2019 TRACKING SDG7

THE ENERGY PROGRESS REPORT

A joint report of the custodian agencies

International Energy Agency

IRENA International Renewable Energy Agency

United Nations Statistics Division

WORLD BANK GROUP

World Health Organization

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PARTNERS

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) (2019 chair)
- International Renewable Energy Agency (IRENA)
- United Nations Statistics Division (UNSD)
- World Bank (WB)
- World Health Organization (WHO)

Technical Advisory Group chaired by United Nations Department of Economics and Social Affairs (UN DESA), and composed as follows:

- African Development Bank (AfDB)
- Clean Cooking Alliance
- Denmark (Ministry of Foreign Affairs)
- European Commission
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- United Nations Framework Convention on Climate Change (UNFCCC)
- United Nations Human Settlements Programme (UN-Habitat)
- United Nations Industrial Development Organization (UNIDO)
- United Nations Institute for Training and Research (UNITAR)

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EXECUTIVE SUMMARY

Photo: World Bank

OVERALL MESSAGES

According to the latest data, the world is making progress towards achieving Sustainable Development Goal 7 (SDG 7), but will fall short of meeting the targets by 2030 at the current rate of ambition. The SDG Target 7.1 is to ensure universal access to affordable, reliable, and modern energy services (7.1.1 focuses on the proportion of the population with access to electricity and 7.1.2, on the proportion relying primarily on clean fuels and technologies for cooking). Target 7.2 is to increase substantially the share of renewable energy in the global energy mix. Target 7.3 is to double the global rate of improvement in energy efficiency.

In recent years, pronounced progress in expanding access to electricity was made in several countries, notably India, Bangladesh, and Kenya. As a result, the global population without access to electricity decreased to about 840 million in 2017 from 1.2 billion in 2010 (figure ES1). Those still lacking access are increasingly concentrated in Sub-Saharan Africa.

Meanwhile, the population without access to clean cooking solutions totaled almost 3 billion in 2016 and was distributed across both Asia and Africa. The widespread use of polluting fuels and technologies for cooking continues to pose serious health and socioeconomic concerns.

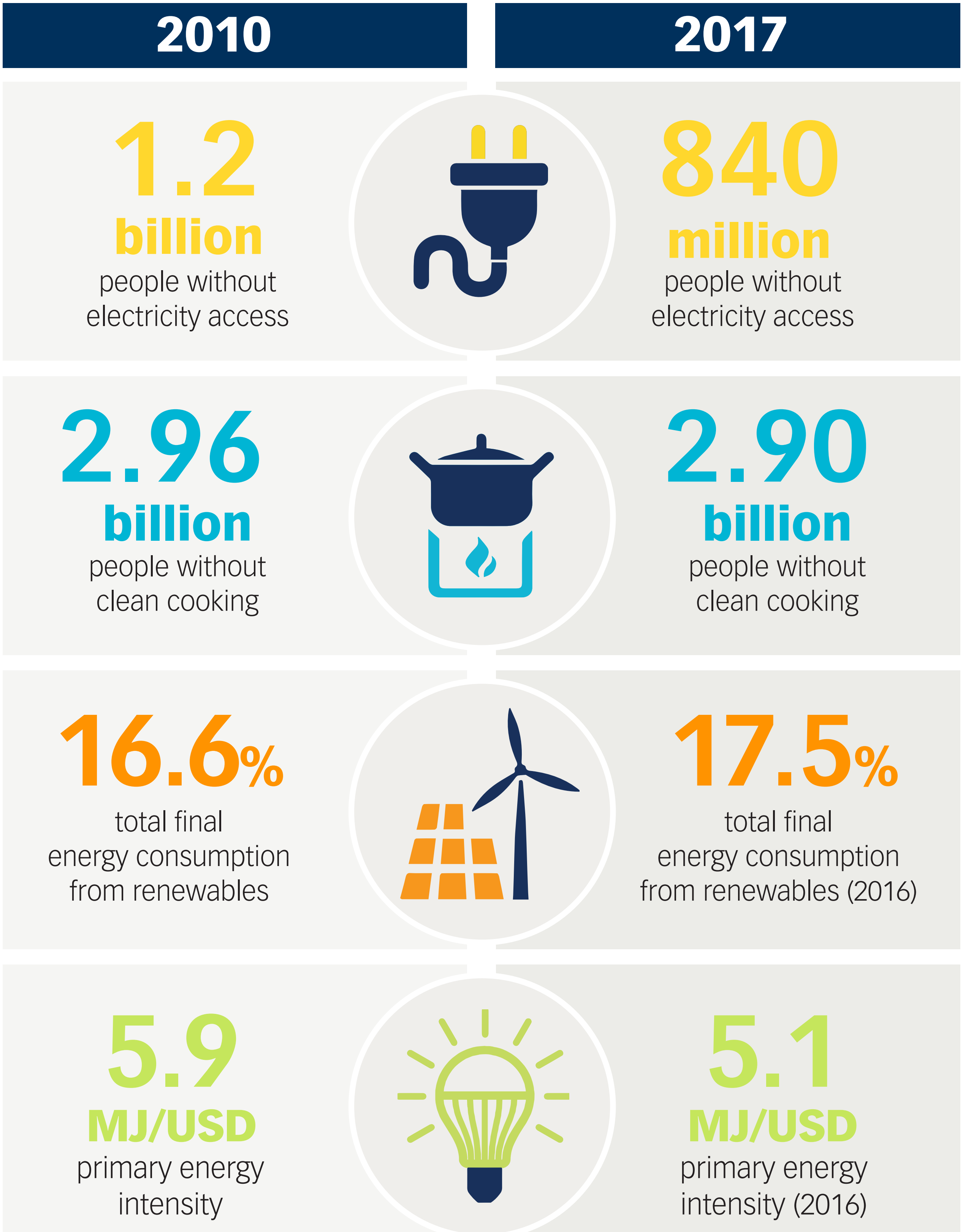
Renewable energy accounted for 17.5% of global total energy consumption in 2016. The use of renewables (i.e., sources of renewable energy) to generate electricity increased rapidly, but less headway was made in heat and transport. A substantial further increase of renewable energy is needed for energy systems to become affordable, reliable, sustainable, focusing on modern uses.

Finally, with respect to energy efficiency, global primary energy intensity was 5.1 megajoules per U.S. dollar (MJ/USD) (2011 purchasing power parity) in 2016. Energy efficiency improvements have increased steadily in recent years, thanks to concerted policy efforts in major economies, including China. However, the global rate of improvement in primary energy intensity still lags behind SDG target 7.3, and estimates suggest that improvements slowed in 2017 and 2018.

Additional effort will be essential in ensuring progress toward not only SDG 7 but also the broader Sustainable Development Agenda. In particular, SDG 7 and climate mitigation (SDG 13) are closely related and complementary. According to scenarios put forward by both the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA), energy sector investment related to all SDG 7 targets will need to more than double in order to achieve these goals. Between 2018 and 2030, annual average investment will need to reach approximately $55 billion to expand energy access, about $700 billion to increase renewable energy, and $600 billion to improve energy efficiency.

This report identifies best practices that have proven successful in recent years, as well as key approaches that policy makers may deploy in coming years. Recommendations applicable to all SDG 7 targets include recognizing the importance of political commitment and long-term energy planning, stepping up private financing, and supplying adequate incentives for the deployment of clean technology options. The following sections review progress in electricity access, access to clean cooking solutions, renewable energy, and energy efficiency.

FIGURE ES1 • LATEST DATA ON PRIMARY INDICATORS OF GLOBAL PROGRESS TOWARD SDG 7 TARGETS



Source: IEA, IRENA, World Bank, WHO, and UNSD 2019.
Note: MJ/USD = megajoules per U.S. dollar.

BOX ES1 • WHAT IS THE ENERGY PROGRESS REPORT?

The Energy Progress Report chronicles progress toward Sustainable Development Goal (SDG) 7 at the global, regional, and country levels. It is a joint effort of 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), all appointed by the United Nations as global custodian agencies responsible for collecting and reporting data related to the energy targets of SDG 7.

The Energy Progress Report reviews progress to 2017 for energy access and to 2016 for renewable energy and energy efficiency, against a baseline year of 2010. Its methodology is detailed at the end of each chapter.

ELECTRICITY ACCESS

Thanks to significant efforts across the developing world, the global electrification rate reached 89% in 2017 (from 83% in 2010), still leaving about 840 million people without access. The progress amounts to an average annual electrification rate of 0.8 percentage points, and newly gained access for more than 920 million people since 2010.

The electrification trend began to accelerate in 2015. An additional 153 million people were electrified yearly between 2015 and 2017, at an annual rate of more than 1 percentage point. However, the momentum remained uneven across regions; difficult-to-reach populations, particularly in Sub-Saharan Africa, where many remain without access.

Electrification efforts have been particularly successful in Central and Southern Asia, where 91% of the population had access to electricity in 2017 (figure ES2)[1]. Access rates in Latin America and the Caribbean, as well as Eastern and Southeastern Asia, climbed to 98% in 2017. Among the 20 countries with the largest populations lacking access to electricity, India, Bangladesh, Kenya, and Myanmar made the most significant progress since 2010.

Sub-Saharan Africa remains the region with the largest access deficit: here, 573 million people—more than one in two—lack access to electricity. The region is also home to the 20 countries with the lowest electrification rates (figure ES3). Burundi, Chad, Malawi, the Democratic Republic of Congo, and Niger were the four countries with the lowest electrification rates in 2017.

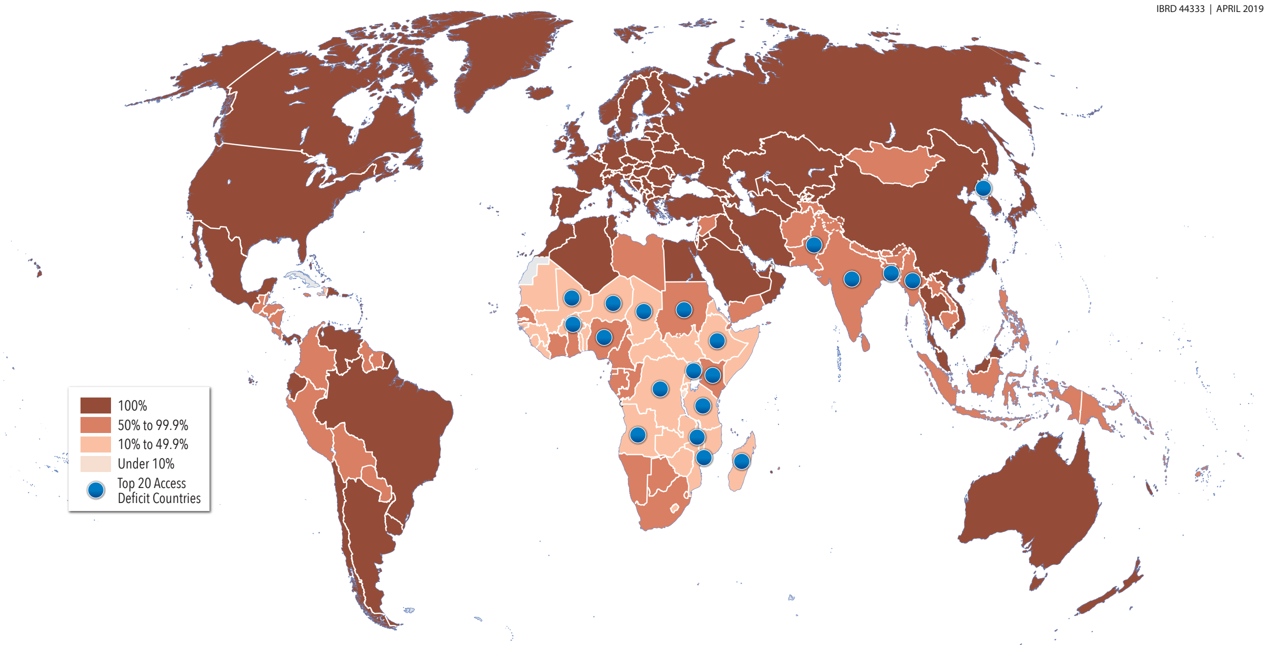
Progress in electrifying inner cities has been slow, and most informal settlements are still supplied through fragile distribution networks. The rural access rate of 79% in 2017 was lower than the urban access rate of 97%. To reach remote areas, off-grid solutions are essential; these include solar lighting systems, solar home systems, and—increasingly—mini-grids.

SDG target 7.1 calls for universal access to affordable, reliable, and modern energy services. Reliability and affordability remain challenging elements in many countries, even as the number of household connections increases. In 2017, one-third of access-deficit countries faced more than one weekly disruption in electricity supply that lasted over four minutes. A basic, subsistence level of electricity consumption (30 kilowatt-hours per month) was unaffordable for 40% of households in about half of these countries. Access also has a gender dimension. In key access-deficit countries analyzed under the World Bank's Multi-Tier Framework for Energy, found significant variability in household access rates based on gender of head of household.

If the rate of progress in expanding access to electricity remained at the same level as that between 2015 and 2017, universal access could be reached by 2030. However, connecting the last of the unserved populations may be more challenging than past electrification efforts, since many such populations live in remote locales or overburdened cities. A projected 650 million people are likely to remain without access to electricity in 2030, and 9 out of 10 such people will be in Sub-Saharan Africa.

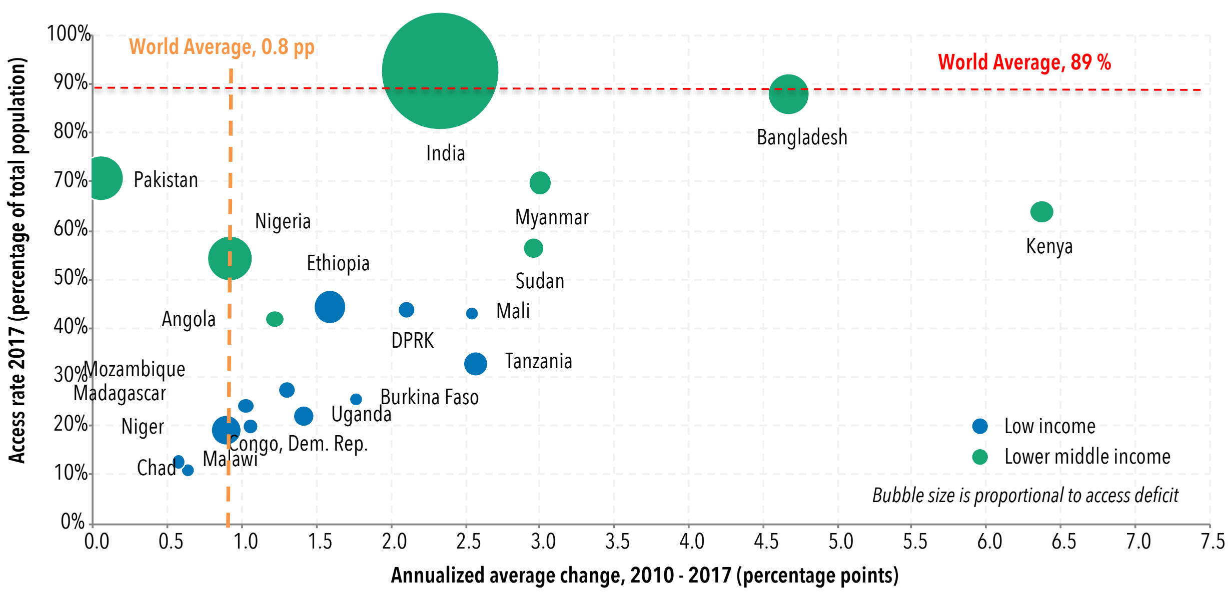
Key strategies for closing this gap will include data-based decision-making and advanced policy-planning frameworks, private sector financing, versatile solutions that include decentralized renewables, and efforts to both extend rural electrification and cope with urban densification.

FIGURE ES2 • SHARE OF POPULATION WITH ACCESS TO ELECTRICITY IN 2017



Source: World Bank.
Note: This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

FIGURE ES3 • THE 20 COUNTRIES WITH THE LARGEST ACCESS DEFICIT OVER THE 2010-2017 TRACKING PERIOD



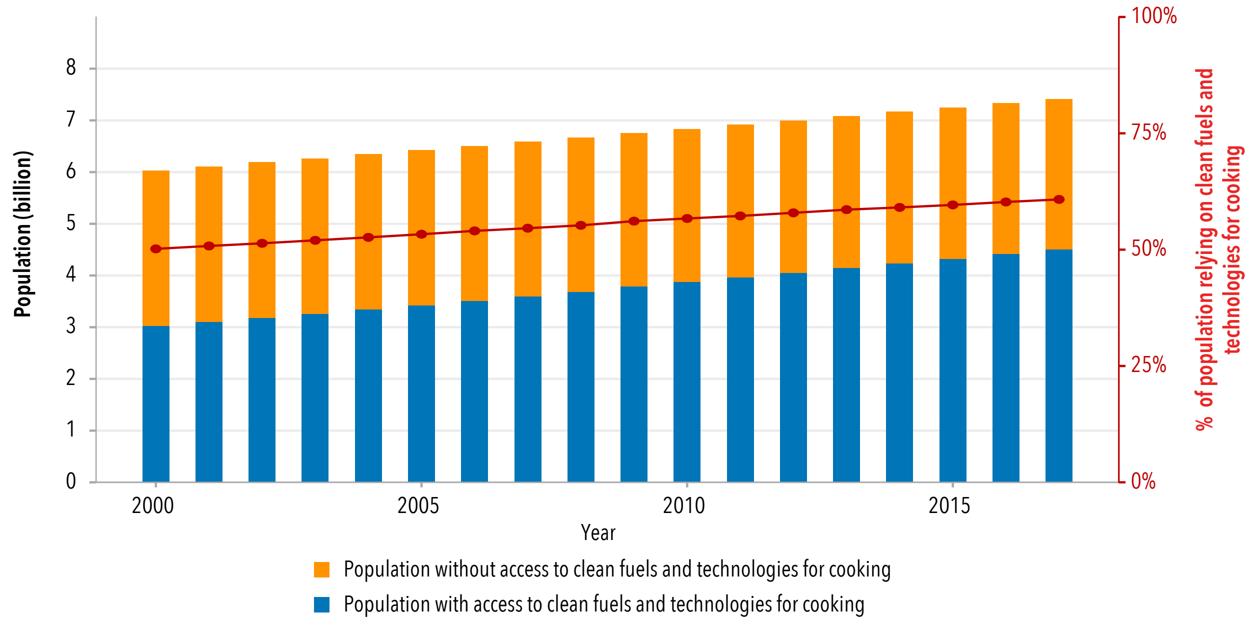
Source: World Bank.
Note: DPRK = Democratic People's Republic of Korea.

ACCESS TO CLEAN COOKING SOLUTIONS

The share of the global population with access to clean fuels and technologies for cooking increased from 57% [51, 62] in 2010 to 61% [54, 67] in 2017. However, because population growth is outpacing annual growth in access, especially in Sub-Saharan Africa, the population without access to clean cooking remains just under 3 billion (figure ES4).

Between 2010 and 2017, the percentage of the population relying on clean cooking solutions grew by an annual average of 0.5 percentage points [-0.5, 1.6][2] , though annual progress slowed in 2008. During this period, global improvements were driven by gains in the regions of Central and Southern Asia and Eastern and Southeastern Asia, which posted average annual increases of 1.2 and 0.9 percentage points, respectively. To reach universal clean cooking targets by 2030 and outpace population growth, the annual average increase in access must rise to 3 percentage points, from the rate of 0.5 percentage points observed between 2010 and 2017.

FIGURE ES4 • CHANGE OVER TIME IN THE ABSOLUTE NUMBER OF PEOPLE WITH AND WITHOUT ACCESS TO CLEAN COOKING (LEFT AXIS) AND PERCENTAGE OF THE GLOBAL POPULATION WITH ACCESS TO CLEAN COOKING (RIGHT AXIS), 2000-2017



Source: WHO.

Looking at individual countries, in absolute terms, India and China account for the largest shares of the global population without access to clean cooking, at 25% and 20%, respectively (figure ES5). These two countries alone are home to 1.3 billion people without access to clean cooking solutions. Meanwhile, in 6 of the 20 countries with the largest access deficits—the Democratic Republic of Congo, Ethiopia, Madagascar, Mozambique, Uganda, and Tanzania—less than 5% of the population uses clean fuels and technologies as their primary means of cooking.

In most access-deficit regions, the use of wood is steadily declining, but this trend is offset by an increase in charcoal usage, primarily in Sub-Saharan Africa. An inverse relationship between kerosene and cleaner gaseous fuels (liquid petroleum gas, natural gas, and biogas) has also been observed: as kerosene use declines, reliance on cleaner gaseous fuels for cooking increases. The uptake of cleaner fuels remains slow in rural Africa, in large part due to issues of affordability and supply.

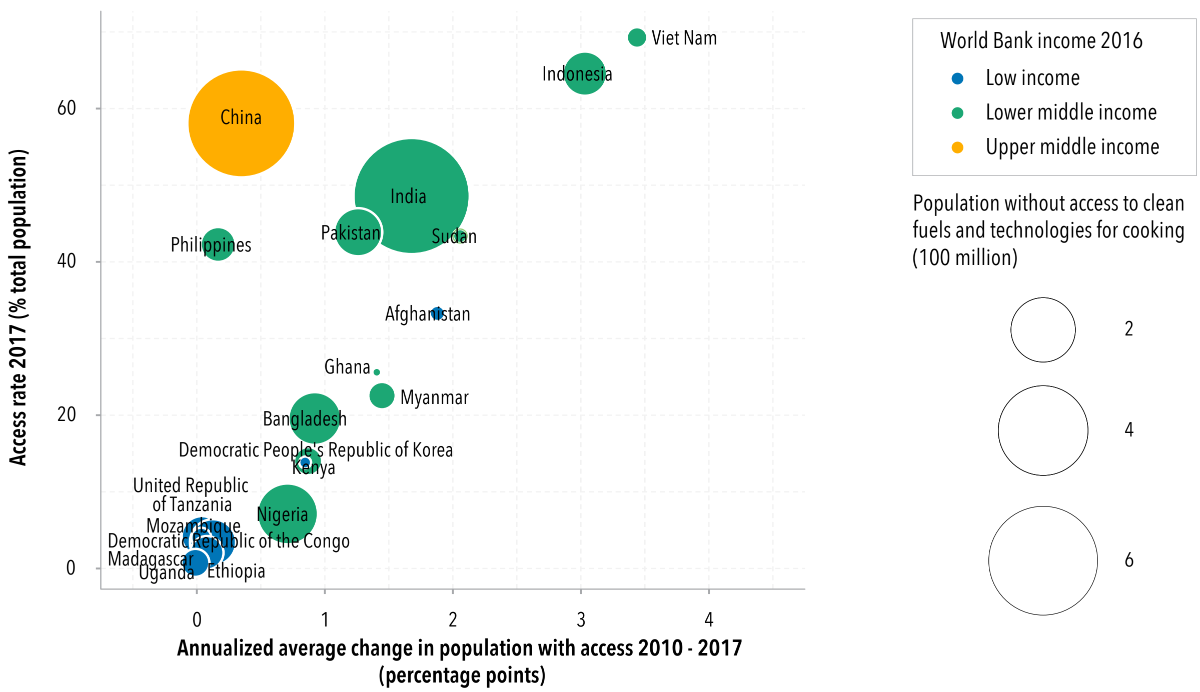
The business as usual pathway will not meet the universal access goal by 2030. Based on the projections of current and planned policies, the IEA estimates that 2.2 billion people will still be dependent on inefficient and polluting energy sources for cooking. Most of this population will reside in Asia and Sub-Saharan Africa. To achieve universal access by 2030, greater use of liquid petroleum gas would be appropriate in urban areas (accounting for an estimated 92% of new connections) since population density justifies the necessary investment in infrastructure. Meanwhile, improved biomass cookstoves, which represent 37% of clean cooking solutions, would be particularly suited for rural or more remote areas.

Cleaner household energy is closely linked with other development goals, including those touching on human health, the environment, and gender equality. Universal access to clean cooking solutions would help prevent some 3.8 million premature deaths each year, primarily among women and children, from exposure to household air pollution. It would also save time spent collecting fuel (wood or other biomass) and tending fires—time that could otherwise be used for learning, earning, and social activities. Clean cooking solutions reduce deforestation and lower climate-changing emissions. For these and other co-benefits to be realized, however, clean cooking must be integrated into national policy, by scaling up solutions, increasing public and private investment in clean cooking, and enhancing multi-sectoral collaboration.

Transitioning to clean cooking requires tailored policies and programs that focus on key barriers to the adoption of clean cooking solutions, such as their affordability, lack of supply, and social acceptability. Particularly successful programs to date have addressed behavioral patterns, cultural norms, and regional variations. Because women are typically responsible for cooking, they often have a comparative advantage in reaching out to other users of clean cookstoves. Other success factors are enhanced multisectoral collaboration and greater public and private investment in clean cooking.

FIGURE ES5 • THE 20 COUNTRIES WITH THE LARGEST CLEAN COOKING ACCESS DEFICIT, 2010-2017

Source: WHO.



RENEWABLE ENERGY

In 2016, the share of renewables in total final energy consumption increased at the fastest rate since 2012 and reached almost 17.5%. Renewables are essential in the drive towards universal access to affordable, sustainable, reliable and modern energy, except for the traditional uses of biomass (e.g. for cooking) which is linked to significant negative health impacts. In 2016, the share of modern renewables (that is, excluding these traditional uses of bioenergy) in total energy consumption reached 10.2%, up from 8.6% in 2010, while the share of traditional uses of biomass declined to 7.3% from 7.9%.

Of the three end uses of renewables—electricity, heat, and transport—the use of renewables grew fastest with respect to electricity (figure ES7), driven by the rapid expansion of wind and solar technologies.

The share of renewables in electricity consumption increased by 1 percentage point to 24% in 2016. This was the fastest growth since 1990, more than double that of 2015. It was driven by three key developments: (i) drought recovery in Latin America and an associated increase in hydropower generation, (ii) China's record-level wind capacity additions in 2015, which became fully operational in 2016, and (iii) rapid expansion of solar capacity in China and the United States. Hydropower remains the largest source of renewable electricity, accounting for 68% in 2016. It is followed by wind, bioenergy, solar, and geothermal.

The share of renewables in heat remains the highest among the three end uses. That share surpassed 24% in 2016, an increase of 0.5% year on year. However, most of the share reflects traditional uses of biomass. Only 9% of heat was generated from modern renewables in 2016.

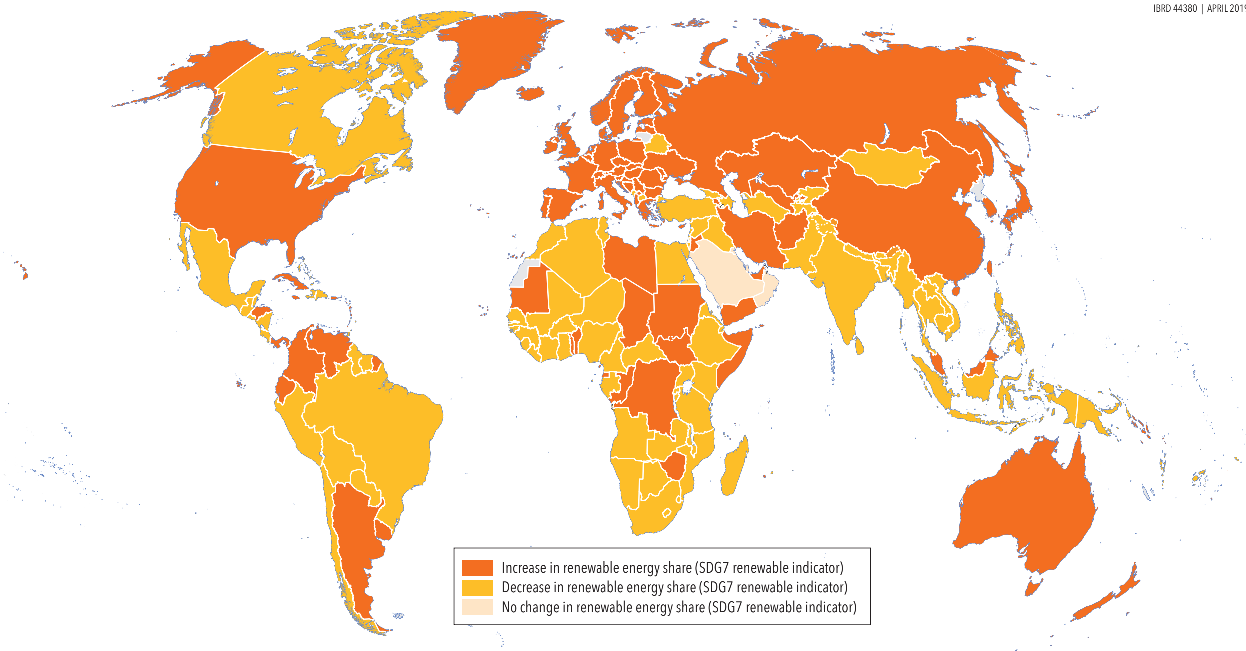
The share of renewable energy in transport remains lowest: it increased by 0.1% year on year to reach 3.3% in 2016. Biofuels constitute the majority of renewable energy used for transport in the United States, Brazil, and the European Union. Electricity generated from renewable sources also grew, linked to rail and the rapid increase of electric vehicles.

