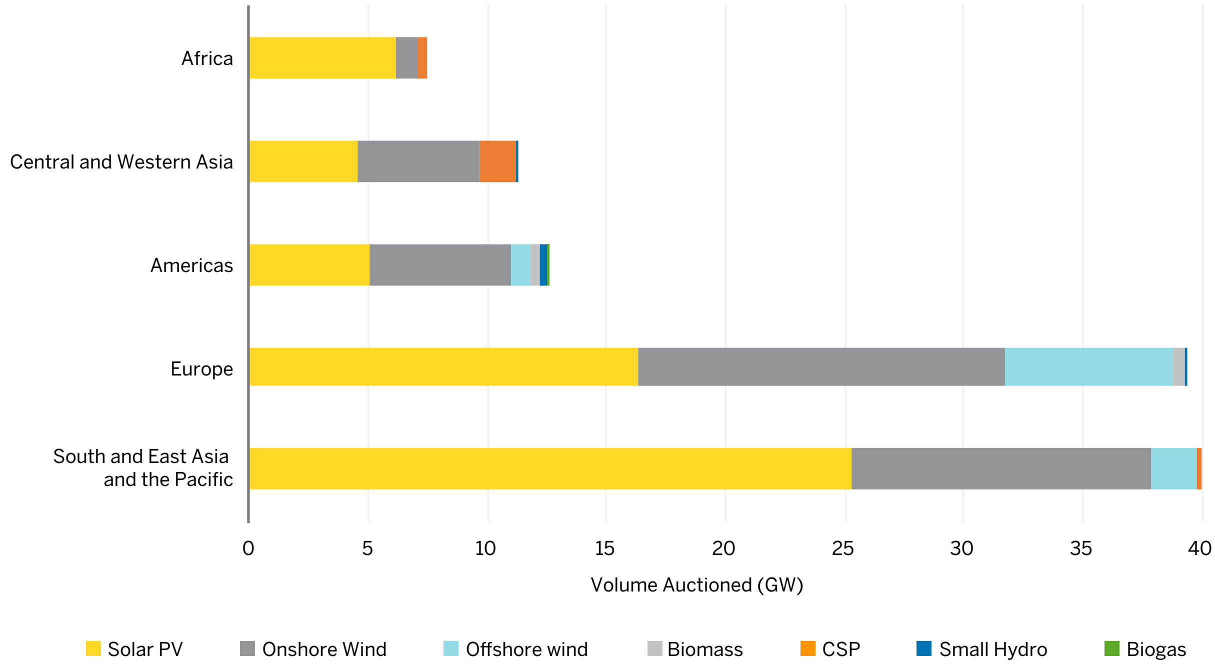
FIGURE 3.14 • Global weighted average prices resulting from auctions and capacity awarded each year, 2010–18



Source: IRENA (2019a), based on BNEF (2019a) and PSR (n.d.).

In the period between 2017 and 2018, an estimated total volume of 111 GW was auctioned or announced. Solar PV and onshore wind—the variable renewable energy sources—accounted, respectively, for 52 percent and more than 36 percent of the total volume (IRENA 2019a). As shown in Figure 3.15, the use of auctions varied across regions as a function of varying levels of development of the renewable sector, power market structures and macroeconomic contexts.

FIGURE 3.15 • Volume auctioned between January 2017 and December 2018, by region and technology (GW)



Source: IRENA (2019a), based on BNEF (2019a) and PSR (n.d.).

Most African countries that held auctions in 2017–18 were doing so for the first time. Their auctions were dominated by solar PV, where dedicated programs, such as the IFC's Scaling Solar Program, succeeded in attracting investments in Ethiopia, Madagascar, Senegal, and Zambia. The choice of auctions in Africa is driven for the most part by their potential for price discovery, especially when there is uncertainty regarding how to set the right price administratively (e.g., for a feed-in tariff). The flexibility in their design is also crucial: auctions can be tailored to specific contexts and designed to achieve low prices, through, for example, allocation of risks across multiple stakeholders. In this context, the right risk allocation and transparent processes are key to success in attracting private investment, both domestic and foreign. Auctions can be tailored to other policy purposes, as well, such as socioeconomic benefits, including job creation and development of a local industry.

Countries in Europe and Southern and Eastern Asia and the Pacific auctioned much higher volumes, predominantly solar PV and wind (both offshore and onshore). Some of those countries that had been supporting renewables through administratively-set tariffs (e.g., Germany, Japan, and Malaysia) turned to auctions to reduce the cost of support. In addition, members of the European Union have been required to follow the European Commission's Guidelines on State Aid for Environmental Protection and Energy for 2014–20, which established market-based mechanisms as the main instrument of support for renewables. The guidelines favor competition between renewable technologies but explicitly allow for technology-specific auctions. Many countries adopted technology-specific auctions (namely, in Europe, Southern Asia, Eastern Asia, and the Pacific) to support the introduction of specific technologies into the mix (e.g., offshore wind in Germany, Japan, and the Netherlands) or to achieve technology-specific targets (e.g., solar PV in India). Increasing generation from variable renewable energy sources poses system integration challenges that can also be addressed through auction designs that make geographical allocations sensitive to resource availability and network integration costs. Strategies include introducing hard limits on volumes that can be commissioned in congested zones, procurement of specific projects (e.g., solar PV and batteries combined), or implementing price adjustments to incentivize the production of power when and where it is most needed.

Moving toward a higher share of variable renewable energy will require a more comprehensive and integrated approach to power market design. The existing power markets (both regulated and liberalized) were originally designed around the technologies of the fossil fuel era, where large, centralized, and dispatchable generation provided electricity to a largely passive demand. Such system designs can limit the deployment of renewable power, increase electricity costs, and reinforce social inequalities (IRENA 2020b). The experience of auctions can assist in the redesign of power markets.

As the results of renewable energy auctions fall more and more in line with prices of conventional generation, they are being reshaped from support mechanisms to market mechanisms. In developed markets, their current role is centered more on overcoming market structure failures rather than on providing support (IRENA 2020a). In Latin America, in particular, auctions are already a functioning part of the power markets, and renewable energy generators are able to achieve cost-competitiveness with fossil fuels (Batlle et al. 2018; Roques et al. 2017). Policy makers are thus able to consider the restructuring of power markets, as auctions offer a viable solution for the large-scale procurement of low-cost renewable energy (IRENA 2020a, 2020b).

The restructuring of power markets should also enable responsive demand, including end uses, which are currently dominated by fossil fuel solutions. Sector coupling through heat pumps, electrified industrial loads, and electric vehicles, for example, could complement future power sector needs, providing the ability to shift demand during periods of high production of variable renewable energy. At the same time, further electrification using renewable energy would assist the decarbonization of all end-use sectors, and the direct use of renewables could complement nonelectrifiable loads.

The large-scale adoption of these technologies, however, will require proper planning for the energy sector as a whole. Electrified loads and renewable energy should be deployed in a coherent fashion that enables and exploits synergies between resources. Investments should prioritize long-term solutions so as to avoid stranding assets and locking consumers into technologies not suited for the renewable energy era.

As renewable energy technologies become mainstream, the policies driving their deployment are quickly evolving. This rapid evolution reflects many factors, among them changing market conditions, technical and socioeconomic hurdles, and the need to ensure a just transition. Through the increasing use of auctions, policy makers have sought to procure renewable electricity cost-effectively while fulfilling other, often country-specific social and economic goals. In other words, the trade-offs between achieving the lowest price and meeting other objectives can and should be considered when designing auctions. Design elements such as winner selection criteria, limits on project size, and qualification requirements, among others, can be introduced to include small and new players, foster the development of local industries, create local jobs, contribute to subnational development, and engage communities, even if at a marginally higher price for electric power. But it must be rememered that these design elements, effective as they are, are just a part of a broader policy framework devoted to more just and inclusive energy transition, one that promotes renewables deployment as a catalyst of inclusive and sustainable development and it rests on three transformative sets of policies: deployment, enabling, and integrating policies (IRENA, IEA, REN21, 2018).

BOX 3.2 • RENEWABLE ENERGY TO ADVANCE PROGRESS TOWARD SDG 8

An increase of renewable energy in the global energy mix translates into a number of tangible benefits, including progress toward SDG 8 on jobs and economic well-being. As renewable energy has developed into a jobs engine of growing significance, the linkages between SDG 7 and 8 are increasingly acknowledged.

IRENA's analysis shows that the number of renewable energy jobs worldwide has expanded from 7.3 million in 2012 to 11 million in 2018 (IRENA 2019b). Modeling suggests that the energy transition could expand renewable energy employment to 30 million by 2030 and 42 million by 2050 (IRENA 2020c). Although most jobs grew out of a modern energy context, recent growth in decentralized renewable energy solutions appears to be creating jobs, too. For instance, GOGLA and Vivid Economics estimated direct off-grid solar employment in Southern Asia and parts of Sub-Saharan Africa at 372,000 full-time-equivalent jobs (GOGLA 2018).

But in moving toward SDG 7, SDG 8, and the global energy transition, the centrality of jobs is about more than numbers. A decent job should provide an adequate wage or salary, SDG 8 states, irrespective of gender, in a safe and productive workplace. In the energy transition, well-trained workers who stay long enough in their jobs will be able to hone their skills and build the experience essential to success.

As of today, progress on employment related to achieving SDG 7 is evident but uneven. Most renewable energy jobs are concentrated in key markets—namely, Brazil, China, Europe, India, and the United States—the home states of the leading manufacturers and installers. Still, more countries are beginning to realize benefits of their own. They will be in a strong position to benefit further to the extent they can combine ambitious renewable energy deployment policies with related measures to build industrial capacities, expand education and skill-building, and ensure that the social benefits of the energy transition are broadly shared.

Benefits are still uneven with regard to the status of women. Although recognized as change agents in the promotion of renewable energy, women remain underemployed and underrepresented amongst entrepreneurs. A global survey indicated that women constitute only 21 percent of the wind energy workforce (IRENA 2020d), compared with 32 percent in renewables overall and 22 percent in traditional energy industries like oil and gas (IRENA 2019c). Substantial efforts are still needed to allow women to marshal their skills, talents, and perspectives in support of the coming transformation (IRENA 2019c; GWNET 2020).

Achieving SDG 7 and SDG 8 rests on the creation of more renewable energy jobs and on gaining a better understanding of the required skills. Additional data gathering and policy analysis are needed, which led IRENA and several international partners to launch a joint initiative at the start of 2020: for more information on the Sustainable Energy Jobs Platform, please visit: http://sejplatform.org/.

SUSTAINABLE ENERGY JOBS PLATFORM

METHODOLOGY

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 SDG 7.2 is the share of renewable energy in total final energy consumption. Data from the International Energy Agency (IEA) and United Nations Statistics Division (UNSD) energy balances are used to calculate the indicator according to the formula:

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

where the variables are derived from the energy balance flows (TFEC = total final energy consumption as defined in Table 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 1) while the numerator, the 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 at the final energy service is unavailable.

Heat refers to the amount of energy consumed-for heat-raising purposes in the industry and other sectors. It is not equivalent to the final energy end use service. It is also important to note that in this chapter in the context of an "end-use", 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 sectors. Electricity used in the transport sector is mostly comprised of the rail and road sectors (and in some cases, pipeline transport). The amount of renewable electricity consumed in the transport sector is estimated based on the share of renewable electricity in gross production.

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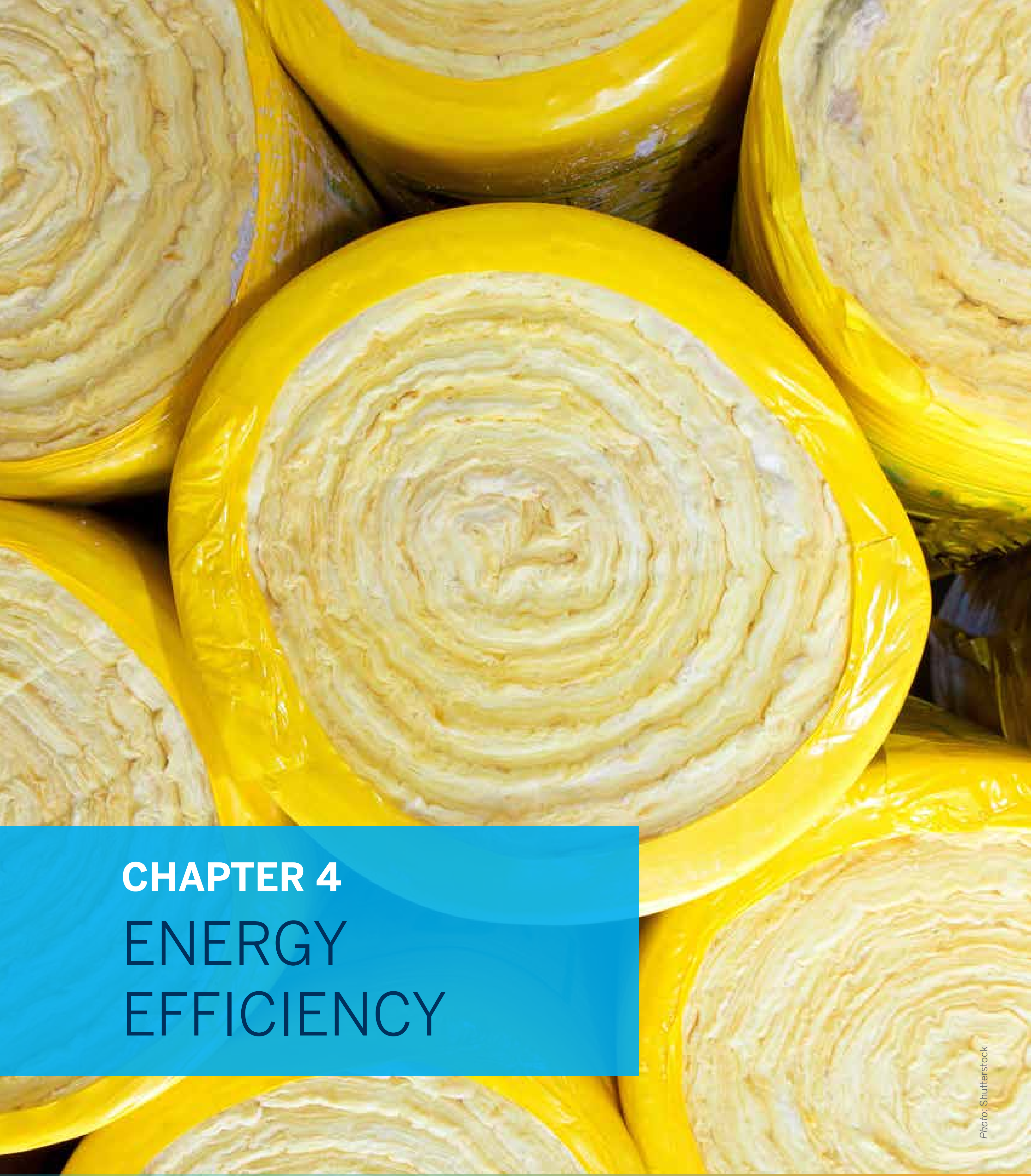


CHAPTER 4
ENERGY EFFICIENCY

Photo: Shutterstock

MAIN MESSAGES

- **Global trend:** After a period of relative stability, the rate of global primary energy intensity—defined as the percentage decrease in the ratio of global total primary energy supply per unit of gross domestic product (GDP)—has slowed in recent years. Global primary energy intensity was 5.01 megajoules (MJ) per U.S. dollar (2011 PPP [purchasing power parity]) in 2017, a 1.7 percent improvement from 2016. This was the lowest rate of improvement since 2010.
- **2030 target:** Energy intensity improvements are moving further away from the target set under the United Nations' Sustainable Development Goal (SDG) for 2030. Between 2010 and 2017 the average annual rate of improvement[27] in global primary energy intensity was 2.2 percent. Although better than the rate of 1.3 percent between 1990 and 2010, it is well below the SDG 7.3 target of 2.6 percent—which would have doubled the historic trend. Annual improvement until 2030 will now need to average over 3 percent to meet the target set in SDG 7.3. Even a positive rebound, as indicated by a preliminary estimate of 2 percent for 2019, remains well below the 3 percent annual increases needed to reach SDG target 7.3—or even the 2.2 percent seen between 2010 and 2017.
- **Regional highlights:** Asia is where more robust, continuous improvements are seen in energy intensity than in than any other world region. Between 2010 and 2017, primary energy intensity in Eastern Asia and South-eastern Asia improved by an annual average rate of 3.3 percent. Similarly, in Central Asia and Southern Asia and Oceania, the average annual improvement rate of 2.5 percent between 2010 and 2017 was above the global average (2.2 percent) and an improvement on historic trends. Rates of improvement were just below the global average in Northern America and Europe (2.1 percent), with the lowest rates of improvement in Sub-Saharan Africa (1.3 percent), Western Asia and Northern Africa (1 percent), and Latin America (0.9 percent). Data on absolute energy intensity reveal wide regional differences: the most energy-intensive region is Sub-Saharan Africa, and Latin America and the Caribbean the least. These variations likely mirror not energy efficiency so much as economic structure, energy supply, and access.
- **Top 20 countries in energy intensity:** Comparing the periods 2000–10 and 2010–17, the annual rate of improvement in primary energy intensity increased in 14 of the 20 countries with the largest total primary energy supply in the world. But, of these, only 8 performed better than the global average. China continues to improve primary energy intensity at the fastest rate, at an annual average of 4.5 percent between 2010 and 2017. Other emerging economies with average energy intensity rates that are at or above those aimed for in SDG target 7.3 include India, Indonesia, and Mexico. Japan and the United Kingdom 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 energy intensity improved across all sectors during the period 2010–17, the rate differs by sector. Using different intensity metrics, the rate of improvement declined compared with the period 1990–2010 in all sectors except transport, where fuel-efficiency standards drove improvements. The decline in the rate of improvement from one period to the other is most noticeable in services, agriculture, and, to a lesser extent, industry. All three of these sectors were strongly 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.

27 Calculated as a compound average annual growth rate.

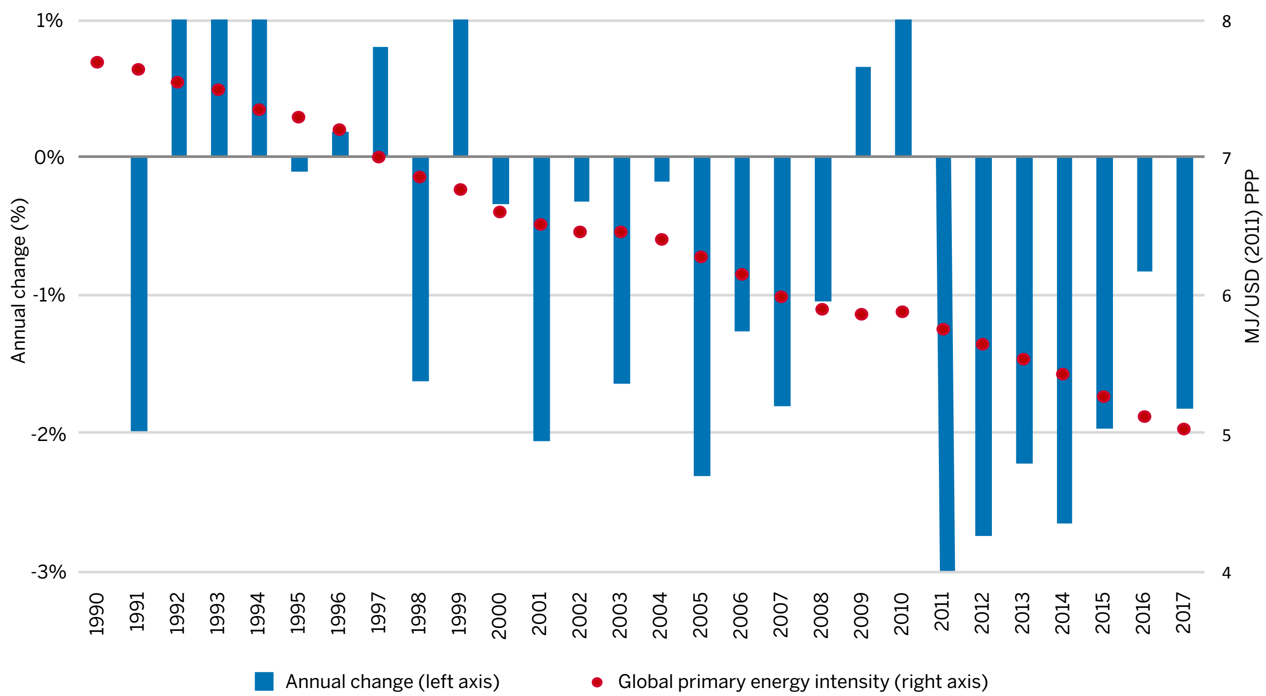
- **Electricity supply trends:** The mounting share of renewables in electricity supply also improves the supply efficiency by eliminating the losses that accompany the conversion of primary (non-renewable) fuels into electricity. This relationship between efficient renewable electricity and a decrease in primary energy intensity highlights the synergies between SDG target 7.2 and SDG target 7.3. In addition, nearly 40 percent of the average efficiency of fossil fuel electricity generation is due to relatively more efficient gas-fired generation and the construction of highly efficient coal-fired generation in China and India. Major producing countries are seeing declines in electricity transmission and distribution losses, which indicate higher rates of electrification and a modernized supply infrastructure.

ARE WE ON TRACK?

SDG 7 commits the world to ensure universal access to affordable, reliable, sustainable, and modern energy. Energy efficiency supports all of SDG 7's targets, but it is especially relevant to SDG target 7.3: doubling the current global rate of energy efficiency by 2030. Energy efficiency is most commonly measured in terms of "energy intensity," or the ratio of primary energy supply to the annual 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, the annual improvement rate now required to achieve SDG target 7.3 is at least 3 percent. Figure 4.1 illustrates global energy intensity improvements since 1990.[28] Recent numbers show that global primary energy intensity improved by 1.7 percent in 2017 to 5.01 MJ/U.S. dollar (2011 PPP).

FIGURE 4.1 • Global primary energy intensity and its annual change, 1990–2017

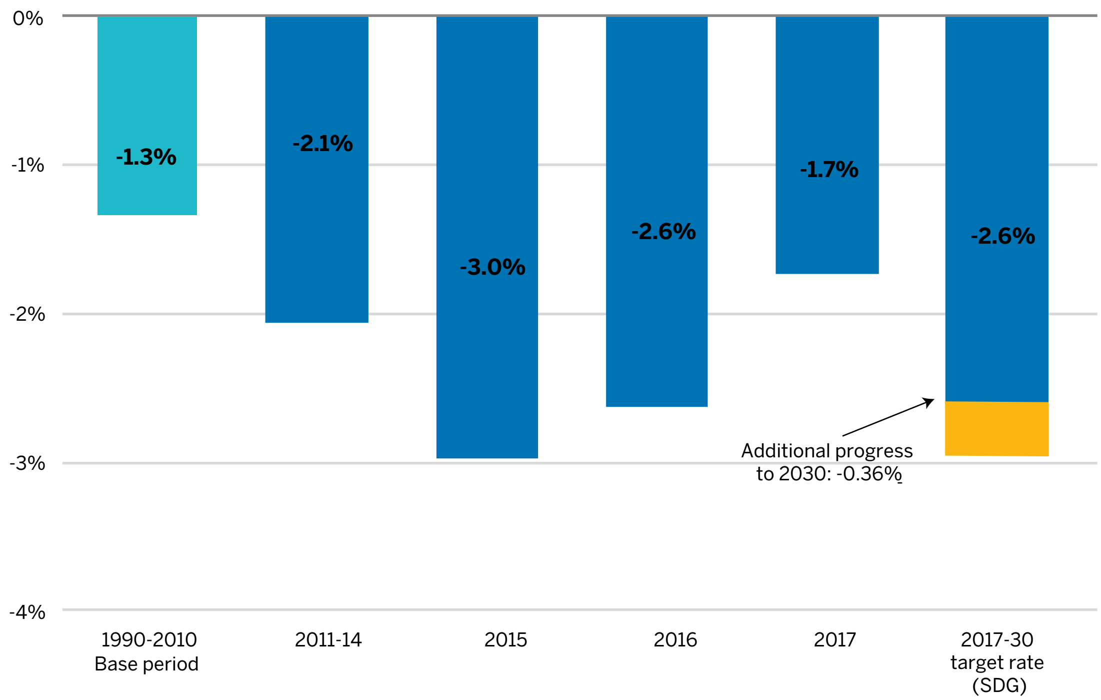


Source: IEA, UNSD, and World Bank (see footnote 2).

MJ = megajoule; PPP = purchasing power parity.

28 Most of the energy data in this chapter, including that used for many of the figures, come from the International Energy Agency's (IEA) World Energy Balances database (https://www.iea.org/data-and-statistics/) and the United Nations Statistical Division's (UNSD) Energy Balances database (https://unstats.un.org/unsd/energystats/). GDP data are sourced from the World Bank's World Development Indicators database (http://datatopics.worldbank.org/world-development-indicators/).

FIGURE 4.2 • Growth rate of primary energy intensity, by period and target rate, 1990-2030



Source: IEA, UNSD, and World Bank (see footnote 2).

The 2017 rate of 1.7 percent was the lowest rate of improvement since 2010, continuing the slowing trend since 2015 (Figure 4.2). As a consequence of this slowing, the average rate of improvement needed to meet SDG target 7.3 has now increased to 3 percent per year between 2017 and 2030, a difference of 0.4 percent from the 2.6 percent initially estimated when the SDGs were enacted.

LOOKING BEYOND THE MAIN INDICATORS

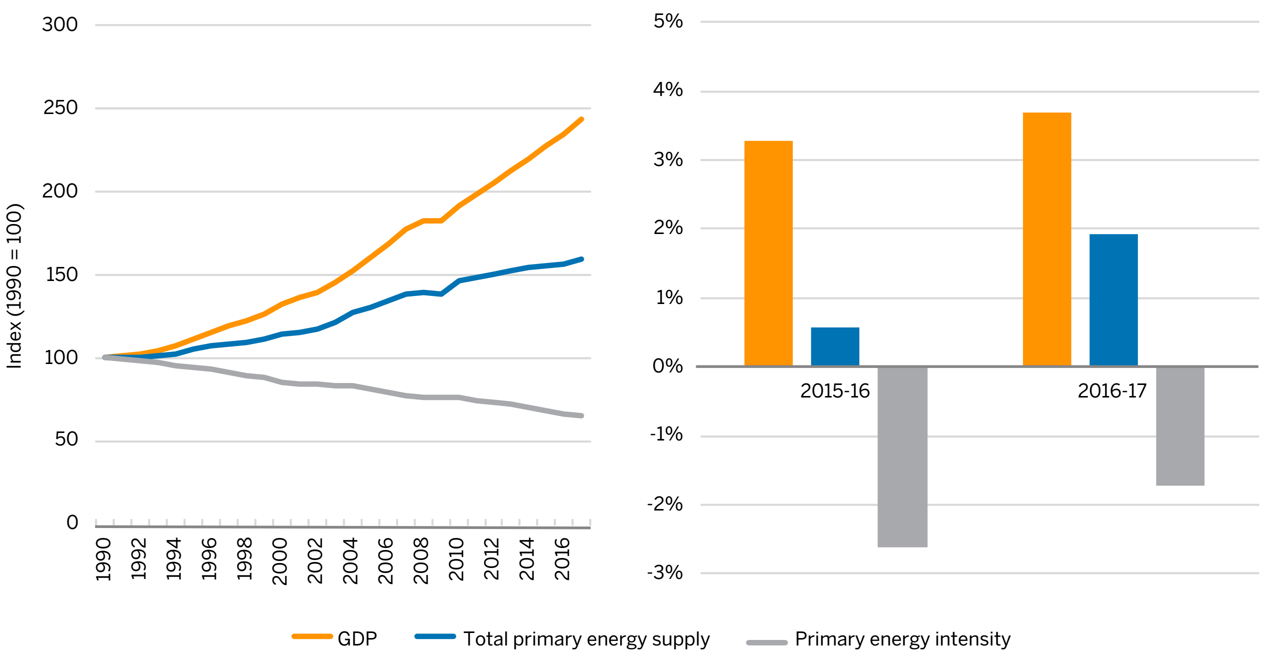
COMPONENT TRENDS

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 2017, global GDP more than doubled while global total primary energy supply increased by just over 50 percent. Although growth in primary energy supply slowed markedly in 2015 and 2016, it picked up again in 2017, growing by nearly 2 percent.

The difference in growth rates for global GDP and total primary energy supply is reflected by consistent improvements in global primary energy intensity, which fell more than 30 percent between 1990 and 2017, signaling trends in the decoupling of energy use and economic growth. In the period 2010–17, global primary energy intensity fell by 10 percent, or just slightly more than the percentage drop observed between 2000 and 2010.

The recent slowdown in the improvement rate for energy intensity—from 2.6 percent in 2016 to 1.7 percent in 2017 (Figure 4.3, right)—means that while GDP growth trended modestly upward, the growth rate for primary energy supply tripled.

FIGURE 4.3 • Trends in underlying components of global primary energy intensity, 1990–2017 (left); and growth rates of GDP, primary energy supply, and intensity, 2015–17 (right)

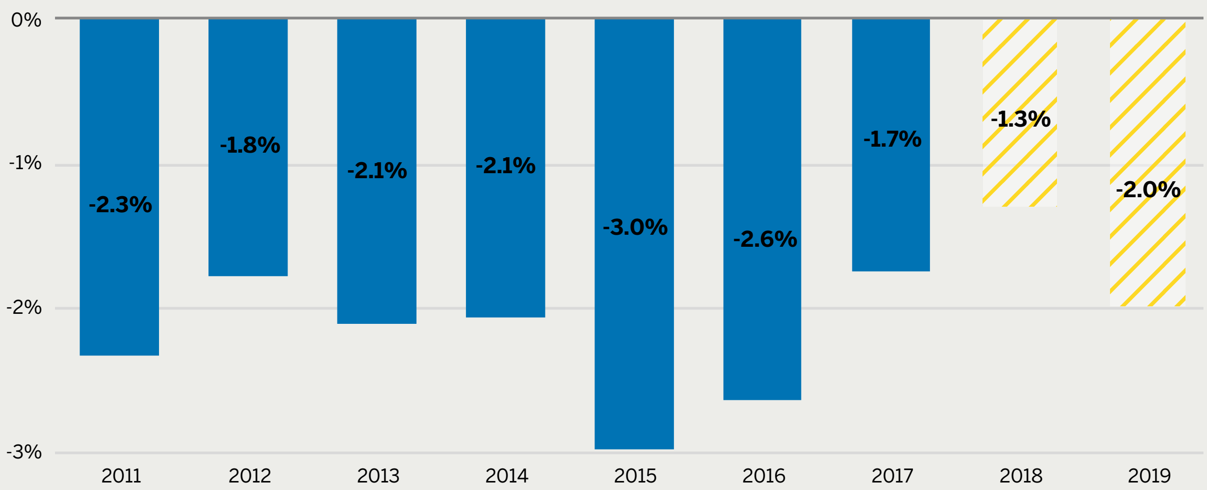


Source: IEA, UNSD, and World Bank (see footnote 2).
GDP = gross domestic product.

BOX 4.1 • ESTIMATES FOR 2018 AND 2019 INDICATE SLOWING RATES OF PRIMARY ENERGY INTENSITY IMPROVEMENT

Estimates from the International Energy *Agency's Global Energy Review: Energy and carbon emissions status report 2020* show that the rate of improvement in global primary energy intensity continued to slow in 2018 but may have improved slightly in 2019 (Figure B4.1.1). Global primary energy intensity is estimated to have improved by just 1.3 percent in 2018 and 2 percent in 2019, well below the 3 percent annual improvement target required to achieve SDG target 7.3.

FIGURE B4.1.1 • Growth rate of global primary energy intensity, 2011–19



Source: IEA 2020.

Although it is estimated that efficiency continued to improve in 2018 and 2019, its impact has been overwhelmed by factors leading to increased energy demand, such as changes in energy users' purchasing decisions and structural shifts back toward more-energy-intensive industries. These factors, linked to strong economic growth and low energy prices, have combined with a static energy efficiency policy landscape to shrink improvements in primary energy intensity. Progress in implementing new energy efficiency policies or strengthening existing policies has been slow, limiting the ability of energy efficiency gains to offset the impact of economic growth on energy demand. Slowing rates of improvement mean that additional effort will be required, on top of that already needed, to reach SDG target 7.3.

Note: Further information available from IEA (2020).

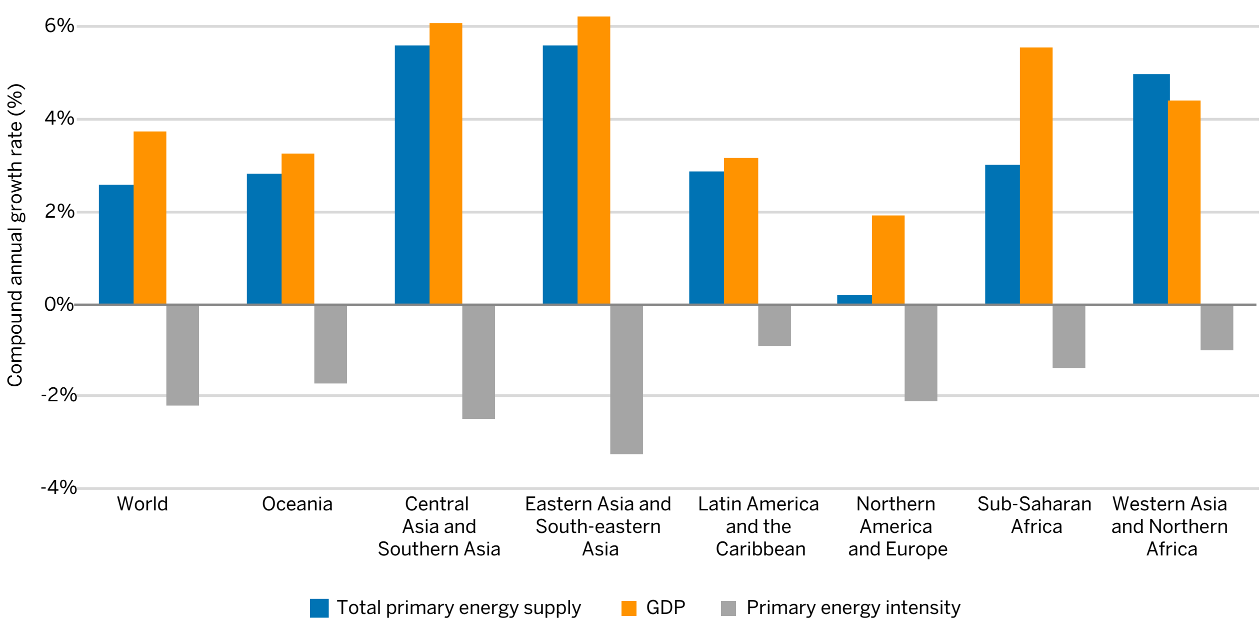
REGIONAL TRENDS

Overall, since 2010, primary energy intensity has improved across the world, but noteworthy differences in trends are observed across regions (Figure 4.4). Emerging economies in Eastern and South-eastern Asia have seen a rapid increase in economic activity; however, the rise in primary energy supply associated with such growth has been mitigated in part by substantial improvements in energy intensity, 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 primary 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 the improvements in energy efficiency observed when mature policies are in place, particularly in buildings (Northern America) and industry (Europe). In these economies, energy intensity improved at a rate just below global trends, leading to an absolute level of energy intensity just below the global average (Figure 4.5).

From 2010 to 2017, economic activity steadily increased across Northern Africa, Oceania, Sub-Saharan Africa, and Western Asia, accompanied by growth in primary energy consumption well above the global average. Improvements in energy intensity in these regions have been modest and unable to offset the effects of economic growth on demand. In absolute terms, significant differences exist between these regions, reflecting differences in their stages of development and economic output (Figure 4.5). For example, economic output in Sub-Saharan Africa is highly energy intensive, at nearly 7 MJ/U.S. dollar (2011 PPP), partly reflecting the low value of economic output in this region, compared to 4.3 MJ/U.S. dollar (2011 PPP) in Northern Africa and Western Asia (Figure 4.5).