The top 20 energy-consuming countries in 2016 were responsible for three-quarters of global energy demand and two-thirds of global renewable energy consumption. In the six countries where consumption of renewables was above the global average, the trend was led by traditional uses of biomass (in India, Indonesia, Nigeria, and Pakistan), modern biomass (in Brazil), or hydropower (Canada).

Strong policy support and the increasing cost-competitiveness of solar photovoltaic and wind technologies are projected to bolster the deployment of renewable electricity across all regions. However, according to long-term scenarios developed by both IEA and IRENA, global renewable energy consumption needs to accelerate substantially to ensure access to affordable, reliable, sustainable and modern energy for all.

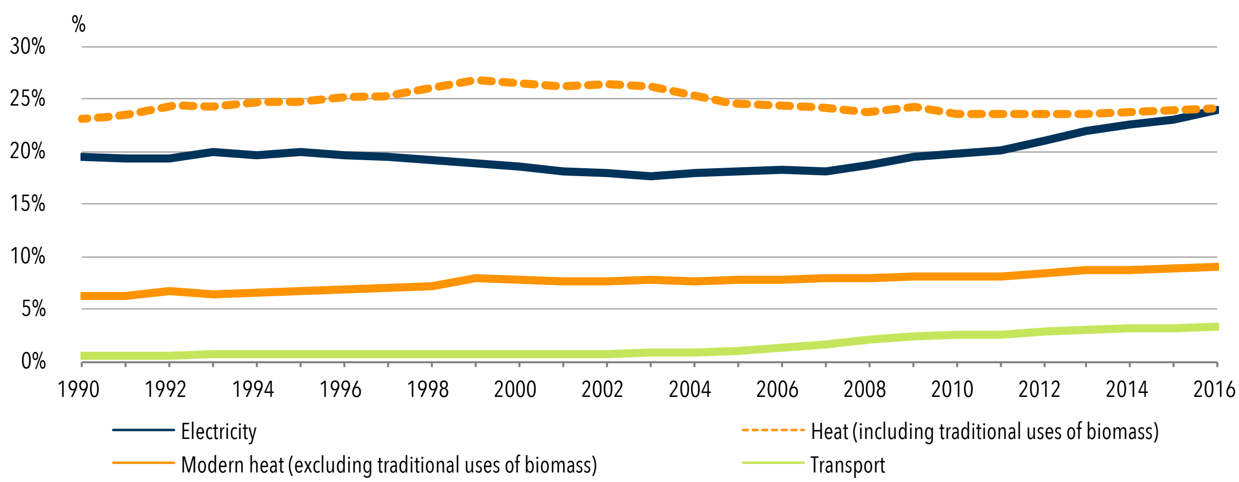
Despite remarkable progress over the past decade, renewables still face persistent financial, regulatory, and sometimes technological barriers. Policies have focused on renewable electricity so far, and fewer countries have implemented policies for renewables use for heating and transport. To foster an enabling environment, it is important that various policies work in tandem to integrate renewables into energy systems and directly support their deployment in all end uses. To ensure that the renewables-based energy transition is inclusive in all respects, gender considerations need to be mainstreamed in energy sector policies, education and training programmes, and private sector practices.

FIGURE ES6 • CHANGE IN RENEWABLE ENERGY'S SHARE OF TOTAL FINAL ENERGY CONSUMPTION BETWEEN 2010 AND 2016



Source: IEA and UNSD.
Note: This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

FIGURE ES7 • RENEWABLES' SHARE OF ALL ENERGY CONSUMED, BY END USE, 1990-2016



Source: IEA and UNSD

ENERGY EFFICIENCY

Rates of improvement in global primary energy intensity—defined as the percentage drop in global total primary energy supply per unit of gross domestic product—were more sustained in 2010-2016 (falling by more than 10%) than they had been in 1990-2010 (figure ES8). Global primary energy intensity was 5.1 MJ/USD (2011 US dollar at purchasing power parity) in 2016, a 2.5% improvement from 2015. Yet this lags behind the annual rate of improvement to 2030 targeted by SDG 7.3, which now exceeds 2.7% and it is estimated that further declines in the rate of improvement have been observed in 2017 and 2018, with the rate of improvement in 2018 falling to a mere 1.3%.

To realize the significant cost savings to be gained from improved energy efficiency, more needs to be done. Concerted policy efforts, technology change, and changes in economic structure will contribute to improving global primary energy intensity. Recent progress has been more sustained than historical trends. In 2010-2016, the annual rate of primary energy intensity improvement accelerated in 16 of the world's 20 economies with the greatest energy demand. China saw the most significant improvement, with India, Indonesia, Japan, and the United Kingdom also recording strong progress.

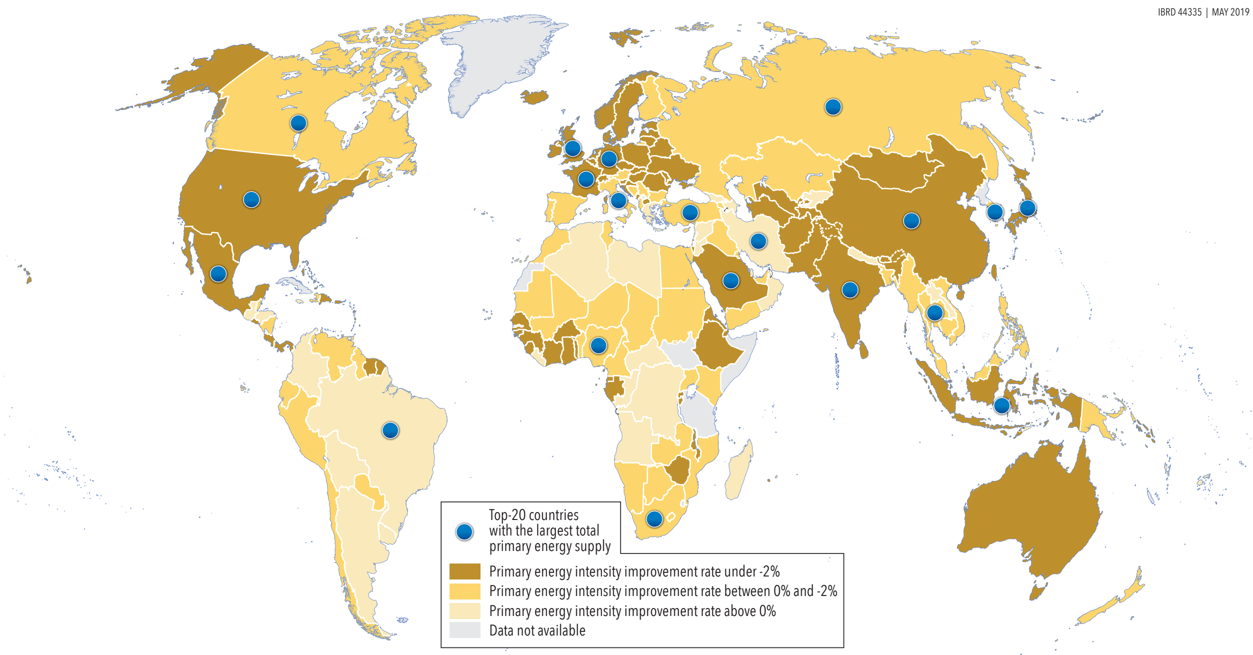
Energy intensity has decreased at varied rates across end-use sectors. Progress has been fastest in industry and passenger transport, where the average annual rate of improvement exceeded 2%. Rates of efficiency improvement in the services, agriculture, and residential sectors exceeded 1.5%. Freight transport lagged slightly behind, but a changing policy landscape following the implementation of fuel economy standards for trucks in the United States, Canada, Japan, China and India, as well as proposed standards in Europe signals potential change in the coming years.

The rate of improvement in global primary energy intensity is also influenced by supply-side factors—chief among them efficiency in fossil fuel generation and reductions in the losses incurred in the transmission and distribution of electricity. Fossil fuel electricity generation has become steadily more efficient since 2000 - the efficiency level reached nearly 40% in 2016. Meanwhile, the modernization of electricity networks in the world's largest electricity-generating countries, including China and India, has reduced transmission and distribution losses.

Looking ahead, improvements in energy intensity are likely to fall short of the SDG 7.3 target, leaving a large portion of potential benefits unrealized. Given current and planned policies, energy intensity improvements are projected to average 2.4% per year between 2017 and 2030.

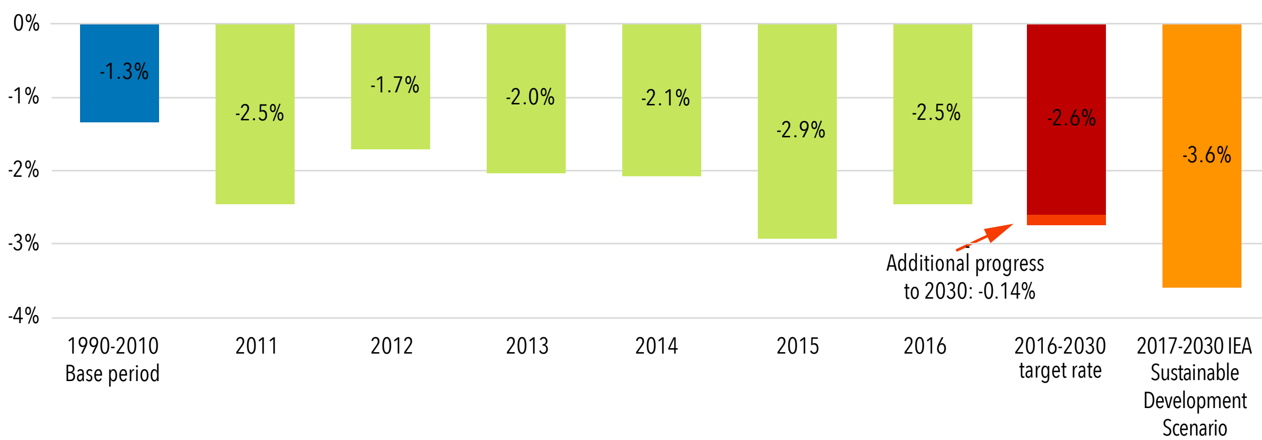
In the IEA's Sustainable Development Scenario, in which cost-effective energy efficiency potentials are maximized, the rate of intensity improvement between 2017 and 2030 reaches 3.6%. This highlights that it is still possible not only to meet but even to exceed SDG target 7.3. Key efforts that governments can undertake to realize this potential include strengthening mandatory energy efficiency policies, providing targeted fiscal or financial incentives, leveraging market-based mechanisms, and disseminating high-quality information about energy efficiency. The spread of digital technologies will also create new ways to harness efficiency improvements through improved devices and business models.

FIGURE ES8 • COMPOUND ANNUAL AVERAGE GROWTH RATE OF PRIMARY ENERGY INTENSITY, 2010-2016



Source: IEA, UNSD, and World Development Indicators.
Note: This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

FIGURE ES9 • GROWTH RATE OF PRIMARY ENERGY INTENSITY BY PERIOD, TARGET RATE FOR 2016-2030, AND POTENTIAL FOR 2017-2030 IN IEA SUSTAINABLE DEVELOPMENT SCENARIO



Source: IEA, UNSD, and World Development Indicators.

ENDNOTES

1 South Asia has an access rate of 90% and Central Asia has an access rate of 99%.

2 Bracketed percentages represent the 95% confidence interval. The Methodology section at the end of Chapter 3 provides details.

CHAPTER 1

ACCESS TO ELECTRICITY

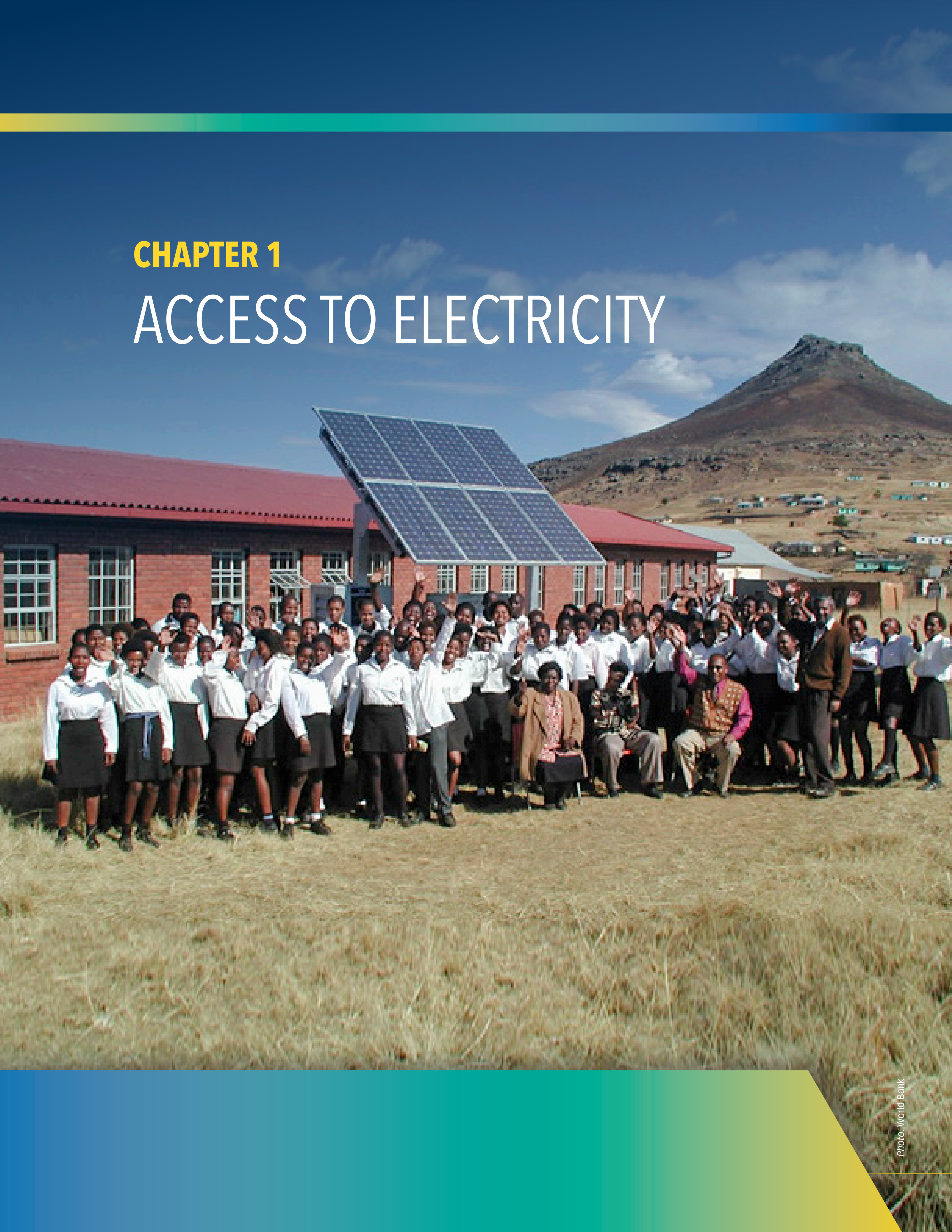


Photo: World Bank

MAIN MESSAGES

- **Global trend:** The current decade has seen significant progress in electrification across the developing world, where the great majority of the unelectrified population resides. The share of global population with access to electricity rose from 83% in 2010 to 89% in 2017. This amounts to an average annual electrification rate of 0.80 percentage points, and newly gained access for more than 920 million people. Due to this remarkable electrification growth, the global population without access to electricity fell from 1.2 billion in 2010 to 840 million in 2017. It is noteworthy that the number of people electrified between 2010 and 2017 is higher than the access deficit as of 2017. Notably, the electrification trend started to accelerate in 2015: an additional 153 million people were electrified yearly between 2015 and 2017 in comparison to 122 million between 2010 and 2015. However, after accounting for population growth, the annual net increase in the number of people with access was about 67 million during the 2015-2017 period.

- **2030 target:** Globally, there was a surge in electrification growth in 2015-2017. Despite this, the average annual gain in the electrification rate since 2010, at 0.80 percentage points per year, falls short of the target rate required to reach universal access by 2030. To make up for the lag, this rate needs to be 0.86 percentage points annually from 2018 to 2030. Meanwhile, keeping up the current momentum will be increasingly challenging as progress is uneven and there is a growing gap between fast-electrifying countries and those lagging behind. Furthermore, achieving universal access faces the difficulty of reaching the remaining unserved populations, which include those connected to frail and overburdened urban grids, as well as displaced and hard-to-reach populations. Given the many challenges facing access-deficit countries, the latest projection places the access rate in 2030 at 92%, leaving 650 million people around the world without access to electricity.[3]

- **Regional highlights:** All regions saw an acceleration in the growth in population with access to electricity over the 2010-2017 period.[4] This trend dates back to 2010 in Central and Southern Asia, where 91% of the population had access to electricity by 2017[5], as well as in Latin America and the Caribbean and Eastern and South-eastern Asia, where the regional access rates climbed up to 98% in 2017. In Sub-Saharan Africa, electrification efforts began to outstrip population growth in 2015. With a regional access rate of 44%, Sub-Saharan Africa's access deficit remains the largest: about 573 million people lacked access to electricity in 2017.

- **Urban-rural distribution:** Although the advance of electrification was more rapid in rural areas than in cities between 2015 and 2017, the rural access rate of 79% was still far behind the urban access rate of 97% in 2017. In fact, the unserved rural population of 732 million represented 87% of the global access deficit in 2017. The urban access rate has plateaued despite the relatively small share of urban populations still waiting to be electrified. This is in large part owing to the challenges of electrifying an increasing urban population, as well as those living in inner cities and informal settlements who receive electricity supply through fragile distribution networks. In Central and Southern Asia, the annual access gain in rural areas was 48 million compared with only 22 million in urban settings between 2015 and 2017, indicating a focus on rural electrification in this part of the world. However, in Sub-Saharan Africa, there was greater attention to urban electrification. Here, the incremental rural electrification of 16 million people a year was two-thirds that of the urban rate in 2015-2017.

- **Top 20 access-deficit countries:** In 2017, the 20 countries with the greatest access deficit (as measured by the number of people without access to electricity) accounted for about 78% of the global population lacking electricity. Thus, efforts to electrify these countries will determine in large part the degree of progress made on Sustainable Development Goal (SDG) indicator 7.1.1. Of these 20 countries, Bangladesh, Kenya, and Myanmar have made the most progress since 2010, at an annual rate of over 3 percentage points. Some countries with unserved populations of over 50 million in 2017—such as the Democratic Republic of Congo, Nigeria, and Pakistan—have expanded electricity access by less than 1 percentage point annually since 2010 and in a majority of the top 20 access-deficit countries, the electrification rate between 2010 and 2017 did not keep pace with population growth during the same period.

- **Affordability and reliability of service:** SDG target 7.1 calls for universal access to affordable, reliable, and modern energy services by 2030. Using electricity tariff data, the 2018 edition of the World Bank's Regulatory Indicators for Sustainable Energy (RISE) reveals that basic, subsistence-level electricity consumption (30 kilowatt-hours [kWh]/month) is unaffordable (costs more than 5% of monthly household income) for the poorest 40% of households in half of the access-deficit countries[6], representing 285 million people (ESMAP 2018d).[7] Pertinently, an electricity connection costs more than one month's income for the poorest 40% of households, or over 400 million people, residing in access-deficit countries. Regarding reliability, households in one out of three access-deficit countries face more than one weekly disruption in electricity supply that lasts over four minutes on average.[8]

- **Off-grid solar and mini grids:** According to data from the International Renewable Energy Agency (IRENA 2019), globally, in 2017, at least 34 million people had access to the equivalent of Tier 1 and above (Tier 1+) electricity service either through a standalone system or connection to a mini grid. In-depth analysis of electrification solutions in six countries (Bangladesh, Cambodia, Ethiopia, Kenya, Myanmar, and Rwanda) in 2017, conducted under the Multi-Tier Framework for Energy (MTF), indicates that off-grid solutions constitute critical sources of Tier 1+ service (ESMAP 2018a, b, and c). Most off-grid solutions centred on SHSs and solar lighting, but mini grids are gaining traction.

- **Gender gap:** Gender-disaggregated electricity access data from MTF for Bangladesh, Cambodia, Ethiopia, Myanmar, and Rwanda found significant variability in household access rates based on gender of head of household which stem from various factors including gender gaps in affordability, access to finance, and location.

ARE WE ON TRACK?

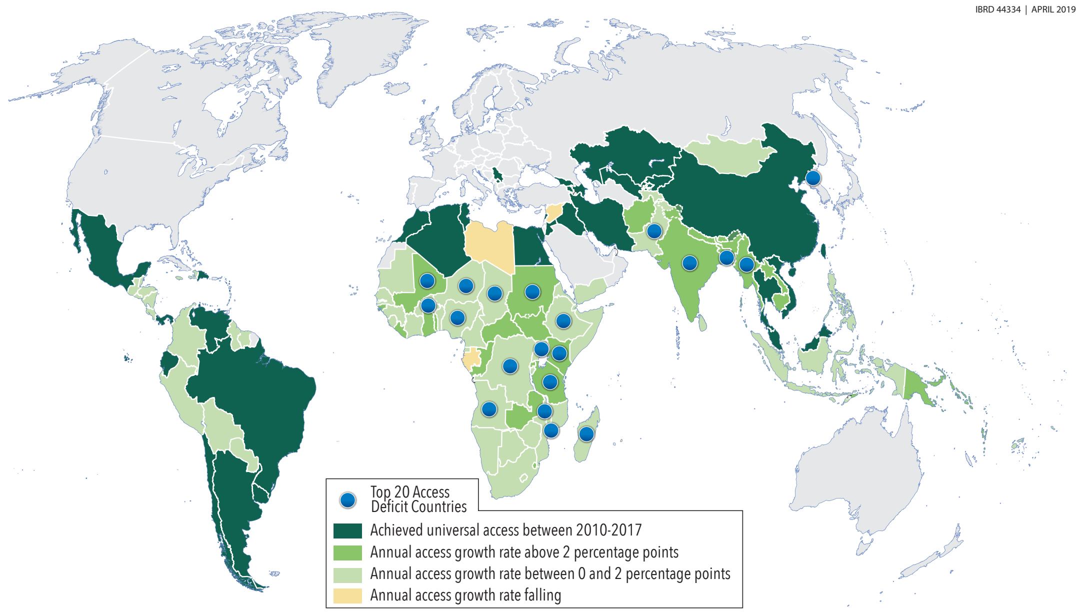
In 2017, 89% of the world's population had access to electricity.[9] Between 2010 and 2017, the global population without access to electricity fell from 1.2 billion to 840 million[10]. Encouragingly, the electrification rate has accelerated since 2015, with 153 million additional people being electrified each year. Given the wide variety of country contexts and various complexities of bringing electricity to the remaining unserved population, a projected 92% of the global population will have access to electricity in 2030[11] (figure 1.1), leaving 650 million people without access[12].

FIGURE 1.1 • PERCENTAGE OF POPULATION WITH ACCESS TO ELECTRICITY (%)

Source: World Bank.

Since 2010, 44 countries achieved universal access, while another 29 countries accelerated their electrification rate at a pace of at least 2 percentage points annually.[13] However, as of 2017, 96 countries were yet to achieve 100% access to electricity, a large majority of which were in Sub-Saharan Africa and Central and Southern Asia.14 One-third of these access-deficit countries, including 8 of the 20 countries with the largest unserved populations, upped their rate by over 2 percentage points each year in the period 2010-2017 (figure 1.2). In Sub-Saharan Africa, the electricity access gained by nearly 450 million people pushed up the regional access rate from 39% in 2015 to 44% in 2017. In Central and Southern Asia, over 1.76 billion or 91% of the population had access to electricity in 2017.

FIGURE 1.2 • ANNUAL INCREASE IN ELECTRIFICATION RATE IN ACCESS-DEFICIT COUNTRIES, 2010-2017 (PERCENTAGE POINTS)



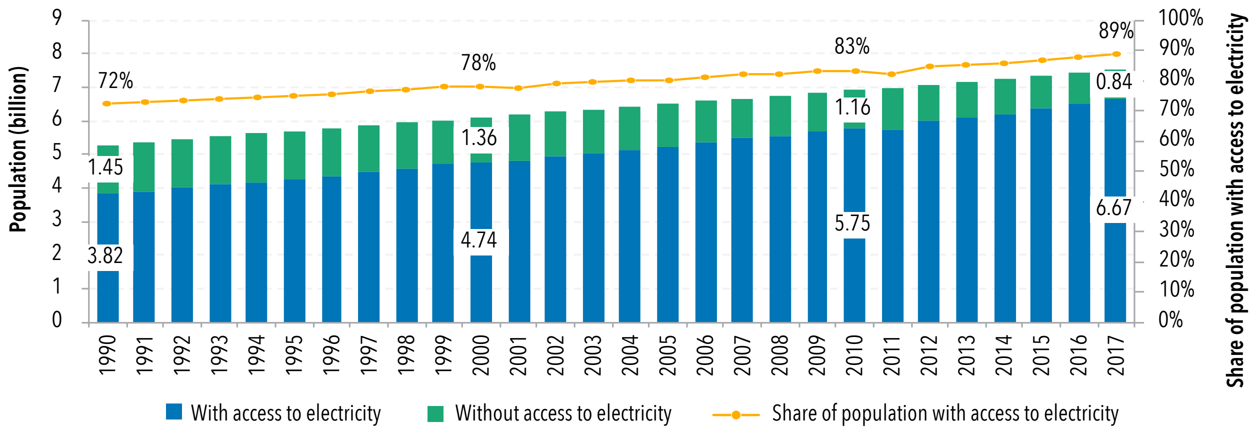
Source: World Bank.

LOOKING BEYOND THE MAIN INDICATORS

ACCESS AND POPULATION

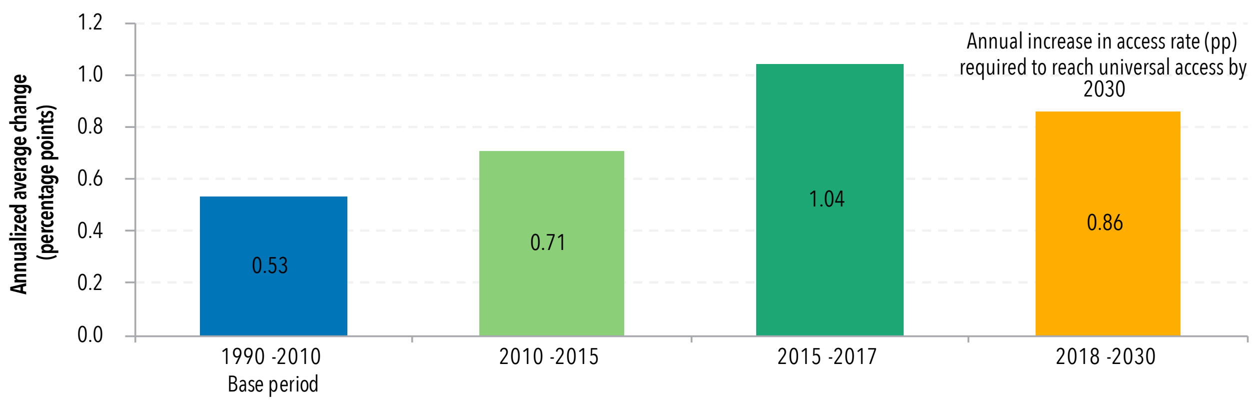
Recent trends confirm that the sustained electrification rate of recent years is faster than the pace of population growth in the underserved parts of the world. Global electrification has seen a consistent uptick since 2010, surging from 83% in 2010 to 89% in 2017 (figure 1.3). During the same period, the global population without access to electricity fell from 1.2 billion to 840 million. Despite accelerated electrification growth at 1 percentage point between 2015-2017, it will be challenging to achieve the 0.86 average annual percentage point increase needed to reach universal access by 2030 (figure 1.4), given lagging progress in many large access-deficit countries and difficulties in bringing electricity to the remaining unserved population.

FIGURE 1.3 • GAINS IN ELECTRICITY ACCESS, 1990-2017 (IN BILLIONS OF PEOPLE AND SHARE OF POPULATION WITH ACCESS TO ELECTRICITY)



Source: World Bank.

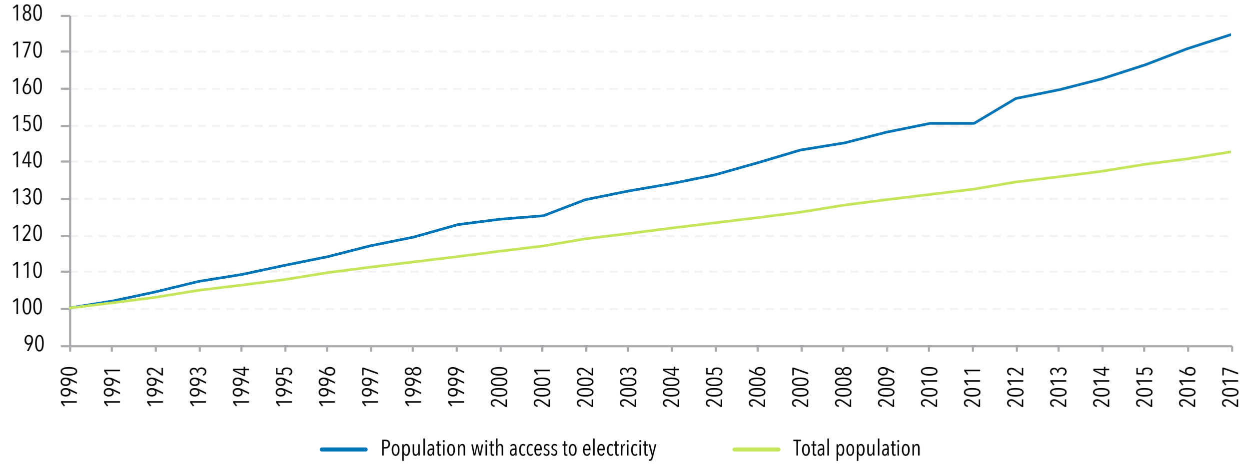
FIGURE 1.4 • AVERAGE ANNUAL INCREASE IN ELECTRICITY ACCESS RATE (PERCENTAGE POINTS)



Source: World Bank.

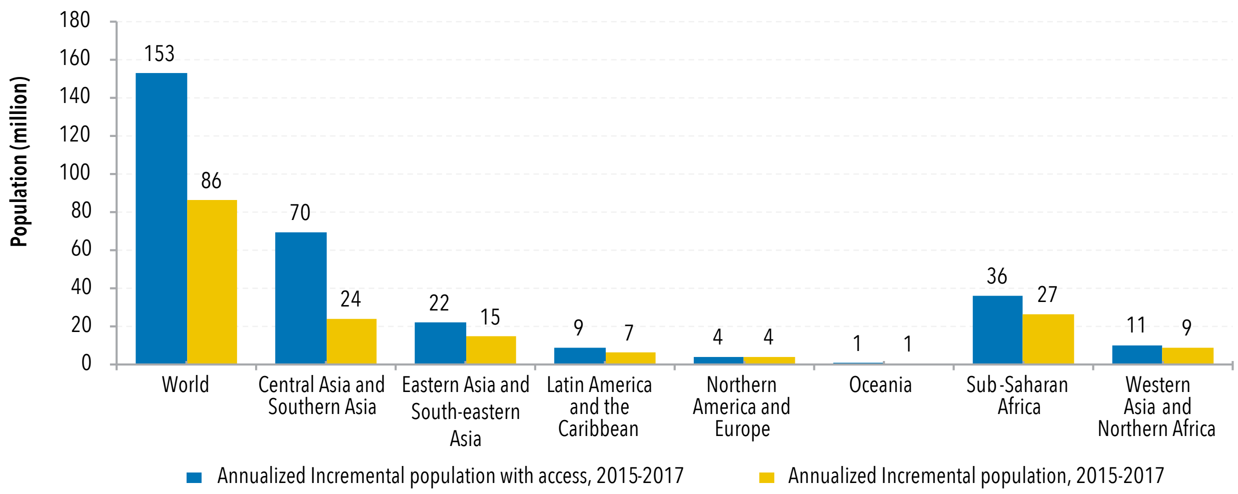
As a result of robust electrification efforts in 2015-2017 (figure 1.5), the global electrification rate accelerated 1.8 times faster than population growth. In a reinforcement of a trend seen since 2011, when the gains in the electrified population began to outpace population growth, the years 2015-2017 also saw a net decline in the number of people lacking access in all regions of the world (figure 1.6). This was underscored by a drop in unserved populations in Central and Southern Asia, and Sub-Saharan Africa. An annual net decrease of 45 million in Central and Southern Asia is particularly stunning, driven mainly by progress in India and Bangladesh, which together constitute 14% of the global access deficit. Central and Southern Asia's remarkable progress brought the region's access rate from 75% in 2010 to 91% in 2017. In 2015-2017, the annual net decrease in Sub-Saharan Africa was 10 million people.

FIGURE 1.5 • PACE OF ELECTRICITY ACCESS VS POPULATION GROWTH, 1990-2017 (INDEX, 1990 = 100)



Source: World Bank.

FIGURE 1.6 • ANNUAL INCREMENTAL GAINS IN ELECTRIFICATION AND POPULATION GROWTH, 2015-2017, BY REGION

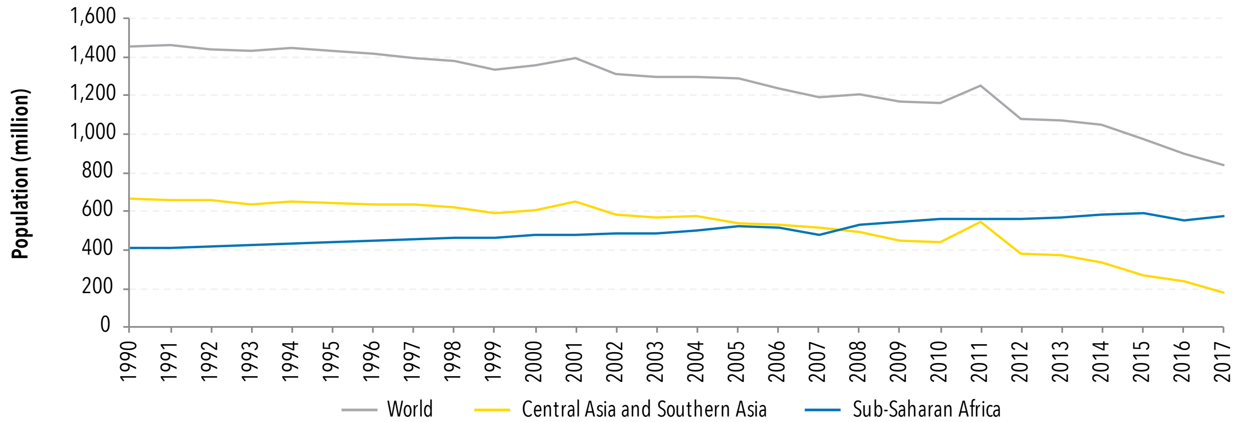


Source: World Bank.

THE ACCESS DEFICIT

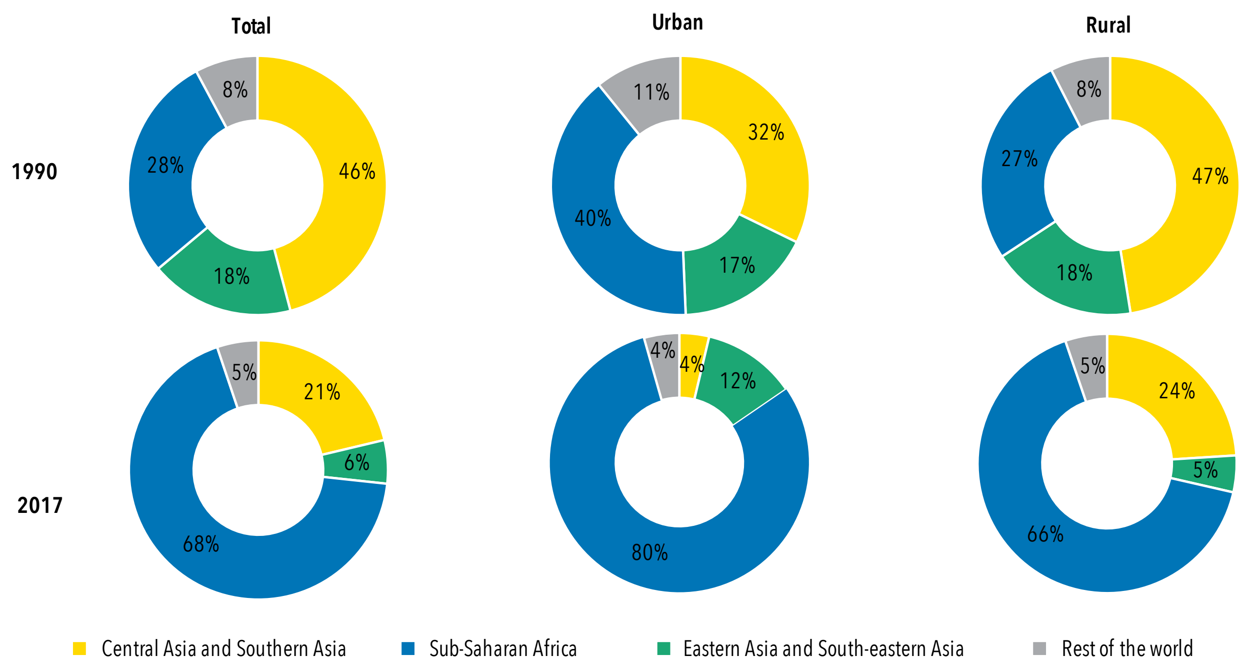
The number of people without electricity has been falling across all regions since 1990, a trend that started to accelerate in 2015. This decline has been significant in Central and Southern Asia, and to a lesser degree in Sub-Saharan Africa, where 7 out of 10 people without access resided in 2017 (figure 1.7). As of 2017, the share of global population without access to electricity in Eastern and South-eastern Asia fell to about a quarter of what it had been in 1990 (figure 1.8). Over that same period, 1990-2017, the share in Sub-Saharan Africa doubled, reaching 68% in 2017, with the result that Sub-Saharan Africa supplanted Central and Southern Asia as the region with the largest unserved population. In 2017, there were 178 million people without electricity in Central and Southern Asia and 573 million people without access in Sub-Saharan Africa. Latin America and the Caribbean is closing in on universal access, with an access rate of 98%, leaving close to 12 million people without access to electricity in 2017.

FIGURE 1.7 • EVOLUTION OF THE ACCESS DEFICIT (MILLIONS OF PEOPLE), 1990-2017



Source: World Bank.

FIGURE 1.8 • REGIONAL SHARES OF THE GLOBAL ACCESS DEFICIT, IN TOTAL AND ALONG THE URBAN/RURAL DIVIDE, 1990 AND 2017



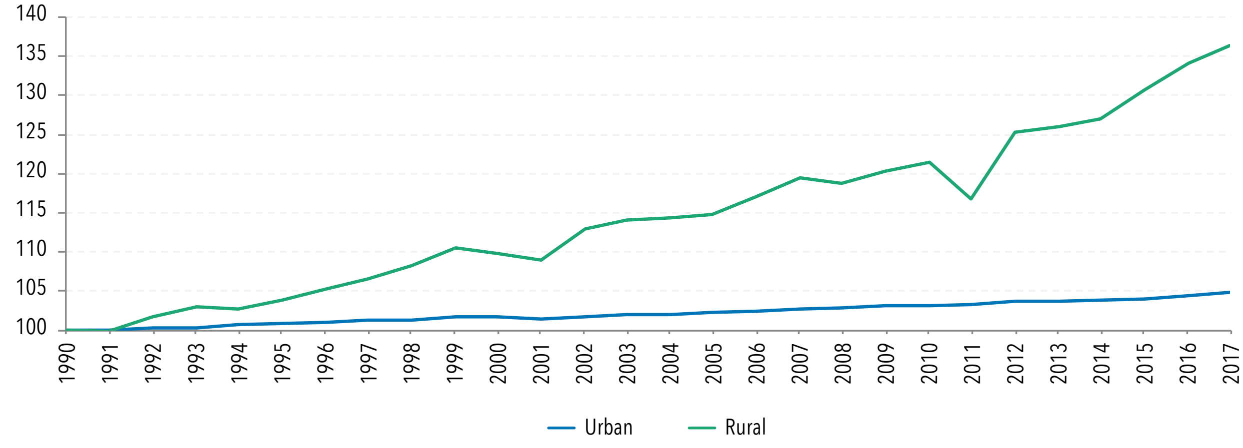
Source: World Bank.
Note: Based on population without access to electricity

URBAN-RURAL DIVIDE

While the pace of access expansion accelerated in rural areas, it remained almost constant in urban areas (figure 1.9). The 2017 global rural access rate of 79% (comprising an access deficit of 728 million people) was significantly lower than the urban access rate of 97% (or 108 million people unserved). A global focus on electrifying the rural population meant that, on average, an additional 60 million rural residents gained access to electricity each year between 2015 and 2017 (the number goes down to a net increase of 54 million people taking population growth into account (figure 1.10)). Incremental rural electrification was six times the additional rural population in Central and Southern Asia over the period 2015-2017. In Sub-Saharan Africa, meanwhile, electrification kept pace with population growth in rural areas.

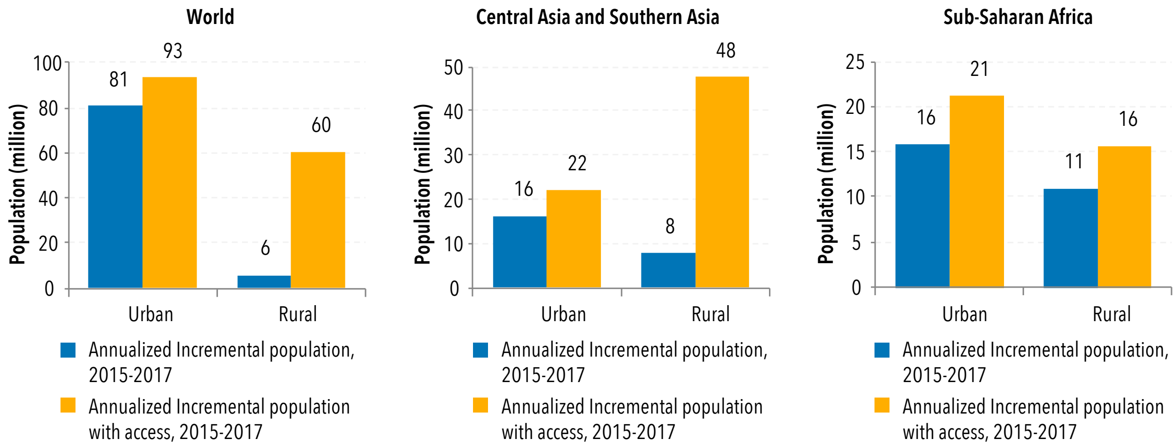
An even larger number of urban residents, about 93 million on average, gained access each year, outpacing the world's urbanization growth. It is important to note that maintaining the urban access rate is more challenging than improving rural access from its low base, and global urbanization trend anticipated over the next decade could lead to larger populations without access in urban areas.

FIGURE 1.9 • SHARE OF POPULATION WITH ELECTRICITY ACCESS IN URBAN AND RURAL AREAS, 1990-2017 (INDEX 1990 = 100)



Source: World Bank.

FIGURE 1.10 • ANNUAL INCREMENTAL ACCESS GAINS AND POPULATION IN THE WORLD, SUB-SAHARAN AFRICA, AND CENTRAL AND SOUTHERN ASIA, ALONG THE URBAN/RURAL DIVIDE, 2015-2017



Source: World Bank.

BOX 1.1 • THE GENDER GAP IN ELECTRICITY ACCESS

Gender-disaggregated analysis of electricity access for Bangladesh, Cambodia, Ethiopia, Myanmar, and Rwanda show significant variability in households' access rates based on gender of head of household. In rural areas, results are mixed: in Ethiopia and Myanmar, female-headed households have higher access rates, while in Bangladesh, Cambodia, and Rwanda, male-headed households are more likely to have access (figure B1.1.1). In urban areas, electricity access is higher among female-headed households in all countries except Rwanda. Shifting focus to electricity source, there is a more significant gender gap in off-grid penetration. Male-headed households are more likely to be connected to the grid than female-headed households in Bangladesh, Cambodia, and Rwanda, while the contrary is true for Ethiopia and Myanmar. Male-headed households have higher access to off-grid electricity in Ethiopia, Myanmar, and Rwanda, while female-headed households have higher off-grid access in Cambodia. Ethiopia and Myanmar have the widest gender gaps, while there is no gender gap in Bangladesh (figure B1.1.2).

FIGURE B1.1.1 • ELECTRICITY CONNECTIVITY IN URBAN AND RURAL HOUSEHOLDS, BY GENDER OF HOUSEHOLD HEAD, 2017

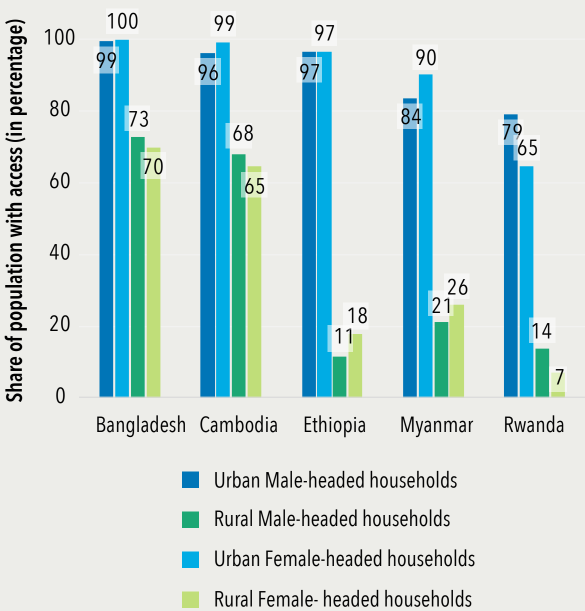
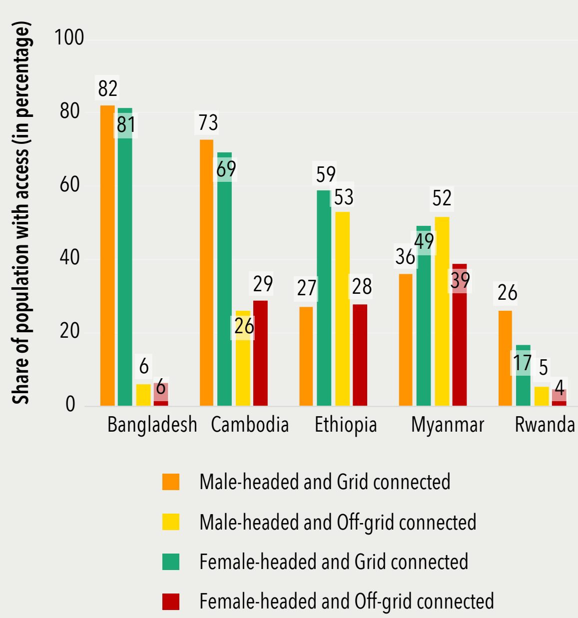


FIGURE B1.1.2 • TYPE OF ELECTRICITY CONNECTIVITY, BY GENDER OF HOUSEHOLD HEAD, 2017



Source: MTF, World Bank.

OFF-GRID ELECTRIFICATION

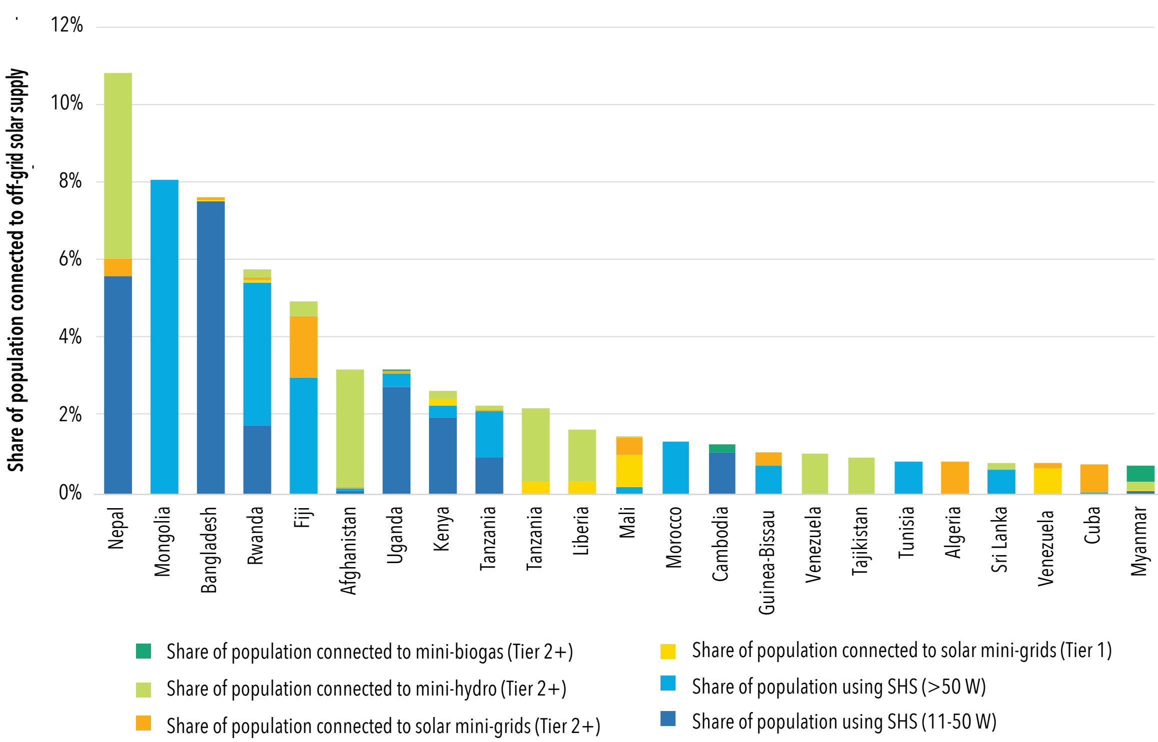
While significant strides are being made to improve data on off-grid electrification, the progress is difficult to track because it is often private sector-driven, and includes small, local, and even informal providers. It is therefore necessary to rely on a supply-side data in the IRENA or GOGLA's databases[15] as well as demand-side perspective available through the MTF (Box 1.2).

Globally, at least 34 million people had access to the equivalent of Tier 1+ electricity service either through SHSs or connection to mini grids based on solar, hydropower and biogas in 2017 (IRENA 2019).[16] This marks a threefold increase from 2010 – 2017 in the population connected to electricity from off-grid sources. Population with access to SHS providing Tier 1+ service has grown 3.5 times between 2010 – 2017, while population with access to PV mini grids grew 4.5 times between 2010 – 2017. In In 2017, a small set of access-deficit countries—Afghanistan, Bangladesh, Fiji, Mongolia, Nepal, Rwanda, and Uganda—provided 3-11% of their populations with access to electricity from off-grid sources (figure 1.11). Another 34 such countries (10 more than in 2016) supplied 0.25-3% of their population with access to Tier 1 supply from off-grid solar sources. 71% of Tier 1+ access came from SHSs of minimum 11 watts (W) and above and the rest from mini grids.

In addition to Tier 1+ supply, a sizeable population of about 120 million globally had access to basic electricity services provided by solar lights of under 11-watt capacity in 2017. In about 10 countries (Benin, Burkina Faso, Fiji, Jordan, Kenya, Papua New Guinea, Rwanda, Samoa, Tanzania, and Vanuatu) at least 9% of the population benefited from such lighting systems (figure 1.12).

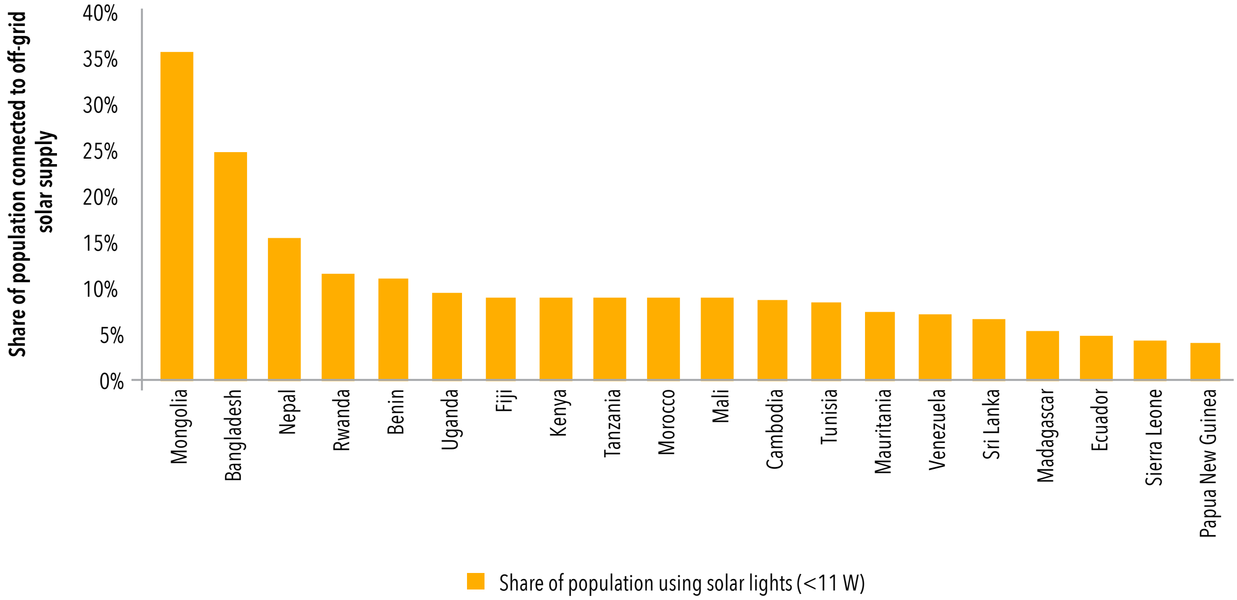
There is a slowdown in the uptake of Tier 1+ SHS in recent years because of the transition to grids and mini grids in countries such as Bangladesh, but there continues to be an uptick in in several countries including Kenya, Rwanda and Uganda. The share of the population getting access through min grids increased by 16 percentage points between 2015 and 2017. These trends indicate the increasing maturity of off-grid and mini grid markets and technologies, but there is still scope for countries to exploit the full potential of these electricity sources.

FIGURE 1.11 • TOP 20 COUNTRIES WITH HIGHEST RATES OF ELECTRICITY ACCESS TO OFF-GRID SOLAR SUPPLY (TIER 1 OR HIGHER), 2017



Source: IRENA.

FIGURE 1.12 • TOP 20 COUNTRIES WITH HIGHEST SHARE OF SOLAR LIGHTING SYSTEMS (BELOW TIER 1), 2017



Source: IRENA.

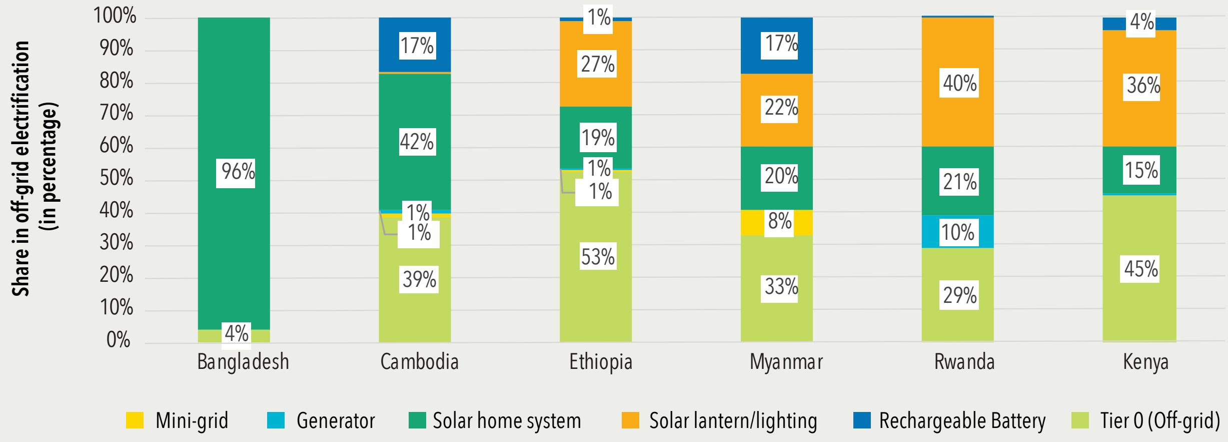
BOX 1.2 • OFF-GRID DEVELOPMENT: A DEEP DIVE THROUGH THE MULTI-TIER FRAMEWORK ENERGY SURVEYS

Off-grid electrification solutions that provide Tier 1+ access, including mini grids, generators, off-grid solar products, and rechargeable batteries, served 14% of the combined population of Bangladesh, Cambodia, Ethiopia, Kenya, Myanmar, and Rwanda in 2017.

The role of off-grid energy solutions is crucial in electrification, but the type of off-grid energy solutions varies between countries (figure B2.2.1). In Myanmar, mini grids have made strong inroads and been instrumental in bolstering electrification efforts in the country. In Rwanda or Ethiopia, the most prevalent off-grid energy solutions are solar lantern or solar lighting systems which provide basic lighting services along with mobile charging and radio. Even though currently only 3.6% and 11.3% of Rwandan and Ethiopian households, respectively, use Tier 1+ level of off-grid solar solutions, most of these households have obtained their off-grid solar products within the last 2-3 years. In Bangladesh, where there is high grid connectivity, off-grid penetration was relatively low at around 5% serving more than 9.7 million of households in remote rural communities.

Off-grid solar solutions constitute about 85% of all off-grid energy solutions: Solar home systems and solar lanterns/solar lighting systems account for about 50% and 35%, respectively. This is followed by rechargeable batteries (10%) and mini grids (2%).