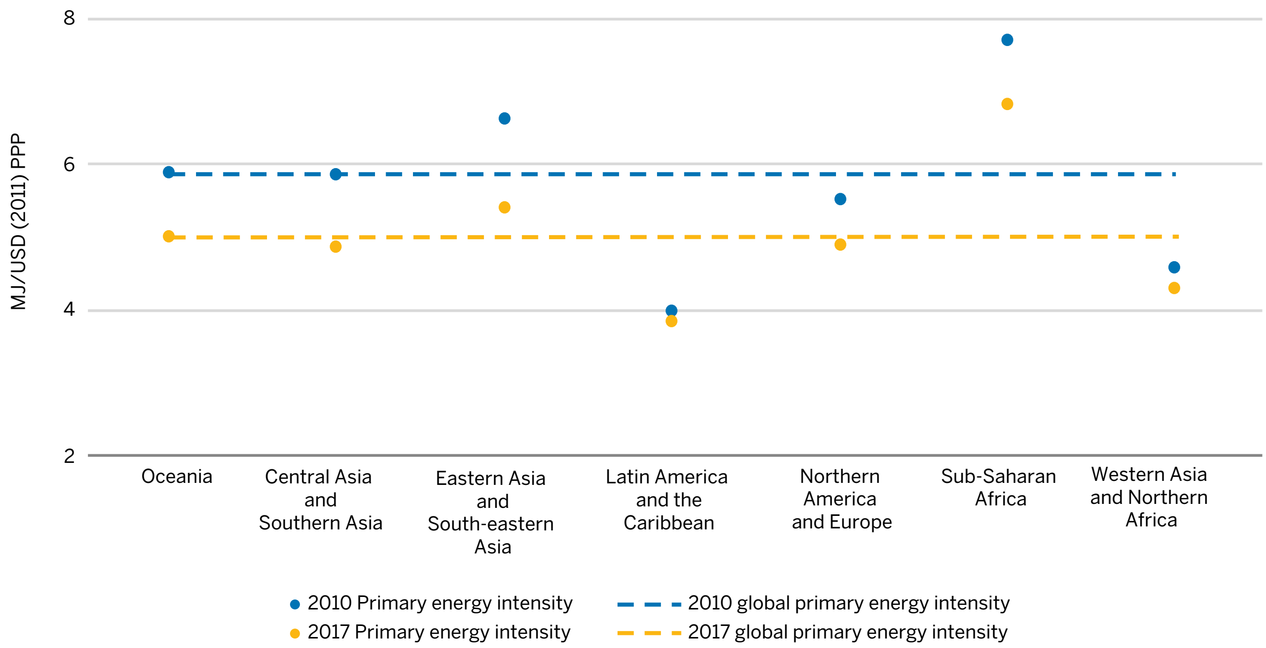
Despite continuing to record the smallest average gains in energy intensity improvement over the period 2010–17 (less than 1 percent), the Latin America and the Caribbean region experienced a year-on-year improvement in energy intensity of 2.1 percent in 2017, the largest gain there since 2011. This region is also the least energy intensive in the world, at just below 4 MJ/U.S. dollar (2011 PPP) (Figure 4.5).

FIGURE 4.4 • Growth rate of GDP, primary energy demand, and regional energy intensity, 2010–17



Source: IEA, UNSD, and World Bank (see footnote 2).
GDP = gross domestic product.

FIGURE 4.5 • Primary energy intensity, by region, 2010 and 2017



Source: IEA, UNSD, and World Bank (see footnote 2).
MJ = megajoule; PPP = purchasing power parity.

MAJOR COUNTRY TRENDS

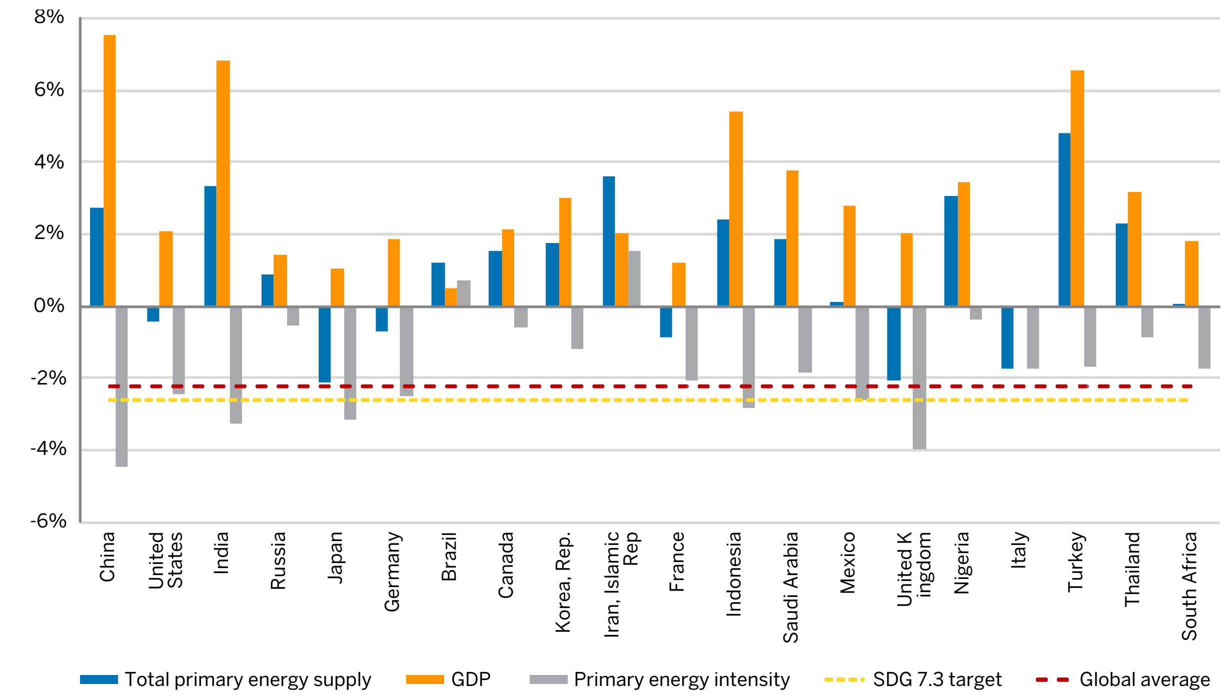
Rates of improvement for primary energy intensity in the 20 countries with the largest total primary energy supply would be central to realizing SDG 7.3. Over the period 2010 to 2017, 14 of these countries increased their rate of improvement, but only 8 performed better than the global average, with 6 (China, India, Indonesia, Japan, Mexico, and the United Kingdom) exceeding the level required by SDG target 7.3 (Figure 4.6).

Of these six countries, four—China, India, Indonesia, and Mexico—are 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 of Japan and the United Kingdom have expanded as their energy use declined. Both display energy intensity improvement rates above the global average, suggesting that economic growth is being decoupled from energy use. A similar trend is observed in France, Germany, and the United States. High-value, service-related activities are less energy intensive, and the economies in these countries all have strong, decades-long records of policy action on energy efficiency.

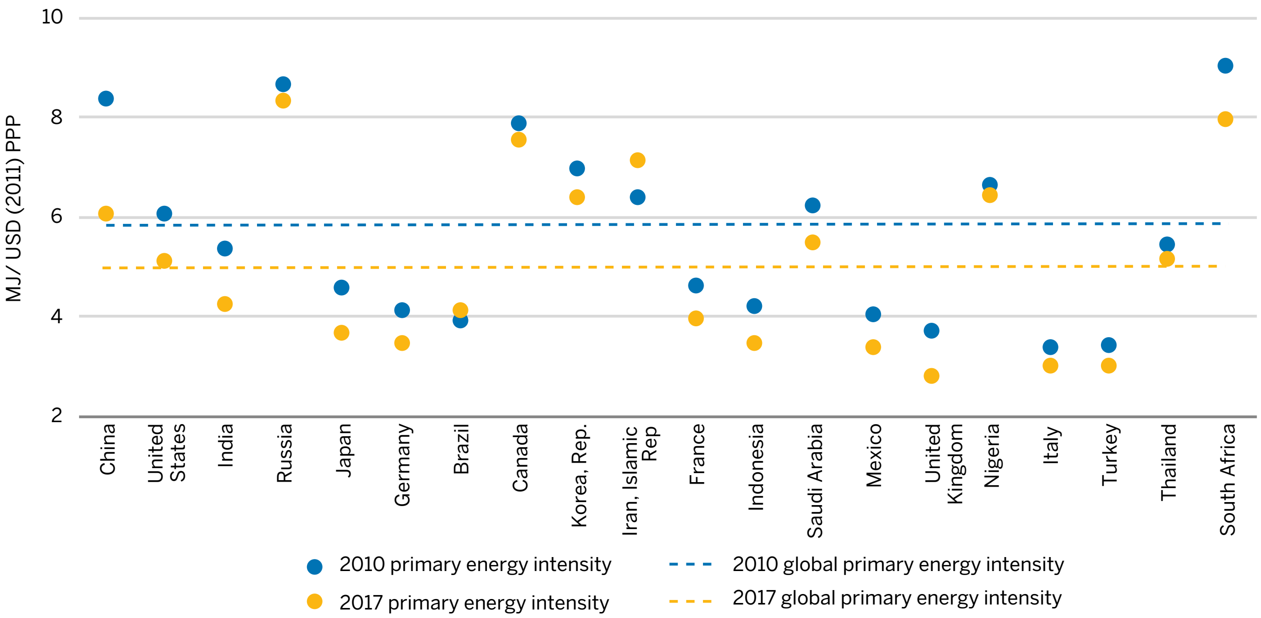
By contrast, Brazil and Iran are two major energy-consumers with worsening primary energy intensity, partly because their stagnant economic conditions inhibit greater investment in industrial efficiency. Notably, both countries have sizable energy-intensive industry sectors. In Iran, where fossil fuels are plentiful, energy efficiency has not been a priority; meanwhile, generous government subsidies of fuel prices have further entrenched inefficient energy use.

FIGURE 4.6 • Growth rate of GDP, primary energy demand, and intensity in the 20 countries with the highest total primary energy supply, 2010–17



Source: IEA, UNSD, and World Bank (see footnote 2).
Note: Countries along x-axis ordered by total primary energy supply.
GDP = gross domestic product; SDG = Sustainable Development Goal.

FIGURE 4.7 • Primary energy intensity in the 20 countries with the highest total primary energy supply, 2010 and 2017



Source: IEA, UNSD, and World Bank.
Note: Countries along x-axis ordered by total primary energy supply.
MJ = megajoule; PPP = purchasing power parity.

In absolute terms, the energy intensity of 10 of the top 20 energy-consuming countries remain above the global average, compared to 9 in 2010. For example, energy intensity in Thailand grew from being below the global average in 2010, to above it in 2017 (Figure 4.7). Since 2010, however, average global energy intensity has fallen by nearly USD 1/MJ (2011 PPP). Certain countries have made progress by moving further below global average energy intensity, including India, Japan, and the United Kingdom. Others (such as China, South Africa, and the United States), despite remaining more energy intensive than the global average, are improving and shifting toward the global average.

Countries that have made the least progress include those where energy-intensive fossil fuel extraction is a major economic activity—namely, Canada, Iran, Nigeria, and Russia.

BOX 4.2 • THE IMPACT OF PRIMARY ENERGY INTENSITY IMPROVEMENTS ON GDP GROWTH

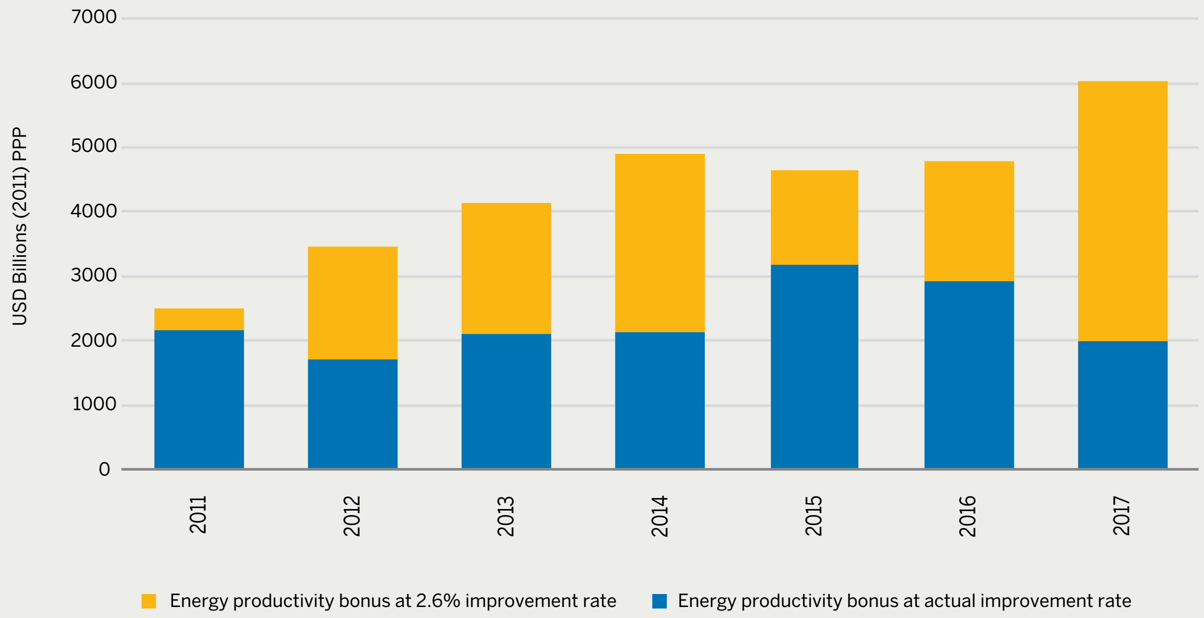
Improvements in primary energy intensity can have a marked effect on economic growth because less energy-intensive economies create more wealth for every unit of energy consumed. This additional wealth is termed the "productivity bonus"—that is, the bonus wealth created by annual energy intensity improvements. The productivity bonus can also be used to track the economic opportunities missed because rates of energy intensity improvement are slowing. By comparing the energy productivity bonus of a given year with a theoretical bonus attained through a given higher level of efficiency that year, we can assess the opportunity cost of continuing to operate in a business-as-usual manner.

Figure B4.2.1 shows the annual global productivity bonus from 2011 to 2017 and compares those improvements against the productivity bonus that could have been created had the world achieved, with respect to the energy consumed between 2011 and 2017, the 2.6 percent improvement rate in annual energy efficiency set in Sustainable Development Goal (SDG) 7. As the figure shows, the world has fallen short of this goal since it was announced, missing out on an average of USD 2 trillion per year, totaling more than USD 14 trillion over the seven-year period.

These global figures are driven by the largest economies—India, China, the European Union, and the United States. These four economies account for more than 60 percent of global gross domestic product, so as their contributions to global growth increase and decrease in scale, so, too, do their energy intensity rates affect the global efficiency measures. For example, in 2017, the global productivity bonus dropped by about 33 percent, from approximately USD 3 trillion in 2016 to approximately USD 2 trillion in 2017. China's 2016 productivity bonus, which was larger than all other countries combined, dropped by 42 percent in 2017 after its energy intensity improvement rate more than halved from 6.9 percent in 2016 to 3.4 percent in 2017. The year-on-year change in China's intensity contributed significantly to the loss of global productivity bonus, comprising 77 percent of the total loss. With the European Union and India responsible for 8 percent and 11 percent of the total loss, respectively, and the United States contributing an 11 percent gain, only 15 percent of the total effect is attributable all other countries (IEA 2018). This comparison underscores the heavy hand these four economies have over global efficiency and its impact on potential benefits brought with improvements.

Because of its capacity to increase economic productivity, energy efficiency can support not only SDG 7 but also the world in its progress toward SDG 8, which calls for greater economic growth and productivity.

FIGURE B4.2.1 • Energy productivity bonus, 2011–17



Source: IEA 2019a.
PPP = purchasing power parity.

END-USE TRENDS

Overall, during the period 2010–17, energy intensity improved in all sectors. Using different energy intensity metrics, it is possible to examine the impact across 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 the most-energy-intensive economic activities, the annual rate of energy intensity reductions dropped by roughly a third: from 3.7 percent to 2.5 percent. In spite of this slowdown, industry energy intensity improved at the highest rate of all the sectors over the seven-year 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 production of cement production in China and India (where energy intensities are among the lowest in the world) rose from 42 percent to 65 percent between 2004 and 2017. Furthermore, the policy framework for industry energy efficiency tends to be more developed than for other sectors across countries worldwide (IEA 2018).

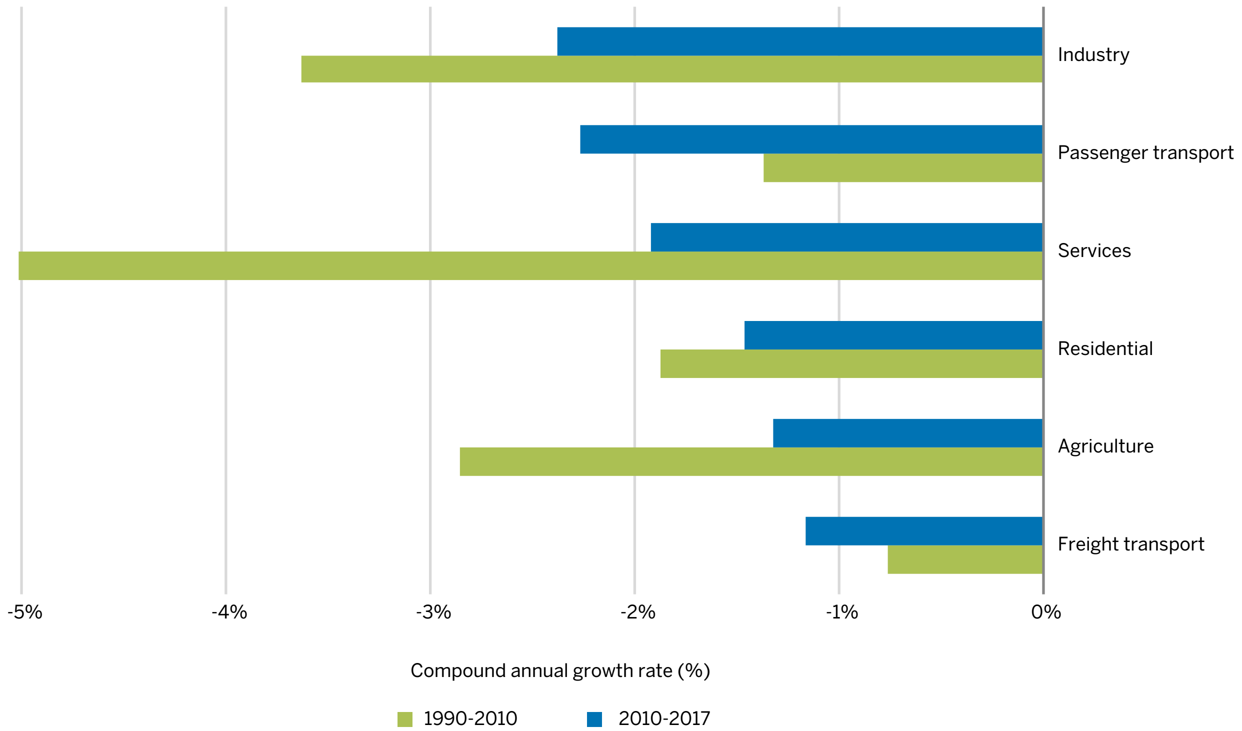
Between 2010 and 2017, the passenger transport sector experienced the second-highest rate of energy intensity improvement, after the industry sector, at 2.3 percent. This increase is higher than the growth rate of 1.4 percent seen in the period 1990–2010. Similarly, energy intensity for freight transport improved at a faster rate compared with the previous period. Nevertheless, its gains remained the lowest across all sectors, at only 1.3 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 transport behavior and consumer preferences. 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 roughly 27 percent of electricity consumption worldwide, has seen a minor slowdown in the rate of energy intensity improvement, from 1.9 percent to 1.5 percent. Demand for new construction continues to swell with population growth, and recent years have seen rising demand for cooling and larger living spaces. Mitigating some of these effects would require greater ambition in the enforcement of buildings' energy codes, especially in emerging economies, where a large share of new dwellings is being built.

Between 2010 and 2017, the service sector's rate of energy intensity improvement slowed more starkly than that of any other sector, falling from 5 percent in the previous period (1990–2010) to just 1.9 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, which tend to be more energy intensive to produce.

Similarly, the improvement rate for agriculture's energy intensity more than halved—from nearly 3 percent in 1990–2010 to just 1.3 percent between 2010 and 2017. 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 • Growth rate of energy intensity by sector, 1990–2010 and 2010–17



Source: IEA, UNSD, and World Bank (see footnote 2).

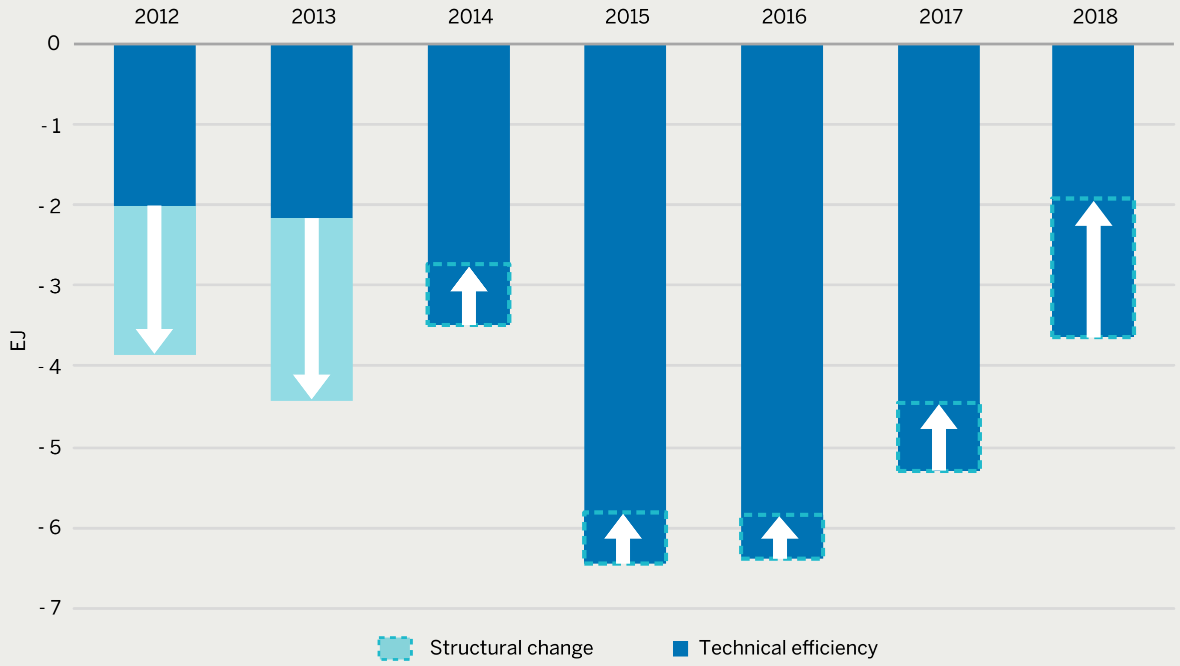
Note: The measures for energy intensity used here differ from those applied to global energy intensity. Here, energy intensity for freight transport is defined as final energy use per tonne-kilometer; for passenger transport it is final energy use per passenger-kilometer; for residential use it is final 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 2011 U.S. dollars at purchasing power parity).

BOX 4.3 • THE EFFECT OF STRUCTURAL FACTORS ON ENERGY DEMAND

In any year, energy demand is affected by a combination of energy-using activities, structural effects, and technical energy efficiency. Analysis of some of the world's major economies shows that in 2012 and 2013, structural effects reduced final energy demand by the same or more than the energy savings achieved by technical energy efficiency improvements alone (Figure B4.3.1).

However, in recent years, structural impacts have added to energy demand, offsetting some of the energy savings brought about by technical efficiency improvements. Final demand across major economies grew by over 4 percent between 2015 and 2018, a slight increase over previous years. This reflects the effect of population and economic growth, as well as structural shifts in the nature of energy-using activities in various economic sectors. For example, evidence suggests that, on average, consumers have increased their travelling distances, have changed their modes of transport to more energy-intensive options, own more appliances, and live in buildings with larger floor areas. It is estimated that such structural effects alone were responsible for an almost 1.5 percent increase in energy use between 2015 and 2018 in some of the world's major economies. The recent shift in energy-using behavior in these countries might be at least partially related to low crude oil prices during the period 2014–17.

FIGURE B4.3.1 • **Combined effects of technical efficiency improvements and structural effects on demand, annually, 2012–18**



Source: IEA 2019a.

Note: The "major economies" referred to in the above analysis are IEA Member Countries—Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States—plus Argentina, Brazil, China, India, Indonesia, and the Russian Federation.

EJ = exajoule.

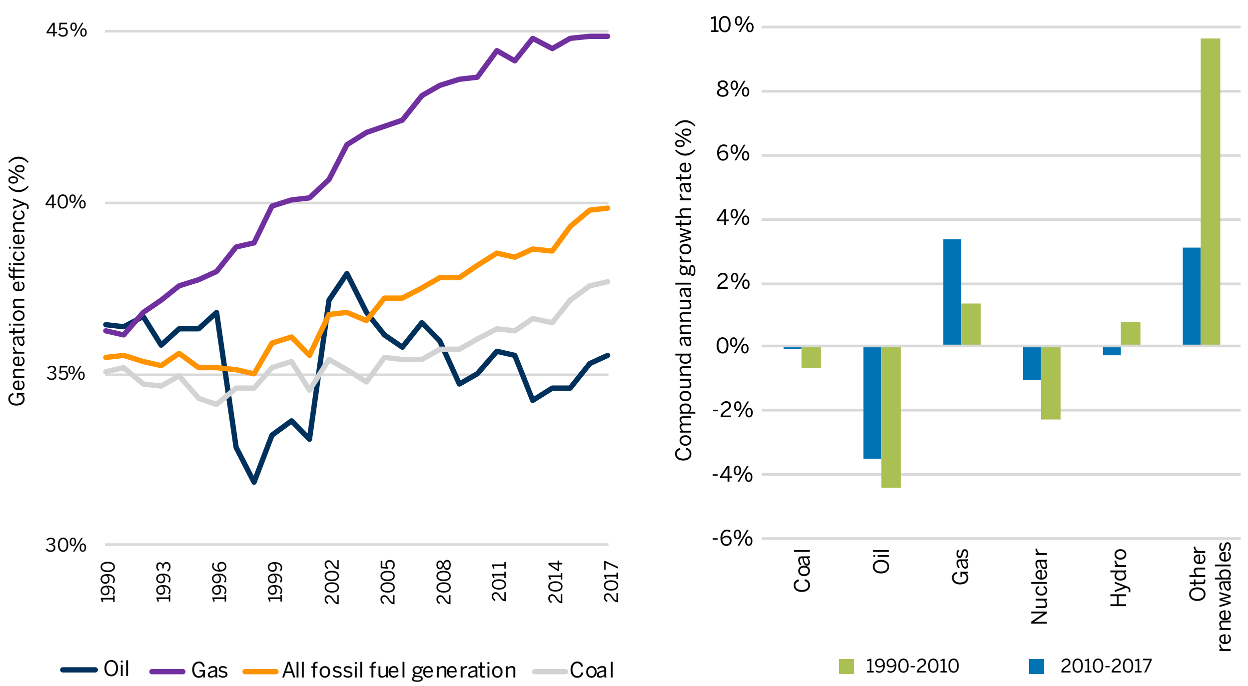
TRENDS IN ELECTRICITY SUPPLY EFFICIENCY

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 has steadily improved since 2000, after showing flat rates of improvement during the preceding decade, to reach nearly 40 percent in 2017 (Figure 4.9, left).

Another factor affecting supply efficiency for global electricity is the share of renewable energy sources in the mix. Statistically, renewable energy technologies are treated as being 100 percent efficient because no losses accompany the conversion of resources such as sunlight and wind into electricity. So, the more renewable energy there is in the mix, the greater the efficiency of electricity supply.

In 2017, renewable energy comprised only 17.3 percent of global electricity consumption; nevertheless, it made a notable contribution to energy efficiency. Between 2010 and 2017, renewable electricity sources other than hydropower grew at an annual average rate of 10 percent, up from 3 percent in the period 1990–2010 (Figure 4.9, right). Hydropower electricity also grew at a faster rate than during the preceding period. Conversely, growth rates for fossil fuel generation were all lower in 2010–17 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 primary energy into electricity. That increasing the share of renewable electricity helps to reduce primary energy intensity shows the 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), 1990–2017



Source: IEA, UNSD, and World Bank (see footnote 2).

BOX 4.4 • RELATIONSHIP BETWEEN THE EFFECT OF DEMAND- AND SUPPLY-SIDE FACTORS ON EMISSIONS

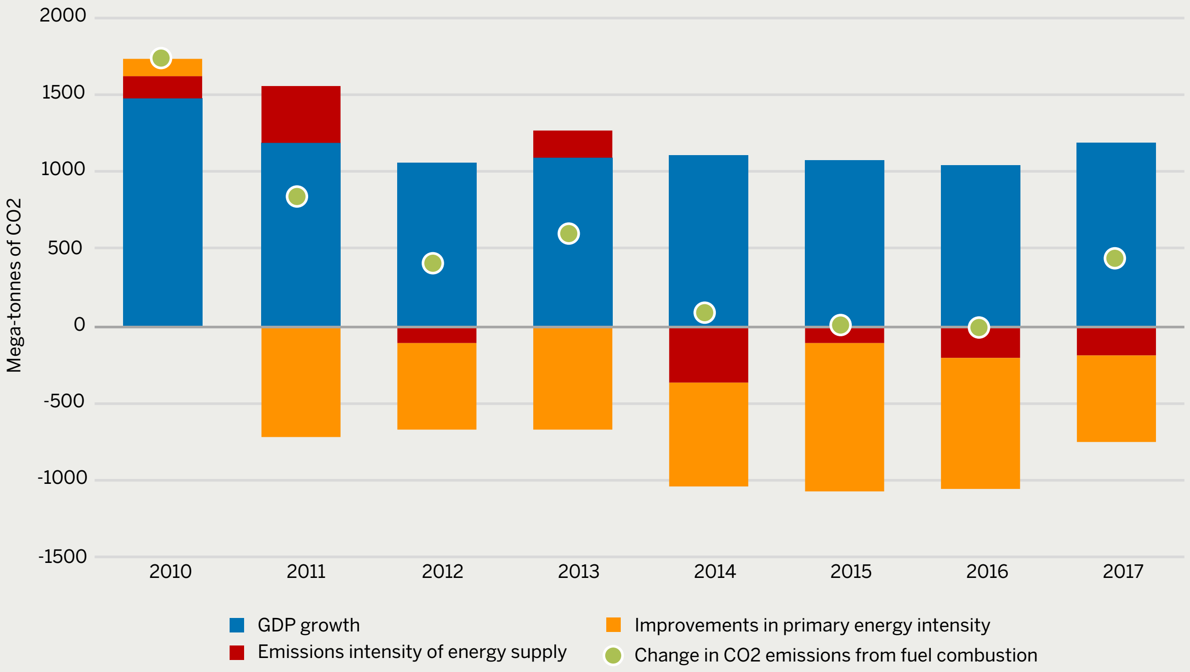
Carbon emissions associated with the energy sector are one of the biggest contributors to human-induced climate change. The goal of reducing global emissions therefore depends largely on reducing primary energy intensity. Given that the time frame for action is shrinking, it is important to determine where in the energy system countries should target their efforts.

Each year, changes in energy sector emissions are determined by a combination of factors, including changes in energy-using activities, the intensity of both the supply and demand sides, and the emissions intensity of the energy mix. Decomposition analysis allows for the identification of the factors responsible for annual changes in emissions.

Analysis shows that in 2010, the rise in global emissions was driven by economic growth, a more emissions-intensive energy mix, and declines in the energy intensity of supply and demand. Since then, the major factor helping to reduce the growth of energy-related emissions has been improved final energy intensity, thanks largely to efficiency gains in buildings, industry, and transport. Another factor helping to lessen annual growth in emissions is the switch to renewable energy sources, which has reduced the emissions intensity of the energy mix annually since 2014.

The effect of an efficient energy supply (the ratio of primary energy needed to supply a unit of final energy demand) has frequently changed, in some years helping to reduce annual emissions growth, while in others, increasing emissions. This reflects yearly variations in the energy supply mix, such as changes in electricity demand, which are often determined by factors such as weather.

FIGURE B4.4.1 • Decomposition of energy sector emissions, 2010–17



Source: IEA, UNSD, and World Bank (see footnote 2).

Note: Countries covered are IEA member countries plus Argentina, Brazil, China, India, Indonesia, Russia, and South Africa—together representing around 75 percent of global energy use.

CO_2 = carbon dioxide; GDP = gross domestic product.

EMERGING TRENDS: DIGITALIZATION

Digitalization is rapidly transforming the energy sector, with possible implications for the achievement of SDG 7.3. By gathering and analyzing data from a vast network of sources, digital technologies have the potential to optimize energy production and consumption at a scale that would otherwise not be possible. With the proliferation of digital devices and low-cost sensors, a wealth of data is now available to optimize energy use: linking data from smart meters, commuter movements, mobile telephone networks, consumer purchasing decisions, social media, weather conditions, and more.

Digitalization makes end-use energy more efficient while distributing flexible load, generation, and storage. By broadening energy efficiency, digitalization contributes to system efficiency. Connected components of the energy network increase end-use efficiency and in doing so support "prosumers" and integrate new sources of demand response. Together they help make the system more efficient (IEA 2019a).

Although a complete accounting of digitalization is still uncertain—along with its promise of energy efficiency—research suggests global potential. IEA estimates suggest that in the building sector, digitalization could cut total energy use by 10 percent by 2040, creating a cumulative energy savings of 234 exajoules—equivalent to more than half the final demand consumed globally per year (IEA 2019a). Some models of urban transport suggest that digital innovations such as teleworking, shared mobility, and connected and autonomous vehicles could reduce transport carbon emissions by more than 50 percent in 2050 compared to business-as-usual emissions (ITF 2019).

It is important to note, however, that digitalization also poses risks. For example, the rapidly shifting transport landscape (e.g., ride-hailing and micromobility) creates uncertainty around net energy use. Depending on which effects dominate, models estimate that digitalization and automation trends could have a range of different effects on final transport energy demand. Optimistic scenarios in which efficiencies are maximized could halve transport energy use compared with current levels; pessimistic scenarios see transport demand doubling (Waduda, MacKenzie, and Leiby 2016). Smart policies are therefore key to ensuring that digitalization leads to a more energy-efficient and sustainable energy system (see below).

POLICY RECOMMENDATIONS AND CONCLUSIONS

Recent shortfalls in energy intensity—below rates that would meet SDG target 7.3—will require strengthened government policies on energy efficiency. Decades of global experience demonstrate that well-designed and -implemented energy efficiency policies can deliver a range of benefits beyond energy and emissions savings. Governments can realize these benefits through straightforward policy decisions.

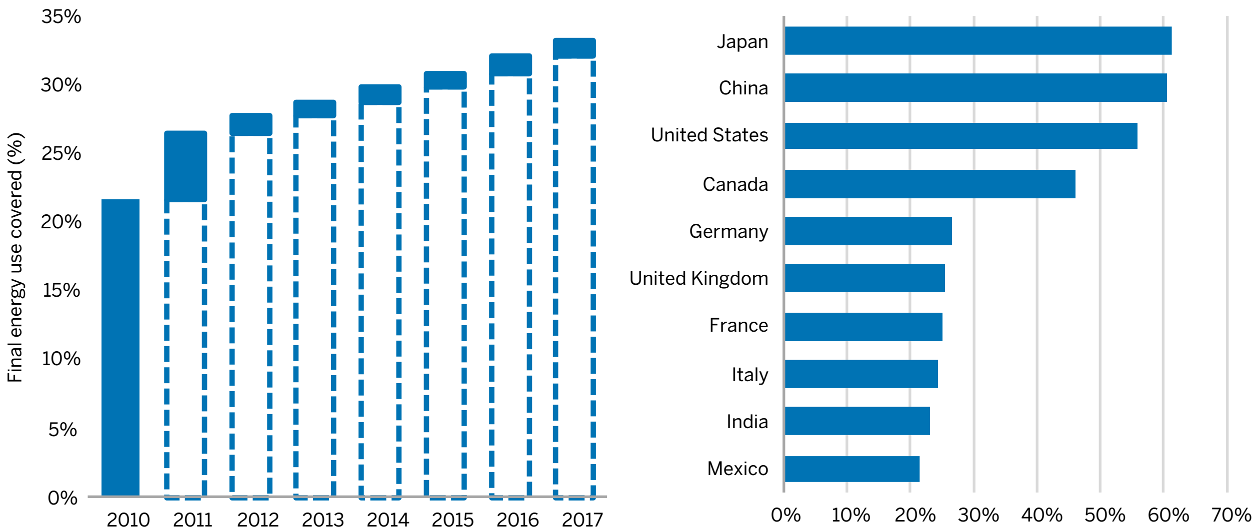
Strong policy action is also vital to signal to investors that energy efficiency is a long-term priority, which will create more certainty for investors and catalyze the transformative investments needed to return the world to a path leading to the fulfillment of SDG target 7.3.