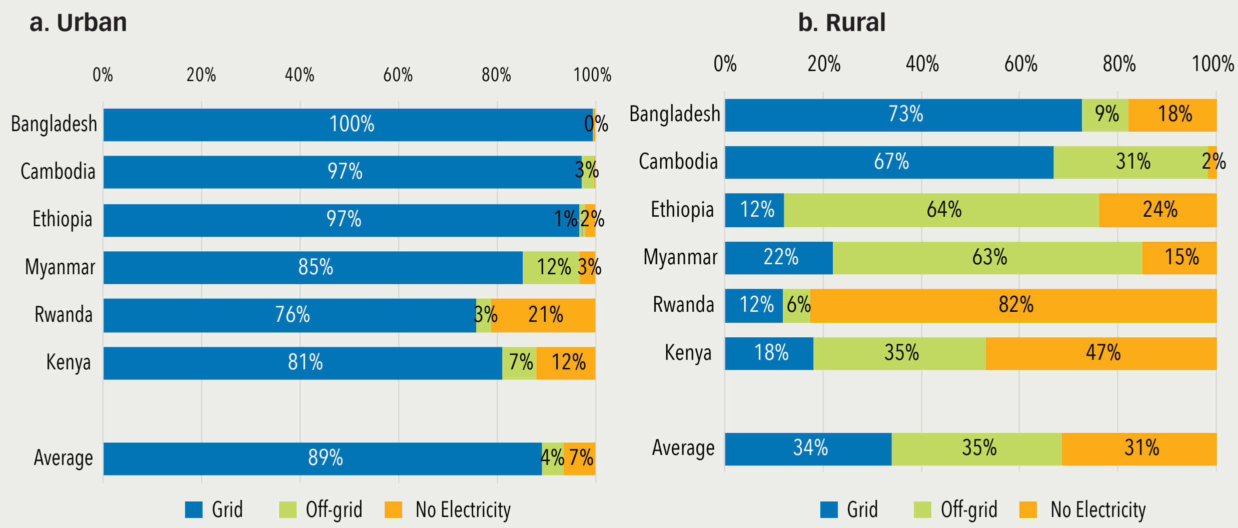
FIGURE B1.2.1 • OFF-GRID SOLUTIONS IN BANGLADESH, CAMBODIA, ETHIOPIA, MYANMAR, KENYA AND RWANDA, BY TECHNOLOGY, 2017



Source: MTF, World Bank

Off-grid energy solutions play a critical role in serving rural areas where the grid electrification rate is lower than urban areas. On average, 35% of rural population have access to electricity via off-grid energy solutions while 4% of population in urban areas use off-grid energy solutions as their primary electricity source (figure B2.2.2). MTF data also shows that poor households benefit more from off-grid energy solutions than rich households across all MTF countries. For example, in Myanmar, 61.1% of the bottom expenditure quintile, on average, have access to electricity via off-grid energy solutions compared to 34.5% of the top 20%.

FIGURE B1.2.2 • TYPE OF ELECTRICITY CONNECTIVITY IN BANGLADESH, CAMBODIA, ETHIOPIA, KENYA, MYANMAR, AND RWANDA, BY SHARE OF TOTAL AND ALONG THE RURAL/URBAN DIVIDE, 2017

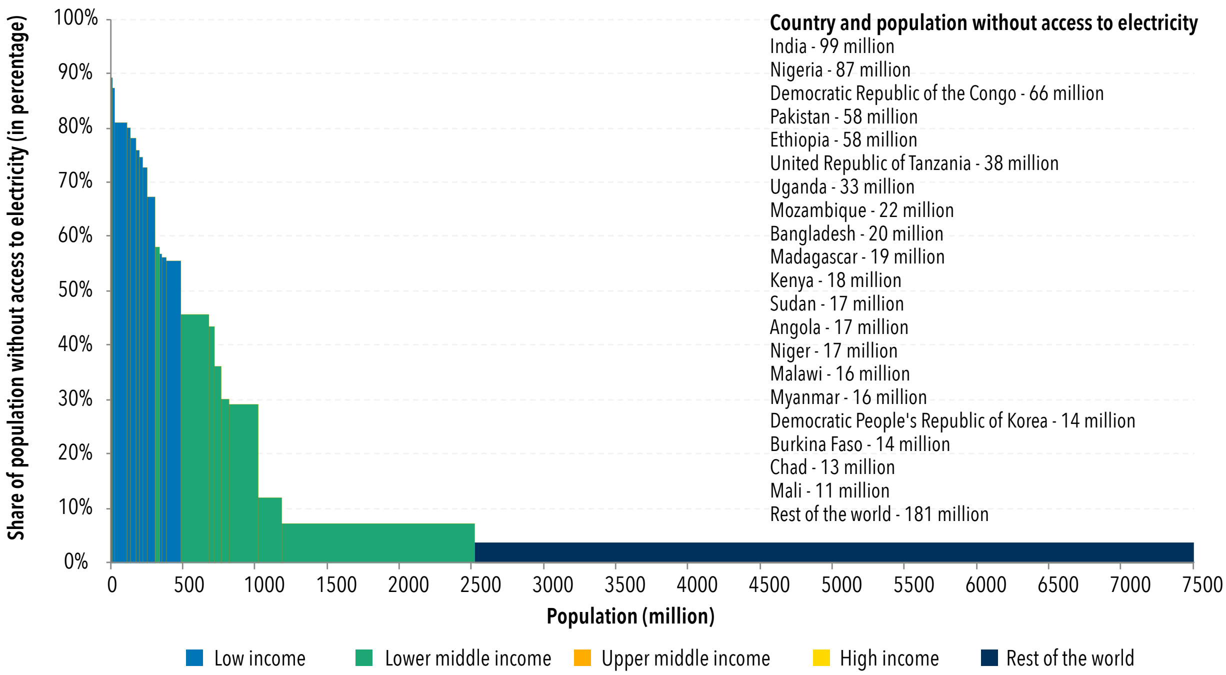


Source: MTF, World Bank

COUNTRY TRENDS

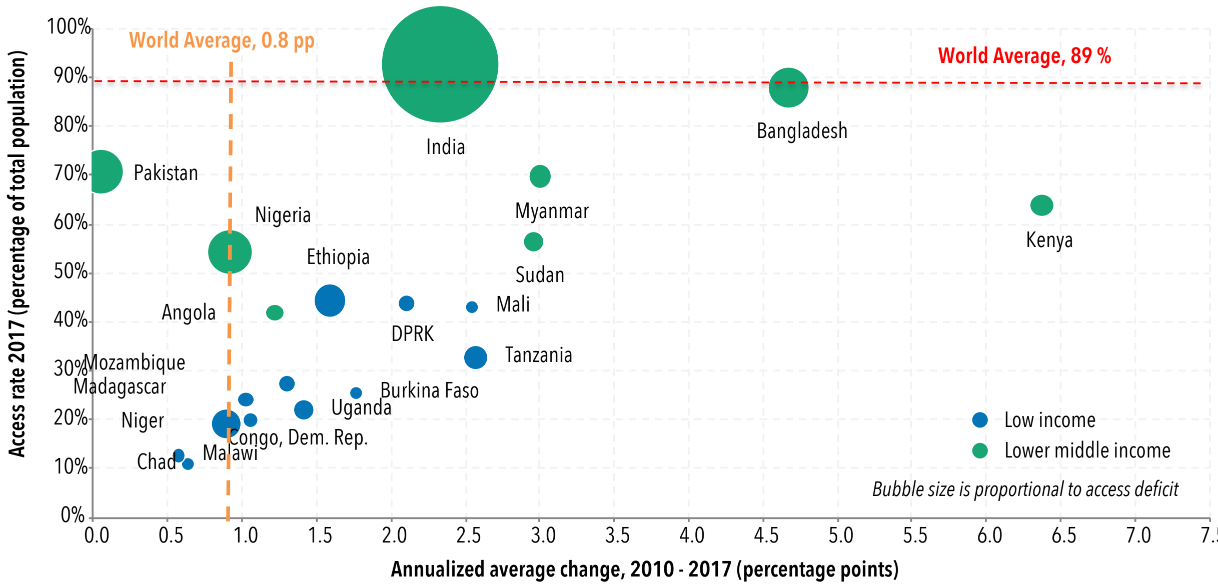
In 2017, about 78 percent of the world's population without electricity lived in the top 20 access-deficit countries (figure 1.13). Although India, with 12% of the global deficit, reached an access rate of 93%, surpassing the global electrification rate, 99 million of its population remained without access to electricity in 2017. With 16 out of the top 20 countries electrifying at over 1 percentage point each year since 2010, the largest access-deficit countries are also driving the global increase in electrification (figure 1.14)—and progress on SDG indicator 7.1.1. But, this growth had only a marginal effect on the net decline in the population without access. Global growth in access was in fact driven by countries like India and Bangladesh, where incremental access outpaced population growth by a significant margin. Yet, in a majority of the top 20 access-deficit countries, this incremental access between 2010 and 2017 did not keep pace with population growth. Moreover, some of the countries with unserved populations of over 50 million in 2017—like the Democratic Republic of Congo, Nigeria, and Pakistan—have electrified less than 1 percentage point of their population annually since 2010.

FIGURE 1.13 • SHARE OF POPULATION AND TOTAL POPULATION WITHOUT ACCESS, TOP 20 ACCESS-DEFICIT COUNTRIES AND REST OF THE WORLD, 2017



Source: World Bank.

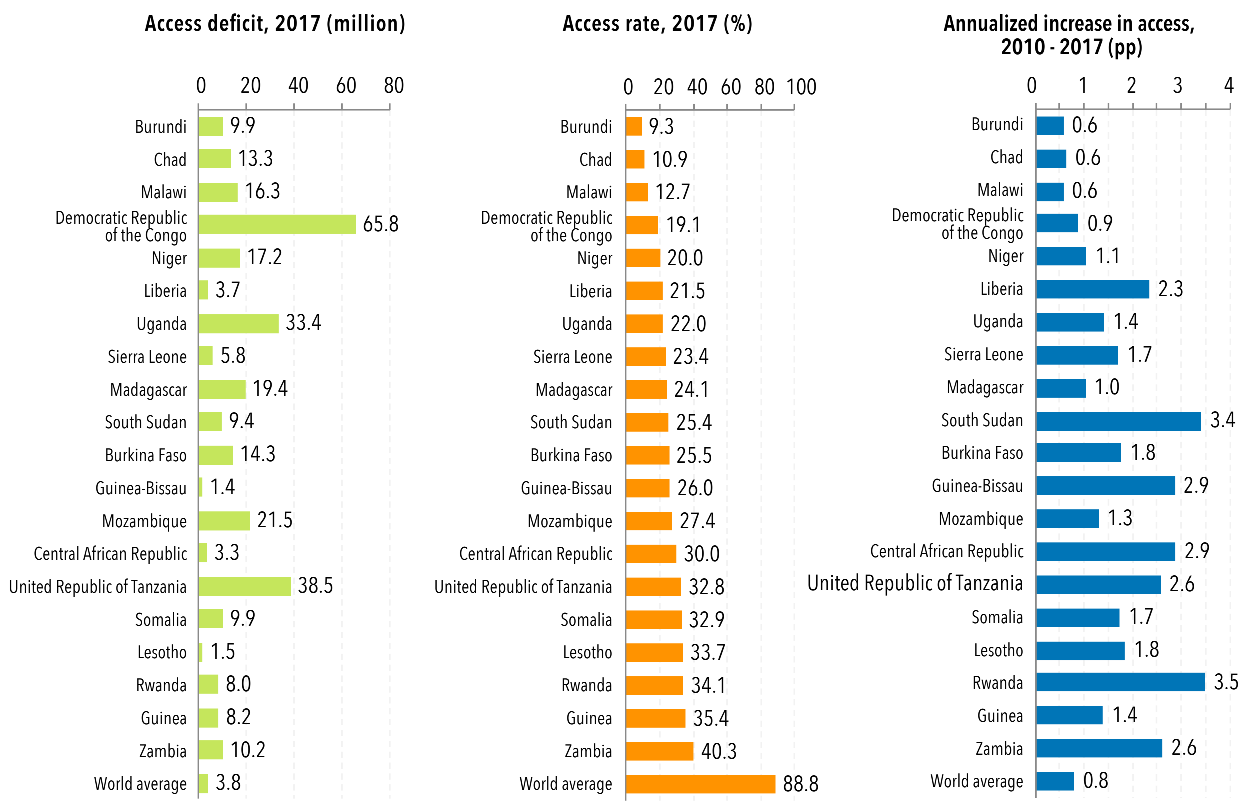
FIGURE 1.14 • CHANGES IN ELECTRICITY ACCESS RATES IN TOP 20 ACCESS-DEFICIT COUNTRIES, 2010-2017



Source: World Bank.

The 20 least-electrified countries are concentrated in the Sub-Saharan African region and were home to over 320 million people lacking access to electricity in 2017 (figure 1.15). Apart from Burundi, Malawi, Chad, and the Democratic Republic of Congo, these countries have been electrifying at a rate of over 1 percentage point annually since 2010. South Sudan and Rwanda, in particular, stand out for their annual rate of over 3 percentage points.

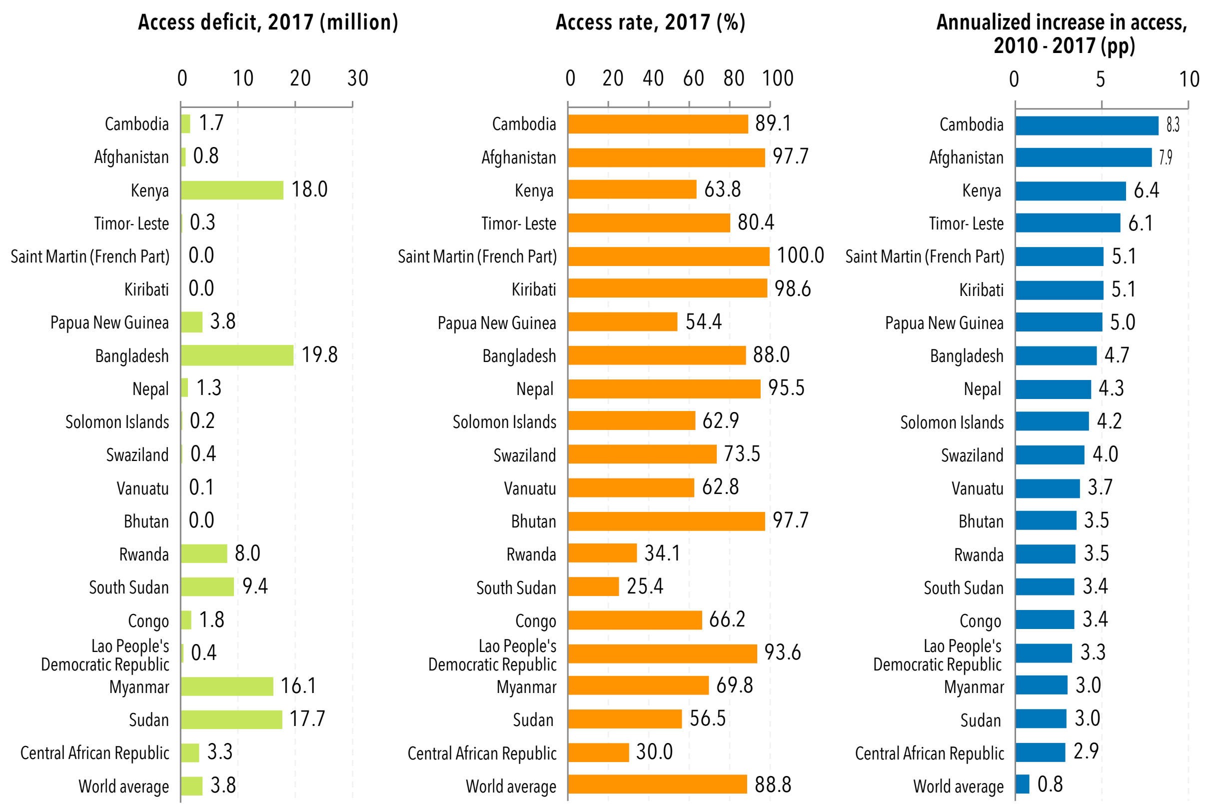
FIGURE 1.15 • ELECTRICITY ACCESS IN THE 20 LEAST-ELECTRIFIED COUNTRIES, 2010-2017



Source: World Bank.

Four countries have electrified at a rate of about 5 percentage points each year since 2010: Afghanistan, Bangladesh, Cambodia, and Kenya (figure 1.16). In Afghanistan's two-pronged approach, urban electrification was improved through grid expansion and rural electrification through the widespread use of SHS. In Cambodia, off-grid solutions constitute the fastest means for expanding access in rural areas. The diversity amongst the fastest-electrifying countries with low access rates, like Rwanda and South Sudan, as well as countries close to universal access, such as Lao People's Democratic Republic, Cambodia, and Afghanistan, shows that it is possible to maintain fast-paced electrification both at early and late stages of the electrification process if the right enabling environment is put in place.

FIGURE 1.16 • ELECTRICITY ACCESS IN THE 20 FASTEST-ELECTRIFYING COUNTRIES, 2010-2017



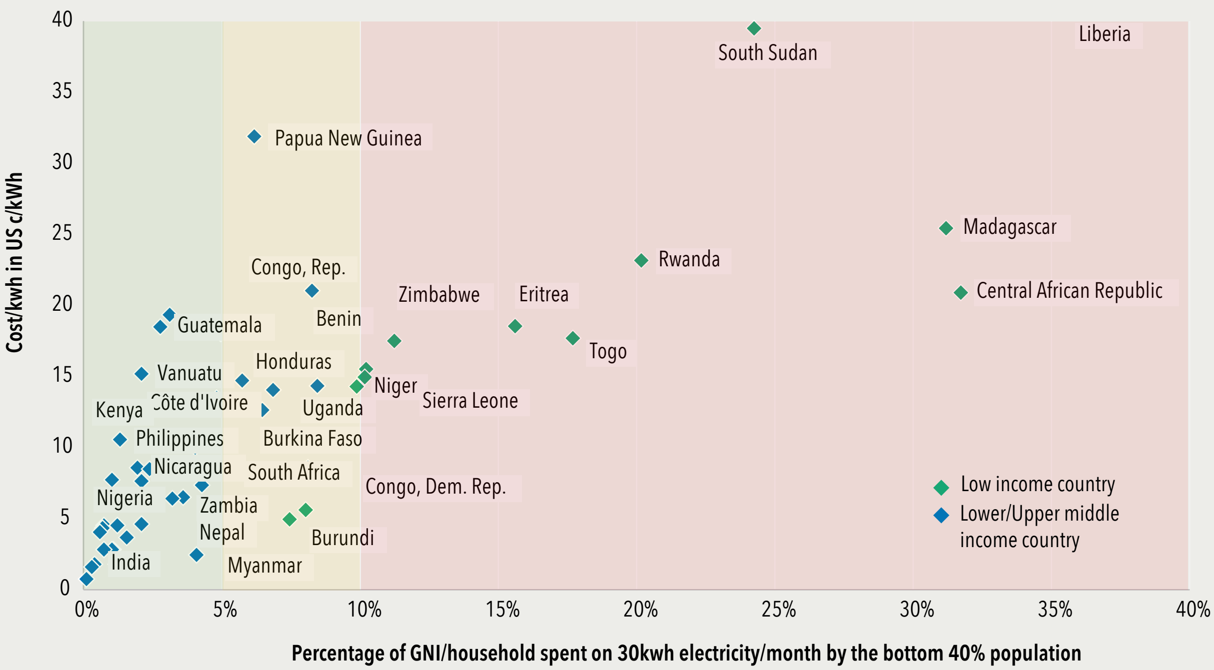
Source: World Bank.

BOX 1.3 • THE AFFORDABILITY AND RELIABILITY OF ELECTRICITY: TWO ELEMENTS CRITICAL TO MAKING PROGRESS ON SDG INDICATOR 7.1.1

Affordability: According to the Regulatory Indicators for Sustainable Energy (RISE) (ESMAP 2018d), in 26 access-deficit countries in 2017,17 the poorest 40% of households spent more than 5% of their monthly household expenditure on 30 kilowatt-hours (kWh) of electricity (figure B1.3.1). For 285 million people with access to electricity in these countries, basic subsistence levels of electricity consumption were unaffordable. Pertinently, a third of the access-deficit countries face relatively high electricity tariffs in excess of $0.15 per kWh, which amounts to monthly expenditures in excess of $4.50 for just 30 kWh of electricity. High costs are often associated with landlocked countries (Rwanda), island states (Madagascar, Papua New Guinea), or small fragile countries with poorly developed infrastructure (Liberia, Somalia).

Also, in 2017, in over half of these countries, getting an electricity connection cost more than one month's income for their poorest 40%, representing 400 million people (figure B1.3.2). In over one-third of these countries, the connection fee was greater than $100 (figure B1.3.3). To tackle the burden of electricity connection costs, over 30% of the access-deficit countries subsidize connection fees. In others, consumers may pay the connection fees in instalments, or utilities may recover connection costs through general tariffs.

FIGURE B1.3.1 • ELECTRICITY TARIFFS AS A SHARE OF GNI PER HOUSEHOLD AMONG THE POOREST 40% OF HOUSEHOLDS, BY COUNTRY, 2017



Source: RISE 2018, World Bank.

FIGURE B1.3.2 • ELECTRICITY TARIFFS AS A SHARE OF GNI PER HOUSEHOLD AMONG THE POOREST 40% OF HOUSEHOLDS IN 54 ACCESS-DEFICIT COUNTRIES, 2017

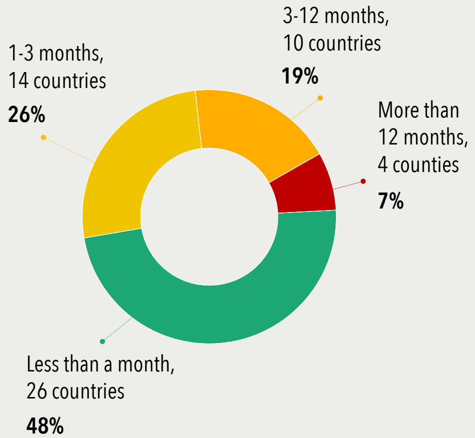
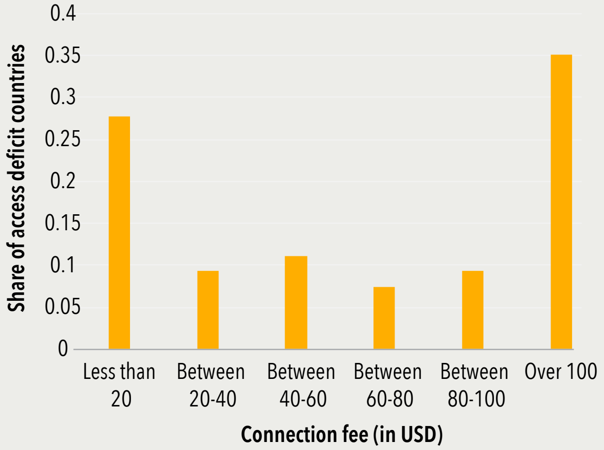


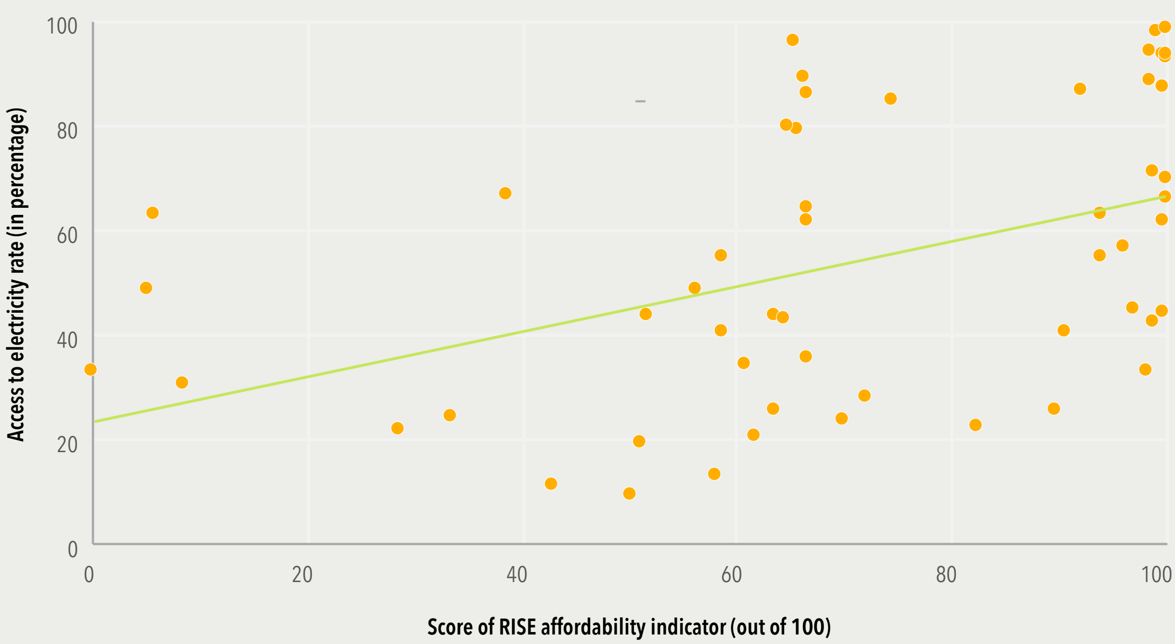
FIGURE B1.3.3 • ELECTRICITY CONNECTION FEES (US$) IN 54 ACCESS-DEFICIT COUNTRIES, 2017



Source: RISE 2018, World Bank.

There is a moderate correlation between electricity access rates and country-level policies that make electricity connection and supply affordable. This goes to show that the countries best placed to achieve progress on SDG indicator 7.1.1 are those that are simultaneously furthering affordability and progress toward universal access (figure B1.3.4).

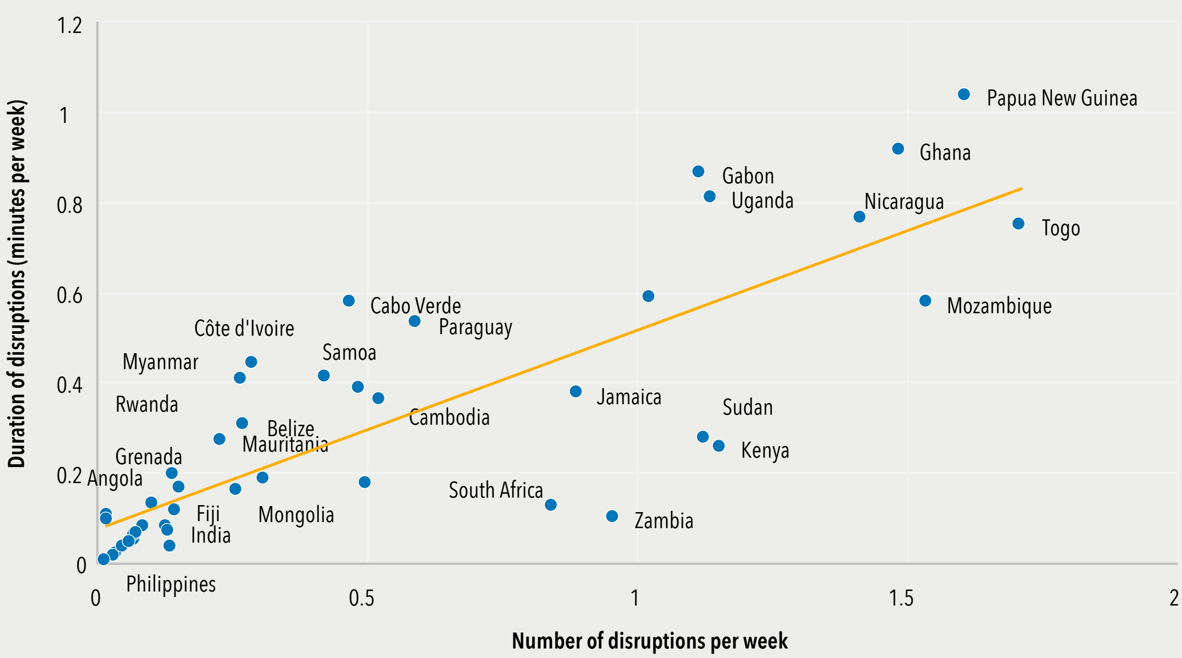
FIGURE B1.3.4 • CROSS PLOT OF 54 COUNTRY-LEVEL ELECTRICITY ACCESS RATES (%), AND SCORE ON RISE AFFORDABILITY INDICATOR (OUT OF 100), 2017



Source: RISE 2018, World Bank.

Reliability: Another important attribute of electricity access is the reliability of its supply as envisaged under SDG indicator 7.1.1. Captured by utilities through a combination of two indexes—the frequency of outages using the System Average Interruption Frequency Index (SAIFI) and the duration of outages using the System Average Interruption Duration Index (SAIDI)—the continuous and uninterrupted supply of the right quantity and quality of electricity is the cornerstone of reliable electricity access. One-third of the access-deficit countries18 face more than one weekly disruption in electricity supply that lasts over four minutes on average19 (figure B1.3.5). Six countries—namely Eritrea, Eswatini, Honduras, Maldives, Palau, and South Sudan have more than three disruptions or aggregate disruption of more than two hours per week.20 In a continuation of the trend seen since 2014, a strong correlation persists between SAIDI and SAIFI, indicating that where disruptions are frequent, they also tend to last longer.

FIGURE B1.3.5 • WEEKLY AVERAGE NUMBER OF AND DURATION OF DISRUPTIONS, 2017



Source: IFC 2018.

POLICY INSIGHTS

The surge in electrification in 2015-2017 is a promising development. But to achieve universal access, sustain the acceleration and leave no one behind, steady progress is needed across all access deficit countries. Electrification will become more difficult as the focus shifts to people who are the hardest to reach – including those living in the most remote areas, marginalized urban communities and the displaced. Examples of tapered progress in electrification as countries near the 100% mark can be found in Colombia, Indonesia, Peru, the Philippines, and Sri Lanka.

Nearly halfway to the SDG 7 target date of 2030, it is imperative to identify the success factors that have enabled progress since 2010 and to highlight the potential game changers.

REINFORCING DATA-DRIVEN DECISION MAKING

Access to more and better data has helped to inform policy and to target policy actions. Geospatial planning, meanwhile, has become an affordable way for policy makers and utility managers to design electrification roadmaps and identify least-cost options. Satellite imagery of night-time lights can precisely identify electrified settlements and track shifts in access. Such analyses are cost-effective complements to surveys performed on the ground. Improving the accuracy of demand estimates is also imperative, since they are indispensable for planning electrification efforts, power systems, and long-term investments.

Understanding end-user needs and perceptions enables policy makers to deploy their tools with greater accuracy. Supply and demand-side data complement each other and will help fill data gaps notably on off grid deployment. Equally important is the availability of sex-disaggregated data on electricity access which needs to be enhanced to allow for an accurate understanding of users' energy needs and priorities, including how male and female users experience electricity supply.

ADOPTING AN ADVANCED POLICY FRAMEWORK AND LEVERAGING PRIVATE FUNDING

A strong policy and regulatory framework are key to successful and sustainable efforts to expand access to electricity. Countries that have increased their access rates the most since 2010 also showed a noticeable improvement in access policies (ESMAP 2018d). National electrification planning is a primary step in building the policy apparatus for the expansion of electricity access. Creating an enabling environment for the three supply options of grids, mini grids, and stand-alone systems is critical, as are policies designed to ensure affordability. As countries improve their policies and regulations, it is also imperative to ensure that these are properly implemented, monitored, and enforced.

In the 20 countries with the greatest access deficit, financing commitments for residential uses of electricity amounted to over $8 billion in 2015-2016. About 60% of the financing came from the domestic and international private sector, doubling the private share from its 2013-2014 levels (SEforALL and CPI 2018). The investment needed to achieve universal access is estimated at $55 billion annually between 2018 and 2030 (IEA 2018). Increased private sector investment will require an enabling business environment characterized by regulatory certainty, investment safeguards, accessible and affordable financing, and, where needed, public sector funding (ESMAP 2017). Easily accessible incentives for both male and female entrepreneurs aimed at supporting their entry into the renewable energy market—including microfinancing, financing for small and medium enterprises, grants, concessional loans, tax benefits, and technology rebates—should be developed. Measures and incentives improving domestic banks' and financial institutions' risk perceptions and awareness regarding lending to women entrepreneurs could facilitate access to finance (ADB 2012).

EXPLOITING THE FULL POTENTIAL OF DISTRIBUTED RENEWABLE-BASED SOLUTIONS

The 2018 High-Level Political Forum called upon governments and other stakeholders to close the access gap by harnessing the potential of the decentralized renewable energy solutions that are transforming the power sector. The strength of off-grid solutions lies in their suitability for rapid deployment and for reaching last-mile customers unlikely to be served by the national grid in the foreseeable future. They also support varying demand and supply needs through a range of products available to end users. From solar lights to SHSs to large stand-alone solar systems to solar/hydro mini grids to biodigesters, off-grid solutions can meet various levels of electricity needs and help ensure households' transition to higher tiers of service.

RISE suggests that programs supporting mini grids and stand-alone systems have benefited from a stronger regulatory push since 2010 than grid electrification. Finance commitments for off-grid solutions, including mini grid technologies, nearly doubled between 2013-2014 and 2015-2016 to reach an average of $380 million per year. While this is a positive trend, these investments remain a small portion (1.3%) of the total finance tracked (SEforALL and CPI 2018). To make the deployment of off-grid solutions as effective as possible, adequate financing structures are needed to overcome the barriers of high up-front costs, regulatory uncertainty, competition from other technologies, and the lack of skilled operators and managers (ESMAP 2017).

STIMULATING DEMAND FOR PRODUCTIVE USES OF ELECTRICITY

Stimulating demand for electricity, especially for productive uses, could significantly enhance the financial sustainability of electrification projects while transforming communities. Therefore, it should be integral to electrification efforts (IEG 2015). Demand for electricity does not necessarily grow organically and instantly after the arrival of electricity. Obstacles to demand include limited access to markets, unreliable supply, poor access to information, inadequate access to capital and financing, and a lack of affordable appliances. Measures include end-user training and awareness raising, mechanisms to make energy efficient appliances available and affordable, appropriate financing, and advisory business services (ADB 2012). Targeting both male and female users is likely to yield the best results (ESMAP 2013).

TAILORING MULTIFACETED ELECTRIFICATION STRATEGIES TO LEAVE NO ONE BEHIND

To be effective, electrification efforts must be attuned to population growth, especially in cities, while addressing the creditworthiness of utilities. To be inclusive, they must close the gaping chasm between urban and rural electrification rates. At the same, it is important not to ignore the quality of electricity service and risk underutilizing the economic benefits of reliable electricity supply. Commitments to leave no one behind in the achievement of SDG 7 require that the energy needs of the forcibly displaced be specifically addressed. Over 85% of the world's 68.5 million forcibly displaced people are hosted by developing countries, and most of them lack access to legal, safe, reliable, and affordable electricity (UNHCR n.d.). To date, data on their rates of access to energy are limited to a few specific camps and sample studies, including the Global Plan of Action for Sustainable Energy Solutions in Situations of Displacement (UNITAR 2019). One global study estimates that over 80% of those living in camps have minimal access, and that levels of access and incomes vary considerably across contexts (Lahn and Grafham 2015). Meanwhile 80% of internally displaced people and 60% of refugees find refuge in urban areas, where energy systems may already be under stress and under resourced (UNHCR n.d.). Much work needs to be done to identify actual needs and the most appropriate ways to put electricity within reach of these vulnerable populations under circumstances often complicated by political sensitivities and security issues.

METHODOLOGY

DATABASE

The World Bank's Global Electrification Database compiles nationally representative household survey data, and occasionally census data, from sources going back as far as 1990. The database 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, which are based on similar surveys (table 1.1). At the time of this analysis, the Global Electrification Database contained 1,006 surveys from 144 countries, excluding high-income countries (as classified by the United Nations) for 1990-2017.

TABLE 1.1 • OVERVIEW OF DATA SOURCES

Name	Statistical agency	Number of countries	Number of surveys	Question(s) on electrification standardized across countries
Censuses	National statistical agencies	65	125 (12%)	Is the household connected to an electricity supply? Does the household have electricity?
Demographic and Health Survey	Funded by the United States Agency for International Development (USAID); implemented by ICF International	87	275 (27%)	Does your household have electricity?
Living Standards Measurement Survey	National statistical agencies supported by the World Bank	19	26 (3%)	
Income expenditure survey, or other national surveys	National statistical agencies, supported by the World Bank	96	446 (44%)	Is the house connected to an electricity supply? What is your primary source of lighting?
Multi Indicator Cluster Survey	United Nations Children's Fund (UNICEF)	64	103 (10%)	Does your household have electricity?
World Health Survey	World Health Organization	8	8 (<1%)	
Multi-Tier Framework	World Bank	8	8 (< 1%)	
Other		12	15 (1.5%)	

Source: World Bank.

ESTIMATING MISSING VALUES

The typical frequency of surveys is every two to three years, but in some countries and regions, surveys can be irregular in timing and much less frequent. To estimate missing values, a multilevel nonparametric modeling approach—developed by the World Health Organization for estimating clean fuel use—was adapted to electricity access and used to fill in the missing data points for 1990-2017. 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). Regional groupings are based on the UN breakdown.

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, assuming access scale-up is likely to be similar. 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 an electrification rate of 100% from the first year the country entered the category.

In the current report, to avoid electrification trends from 1990 to 2010 overshadowing electrification efforts since 2010, the model was run twice:

- With survey data + assumptions from 1990 to 2017 for model estimates from 1990 to 2010
- With survey data + assumptions from 2010 to 2017 for model estimates from 2010 to 2017

MEASURING ACCESS TO ELECTRICITY THROUGH OFF-GRID SOURCES

The 2017 International Renewable Energy Agency's off-grid database covers only developing countries (excluding China). The database sources data from large databases, including GOGLA, country, and regional databases, along with significant data from off-grid plants.

The tier-wise data is presented by technologies as:

- Tier 0: Lights (<11W);
- Tier 1: Small SHS (11-50W); large SHS (>50W); PV mini grid access Tier 1;
- Tier 2+: PV mini grid access and non-PV mini grids.

Detailed methodology is available at Measurement and estimation of off-grid solar, hydro and biogas energy.

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 in order 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.

WORLD BANK-IEA ELECTRIFICATION DATA METHODOLOGY COMPARISON

The World Bank and IEA each maintain a database of global electricity access rates. The World Bank Global Electrification Database derives estimates from a suite of standardized household surveys that are conducted in most countries every two to three years, along with a multilevel nonparametric model used to extrapolate data for the missing years. The IEA Energy Access Database sources data, where possible, from government-reported values for household electrification (usually based on utility connections).

The two different approaches can lead to estimates that differ for some countries. Access levels based on household surveys are moderately higher than those based on energy sector data (as is typical) because they capture a wider range of phenomena including off-grid access, informality, and self-supply.

A comparison of the two datasets that was initiated in the last edition of this report and updated in this edition highlights their different strengths. Household surveys, typically conducted by a national statistical agency, offer two distinct advantages when it comes to measuring electrification. First, because of longstanding international efforts to harmonize questionnaire design, electrification questions are most often standard across country surveys. Although not all surveys reveal detailed information on the forms of electricity access, as the market evolves survey questionnaire designs can and are being updated to better reflect important emerging phenomena such as off-grid solar access. Second, data from surveys convey a user-centric perspective on electrification. Using survey data captures all the electricity access forms, painting a more complete picture of access than may be possible from service provider data.

Administrative data on electrification reported by the ministry of energy in each country convey the electrification status from the perspective of supply-side data on utility connections. Although not published by every government, these kinds of data offer two principal advantages. First, administrative data are often available on an annual basis and, for this reason, may be more up to date than surveys, which are typically updated only every two to three years, necessitating model estimates in intervening years. Second, administrative data are not subject to the challenges that can arise when implementing surveys in the field as some household surveys may suffer from sampling errors, particularly in remote rural areas, which could lead to an underestimation of the access deficit.

Data from the two methodologies yielded different results for 2017 for both access rates and the population without access at the global and country levels, with over 70 percent of the difference in results emanating from just 20 countries.

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ENDNOTES

3 IEA, 2018 - See chapter 5.

4 Regional results based on UN regional classification.

5 South Asia has an access rate of 90% and Central Asia has an access rate of 99%.

6 Access deficit countries in RISE refer to countries with over 1 million population with electricity access or an access rate of less than 90%.

7 Countries with an access deficit of over 5 million people or an access rate of less than 90%.

8 The World Bank's "Getting Electricity" data on the System Average Interruption Frequency Index (SAIFI) and duration of outages using the System Average Interruption Duration Index (SAIDI) (World Bank 2019). The database has reliability data on 43 out of 96 access-deficit countries.

9 The use of the term "access to electricity" refers to electricity being the source of lighting in a household, or to service at Tier 1 and above.

10 The World Bank's Global Electrification Database, the source of the electrification data needed to track SDG 7.1.1, uses a demand-side approach based on standardized household surveys and, as needed, fills data gaps with model estimates using a suite of alternative surveys (for more details, refer to the methodology section at the end of this chapter). The International Energy Agency's (IEA's) electrification database offers a supply-side perspective based on utility-level data (IEA 2018).

11 See chapter 5 of this report.

12 The International Energy Agency's New Policies Scenarios projects that 580 million people without access to electricity will live in Sub-Saharan Africa, 50 million in Developing Asia, and 20 million in other regions. See chapter 5 of this report for details.

13 The Dominican Republic, Ecuador, Palau, Panama, Saint Vincent and the Grenadines, and Tuvalu achieved universal access between 2015 and 2017.

14 Including India.

15 GOGLA Global Off Grid Solar Database (sourced through the Lighting Global / GOGLA Sales Data Collection).

16 Data on the number of people with access to these forms of electricity supply are gathered by IRENA (2019) based on sales of solar panels, project reports, and other publicly available sources.

17 With an access deficit of over 5 million or an access rate of less than 90%.

18 The World Bank's Getting Electricity Database contains SAIDI and SAIFI data for 47 access-deficit countries.

19 Data pertain to electricity supply to commercial enterprises (IFC 2018).

20 The World Bank's Multi-Tier Framework for Energy Access describes Tier 5 access as a maximum of three disruptions per week with an aggregate disruption duration of less than two hours per week.

CHAPTER 2

ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

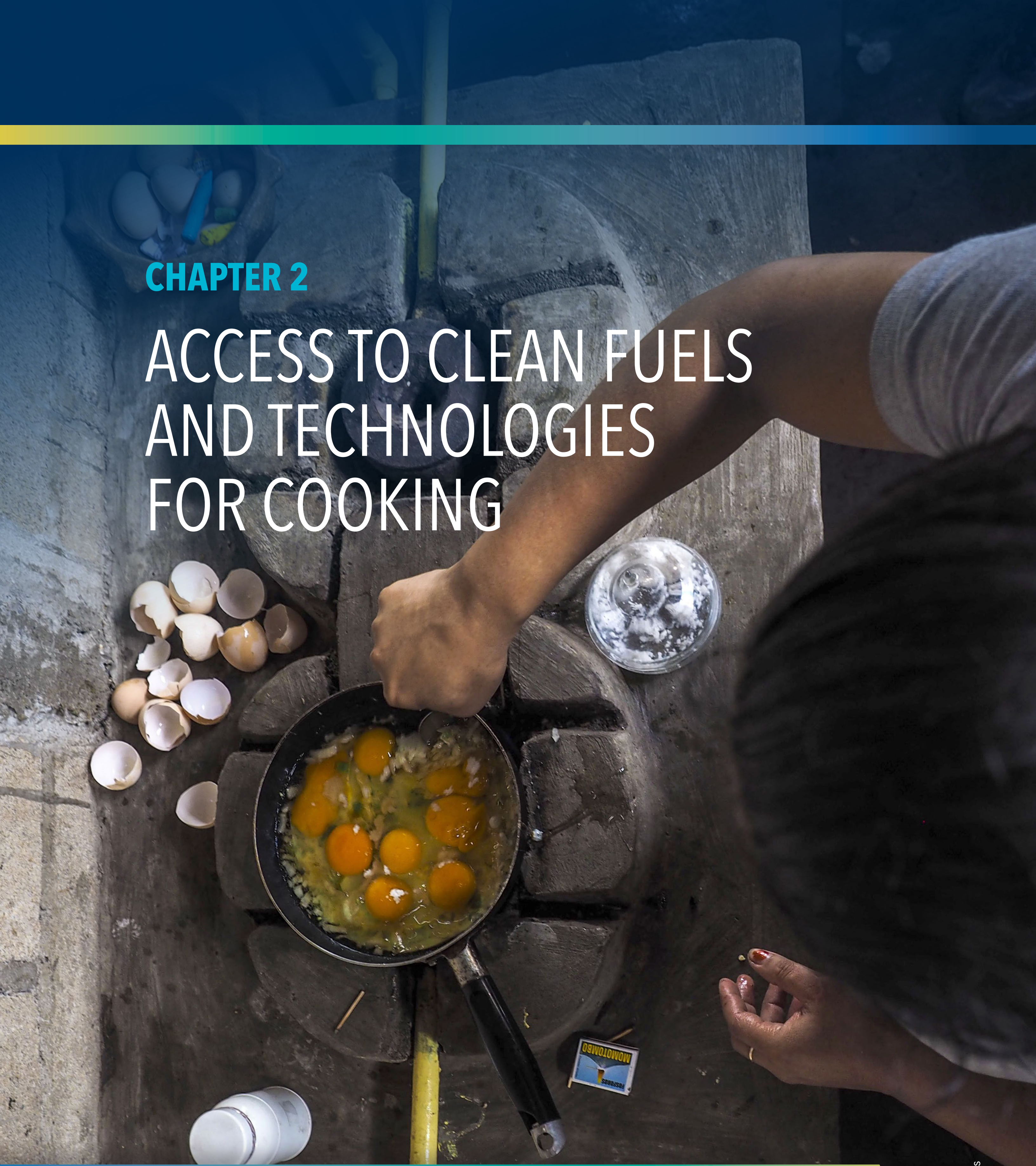


Photo: Gettyimages

MAIN MESSAGES

- **Global trend:** The share of the population with access to clean[21] fuels and technologies for cooking increased from 57% [51, 62][22] in 2010 to 61% [54, 67] in 2017, an average annual increase of 0.5 percentage points [1.6, -0.5]. However, because population growth is outpacing annual access gains, the global access deficit has remained stagnant since 2016, at around 3 billion, having decreased between 2000 and 2017 by 3%. Unless rapid action is taken, household air pollution will remain the cause of millions of deaths from noncommunicable diseases (including heart disease, stroke, and cancer), as well as pneumonia (WHO 2018a).

- **2030 target:** While the global access rate appears to have increased by approximately 0.5 percentage points [1.6, -0.5] annually from 2010 to 2017, annual progress slowed down after 2008. The majority of gains was driven by Central and Southern Asia and Eastern and Southeastern Asia, where the average annual increase in the access was 1.2 percentage points and 0.9 percentage points, respectively, in 2010-2017. To reach universal clean cooking targets by 2030 and outpace population growth, especially in the Sub-Saharan Africa region, the annual rate of access expansion needs to increase to around 3.0 percentage points from the rate of 0.5 percentage points observed between 2010 and 2017. Based on the current trajectory and population projections, around 2.2 billion people will be without access to clean cooking solutions by 2030 (IEA 2018). Each year without a substantial increase in access expansion adds tens of millions to the global access deficit.

- **Regional highlights:** Central and Southern Asia, Eastern and Southeastern Asia, and Sub-Saharan Africa account for the majority of the access-deficit population. Population growth between 2010 and 2017 in Sub-Saharan Africa was 2.5% annually, while the annual change in the share of the region's population with access to clean cooking solutions was less than 0.3 percentage points annually. For this reason, the access-deficit population in this region increased from less than 750 million in 2010 to around 900 million in 2017. In Latin America, access remained stable (around 88% [85, 90]) between 2016 and 2017, with an average annual increase of 0.4 percentage points between 2010 and 2017. The only part of the world that saw substantial progress relative to population growth was Asia, with Central and Southern Asia showing an average annual increase of 1.2 percentage points between 2010 and 2017, and Eastern and Southeastern Asia an annual increase of 0.9 percentage points.

- **Urban-rural distribution:** The rate of access to clean cooking solutions remains much higher in urban areas, where 83% [79, 85] have access, than in rural areas, where only 34% [29, 40] have access.

- **Top 20 access-deficit countries:** The population-weighted average national access rate among the top 20 countries[23] was 44% [54, 33] in 2017, while the average non-population-weighted access rate among these countries was 26% [23, 29]. The country with the largest access deficit in 2017 was India, where an estimated 700 million did not have access to clean cooking solutions. Six of the 20 countries had access rates below 5% and in only 5 of the 20 countries did the expansion of access outpace population growth between 2010 and 2017.

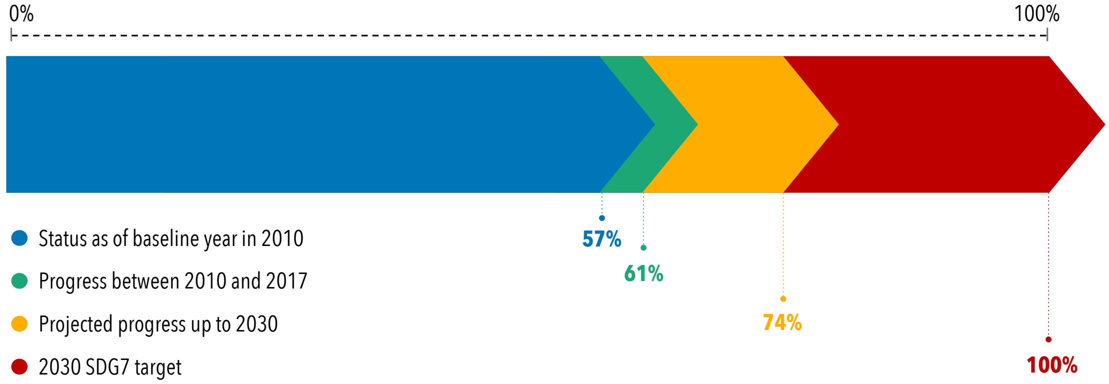
- **Fuel trends:** Based on the results of national surveys, in most access-deficit regions, the use of wood is declining steadily. However, this trend is largely offset by an increase in charcoal usage, primarily in Sub-Saharan Africa.[24] Across the board, use of kerosene as a primary source of cooking energy is gradually declining. Meanwhile, the use of cleaner cooking fuels and technologies such as liquefied petroleum gas, natural gas, and biogas is increasing in both Asia and Sub-Saharan Africa. This increase can be observed in both urban and rural settings in Asia, but is primarily seen among urban households in Africa. Anecdotal evidence suggests that more efficient and cleaner processed biomass fuels are on the rise in some countries, particularly in rural areas, illustrating their important role in the transition to cleaner household energy.

- **Outlook:** Even though overall progress in access to clean fuels and technologies is slowing down, putting Sustainable Development Goal 7 further out of reach, there is evidence to show that faster progress may be possible in the near future. Overall, 4 of the top 20 access-deficit countries (Vietnam, Indonesia, Sudan, and Afghanistan) expanded access to clean cooking solutions by more than 2 percentage points annually between 2010 and 2017, or at least four times faster than the rest of the world. Achieving universal access to clean and sustainable cooking solutions holds substantial benefits for the health and well-being of women and children. Millions of deaths and years of disability can be attributed to exposure to the inefficient use of cooking energy. Empirical evidence shows women and children in developing countries can spend up to 10 hours a week gathering fuels, and this time-poverty has detrimental impacts on access to education and income-generating opportunities.[25]

ARE WE ON TRACK?

Unless clean cooking is prioritized and progress accelerated, the world will not achieve universal access to clean cooking solutions by 2030. In 2017, 61% [54, 67] of the world's population had access to clean cooking fuels and technologies (electricity, liquid petroleum gas [LPG], natural gas, biogas, solar, and alcohol fuels) but around 3 billion people were still relying on polluting fuels and technology for cooking.

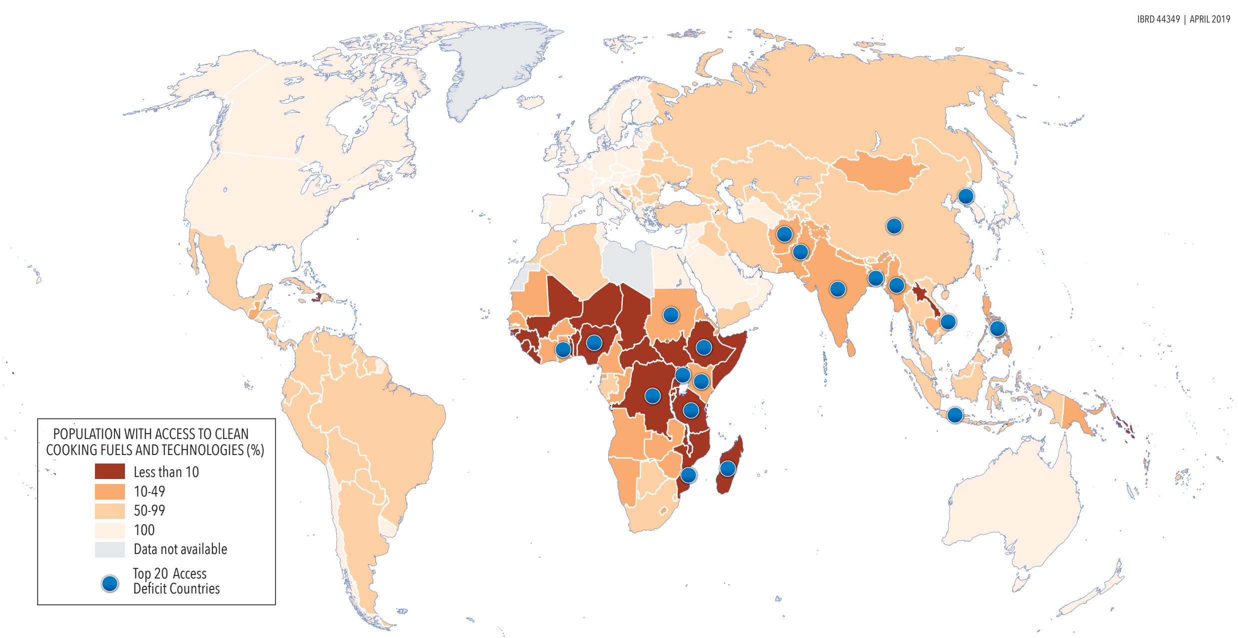
FIGURE 2.1 • PERCENTAGE OF THE GLOBAL POPULATION WITH ACCESS TO CLEAN COOKING SOLUTIONS (%)



Source: WHO 2019.
Note: The projected progress up to 2030 was estimated based on current rates of progress. SDG = Sustainable Development Goal.

Assuming the annual rate of increase in access of 0.5 percentage points per year seen between 2010 and 2017, clean cooking solutions will reach only 74% of the global population by 2030. As illustrated in figure 2.1, this still leaves approximately a third of the global population without access to clean cooking by 2030 (the majority of which will reside in Sub-Saharan Africa), undermining progress measured using the Sustainable Development Goal (SDG) indicator 7.1.2 (proportion of population with primary reliance on clean fuels and technology).

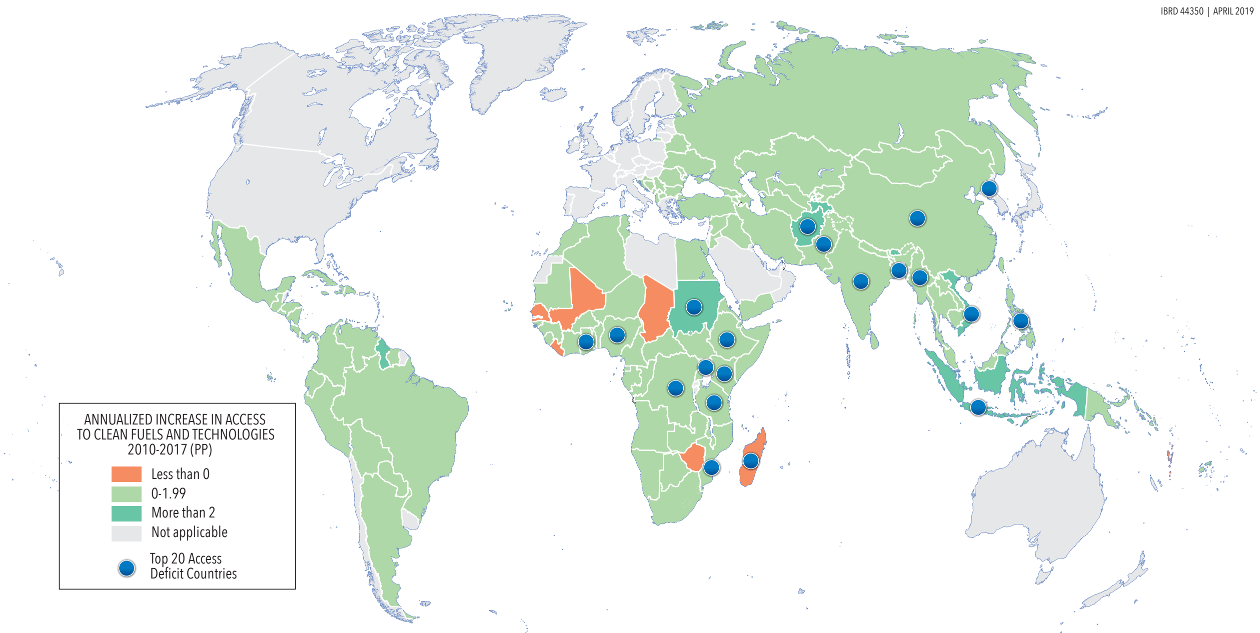
FIGURE 2.2 • REGIONAL POPULATIONS, BY RATE OF ACCESS TO CLEAN COOKING FUELS AND TECHNOLOGIES, 2017



Source: WHO 2019.

As illustrated in figure 2.2, access to clean fuels is distributed unevenly across the globe: the lack of access is most pronounced throughout developing Asia and Sub-Saharan Africa, where all of the top 20 access-deficit countries are located (as shown by the blue dots). In developing Asia, the use of gaseous fuels (LPG, natural gas, and biogas) is high, and is increasing in both urban and rural areas.