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 educated decisions. Here, we describe some options and policies.[29]

Analysis of energy use covered by regulatory instruments[30] 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, 2010–17 (left), and 2017 coverage in the 10 countries with the highest total primary energy supply (right)



Source: IEA 2019a.

29 More information and examples can be found in 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 forthcoming recommendations of IEA's Global Commission for Urgent Action on Energy Efficiency.

30 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 (as in the Technology Collaboration Programme on Energy Efficient End-Use Equipment, 4E-TCP [IEA 2016]). To date, over 80 countries have adopted MEPS, covering more than 50 different types of technologies in different 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.

Japan, for example, encourages companies to compete with one another to obtain the official "Top Runner" label. Consumers know this label confers a "best in class" energy efficiency rating. The program covers everything from passenger cars to refrigerators. Performance standards are dynamic, so every few years the most efficient devices are set as the new standard for everyone to meet (METI 2015). In operation since 1999, Top Runner has increased the international competitiveness of Japanese companies and given consumers access to efficient and highly cost-effective equipment. The program also reduced oil imports by more than 220,000 barrels in 2015 (METI 2015).

Government actions to reduce the cost of energy-efficient equipment include economic incentives such as grants or loans. But bulk procurement policies are another tool for easing the cost of energy efficiency investments. Bulk procurement has governments leveraging their considerable purchasing power to procure energy-efficient services or products. Bulk procurement creates economies of scale, cuts the costs of services and products, and in some cases fosters new or spin-off markets.

India, for example, is procuring millions of efficient lights through a national program called Unnat Jyoti by Affordable LEDs for All (UJALA), which has already delivered more than 300 million lamps across India.[31] Although the program receives no public subsidy, consumers are able to pay for the lamps partly up front and partly out of the ongoing savings. The purchasing power of the large program means that consumers pay only Rs. 70 (USD 1) for an energy-efficient light-emitting diode (LED) bulb, well below the market price.

POLICIES FOR LEVERAGING DIGITAL TECHNOLOGIES TO SCALE UP EFFICIENCY

Emerging digital technologies could be harnessed to make them more energy efficient so they do not simply add to global energy demand. But this would require concerted policy action across several fronts. IEA's Readiness for Digital Energy Efficiency policy framework (IEA 2019a) identifies eight principles for policy makers to consider when planning for emerging digital technologies. Many of these principles would require energy policy makers to work closely with their counterparts across the government to address complicated, cross-cutting issues such as data protection, privacy, and access. The eight principles are as follows:

1. Improve access to energy-related data
2. Ensure adequate protection for cyber security and data privacy
3. Strengthen trust in digital technologies
4. Ensure energy markets value the services provided by digital energy efficiency
5. Ensure equitable access to digital technology and infrastructure
6. Increase digital skills and plan for job market transformation
7. Minimize negative environmental impacts
8. Encourage technology and business model innovation

31 India's UJALA program is described at https://eeslindia.org/content/raj/eesl/en/Programmes/UJALA/About-UJALA.html.

BOX 4.5 • MARKET DESIGN AND INCENTIVES FOR EFFICIENCY INVESTMENTS

In addition to applying the right mix of available efficiency policy instruments, policy makers may also need to consider how the design of energy and power markets may create incentives and disincentives to efficiency investments. With conducive regulatory frameworks, and opportunities to bid into capacity markets, for example, policy makers have an opportunity to incentivize greater investments in energy efficiency

Light-emitting diode (LED) street lighting is a further example of how efficiency incentives may be affected by power market design. Converting older street lighting technologies to LED can generate energy savings of between 40 and 70 percent, not to mention additional maintenance savings and improved urban lighting. Thanks to these large potential savings, LED projects can offer competitive and swift returns. In some countries, however, municipal and other public lighting projects are not being deployed at scale due to energy market distortions (which may have adverse effects not only on efficiency but also on supply quality and system costs). These may include the way in which electricity generators and network distribution companies are regulated and compensated, for example, through obligated procurement or power purchase agreements with a regulated price for electricity set above competitive market rates. In cases where a utility operates street lighting infrastructure, and in parallel obtains a fixed amount from municipalities for the electricity to operate that infrastructure, there is little incentive for the utility to invest in conversion to LED lamps.

Policy makers wishing to address these kinds of distortions might consider regulation more aligned with market mechanisms as well as with social, economic, and environmental objectives. In addition to delivering carbon emission reductions and reducing consumer energy bills, such an approach can lower system costs, improve quality of supply, and incentivize efficiency gains across the distribution network. It can also lessen risks and cut transaction costs, creating a more attractive environment for efficiency investments.

ENERGY EFFICIENCY INVESTMENT

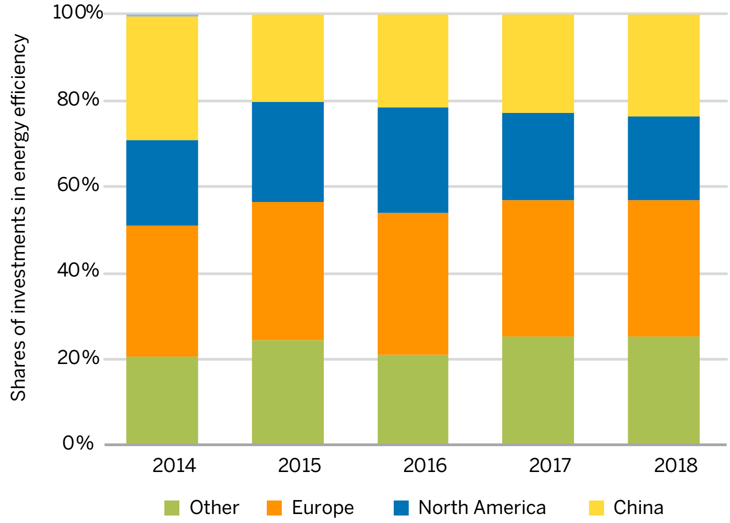
Annual global investments in energy efficiency have remained largely unchanged since 2015. Investments into energy efficiency typically fall into one of the following four key areas:

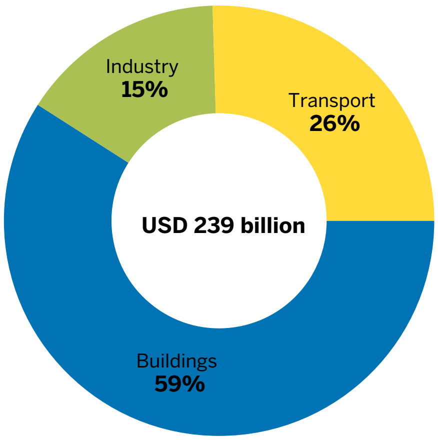
1. Incremental spending on more efficient technologies
2. Project investments by energy service companies
3. Green mortgages, green bonds, and property-based repayment schemes
4. Climate mitigation investments by international financial institutions

In 2018, incremental efficiency investments across the buildings, transport, and industry sectors stood at USD 236 billion, representing a growth rate of less than 1 percent compared to average annual investment between 2015 and 2017 (Figure 4.11). While declining slightly in 2018, the buildings sector consistently receives the highest share—nearly 60 percent—of total investments. Industrial energy efficiency investments increased in China by 12 percent and in India by 5 percent in 2018, but have continued to decline in the United States since 2015. Transport efficiency investments increased only slightly in 2018, and mainly in freight, while sales of less-efficient light-duty trucks increased (IEA 2019a).

Deploying readily available efficiency technologies is one of the most cost-effective means of saving energy while reducing emissions and achieving wider SDG objectives. At current levels, however, the world is not investing enough in efficiency, suggesting a major missed opportunity. Unlocking the full potential of efficiency would require current annual investment levels to double by 2025, and double again between 2025 and 2040, according to IEA (2018) analysis.

FIGURE 4.11 • Energy efficiency investment by region (left) and sector (right), 2018





Source: IEA 2019a.
HVAC = heating, ventilation, and air conditioning.

CONCLUSIONS

The improvement rate for energy intensity has slowed over the past few years, falling below the annual 2.6 percent initially projected as a prerequisite to reaching SDG target 7.3. The year 2017 saw a 1.7 percent improvement from 2016—the lowest since 2010. The average rate over that seven-year period, 2.2 percent, was better than the 1.3 percent annual average of the previous decade, but still low enough to require an average rate of more than 3 percent every year through 2030 in order to meet the target of halving energy intensity by 2030. Early estimates for 2018 and 2019 suggest improvement rates of 1.3 percent and 2.0 percent, respectively, indicating that the slowing progress since 2015 may be turning around.

The 3 percent target remains within reach, given substantial investment in cost-effective energy efficiency improvements on a systematic scale. In addition to reducing emissions and mitigating global warming effects, improved efficiency at this scale would be a key factor in achieving affordable, sustainable energy access for all. The recent slowdown of intensity improvements, the potential opportunities for investment, 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.

Key to the progress some countries are making toward energy efficiency has been the decoupling of their economy from their energy use. This is most noticeable in countries like Japan, where minimally energy-intensive sectors (e.g., the services sector) 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 service 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 every segment of the sector aside from freight shows improved efficiency rates. 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-scale data collection, analysis, and utilization can help to optimize demand and consumption at scale and improve energy efficiency at a systems level. Sector-specific digitalization solutions are also having a marked effect on energy efficiency. Some applications for the urban transport sector, for example, could achieve a 50 percent reduction in carbon emissions by 2050 against business-as-usual rates. This burgeoning trend is not exempt from risks, however. In addition to the opportunities to optimize efficiency, digitalization also can improve access to energy and in some cases drive up demand. 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 the technology and resources it needs to double the rate of energy efficiency improvement by 2030, over the rate observed between 1990 and 2010. 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 7.3, improve economic development, and ensure universal access to clean, efficient energy.

METHODOLOGY

Total primary energy supply (TPES) in megajoules (MJ)	This represents the amount of energy available in the national territory during the reference period. It is calculated as follows: Total primary energy supply = Primary energy production + Import of primary and secondary energy – Export of primary and secondary energy – International (aviation and marine) bunkers – Stock changes. (The definition is consistent with International Recommendations for Energy Statistics). *Data sources:* IEA Energy Balances, supplemented by UNSD for countries not covered by IEA.
Gross domestic product (GDP) in 2011 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 2011 USD PPP. *Data source:* World Development Indicators.
Primary energy intensity in MJ/ USD (2011) PPP	$Primary\ energy\ intensity = \frac{TPES\ (MJ)}{GDP\ (USD\ 2011\ PPP)}$ Ratio between TPES and GDP is measured in MJ per USD (2011) 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:* IEA Energy Balances, supplemented by UNSD for countries not covered by IEA.
Value added in USD (2011) 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:* World Development Indicators.
Industrial energy intensity in MJ/ USD (2011) PPP	$Industrial\ energy\ intensity = \frac{Industrial\ TFEC\ (MJ)}{Industrial\ value\ added\ (USD\ 2011\ PPP)}$ Ratio between industry TFEC and industry value added, measured in MJ per USD (2011) PPP. *Data sources:* IEA Energy Balances and World Development Indicators (for value added).
Services energy intensity in MJ/ USD (2011) PPP	$Services\ energy\ intensity = \frac{Services\ TFEC\ (MJ)}{Services\ value\ added\ (USD\ 2011\ PPP)}$ Ratio between services TFEC and services value added measured in MJ per USD (2011) PPP. *Data sources:* IEA Energy Balances and World Development Indicators (for value added).

Agriculture energy intensity in MJ/ USD (2011) PPP	$$Agriculture\ energy\ intensity = \frac{Agriculture\ TFEC\ (MJ)}{Agriculture\ value\ added\ (USD\ 2011\ PPP)}$$ Ratio between agriculture TFEC and agriculture value added measured in MJ per USD (2011) PPP. *Data sources:* IEA Energy Balances and World Development Indicators (for value added).
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/tonne-km	$$Freight\ transport\ energy\ intensity = \frac{Freight\ transport\ TFEC\ (MJ)}{Tonne\text{-}kilometers}$$ Ratio between freight transport final energy consumption and activity measured in MJ per tonne-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 TPES input to power generation. *Data source:* IEA Energy Balances.
Power transmission and distribution losses (%)	$$Power\ transmission\ and\ distribution\ losses = \frac{Electricity\ losses}{(Electricity\ output\ main + Electricity\ output\ CHP + Electricity\ imports)}$$ Where: Electricity losses are electricity transmission and distribution losses; Electricity output main is electricity output 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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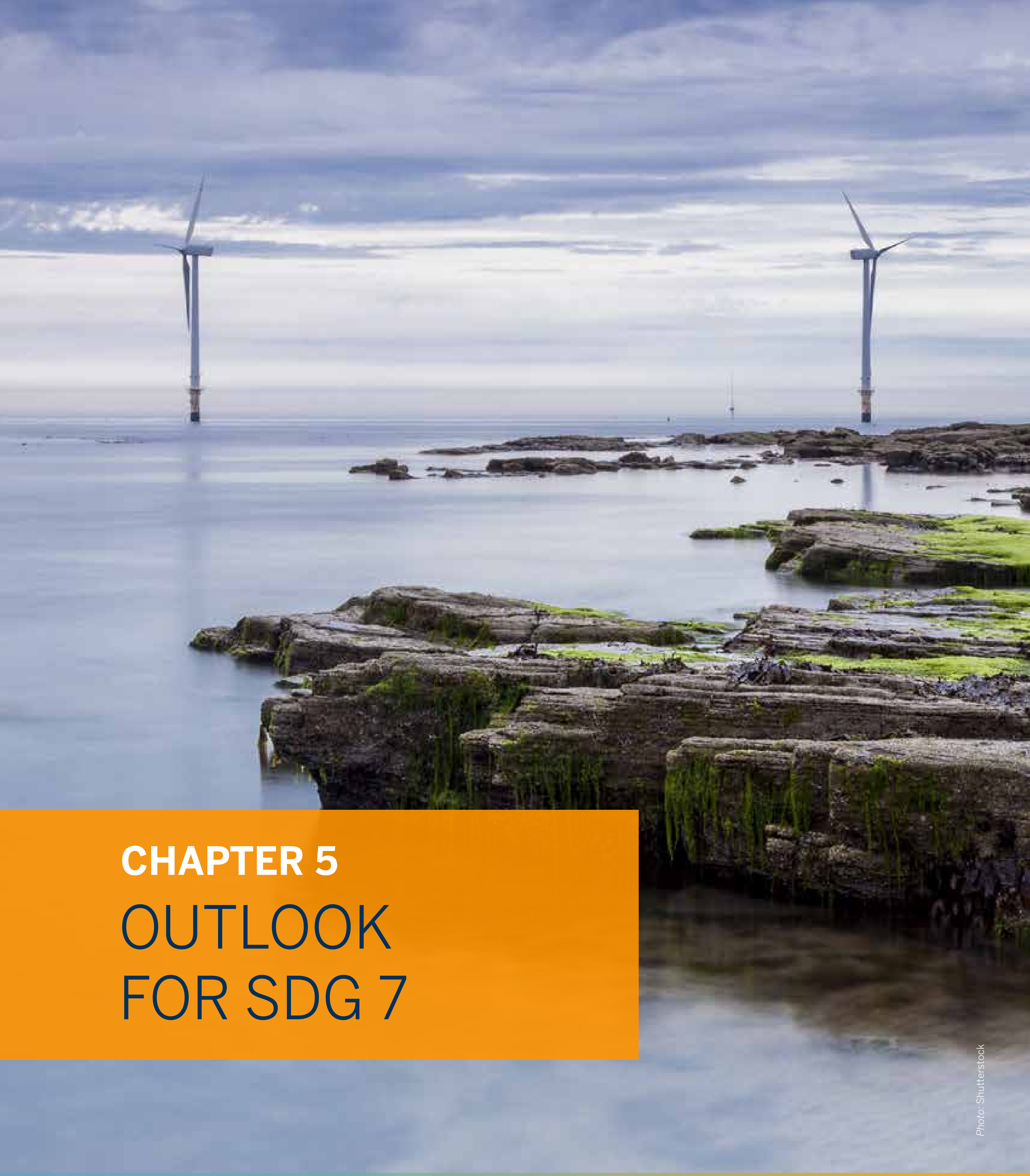


Photo: Shutterstock

CHAPTER 5
OUTLOOK FOR SDG 7

MAIN MESSAGES

- **Outlook for progress toward 2030:** At the current 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 will not be enough to meet the goals; in fact, under this scenario, none of the target is reached by 2030. IEA's Sustainable Development Scenario lays out a pathway to put the world's energy system on track to achieve the SDG targets most closely related to energy (those in SDG 3.9, SDG 7, and SDG 13).[32] For renewables, the Transforming Energy Scenario 2030 of the International Renewable Energy Agency (IRENA) also presents a possible way to achieve the goal of substantially increase renewable energy.
- **Outlook for access to electricity:** Recent progress was mixed, as is the outlook to 2030: under IEA's Stated Policies Scenario, around 620 million people would still lack access to electricity in 2030. Thanks to well-designed policies, the countries of Developing Asia are expected to expand electricity access to 98 percent of the region's population by 2030. In Sub-Saharan Africa, Ethiopia, Ghana, Kenya, Rwanda, Senegal, and South Africa should reach universal access. Nonetheless, without further efforts, 36 percent of the population of Sub-Saharan Africa would be without access in 2030 if current and planned policies are continued. Decentralization is an important part of the answer. IEA's most recent analysis of Africa demonstrates that decentralized solutions constitute the least-cost way of providing access to more than half of the population who must gain access by 2030 to meet the target. The challenge boils down to expanding access to those living close to the central grid, while deploying in parallel decentralized systems to connect those living farther away—particularly in countries where access is least advanced.
- **Outlook for access to clean cooking solutions:** If clean cooking remains low on the political agenda, 2.3 billion people in 2030 will still be relying on traditional uses of biomass, kerosene, or coal for cooking, according to IEA's Stated Policies Scenario, with dramatic consequences for the environment and for the health of women and children. The acute challenge in Developing Asia and Sub-Saharan Africa is to understand how cultural, economic, and social factors combine to slow progress. A possible path forward lies in building on successful policies implemented in countries such as Ethiopia, Ghana, and India, and on the innovations observed elsewhere, to support the deployment of clean fuels and technologies, notably liquefied petroleum gas (LPG), natural gas, improved biomass cookstoves and innovative, renewables-based electric stoves and alcohol stoves.
- **Outlook for renewable energy:** The IEA and IRENA scenarios both conclude that solar photovoltaic (PV) and wind will account for most renewables-based electricity generation by 2030. The 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 23 percent, in which case renewables would supply around 50 percent of electricity generation. In IRENA's Transforming Energy Scenario, the rise in renewables by 2030 is slightly higher, reaching 28 percent of TFEC and 57 percent of electricity generation. While renewables would climb to around 50 percent or more of electricity generation under both the IEA and IRENA scenarios, more dedicated efforts are needed to boost the penetration of renewables in transport and heating.

32 Most of this chapter is based on results from IEA's World Energy Model (IEA 2019e) and from analysis in the World Energy Outlook (IEA 2019a). 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

- **Outlook for energy efficiency:** Recent estimates indicate that annual improvements in global energy intensity is low for 2018 (1.3 percent) and 2019 (2.0 percent), moving the world further from achieving SDG 7.3. For example, the efficiency improvement in transport slowed in 2018, in large part because global consumer preferences shifted toward heavier SUVs. As a result, the new annual rate of improvement required from 2017 to 2030 to achieve the target would be over 3 percent, while IEA's Stated Policies Scenario shows that the expected improvement resulting from current and planned policies would only be around 2.3% annually from 2017 to 2030. With the right policies in place, IEA's Sustainable Development Scenario shows that an annual average rate of improvement of 3.6 percent between 2017 and 2030 is nonetheless possible. The building sector holds large potential for energy savings from efficiency improvements. It is the locus of more than 40 percent of the needed savings in energy demand by 2030 under the Sustainable Development Scenario, compared with the Stated Policies Scenario.
- **Additional investments and fuel savings:** IEA and IRENA's scenarios estimate that achieving SDG 7 would require annual investments by 2030 of around $680 billion to renewable energy (IRENA and IEA scenarios), around $45 billion going to energy access and $625 billion to energy efficiency (IEA scenario). Furthermore, a redirection of investment from fossil fuels to renewables is necessary to unlock the capital needed to put the world back on track to a sustainable future. In total, savings of up to USD 220 billion per year in fossil fuels investment could be achieved under the Sustainable Development Scenario. IRENA's Transforming Energy Scenario suggests that USD 10 trillion would have to be redirected from fossil fuels and related infrastructure.
- **International public financial flows to developing countries in support of clean and renewable energy:** While the bulk of investment in the energy transition has and would continue to come from private sources, public finance will play a significant enabling role to spur investment. Tracking of progress toward SDG indicator 7.A.1 performed by IRENA and the Organisation for Economic Co-operation and Development (OECD) shows that international public financial flows to developing countries in support of clean and renewable energy have grown by around USD 1.6 billion per year since 2010, reaching USD 21.4 billion in 2017.[33] Although this increase in public financial flows to renewables is promising, only 12 percent of the flows reached the least-developed countries in 2017.
- **SDG 7 and emissions:** The energy system is strongly linked with greenhouse gas emissions, and the achievement of SDG 7 is critical to the attainment of SDG 13, which aims to slow climate change. Scenarios from both IEA and IRENA show that greater policy efforts in renewable energy and energy efficiency (complemented by several other technologies) account for most of the energy-related reductions in CO_2 emissions needed to realize the Paris Agreement.

33 The figures are drawn from the Renewable Energy Public Investments Database, a joint OECD/IRENA database on international financial flows to developing countries in support of clean and renewable energy. https://www.irena.org/Statistics/View-Data-by-Topic/Finance-and-Investment/Renewable-Energy-Finance-Flows

This chapter describes the results of global modeling exercises undertaken to determine whether current policy ambitions are sufficient to meet the SDG 7 targets, and to identify what additional actions might be needed. It also analyzes what investments are required to achieve the goals, including an update on SDG indicator 7.A.1 on international financial flows to developing countries in support of renewables. It finishes by highlighting the links between the energy system and emissions of greenhouse gases, suggesting that tackling both through well-guided actions will be critical to progress toward SDG 13. Scenarios for the various targets are taken from IEA's flagship publication, World Energy Outlook (IEA 2019a). With respect to the renewable energy target, scenarios are also derived from IRENA's Global Renewables Outlook: Energy Transformation 2050 (IRENA 2020d).

IEA's Stated Policies Scenario (referred to in earlier IEA publications as 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 policies covered by the scenario span a broad range, starting with Nationally Determined Contributions under the Paris Agreement. In practice, the bottom-up modeling implied by the scenario involves a great deal of detail at the sectoral level, including pricing policies, efficiency standards and schemes, electrification programs, and specific infrastructure projects.

IEA's normative Sustainable Development Scenario[34] describes an integrated least-cost pathway allowing the world's energy system to deliver on energy-related SDGs: to ensure universal access to affordable, reliable, sustainable, and modern energy services by 2030 (SDG 7); to substantially reduce the air pollution that causes deaths and illness (SDG 3.9); and to take effective action to combat 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 23 percent of total final energy consumption, more than doubling today's share; 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 2019 and 2030; and the global temperature increase over preindustrial levels is held well below 2°C.

Two IRENA scenarios sharpen the picture. IRENA has explored global energy development pathways to 2030 and 2050 from two perspectives. The first is an energy pathway shaped by current and planned policies (the Planned Energy Scenario); the second, a cleaner, climate-resilient pathway based largely on a more ambitious, yet achievable, uptake of renewable energy and energy efficiency measures (the Transforming Energy Scenario).[35]

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

35 More information on the IRENA Transforming Energy Scenario can be found at: https://www.irena.org/publications/2020/Apr/Global-Renewables-Outlook-2020.

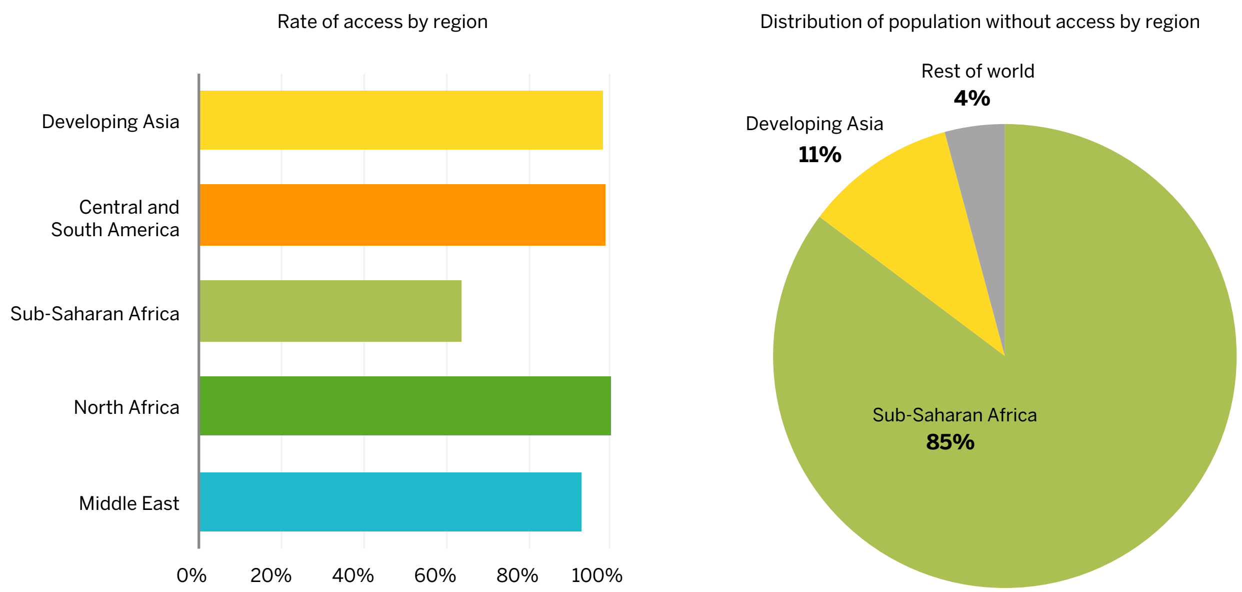
THE OUTLOOK FOR ELECTRICITY ACCESS

WHERE ARE WE HEADED?

Thanks to recent progress in several countries (chapter 2), the outlook for access to electricity indicates continued progress to 2030 but without achieving universal access. The number of people still lacking access to electricity in 2030 is expected to shrink under the current and planned policies mapped out in the Stated Policies Scenario to around 620 million (roughly 7 percent of the global population), 530 million of them in Sub-Saharan Africa. SDG target 7.1 remains within reach, and policies implemented in several countries have put them on track to achieve universal access, but the same cannot be said for many Sub-Saharan African countries.

Strong performance should put Developing (non-OECD) Asia on track to reach an access rate of 98 percent by 2030 (Figure 5.1). Bangladesh, India, Indonesia, and the Philippines are well on track to reach full access before 2030. Greater efforts are needed in Afghanistan or Mongolia, however, if the region is to achieve 100 percent access in 2030. Central and South America is projected to continue its steady progress, moving to 99 percent in 2030, with Haiti the only major country in the region to have a substantial unelectrified population.

FIGURE 5.1 • Electricity access rates and distribution of population still lacking access in 2030, by region, under Stated Policies Scenario



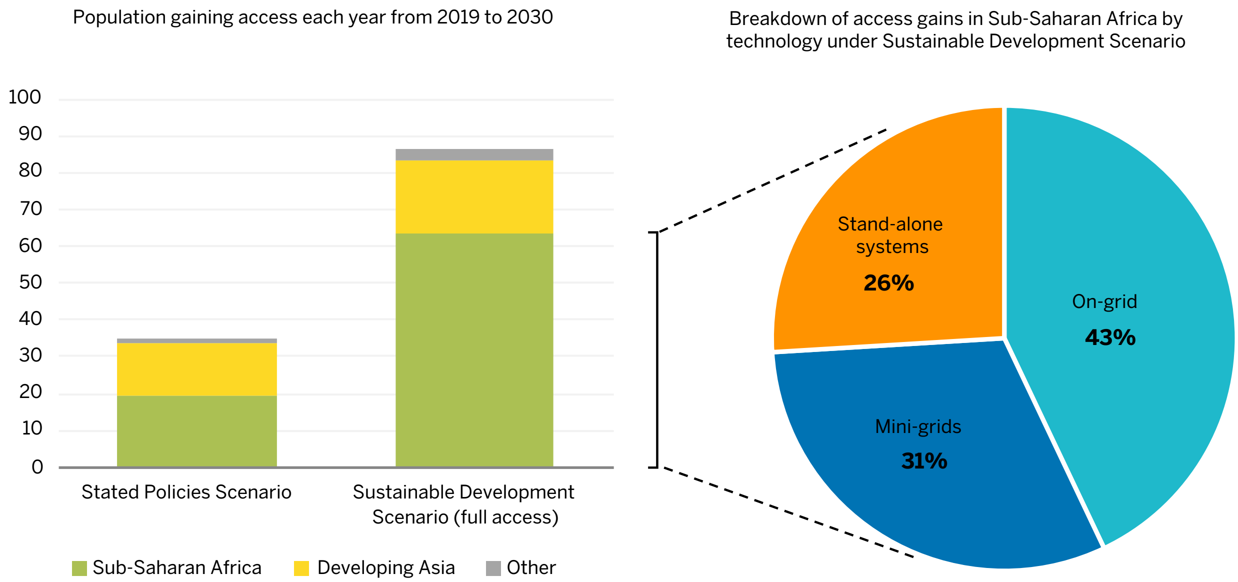
Source: IEA 2019a.

The situation is improving in Sub-Saharan Africa, where effective policies should allow Ethiopia, Ghana, Kenya, Rwanda, Senegal, and South Africa to reach full access by 2030 under the Stated Policies Scenario (IEA 2019b). For the region as a whole, the access rate is projected to rise to around 64 percent, though high rates of population growth mean that the number of people without access would still be about 530 million in 2030 under the Stated Policies Scenario. There would be almost 20 countries where less than half of the population has access, and 10 where less than one in four has access. Among the latter group are Chad, the Democratic Republic of Congo, Malawi, Niger, and Somalia. As a result, by 2030, 85 percent of the global population without access would be concentrated in the region. By 2040, that share would be more than 90 percent.

HOW TO BRIDGE THE GAP

To bridge the gap and connect the remaining 620 million people projected by the Stated Policies Scenario to be without access in 2030, the connection rate would have to triple from its current level—to nearly 90 million a year between 2019 and 2030 (figure 5.2). Most of the acceleration would have to happen in Sub-Saharan Africa, as discussed in the previous paragraph. Certain countries would have to scale up efforts, notably the Democratic Republic of Congo, Niger, Nigeria, Sudan, and Uganda, which together are home to half of the regional population lacking access in 2030 under the Stated Policies Scenario.

FIGURE 5.2 • Projected gains in access to electricity by region and technology, 2019–30



Source: IEA 2019a, 2019b.

Policies that promote centralized and decentralized solutions in parallel are crucial to unlocking electricity access. Geospatial analysis developed by IEA identified decentralized systems as the least-cost option for more than half of the electricity connections (representing nearly 440 million people) that would have to be made in Sub-Saharan Africa if the region were to achieve universal access by 2030. Decentralized solutions (largely based on renewables) can be adapted to conditions in remote rural areas, where around 80 percent of the population without access in Africa would be concentrated in 2030.[36] If deployed carefully, such systems can complement the grid, providing energy services immediately and preparing the way for grid expansion in the future. Parallel efforts should be made to increase the central grid's density so as to connect nearby households and, where feasible, to extend it to reach large population centers. Capitalizing on the coverage of its main grid, Kenya implemented the Last Mile Connectivity Project, which has connected an average of one million households annually since 2015. Direct investment in the existing electricity network is also essential to improve and maintain energy services, increase trust in the central network, and raise the financial and operational performance of utilities.

Unlocking this potential for progress requires well-defined and transparent government planning that integrates all solutions, assesses the related investment needs, and provides clarity about the roles of all actors. Cross-sectoral planning and coordination to support the deployment of energy-efficient appliances and productive uses of energy will also be necessary. Several countries—among them Ethiopia, Ghana, Rwanda, and Senegal—developed comprehensive, long-term strategies of the sort needed to provide modern energy services to everyone in Sub-Saharan Africa in coming years.

36 In collaboration with the KTH Royal Institute of Technology, IEA developed a geospatial model to identify optimal country-by-country electrification solutions, taking into account local geography, population density, technology costs, existing infrastructure, and resource availability. The analysis covered 44 countries of Sub-Saharan Africa, with a deep focus on 11: Angola, Côte d'Ivoire, Democratic Republic of Congo, Ethiopia, Ghana, Kenya, Mozambique, Nigeria, Senegal, South Africa, and Tanzania. Maps illustrating the results for the 11 focus countries can be found in the country profiles of the Africa Energy Outlook 2019 (IEA 2019b) and online at https://www.iea.org/reports/africa-energy-outlook-2019.

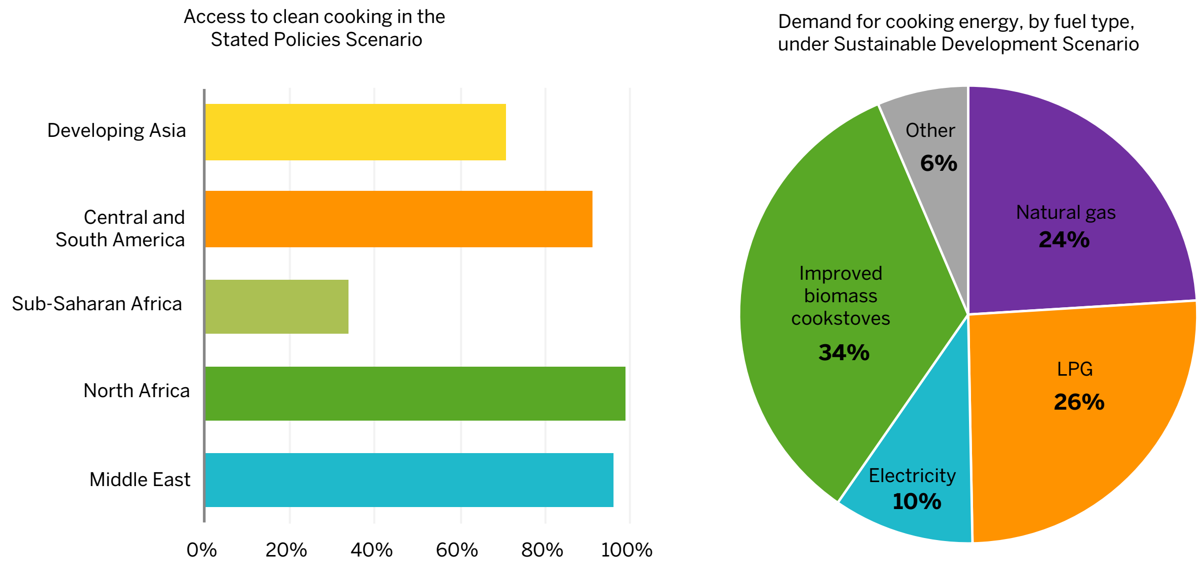
THE OUTLOOK FOR ACCESS TO CLEAN COOKING FUELS AND TECHNOLOGIES

WHERE ARE WE HEADED?

The outlook for clean cooking is of the utmost concern; the world is far off track from achieving universal access to clean cooking solutions. In 2030, under the Stated Policies Scenario, 27 percent of the world's population would still be deprived of access to clean fuels and technologies for cooking. This means that, with population growth, around 2.3 billion people would still be relying on traditional uses of biomass, kerosene, or coal as their primary cooking fuel. It also means that premature deaths from household air pollution would remain roughly at today's level. Forest degradation, sometimes leading to outright deforestation, is yet another grave consequence of the unsustainable harvesting of fuelwood, chiefly for the production of charcoal to be used in cities.

In 2030, the population without access to clean cooking solutions is split almost equally between Developing Asia and Sub-Saharan Africa. In Developing Asia, the projected access rate in 2030 is 70 percent, leaving some 1.2 billion people without access (figure 5.3). Great progress is projected in India, which is expected to shrink the population without access to 500 million in 2030, achieving an access rate of 67 percent. This outcome is the result of the government's determination to promote clean cooking through the Pradhan Mantri Ujjwala Yojana (PMUY) scheme, which offers free LPG stoves and cylinders to women in poor households. The government is also extending and improving urban gas infrastructure.

FIGURE 5.3 • Rates of access to clean cooking fuels and technologies in 2030



Source: IEA 2019a.

LPG = liquefied petroleum gas.

In Sub-Saharan Africa, greater efforts to reduce reliance on traditional uses of solid biomass for cooking would bring the rate of access to 34 percent by 2030. Nevertheless, because of rapid population growth, more than 970 million would remain without access in 2030. In some countries such as Ethiopia, Côte d'Ivoire, Ghana, Kenya, and Tanzania, ambitious policies will bend the curve and shrink the numbers without access, providing clean cooking solutions to around half of their population by 2030. For example, Ethiopia's government launched phase two of its National Biogas Program in 2017; the program aims to provide at least 180,000 people with biogas digesters by 2022.

HOW TO BRIDGE THE GAP

Under the Sustainable Development Scenario, every household in the world would have access to clean cooking by 2030, an achievement that would require providing access to a total of 2.5 billion people. Clean cooking solutions cut household air pollution and improve health, particularly for women and children. In view of the stakes, efforts to deploy effective technologies need to be moved up on the international political agenda. Engaging with local women in the design, uptake, and sale of clean cookstoves is a key part of successful implementation.

How best to expand access to clean cooking depends on a variety of cultural and economic factors, notably the availability of resources and infrastructure. Under IEA's Sustainable Development Scenario, more than half of the population gains access through LPG in urban areas, while advanced cookstoves are a determining factor in rural areas. Other fuels—such as electricity, biogas, ethanol, and natural gas—also play a growing role in reaching universal access.

Providing access to clean cooking solutions for all by 2030 and action to mitigate climate change are complementary objectives. The dramatic acceleration in deployment of clean cooking solutions needed to reach universal access by 2030 requires all currently available and scalable fuels and technologies, with LPG and natural gas playing an important role in transitioning to decarbonized cooking solutions. While the range of uncertainty is high, analyses show that providing access to all and moving away from traditional uses of biomass could support the fight against climate change, considering the high levels of methane, black carbon, and nitrous oxide emissions resulting from incomplete combustion of biomass, as well as the associated deforestation (IEA 2018).

THE OUTLOOK FOR RENEWABLE ENERGY

WHERE ARE WE HEADED?

SDG target 7.2 envisions a substantial increase 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 assist in benchmarking progress. IEA's Stated Policies Scenario and IRENA's Planned Energy Scenario both plot where the world is headed under existing policy frameworks and stated policy plans.

The outlook for renewables under IEA's Stated Policies Scenario has been steadily improving in all regions in response to supportive policies and falling technology costs. The share of all renewables (including traditional uses of biomass) is projected to rise above 21 percent of TFEC by 2030, from 17 percent in 2017, while that of modern renewables would increase to 15.5 percent in 2030 from 10.5 percent in 2017.[37] IRENA's Planned Energy Scenario, by contrast, shows slightly higher growth in the share of modern renewables in TFEC—from 10 percent in 2017 to 17 percent in 2030.

The use of renewables to generate electricity has grown the fastest in recent years, and the various scenarios predict that will continue. According to IEA's Stated Policy Scenario, renewables-based generation is expected to overtake generation from coal in the mid-2020s and, by 2030, to account for 37 percent of all electricity generated. Of the renewable sources of electricity, solar PV is projected to grow by an average of 13 percent each year through 2030, putting it on a pathway to rival wind as the largest source of renewable-based generation. According to IRENA's Planned Energy Scenario, the supply of renewable electricity would reach 38 percent by 2030. Direct uses of renewables have not enjoyed the same level of policy support and cost reduction as the renewables used to generate electricity.[38] As a result, projected growth is slower for the direct uses of renewables such as biofuels, solid biomass, and solar thermal, with their shares in meeting demand for heat and transport fuels growing to 10 percent and 5 percent respectively by 2030, up from 8 percent and 3 percent in 2017, according to IEA.[39]

HOW TO BRIDGE THE GAP

Insights from IEA's Sustainable Development Scenario

The increases in the use of renewable energy that are likely to occur under current and stated policies fall short of what is required to achieve global goals for climate protection and sustainable development. IEA's Sustainable Development Scenario charts a path to achieve these goals, and renewables play a major role, with their use growing twice as fast as under current and stated policies. Under this more ambitious scenario, modern renewables are expected to reach nearly 23 percent of TFEC in 2030 (figure 5.4).

The share of renewables-based electricity generation increases most rapidly, doubling its current share to just under 50 percent by 2030, 11 percentage points higher than under the Stated Policies Scenario. The promising outlook for electricity generated from renewables is aided by strong policy support toward decarbonization of the power sector and continued declines in the cost of key technologies, notably solar PV, batteries, and wind. At the global level, electricity generation from renewable sources more than doubles from today's level to over 15,000 terawatt-hours (TWh) by 2030, more than triple the amount of electricity generated in the United States today from all sources.

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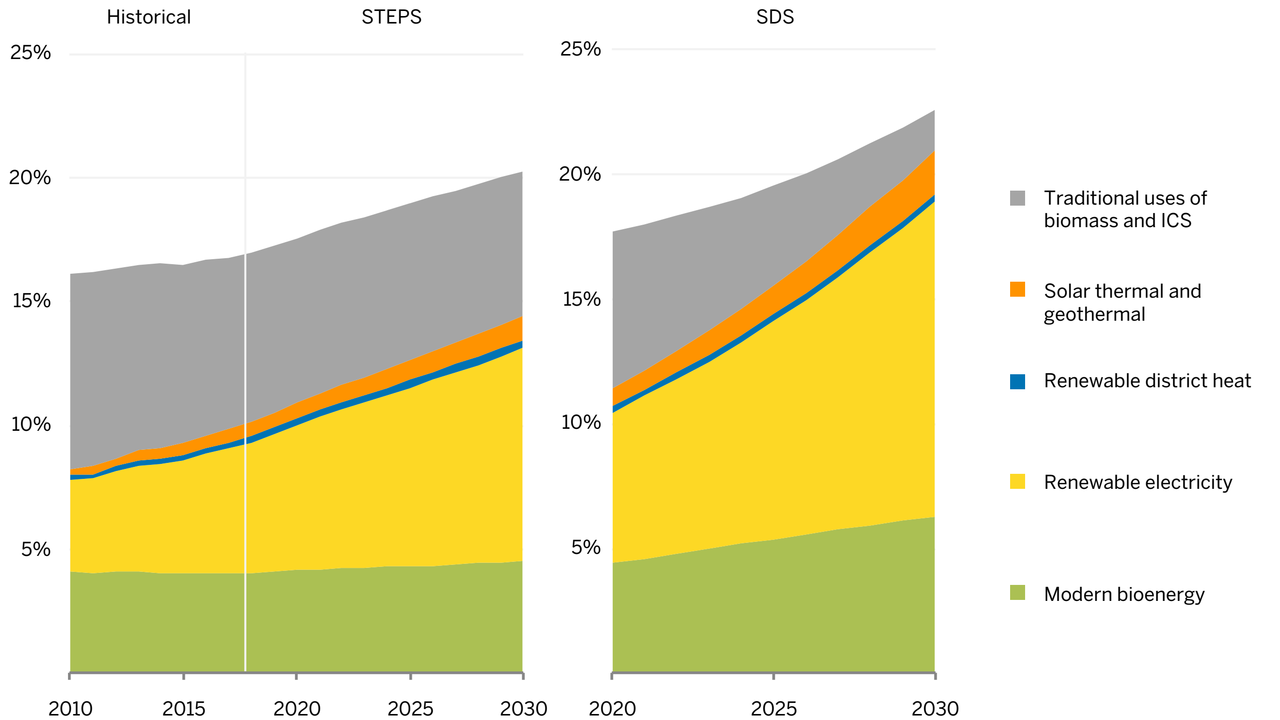
37 Because traditional uses of biomass are linked with significant pollution and deforestation, and because the use of biomass for cooking must be scaled back to achieve other SDGs, this section focuses on modern renewables.

38 Renewable energy may be used in a relatively direct way to provide an energy service (such as solar power for heat) or indirectly from renewables-based electricity or renewables-based heat, which is then used to provide an energy service (such as to power heat pumps or electric vehicles, or to supply district heating).

39 "Heat" in this chapter refers to the amount of 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, after taking into account transformation losses.

FIGURE 5.4 • Share of modern renewables in total final energy consumption under the Stated Policies and Sustainable Development Scenarios, 2010–30



Source: IEA 2019a.

Note: "Traditional uses of biomass" refers to the use of local solid biomass resources by low-income households that do not have access to modern cooking and heating fuels or technologies.

STEPS = Stated Policies Scenario; SDS = Sustainable Development Scenario; ICS = Improved cookstoves.

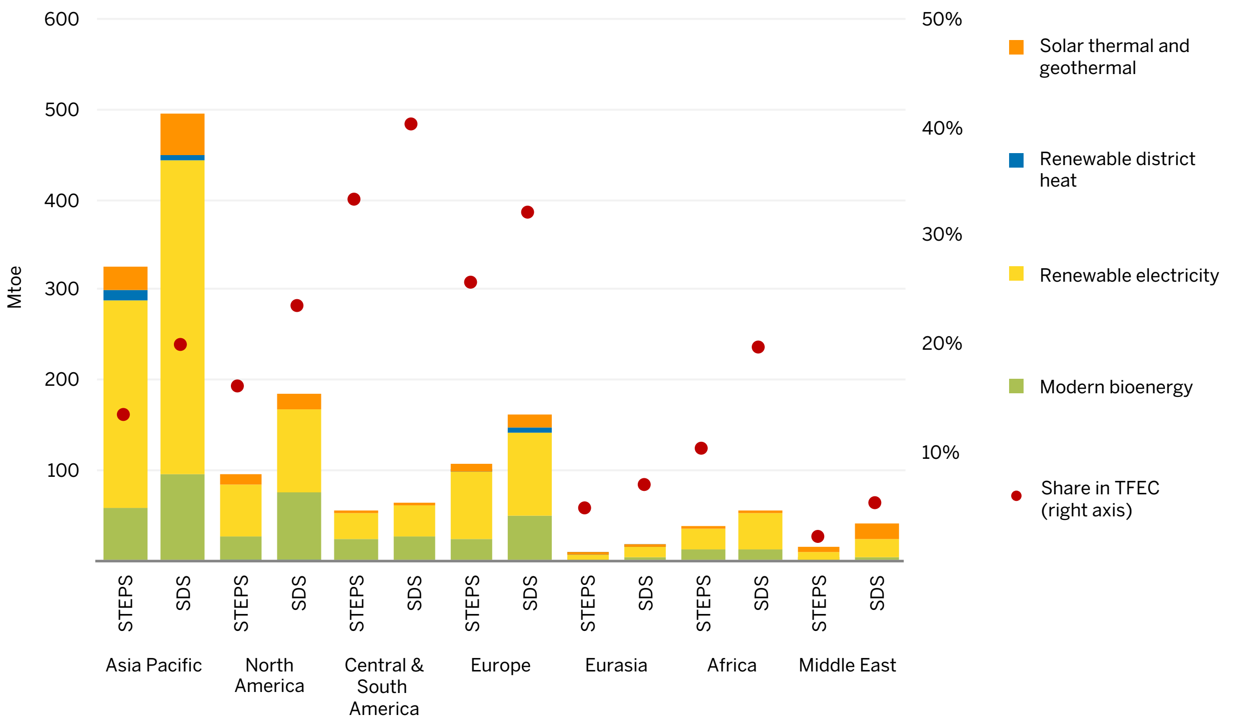
IEA's Sustainable Development Scenario also sees a greater electrification of energy use, with electricity meeting 23.7 percent of TFEC in 2030, compared with 21.6 percent under the Stated Policies Scenario. Increased electrification of transport and heating complements the direct use of renewables in efforts to decarbonize energy use. Direct renewables, principally biofuels, increase to 10 percent their share of demand for transport-related energy; combined with growing electrification, renewables' share in transport rises to 12 percent. Although light-duty vehicles are on a pathway to decarbonization by 2030, challenges remain to decarbonize trucking, aviation, and shipping. The use of renewables to provide heat also grows considerably under the Sustainable Development Scenario, with the direct use of bioenergy, solar thermal, and geothermal energy expanding by an average of 3 percent annually to reach a combined share of 14 percent of total energy demand for heat in 2030. When the increased electrification of energy demand is factored in, the total share of renewables in heating rises to 19 percent by 2030.

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

Across regions, variations in energy policy, socioeconomic trends, and natural-resource endowments result in differing growth trajectories for renewables. Developing economies account for two-thirds of the growth in 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 of the increase.

Under the Stated Policies Scenario, the outlook for electricity generation from renewable sources ranges from 9 percent in the Middle East and 16 percent in North Africa, at the low end, to well over 70 percent in Central and South America, where hydropower is the backbone of the power mix. Under the Sustainable Development Scenario, the share of renewable electricity generation increases in every region across the globe, approaching or surpassing half of all electricity generation by 2030 in several regions. Indonesia and other Southeast Asian economies see the most significant increase in the share of renewables in electricity generation under the Sustainable Development Scenario, led by growth in wind and solar PV.

FIGURE 5.5 • Change in consumption of modern renewable energy, by region under the Stated Policies and Sustainable Development Scenarios, 2018-30



Source: IEA 2019a.

Note: Modern bioenergy excludes traditional uses of biomass.

Mtoe = million tonnes of oil equivalent; STEPS = Stated Policies Scenario; SDS = Sustainable Development Scenario; TFEC = total final energy consumption.

Insights from IRENA's Transforming Energy Scenario

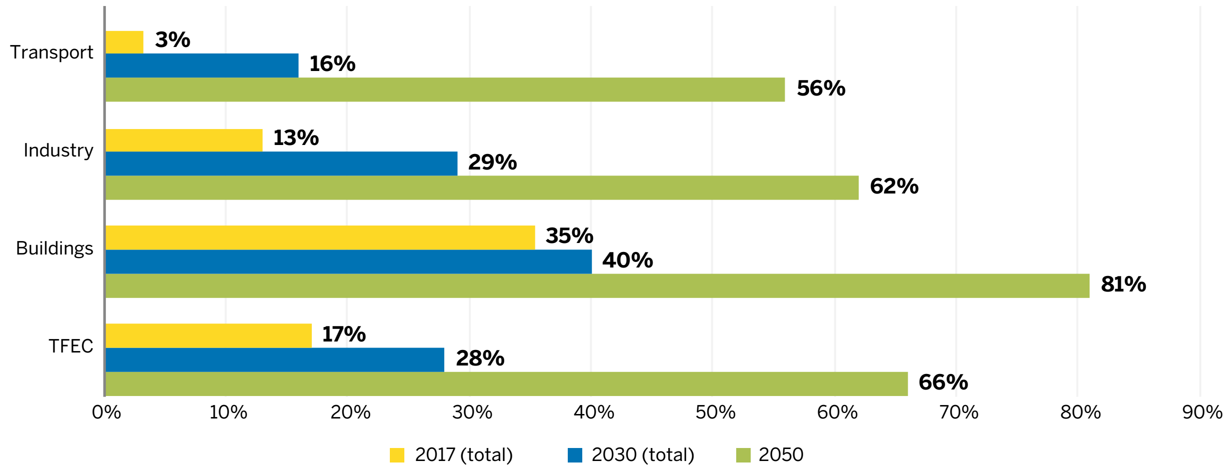
The increase in renewable energy use under IRENA's Planned Energy Scenario, a pathway set by current and planned policies, falls short of what is required to achieve global climate objectives and SDG 7. In it, the share of modern renewables would reach only 17 percent in 2030. By contrast, under the agency's more ambitious Transforming Energy Scenario for 2030, the share of modern renewable energy in TFEC would rise steeply, from around 10 percent in 2017 to 28 percent by 2030 (Figure 5.6). The increase would proceed from a combination of factors—chief among them significant growth in the supply of renewables-based electricity, increased electrification of end uses, greater direct use of renewable energy, and improved energy efficiency.

At a sectoral level, the buildings sector would show the highest share of renewable energy by 2030. Renewables would raise their share of TFEC from the 2017 levels of 35 percent (when traditional uses of biofuels are included) or 13 percent (excluding traditional uses of biofuels) to 40 percent by 2030 (with all traditional uses of biofuels phased out).

The next-largest renewables share would be in industry (including blast furnaces and coke ovens), where renewables would increase from a 13 percent share in 2017 to 29 percent by 2030 (of which 17 percent would be direct application of renewable energy, 11 percent electricity, and 1 percent district heat). The industrial sector offers great potential for improving efficiency through advances in industrial processes, demand-side management solutions, recycling of materials, and better waste management.

Transportation would have the lowest share of renewables in 2030 but the greatest growth, climbing to 16 percent of the sector's final energy consumption by 2030, from just 3 percent in 2017. Energy efficiency is as critical for the transport sector as for the previous two; it can be achieved through the adoption of low-carbon technologies, as well as through modal shifts—for example, to innovative mobility services such as car sharing, to public transport, or from airplanes to trains for short and medium-distance trips.

FIGURE 5.6 • Share of renewable energy in total final energy consumption under IRENA's Transforming Energy Scenario, in total and by major end uses



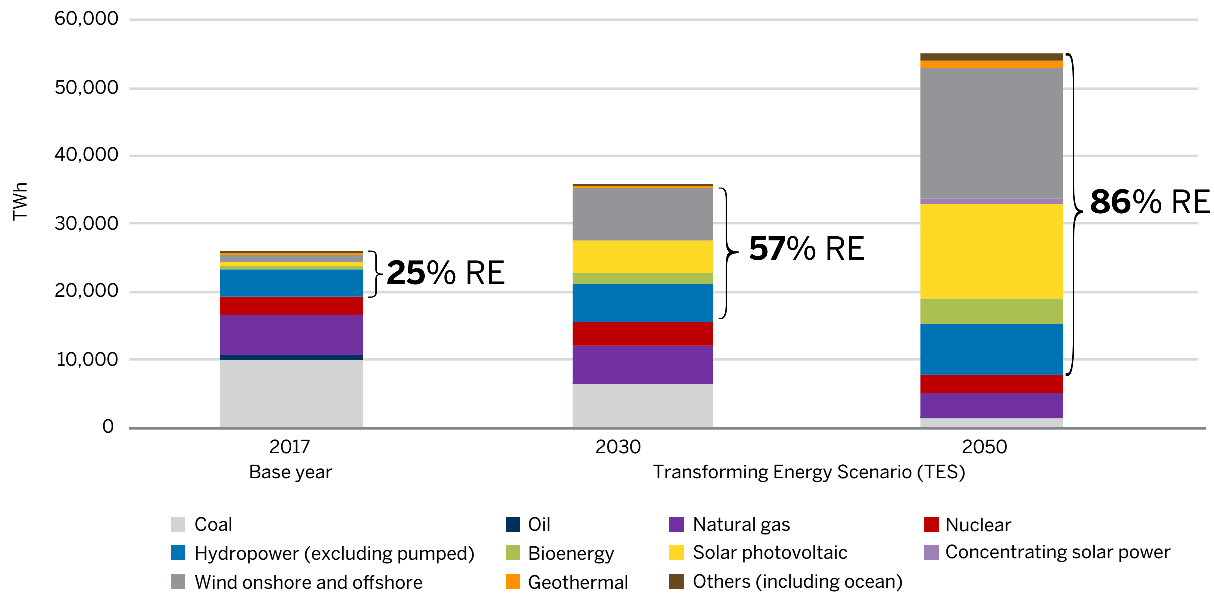
Source: IRENA 2020d.

Note: 2017 includes traditional uses of biofuels in the building sector and in TFEC. By 2030, all traditional uses of biofuels are phased out of the energy supply.

Scaling up electricity from renewables is a prerequisite for decarbonizing the world's energy system. Increasingly, electrification based on renewables is seen as a major solution, and the contribution of renewable electricity will be the single largest driver for change in the global energy transformation. IRENA's Transforming Energy Scenario sets a pathway to achieve, by 2030, a 57 percent share of renewables in the global power generation mix, up from 25 percent in 2017 (Figure 5.7). The role of electricity as an energy carrier will also increase, growing from a 20 percent share of TFEC to 29 percent share in the Transforming Energy Scenario in 2030, with gross electricity consumption increasing 50 percent between 2017 and 2030, from 25,600 TWh to 35,900 TWh.

Looking beyond 2030, IRENA's Transforming Energy Scenario also outlines a pathway to 2050 (figure 5.6). In it, electricity would become the central energy carrier, coming to account for nearly 50 percent of TFEC by 2050. Simultaneously, gross electricity consumption would more than double from 2016 levels to 55,000 TWh in 2050.

FIGURE 5.7 • Share of modern renewables in electricity generation in 2017, 2030, and 2050



Source: IRENA 2019

In this context, the most important synergy of the global energy transformation is the increasingly low cost of renewable power technologies, combined with wider adoption of electricity for end-use applications in transport and heat.

Among all power generation sources, wind and solar PV would dominate global electricity generation and capacity additions under IRENA's Transforming Energy Scenario. By 2030, one-third of the world's electricity would come from solar and wind power, increasing to almost 60 percent by 2050, with total installed wind and solar capacity exceeding 6,000 and 8,500 gigawatts, respectively, by 2050. However, while a 50 percent electricity share in TFEC is feasible by 2050, the other 50 percent, which cannot be electrified, must be decarbonized.

Each sector has options for decarbonization. The first option is energy efficiency, which includes advances in both technical efficiency and behavior. Energy efficiency would also contribute (together with renewables and electrification) to better energy intensity, predicted to increase by 3.2 percent each year through 2050 under the Transforming Energy Scenario.

Reduced consumption of fossil fuels is the second option. Under the Transforming Energy Scenario, fossil fuels retain a role in 2050, providing one-third of the energy supply. But global production of oil and coal would decline. Oil would largely be used in industry for petrochemicals, as well as in aviation and shipping. Coal would be used only in industry (7 percent of TFEC), mostly for steel production. Production of natural gas would grow through the mid-2020s, dropping by 2050 to two-thirds of the 2017 level. By 2050, natural gas would be the most widely used fossil fuel.

The third major decarbonization option involves indirect electrification (using hydrogen and synthetic fuels) and the direct use of renewables, including bioenergy. Both would increase significantly. Liquid biofuels, in particular, would play an important role in aviation and marine energy supply, and in providing heat for industrial processes. Hydrogen is also a promising energy carrier, complementing the direct use of electricity, which, under the Transforming Energy Scenario, has the potential to supply 11.1 exajoules of global energy demand by 2030 (of which 3.2 exajoules would be from renewable sources) and nearly 29 exajoules by 2050 (two-thirds from renewable sources). Other direct uses of renewables include geothermal and solar thermal heat; both of these heating technologies would contribute to the decarbonization of heat supply in industry.

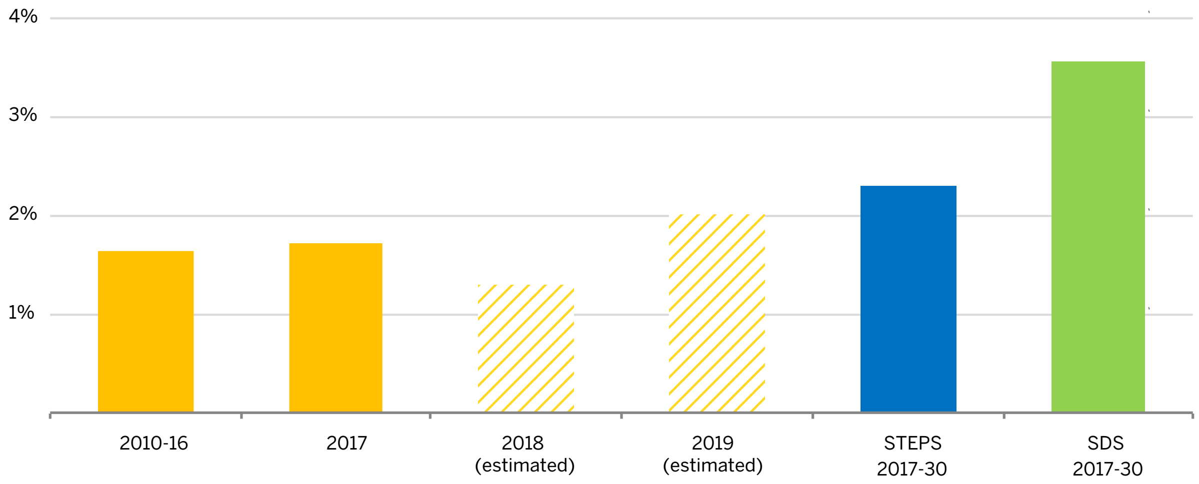
THE OUTLOOK FOR ENERGY EFFICIENCY

Global energy intensity, measured by the ratio of primary energy demand to gross domestic product (GDP), is the key indicator used to gauge global progress on energy efficiency. Global energy intensity reached 120 tonnes of oil equivalent (toe) per thousand dollars (2010 PPP) of GDP in 2017, an improvement of only 1.7 percent over 2016. The slowdown means that to achieve SDG target 7.3 (which calls for a doubling of the rate of global energy intensity by 2030), annual improvements for 2018 forward would have to be around 3 percent, rather than the 2.6 percent originally required. Recent estimates show that the improvement for 2018 was even lower, at just 1.3 percent, pointing to a third consecutive year of slowdown in the rate of improvement. The slowdown likely reflects weaker implementation of energy efficiency policy and strong demand in energy-intensive economies and sectors. A clear example of the global slowdown in improvements can be seen in the transport sector, where heavier, less-fuel-efficient SUVs are increasing their market share, not only in the United States and Europe, but also in emerging nations such as China, India, and South Africa.

IEA's Stated Policies Scenario assumes an annual efficiency improvement of just 2.3 percent between 2017 and 2030, accompanied by a steady rise in global final energy consumption to more than 11,600 million tonnes of oil equivalent by 2030.

By contrast, energy efficiency is a cornerstone of IEA's Sustainable Development Scenario. The accelerated improvements in energy efficiency across all energy end uses under this scenario would cause global energy demand to peak by 2025, followed by a decline. The adoption of the measures outlined in the scenario translates to energy savings of 1,700 million tonnes of oil equivalent over the Stated Policies Scenario, overshooting SDG target 7.3. The annual 3.6 percent improvement in energy intensity under the Sustainable Development Scenario between 2017 and 2030 is obtained through a combination of well-implemented policies and regulations.

FIGURE 5.8 • Average annual improvement in primary energy intensity under the Stated Policies and Sustainable Development scenarios, 2010–30

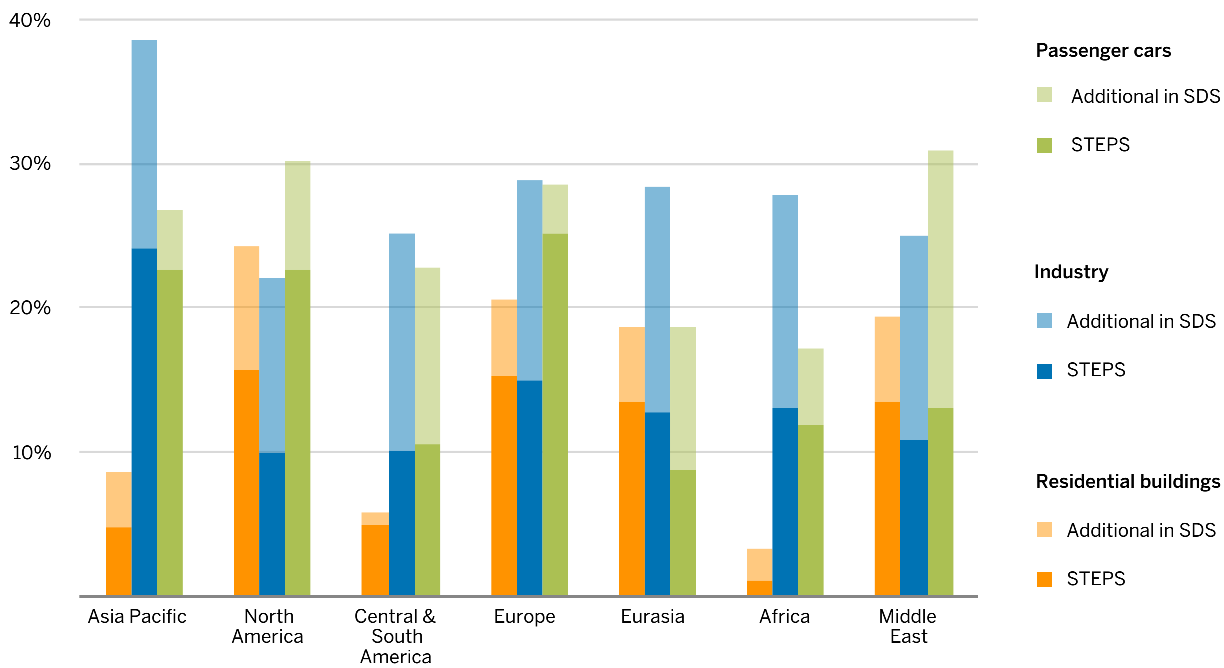


Source: IEA 2019a, 2020

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

More than 40 percent of the global savings in energy consumption achieved by 2030 under the Sustainable Development Scenario compared with the Stated Policies Scenario stem from the buildings sector, where building codes and energy efficiency standards for appliances and devices offer significant scope for improvement in most regions. Industry is the second-largest potential source of savings, representing around 30 percent of the global total. The gain would come from replacing outdated equipment, processes, and systems with more efficient versions. The remaining savings in energy consumption are attributed to transport, where stricter fuel-economy standards and emissions restrictions, combined with a variety of measures to accelerate the uptake of electric vehicles, could reduce global energy consumption by more than 20 percent by 2030.

FIGURE 5.9 • Improvement in energy intensity by sector and region in the Stated Policies and Sustainable Development Scenarios, 2018–30



Source: IEA 2019a.
STEPS = Stated Policies Scenario; SDS = Sustainable Development Scenario.

To realize the Sustainable Development Scenario, the world has to exploit the full potential for efficiency improvements. Success will depend on a thorough understanding of global energy needs, as energy demand trends vary substantially from region to region, with sectors playing larger or smaller roles in country economies. There is no single solution to apply across the board. In every region, it is essential to start with the sectors where demand is high and room for improvement is greatest. For example, in Asia, the dominant sources of growth in energy demand is set to be industry and transport—these are the sectors that will require the greatest policy attention. In most parts of Africa, by contrast, efficient urban planning and strict building codes would help reduce the rapidly rising demand for energy. In North America and Europe, energy demand has been rising because of increased cooling needs in summer and heating needs in winter, attention should be paid to improving the efficiency of cooling and heating systems. Global commitment to achieve greater efficiency progress is nonetheless evident. At the United Nations Climate Action Summit in September 2019, 15 countries launched the Three Percent Club[40] and announced plans to work together to drive a 3 percent annual rate of improvement in global energy intensity.

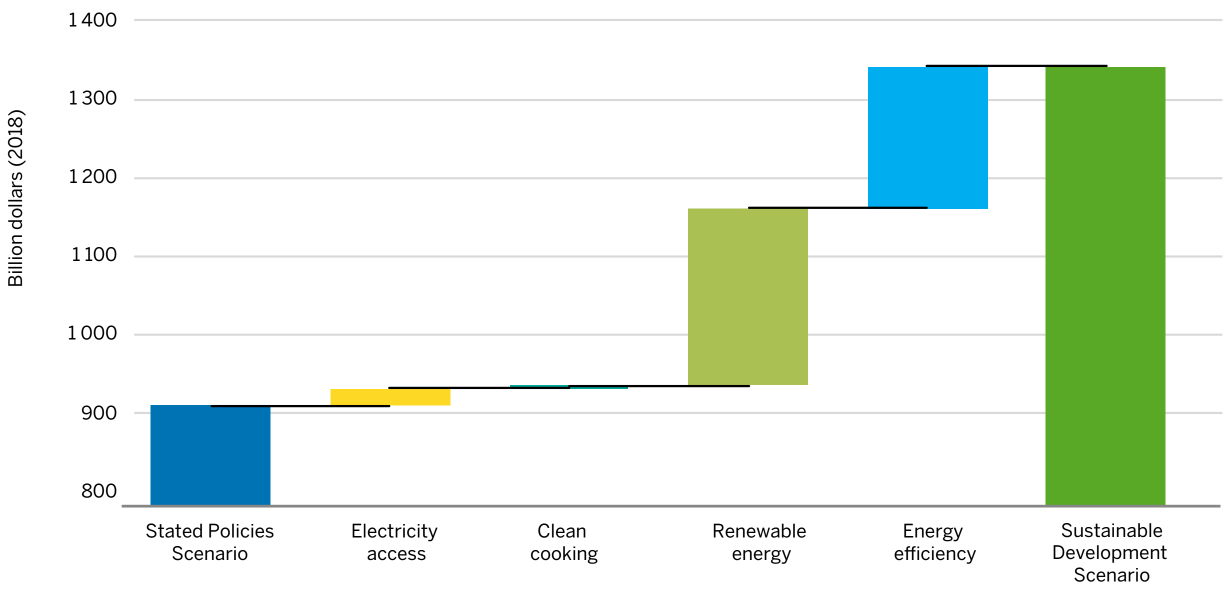
40 The Three Percent Club is a coalition of governments and supporting organizations committed to placing the world on a path to a 3 percent annual improvement in efficiency. The target was based on IEA's Efficient World Scenario, derived from the Sustainable Development Scenario. To support the member countries, the coalition leverages the combined global resources of the IEA, the SEforAll Energy Efficiency Accelerators and Hub, the Global Environment Facility, the UN Environment Programme, the European Bank for Reconstruction and Development, and the Energy Efficiency Global Alliance. Key industry partners commit to provide technical, financial, and project support to the participating countries, acting through the Energy Efficiency Global Alliance.

INVESTMENT NEEDED TO ACHIEVE SDG 7

In the Sustainable Development Scenario, total energy sector investments needed to achieve all targets of SDG 7 are estimated to average USD 1.36 trillion per year between 2019 and 2030 (Figure 5.10) (IEA 2019a). To achieve universal access to energy would require investments of around USD 45 billion per year between 2019 and 2030. Of these investments, USD 40 billion would be required to attain universal access to electricity, or more than twice the amount observed in the Stated Policies Scenario. Significant scale-up of investment would be required in Sub-Saharan Africa, compared with that observed under current and planned policies, as it totals two-thirds of the additional investment in electricity access.

Providing access to clean cooking facilities to all the population now without access would require five times the investment spelled out in the Stated Policies Scenario, or almost USD 5 billion per year. Clean cooking needs to be placed higher on the political agenda so as to accelerate efforts to widen access and take advantage of the momentum achieved to date. The latest estimates (2017) show USD 32 million supporting access to clean cooking in high-impact countries: Afghanistan, Bangladesh, China, Democratic Republic of Congo, Ethiopia, India, Indonesia, Kenya, Democratic Republic of Korea, Madagascar, Mozambique, Myanmar, Nepal, Nigeria, Pakistan, Philippines, Sudan, Tanzania, Uganda, and Viet Nam (SEforAll and CPI 2019). It is worth noting that total investment for access to clean cooking represents less than 2 percent of the total annual energy sector investment under the Sustainable Development Scenario.

FIGURE 5.10 • Additional annual direct investment needed to meet SDG 7 targets, 2019–30



Source: IEA 2019a.

Note: Investments under the Stated Policies Scenario include investment in the power sector and additional investments in end-use efficiency.