FIGURE 2.3 • AVERAGE ANNUAL INCREASE (PERCENTAGE POINTS) IN THE CLEAN COOKING ACCESS RATE IN ACCESS-DEFICIT COUNTRIES, 2010-2017



Source: WHO 2019.

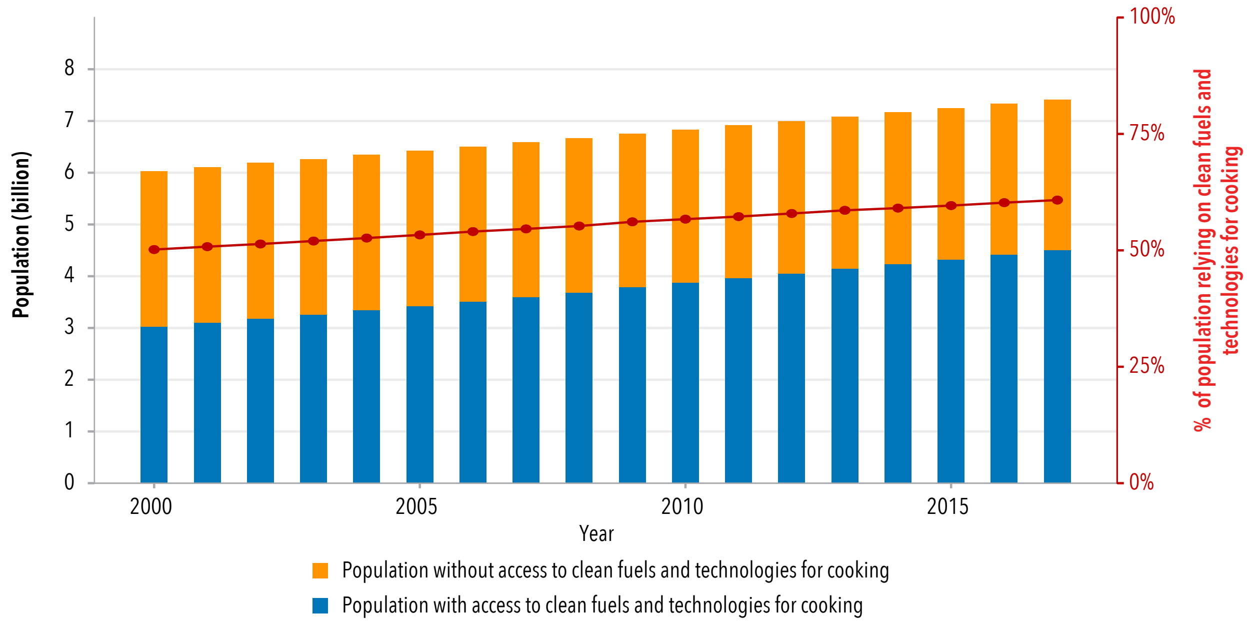
Unfortunately, most countries have made only incremental progress in recent years: figure 2.3 shows the average annual increase between 2010 and 2017, by country. Access did not improve substantially in Sub-Saharan Africa, remained stable in Latin America, and showed only slow progress in Developing Asia. Arguably, the access rate at the regional level in Sub-Saharan Africa needs to accelerate even faster than the global average. Worldwide, only seven countries saw their access expand at an annual rate greater than 2 percentage points. In 95% of the access-deficit countries, the average annual increase in access was below 2% for the same period, and in five countries the access rate declined.

LOOKING BEYOND THE MAIN INDICATORS

ACCESS AND POPULATION

The global access to clean cooking fuels and technologies reached 61% [54, 67] in 2017. As seen in figure 2.4, the access rate increased steadily between 2000 and 2017, while average annual access increased by 0.5 percentage points [1.6, -0.5] from 2010 to 2017.

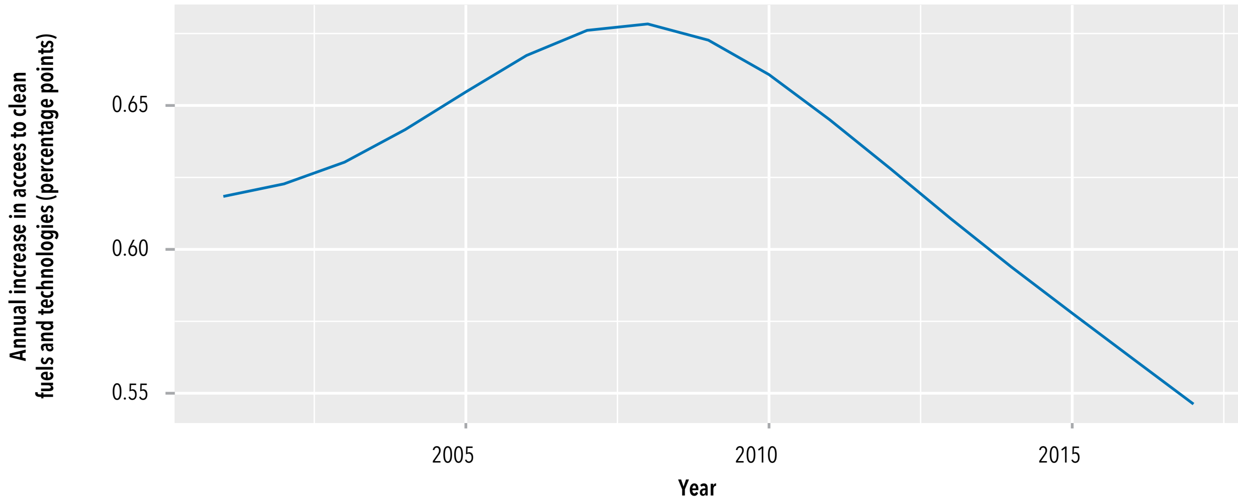
FIGURE 2.4 • CHANGE OVER TIME IN THE ABSOLUTE NUMBER OF PEOPLE (LEFT AXIS) AND PERCENTAGE OF THE GLOBAL POPULATION (RIGHT AXIS) WITH AND WITHOUT ACCESS TO CLEAN COOKING SOLUTIONS, 2000-2017



Source: WHO 2019.

However, as shown in figure 2.5, progress in access progressively decelerated after 2008, from 0.7 percentage points to 0.5 percentage points per year. Even discounting this slowdown, the overall rate of progress is not enough to reach SDG target 7.1 by 2030. Moreover, as seen in previous years, population growth continues to outpace access in Sub-Saharan Africa. Figure 2.6 compares the annual increase in the number of people with access to clean fuels and technologies (yellow) to the annual population increase (orange), by region, over the period 2015-2017. It can be seen that, over this period, population growth in Sub-Saharan Africa vastly outstripped growth in the number of people with access to clean cooking solutions. In 2017 around 3 billion people lacked access to clean fuels and technologies for cooking; in 2030 around 40% of the access-deficit population will reside in Sub-Saharan Africa and around 26% in Central and Southern Asia.

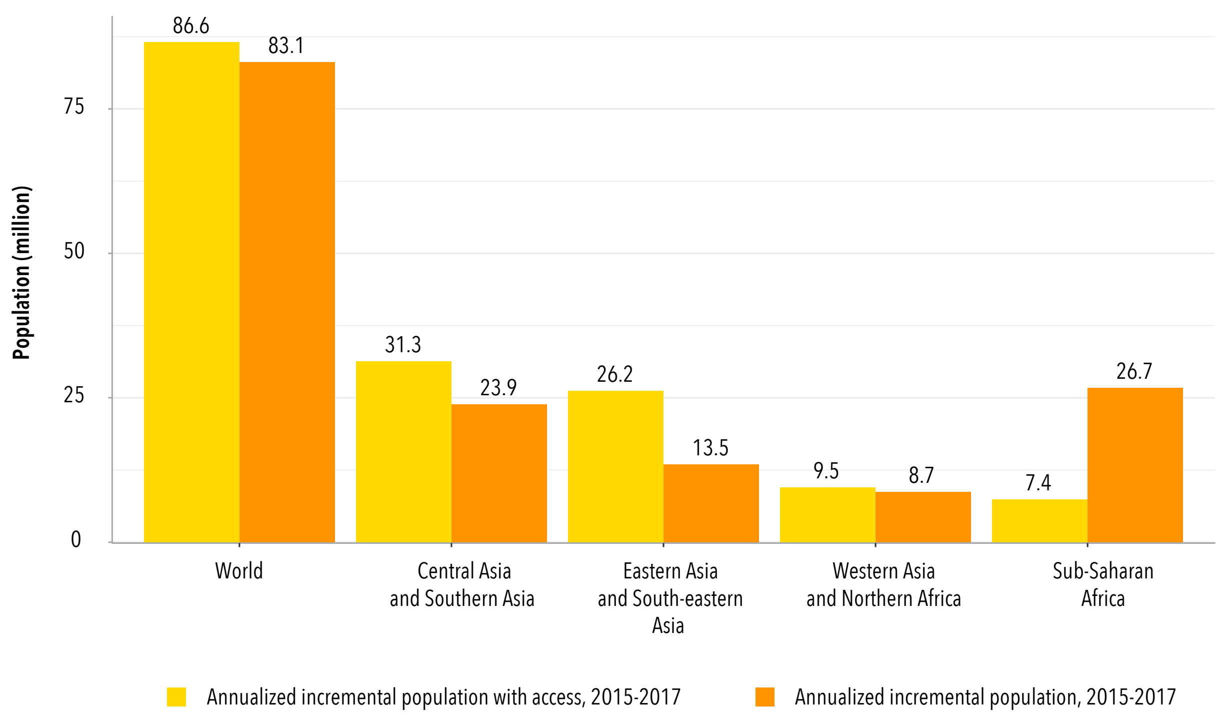
FIGURE 2.5 • AVERAGE ANNUAL INCREASE (PERCENTAGE POINTS) IN THE GLOBAL CLEAN COOKING ACCESS RATE (THE PERCENTAGE OF PEOPLE WITH ACCESS)



Source: WHO 2019.

In 2010, it was estimated that an average annual increase of 2 percentage points would be necessary to achieve the goal of universal access to clean cooking. However, to make up for slower progress than required over the period 2010-2017, the necessary annual access rate is now 3 percentage points, six times higher than the 0.5 percentage points seen in the period 2010-2017. The longer the world sees only marginal improvements, the more challenging it will become to achieve the goal of universal access to clean cooking by 2030.

FIGURE 2.6 • ANNUALIZED INCREMENTAL CLEAN COOKING ACCESS AND POPULATION GROWTH, BY REGION, 2015-2017

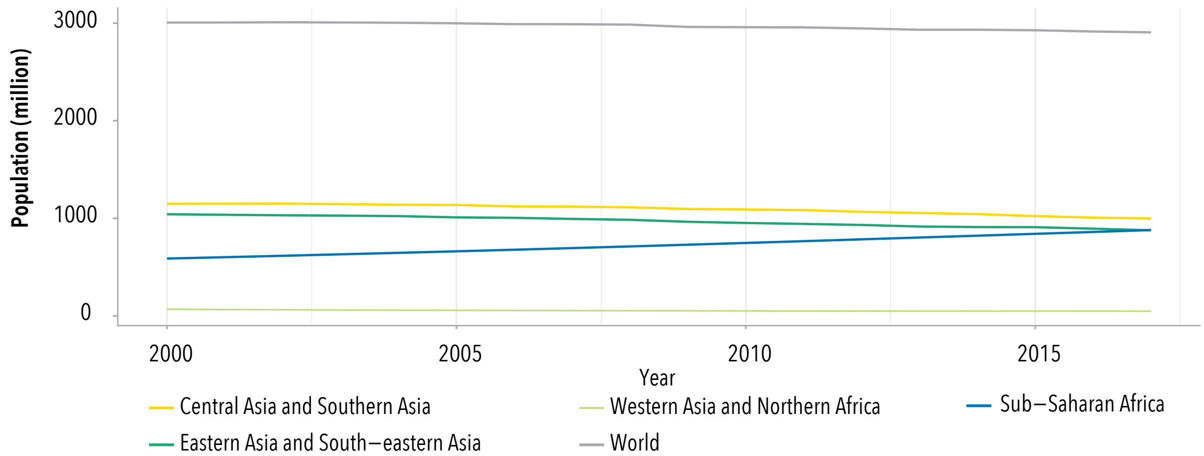


Source: WHO 2019.
Note: UN estimates of population were used.

THE ACCESS DEFICIT

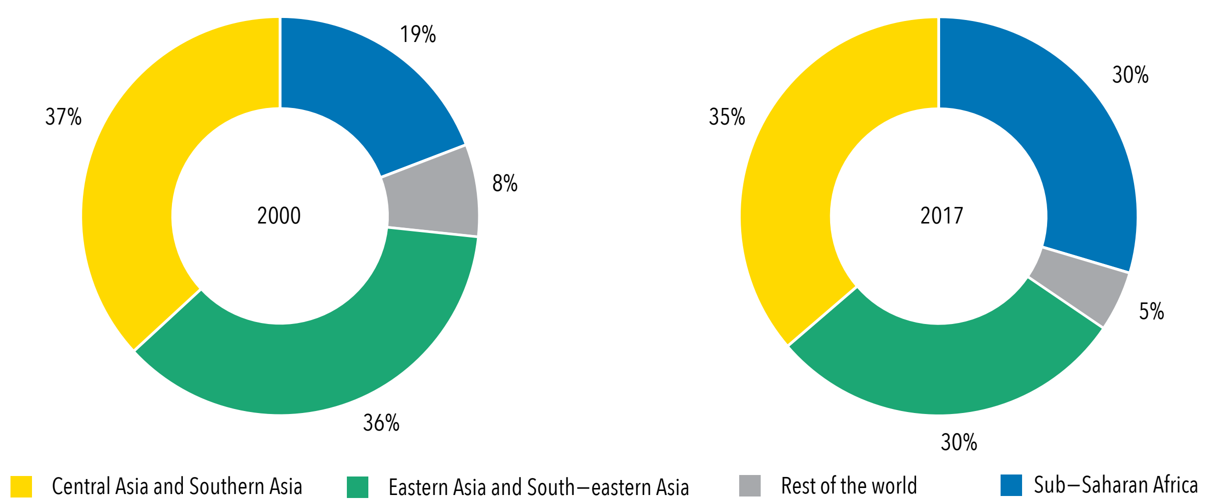
In some parts of the world, the human cost from cooking-related air pollution is increasing. The change over time in the population lacking access to clean cooking solutions, known as the access deficit, is illustrated for each region in figure 2.7. The plot shows that the global population lacking access to clean cooking has plateaued at around 3 billion. This is because substantial deficit reductions in the two Asian regions are being offset by increases in the Sub-Saharan African region (figures 2.7 and 2.8).

FIGURE 2.7 • EVOLUTION OF THE ACCESS DEFICIT (MILLIONS OF PEOPLE), 2000-2017



Source: WHO 2019.

FIGURE 2.8 • PERCENTAGE OF GLOBAL POPULATION WITHOUT ACCESS TO CLEAN COOKING FUELS AND TECHNOLOGIES, BY REGION, 2000 AND 2017



Source: WHO 2019.

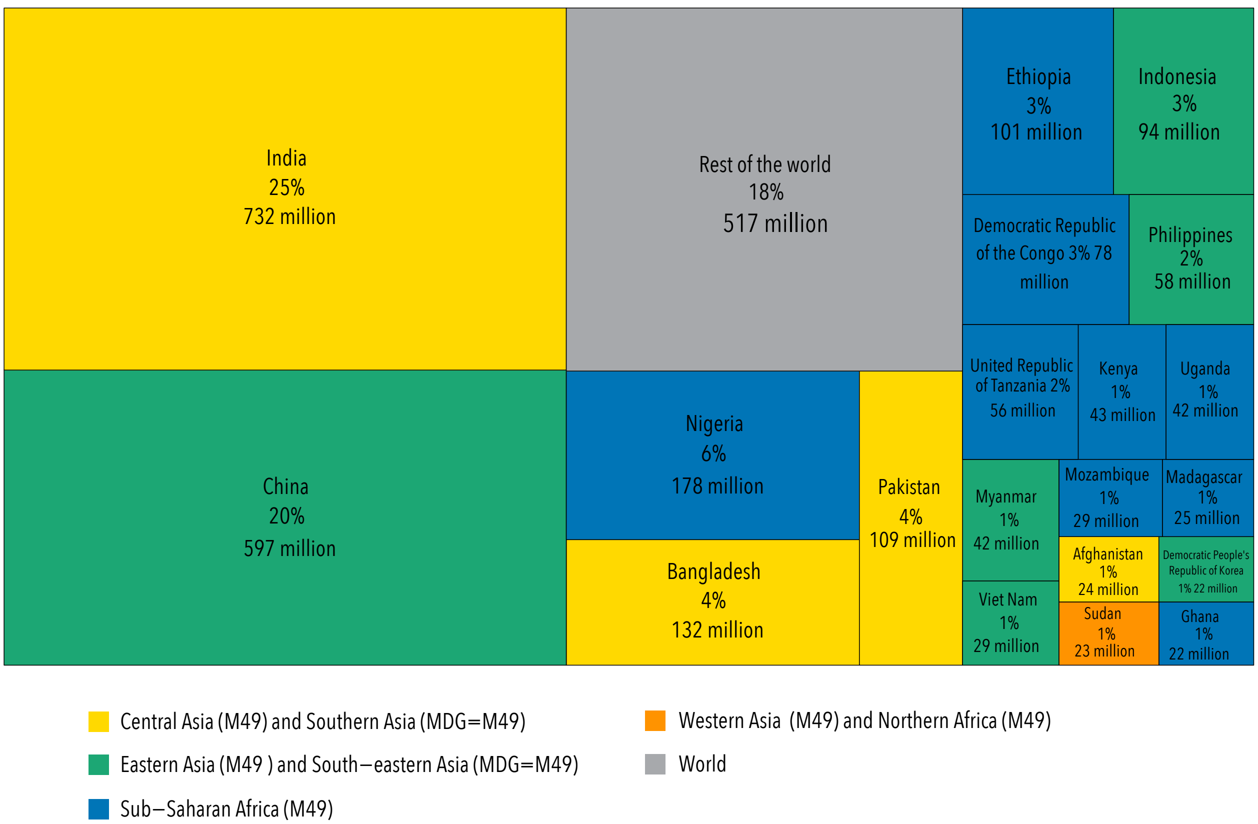
From 2000 to 2017, the percentage of the global access-deficit population who resides in Central and Southern Asia changed only a little, being still slightly more than one-third. Meanwhile, the proportion in Sub-Saharan Africa increased from approximately one-fifth to almost one-third of the total; the proportion residing in Eastern and Southeastern Asia decreased by 6 percentage points. At the current pace of change in both access and population, in 2030 around 40% of the access-deficit population will reside in Sub-Saharan Africa.

COUNTRY TRENDS

The top 20 access-deficit countries (figure 2.3) accounted for 82% of the global population without access and decreased less than 1 percentage points from 2015. India alone still accounts for the largest share of the access deficit at 25%, followed by China at 20%. Put together, India and China accounted for 45% of the total population without access to clean cooking fuels in 2017 (figure 2.9).

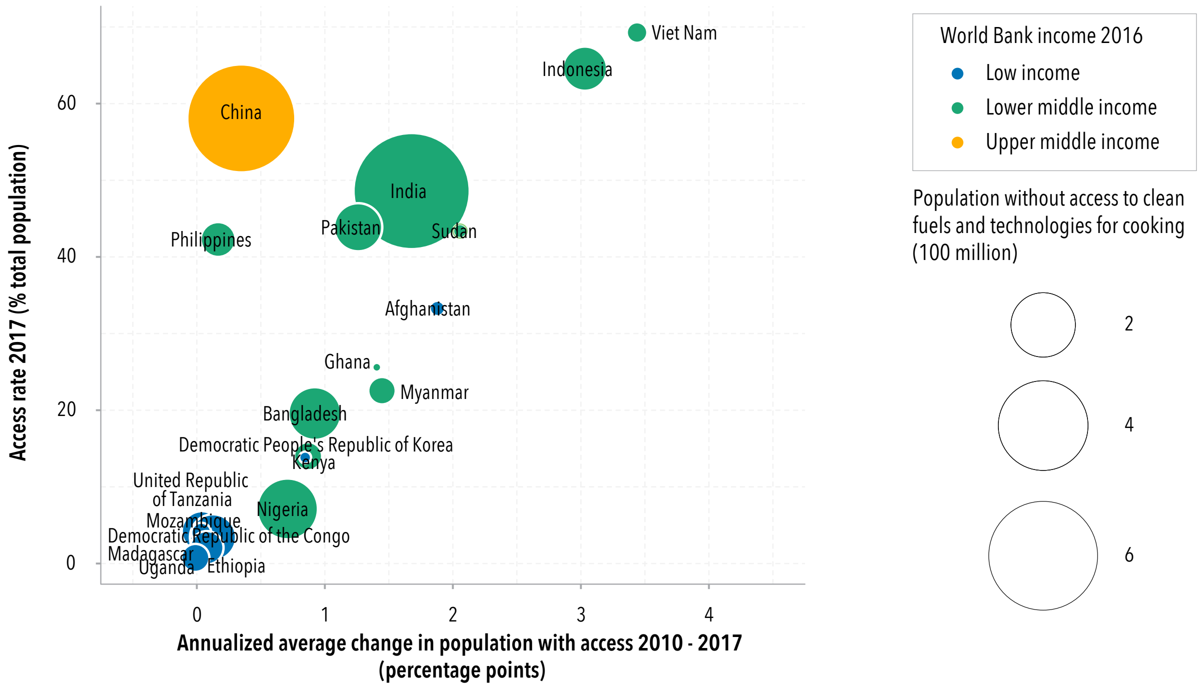
Six of the 20 countries had access rates below 5%; these were the Democratic Republic of Congo, Ethiopia, Madagascar, Mozambique, Uganda, and Tanzania. Seventeen of the 20 countries had access rates under 50% (figure 2.10). However, rapid annual access gains can be seen in select countries, such as Vietnam and Indonesia (up 3% between 2010 and 2017); Sudan, Afghanistan, and Myanmar (up 2%); and Ghana, Pakistan (up >1%) (figure 2.12).

FIGURE 2.9 • THE 20 LARGEST ACCESS-DEFICIT COUNTRIES, BY SHARE OF TOTAL ACCESS DEFICIT AND NUMBERS OF PEOPLE WITHOUT ACCESS, 2017



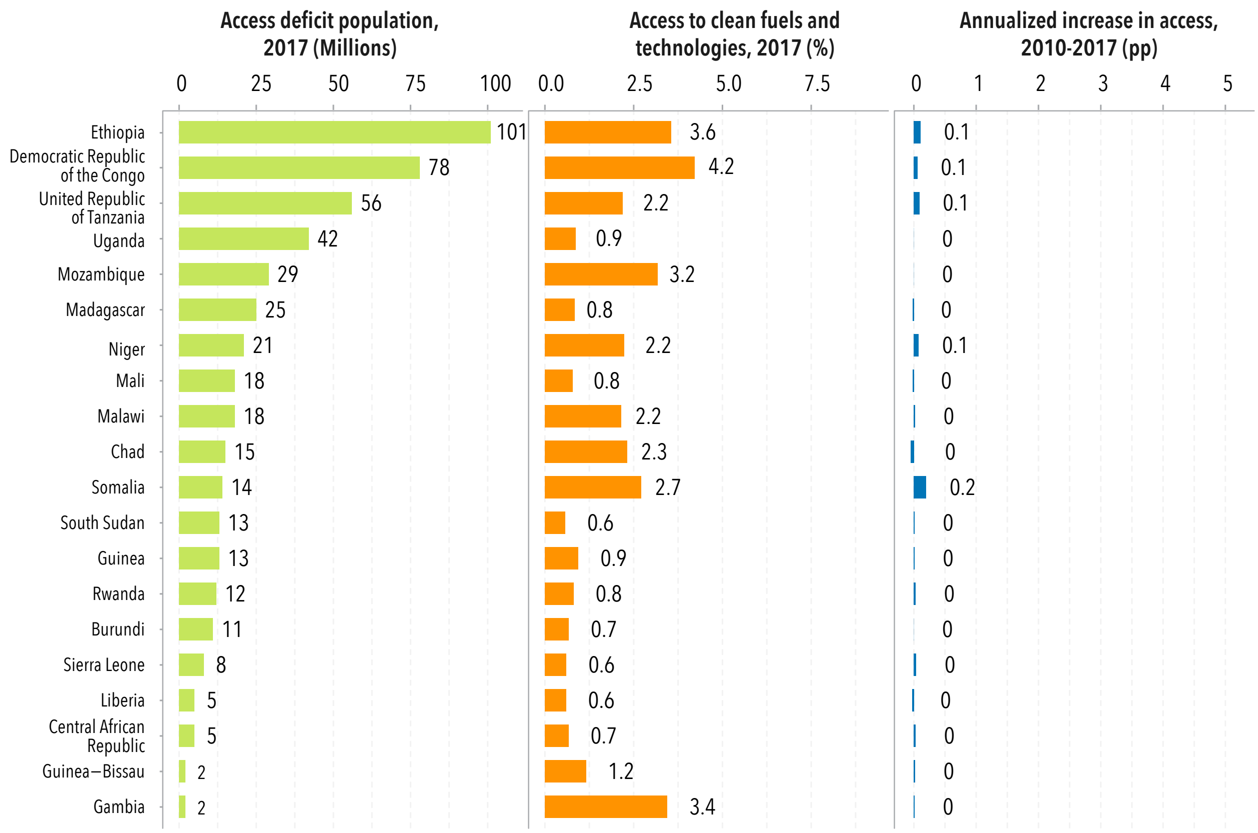
Source: WHO 2019.

FIGURE 2.10 • THE 20 COUNTRIES WITH THE LARGEST DEFICIT IN ACCESS TO CLEAN COOKING, 2010-2017



Source: WHO 2019.

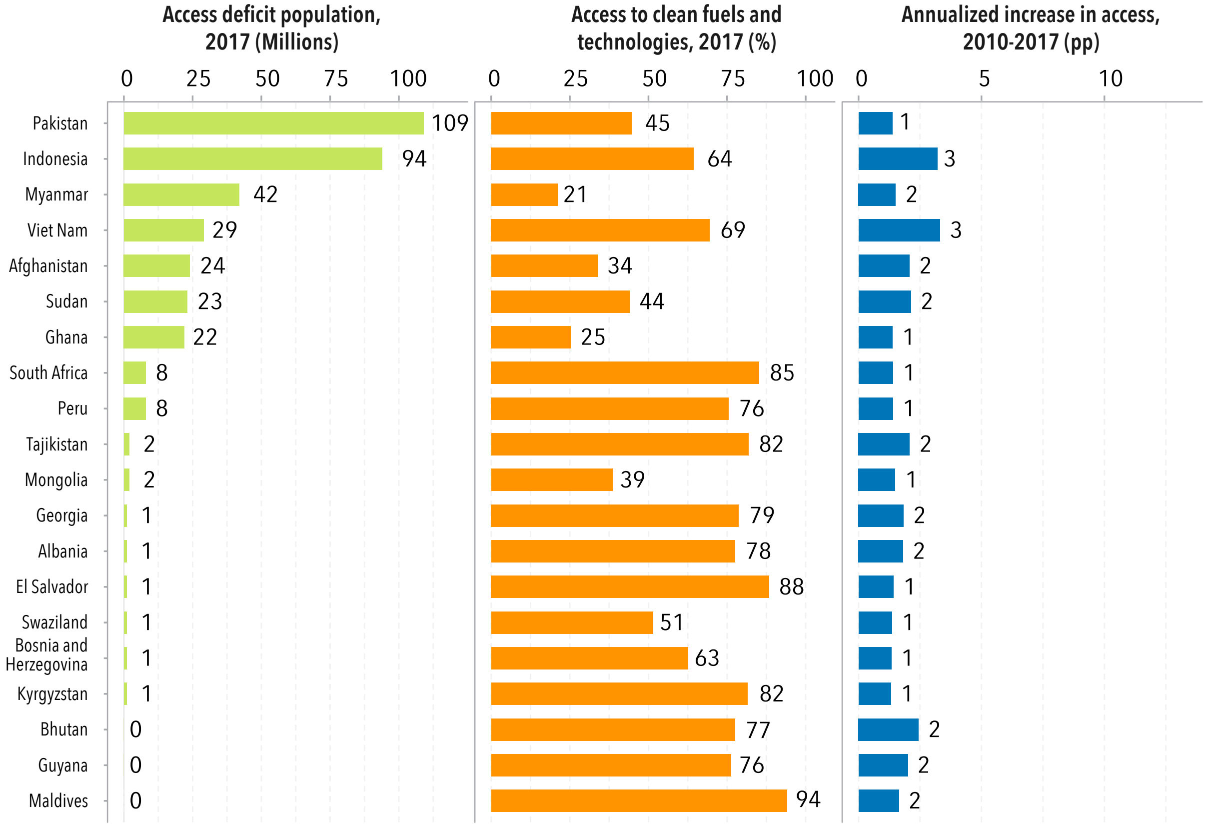
FIGURE 2.11 • ANALYSIS OF THE 20 COUNTRIES WITH THE LARGEST DEFICIT IN ACCESS TO CLEAN COOKING FUELS



Source: WHO 2019.
Note: pp = percentage points.