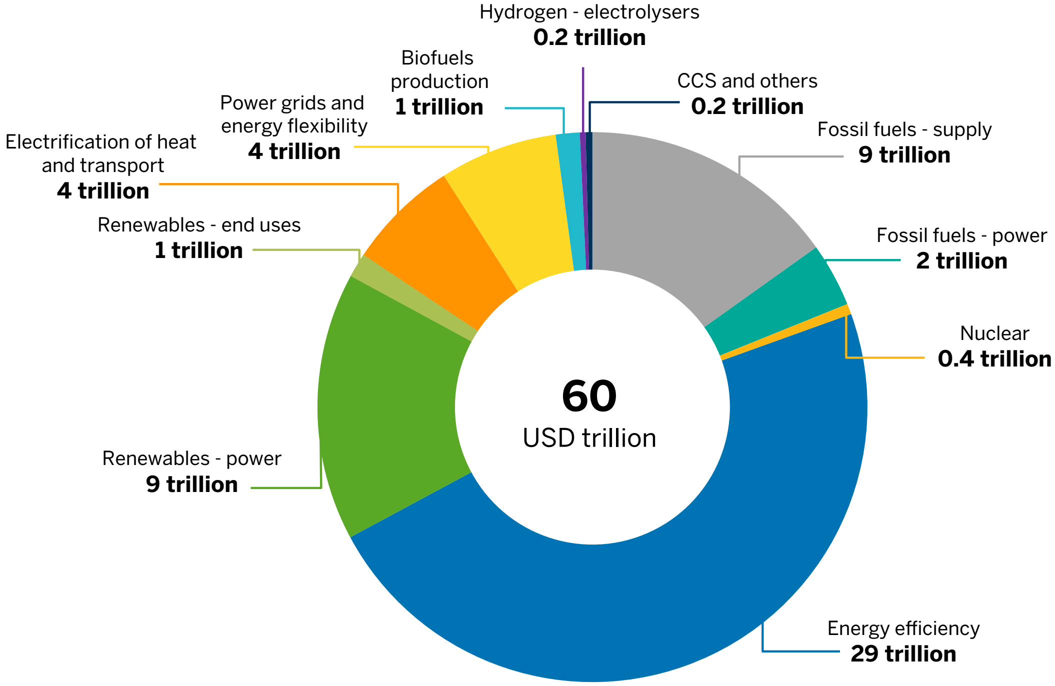
Under the Sustainable Development Scenario, the bulk of the investment required for meeting SDG 7 needs to go to renewable energy and end-use efficiency,[41] accounting for around USD 690 billion and USD 625 billion respectively. Compared to investments realized under current and planned policies, this represents an increase of almost USD 230 billion per year for renewables, principally going to renewables-based power, and of nearly USD 180 billion for efficiency, the greater part of it going to more efficient buildings and transport. These additional capital investments nonetheless conceal a different approach to financing compared with the Stated Policies Scenario; they could be achieved through

41 Renewable energy investments include investments in renewables power generation and grid integration costs. It also includes investments directly related to renewable energy capacity in industry and buildings end uses. Energy efficiency investments include those directly related to the efficiency of industry, buildings, and transport end uses.

a redirection of capital within the energy system. Indeed, the combination of lower energy use from efficiency investment alongside greater shares of renewables leads to a reduction of investments into fossil fuel of more than USD 220 billion per year, thereby demonstrating the economic viability of reaching the goals. All in all, the energy system would see additional annual investments limited to USD 210 billion to follow the pathway of the Sustainable Development Scenario relative to the Stated Policies Scenario.

Analysis performed for IRENA's Transforming Energy Scenario suggests that investments of nearly USD 10 trillion should be redirected from fossil fuels and related infrastructure to low-carbon technologies by 2030. Cumulative investments in the energy system over the period to 2030, including infrastructure and efficiency, would be reaching USD 60 trillion (Figure 5.11). Nearly USD 9.5 trillion of these investments would be needed to scale up renewable power generation capacity through 2030. In annual terms this would imply doubling of investments in renewable power generation capacity to USD 676 billion per year to 2030, compared with the USD 289 billion invested in 2018 (Frankfurt School–UNEP Centre/BNEF 2019). This would require a substantial investment. But leaving the energy system untransformed would be costlier. IRENA has estimated that between now and 2030, every additional dollar spent on the energy transformation would pay back between USD 2.5 and USD 7.5 in fuel savings, lower net energy subsidies, and reduced health externalities.

FIGURE 5.11 • Cumulative investment in the energy system under the Transforming Energy Scenario, 2016–30



Source: IRENA 2020d.
CCS = carbon capture and storage.

Scaling-up of renewable energy investments requires coordinated action on multiple fronts. One recent initiative to coordinate action to mobilize renewable energy investment at the necessary scale is the Climate Investment Platform, an inclusive partnership of public and private stakeholders.[42] While the bulk of investment in the energy transition will need to come from private sources, public finance will play a significant enabling role to spur investment. Greater and more efficient risk-mitigation solutions by public institutions and financiers (including development finance institutions and multilateral development banks) can scale up investment, in particular in developing countries (IRENA 2020c). Included for the first time in Tracking SDG 7 is an overview of progress toward SDG indicator 7.A.1 on international public financial flows to developing countries in support of clean and renewable energy (box 5.1).

42 https://www.climateinvestmentplatform.com/.

BOX 5.1 • SDG INDICATOR 7.A.1 ON INTERNATIONAL PUBLIC FINANCIAL FLOWS TO DEVELOPING COUNTRIES IN SUPPORT OF CLEAN AND RENEWABLE ENERGY

SDG target 7.A envisions enhanced international cooperation to facilitate access to clean energy research and technology, including the enabling of investment in renewables, with SDG indicator 7.A.1 focusing on international public financial flows to developing countries in support of clean and renewable energy.

Recent international public flows and trends

Between 2000 and 2017, developing countries received a cumulative sum of USD 138.9 billion (2017 PPP) in financial flows in support of renewables. In 2017, these flows reached USD 21.4 billion—up 13 percent from 2016, twice the amount recorded in 2010, and a 15-fold increase since 2000, reflecting the rapidly intensifying focus on development aid for clean and renewable energy.

Hydropower receives almost half of 2017 flows

Of the accumulated USD 138.9 billion (2017 PPP) in support of renewables between 2000 and 2017, USD 64.5 billion went to hydropower projects, 27.8 billion to solar, USD 10.1 billion to wind, and USD 36.5 billion to other energy sources. After a few years of dominance by solar, hydropower was back to receiving the greatest share in 2017, at 46 percent, while solar projects received 19 percent, wind 7 percent, and geothermal 6 percent.

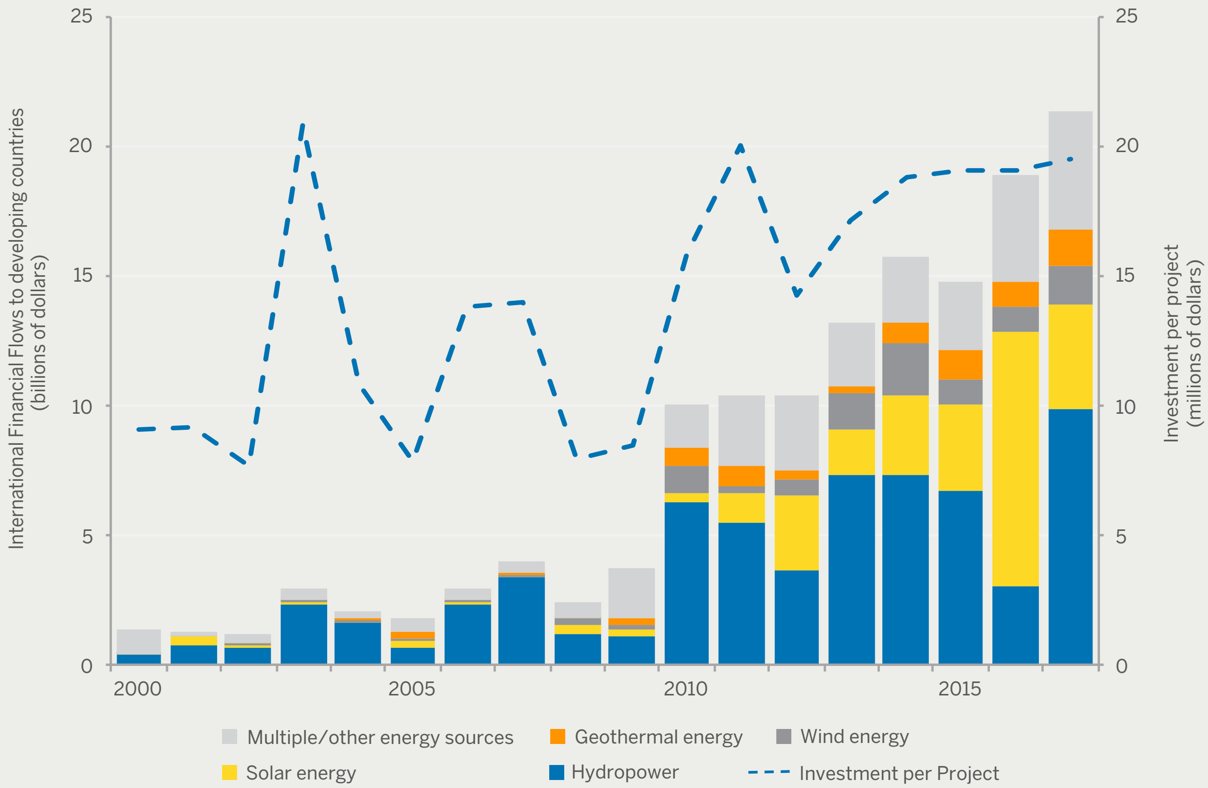
The scale of public investment projects also increased over the period, from an average of USD 10 million per project in 2000–09 to USD 19 million over the four years from 2014 to 2017. From 2016 to 2017, project scale grew the most for hydropower, with a two-fold increase from USD 53 million to USD 104 million per project. During the same period, the scale of solar projects decreased from USD 25 to 13 million per project, wind remained stable at USD 27 million per project, and geothermal inched up from USD 31 to 34 million per project.

The least-developed countries receive only small shares of 2017 flows

Although public financial flows grew after 2010 by an average of USD 1.6 billion per year, most of the growth was not targeted to those most in need—the least-developed countries. Between 2000 and 2017, only 20 percent of cumulative flows reached that set of countries. In 2017, the least-developed countries received USD 2.7 billion (12 percent of flows) and small island developing states less than USD 0.8 billion (4 percent of flows).

Out of 65 donors, four Asian donors committed 52 percent of the investments in 2017. The China Development Bank and the Export-Import Bank of China led with USD 9.0 billion, with an average of USD 651 million per project, followed by the Asian Development Bank (USD 1.1 billion) and the government of Japan (USD 1.0 billion).

FIGURE B5.1.1 International financial flows to developing countries in support of clean and renewable energy (at 2017 prices and exchange rates)



Source: Renewable Energy Public Investments Database.

Note: Figures in this box are drawn from the Renewable Energy Public Investments Database, a joint OECD/IRENA database on international financial flows to developing countries in support of clean and renewable energy (https://www.irena.org/Statistics/View-Data-by-Topic/Finance-and-Investment/Renewable-Energy-Finance-Flows).

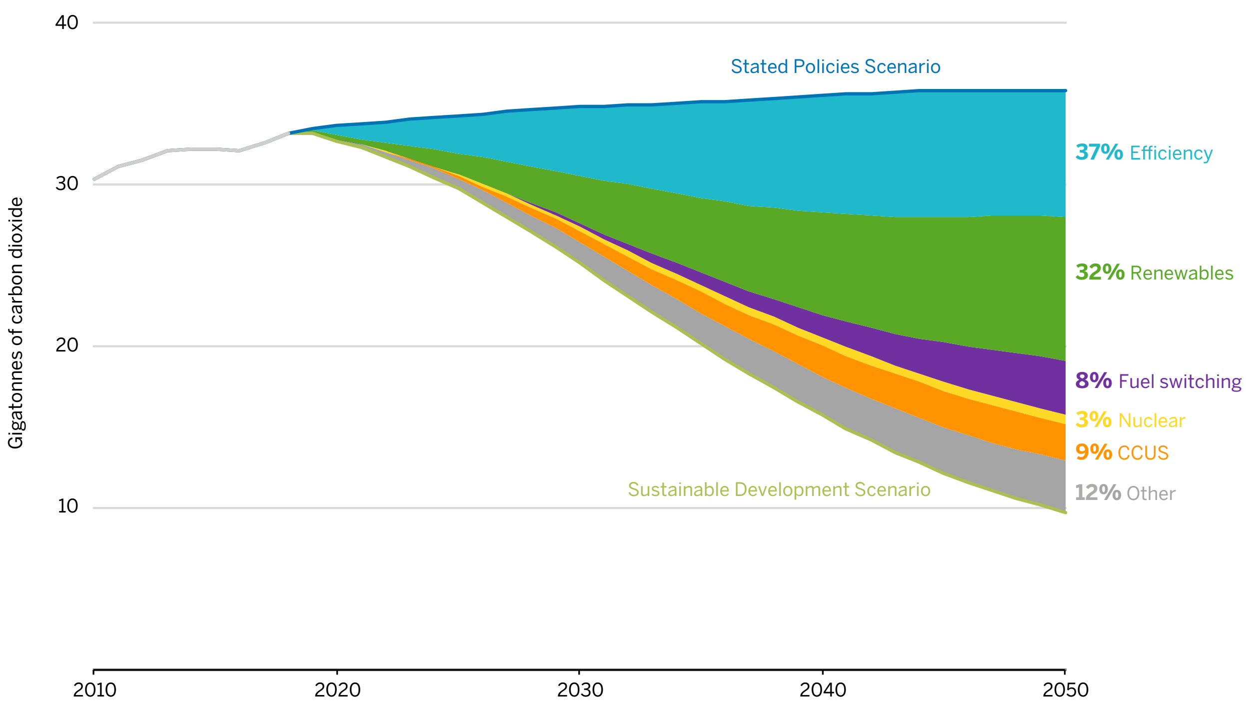
SDG 7 AND REDUCTION OF EMISSIONS

The current energy system produces numerous greenhouse gases, making the energy sector responsible for around 75 percent of such emissions. Climate change mitigation is thus a mounting concern for the sector, and in 2020 countries will have to present revised and more ambitious commitments for the first time as a result of the Paris Agreement, which was adopted in 2015.

The reductions in CO_2 emissions needed to realize the Paris Agreement will require a deep transformation across the energy system. To understand the weight of each lever, the Sustainable Development Scenario assessed country-by-country pathways that could deliver these targets, depending on local policy preferences, costs, resources, and societal preferences. Efficiency and renewables would produce the greatest reductions, equivalent to 37 percent and 32 percent respectively of the additional efforts required in the Sustainable Development Scenario relative to the Stated Policies Scenario (Figure 5.12).

Energy efficiency is the primary "fuel" of choice in most regions owing to its cost-effectiveness; no pathway compatible with the Paris Agreement can afford to leave it aside. It can drastically reduce the fuel intensity of energy service demand in the buildings, industry, and transport end-use sectors. It is also central to reducing the peak load on the power grid, leading to a decrease of the peaking capacity, which is often associated with higher-cost and more-carbon-intensive technologies. While energy efficiency alone is insufficient, it is essential to attaining stable, energy-related CO_2 emissions below 30 gigatonnes by around 2040.

FIGURE 5.12 • Additional reductions in CO_2 emissions by measure under the Sustainable Development Scenario relative to the Stated Policies Scenario



Source: IEA 2019a.
Note: Reduced thermal losses in power generation account for 15 percent of efficiency improvements.
CCUS = carbon capture, utilization, and storage.

The second major contributor would be the increased deployment of renewables. Policies would be central to strengthening the competitiveness of renewable technologies relative to fossil fuel power plants, capitalizing on the cost reductions observed to date for solar and wind technologies. Measures supporting the integration of renewables into the energy system would complement cost reductions and tap into their huge potential. Any increase in renewables should nevertheless be accompanied by the phaseout of inefficient fossil fuel power plants to reduce the carbon intensity of power generation. The contribution of renewables could go further than power systems and targeted policies; their increased use for heating in industry and buildings as well as for transport (through advanced biofuels) would offer major benefits.

These two technologies alone—energy efficiency and renewables—could account for almost 70 percent of the effort needed to reach the targeted emissions pathway. Reaching sustainable development goals would also require a host of other technologies and policies, from carbon capture utilization and storage (CCUS) to hydrogen. There is no single or simple solution to reach the Sustainable Development Goals.

Similarly, IRENA's Transforming Energy Scenario shows that annual energy-related CO_2 emissions under current and planned policies (the Planned Energy Scenario) are expected to remain flat, at 33 gigatonnes of CO_2 per year in 2050. However, under the Transforming Energy Scenario, emissions would be reduced by 70 percent by 2050, with continued reductions thereafter, keeping the rise in global temperature to well below the 2°C climate goal. The Transforming Energy Scenario analysis shows that the accelerated deployment of renewables, combined with extensive electrification and increased energy efficiency, could achieve over 90 percent of the energy-related CO_2 emissions reductions needed by 2050. Electrification with renewable power is key in lowering energy-related carbon emissions, together comprising 60 percent of the mitigation potential. If the additional reductions from direct use of renewables are considered, the share increases to 75 percent, and to more than 90 percent when counting energy efficiency.

CONCLUSION

Despite the great progress unlocked recently by innovative policies and technologies throughout the energy sector, the world is not on track to reach SDG 7 under current and planned policies. Efforts need to be scaled up across all goals so sufficient progress can be made. Providing universal access to energy requires a greatly accelerated pace of electricity connections in Sub-Saharan Africa. In parallel, access to clean cooking solutions needs to be placed much higher on political agendas in the developing and emerging world. Commercially viable renewables, especially for heat and transport, and renewed commitment to improving the coverage and stringency of efficiency regulations are urgently needed. It is increasingly realized that universal energy access targets are unlikely to be met without addressing the need for gender equality in energy access and in energy supply, whether in households or in businesses and energy companies.

A world on track to meet SDG 7 would deliver numerous socioeconomic benefits, which is why SDG 7 is central to achieving the other Sustainable Development Goals set out by the United Nations. In particular, energy and climate goals are interlinked and complementary. Pushing renewables and energy-efficient technologies across the energy system will play the main role in reducing greenhouse gas emissions as needed to meet the Paris Agreement.

METHODOLOGY

IEA METHODOLOGY

The analysis presented in this chapter is based on results from the World Energy Model (WEM) and IEA analysis in the *World Energy Outlook* (WEO). A detailed documentation on the World Energy Model methodology can be found here.

The 2019 edition of WEO featured a special look at Africa. IEA updated and expanded its analysis of the continent's energy outlook in this year's WEO. For the first time, models were developed for 11 selected Sub-Saharan countries, and these models were fed into the WEM. The country models enabled us to produce comprehensive, data-rich profiles for these countries and to draw implications for the continent as a whole.

IEA scenarios

The analyses shown above are built on two main scenarios described below. This page contains further details about how these two scenarios are modeled:

- **Stated Policies Scenario:** The Stated Policies Scenario reflects the impact of existing policy frameworks and today's announced policy intentions. Its aim is to provide a detailed sense of the direction in which existing policy frameworks and today's policy ambitions would take the energy sector out to 2040. Previously known as the New Policies Scenario, it has been renamed in WEO 2019 to underline that it considers only specific policy initiatives that have already been announced. The policies assessed in the Stated Policies Scenario cover a broad spectrum. These include Nationally Determined Contributions under the Paris Agreement and much more besides. In practice, the bottom-up modeling effort in this scenario requires a lot of detail at the sectoral level, including pricing policies, efficiency standards and schemes, electrification programs, as well as specific infrastructure projects. You can find more information about this scenario here.
- **Sustainable Development Scenario:** The Sustainable Development Scenario is a forward-looking, normative scenario, which describes an integrated, least-cost pathway for the world's energy system to deliver on energy-related SDGs: to ensure universal access to affordable, reliable, sustainable, and modern energy services by 2030 (SDG 7); to substantially reduce the household air pollution that causes deaths and illness (SDG 3.9); and to take effective action to combat climate change (SDG 13). It shows how the respective objectives can be reconciled, addressing potentially conflicting priorities so as to realize mutually supportive benefits. In this scenario, looking toward 2030, universal access to both electricity and clean cooking is achieved; modern renewables reach 21 percent of TFEC, more than doubling today's share; the energy efficiency aims set in SDG target 7.3 are exceeded in the Sustainable Development Scenario, with average annual improvements in global energy intensity accelerating to 3.4 percent annually to achieve critical energy sector objectives. You can find more information about this scenario here.

Methodology for access to electricity and access to clean cooking

The projections presented in the WEO and in this chapter focus on two elements of energy access: a household having access to electricity and to clean cooking facilities. These are measured separately. The IEA maintains databases on levels of 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. For the Special Focus on Africa of WEO 2019 (IEA 2019b), IEA refined its geospatial estimation of the least-cost pathway toward universal access to electricity by 2030, using latest WEM results and the latest version of the Open Source Spatial Electrification Tool (OnSSET) developed by KTH-dESA.[43] The results provide detailed coverage of 44 countries in Sub-Saharan Africa.

Further details about the 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 sub-module 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. Our modeling, in all scenarios, incorporates a process of learning-by-doing that affects the 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 separated 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

43 For more details on the Open Source Spatial Electrification Tool, see www.onsset.org; for the latest OnSSET methodology update refer to Korkovelos and others (2018).

IRENA scenarios

IRENA's energy transformation scenarios outlined in this report were developed by the Renewable Energy Roadmaps (REmap) team at IRENA's Innovation and Technology Centre in Bonn. Since 2014, IRENA's REmap team[44] has produced a succession of roadmaps with ambitious, yet technically and economically 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*. This report considers policy targets and developments through April 2019; any policy changes and targets announced since then are not considered in the present analysis.

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

Methodology for SDG indicator 7.A.1

This year's edition of Tracking SDG 7: The Energy Progress Report covers SDG indicator 7.A.1 for the first time. International financial flows to developing countries in support of clean and renewable energy comprise three categories of investment flows. Official development assistance (ODA) and other official flows (OOF) to developing countries together make up the public financial support that donors provide to developing countries for renewable energy. The additional flows (from the IRENA database) capture the flows to non-ODA recipients in developing regions and flows from countries and other public institutions not currently reporting to the OECD's Development Assistance Committee (DAC).

SDG indicator 7.A.1 is an indicator jointly produced by OECD and IRENA. The flows covered by the OECD are defined as the sum of official loans, grants, and equity investments that countries on DAC's list of ODA recipients receive from foreign governments and multilateral agencies for the purpose of clean energy research and development and renewable energy production (including in hybrid systems). These figures are extracted from the OECD/DAC Creditor Reporting System.

The flows covered by IRENA 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 development finance institutions 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, etc.) as listed above and, to avoid duplication of data, exclude all flows extracted from the OECD/DAC Creditor Reporting System.

44 https://www.irena.org/remap.

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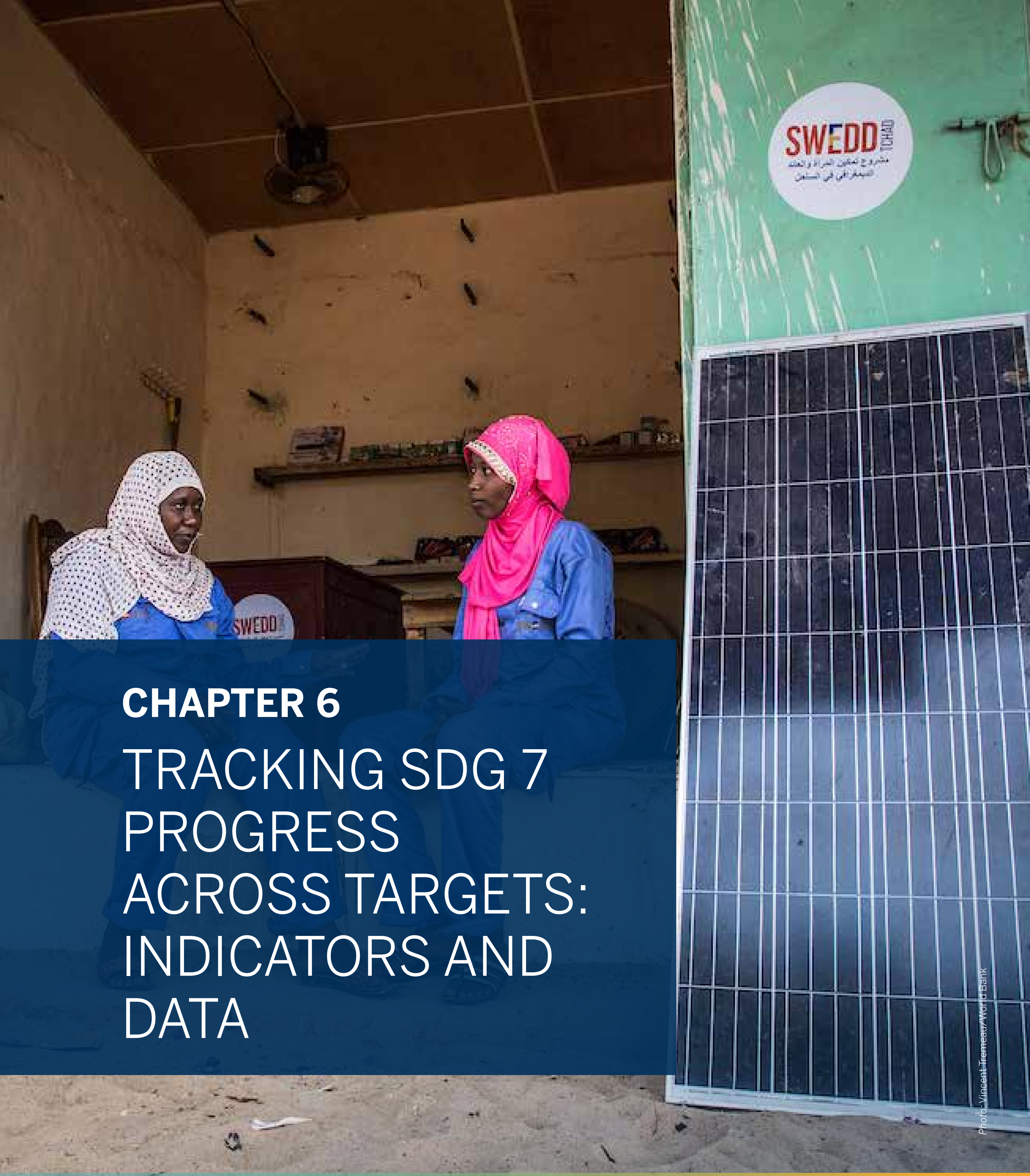

Photo: Vincent Tremeau / World Bank

CHAPTER 6

TRACKING SDG 7 PROGRESS ACROSS TARGETS: INDICATORS AND DATA

Comprehensive and accurate data are a prerequisite for making evidence-based decisions, monitoring trends, and tracking progress toward policy goals. In developed and developing countries alike, well-designed and appropriately resourced statistical systems play a fundamental role in monitoring progress toward Sustainable Development Goal 7 (SDG 7).

Leveraging national data efforts worldwide, the global tracking presented in this report is a joint effort of the custodian agencies responsible for monitoring progress toward the SDG 7 targets—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).[45] International organizations typically collect information from across countries, adding value by promoting coherent standards, definitions, and methodologies for both raw data and derived indicators. The ultimate goal is to produce internationally comparable datasets.[46]

The quality of global tracking certainly benefits from continuous improvements in national data systems, as countries (i) establish frameworks and institutional arrangements to collect comprehensive data on energy supply and demand and prepare full energy balances; (ii) prepare and carry out surveys of households, businesses, and other categories of end users; and (iii) apply sound quality-assurance frameworks.[47]

The data tables that follow this introduction cover all of the indicators of progress toward the SDG 7 targets, as summarized in table 6.1. What follows is a brief description of work done at the national and international levels to obtain the underlying data. Short descriptions of the methodologies and indicators used in the report were presented in the final sections of chapters 1–5.

TABLE 6.1 • 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 for cooking
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 as a ratio of primary energy supply to gross domestic product
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

45 The World Bank and WHO are responsible for tracking progress toward SDG target 7.1 (access to electricity and clean cooking fuels and technology); IEA, IRENA, and UNSD are responsible for SDG target 7.2 (renewable energy); and IEA and UNSD are responsible for SDG target 7.3 (energy efficiency). Target 7.A on international cooperation is tracked by IRENA and the Organisation for Economic Co-operation and Development (OECD).

46 A consultation on harmonized definitions and concepts for energy statistics, conducted across organizations, fed the country-led drafting of the International Recommendations for Energy Statistics (IRES), which were adopted by the United Nations in 2011 (https://unstats.un.org/unsd/energystats/methodology/ires/). IRES provides the fundamental definitions behind energy statistics, pointing to international classifications of products (SIEC) and sectors (ISIC). Examples of international data compilations used for this report include IEA's World Energy Balances (https://www.iea.org/reports/world-energy-balances-2019) and UNSD's energy statistics (https://unstats.un.org/unsd/energystats/).

47 *Institutional arrangements* optimize data production, exchange, and governance across organizations, chiefly statistical offices and specialized governmental agencies responsible for implementing energy polices (energy ministries). Energy balances are comprehensive accounts of all the energy entering, exiting, and used in a given country or territory, typically covering production, import, and export of primary energy sources; transformation into fuels for final consumption; and final consumption within each major end-use sector. Examples of energy balances are available at: https://www.iea.org/data-and-statistics/data-tables?country=WORLD. Important aspects of data quality are relevance, accuracy, and reliability; timeliness and punctuality; coherence and comparability; and accessibility and clarity. Information on quality assurance frameworks is contained in IRES (https://unstats.un.org/unsd/energystats/methodology/ires/).

ACCESS TO ELECTRICITY

Tracking electrification efforts has been a complex process that has raised many challenges, the first being to devise a universally applicable and transparent approach. Measuring access to electricity requires tracking cumulative progress across interventions by a variety of players—governments, energy utilities, private sector companies, funding agencies, and development organizations at the national and international levels. Particularly challenging are the socioeconomic complexities of low-access countries. Measuring access also implicates a variety of technologies—not only national grids but mini grids and off-grid solutions, such as solar home systems. Finally, it requires assessing the number of people who actually benefit from these interventions, as well as the nature and degree of improvement they provide. But however difficult it may be, measuring access is critical to enable governments and practitioners to understand the current status of access, to identify bottlenecks to further electrification, and to achieve universal access goals in more efficient ways.

The definition and measurement of access to electricity should focus not only on the number of users benefitting from improved energy access, but also on the nature and degree of improvement across various attributes: capacity (adequacy), availability, reliability, affordability, quality, legality, health impact, safety, and convenience, among others. To provide this fuller picture, and to help prioritize investment and track progress, a set of international agencies joined together to produce a multi-tier framework (MTF) for household surveys.[48] The MTF has been rolled out by national statistical offices and the World Bank in about 16 countries since 2016. Given the paucity of data for multi-tier metrics, however, standardized country-level surveys and supply-side data from governments and utilities must still be used to complement the MTF approach.

Additional methods of improving the tracking of access to electricity are: (i) developing the capacity of national statistical offices to collect energy data (for example, through workshops organized by development partners on data collection and analysis for the energy sector); (ii) helping governments apply new technology and data analytics, since survey design can be challenging if the national census is outdated or if a census has never been conducted; (iii) improving and adapting the usability of existing datasets for energy practitioners; (iv) exploring the use of large-scale open databases, such as satellite data. Most microdata (including household surveys, enterprise surveys, and agricultural surveys) contain information useful for energy practitioners and the ministries of energy. However, significant time and effort are usually required to extract from such sources data related to 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 project design and policy formulation.

ACCESS TO CLEAN COOKING SOLUTIONS

To monitor SDG 7 on access to clean cooking and SDG 3 on health, country and regional estimates are derived using a nonparametric statistical model. "Clean cooking" is defined as the performance of a particular fuel and technology combination, as measured by its emissions. Currently, the analysis for SDG indicator 7.1.2 relies only on cooking fuel as a practical proxy for the population practicing clean cooking. This is due to a lack of globally representative data on the cooking technologies used by households. Therefore, households considered to have access to clean cooking—for purposes of tracking SDG indicator 7.1.2—are those that rely primarily on electricity, biogas, solar, alcohol fuels, natural gas, and liquefied petroleum gas for cooking.

In future, designing, implementing and monitoring the effectiveness and impacts of policies and programs for clean cooking will depend on better survey coverage of all the types of cooking fuels and technologies used, as well as their duration of use. Presently, country-level estimates of clean cooking access are also used to estimate the incidence of disease caused by household air pollution and ultimately to the "mortality rate from the joint effects of ambient and household air pollution," which is one of the SDG indicators of environmental health (SDG indicator 3.9.1). By enhancing data collection on the parallel use of multiple cooking solutions in the home (a practice known as "stove stacking," common in low- and middle-income countries), more refined estimates of human exposure to pollution and the related disease burden will become possible.

Simple changes to surveys can greatly improve the monitoring of trends and effects related to clean cooking. The clean

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48 The agencies contributing to the development of the MTF were the Energizing Development Program (EnDev), the Energy Sector Management Assistance Programme, the Global Alliance for Clean Cookstoves, IEA, Practical Action Consulting, the United Nations Development Programme, the UN Foundation, the UN Industrial Development Organization, the World Bank, and WHO.

cooking estimates presented in this report, for example, drew on more robust data on the specific fuels households use for cooking, which in turn made possible the application of more advanced modeling techniques. The result is the estimation, presented here for the first time, of the percentage of households in each country and region primarily using biomass, charcoal, coal, kerosene, gaseous fuels, and electricity. Armed with such specific fuel-use estimates, decision-makers can better monitor trends and the effects of changes in subsidies, tariffs, and other policies.

As refinements in household surveys and censuses are made, countries should seize the opportunity to gather a more complete picture of household energy use, including fuels and technologies employed for heating and lighting, which can also have a significant effect on air pollution within the household. Steps have already been taken to enable stakeholders to better monitor household energy use and its effects through the use of a set of harmonized questions for national household surveys and censuses. More information on such initiatives by WHO and the World Bank can be found in chapter 2.

RENEWABLE ENERGY

Progress on renewable energy is tracked as the share of renewables in total final energy consumption,[49] which depends on the availability of comprehensive data across all energy sources, renewable and non renewable alike, and across the sectors of supply, transformation, and final consumption. In terms of data, computation of this indicator relies on the availability of a full energy balance, as well as some assumptions regarding electricity and heat.

Two specific challenges in tracking the penetration of renewables are the need to better monitor the rapid expansion of geographically distributed resources (solar photovoltaic, wind, and other resources powering mini-, micro-, and off-grid systems) and to enhance countries' capacity to measure traditional household uses of biomass (solid biofuels), which remains the largest segment of renewable energy in the developing world.

Arriving at better estimates of the latter will require dedicated efforts—either enhancing existing surveys with an energy module or establishing new energy surveys. Survey-based results are very valuable; often they trigger significant revisions of previous estimates—and might well do so in the case of tracking progress toward SDG target 7.2.

A broader question about biomass is the extent to which its use should be considered sustainable. Although forests are technically "renewable," traditional harvesting practices often cause deforestation.

ENERGY EFFICIENCY

For purposes of SDG 7, energy efficiency is tracked as energy intensity, the ratio of total energy supply to economic output. Determining the total energy supply requires robust information on production of and trade in all types of energy. The supply information may be collected from administrative sources or by surveying the key energy suppliers. Reasonably good information on supplies of most energy sources is available in most countries, with the notable exception of supplies of solid biofuels in several countries. Thus, where solid biofuels are a significant part of the overall energy mix, estimates of total energy supply may be less certain.

To assess progress in energy efficiency, overall energy intensity should be complemented by analysis of energy demand drivers across the principal end-use sectors, such as industry, transport, and buildings. Given the diversity of end uses, demand-side data collection is inherently more complex, time consuming, and costly than on the supply side. Direct consumer surveys may be necessary, especially when energy suppliers cannot provide detailed data on how much energy is being delivered to the various types of energy users.

To analyze sectoral progress in energy efficiency, countries are encouraged to monitor intensities at the end-use level, at least for priority sectors. Examples of energy efficiency indicators include, for transport, energy per passenger-kilometer (or tonne-kilometer for freight), by vehicle type; for buildings, energy for space heating and cooling as a function of area; and for industry, energy by quantity of physical production of a given good. IEA's 2014 statistics report, "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 country experiences.

49 The methodology used to derive total final energy consumption is part of IRES (https://unstats.un.org/unsd/energystats/methodology/ires/).

Developing such indicators requires not only finer disaggregation of data but also greater coordination across entities responsible for matters beyond the energy sector, such as building registers, vehicle registrations, and so on. Despite the challenges, many countries have started to collect end-use data and compile energy efficiency indicators to better support their policy and planning.[50]

INTERNATIONAL FINANCIAL FLOWS TO DEVELOPING COUNTRIES IN SUPPORT OF CLEAN AND RENEWABLE ENERGY

Data on flows of development finance are susceptible to changes and adjustments that call for careful attention to detail, standardization of cycles of data collection and management, and continuous revision of commitment values.

Based on the nature of SDG indicator 7.A.1, four areas of improvement in the tracking of international investment flows are suggested: (i) improving investment tracking; (ii) standardizing commitment details; (iii) centralizing data collection efforts; and (iv) presenting constant flows.

Improving investment tracking. It is important to know how aid recipients spend the funds they receive. The practices presently in use are not sufficient to track public aid from origin to end. Such tracking requires a system of identification numbers to trace commitments from public investors through to their end uses in organizations and projects. Recipients may include financial instruments (such as energy bonds and funds), multilateral organizations, or projects involving one or more energy technologies. Donors often have trouble specifying how their commitments should be spread across various energy technologies. International flows may go through additional stages of investment after the initial commitment, passing through local governments, ventures, or funds. Successive revisions of historic investment flows may include several years' of investments, since individual commitments may be announced (and counted) before they materialize. Some of these commitments may be cancelled or changed, altering the values of existing data.

Standardizing commitment details. To increase the accuracy of tracking SDG indicator 7.A.1 it would be desirable to standardize commitment details by sharing best practices among public investors, refining reporting directives, and encouraging public investors to provide energy details that meet international standards. Data collection related to investments tends to follow the norms and practices of the financial world and often is short on energy-related details. Thus, committed flows are often linked to projects that involve multiple renewable energy technologies or that mix energy efficiency and other end uses, compromising their comparability with other data being considered. Information may be lost owing to nonstandard reporting of public flows across investors. For these reasons, only a limited amount of commitment information may match across investors.

Centralizing data collection. Data collection can be centralized by encouraging preformatted questionnaires and online data entry to increase comparability across public investors. The OECD's Creditor Reporting System database is exemplary in this regard. However, collection of most data on international public investments in clean energy and renewables remains decentralized, reducing the consistency of commitment data.

Presenting constant flows. International commitments must be corrected for currency exchange rates and inflation if they are to be comparable across countries and over time. SDG indicator 7.A.1 uses the OECD methodology to deflate international flows by first adjusting for inflation from the year the flows occurred to a baseline year (2017), and then converting local currency values to U.S. dollars using the exchange rates in the baseline year (2017).

50 Examples include IEA's energy efficiency indicators: https://www.iea.org/reports/energy-efficiency-indicators-2019; and the Odyssée database for Europe: https://www.indicators.odyssee-mure.eu/energy-efficiency-database.html.

CONCLUSION

The work performed for this report has highlighted the need for good quality data to inform policy at the national, regional, and international levels, as well as opportunities to further develop national statistical capacity and to enhance data quality through national and international cooperation.

At the national level, cooperation between national statistical offices and institutions in various policy domains will be key to optimizing the use of data-collection resources. For example, household surveys could and should be designed to support tracking of several SDG 7 targets at once, such as clean cooking and energy efficiency, as well as of targets beyond SDG 7, such as those on quality of life, air pollution, and health.[51]

International cooperation strengthens the world's ability to track SDG 7 by raising awareness of the importance of good quality data to inform policy; by proposing standardized methodologies for indicators as well as common frameworks for data-collection surveys; by compiling international databases; and by supporting the development of statistical capacity in countries and regions. Tracking SDG 7 has given the custodian agencies an opportunity to further improve their collaboration on data, both with countries and between one another.

The custodian agencies would like to acknowledge the work and dedication of all their colleagues working to collect energy data across national administrations worldwide. It is they who make possible the international tracking work reflected in this report.

51 For example, clean cooking and space heating are significantly linked for rural households in colder climates. More broadly, all end uses of energy within a household (lighting, appliances, cooking, heating, cooling) can be addressed in a single survey.

DATA

SDG 7.1.1 - ACCESS TO ELECTRICITY

Data provided by the World Bank

Country	Total electricity access rate (%)					Urban electricity access rate (%)	Rural electricity access rate (%) b
	1990	2000	2010	2015	2018	2018	2018
Afghanistan			43 *d*	72 *d*	99	100	98
Albania	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Algeria	96	98	99	100	100	100	100
American Samoa							
Andorra	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Angola	12	23	33	42 *d*	43	74	
Anguilla	90	95	98	100	100		
Antigua and Barbuda	96	97	98	100 *m*	100 *m*	100 *m*	100 *m*
Argentina	92	96	99 *e*	100	100 *m*	100 *m*	100 *m*
Armenia	98	99 *d*	100 *d*	100 *d*	100	100	100
Aruba	100 *m*	92 *e*	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	96	99 *c*	100	100	100	100	100
Bahamas	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Bahrain	100	100	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Bangladesh	7	32 *d*	55 *g*	73	85	97	78
Barbados	100	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Belarus	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Belgium	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Belize	68	79 *e*	90 *e*	92 *c*	100	98	100
Benin	10	21	34 *g*	38	42	67	18
Bermuda	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Bhutan		31 *g*	73 *c*	95	100	100	100
Bolivia (Plurinational State of)	57	70 *h*	88	92 *h*	96	100	86
Bosnia and Herzegovina	100 *m*	100 *m*	100 *m*	100 *g*	100 *m*	100 *m*	100 *m*
Botswana	6	27	53	58	65	81	28
Brazil	87 *h*	94	99	100 *h*	100	100	100

Country	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%) b	
	1990		2000		2010		2015		2018		2018		2018	
British Virgin Islands	92		95		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	4		9		13	*d*	16		14	*d*	62	*d*	3	*d*
Burundi			3		5	*d*	9		11		62		3	
Cabo Verde	37		57		81	*e*	87		94		92		97	
Cambodia			17	*d*	31	*d*	69		92		100		89	
Cameroon	30		41	*c*	53		59		63		93		23	
Canada	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Cayman Islands	100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Central African Republic			6	*c*	10	*c*	24		32		55		16	
Chad			3		6	*c*	8	*d*	12		42		3	
Channel Islands														
Chile	92	*h*	98	*h*	99		100	*h*	100	*m*	100	*m*	100	*m*
China	94		97		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	90	*d*	95	*d*	97	*h*	98	*h*	100		100		100	
Comoros	16		40		70		74		82		94		77	
Congo			21		42		60	*c*	69		92		20	
Cook Islands	95		97		99		100		100		100			
Costa Rica	98		99		99	*h*	99	*h*	100		100		100	
Côte d'Ivoire	38		48		58		63	*g*	67		100		33	
Croatia	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Cuba	93		97	*k*	98		99		100		100		100	
Curaçao	100		100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Cyprus	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Czechia	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*

Country	Total electricity access rate (%)					Urban electricity access rate (%)	Rural electricity access rate (%) b
	1990	2000	2010	2015	2018	2018	2018
Democratic People's Republic of Korea		7	29	41	49	56	40
Democratic Republic of the Congo		7 *c*	13	16	19	51	
Denmark	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Djibouti	56	56	56	58	60	71	24
Dominica	67	81	94	100	100	100	100
Dominican Republic	80	89 *h*	98 *h*	99 *h*	100	100	100
Ecuador	90	94	97 *h*	99 *h*	100	100	100
Egypt	95	98 *d*	99	99 *g*	100	100	100
El Salvador	73	85 *h*	92 *h*	95 *h*	100	99	100
Equatorial Guinea	64	65	66	66	67	90	7
Eritrea	18	29	40	46	50	77	35
Estonia	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Eswatini		20	46 *c*	66	77	97	70
Ethiopia		13 *d*	33	29 *d*	45	92	33
Faroe Islands	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Fiji	63	76	89	95	100	100	99
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	66	74 *d*	92	90	93	97	63
Gambia	12	34 *c*	47	54	60 *c*	76 *c*	35
Georgia	97	99	99	100	100	100	100
Germany	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*	100 *m*
Ghana	24	44 *e*	64 *e*	76	82	94	67
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	82	86	90	92	95		100

Country	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%) b	
	1990		2000		2010		2015		2018		2018		2018	
Guam	100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Guatemala	60		73	*h*	84		91		95		96		94	
Guinea	3		16		27		34		44	*d*	87	*d*	20	
Guinea-Bissau					6	*g*	20		29		53		10	
Guyana	68		75		82		88		92		97		90	
Haiti	26		34	*d*	37		41		45		79		4	
Honduras	55		67		81	*h*	90	*h*	92		100		81	
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	42		59		76	*g*	88	*d*	95		100		93	
Indonesia	63		86	*g*	94	*g*	98	*g*	99	*g*	100	*g*	97	*g*
Iran (Islamic Republic of)	96		98	*d*	99		100		100		100		100	
Iraq	95		97		98		99		100	*c*	100	*c*	100	*c*
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	70	*h*	84		92	*g*	95	*g*	99		100		98	
Japan	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Jordan	97	*d*	99		99		100		100	*g*	100		99	
Kazakhstan	98		99		100		100	*c*	100		100		100	
Kenya			15		19	*d*	42	*d*	75	*l*	84		72	
Kiribati	26		51		63	*e*	91	*e*	100	*k*	94	*k*	100	*k*
Kosovo	100	*m*	100	*m*	99		100	*m*	100	*m*	100	*m*		*m*
Kuwait	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Kyrgyzstan	100		100		99	*i*	100		100	*c*	100	*c*	100	*c*
Lao People's Democratic Republic	15		43		71		90	*e*	98		99		97	
Latvia	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Lebanon	98		99		100		100		100		100		100	

Country	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%) b	
	1990		2000		2010		2015		2018		2018		2018	
Lesotho			4	c	17		32	g	47	c	71	c	38	
Liberia					5		16		26		44		7	
Libya	100		100	k	81		73		67	k	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	9		14	k	18		20		26		70			
Malawi			5	d	9	d	11	d	18	g	55		10	
Malaysia	94		97		99		100		100		100		100	
Maldives	77		84	e	99		100		100		100		100	
Mali			9		28		38	d	51	d	86	d	25	
Malta	100	m	100	m	100	m	100	m	100	m	100	m	100	m
Marshall Islands	53		69		89		93		96		96		98	
Mauritania	5		19	k	34		40	c	45		82		1	
Mauritius	100		99	e	100		97		97		88		100	
Mexico	95		98	h	99	d	99	d	100		100		100	
Micronesia (Federated States of)	28		46	e	65	e	76		82		94		79	
Monaco	100	m	100	m	100	m	100	m	100	m	100	m	100	m
Mongolia	60		67	e	79	c	88		98	c	100	c	95	
Montenegro	100	m	100	m	100	m	100	m	100	c	100	c	100	c
Morocco	49		70		92		100		100		100		100	
Mozambique			6		18		24	d	31	d	72	d	8	
Myanmar	30		42		49	g	61	g	66		92		55	
Namibia	25		37	d	44		52		54		72		36	
Nauru	100		100		99		99	g	100		100			
Nepal			28		69	g	85		94	l	96	l	93	
Netherlands	100	m	100	m	100	m	100	m	100	m	100	m	100	m
New Caledonia	100		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

Country	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%) b	
	1990		2000		2010		2015		2018		2018		2018	
Nicaragua	66		73	*k*	79		84		88		100		71	
Niger	2		6	*c*	13		17	*g*	18	*l*	48	*l*	12	
Nigeria	27	*d*	43		48	*d*	53	*d*	57	*d*	82	*d*	31	
Niue	93		96		99		100		100		100			
North Macedonia	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Northern Mariana Islands	100		100	*m*	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		70		70		71		71		100		54	
Palau	97		98		98		99		100	*m*	100	*m*	100	*m*
Panama	70	*e*	81	*e*	87	*e*	95		100	*m*	100	*m*	100	*m*
Papua New Guinea			9		20	*g*	44		59		82		55	
Paraguay	81		89		97	*h*	99	*h*	100		100		100	
Peru	61		72	*h*	88	*h*	94	*h*	95	*g*	99	*g*	82	*g*
Philippines	64		75		85		89	*f*	95		98		93	
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		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		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Republic of Moldova	100	*m*	100	*m*	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	*m*	100	*m*	100	*m*	100	*m*
Rwanda			6	*d*	10	*d*	23	*d*	35		89		23	
Saint Kitts and Nevis	91		95	*d*	100		100	*m*	100	*m*	100	*m*	100	*m*
Saint Lucia	84		89		94	*e*	97		100		98		100	
Saint Martin (French Part)	47		68	*e*	64		100		100	*m*	100	*m*	100	*m*
Saint Vincent and the Grenadines	66		80		93		100		100		98		100	
Samoa	79		88		97		100		100		100		100	

Country	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%) b	
	1990		2000		2010		2015		2018		2018		2018	
San Marino	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Sao Tome and Principe	41		53	*c*	60		66		71	*l*	77	*l*	56	
Saudi Arabia	100		100		100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Senegal	21		38	*c*	57	*g*	61	*d*	67		92		44	
Serbia	100	*m*	100	*m*	100	*m*	100	*k*	100	*m*	100	*m*	100	*m*
Seychelles	90		94		97	*e*	100	*m*	100	*m*	100	*m*	100	*m*
Sierra Leone			8		11	*c*	20		26	*g*	53	*g*	6	
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		34		55	*d*	67		77		64	
Somalia			5		21		30		35		60		15	
South Africa	61		72		83	*g*	86	*g*	91		92		90	
South Sudan					2	*e*	18		28		47		24	
Spain	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*
Sri Lanka	53		69		85	*g*	94		100		100		99	
State of Palestine	98		100	*g*	100	*g*	100	*g*	100		100		100	
Sudan	33	*d*	23	*c*	41		49		60		84		47	
Suriname	96		96		91	*c*	95		97	*c*	99	*c*	94	
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	96		93		93	*g*	90		86	*k*	100		69	
Tajikistan	98		98	*c*	98		98	*g*	99	*d*	99	*d*	99	*d*
Thailand	80		82	*d*	100	*f*	100	*c*	100		100		100	
Timor-Leste			18		38	*d*	67	*e*	86		100		79	
Togo			17	*c*	31	*c*	45		51		92		22	
Tonga	78		85		92		96		99		99		99	
Trinidad and Tobago	93		91	*e*	100	*m*	100	*m*	100	*m*	100	*m*	100	*m*

Country	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%) b	
	1990		2000		2010		2015		2018		2018		2018	
Tunisia	89		95	g	100	j	100	g	100	c	100	c	100	c
Turkey	93		97		100	i	100		100		100		100	
Turkmenistan	99		100	d	100	i	100	c	100		100		100	
Turks and Caicos Islands	89	e	96	e	100	m	100	m	100	m	100	m	100	m
Tuvalu	91		94		97		99		100		100		100	
Uganda			8		12	g	19	d	43	l	58	l	38	
Ukraine	100	m	100	m	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	2		10		15	d	27		36		68		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	97		98		99		100	h	100	m	100	m	100	m
Uzbekistan	99		100		100		100		100		100		100	
Vanuatu	4		22		44	g	52		62		94		51	
Venezuela (Bolivarian Republic of)	98		99	h	99		100		100		100		100	
Viet Nam	78		87		98		100		100		100		100	
Yemen	37		50		74		71		62	k	85	k	49	
Zambia	14	e	17	e	22	e	31	g	40		77		11	
Zimbabwe	30		34		40		34	d	41		85		20	
World	72		78		83		87		90		97		80	
Northern America and Europe	100		100		100		99		100		100		100	
Latin America and the Caribbean	86		92		96		97		98		100		93	
Central Asia and Southern Asia	45		60		75		86		92		100		88	

Country	Total electricity access rate (%)					Urban electricity access rate (%)	Rural electricity access rate (%) b
	1990	2000	2010	2015	2018	2018	2018
Eastern Asia and South-eastern Asia	86	91	96	97	98	99	97
Western Asia and Northern Africa	85	87	92	93	94	99	86
Sub-Saharan Africa	17	25	34	39	47	78	27
Oceania	80	80	82	87	91	99	73

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.

Source: World Bank

SDG 7.1.2 – ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

Data provided by WHO

Country	2000			2010			2015			2018		
	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)
Afghanistan	11	48	<5	20	72	6	29	82	14	37	86	21
Albania	39	67	17	67	86	46	76	90	58	80	92	62
Algeria	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
American Samoa												
Andorra	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Angola	44	84	8	47	81	7	48	77	7	48	75	8
Anguilla												
Antigua and Barbuda	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Argentina	95	>95	68	>95	>95	88	>95	>95	93	>95	>95	94
Armenia	79	>95	53	>95	>95	92	>95	>95	95	>95	>95	95
Aruba												
Australia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Austria	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Azerbaijan	70	>95	44	93	>95	87	>95	>95	92	>95	>95	94
Bahamas	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Bahrain	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Bangladesh	8	35	<5	12	41	<5	18	52	6	24	60	9
Barbados	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Belarus	95	>95	88	>95	>95	>95	>95	>95	>95	>95	>95	>95
Belgium	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Belize	80	94	67	83	>95	73	83	>95	74	83	95	74
Benin	<5	<5	<5	5	9	<5	5	9	<5	5	8	<5
Bermuda												
Bhutan	28	89	10	64	>95	47	74	>95	60	77	>95	64
Bolivia (Plurinational State of)	63	92	18	77	>95	41	82	>95	51	84	>95	53
Bosnia and Herzegovina	52	81	30	44	69	22	45	65	19	45	64	19

Country	2000			2010			2015			2018		
	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)
Botswana	45	71	20	56	78	29	55	75	26	53	72	24
Brazil	88	>95	51	94	>95	69	>95	>95	77	>95	>95	80
British Virgin Islands												
Brunei Darussalam	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Bulgaria												
Burkina Faso	<5	12	<5	6	21	<5	8	28	<5	10	32	<5
Burundi	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cabo Verde	63	90	31	70	91	33	75	93	39	78	94	42
Cambodia	<5	15	<5	12	46	<5	17	59	7	22	65	10
Cameroon	10	20	<5	20	37	<5	23	42	<5	24	43	<5
Canada	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Cayman Islands												
Central African Republic	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chad	<5	7	<5	<5	9	<5	<5	12	<5	<5	13	<5
Channel Islands												
Chile	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
China	43	69	24	53	77	27	60	81	33	64	82	36
China, Hong Kong Special Administrative Region												
China, Macao Special Administrative Region												
Colombia	78	93	34	85	>95	40	90	>95	56	93	>95	69
Comoros	<5	<5	<5	<5	7	<5	6	14	<5	8	17	<5
Congo	9	15	<5	17	26	<5	26	38	<5	32	46	<5
Cook Islands	81	>95	43	80	>95	33	78	>95	26	77	>95	23
Costa Rica	89	>95	78	92	>95	80	94	>95	84	95	>95	87
Côte d'Ivoire	18	38	<5	17	36	<5	23	47	<5	29	57	<5
Croatia	85	93	76	88	89	88	87	86	92	86	85	93
Cuba												

Country	2000			2010			2015			2018		
	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)
Curaçao												
Cyprus	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Czechia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Democratic People's Republic of Korea	<5	<5	<5	6	9	<5	9	13	<5	10	16	<5
Democratic Republic of the Congo	5	11	<5	<5	10	<5	<5	9	<5	<5	8	<5
Denmark	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Djibouti	5	5	<5	6	7	<5	6	7	<5	6	8	<5
Dominica	77	>95	28	82	>95	38	82	>95	38	82	>95	36
Dominican Republic	84	95	67	87	95	69	88	94	69	89	94	70
Ecuador	88	>95	70	94	>95	83	94	>95	85	94	>95	85
Egypt	84	>95	75	>95	>95	>95	>95	>95	>95	>95	>95	>95
El Salvador	56	81	24	77	92	50	86	94	70	91	95	81
Equatorial Guinea	19	31	5	23	34	5	24	34	5	24	33	<5
Eritrea	<5	11	<5	8	21	<5	9	21	<5	9	20	<5
Estonia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Eswatini	24	60	10	39	79	24	48	86	32	54	88	39
Ethiopia	<5	<5	<5	<5	9	<5	<5	17	<5	5	24	<5
Faroe Islands												
Fiji	30	51	12	30	47	11	29	45	9	28	44	8
Finland	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
France	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
French Polynesia												
Gabon	65	80	15	81	90	29	86	93	38	87	94	42
Gambia	<5	6	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Georgia	49	86	11	65	93	34	75	94	53	81	94	63
Germany	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Ghana	6	14	<5	16	29	<5	23	38	7	28	43	9

Country	2000			2010			2015			2018		
	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)
Gibraltar												
Greece	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Greenland												
Grenada	92	94	91	93	92	94	91	90	94	89	88	94
Guam												
Guatemala	41	69	18	42	68	13	45	69	14	46	70	14
Guinea	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Guinea-Bissau	<5	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Guyana	36	56	27	61	75	55	71	81	68	76	83	73
Haiti	<5	5	<5	<5	7	<5	<5	7	<5	<5	7	<5
Honduras	30	56	7	44	71	18	51	74	31	57	76	41
Hungary	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Iceland	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
India	23	50	7	35	69	14	43	77	21	49	81	28
Indonesia	6	12	<5	41	62	23	67	85	51	80	91	68
Iran (Islamic Republic of)	94	>95	90	>95	>95	93	>95	>95	94	>95	>95	94
Iraq	78	89	57	>95	>95	91	>95	>95	>95	>95	>95	>95
Ireland	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Isle of Man												
Israel	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Italy	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Jamaica	76	>95	54	86	>95	75	85	93	78	84	91	78
Japan	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Jordan	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Kazakhstan	84	>95	68	93	>95	86	>95	>95	92	>95	>95	95
Kenya	<5	<5	<5	7	20	<5	9	23	<5	10	24	<5
Kiribati	<5	6	<5	<5	6	<5	<5	6	<5	<5	6	<5
Kosovo												

Country	2000			2010			2015			2018		
	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)
Kuwait	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Kyrgyzstan	53	86	33	72	93	60	76	95	65	77	95	66
Lao People's Democratic Republic	<5	11	<5	<5	10	<5	5	14	<5	7	17	<5
Latvia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Lebanon												
Lesotho	17	47	9	31	73	15	36	78	18	39	79	19
Liberia	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Libya												
Liechtenstein												
Lithuania	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Luxembourg	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Madagascar	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Malawi	<5	12	<5	<5	11	<5	<5	10	<5	<5	9	<5
Malaysia	>95	>95	>95	>95	>95	95	>95	>95	93	>95	>95	93
Maldives	56	>95	41	93	>95	90	>95	>95	>95	>95	>95	>95
Mali	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Malta	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Marshall Islands	15	22	<5	53	71	<5	63	83	<5	65	86	<5
Mauritania	30	53	14	42	68	19	43	68	18	43	66	19
Mauritius	94	>95	91	>95	>95	>95	>95	>95	>95	>95	>95	>95
Mexico	83	>95	45	85	95	52	85	93	53	84	92	54
Micronesia (Federated States of)	30	10	34	10	23	5	9	26	<5	8	27	<5
Monaco	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Mongolia	23	41	<5	35	50	7	44	62	11	50	68	13
Montenegro	67	82	47	63	75	40	58	69	37	56	66	35
Morocco	91	>95	81	>95	>95	91	>95	>95	94	>95	>95	95
Mozambique	<5	7	<5	<5	9	<5	<5	11	<5	<5	12	<5

Country	2000			2010			2015			2018		
	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)
Myanmar	<5	6	<5	10	26	<5	20	54	5	28	70	7
Namibia	34	81	9	41	75	12	44	74	12	46	72	12
Nauru	86	87	26	90	91	24	90	91	25	90	91	23
Nepal	7	22	<5	21	66	11	27	65	15	29	60	18
Netherlands	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
New Caledonia												
New Zealand	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Nicaragua	34	55	7	44	69	8	47	72	9	48	74	9
Niger	<5	<5	<5	<5	6	<5	<5	10	<5	<5	13	<5
Nigeria	<5	<5	<5	<5	<5	<5	5	11	<5	10	21	<5
Niue	93	92	94	90	95	89	86	>95	86	84	>95	84
North Macedonia	58	68	45	65	87	39	66	91	33	65	93	29
Northern Mariana Islands												
Norway	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Oman	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Pakistan	24	66	5	35	83	11	40	86	16	44	87	20
Palau	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Panama	80	>95	54	86	>95	67	88	>95	69	88	>95	69
Papua New Guinea	6	33	<5	7	39	<5	7	39	<5	8	38	<5
Paraguay	48	72	16	58	77	29	65	84	35	68	86	38
Peru	43	61	5	66	84	13	74	90	25	80	93	36
Philippines	38	57	19	40	60	20	43	63	23	46	67	27
Poland	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Portugal	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Puerto Rico												
Qatar	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Republic of Korea	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Republic of Moldova	64	>95	40	91	>95	86	95	>95	92	>95	>95	94

Country	2000			2010			2015			2018		
	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)
Romania	77	>95	55	88	>95	78	80	>95	61	75	>95	50
Russian Federation	>95	>95	>95	>95	>95	>95	94	95	95	90	92	93
Rwanda	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Saint Kitts and Nevis	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Saint Lucia	86	78	91	>95	95	>95	>95	>95	>95	>95	>95	>95
Saint Vincent and the Grenadines	95	>95	>95	95	>95	>95	95	>95	>95	95	>95	>95
Samoa	21	46	12	26	57	18	31	62	24	35	65	27
San Marino	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Sao Tome and Principe	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Saudi Arabia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Senegal	35	70	7	35	65	7	27	49	5	23	41	<5
Serbia	63	85	39	67	85	44	67	85	44	66	84	43
Seychelles	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Sierra Leone	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Singapore	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Sint Maarten (Dutch part)												
Slovakia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Slovenia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Solomon Islands	9	40	<5	8	38	<5	8	36	<5	9	36	<5
Somalia	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
South Africa	55	76	29	77	89	56	83	93	61	85	94	63
South Sudan	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Spain	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Sri Lanka	21	58	14	20	55	13	26	63	18	31	69	23
State of Palestine												
Sudan	12	20	8	32	51	22	44	62	35	50	66	43
Suriname	78	89	59	87	94	76	92	>95	84	94	>95	89

Country	2000			2010			2015			2018		
	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)
Sweden	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Switzerland	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Syrian Arab Republic	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Tajikistan	39	85	24	69	95	60	77	>95	70	81	>95	75
Thailand	63	87	50	74	87	64	78	87	70	79	87	73
Timor-Leste	<5	5	<5	5	12	<5	9	20	<5	12	26	5
Togo	<5	<5	<5	<5	8	<5	7	15	<5	9	20	<5
Tonga	58	87	49	55	85	45	52	81	43	50	79	41
Trinidad and Tobago	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Tunisia	>95	>95	93	>95	>95	>95	>95	>95	>95	>95	>95	>95
Turkey	94	>95	88	95	>95	86	95	>95	84	95	>95	82
Turkmenistan	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Turks and Caicos Islands												
Tuvalu	31	23	13	41	44	17	42	45	15	43	42	14
Uganda	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Ukraine	92	95	86	95	>95	87	95	>95	87	95	>95	87
United Arab Emirates	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
United Kingdom of Great Britain and Northern Ireland	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
United Republic of Tanzania	<5	<5	<5	<5	<5	<5	<5	5	<5	<5	7	<5
United States of America	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
United States Virgin Islands												
Uruguay	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Uzbekistan	84	>95	71	86	>95	74	86	>95	74	85	>95	73
Vanuatu	17	57	5	12	39	<5	9	29	<5	8	24	<5

Country	2000			2010			2015			2018		
	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)	Total clean cooking access rate (%)	Urban clean cooking access rate (%)	Rural clean cooking access rate (%)
Venezuela (Bolivarian Republic of)	>95	>95	87	>95	>95	87	>95	>95	85	>95	>95	84
Viet Nam	13	38	5	49	79	35	59	82	48	64	82	54
Yemen	56	93	42	60	95	43	60	94	43	60	94	42
Zambia	14	38	<5	16	37	<5	15	32	<5	13	28	<5
Zimbabwe	34	88	5	30	81	5	29	78	5	29	75	5
World	50	76	25	56	81	29	60	82	33	63	83	37
Central Asia and Southern Asia	26	58	10	37	72	15	44	78	22	49	82	28
Eastern Asia and South-eastern Asia	42	65	24	54	77	29	62	82	37	67	84	42
Latin America & the Caribbean	80	93	42	85	95	52	87	95	57	88	94	60
Northern America and Europe	>95	>95	94	>95	>95	>95	>95	>95	95	>95	>95	94
Sub-Saharan Africa	10	25	<5	12	26	<5	13	28	<5	15	31	<5
Western Asia and Northern Africa	82	93	68	89	>95	79	91	>95	81	91	>95	82
Oceania	78	>95	40	77	96	36	76	96	35	76	96	34

Note:
Data source: Household Energy Database, WHO, January 2020.

Source: World Health Organization

SDG 7.2 – RENEWABLE ENERGY

Data provided by the IEA and UNSD

UN country name	Share in total final energy consumption (%)													Final consumption of renewable energy (PJ)			Total final energy consumption (PJ)	
	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Tide	Wind	Solar	Geothermal	Municipal waste (renew)	Electricity consump-tion (1)	Heat raising (2)	Transport (3)		
	2000	2010	2015	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	
Afghanistan	54.2	14.9	20	24.7	12.2	0	0	12.4	0	0	0	0	0	13.8	13.5	0	110.6	a
Albania	41.4	37.1	38.6	37.2	7.9	3.8	0	24.9	0	0	0.6	0	0	21.4	7.4	3.2	86.2	b
Algeria	0.4	0.3	0.1	0.1	0	0	0	0	0	0	0.1	0	0	1.7	0.4	0	1472.5	b
American Samoa	0	0	1.5	1.8	0	0	0	0	0	0	1.8	0	0	0	0	0	0.5	a
Andorra	14.5	18.7	19.3	19.1	0.3	0	0	17.2	0	0	0	0	1.7	1.6	0	0	8.6	a
Angola	73.4	50.8	47.8	56.2	50.2	0	0	6	0	0	0	0	0	23.8	199.3	0	397.3	b
Anguilla	0.2	0.1	0.2	0.2	0.1	0	0	0	0	0	0.1	0	0	0	0	0	1.4	a
Antigua and Barbuda	0	0	0.5	0.6	0	0	0	0	0	0	0.6	0	0	0	0	0	3.9	a
Argentina	11.1	9	10.1	11.2	3.1	2.6	0	5.5	0	0.1	0	0	0	135.4	66.1	61.1	2335.7	b
Armenia	7.2	9.4	11.6	12.5	6	0	0	6.4	0	0	0	0	0	5.8	5.6	0.1	92.2	b
Aruba	0.2	5.5	6.7	6.5	0.3	0	0	0	0	6.1	0	0	0	0.4	0	0	6.8	a
Australia	8.4	8.1	9.2	9.5	5.4	0.1	0.1	1.5	0	1.1	1.2	0	0	115	185.1	7.5	3224.4	b
Austria	26.2	30	34.3	33.2	15.7	1.9	0.4	11.8	0	2	1.1	0.1	0.3	161.7	173.5	28.3	1093.4	b
Azerbaijan	2.1	4.4	2.3	1.9	0.5	0	0	1.3	0	0	0	0	0.1	4.7	1.5	0.1	329.2	b
Bahamas	0	1.7	1.4	1.4	1.4	0	0	0	0	0	0	0	0	0	0.3	0	19.6	a
Bahrain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	191.4	b
Bangladesh	59	41.1	34.6	32	31.7	0	0	0.2	0	0	0	0	0	3.6	391.9	0	1236.5	b
Barbados	14.3	9.1	3.2	3.6	2.8	0	0	0	0	0	0.8	0	0	0.1	0.3	0	11.9	a
Belarus	5.6	7.3	6.8	7.3	6.8	0.1	0	0.2	0	0	0	0	0	2.3	47.4	0.2	686.9	b
Belgium	1.4	5.8	9.3	9.6	4.8	1.5	0.5	0.1	0	1.6	0.9	0	0.3	53.5	59.5	21.1	1393	b
Belize	34.6	32.9	33.1	38.7	30.9	0	0	7.8	0	0	0	0	0	2	3.4	0	14.2	a
Benin	70.3	48.1	50.9	45.6	45.6	0	0	0	0	0	0	0	0	0.1	79.6	0	174.6	b
Bermuda	0	3.8	0.5	0.5	0.1	0	0	0	0	0	0	0	0.4	0	0	0	4.7	a
Bhutan	91.4	90.6	86.5	83.4	71.6	0	0	11.9	0	0	0	0	0	7.9	47.4	0	66.3	a
Bolivia (Plurinational State of)	28.1	19.8	17.5	13.4	11.2	0	0	2.2	0	0.1	0	0	0	7.8	33.8	0	309.4	b

UN country name	Share in total final energy consumption (%)													Final consumption of renewable energy (PJ)			Total final energy consumption (PJ)	
	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	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	
Bonaire, Sint Eustatius and Saba	0	0	3	2.8	0.1	0	0	0	0	2.3	0.3	0	0	0.1	0	0	4	a
Bosnia and Herzegovina	19.4	19.6	25.3	18.8	11.9	0	0	6.8	0	0	0	0	0	10	17.4	0.1	146.2	b
Botswana	36.6	29.9	28.4	28.6	28.5	0	0	0	0	0	0	0	0	0	23.6	0	82.6	b
Brazil	42.8	46.9	43.7	45.3	22.8	7.9	0	12.7	0	1.4	0.4	0	0	1412.6	1912.2	713.4	8915.6	b
British Virgin Islands	1	0.7	1	1.3	1	0	0	0	0	0.2	0.1	0	0	0	0	0	1.3	a
Brunei Darussalam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38.4	b
Bulgaria	8	14.4	17.7	17	10.8	1.7	0.2	1.7	0	0.9	1.1	0.4	0.3	14.5	47.5	7	404.8	b
Burkina Faso	85.4	81.5	72.7	70	69.6	0	0	0.4	0	0	0	0	0	0.7	110.6	0	158.9	a
Burundi	93.2	92.6	91.2	88.2	87.4	0	0	0.8	0	0	0	0	0	0.5	48.5	0	55.5	a
Cabo Verde	38.5	21.2	26.3	22.9	19.9	0	0	0	0	2.7	0.2	0	0	0.2	1.4	0	7	a
Cambodia	81.1	68.5	64.9	61.5	58	0	0	3.4	0	0	0	0	0	9.7	160.4	0	276.8	b
Cameroon	84.5	78.6	78	78.6	74.9	0	0	3.8	0	0	0	0	0	11.6	230.3	0	307.6	b
Canada	21.5	22.5	21.4	23.1	5.6	1.2	0.1	14.9	0	1.1	0.2	0	0	1183.7	402.3	109.3	7323.5	b
Cayman Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	a
Central African Republic	85.1	79.8	76.4	75.8	73	0	0	2.6	0	0	0.1	0	0	0.5	12.8	0	17.5	a
Chad	88.7	81.6	85.4	85.4	85.4	0	0	0	0	0	0	0	0	0	60.7	0	71.1	a
Chile	31.4	27	25.1	23.5	14.9	0	0.1	6.2	0	1	1.3	0	0	108.8	147	1.5	1095.1	b
China	29.6	12.3	12.2	12.8	4.2	0.1	0.4	4.6	0	1.2	1.8	0.6	0	4906.8	4686.8	204.1	76741.2	b
China, Hong Kong Special Administrative Region	0.6	0.8	0.8	0.8	0.6	0	0.1	0	0	0	0	0	0	0.5	2.4	0.2	388.5	b
China, Macao Special Administrative Region	0.2	5.4	7.4	5.9	0.1	0	0	0	0	0	0	0	5.8	2	0	0	34.6	a
Colombia	28	27.9	28.8	29.2	14.9	0.1	0	14.2	0	0	0	0	0	176.2	177.9	1.6	1216.9	b
Comoros	48.3	46.4	44.9	38.8	38.8	0	0	0	0	0	0	0	0	0	1.7	0	4.3	a
Congo	64.9	54.8	64.8	70	67	0	0	2.1	0	0	1	0	0	2.5	53.7	0	80.2	b
Cook Islands	0	0	1.2	1.7	0	0	0	0	0	0	1.7	0	0	0	0	0	0.7	a
Costa Rica	32.9	40.4	38.3	36.2	14.7	0	0	16.8	0	2.5	0	2.2	0	35.5	23.4	0	162.5	b
Côte d'Ivoire	63.7	75.4	64.9	62.7	61.6	0	0	1.2	0	0	0	0	0	4	183.9	0	299.4	b