Overall, in the 20 countries where the shares of population with access to clean cooking fuels are the smallest (figure 2.11), the annual increase in access between 2010 and 2017 was very small (always less than 0.2%) and a few countries saw rates of access decrease (e.g., Mali, Madagascar, and Chad).

FIGURE 2.12 • THE 20 COUNTRIES WITH THE FASTEST GROWING RATES OF ACCESS TO CLEAN COOKING FUELS, 2010-2017



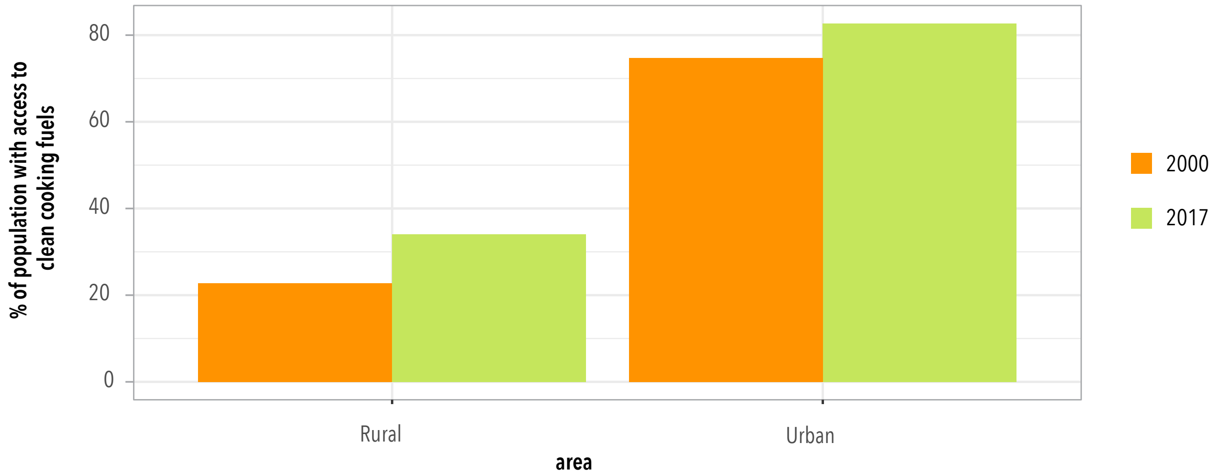
Source: WHO 2019.
Note: pp = percentage points.

As can be seen in figure 2.12, despite a large increase in the share of the population with access to clean fuels between 2010 and 2017, the population without access is still very large in some of these countries.

URBAN-RURAL DIVIDE

There continues to be a vast disparity in access to clean cooking solutions between urban and rural areas, but there is limited evidence that access is improving more quickly in one or the other (figure 2.13).

FIGURE 2.13 • PERCENTAGE OF PEOPLE WITH CLEAN COOKING ACCESS IN URBAN AND RURAL AREAS, 2010 AND 2017



Source: WHO 2019.

UNDERSTANDING THE HOUSEHOLD ENERGY MIX: FUEL TYPES

A deeper analysis of access rates, by access to clean fuels at country and regional levels, can help policy makers better estimate the impacts of current policies affecting household energy use, as well as inform the development of future policies and programs. Using the results found in household surveys, a few notable trends can be seen in the fuels and technologies used for cooking across countries and regions.

Use of clean gaseous fuels (such as LPG, natural gas, and biogas) increased in Asia and slightly in Africa, but remained steady in Latin America (where it was high to start), as did the use of electricity for cooking. Most gains in gaseous fuels were made in urban areas between 2012 and 2017.

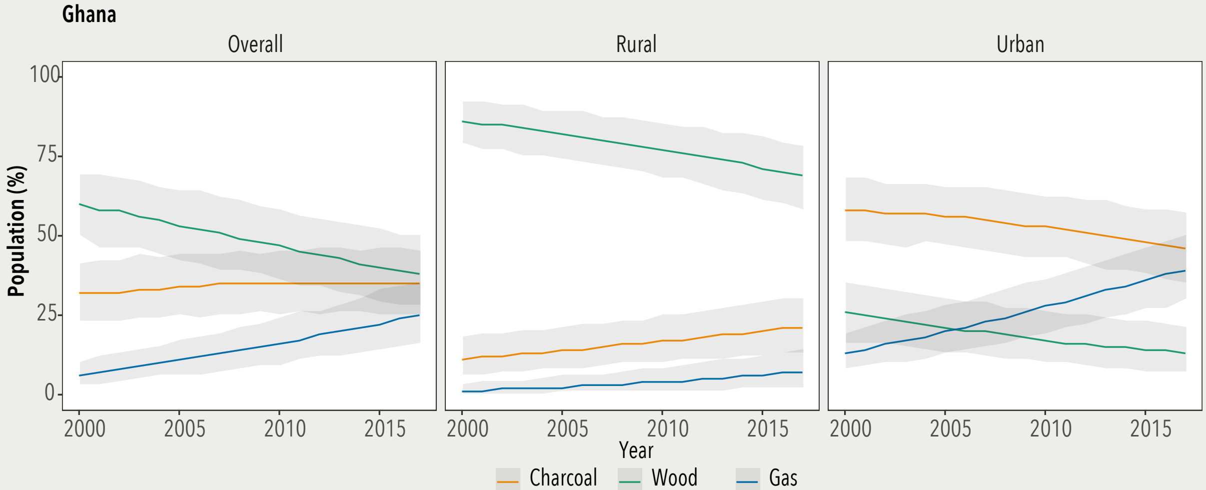
It is worth noting that between 1990 and 2017, an inverse relationship between the use of kerosene and gaseous fuels was observed in low- and middle-income countries around the world. As kerosene use decreased, use of gaseous fuel increased in many areas. Policy makers should set up incentives to pursue this trend and to eliminate kerosene as much as possible.

Between 2012 and 2017, use of wood as a primary fuel decreased in all regions, especially in urban settings, but use of charcoal increased, often offsetting gains in access to clean fuels. Unlike other regions, in Africa, both urban and rural populations are seeing an increased reliance on charcoal and a slower uptake of cleaner gaseous fuels, in large part due to issues of affordability and supply. In Developing Asia, there was a notable increase in the use of biomass fuels between 2012 and 2017 as a primary fuel in both urban and rural areas.

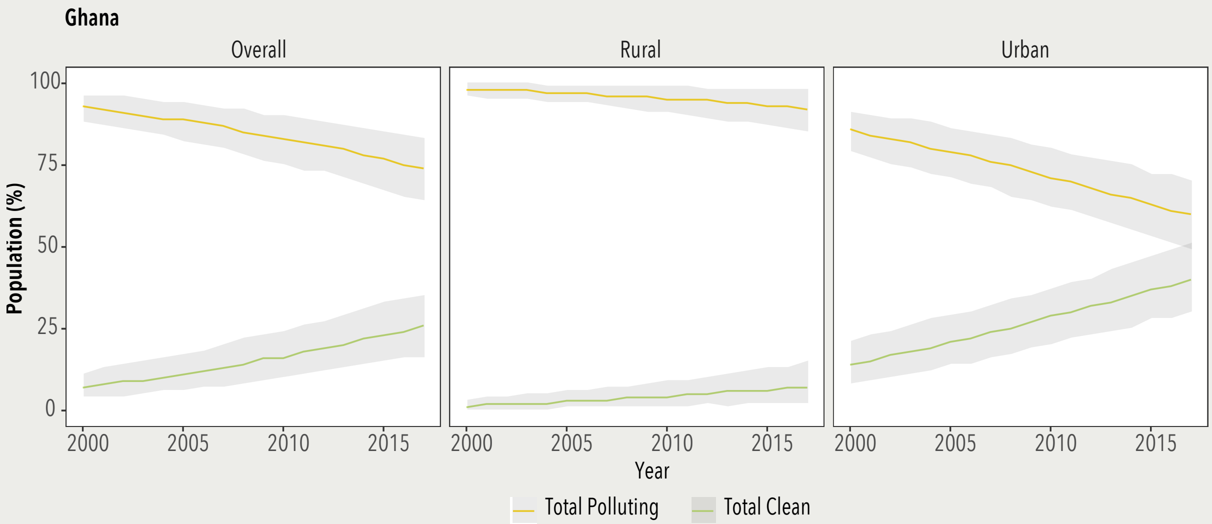
BOX 2.1 • ANALYSIS OF FUEL USE IN GHANA

In Ghana, overall use of charcoal was around 35% [25, 45] in 2017 and its use decreased in urban settings, from 58% [48, 68] in 2000 to 46% [35, 57] in 2017. About 69% [58, 78] of the rural population relied on wood as a cooking fuel in 2017, compared with 13% of the urban population [7, -21]. Wood use decreased in all areas in Ghana between 2000 and 2017. The use of gas as a cooking fuel saw an annual increase of 1.5% in urban areas, compared with only 0.4% in rural areas. More efforts are needed to increase the share of the rural population relying on clean cooking solutions.

FIGURE B2.1.1 • FUELS USED FOR COOKING IN GHANA, BY SHARE OF THE POPULATION (%), 2000-2017



Source: Stoner et al. 2019.
Note: Associated confidence intervals are 95%.



Source: Stoner et al. 2019.
Note: Associated confidence intervals are 95%.

POLICY INSIGHTS

A continuation of business as usual—whether in terms of financing or approaches—is clearly not enough to meet the goal of universal access. Lack of access to clean fuels and technologies for cooking is one of the most significant contributors to poor health, environmental degradation, and climate change in low- and middle-income countries. It is also a contributor to women's workloads, and a barrier to women's market employment and to gender equality. Around 40% of the world's population cooks with polluting stove and fuel combinations. The use of inefficient stoves or open fires paired with wood, charcoal, coal, animal dung, crop waste, and kerosene is a major source of air pollution in and around the home, particularly in Eastern and Southeastern Asia, Central Asia, Sub-Saharan Africa, Latin America and the Caribbean, and Eastern Europe. Achieving SDG 7—that is, universal access by 2030 to affordable, reliable, and modern energy services—is essential for achieving other, interconnected, SDGs, including those related to public health, poverty alleviation, gender equality, climate, and the environment. And clean cooking is integral to SDG 7.

The share of the population with access to clean cooking increased to 61% [54, 67] in 2017, up from 57% [51, 62] in 2010. However, because population growth outpaced annual access gains, the global access deficit remained stable at some 3 billion. Globally, improvements in access appear to have progressively slowed down after 2008, to an approximate 0.5 percentage point annual increase between 2016 and 2017 (figure 2.6), with the majority of gains seen in Central and Southern Asia, and Eastern and Southeastern Asia. To achieve universal clean cooking targets by 2030 and outpace population growth, especially in the Sub-Saharan Africa region, the annual rate of access expansion needs to increase from around 0.5 percentage points, the rate observed between 2016 and 2017, to around 3 percentage points. Based on population projections and the current trajectory, around 2.2 billion people will be without access to clean cooking by 2030. Each year without a significant improvement in the rate at which households gain clean cooking access adds tens of millions of people to the global energy access deficit.

BOX 2.2 • ACCELERATING THE TRANSITION: POLICY RECOMMENDATIONS FROM THE HLPF BRIEFINGS

In support of the first review of Sustainable Development Goal (SDG) 7 at the UN High-level Political Forum (HLPF) 2018, the multistakeholder SDG 7 Technical Advisory Group prepared a set of policy briefs and articulated an action agenda for accelerating the achievement of SDG 7. Clean cooking was recognized as a top political priority requiring targeted policies to increase both supply and demand, as well as foster a more enabling policy environment. Below are the key challenges and a set of priority actions identified for achieving universal access to clean cooking.

The key challenges are:

Supply: The lack of a stable supply of clean, affordable, and culturally acceptable solutions is a major impediment to the adoption of clean cooking by households, particularly in rural areas.

Demand: Lack of knowledge and understanding of the economic, social, and health benefits of exclusively clean cooking serve as a barrier to the adoption of clean household energy.

Enabling environment: A lack of policies focused on clean cooking paired with the allocation of financial resources are critical challenges to facilitating the cross-sectoral collaboration needed to scale up clean cooking.

Priority policy actions include:

Scaling up clean cooking solutions: Policies should focus on promoting reliable and affordable solutions that are clean and good for human health as defined by the World Health Organization guidelines.

Transitional cooking solutions: To maximize the benefits during the transition to universal clean cooking, intermediate cooking solutions with some health and environmental benefits should be prioritized.

Increased investments: Governments should increase investment in clean cooking to overcome barriers and constraints in liquidity constraints, supply, and delivery of clean cooking solutions.

Enhanced multisectoral collaboration: Governments should encourage a cross-sectoral approach between health, climate, and energy sectors to better mainstream clean cooking.

However, there is evidence to show that faster progress may be possible in the near future. Overall, 4 of the 20 access-deficit countries (Vietnam, Indonesia, Sudan, and Afghanistan) expanded access to clean cooking by more than 2 percentage points annually between 2010 and 2017, or at least four times faster than the rest of the world (see figure 2.12). Some of the other countries were natural gas producers and, importantly, prioritized clean cooking access at the national level. Supply trends include technological innovation in clean solutions such as advanced gasifier biomass stove technologies, and the growth of renewable alternative fuels, such as biogas, ethanol, and biomass pellet fuels. Nevertheless, these trends should only be seen as an opportunity, not the guarantee of a market shift.

Financing alone will not solve the problem, although it is critical to enable much-needed innovation in performance and user-friendly technologies, strengthen delivery models, and enhance affordability for consumers. This will require action from both the private and public sectors. Given the affordability and willingness-to-pay gap in the sector, mechanisms that drive down the cost of adoption and promote sustained use have the potential to accelerate scale and ensure that solutions reach rural, low-income, and vulnerable populations who need them most.

GEOGRAPHIC VARIATIONS

Generally, countries that integrated clean cooking into the national policy landscape increased access to clean cooking at a faster pace than the global average. In Indonesia, for example, clean cooking has been a policy priority since 2001, and since then, the country has made considerable progress, particularly over the last decade, through its LPG conversion program shifting household subsidies for kerosene to LPG.

The Government of India has launched two successful programs focused on increasing the usage and financing of LPG, with the explicit aim of empowering women and improving their health. The Pradhan Mantri Ujjwala scheme, a program designed to provide women living below the poverty line with a free LPG connection and subsidized refills, has reached tens of millions of women in India over just a few years. Key to the scheme's success was the Aadhaar identity system, which linked subsidy payments to bank accounts, and better targeting of subsidies directly to women, which have increased women's financial inclusion and LPG connections. The Government of India, in collaboration with oil companies, also launched a "Give It Up" campaign in which wealthier consumers with higher incomes are asked to volunteer to forego or "transfer" their LPG subsidy to a lower-income household. Currently efforts are underway to evaluate the impacts and success of these programs in ensuring sustained use or longer-term adoption of LPG in households.

None of the top 20 access-deficit countries in Sub-Saharan Africa saw a significant increase in access, with the exception of Ghana, which increased access from 24% in 2015 to 25% in 2017 and expanded access of 1.4 percentage points annually between 2010 and 2017. In terms of policy, Ghana has put many of the building blocks in place for a successful clean cooking transition, including the development of national standards for cookstoves and a national rural LPG program, which has already distributed some 70,000 LPG cylinders to households since 2014, and efforts to expand the use of biogas and alcohol fuels at the household level. However, misperceptions regarding the safety of LPG use, unaffordable supply, user preferences, and the penetration of inefficient charcoal use in both urban and rural areas are some of the critical barriers toward the sustained adoption of clean household energy in Ghana.

There are signs that other countries in the region are also starting to pave the way for the transition to clean household energy. Kenya has been at the forefront of establishing policies that support the clean cooking sector growth. For example, in 2015, the government removed the excise duty on denatured ethanol as a way to increase affordability and stimulate investment. In 2016, it removed the 16% value added tax (VAT) on LPG, and there are several initiatives underway to raise awareness about the benefits of clean cooking among the general population. Likewise, in Rwanda and Ethiopia, the governments are working to increase the uptake of efficient and cleaner renewable fuels like biogas and processed biomass fuels.

Latin America is paving the way for a transition away from inefficient solid fuels for cooking. Ecuador is noticeably working to transition households from LPG to renewable electricity for cooking. Likewise, clean cooking has been a priority of the Peruvian government for a number of years, and Peru is beginning to see a substantial transition. Importantly, authorities are specifically working to increase the expansion of clean gaseous fuels in rural areas, and are harnessing alternative mechanisms currently in place, like power infrastructure to facilitate the distribution of gaseous fuels in these areas.

Across all regions, there is greater access to clean energy in urban areas than in rural areas. It is therefore recommended to increase efforts to build the requisite infrastructure for a reliable and affordable supply of clean cooking solutions in rural areas, particularly as these households already face a number of other challenges in accessing services for basic needs.

GENDER AND HEALTH IMPLICATIONS

Clean cooking programs in which women are trained to use, market, and sell cookstoves have had large-scale success. Exposure to smoke from polluting fuels from cooking contributes to approximately 4 million premature deaths each year—more than malaria, HIV, and tuberculosis combined—of which 54% are of women and children (WHO 2018a). Even as women are primary users and beneficiaries, they must also be incorporated along the value chain in design, marketing, sales, and after-sales service.

Women, who are the ones most impacted by the effects of inefficient cooking, remain an untapped resource to scale adoption. A 2015 study[26] showed that empowerment training in Kenya led the sale of cookstoves to more than double. Women sales representatives who received empowerment training outsold men by a margin of three to one. Women can better reach female consumers, which can increase overall sales and peer-to-peer communication to enhance demand, adoption, and ultimately, willingness-to-pay.

LOOKING AHEAD

An often overlooked but essential part of a clean cooking program is its attention to behavioral patterns, cultural norms, and regional variations. Unlike electrification, cooking practices are heavily dependent upon culture, cuisine, household dynamics, as well as the availability of socially acceptable and affordable fuels and technologies. There is no one-size-fits-all solution when it comes to clean cooking; each region has its own preferences and acceptability thresholds, which directly influence adoption rates.

Women entrepreneurs can be a valuable vector for scaling up clean cooking programs, if they are supported to use, market, and sell cookstoves (IRENA 2019). There is a huge global market opportunity for the private sector in access to cooking energy. Developing women's enterprises in the clean energy sector can play a key role along every step of the value chain. New approaches and business models include a comprehensive entrepreneurship development process that entails a careful identification of the barriers that women face in starting a business and then systematically addresses them through technical, managerial, leadership, and empowerment training; customized support from mentors; the strengthening of product supply chains using the private sector; and the building of partnerships with the private sector and financing institutions, in an ecosystem approach to women's enterprise development. Access to capital is important, but must be complemented by a raft of other measures. These approaches have been demonstrated to be able to overcome market barriers and tap into last-mile markets, for example, the ENERGIA Women's Economic Empowerment Program, which has enabled 4,000 women entrepreneurs in seven countries (Dutta 2018).

Fuel and stove stacking is indicative of a larger issue in the cookstove landscape: most stoves do not adequately meet the needs of consumers. In Indonesia, for example, a survey conducted by the World Bank Clean Stove Initiative showed that about half of the households in the sample, across all income groups, use LPG and biomass simultaneously for different cooking tasks (Durix et al. 2016), a phenomenon known as "stacking." Taking a closer look, 96% of stove users in Indonesia are women, who need technologies that lessen cooking time and are easy to use, as many are performing childcare and household duties while preparing meals (Durix et al. 2016). It is therefore critical to consider various factors, particularly consumer preferences and needs, to ensure the long-term adoption of clean cooking solutions. Other factors critical for scale-up include perceptions of modernity, affordability, ease of operation, use of local materials and labor, and ability to perform specialized functions, which may include space heating or lighting. Household decision making and women's access to finance for clean cooking are also key.

Scaling up investment in clean cooking solutions is critical to achieving the SDG 7 targets. It is estimated that an annual investment of at least $4.4 billion is needed to achieve universal access to clean cooking. However, looking at current financial commitments to clean cooking, a negative trend is seen in financing for residential clean cooking, which dropped 5% from $32 million in 2013/2014 to $30 million in 2015/2016 (SEforALL and CPI 2018). The financial situation is even more dire in individual countries. Many countries with little access to clean cooking solutions—like the Democratic Republic of Congo, Mozambique, and Madagascar—have received little to no funding for clean cooking.

The large majority of finance for clean cooking is from international funding sources, representing around 92% of total financial commitments between 2015 and 2016, almost all of which came from public sources like grants. The role of private investment is growing, with an annual commitment of some $6 million in 2013/2014 growing to $9.6 million in 2015/16, showing an increase of 60%.

Reviewing policy and investments at the country level can help to better allocate the necessary financial resources for ensuring the uptake of clean cooking solutions. For example, removing the excise duty on denatured ethanol and the 16% VAT on LPG helped to accelerate the adoption of clean cooking by Kenyan households.

Expanding and sustaining access to clean cooking will require cross-sectoral global, regional, national, and local coordination, with strong political will from governments; targeted financial incentives to producers and last-mile consumers to ensure affordability and scale; and strategic investments from the international community in behavioural interventions, awareness raising, and gender-sensitive technologies and messaging. Several analyses such as the World Bank's Regulatory Indicators for Sustainable Energy and the World Health Organization's HEART reports recommend that governments that have made commitments can benefit from institutionalizing collaboration and taking inter-ministerial action to design data-driven interventions. Countries that have already made considerable progress should consider implementing programs to target rural consumers, who bear the largest access-deficit burden, as well as integrating the clean cooking issue at the policy level with public health; climate change; environmental mitigation; and water supply, sanitation, and hygiene interventions to drive sustainable impact.

METHODOLOGY

DATA SOURCES

The World Health Organization's Household Energy Database (WHO 2018b), which is a collection, regularly updated, of nationally representative household survey data from various sources (see table 3.1), was used as input for the model (Bonjour et al. 2013; Stoner et al. 2019). At the time of its use, the database was a repository for 1,249 surveys from 168 countries (including high-income countries, HICs) between 1970 and 2017. Twenty-five percent of the surveys cover the years from 2012 to 2017 and 121 new surveys cover the period from 2015 to 2017. Modelled estimates for low- and middle-income countries (LMICs) are provided only if there are underlying survey data on cooking fuels, so there are no estimates for Lebanon, Libya, and Turkey.

Population data from the United Nations Population Division were also used.

MODEL

As household surveys are conducted irregularly and reported heterogeneously, a multilevel nonparametric modeling approach developed by WHO (Bonjour et al. 2013) and recently updated by the University of Exeter (Stoner et al. 2019) was adopted to estimate a complete set of values in between surveys.

Multilevel nonparametric modeling takes into account the hierarchical structure of the data: survey points are correlated within countries, which are then clustered within regions. Time is the only explanatory variable; no covariates are used.

To enable direct comparability with previous estimates, the same model used for the 2016 results was used to calculate the proportion of people relying on clean fuels for 2017.

An updated version of the previous model was used to estimate the proportion of people relying on individual fuels for cooking in each country. In this case, the model jointly estimates trends in the use of eight individual fuels (charcoal, coal, crop waste, dung, electricity, gas, kerosene, and wood). It also includes corrections to overcome the sampling bias in the proportion of urban and rural survey respondents and missing total number of survey respondents.

The proportion of people relying on individual polluting fuel for cooking (charcoal, coal, crop waste, dung, kerosene, and wood) are calculated for all countries. The proportion of people relying on individual clean fuels for cooking was calculated for LMICs only, while for HICs the total proportion of people relying on clean fuels was set to 100%, without distinguishing between gas and electricity. The estimates for the eight individual fuels are then presented for LMICs only, while for HICs, gas and electricity are grouped together.

CONFIDENCE INTERVALS

Confidence intervals are associated to the model estimates and they give a sense of the certainty in the point estimate and can be used to understand the range in which the true values lie. Small annual changes may be due to statistical variability accounted by the model, together with survey variability, and may therefore not reflect a true statistically significant variation in the number of people relying on the different fuels between different years. The confidence intervals should therefore always be taken into account when considering annual changes in the access rate across multiple years.

GLOBAL AND REGIONAL AGGREGATED AND ANNUAL GROWTH RATE

Global and regional aggregates are population weighted. Regional groupings are based on WHO (n.d.) and Sustainable Development Goal regions (UN n.d.). HICs for which no data were available are assumed to have either transitioned to clean fuels, or to be using polluting fuels with health-protecting technologies.

The annual 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 the population growth into account by working with the final national access rate.

TABLE 2.1 • OVERVIEW OF DATA SOURCES FOR CLEAN FUELS AND TECHNOLOGY

Name	Entity	Number of unique countries	Distribution of data sources	Question
Census	National statistical agencies	104	18.09%	What is the main source of cooking fuel in your household?
Demographic and Health Survey (DHS)	Funded by USAID; implemented by ICF International	77	16.57%	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	21	2.88%	Which is the main source of energy for cooking?
Multi-indicator cluster survey	UNICEF	78	10.65%	What type of fuel does your household mainly use for cooking?
Survey on global AGEING (SAGE)	WHO	6	0.48%	
World Health Survey	WHO	49	3.92%	
National Survey		100	36.99%	
Other		78	10.89%	

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ENDNOTES

21 Electricity, liquid petroleum gas, natural gas, biogas, solar, and alcohol fuels.

22 Bracketed percentages represent a 95% confidence interval (for more details, refer to the methodology section at the end of this chapter).

23 The 20 countries with the largest access-deficit population. These are Afghanistan, Bangladesh, China, the Democratic People's Republic of Korea, the Democratic Republic of Congo, Ethiopia, Ghana, India, Indonesia, Kenya, Madagascar, Mozambique, Myanmar, Nigeria, Pakistan, the Philippines, Sudan, Uganda, Tanzania, and Vietnam.

24 See WHO Household Energy Database (WHO 2018b) and Stoner et al. (2019).

25 For additional information, see the Clean Cooking Alliance (2019).

26 Agency-based empowerment training has been seen to enhance sales capacity of female energy entrepreneurs in Kenya (Shankar, Onyura, and Alderman 2015)C:\Users\fayre\Documents\Clients\SBK\bmed\25839204.

CHAPTER 3

RENEWABLE ENERGY

Photo: Pranab Basak

MAIN MESSAGES

- **Global trend:** The share of renewable energy (including traditional uses of biomass) in total final energy consumption is the main indicator being used to assess progress toward Sustainable Development Goal (SDG) 7.2. In 2016, the share of renewables increased at the fastest rate since 2012, up 0.24 percentage points, and reached almost 17.5% owing to rapid growth in hydropower, wind, and solar. Since 2010, renewable energy consumption has grown by 14% in absolute terms, equivalent to twice the current energy use in Turkey. The fastest penetration of renewables continued to be in electricity, which increased 1 percentage point to 24% in 2016. With this growth, the share of renewables in electricity reached the same level as renewables used for heating (including traditional uses of biomass) for the first time. Excluding traditional uses of biomass, which involves an inefficient combustion process associated with negative health and environmental impacts, the share of renewables used for heating was only about 10% at the end of 2016. The share of renewables in the energy consumed for transport remained the lowest, at 3.3%, although it had been steadily increasing since 2000.

- **2030 target:** While there is no quantitative target for SDG 7.2, the share of renewable energy would need to accelerate substantially to ensure access to affordable, reliable, sustainable and modern energy for all (according to the long-term scenarios of the International Energy Agency and the International Renewable Energy Agency).

- **Regional highlights:** Sub-Saharan Africa has the highest renewable energy share among all regions due to the large consumption of solid biomass in the residential sector, with the region's use of modern renewables significantly below the global average. In Latin America and the Caribbean, almost 30% of the share of renewables in total final energy consumption is traceable to hydropower generation in electricity and bioenergy use in industry and transport; also, the share of wind and solar photovoltaic (PV) is growing.

- **Top 20 countries:** The top 20 energy consumers account for three-quarters of global energy demand but represent only two-thirds of global renewable energy consumption. Of the six countries with renewable shares above the global average, traditional uses of biomass dominate renewable consumption in four (India, Indonesia, Nigeria, and Pakistan); in the remaining two countries, modern uses of biomass are most prevalent in Brazil and hydropower in Canada.