UN country name	Share in total final energy consumption (%)													Final consumption of renewable energy (PJ)			Total final energy consumption (PJ)	
	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	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	
Croatia	26.8	29.8	33.1	29.8	17.5	0	0.6	9.1	0	2.1	0.3	0.1	0	34.2	49.7	0.6	283.3	b
Cuba	34.4	14.6	20.1	17.7	14.7	2.9	0	0.1	0	0	0.1	0	0	2.1	54.6	0	320.3	b
Curaçao	0.1	0.5	2.4	3.7	0	0	0	0	0	3.4	0.3	0	0	0.9	0	0	24.8	b
Cyprus	3.1	6.4	9.9	10.4	1.3	0.6	0.6	0	0	1.1	5.5	0.1	1.2	1.4	4.9	0.4	64	b
Czechia	5.9	11	14.8	14.5	10.4	1.3	1.3	0.4	0	0.1	0.6	0	0.2	22.4	110.6	13.8	1014.9	b
Democratic People's Republic of Korea	8.7	13.5	23.1	27.4	14.7	0	0	12.7	0	0	0	0	0	32	37.1	0	252.2	b
Democratic Republic of the Congo	97.9	96.8	95.8	97.1	94.7	0	0	2.5	0	0	0	0	0	25.9	999.8	0	1056.1	b
Denmark	10.7	21.3	33.5	36.5	20.2	1.6	1.6	0	0	9.4	0.8	0	2.9	78.5	120	10.1	571.3	b
Djibouti	31.4	32.5	13.3	14.5	14.5	0	0	0	0	0	0	0	0	0	0.9	0	6.5	a
Dominica	11	10.1	8.6	9.8	4	0	0	5.8	0	0	0	0	0	0.1	0.1	0	1.6	a
Dominican Republic	19.1	17	15	17	13.6	0	0	2.7	0	0.5	0.3	0	0	8.6	33.6	0	248.5	b
Ecuador	20	11.4	13	16.7	4.3	0.1	0	12.2	0	0	0	0	0	62.7	20.1	0.6	498.6	b
Egypt	8.1	5.7	5.7	5.5	3.4	0	0	1.8	0	0.3	0	0	0	49.1	76.3	0.2	2266.8	b
El Salvador	33.5	29.1	21.3	25.3	11.5	0	0.2	6.6	0	0	0.7	6.4	0	16.5	8.7	0	99.2	b
Equatorial Guinea	50.4	5.9	9.8	12	10.3	0	0	1.6	0	0	0	0	0	0.6	3.8	0	37	a
Eritrea	76.8	81.2	79	78.4	78.4	0	0	0	0	0	0	0	0	0	17.6	0	22.5	b
Estonia	19.8	25.1	27.5	27	25.3	0	0.4	0	0	1.2	0	0	0	3.6	28.1	0.1	117.7	b
Eswatini	62.1	63.1	66.4	60.6	56.5	0	0	4.1	0	0	0	0	0	4.8	15.9	0	34.2	a
Ethiopia	95.6	94.1	91.5	89.8	87.7	0	0	1.9	0	0.1	0	0	0	34.1	1460.7	0.1	1665	b
Falkland Islands (Malvinas)	1.4	3.4	4.7	4.9	1.3	0	0	0	0	3.6	0	0	0	0	0	0	0.5	a
Faroe Islands	2.8	3.4	7.5	6	0	0	0	3.9	0	2.1	0	0	0	0.6	0	0	9.5	a
Fiji	52.2	28	29.9	27	20.3	0	0	6.7	0	0	0	0	0	1.6	4.8	0	23.7	a
Finland	31.7	33.6	43.2	44.4	32.9	1.7	0.4	6.3	0	2	0	0	1	134.7	296.6	17.7	1011.9	b
France	9.3	12	13.7	14.5	7	2.4	0.3	2.4	0	1.2	0.6	0.1	0.5	255	450.8	146.2	5867.2	b
French Guiana	23.8	29.4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
French Polynesia	9.9	12.5	10.2	10.9	0.4	0	0	9.8	0	0	0.7	0	0	0.8	0	0	7.6	a
Gabon	72.8	85.8	82	81.2	79.7	0	0	1.5	0	0	0	0	0	2.9	155.6	0	195.3	b

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	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Tide	Wind	Solar	Geothermal	Municipal waste (renew)	Electricity consump-tion (1)	Heat raising (2)	Transport (3)		
	2000	2010	2015	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	
Gambia	63.1	54.7	51.3	50.8	50.8	0	0	0	0	0	0	0	0	0	5.2	0	10.3	a
Georgia	47.3	39.1	28.7	28.7	9	0	0	19	0	0.2	0.1	0.4	0	31.6	16	1	169.3	b
Germany	3.7	10.3	14.2	15.3	5.2	1.4	2	0.7	0	3.6	1.7	0.1	0.7	609.6	570	123.2	8541.3	b
Ghana	71.6	48.3	40	40	33.9	0	0	6.1	0	0	0	0	0	17.5	96.1	0	283.7	b
Gibraltar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.8	b
Greece	7.5	11.1	17.2	16.1	5.7	1.1	0.3	2.1	0	3	3.8	0.1	0	48.4	50.3	7.3	660.3	b
Greenland	12.8	10.1	13.1	11.3	0	0	0	11	0	0	0	0	0.3	0.9	0	0	8	a
Grenada	10.5	10.5	12.3	12.6	12.6	0	0	0	0	0	0	0	0	0	0.4	0	3	a
Guadeloupe	2.6	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Guam	0	0	1.3	3	0	0	0	0	0	0	2.9	0	0	0.2	0	0	5.8	a
Guatemala	62.7	67.3	63	64.2	60.5	0	0	3.3	0	0.1	0.1	0.2	0	24.2	281.3	0	475.8	b
Guernsey	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.3	a
Guinea	85.6	75.7	78	77	76	0	0	1	0	0	0	0	0	1.4	102.8	0	135.2	a
Guinea-Bissau	91.2	87.8	86.9	86.5	86.5	0	0	0	0	0	0	0	0	0	24.2	0	28	a
Guyana	30	30.5	25.6	22.5	22.5	0	0	0	0	0	0	0	0	0.2	6.2	0	28.4	a
Haiti	76	79	76.1	76.1	76	0	0	0.1	0	0	0	0	0	0.2	106.6	0	140.3	b
Honduras	55.2	50.2	52.6	53.3	46.4	0	0	4.5	0	0.9	1.4	0.1	0	17.3	97.7	0	215.9	b
Hungary	5.2	13.5	15.5	14.3	11.6	0.8	0.3	0.1	0	0.4	0.3	0.6	0.2	14.2	87	6.7	752.3	b
Iceland	60.7	75.4	77	76.7	0	0.6	0.1	38.1	0	0	0	37.9	0	64.2	29.6	1	123.5	b
India	51.8	40.6	34.5	32.2	29.3	0.1	0	1.7	0	0.6	0.5	0	0	711.7	6614.5	25.6	22830.2	b
Indonesia	45.6	39.5	35.5	35	32.4	1.1	0	0.8	0	0	0	0.6	0	100.8	2272.9	77.5	7004.4	b
Iran (Islamic Republic of)	0.4	0.9	0.9	1	0.3	0	0	0.6	0	0	0	0	0	45.5	21.3	0.1	6848.5	b
Iraq	0.4	1.7	0.8	0.4	0.1	0	0	0.3	0	0	0	0	0	2.4	1.1	0	827.4	b
Ireland	2	5.2	9.1	10.2	2.1	1.6	0.2	0.5	0	5.1	0.1	0	0.6	26.9	11.3	7.4	445.6	b
Isle of Man	0	1.9	2.2	1.9	0	0	0	0.5	0	0	0	0	1.4	0	0	0	2.4	a
Israel	6	8.6	3.7	3.8	0.2	0	c	c	0	0.1	3.6	0	0	5.1	17	0	573.9	b
Italy	5.1	12.8	16.6	16.4	7.2	1.3	0.8	2.8	0	1.4	2.1	0.6	0.3	357	347.9	58.9	4648.2	b
Jamaica	5.3	9.7	13.4	12.4	9	1.8	0	0.5	0	1	0.1	0	0	2	6.4	1.4	79.4	b

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	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Tide	Wind	Solar	Geothermal	Municipal waste (renew)	Electricity consumption (1)	Heat raising (2)	Transport (3)		
	2000	2010	2015	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	
Japan	3.8	4.8	6.3	6.9	2.1	0.2	0	2.5	0	0.2	1.8	0.1	0.1	540.3	177.9	27.6	10809.6	b
Jersey	0	4.8	15.9	16.9	0	0	0	0	0	0	0	0	16.9	1	0	0	6.1	a
Jordan	2.1	3	3.2	5.1	0.9	0	0	0	0	0.5	3.6	0	0	4.2	9.6	0	273.3	b
Kazakhstan	2.5	1.4	1.5	1.6	0.1	0	0	1.4	0	0	0	0	0	23.4	2.1	1.8	1683.3	b
Kenya	79	76.5	72.2	71.8	68.4	0	0	1.3	0	0	0	2	0	24.3	480.8	0	703.8	b
Kiribati	56.5	48.3	47.6	45.8	44.6	0	0	0	0	0	1.2	0	0	0	0.5	0	1.2	a
Kuwait	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	692.4	b
Kyrgyzstan	35.2	25.6	23.3	24.5	0	0	0	24.5	0	0	0	0	0	36.1	0.1	0.2	148.1	b
Lao People's Democratic Republic	81.6	64.9	53.9	45.9	37.6	0	0	8.2	0	0	0	0	0	11.3	51.5	0	137	a
Latvia	35.8	33.1	38.1	42.6	31.6	0.3	1.5	8.4	0	0.3	0	0	0.5	16.7	51.8	0.7	162.4	b
Lebanon	4.9	5.7	3.7	3.3	2.4	0	0	0.5	0	0	0.5	0	0	1.1	6.4	0	225.3	b
Lesotho	56.7	53	44.1	38.7	33.5	0	0	5.2	0	0	0	0	0	2.4	15.6	0	46.4	a
Liberia	90.8	88.6	84	85	84.9	0	0	0.1	0	0	0	0	0	0.1	73.5	0	86.5	a
Libya	2	1.5	1.9	1.8	1.8	0	0	0	0	0	0	0	0	0	6	0	340.5	b
Liechtenstein	53.9	52.3	55.5	55.3	6.2	0	0.8	35.6	0	0	12.7	0	0	1.4	0.2	0	3	a
Lithuania	17.2	21.5	29	33.6	21.7	1.2	0.8	2.8	0	6.2	0.3	0	0.6	25.3	45.5	2.7	219.1	b
Luxembourg	6.8	3.7	9.1	15.4	2.8	3.1	1.4	1.4	0	4	1.9	0	0.8	15.1	3.3	5.1	151.6	b
Madagascar	83.4	86.3	78.3	82.6	81.5	0	0	1.1	0	0	0	0	0	2.7	186.7	0	229.3	a
Malawi	82.6	81.2	80.8	75.9	69.2	0	0	6.7	0	0	0	0	0	4.5	44.7	0	64.8	a
Malaysia	4.5	2	3.4	5.2	0.1	0.8	0	4.2	0	0	0.1	0	0	88.7	0	16.2	2012.7	b
Maldives	2.3	1.4	1.4	1.2	0.9	0	0	0	0	0	0.3	0	0	0.1	0.1	0	16	a
Mali	85.4	67.1	58.4	58.6	55.2	0	0	3.4	0	0	0	0	0	2.9	43.8	0	79.6	a
Malta	0	1.2	5.6	7.4	0.3	1.7	0.4	0	0	0	4.9	0	0	0.8	0.3	0.3	20.3	b
Marshall Islands	19.6	13.3	11.3	11.8	11.4	0	0	0	0	0	0.4	0	0	0	0.2	0	1.7	a
Martinique	1.7	2.5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Mauritania	44.4	34	28.9	23.3	22.3	0	0	0	0	0.6	0.5	0	0	0.7	13.8	0	62.1	a
Mauritius	20.4	13.6	11.5	9.7	7.8	0	0.2	0.9	0	0.1	0.7	0	0	2.2	1.2	0	34.6	b
Mayotte	16.2	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	

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	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Tide	Wind	Solar	Geothermal	Municipal waste (renew)	Electricity consump-tion (1)	Heat raising (2)	Transport (3)		
	2000	2010	2015	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	
Mexico	12.2	9.4	9.2	9.5	6.2	0	0	2	0	0.6	0.3	0.4	0	155.9	311.1	0.6	4903	b
Micronesia (Federated States of)	2	1.8	1.4	1.6	1.2	0	0	0	0	0	0.3	0	0	0	0	0	1.4	a
Mongolia	5.7	4.5	3.6	3.5	2.6	0	0	0.1	0	0.7	0.1	0	0	1.4	3.8	0	147.8	b
Montenegro	..	49.1	43	38.1	22.7	0	0	14.1	0	1.3	0	0	0	4.6	6.9	0	30.2	b
Montserrat	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	10.4	7.9	0	0	0.6	0	1.7	0.2	0	0	16.3	51.6	0.2	653.4	b
Mozambique	93.6	84.3	79.1	59.5	41.5	0	0	18	0	0	0	0	0	43	99.4	0	239.6	b
Myanmar	80.2	84.9	70.6	60.6	56.3	0	0	4.3	0	0	0	0	0	34.5	455.8	0	809.4	b
Namibia	36.1	28.9	28	28.1	9.6	0	0	18.4	0	0	0.2	0	0	14	7.4	0	76.3	b
Nauru	0	0.1	0.1	0.8	0	0	0	0	0	0	0.8	0	0	0	0	0	0.5	a
Nepal	88.3	87.3	85	76.6	70.8	0	2.1	3.7	0	0	0	0	0	20.5	408.8	0	560.8	b
Netherlands	1.8	3.9	5.8	6.5	2.1	0.7	0.4	0	0	1.8	0.4	0.2	0.9	55.5	53.8	13.9	1895.2	b
New Caledonia	7.5	4.8	5.1	5.1	0.3	0	0	3.6	0	0.5	0.7	0	0	1.5	0.2	0	34.9	a
New Zealand	29	31.6	31.1	30.4	8.4	0	0.2	14.5	0	1.2	0.1	6	0	113.5	54	0.3	551.5	b
Nicaragua	58.4	52.5	48.6	47.2	42.3	0	0	1.2	0	1.6	0	1.9	0	7	43.3	0	106.5	b
Niger	87.6	80.7	78.9	79.5	79.5	0	0	0	0	0	0	0	0	0	96.4	0	121.4	b
Nigeria	86.2	86.9	82.3	82.5	82.3	0	0	0.3	0	0	0	0	0	16	4512.9	0	5486.4	b
Niue	0.6	26.7	22.4	22.4	0.5	0	0	0	0	0	21.9	0	0	0	0	0	0.1	a
North Macedonia	19.4	22.4	24	19.1	12.3	0	0.3	5.6	0	0.6	0.1	0.3	0	5.1	9.8	0	77.9	b
Northern Mariana Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.1	a
Norway	60.2	56.6	58.5	61.2	4.7	2.8	0.2	51.7	0	1	..	0	0.8	397.1	42.1	24.4	757.9	b
Oman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	770.6	b
Pakistan	51	46.8	45.2	41.4	38.9	0	0	2.3	0	0.2	0.1	0	0	93.2	1401	0	3609.2	b
Palau	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.3	a
Panama	27.7	19.9	21.2	22.8	7.5	0	0	14	0	1	0.3	0	0	23	11.1	0	149.6	b
Papua New Guinea	66.4	55.3	50.9	49.7	46.3	0	0	2.3	0	0	0	1.1	0	4.1	56.2	0	121.3	a
Paraguay	70.4	63.6	61	60.1	42	2.4	0	15.8	0	0	0	0	0	41.6	110.8	6.3	264	b
Peru	32.2	30.5	25	27.7	13.4	2	0	11.6	0	0.4	0.3	0	0	99.3	105.6	14.1	790.8	b

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	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Tide	Wind	Solar	Geothermal	Municipal waste (renew)	Electricity consump-tion (1)	Heat raising (2)	Transport (3)		
	2000	2010	2015	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	
Philippines	34.8	28.8	25.9	23.4	16.9	1.6	0	2.1	0	0.2	0.3	2.3	0	68.7	226.2	19.4	1343.5	b
Poland	6.9	9.5	11.9	11.1	8	0.9	0.3	0.3	0	1.5	0.1	0	0.1	67.7	226.7	27	2890	b
Portugal	20.1	27.8	27.2	24.4	13	1.7	0.2	2.7	0	5.6	1	0.1	0.2	65	79.9	10.8	637.1	b
Puerto Rico	0.7	0.6	1.8	2.2	0	0	0	0.3	0	1.2	0.8	0	0	1.1	0	0	48.8	a
Qatar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	567.9	b
Republic of Korea	0.7	1.3	2.7	2.8	1.1	0.5	0.1	0.2	0	0.1	0.5	0.1	0.3	62	71.1	22.5	5469.6	b
Republic of Moldova	5.7	19.8	24.7	26.1	25.1	0	0.1	0.8	0	0	0	0	0	1.1	31.4	0	125	b
Réunion	11.7	16.4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Romania	16.4	24.1	23.7	23.4	15.6	1.3	0.1	3.8	0	2	0.5	0.1	0	59.6	148	13.9	947.8	b
Russian Federation	3.5	3.3	3.2	3.2	0.6	0	0	2.6	0	0	0	0	0	419.4	102.1	47.6	17525.4	b
Rwanda	86.7	90.7	86.7	86.7	85.4	0	0	1.3	0	0	0.1	0	0	1.1	68.5	0	80.2	a
Saint Helena	7.1	9.2	12.6	13.1	5.2	0	0	0	0	5.3	2.5	0	0	0	0	0	0.1	a
Saint Kitts and Nevis	26.6	1	1.7	1.8	0	0	0	0	0	1.3	0.5	0	0	0	0	0	1.9	a
Saint Lucia	2.6	2.6	2.6	2.7	2.7	0	0	0	0	0	0	0	0	0	0.1	0	2.9	a
Saint Pierre and Miquelon	0.6	1.3	0.7	0.7	0.7	0	0	0	0	0	0	0	0	0	0	0	0.7	a
Saint Vincent and the Grenadines	8.5	5.1	4.5	3.4	2	0	0	1.4	0	0	0	0	0	0	0.1	0	2.8	a
Samoa	42.5	36	26.9	26.8	22.8	0	0	2.7	0	0.1	1.3	0	0	0.2	0.9	0	4	a
Sao Tome and Principe	54.7	43.8	40.2	38.4	37.4	0	0	1	0	0	0	0	0	0	0.8	0	2.1	a
Saudi Arabia	0	0	0	0	0	0	0	0	0	0	0	0	0	0.4	0.3	0	4671	b
Senegal	47.5	50.3	40	37.6	36.5	0	0	0.8	0	0	0.3	0	0	1.6	47.1	0	129.5	b
Serbia	22.1	20.6	21.2	19.9	12.4	0	0.2	7.2	0	0	0	0.1	0	25.5	44.2	0.3	351.6	b
Seychelles	0.6	0.7	1.4	0.6	0	0	0	0	0	0.4	0.2	0	0	0	0	0	5	a
Sierra Leone	90.4	84.2	77.9	77.5	76.6	0	0	1	0	0	0	0	0	0.6	42.5	0	55.5	a
Singapore	0.3	0.5	0.6	0.7	0.2	0	0	0	0	0	0.1	0	0.4	3.3	0	0.2	498.6	b
Sint Maarten (Dutch part)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.9	a
Slovakia	3.7	10.3	13.4	12.4	5.9	1.5	0.9	3.5	0	0	0.5	0	0.1	21.6	23.5	6.8	417	b
Slovenia	15.9	19.5	20.8	20.4	11.7	0.9	0.3	5.8	0	0	0.7	1	0	13.3	26	2	202.5	b
Solomon Islands	55.2	45	48.5	48.7	48.6	0	0	0	0	0	0.1	0	0	0	3.2	0	6.6	a

UN country name	Share in total final energy consumption (%)													Final consumption of renewable energy (PJ)			Total final energy consumption (PJ)	
	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	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	
Somalia	93.3	93.6	94.5	94.9	94.9	0	0	0	0	0	0	0	0	0	107.3	0	113.1	a
South Africa	16	10.1	9.7	10	8.8	0	0	0.1	0	0.5	0.6	0	0	26.2	240.6	0.5	2684	b
South Sudan	..	..	26.2	27.9	27.9	0	0	0	0	0	0.1	0	0	0	5.5	0	19.8	b
Spain	7.9	14.4	16.3	15.6	5.6	1.6	0.2	1.8	0	4.6	1.7	0	0.1	266.8	188.5	58.8	3292.7	b
Sri Lanka	64.2	61.8	52.9	48.4	45.1	0	0	2.9	0	0.3	0.1	0	0	14	190.3	0	422.2	b
State of Palestine	17.5	14.1	11	12.4	5.9	0	0	0	0	0	6.5	0	0	1.6	6.8	0	68	a
Sudan	80.4	61.3	63	60.5	54.7	0	0	5.8	0	0	0	0	0	30.4	287.6	0	526	b
Suriname	23.6	22.4	22.7	21.6	5	0	0	16.5	0	0	0.1	0	0	3.8	1.1	0	23	b
Sweden	40	46	53.1	52.3	26.9	5	0.5	13.9	0	3.8	0.1	0	2.2	260	350.1	73.5	1307.1	b
Switzerland	18.2	20.4	23.9	24.7	5.2	0.7	0.4	15.7	0	0.1	1.1	0	1.5	125	50.6	12.6	760.9	b
Syrian Arab Republic	2	1.4	0.6	1.1	0.1	0	0	1	0	0	0	0	0	2	0.2	0	197.3	b
Tajikistan	62.4	61.8	48.1	41.7	0	0	0	41.7	0	0	0	0	0	46.8	0	0.1	112.5	b
Thailand	22	22.7	22.7	22.7	17.6	2.3	0.9	1.1	0	0.1	0.5	0	0.1	109.4	539.3	74.6	3187.1	b
Timor-Leste	0	34.7	18.2	19	19	0	0	0	0	0	0	0	0	0	0.8	0	4.3	a
Togo	77.1	65.8	70.9	71	66.8	0	0	4.2	0	0	0	0	0	4.3	66.4	0	99.5	b
Tonga	2.5	1	1.9	1.5	0.7	0	0	0	0	0	0.7	0	0	0	0	0	1.8	a
Trinidad and Tobago	0.8	0.3	0.3	0.4	0.4	0	0	0	0	0	0	0	0	0	0.5	0	128.9	b
Tunisia	14.2	12.7	12.6	11.9	10.8	0	0	0	0	0.4	0.8	0	0	1.7	38.5	0	337.5	b
Turkey	17.3	14.2	13.3	11.4	2.4	0.1	0.2	4.1	0	1.3	1	2.3	0	258.4	214	6.1	4195.5	b
Turkmenistan	0.1	0.1	0.1	0.1	0.1	0	0	0	0	0	0	0	0	0	0.4	0	752.6	b
Turks and Caicos Islands	0.7	0.5	0.6	1	0.5	0	0	0	0	0	0.5	0	0	0	0	0	1.3	a
Tuvalu	0	0	8.2	13.5	0	0	0	0	0	0.8	12.7	0	0	0	0	0	0.1	a
Uganda	93.9	91.6	89	88.5	86.8	0	0	1.7	0	0	0	0	0	9.9	484.9	0	559	a
Ukraine	1.3	2.9	4.1	6.5	4.9	0.1	0	1.2	0	0.1	0.1	0	0	28	96.7	3.7	1984.4	b
United Arab Emirates	0.1	0.1	0.1	0.2	0.1	0	0	0	0	0	0.1	0	0	2.4	1.9	0	2062.7	b
United Kingdom of Great Britain and Northern Ireland	1	3.7	8.5	10	3.8	0.8	0.7	0.4	0	3.2	0.8	0	0.3	315.4	141.2	44.2	5017.7	b
United Republic of Tanzania	93.7	88.3	83.6	83.8	82.9	0	0	0.9	0	0	0	0	0	6.4	612.3	0	738.4	b
United States of America	5.4	7.4	9.1	9.9	3.1	2.9	0.1	1.7	0	1.4	0.5	0.1	0.1	2260	1847.2	1599.1	57574.1	b

UN country name	Share in total final energy consumption (%)													Final consumption of renewable energy (PJ)			Total final energy consumption (PJ)	
	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Tide	Wind	Solar	Geothermal	Municipal waste (renew)	Electricity consump-tion (1)	Heat raising (2)	Transport (3)		
	2000	2010	2015	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	
United States Virgin Islands	0	0	3.9	3.5	0	0	0	0	0	0	3.5	0	0	0.1	0	0	1.8	a
Uruguay	38.8	52.8	58.9	60.2	41.5	1.7	0	11.1	0	5.6	0.4	0	0	38.5	75.8	2.9	194.7	b
Uzbekistan	0.8	1.7	1.8	2.4	0	0	0	2.4	0	0	0	0	0	21.5	0.2	0.6	915.9	b
Vanuatu	48.7	38.4	36.4	36.1	33.2	0.8	0	1	0	0.8	0.3	0	0	0.1	0.8	0	2.4	a
Venezuela (Bolivarian Republic of)	14.4	11.5	13.7	14.8	2.1	0	0	12.7	0	0	0	0	0	155	25.3	0	1219.6	b
Viet Nam	58	34.6	30.7	32	21.4	0	0	10.5	0	0	0	0	0	279.9	569.4	0	2656	b
Wallis and Futuna Islands	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	2.4	4.9	2.7	0	0	0	0	0	2.1	0	0	2	2.6	0	94.2	b
Zambia	89.9	92.4	88	84.5	75	0	0	9.5	0	0	0	0	0	37.6	297.3	0.1	396.4	b
Zimbabwe	69.3	82.2	81.6	83.3	79.5	0.3	0	3.5	0	0	0	0	0	15.2	329.5	1	415.1	b
World	17.2	16.3	17	17.3	10.8	1	0.2	3.3	0	0.9	0.7	0.2	0.1	18470.7	41312.6	3821.7	367161.2	c
Northern America (M49) and Europe (M49)	7.4	10	12	12.5	4.7	1.9	0.3	3.2	0	1.5	0.6	0.1	0.2	7533.4	6456.9	2514.8	131571.3	c
Northern America (M49)	7.3	9.1	10.7	11.6	3.4	2.7	0.1	3.3	0	1.4	0.5	0.1	0.1	3558.4	2248.7	1699	64911	c
Europe (M49)	7.4	10.8	13.2	13.5	6	1	0.5	3.1	0	1.6	0.7	0.1	0.3	3939.3	4206.6	829.3	66660.3	c
Latin America and the Caribbean (MDG=M49)	28	28.5	28.1	29.4	15.8	3.3	0	9	0	0.8	0.3	0.1	0	2611.7	3665	804.3	24087.2	c
Central Asia (M49) and Southern Asia (MDG=M49)	37.8	30.6	27.2	25.8	23.3	0	0	1.8	0	0.4	0.3	0	0	1036.1	9091.5	29.2	39312.5	c
Central Asia (M49)	3.7	3.1	3.1	3.4	0.1	0	0	3.3	0	0	0	0	0	115.7	2.7	4.9	3612.4	c
Southern Asia (MDG=M49)	43	34.1	29.9	28.1	25.7	0	0	1.6	0	0.4	0.3	0	0	912.9	9088.8	25.2	35700.1	c
Eastern Asia (M49) and South-eastern Asia (MDG=M49)	23.2	13.6	13.9	14.4	7	0.3	0.3	4	0	0.8	1.4	0.5	0	6366.8	9255.8	438.9	111811.7	c
Eastern Asia (M49)	19.9	10.5	11	11.6	3.8	0.1	0.3	4.1	0	1	1.7	0.5	0	5619.2	4979.4	248.3	93843.6	c
South-eastern Asia (MDG=M49)	38.4	31.7	29.3	29	23.9	1.1	0.2	3.3	0	0	0.1	0.4	0	748.7	4276.4	190.1	17968.1	c
Western Asia (M49) and Northern Africa (M49)	8.4	6.2	5.5	5.3	2.8	0	0	1.3	0	0.3	0.4	0.4	0	397.7	749.4	6.4	21662.2	c
Western Asia (M49)	6.1	4.5	3.9	3.8	0.9	0	0	1.3	0	0.3	0.5	0.6	0	309.1	289.2	5.8	16065.5	c

UN country name	Share in total final energy consumption (%)													Final consumption of renewable energy (PJ)			Total final energy consumption (PJ)	
	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Tide	Wind	Solar	Geothermal	Municipal waste (renew)	Electricity consump-tion (1)	Heat raising (2)	Transport (3)		
	2000	2010	2015	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	
Northern Africa (M49)	14.9	11.2	10.2	9.8	8.2	0	0	1.2	0	0.3	0.1	0	0	88.7	460.4	0.7	5596.7	c
Sub-Saharan Africa (M49)	72.3	70.7	68.5	68.5	66.6	0	0	1.6	0	0.1	0.1	0.1	0	329.1	11767	4.7	17658.1	c
Oceania (M49)	13.1	12.7	13.5	13.7	7.2	0.1	0.1	3.2	0	1.1	1	0.8	0	229.8	306.1	9.6	3993.7	c
Oceania (M49) excluding Australia and New Zealand (M49)	48	38.6	35.8	34.7	30.7	0	0	3	0	0.1	0.3	0.6	0	8.6	67	0	217.9	c
Australia and New Zealand (M49)	11.4	11.3	12.2	12.4	5.9	0.1	0.2	3.2	0	1.2	1.1	0.8	0	221	239.1	9.7	3775.9	c
Least Developed Countries (LDCs)	83.8	75.6	72.7	70.8	67.5	0	0.1	3.2	0	0	0	0	0	353.9	7362.2	0.2	10898.2	c
Small island developing States (SIDS)	23.9	17.5	17.9	18	15.8	0.6	0	1	0	0.2	0.2	0.1	0.1	36	310.9	2.3	1945	c
Landlocked developing countries (LLDCs)	43.4	42.5	43.5	44	39.5	0.1	0.1	4.3	0	0	0	0	0	410.5	3837.4	17.7	9699.7	c
Africa (M49)	60.5	56.1	54.6	54.4	52.6	0	0	1.5	0	0.2	0.1	0.1	0	416.3	12225.2	5	23254.8	c
Asia (M49)	25.2	16.8	15.9	16	10.3	0.2	0.2	3.2	0	0.7	1.1	0.4	0	7660.7	18637.4	464.6	167189.7	c
Americas (m49)	11.7	14.2	15.5	16.5	6.8	2.9	0.1	4.9	0	1.2	0.4	0.1	0	6242.4	5913.5	2503.7	88998.2	c
Caribbean (M49)	23.4	17.7	20.1	20.7	18.4	1	0	0.7	0	0.4	0.2	0	0	16.3	203	1.5	1068.3	c
Central America (M49)	18.1	16.2	16.5	17.3	12.9	0	0	2.9	0	0.7	0.3	0.5	0	279.9	780	0.9	6126.7	c
Eastern Africa (M49)	87.8	87.2	84.2	82.8	79.4	0	0	3.1	0	0.1	0	0.3	0	185.7	4247.6	1.3	5352.8	c
Eastern Europe (M49)	4.3	5.7	6.3	6.4	3.4	0.3	0.1	2.2	0	0.3	0.1	0	0	659.4	923.2	126.2	26748.5	c
Melanesia (M49)	54.5	43.3	39.8	38.5	34.5	0	0	3	0	0.1	0.1	0.7	0	7.4	65.3	0	188.9	c
Micronesia (M49)	5.1	5.5	5.9	6.7	5.3	0	0	0	0	0	1.4	0	0	0.2	0.7	0	14	c
Middle Africa (M49)	88	78.4	77.9	82.4	79.3	0	0	3	0	0	0.1	0	0	66.9	1716.8	0	2164.2	c
Northern Europe (M49)	15.4	19.1	25.7	27.1	11.8	1.7	0.6	8	0	3.2	0.5	0.5	0.8	1347.2	1111	183.3	9753.3	c
Polynesia (M49)	16.6	15.7	12.9	13.1	6.3	0	0	5.6	0	0	1.1	0	0	1	1	0	15	c
South America (M49)	32.3	33.5	32.6	34.2	16.7	4.7	0	11.6	0	0.9	0.3	0	0	2293.7	2682	802.2	16892.2	c
Southern Africa (M49)	18.3	12.2	11.5	11.5	10.2	0	0	0.3	0	0.5	0.6	0	0	33.9	303.1	0.6	2923.5	c
Southern Europe (M49)	8.7	15.4	18.1	17.3	7.6	1.3	0.5	3	0	2.7	1.8	0.3	0.2	842	828.1	142	10452.8	c
Western Africa (M49)	83.3	82	77.2	76.9	76.2	0	0	0.6	0	0	0	0	0	47.9	5500	0	7217.6	c

UN country name	Share in total final energy consumption (%)													Final consumption of renewable energy (PJ)			Total final energy consumption (PJ)	
	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Tide	Wind	Solar	Geothermal	Municipal waste (renew)	Electricity consump-tion (1)	Heat raising (2)	Transport (3)		
	2000	2010	2015	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	2017	
Western Europe (M49)	6.7	11.2	14.2	15	6	1.6	1.1	2.2	0	2.3	1.1	0.1	0.6	1252.5	1358.9	344.5	19705.7	c
Developing regions (MDG)	32.8	23.5	22.4	22.5	16.3	0.6	0.2	3.7	0	0.7	0.8	0.3	0	10145.9	34396.4	1262.1	203302.1	c
Developed regions (MDG)	7.2	9.6	11.5	12.1	4.6	1.7	0.3	3.2	0	1.4	0.7	0.1	0.2	8326.3	6896.2	2550.9	146794.6	c
Northern Africa (MDG)	7.2	5.4	4.8	4.6	3.4	0	0	0.8	0	0.3	0.1	0	0	61.9	172.9	0.5	5070.7	c
Sub-Saharan Africa (MDG)	72.5	70.4	68.3	68.3	66.3	0	0	1.7	0	0.1	0.1	0.1	0	357.5	12054.6	4.9	18184.1	c
Eastern Asia (MDG)	25.4	11.5	11.6	12.1	4	0.1	0.4	4.3	0	1.1	1.7	0.5	0	5063.4	4801.5	221	83033.9	c
Western Asia (MDG)	5.7	3.9	3.7	3.5	0.8	0	0	1.2	0	0.4	0.4	0.6	0	264.1	244.2	5.1	14837	c
Oceania (MDG)	48	38.6	35.8	34.7	30.7	0	0	3	0	0.1	0.3	0.6	0	8.6	67	0	217.9	c
Caucasus and Central Asia (MDG)	4.8	4.2	4	4.3	0.6	0	0	3.7	0	0	0	0	0	151.1	25.8	5.9	4203.1	c

REFERENCE
a. Source: Energy Balances, UN Statistics Division (2019)
b. Source: IEA (2019), World Energy Balances
c. Sources: IEA (2019), World Energy Balances; Energy Balances, UN Statistics Division (2019)

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

UN country name	Energy intensity (MJ/USD 2011 PPP)				Compound annual growth rate of Energy intensity (%)			Source
	2000	2010	2015	2017	2000-2010	2010-2015	2015-2017	
Afghanistan	1.7	2.8	2.2	1.9	5.0%	-4.4%	-7.0%	*a*
Albania	4.5	3.1	2.9	2.9	-3.7%	-1.2%	0.2%	*b*
Algeria	3.6	3.6	4.2	4.1	0.2%	2.8%	-1.2%	*b*
American Samoa	..	..	..	..	..	..	..	
Andorra	..	..	..	..	..	..	..	
Angola	4.5	3.2	3.5	3.4	-3.4%	1.8%	-0.6%	*b*
Anguilla	..	..	..	..	..	..	..	
Antigua and Barbuda	2.8	3.6	3.5	3.2	2.6%	-0.7%	-3.1%	*a*
Argentina	4.7	4.3	4.3	4.3	-0.9%	0.2%	-0.5%	*b*
Armenia	9.4	5.4	5.2	5.2	-5.4%	-0.7%	-0.3%	*b*
Aruba	6.8	7.9	3.4	3.4	1.6%	-15.5%	0.4%	*a*
Australia	6.7	5.8	5.1	4.8	-1.4%	-2.8%	-2.3%	*b*
Austria	3.9	3.9	3.6	3.5	0.1%	-1.7%	-1.0%	*b*
Azerbaijan	12.8	3.3	3.7	3.8	-12.6%	2.3%	1.6%	*b*
Bahamas	2.8	3.3	2.7	2.6	1.8%	-4.0%	-1.3%	*a*
Bahrain	11.2	10.5	9.9	9.1	-0.6%	-1.3%	-4.1%	*b*
Bangladesh	3.6	3.4	3.1	2.9	-0.6%	-1.6%	-3.4%	*b*
Barbados	3.8	4.4	3.6	3.3	1.5%	-3.8%	-5.0%	*a*
Belarus	13.7	7.5	6.5	6.5	-5.9%	-2.8%	0.6%	*b*
Belgium	6.4	5.6	4.7	4.8	-1.3%	-3.6%	1.0%	*b*
Belize	6.4	5.1	5.5	5.5	-2.3%	1.5%	0.6%	*a*
Benin	7.3	9.3	8.8	9.2	2.5%	-1.1%	2.5%	*b*
Bermuda	2.3	2.4	..	..	0.5%	..	..	
Bhutan	21.8	12.2	10.5	9.7	-5.7%	-2.9%	-3.7%	*a*
Bolivia (Plurinational State of)	5.6	4.9	5.0	4.9	-1.3%	0.2%	-0.5%	*b*
Bonaire, Sint Eustatius and Saba	..	..	..	..	..	..	..	
Bosnia and Herzegovina	7.6	7.5	6.7	6.9	-0.2%	-2.3%	1.4%	*b*

UN country name	Energy intensity (MJ/USD 2011 PPP)				Compound annual growth rate of Energy intensity (%)			Source
	2000	2010	2015	2017	2000-2010	2010-2015	2015-2017	
Botswana	4.3	3.4	3.4	3.3	-2.2%	-0.1%	-2.2%	*b*
Brazil	3.9	3.9	4.1	4.1	-0.1%	1.0%	0.1%	*b*
British Virgin Islands	..	..	..	..	..	..	..	
Brunei Darussalam	3.7	4.3	3.7	4.9	1.7%	-3.4%	16.0%	*b*
Bulgaria	10.8	6.6	6.4	6.0	-4.8%	-0.7%	-3.3%	*b*
Burkina Faso	6.6	6.5	6.0	5.7	-0.1%	-1.8%	-2.3%	*a*
Burundi	12.0	9.1	8.5	8.7	-2.7%	-1.4%	1.4%	*a*
Cabo Verde	2.7	3.2	2.8	2.9	1.5%	-2.7%	1.6%	*a*
Cambodia	8.5	6.2	5.8	5.8	-3.1%	-1.4%	0.2%	*b*
Cameroon	6.6	5.0	5.1	4.8	-2.8%	0.4%	-3.1%	*b*
Canada	9.2	7.9	7.7	7.6	-1.6%	-0.6%	-0.7%	*b*
Cayman Islands	2.0	2.2	2.0	2.0	1.0%	-1.9%	-1.0%	*a*
Central African Republic	7.2	5.2	7.3	6.7	-3.2%	6.8%	-4.3%	*a*
Chad	7.4	3.5	2.7	3.3	-7.3%	-4.7%	8.9%	*a*
Chile	4.8	3.9	3.7	3.9	-2.1%	-1.0%	2.4%	*b*
China	10.2	8.4	6.8	6.1	-1.9%	-4.2%	-5.2%	*b*
China, Hong Kong Special Administrative Region	2.5	1.7	1.6	1.4	-3.9%	-1.0%	-6.1%	*b*
China, Macao Special Administrative Region	1.3	0.6	0.7	0.7	-7.3%	3.9%	0.0%	*a*
Colombia	3.2	2.6	2.6	2.5	-2.0%	-0.3%	-2.1%	*b*
Comoros	2.5	2.8	2.7	3.1	1.0%	-0.9%	7.4%	*a*
Congo	2.1	3.1	4.3	4.8	4.1%	6.9%	5.2%	*b*
Cook Islands	..	..	..	..	..	..	..	
Costa Rica	3.1	3.2	2.9	2.8	0.4%	-1.9%	-3.0%	*b*
Côte d'Ivoire	5.8	6.3	5.4	5.0	0.9%	-3.1%	-3.8%	*b*
Croatia	5.0	4.4	4.0	3.9	-1.3%	-2.0%	-1.1%	*b*
Cuba	4.3	2.3	1.9	1.8	-6.1%	-3.2%	-2.9%	*b*
Curaçao	22.5	20.4	20.5	17.5	-1.0%	0.1%	-7.5%	*b*
Cyprus	4.4	3.6	3.2	3.3	-1.9%	-2.3%	0.3%	*b*
Czechia	7.9	6.4	5.5	5.3	-2.2%	-3.0%	-1.8%	*b*

UN country name	Energy intensity (MJ/USD 2011 PPP)				Compound annual growth rate of Energy intensity (%)			Source
	2000	2010	2015	2017	2000-2010	2010-2015	2015-2017	
Democratic People's Republic of Korea	6.9	5.7	3.0	5.8	-1.8%	-12.0%	38.0%	*b*
Democratic Republic of the Congo	21.6	19.5	19.5	19.0	-1.0%	0.0%	-1.5%	*b*
Denmark	3.5	3.3	2.6	2.6	-0.3%	-4.7%	-0.2%	*b*
Djibouti	5.6	4.8	2.8	2.6	-1.5%	-9.9%	-5.2%	*a*
Dominica	2.9	3.5	3.6	3.6	1.9%	0.8%	0.0%	*a*
Dominican Republic	4.4	2.9	2.5	2.3	-4.1%	-3.0%	-2.9%	*b*
Ecuador	4.0	3.5	3.6	3.5	-1.1%	0.3%	-2.0%	*b*
Egypt	3.3	3.7	3.5	3.8	1.3%	-1.0%	3.6%	*b*
El Salvador	4.0	4.6	3.9	3.7	1.4%	-3.3%	-2.3%	*b*
Equatorial Guinea	1.4	2.6	2.0	1.8	5.9%	-5.0%	-5.7%	*a*
Eritrea	5.2	5.0	4.4	4.3	-0.4%	-2.7%	-0.8%	*b*
Estonia	9.0	7.8	6.3	6.1	-1.4%	-4.2%	-1.8%	*b*
Eswatini	6.6	5.0	4.7	4.1	-2.8%	-1.2%	-7.0%	*a*
Ethiopia	25.1	14.8	10.8	9.7	-5.1%	-6.1%	-5.4%	*b*
Falkland Islands (Malvinas)	..	..	..	..	..	..	..	
Faroe Islands	..	..	..	..	..	..	..	
Fiji	4.0	3.4	4.8	4.2	-1.6%	7.1%	-6.7%	*a*
Finland	7.5	7.2	6.3	6.1	-0.5%	-2.4%	-1.6%	*b*
France	5.0	4.6	4.2	4.0	-0.8%	-1.9%	-2.5%	*b*
French Guiana	..	..	..	..	..	..	..	
French Polynesia	..	..	..	..	..	..	..	
Gabon	2.8	8.5	6.7	6.3	11.6%	-4.4%	-3.2%	*b*
Gambia	4.9	4.4	4.6	4.4	-1.0%	0.6%	-1.7%	*a*
Georgia	8.4	5.0	5.8	5.6	-5.1%	3.1%	-1.8%	*b*
Germany	4.7	4.1	3.6	3.5	-1.2%	-2.8%	-1.7%	*b*
Ghana	6.2	4.2	3.7	3.3	-3.8%	-2.5%	-6.1%	*b*
Gibraltar	..	..	..	..	..	..	..	
Greece	4.2	3.6	3.7	3.7	-1.5%	0.5%	-0.5%	*b*
Greenland	..	..	..	..	..	..	..	
Grenada	3.0	3.4	3.0	2.9	1.4%	-2.6%	-1.5%	*a*

UN country name	Energy intensity (MJ/USD 2011 PPP)				Compound annual growth rate of Energy intensity (%)			Source
	2000	2010	2015	2017	2000-2010	2010-2015	2015-2017	
Guadeloupe	..	..	..	..	..	..	..	
Guam	..	..	..	..	..	..	..	
Guatemala	4.2	4.7	4.5	4.6	1.2%	-1.0%	1.2%	*b*
Guernsey	..	..	..	..	..	..	..	
Guinea	10.2	8.7	7.1	5.9	-1.7%	-4.0%	-9.0%	*a*
Guinea-Bissau	13.7	12.8	11.8	10.8	-0.6%	-1.5%	-4.4%	*a*
Guyana	9.7	7.9	6.4	6.4	-2.1%	-4.2%	0.4%	*a*
Haiti	5.7	10.6	10.3	10.4	6.5%	-0.5%	0.0%	*b*
Honduras	5.8	5.9	6.4	6.0	0.2%	1.5%	-3.2%	*b*
Hungary	5.7	5.0	4.3	4.2	-1.4%	-2.9%	-0.4%	*b*
Iceland	13.3	17.8	16.0	13.9	2.9%	-2.1%	-6.6%	*b*
India	6.5	5.3	4.7	4.2	-1.9%	-2.7%	-4.6%	*b*
Indonesia	5.3	4.2	3.5	3.5	-2.3%	-3.6%	-0.9%	*b*
Iran (Islamic Republic of)	5.9	6.4	7.6	7.1	0.7%	3.5%	-3.2%	*b*
Iraq	3.8	3.9	3.7	4.3	0.4%	-1.4%	8.5%	*b*
Ireland	3.7	3.0	2.0	1.8	-2.3%	-7.9%	-4.2%	*b*
Isle of Man	..	..	..	..	..	..	..	
Israel	4.5	4.3	3.5	3.3	-0.5%	-3.9%	-2.9%	*b*
Italy	3.5	3.4	3.1	3.0	-0.2%	-2.0%	-1.1%	*b*
Jamaica	6.9	4.6	4.8	4.8	-4.0%	0.6%	0.1%	*b*
Japan	5.1	4.6	3.8	3.7	-1.0%	-3.9%	-1.2%	*b*
Jersey	..	..	..	..	..	..	..	
Jordan	5.5	4.4	4.6	4.8	-2.3%	1.3%	1.5%	*b*
Kazakhstan	10.1	8.8	7.9	8.2	-1.3%	-2.1%	1.7%	*b*
Kenya	8.7	8.1	7.9	7.6	-0.8%	-0.3%	-2.1%	*b*
Kiribati	5.5	7.4	6.3	6.3	3.0%	-3.3%	0.2%	*a*
Kuwait	5.5	6.0	5.4	5.3	0.9%	-2.1%	-0.4%	*b*
Kyrgyzstan	9.6	7.6	8.7	7.7	-2.3%	2.7%	-6.0%	*b*
Lao People's Democratic Republic	4.4	3.8	4.4	5.4	-1.3%	3.0%	10.9%	*a*
Latvia	6.1	4.9	3.9	3.8	-2.0%	-4.5%	-1.7%	*b*
Lebanon	5.1	3.8	4.5	4.8	-2.9%	3.6%	3.2%	*b*

UN country name	Energy intensity (MJ/USD 2011 PPP)				Compound annual growth rate of Energy intensity (%)			Source
	2000	2010	2015	2017	2000-2010	2010-2015	2015-2017	
Lesotho	14.4	10.7	8.0	8.0	-2.9%	-5.8%	0.3%	*a*
Liberia	13.0	17.5	16.8	17.6	3.0%	-0.8%	2.5%	*a*
Libya	5.6	4.6	6.9	4.9	-2.1%	8.4%	-15.4%	*b*
Liechtenstein	..	..	..	..	..	..	..	
Lithuania	7.0	4.5	3.8	3.8	-4.3%	-3.6%	0.1%	*b*
Luxembourg	3.9	3.8	2.9	2.9	-0.3%	-5.1%	-1.4%	*b*
Madagascar	6.7	6.9	7.6	8.9	0.2%	2.1%	8.0%	*a*
Malawi	6.6	4.8	4.2	4.1	-3.1%	-2.8%	-0.8%	*a*
Malaysia	5.4	5.1	4.6	4.2	-0.5%	-2.0%	-4.8%	*b*
Maldives	2.4	3.1	3.2	3.3	2.6%	1.1%	0.2%	*a*
Mali	3.5	2.8	2.8	2.6	-2.3%	0.2%	-4.7%	*a*
Malta	3.0	3.0	1.8	1.6	0.1%	-10.1%	-3.2%	*b*
Marshall Islands	10.5	11.7	11.4	11.0	1.1%	-0.5%	-1.6%	*a*
Martinique	..	..	..	..	..	..	..	
Mauritania	3.9	3.7	4.0	4.6	-0.3%	1.4%	7.6%	*a*
Mauritius	3.2	2.8	2.5	2.3	-1.3%	-1.8%	-4.3%	*b*
Mayotte	..	..	..	..	..	..	..	
Mexico	4.0	4.1	3.6	3.4	0.2%	-2.2%	-3.6%	*b*
Micronesia (Federated States of)	5.8	4.5	6.2	6.1	-2.4%	6.6%	-1.0%	*a*
Mongolia	9.0	7.9	5.7	5.9	-1.3%	-6.2%	1.7%	*b*
Montenegro	..	5.4	4.5	4.2	..	-3.9%	-3.3%	*b*
Montserrat	..	..	..	..	..	..	..	
Morocco	3.5	3.4	3.2	3.2	-0.5%	-1.2%	0.0%	*b*
Mozambique	29.4	13.3	14.2	13.2	-7.6%	1.4%	-3.8%	*b*
Myanmar	8.9	3.1	2.9	3.2	-10.0%	-1.4%	4.7%	*b*
Namibia	3.8	3.6	3.3	3.5	-0.4%	-1.5%	2.2%	*b*
Nauru	17.1	8.8	4.7	3.5	-6.4%	-12.0%	-13.0%	*a*
Nepal	9.3	8.0	7.4	7.8	-1.5%	-1.5%	2.9%	*b*
Netherlands	4.7	4.5	3.8	3.7	-0.3%	-3.4%	-1.1%	*b*
New Caledonia	..	..	..	..	..	..	..	
New Zealand	6.6	5.5	5.4	5.0	-1.9%	-0.5%	-3.1%	*b*
Nicaragua	6.1	5.4	5.4	5.0	-1.3%	0.0%	-3.2%	*b*

UN country name	Energy intensity (MJ/USD 2011 PPP)				Compound annual growth rate of Energy intensity (%)			Source
	2000	2010	2015	2017	2000-2010	2010-2015	2015-2017	
Niger	7.2	7.0	6.9	6.6	-0.3%	-0.3%	-1.7%	*b*
Nigeria	9.7	6.6	5.9	6.4	-3.8%	-2.3%	4.5%	*b*
Niue	..	..	..	..	..	..	..	
North Macedonia	6.4	5.1	4.2	4.2	-2.2%	-4.0%	0.0%	*b*
Northern Mariana Islands	..	..	..	..	..	..	..	
Norway	4.2	4.0	3.6	3.7	-0.4%	-2.4%	1.1%	*b*
Oman	3.2	5.7	6.3	6.4	6.0%	2.1%	0.6%	*b*
Pakistan	5.5	4.9	4.5	4.4	-1.2%	-1.6%	-0.7%	*b*
Palau	12.3	11.8	10.2	11.0	-0.4%	-3.0%	4.2%	*a*
Panama	3.1	2.6	2.2	2.1	-1.7%	-3.8%	-0.9%	*b*
Papua New Guinea	6.5	6.2	5.4	5.1	-0.4%	-2.9%	-2.3%	*a*
Paraguay	3.8	3.3	3.1	3.7	-1.3%	-1.5%	8.5%	*b*
Peru	3.0	2.8	2.7	2.6	-0.7%	-0.7%	-1.5%	*b*
Philippines	5.1	3.2	3.1	3.1	-4.5%	-0.9%	-0.5%	*b*
Poland	6.6	5.1	4.1	4.2	-2.6%	-4.1%	0.7%	*b*
Portugal	3.9	3.4	3.3	3.3	-1.2%	-0.5%	-0.6%	*b*
Puerto Rico	0.1	0.2	0.4	0.4	7.2%	14.3%	0.0%	*a*
Qatar	7.1	5.2	6.2	5.9	-3.1%	3.5%	-2.7%	*b*
Republic of Korea	8.1	7.0	6.6	6.4	-1.5%	-1.2%	-1.2%	*b*
Republic of Moldova	11.8	9.3	7.7	7.3	-2.4%	-3.7%	-2.5%	*b*
Réunion	..	..	..	..	..	..	..	
Romania	6.5	4.2	3.3	3.0	-4.4%	-4.7%	-3.4%	*b*
Russian Federation	12.5	8.7	8.0	8.3	-3.6%	-1.5%	1.9%	*b*
Rwanda	8.4	6.0	4.8	4.4	-3.4%	-4.2%	-4.9%	*a*
Saint Helena	..	..	..	..	..	..	..	
Saint Kitts and Nevis	3.0	2.6	2.4	2.4	-1.4%	-1.7%	0.0%	*a*
Saint Lucia	3.1	2.7	2.6	2.3	-1.5%	-0.7%	-4.6%	*a*
Saint Pierre and Miquelon	..	..	..	..	..	..	..	
Saint Vincent and the Grenadines	2.8	3.1	2.8	3.3	1.1%	-2.0%	7.9%	*a*
Samoa	4.2	3.9	4.2	4.1	-0.9%	1.8%	-1.4%	*a*
Sao Tome and Principe	5.9	5.2	4.7	4.5	-1.3%	-2.2%	-1.2%	*a*

UN country name	Energy intensity (MJ/USD 2011 PPP)				Compound annual growth rate of Energy intensity (%)			Source
	2000	2010	2015	2017	2000-2010	2010-2015	2015-2017	
Saudi Arabia	4.6	6.2	5.8	5.5	3.1%	-1.4%	-2.8%	*b*
Senegal	4.2	4.7	4.1	3.6	1.1%	-2.5%	-6.5%	*b*
Serbia	9.5	6.7	6.1	6.1	-3.4%	-2.0%	0.2%	*b*
Seychelles	5.4	3.3	2.9	3.2	-4.6%	-2.9%	5.6%	*a*
Sierra Leone	13.1	7.7	7.0	6.5	-5.2%	-1.9%	-4.0%	*a*
Singapore	3.7	2.6	2.8	3.1	-3.4%	1.3%	5.6%	*b*
Sint Maarten (Dutch part)	..	..	9.3	..	..	..	..	
Slovakia	8.8	5.5	4.5	4.4	-4.6%	-4.1%	-0.2%	*b*
Slovenia	5.9	5.2	4.6	4.5	-1.3%	-2.6%	-1.3%	*b*
Solomon Islands	8.7	8.0	6.0	5.5	-0.7%	-5.8%	-4.3%	*a*
Somalia	..	..	..	..	..	..	..	
South Africa	10.5	9.0	7.8	8.0	-1.5%	-2.9%	1.1%	*b*
South Sudan	..	..	1.7	1.5	..	..	-6.5%	*b*
Spain	4.2	3.5	3.3	3.3	-1.7%	-1.3%	-0.2%	*b*
Sri Lanka	3.4	2.4	2.1	2.0	-3.4%	-2.5%	-1.9%	*b*
State of Palestine	3.5	3.5	3.8	3.8	0.1%	1.4%	-0.4%	*a*
Sudan	7.2	4.4	4.7	4.3	-4.8%	1.3%	-3.6%	*b*
Suriname	5.5	3.9	3.3	1.9	-3.4%	-3.3%	-24.4%	*b*
Sweden	6.1	5.3	4.2	4.4	-1.4%	-4.6%	2.4%	*b*
Switzerland	2.9	2.5	2.1	2.0	-1.4%	-3.0%	-2.6%	*b*
Syrian Arab Republic	7.3	6.6	4.1	4.5	-1.0%	-9.0%	4.3%	*b*
Tajikistan	12.2	5.7	5.1	5.2	-7.4%	-2.0%	1.2%	*b*
Thailand	5.2	5.4	5.4	5.1	0.4%	-0.1%	-2.6%	*b*
Timor-Leste	..	0.5	0.9	0.9	..	14.1%	3.9%	*a*
Togo	14.5	16.4	13.3	12.9	1.2%	-4.0%	-1.7%	*b*
Tonga	3.2	3.2	3.0	3.7	-0.1%	-1.1%	10.1%	*a*
Trinidad and Tobago	18.0	20.0	18.4	17.7	1.0%	-1.6%	-1.9%	*b*
Tunisia	4.2	3.9	3.8	3.8	-0.7%	-0.7%	0.4%	*b*
Turkey	3.6	3.4	3.0	3.0	-0.7%	-2.9%	1.3%	*b*
Turkmenistan	25.9	18.8	13.9	12.3	-3.2%	-5.9%	-6.0%	*b*
Turks and Caicos Islands	..	..	3.9	4.0	..	..	1.5%	*a*

UN country name	Energy intensity (MJ/USD 2011 PPP)				Compound annual growth rate of Energy intensity (%)			Source
	2000	2010	2015	2017	2000-2010	2010-2015	2015-2017	
Tuvalu	3.4	3.9	3.8	3.7	1.5%	-0.5%	-1.6%	*a*
Uganda	12.6	10.2	9.8	9.5	-2.1%	-0.8%	-1.4%	*a*
Ukraine	23.8	15.5	12.2	11.2	-4.2%	-4.7%	-4.2%	*b*
United Arab Emirates	4.1	5.4	5.4	4.5	2.8%	-0.2%	-8.5%	*b*
United Kingdom of Great Britain and Northern Ireland	4.8	3.7	3.0	2.8	-2.5%	-4.3%	-3.2%	*b*
United Republic of Tanzania	11.1	7.5	6.3	5.7	-3.8%	-3.4%	-4.8%	*b*
United States of America	7.4	6.1	5.4	5.1	-2.0%	-2.4%	-2.6%	*b*
United States Virgin Islands	..	..	..	..	..	..	..	
Uruguay	3.0	3.0	3.1	3.0	-0.2%	0.7%	-1.0%	*b*
Uzbekistan	34.1	14.7	9.2	7.2	-8.1%	-9.0%	-11.0%	*b*
Vanuatu	4.0	3.9	3.9	3.7	-0.3%	0.0%	-2.9%	*a*
Venezuela (Bolivarian Republic of)	6.1	6.3	5.2	6.0	0.4%	-3.8%	7.6%	*b*
Viet Nam	5.9	6.3	5.9	5.6	0.8%	-1.4%	-3.0%	*b*
Wallis and Futuna Islands	..	..	..	..	..	..	..	
Yemen	2.9	3.1	1.9	2.0	0.8%	-9.6%	4.4%	*b*
Zambia	11.9	8.0	7.8	8.1	-3.8%	-0.6%	1.7%	*b*
Zimbabwe	12.0	16.6	13.7	13.0	3.3%	-3.8%	-2.6%	*b*
World	6.6	5.9	5.2	5.0	-1.2%	-2.2%	-2.2%	*c*
Northern America (M49) and Europe (M49)	6.7	5.6	4.9	4.8	-1.8%	-2.4%	-1.5%	*c*
Northern America (M49)	7.5	6.2	5.6	5.3	-1.9%	-2.2%	-2.4%	*c*
Europe (M49)	6.0	5.1	4.5	4.4	-1.6%	-2.5%	-0.8%	*c*
Latin America and the Caribbean (MDG=M49)	4.1	4.0	3.8	3.7	-0.3%	-0.9%	-1.1%	*c*
Central Asia (M49) and Southern Asia (MDG=M49)	6.7	5.7	5.1	4.7	-1.6%	-2.0%	-3.9%	*c*
Central Asia (M49)	17.6	11.0	8.9	8.3	-4.6%	-4.2%	-3.0%	*c*
Southern Asia (MDG=M49)	6.1	5.3	4.9	4.5	-1.3%	-1.8%	-3.8%	*c*
Eastern Asia (M49) and South-eastern Asia (MDG=M49)	7.1	6.6	5.7	5.3	-0.7%	-3.1%	-3.6%	*c*
Eastern Asia (M49)	7.6	7.2	6.1	5.6	-0.6%	-3.4%	-4.0%	*c*
South-eastern Asia (MDG=M49)	5.3	4.5	4.0	3.9	-1.7%	-2.0%	-1.2%	*c*

UN country name	Energy intensity (MJ/USD 2011 PPP)				Compound annual growth rate of Energy intensity (%)			Source
	2000	2010	2015	2017	2000-2010	2010-2015	2015-2017	
Western Asia (M49) and Northern Africa (M49)	4.3	4.6	4.4	4.2	0.5%	-0.9%	-1.3%	c
Western Asia (M49)	4.5	4.9	4.5	4.4	0.8%	-1.5%	-1.6%	c
Northern Africa (M49)	3.9	3.8	3.9	3.9	-0.3%	0.5%	-0.1%	c
Sub-Saharan Africa (M49)	9.6	7.5	6.7	6.8	-2.4%	-2.1%	0.6%	c
Oceania (M49)	6.7	5.8	5.1	4.9	-1.4%	-2.5%	-2.5%	c
Oceania (M49) excluding Australia and New Zealand (M49)	5.9	5.6	5.3	5.0	-0.4%	-1.3%	-2.9%	c
Australia and New Zealand (M49)	6.7	5.8	5.1	4.8	-1.4%	-2.5%	-2.5%	c
Least Developed Countries (LDCs)	7.8	5.8	5.4	5.3	-3.0%	-1.2%	-1.1%	c
Small island developing States (SIDS)	4.1	3.4	3.3	3.2	-1.9%	-0.9%	-0.3%	c
Landlocked developing countries (LLDCs)	12.5	8.3	7.2	7.0	-4.0%	-3.0%	-1.4%	c
Africa (M49)	7.1	5.9	5.6	5.7	-1.7%	-1.0%	0.2%	c
Asia (M49)	6.6	6.2	5.4	5.0	-0.6%	-2.7%	-3.4%	c
Americas (m49)	6.5	5.5	5.0	4.8	-1.7%	-1.9%	-1.9%	c
Caribbean (M49)	..	..	..	..	..	..	..	
Central America (M49)	4.0	4.1	3.7	3.4	0.2%	-2.1%	-3.3%	c
Eastern Africa (M49)	12.2	9.5	8.3	7.9	-2.5%	-2.6%	-2.5%	c
Eastern Europe (M49)	11.2	7.9	6.9	6.9	-3.5%	-2.6%	0.3%	c
Melanesia (M49)	5.9	5.6	5.3	4.9	-0.4%	-1.4%	-3.1%	c
Micronesia (M49)	8.9	8.4	7.9	7.9	-0.6%	-1.1%	-0.2%	c
Middle Africa (M49)	7.1	5.8	6.1	6.2	-2.1%	1.2%	0.3%	c
Northern Europe (M49)	5.0	4.2	3.3	3.2	-1.8%	-4.2%	-1.8%	c
Polynesia (M49)	..	..	..	..	..	..	..	
South America (M49)	4.2	4.0	3.9	3.9	-0.5%	-0.3%	0.0%	c
Southern Africa (M49)	10.1	8.6	7.4	7.5	-1.6%	-2.9%	0.9%	c
Southern Europe (M49)	3.9	3.6	3.3	3.3	-0.8%	-1.5%	-0.5%	c
Western Africa (M49)	8.6	6.4	5.7	6.0	-2.8%	-2.3%	2.2%	c
Western Europe (M49)	4.7	4.3	3.8	3.6	-1.0%	-2.6%	-1.7%	c
Developing regions (MDG)	6.3	5.9	5.3	5.0	-0.7%	-2.2%	-2.9%	c

UN country name	Energy intensity (MJ/USD 2011 PPP)				Compound annual growth rate of Energy intensity (%)			Source
	2000	2010	2015	2017	2000-2010	2010-2015	2015-2017	
Developed regions (MDG)	6.5	5.5	4.8	4.7	-1.7%	-2.5%	-1.6%	c
Northern Africa (MDG)	3.7	3.7	3.8	3.8	0.2%	0.5%	0.1%	c
Sub-Saharan Africa (MDG)	9.5	7.3	6.6	6.7	-2.5%	-2.0%	0.4%	c
Eastern Asia (MDG)	9.4	8.0	6.6	6.0	-1.6%	-3.8%	-4.7%	c
Western Asia (MDG)	4.3	4.9	4.6	4.4	1.3%	-1.5%	-1.5%	c
Oceania (MDG)	5.9	5.6	5.3	5.0	-0.4%	-1.3%	-2.9%	c
Caucasus and Central Asia (MDG)	16.3	9.1	7.8	7.4	-5.7%	-3.1%	-2.1%	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
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.A – INTERNATIONAL FINANCIAL FLOWS

Data provided by IRENA and OECD

Country	International Commitments (2017 USD Millions)			
	2000	2010	2015	2017
Afghanistan	0.02	35.43	4.75	49.35
Algeria		0.39	0.87	0.01
Angola		0.02	0.02	
Anguilla		0.05		
Antigua and Barbuda			6.88	19.09
Argentina		1.02	600.8	490.09
Armenia		89.85	22.75	1.5
Azerbaijan	4.69	182.97	75.96	0.02
Bahamas				0.02
Bangladesh	2.92	0.18	7.48	210.49
Barbados			0.08	
Belize			0.02	0.01
Benin		0.17	548.94	316.46
Bhutan	4.78	22.35	123.38	0.02
Bolivia (Plurinational State of)	0.09	5.13	1.91	623.16
Botswana	0.03	9.92		0.02
Brazil	123.58	139.83	2.21	560.05
Burkina Faso	0.12	1.32	25.75	20.33
Burundi		12.99	2.43	16.42
Côte d'Ivoire	13.43	0.87	0.78	486.23
Cabo Verde		67.44	3.08	0.1
Cambodia		658.16	7.95	3.64
Cameroon		52.19	2.02	166.94
Central African Republic			3.9	0.03
Chad			0.02	0.01
Chile	0.44	3.13	106.3	204.31
China	238	75.39	90.01	354.05
Colombia		3.38	22.21	179.81
Comoros			1.02	10.92
Congo	0.15			

Country	International Commitments (2017 USD Millions)			
	2000	2010	2015	2017
Cook Islands			17.73	
Costa Rica	0.09	7.39	421.83	243.76
Cuba	0.78	4.05	74.53	108.39
Democratic People's Republic of Korea				2.35
Democratic Republic of the Congo		0.4	0.6	42.7
Djibouti		12.19	3.75	1.68
Dominica				12.95
Dominican Republic	10.77	76.69	0.07	33.61
Ecuador	2.15	2720.13	30.44	26.46
Egypt	10.37	996.34	280.01	1828.16
El Salvador		55.08	75.14	479.05
Equatorial Guinea			0.02	
Eritrea		0.05	14.11	
Eswatini			1.02	
Ethiopia	1.46	90.35	315.98	392.5
Fiji			1.67	0.05
Gabon		6.04	12.8	0.11
Gambia				24.8
Georgia		8.1	6.59	29.19
Ghana	4.07	24.12	59.2	7.69
Grenada			1.69	0.71
Guatemala		9.3	0.02	0.83
Guinea	0.21		1.17	0.12
Guinea-Bissau		0.02		3.29
Guyana		1.16	1.44	
Haiti	0.81	2.28	47.54	25.51
Honduras	32.16	126.24	361.38	240.59
India	474.55	302.37	882.31	800.33
Indonesia	2.25	45.13	369.38	414.12
Iran (Islamic Republic of)	60.21		0.2	0.28
Iraq		153.28		111.79

Country	International Commitments (2017 USD Millions)			
	2000	2010	2015	2017
Jamaica	5.03	0.17	59.75	0.86
Jordan		6.65	162.11	393.1
Kazakhstan		1.34	41.72	146.59
Kenya	0.09	709.68	526.36	288.75
Kiribati		0.96		
Kyrgyzstan	8.27	1.52	0.02	1.22
Lao People's Democratic Republic		10.35	84.69	632.65
Lebanon		1.63	35.99	0.03
Lesotho		0.04	0.04	
Liberia			244.25	45.35
Madagascar			5.24	26.28
Malawi	6.67	14.64	61.37	3.71
Malaysia	136.56	0.14	0.17	0.05
Maldives	4.79	9.4	6.08	0.02
Mali	3.44	0.02	9.24	25.75
Marshall Islands			4.05	40.58
Mauritania			0.12	18
Mauritius		1.99	9.2	0.34
Mexico	2.36	46.12	200.68	487.27
Micronesia (Federated States of)			3.98	1.23
Mongolia	5.03	11.7	0.87	77.43
Montserrat			1.94	0.13
Morocco	0.26	8.2	228.84	116.81
Mozambique	0.04	93	62.05	51.35
Myanmar		0.09	56.75	125.85
Namibia	0.11	45.88		36.59
Nauru			8.79	2.76
Nepal	11.42	22.72	14.9	10.36
New Caledonia				58.06
Nicaragua	0.03	129.28	65.97	137.04
Niger	0.18			81.01

Country	International Commitments (2017 USD Millions)			
	2000	2010	2015	2017
Nigeria		0.56	44.87	5075.65
Niue			0.01	3.66
Pakistan	0.04	258.46	3945.01	1729.61
Palau			5.07	
Panama		8.95	46.49	24
Papua New Guinea			8.59	260.87
Paraguay		0.09		
Peru	1.05	7.64	82.02	535.64
Philippines	11.61	7.16	22.27	1.98
Réunion			1.55	
Rwanda	0.15	2.05		79.25
Saint Helena			1.37	
Saint Lucia			0.01	9.54
Saint Vincent and the Grenadines				3.03
Samoa		0.21	0.01	2
Sao Tome and Principe		0.12	0.35	0.01
Senegal	0.15	1.07	31.39	41.58
Seychelles			0.04	0.93
Sierra Leone		9.09		0.36
Solomon Islands			6.86	156.73
Somalia			0.31	0.02
South Africa	0.38	254.99	701.6	25.51
South Sudan			0.07	0.29
Sri Lanka	1.57	43.13	0.44	206.68
State of Palestine	0.03	1.35	22.42	27.23
Sudan		83.48	0.03	0.01
Suriname				0.01
Syrian Arab Republic		5.05		
Tajikistan		6.34	0.18	288.59
Thailand	0.16	4.03	54.31	1.94
Timor-Leste		4.9		

Country	International Commitments (2017 USD Millions)			
	2000	2010	2015	2017
Togo			4.64	
Tonga		5.48	13.86	19.86
Tunisia	4.32	128.36	8.63	4.88
Turkey	127.88	276.49	393.25	382.66
Turkmenistan			0.13	0.06
Tuvalu		0.55	8.38	
Uganda	26.19	28.6	546.49	87.36
United Republic of Tanzania	0.2	8.68	35.81	25.62
Uruguay		1.09	202.24	55.96
Uzbekistan			0.27	240.16
Vanuatu		0.87	7.1	17.58
Venezuela (Bolivarian Republic of)	0.82	1243.43		
Viet Nam	0.01	92.01	6.17	24.04
Yemen	1.44	0.3		0.01
Zambia	0.01	384.42	1720.64	135.01
Zimbabwe	0.04			5.86
World	1363.86	10051.18	14804.87	21398.39
Northern America and Europe				
Latin America and the Caribbean	182.38	4601.49	2522.28	4562.54
Central Asia and Southern Asia	571.89	719.3	5077.87	3812.66
Eastern Asia and South-eastern Asia	393.62	915.8	693.11	1643.13
Western Asia and Northern Africa	148.99	1949.56	1273.75	2915.67
Sub-Saharan Africa	66.98	1856.15	5149.82	7893.08
Oceania		8.88	88.04	571.32

Source: International Renewable Energy Agency, Organisation for Economic Co-operation and Development

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

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

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- Clean Cooking Alliance
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- The chapter on indicators and data was jointly prepared by all custodian agencies under the coordination of the International Energy Agency (Roberta Quadrelli, Francesco Mattion, Faidon Papadimoulis).

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The report draws on two metadatabases 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, Francesco Mattion, Faidon Papadimoulis) and UNSD (Leonardo Souza, Agnieszka Koscielniak and Costanza Giovannelli). The indicator on international financial flows to developing countries was prepared by IRENA (Adrian Whiteman, Gerardo Escamilla) based on the IRENA Public Investments Database and OECD/DAC Creditor Reporting System. Data on gross domestic product and value-added were mainly drawn from the World Development Indicators of the World Bank. Population data are from the United Nations Population Division.

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ABBREVIATIONS AND ACRONYMS

CO_2	carbon dioxide
DRC	Democratic Republic of Congo
EJ	exajoule
ESMAP	Energy Sector Management Assistance Program
GDP	gross domestic product
GHEM	Global Household Energy Model
GOGLA	Global Off-Grid Lighting Association
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
LED	light-emitting diode
LPG	liquefied petroleum gas
MEPS	Minimum Energy Performance Standards
MJ	megajoule
MTF	Multi-Tier Framework
MWh	megawatt-hour
OECD	Organisation for Economic Co-operation and Development
pp	percentage point
PPP	purchasing power parity
PV	photovoltaic
REN21	Renewable Energy Policy Network for the 21st Century
RISE	Regulatory Indicators for Sustainable Energy
SDG	Sustainable Development Goal
SDS	Sustainable Development Scenario
SEforAll	Sustainable Energy for All
SHS	standalone home system
STEPS	Stated Policies Scenario
TFEC	total final energy consumption
TPES	total primary energy supply
TWh	terawatt-hour
UNHCR	United Nations High Commissioner for Refugees
UNSD	United Nations Statistical Division
W	watt
WEM	World Energy Model
WEO	World Energy Outlook
WHO	World Health Organization

SDG 7 Technical Advisory Group

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Visit the SDG 7 Tracking website to download data and reports, as well as customized maps, comparative graphics, timelines, and country reports.

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