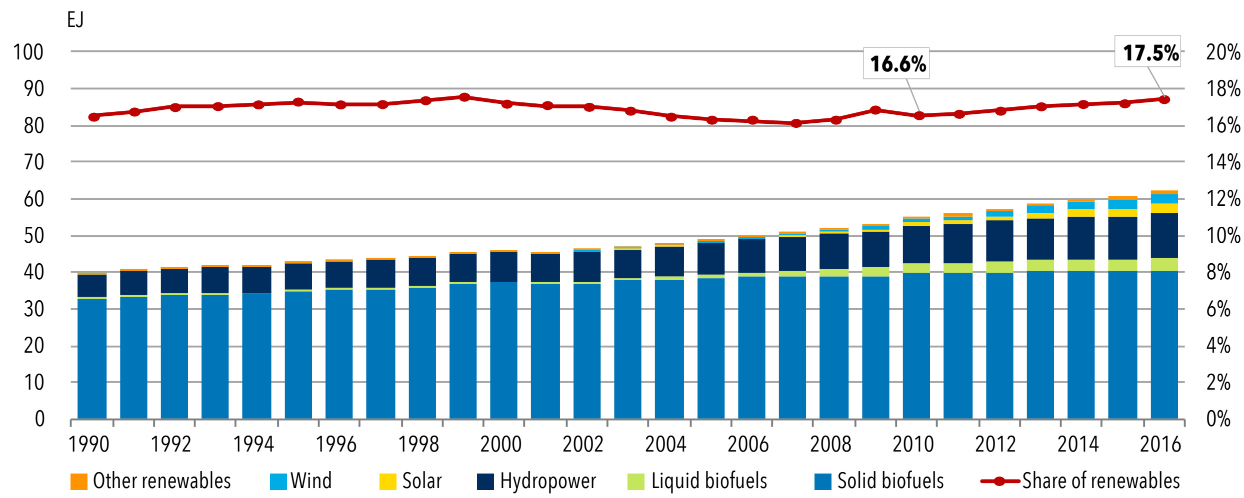
- **Electricity:** The share of renewables in electricity consumption increased by 1 percentage point to reach 24% in 2016, the fastest percentage point growth seen since 1990 and more than double that of 2015. This was driven by continuous drought recovery in Latin America; China's record-level wind capacity growth in 2015, which became fully operational in 2016; and rapid solar capacity expansion in China and the United States, which propelled solar power's rise of 30% in 2016.[27]

- **Heat:** Renewables used for heating increased only modestly (up 0.5%) to surpass 24% in 2016, led by the direct use of modern bioenergy, which accounted for half of the growth, followed by renewable district heating and direct use of geothermal and solar thermal. While traditional uses of biomass continued to decline in 2016, down by 0.5%, they still accounted for over half of renewable heat consumption. Reducing traditional uses of biomass has been an objective of policy makers, given their negative health and environmental impacts.
- **Transport:** The share of renewable energy in transport increased by 0.1% year on year to reach 3.3% in 2016. The majority of consumption was from biofuels, driven mostly by support policies in the United States, Brazil, and the European Union. Renewable electricity accounted for 8% of renewable energy consumption in transport in 2016, led by rail; the consumption of electric vehicles (EVs) has been rapidly increasing, led by China.

ARE WE ON TRACK?

In 2016, renewable energy's share of total final energy consumption increased at the fastest rate, driven by the rapid growth of hydropower and wind and solar energy the same level as in 2000 - at 17.5%.. After 2007, the share of renewable energy slowly increased after a period of modest decline, due to strong growth in coal consumption in China. In 2016 it recovered to the same level as in 2000. Overall, bioenergy accounts for 70% of global renewable energy consumption, followed by hydropower (figure 3.1).

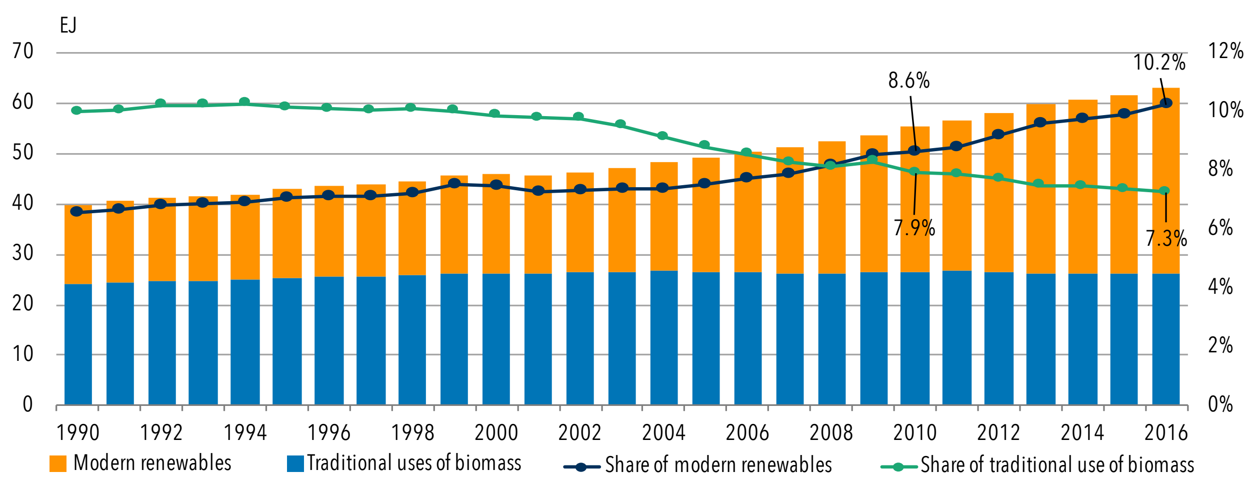
FIGURE 3.1 • RENEWABLE ENERGY CONSUMPTION BY TECHNOLOGY AND SHARE OF TOTAL ENERGY CONSUMPTION, 1990-2016



Source: IEA and UNSD.

By 2016, the share of modern renewables in total energy consumption continued to increase, up to 10.2% while the share of traditional biomass use[28] continued to decline, to 7.3%. However, both trends need to accelerate to achieve not only SDG target 7.2 for renewable energy but also SDG indicator 7.1.2 regarding access to clean fuels, including for cooking (figure 3.2).

FIGURE 3.2 • CONSUMPTION OF MODERN RENEWABLE ENERGY AND TRADITIONAL BIOMASS, 1990-2016

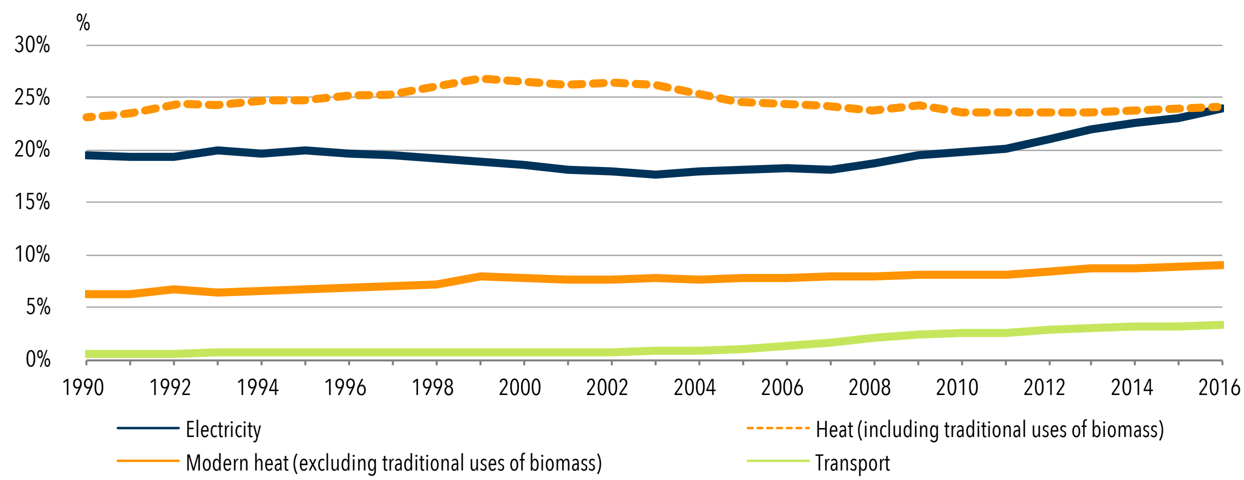


Source: IEA and UNSD.

LOOKING BEYOND THE MAIN INDICATORS

Renewable energy is consumed in direct and indirect forms for three end uses: electricity, transport, and heat.[29] The substantial increase in the share of renewable energy called for under SDG 7 commitments requires the accelerated penetration of renewables in all three end uses. The most rapid increase to date has been in electricity, which grew by 1 percentage point from 23% in 2015 to 24% in 2016. With this growth, the share of renewables in electricity reached the same level as renewables used for heating for the first time. But it should be noted that the historically high share of renewables in heat was mainly due to traditional uses of biomass for cooking and heating in low-income countries. Excluding traditional uses of biomass, the share of modern renewables used for heat remained below 10% in 2016. Renewables in transport have increased steadily since 2000 but their penetration remained the lowest in 2016, at below 4%. Liquid biofuels account for the significant majority of renewables consumed in transport. Renewable electricity for transport is also emerging thanks to the uptake of electric vehicles and electric rail lines (figure 3.3).

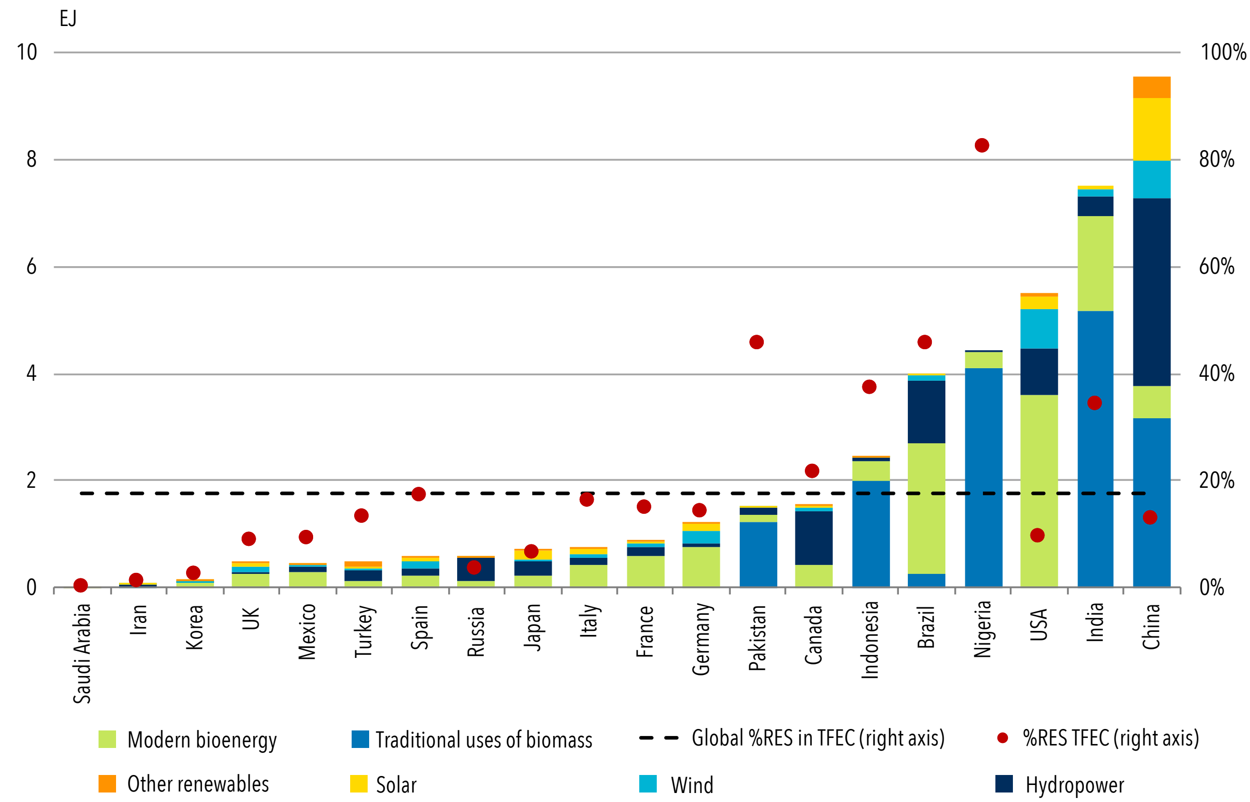
FIGURE 3.3 • THE SHARE OF RENEWABLES IN CONSUMPTION, BY TYPE OF END USE, 1990-2016



Source: IEA and UNSD.

The top 20 most energy-consuming countries account for three-quarters of global energy demand, but only two-thirds of global renewable energy consumption. Overall, China remains the largest consumer of renewable energy globally, due to the country's renewable electricity consumption. Among countries, the share of renewable consumption varies widely depending on resource availability, policy support, and the impact of energy efficiency on total energy demand growth. In 2016, only six (India, Brazil, Indonesia, Nigeria, Canada, and Pakistan) of the 20 top consumers had a renewable share larger than the global average of 17.5%. However, in four of those (India, Indonesia, Nigeria, and Pakistan), this was due to traditional uses of biomass for cooking, which declined only in Indonesia in 2016. The extensive consumption of modern bioenergy (both in power generation and biofuels production) in Brazil and of hydropower in Canada drives these two countries' above-average renewable energy shares. Excluding traditional uses, all but four countries (Nigeria, Italy, Turkey, and the Republic of Korea) saw their share of modern renewable energy increase in 2016, when eight countries had a share larger than the global average of 10.2%. Among the 20 countries, Brazil was the absolute leader with a share of modern renewables of 42% (figure 3.4).

FIGURE 3.4 • RENEWABLE ENERGY CONSUMPTION AS SHARE OF TOTAL FINAL ENERGY CONSUMPTION, BY TYPE, 2016



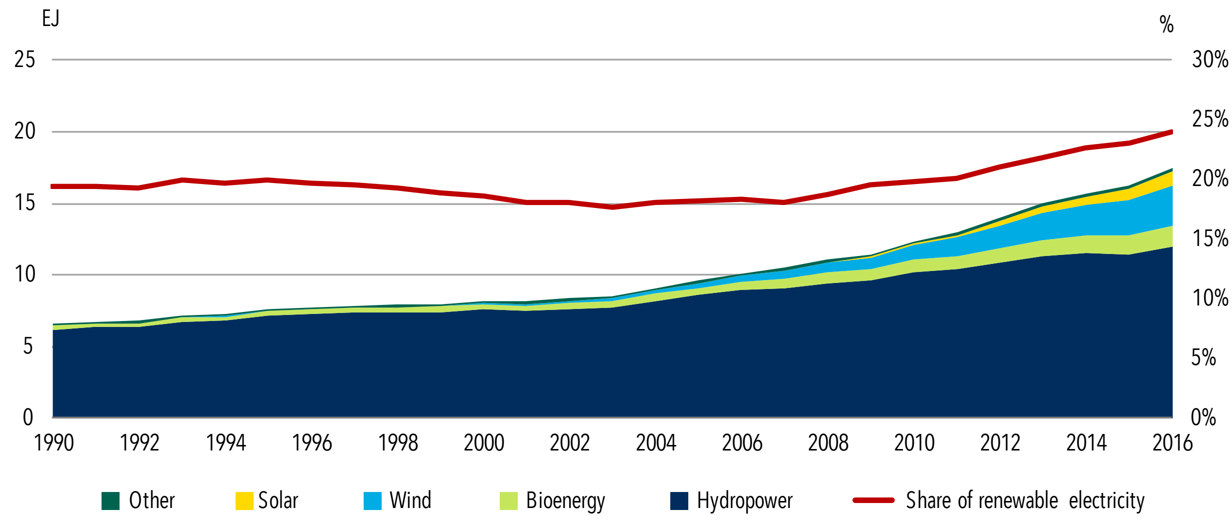
Source: IEA and UNSD.
Note: RES = renewable energy sources, TFEC = total final energy consumption.

ELECTRICITY

In 2016, renewable electricity consumption increased by almost 8%. The share of renewables grew by 1 percentage point to reach 24%. This is the fastest percentage point growth since 1990 and more than double that of 2015. Three key developments drove this trend. First, Latin America continued to recover from a severe drought, with Brazil's hydropower generation growing by 3.5% in 2016. Second, China had record-level wind capacity growth in 2015 that became fully operational in 2016. Third, solar PV consumption grew by 30% as both China and the United States doubled additions between 2015 and 2016.

Hydropower remained the largest source of renewable electricity, accounting for 68% of all renewable electricity consumption in 2016. However, it played a much smaller role than in 2010 (down from 82%) due to the rapid increase of solar PV and wind generation, which grew ten- and threefold over the same period, respectively. This rapid growth was mainly driven by policy support around the world and recent cost reductions. Since 2010, generation costs of solar PV declined on average by 80% and onshore wind by 20%. The shift from government-set tariffs (feed-in tariffs, premiums) to competitive renewable energy auctions with long-term power purchase agreements played an important role in accelerating the cost reductions. Auctions also helped governments contain renewable support costs through volume control mechanisms. Still, wind remained the second-largest source of renewable electricity, followed by bioenergy, solar, geothermal, and ocean technologies (figure 3.5).

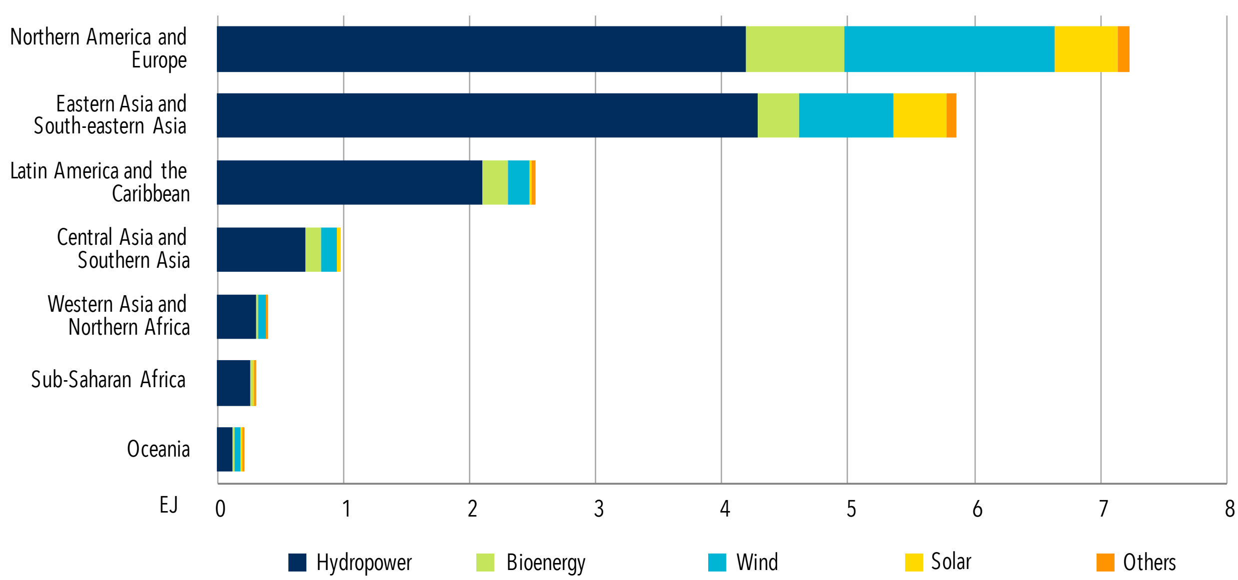
FIGURE 3.5 • GLOBAL RENEWABLE ELECTRICITY CONSUMPTION BY TECHNOLOGY, 1990-2016



Source: IEA and UNSD.

Resource availability and policy support explain regional differences in renewable electricity consumption (figure 3.6). In Northern America and Europe, wind, bioenergy, and solar PV had already reached a significant level of deployment thanks mainly to 2020 targets for renewable energy in the European Union and tax incentives in the United States. However, Asia also experienced substantial wind and solar expansion driven by ambitious targets in China and India. In Latin America and the Caribbean, hydropower remained the largest renewable electricity source but bioenergy and wind were expanding rapidly, bringing diversification. While hydropower was the largest source of renewable electricity in Africa, governments have been introducing policies to increase wind and solar deployment as associated technologies become more affordable.

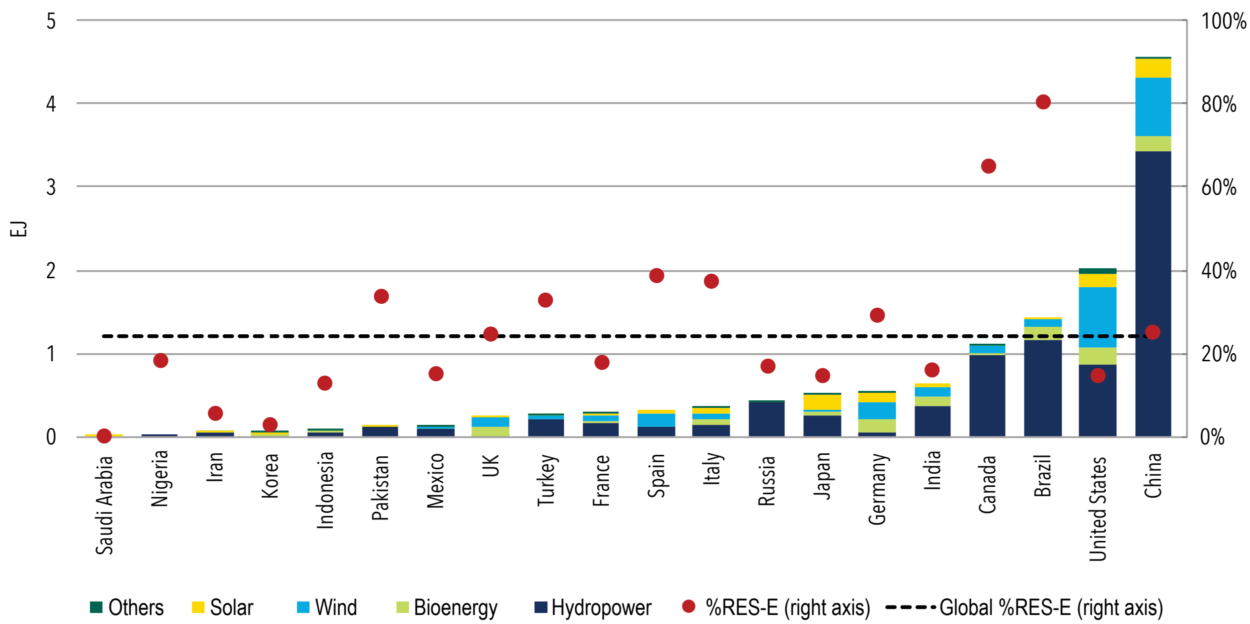
FIGURE 3.6 • RENEWABLE ELECTRICITY CONSUMPTION BY REGION, 2016



Source: IEA and UNSD.

Among the top 20 energy consumer countries, the share of renewables in electricity varied significantly, from less than 1% to over 80%; however, higher shares existed outside these countries (figure 3.7). Renewables accounted for over 95% of electricity generation in countries where abundant hydropower resources had already been exploited, such as in Norway, Paraguay, Uruguay, Ethiopia, Costa Rica, and Nepal. In most European countries, variable wind and solar electricity accounted for the majority of renewables. For example, the share of variable renewable electricity had already exceeded 50% in Denmark and ranged between 15% and 25% in Ireland, Germany, Spain, Italy, and the United Kingdom. Going forward, increasing shares of variable renewables will push up the importance of cost-effective policies that foster system integration.

FIGURE 3.7 • RENEWABLE ELECTRICITY CONSUMPTION BY COUNTRY AND TYPE OF ENERGY, 2016



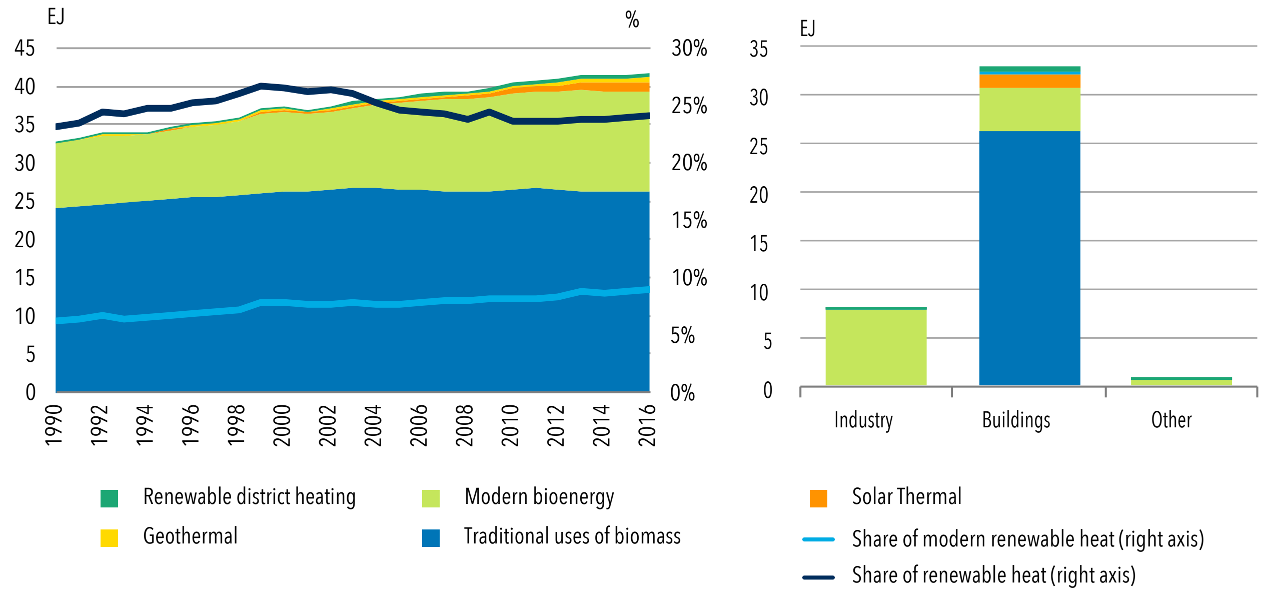
Source: IEA and UNSD.
Note: RES = renewable energy sources, RES-E = renewable electricity.

HEAT

The share of renewable heat increased by 0.1% over 2015-2016 to reach 24.1% in 2016 (figure 3.8). The increase in renewable heat consumption was led by the direct use of modern bioenergy, which accounted for half of the growth, followed by renewable district heating, and direct use of geothermal and solar thermal. While the traditional uses of biomass continued to decline in 2016, down by 0.5%, they still accounted for over half of renewable heat consumption worldwide. Reducing these has been an objective of policy makers, given the negative health and environmental impacts associated with them.

Bioenergy continued to be the renewable most often consumed for heat in 2016, in both direct and district heating applications, accounting for 95% of renewable heat consumption, including traditional uses. The second-largest source was solar thermal. A majority of the latter is used directly in small domestic systems for providing hot water, although larger-scale systems for industrial applications and district heating systems are being implemented. Geothermal, the smallest source of renewable heat, is used mostly for bathing, swimming, and space heating, with a significant share of the world's consumption concentrated in China and Turkey.

FIGURE 3.8 • RENEWABLE HEAT CONSUMPTION, 1990-2016, AND BY SECTOR IN 2016

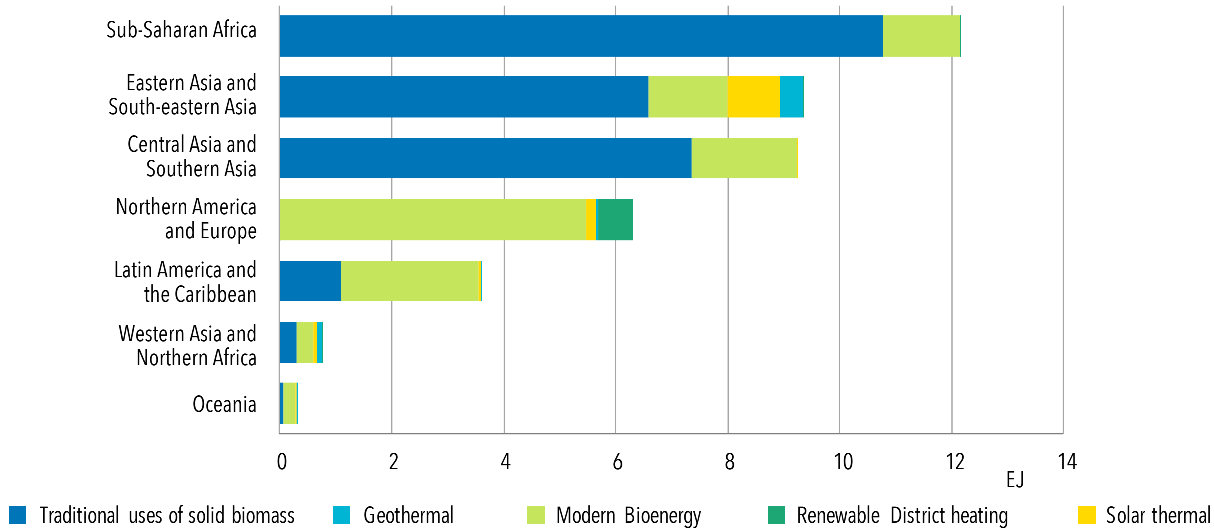


Source: IEA and UNSD.

A majority of renewable heat consumption occurred in the buildings sector because of traditional uses of biomass (80%) in residential housing. Excluding these, industry represents the largest consumer of modern renewable heat, which is dominated almost exclusively by bioenergy. Most of the consumption was in sectors where there are significant amounts of biomass and waste residues produced on site (e.g., wood and wood products, paper, food, and tobacco). Conversely, the majority of solar thermal and geothermal applications was for hot water, space heating, and, in some cases, swimming pool heating in the buildings sector. Their deployment for industrial applications has been limited given the temperature requirements for process heat (often above 400°C) and the cost differentials with other competing technologies.

The largest regional consumers of renewable heat in 2016 were Sub-Saharan Africa and Asia, due to the traditional uses of solid biomass in the residential sector (e.g., for heating and cooking with inefficient traditional techniques such as a three-stone fire). Excluding these, the regions with the largest renewable heat consumption were Northern America and Europe. In the European Union, modern renewable heat consumption has been driven by a 20% binding regional target for renewables by 2020. Europe is also the world's largest consumer of renewable heat via district heating, which in 2016 accounted for 14% of its renewable heat, led by Germany, France, and the Nordic countries (figure 3.9).

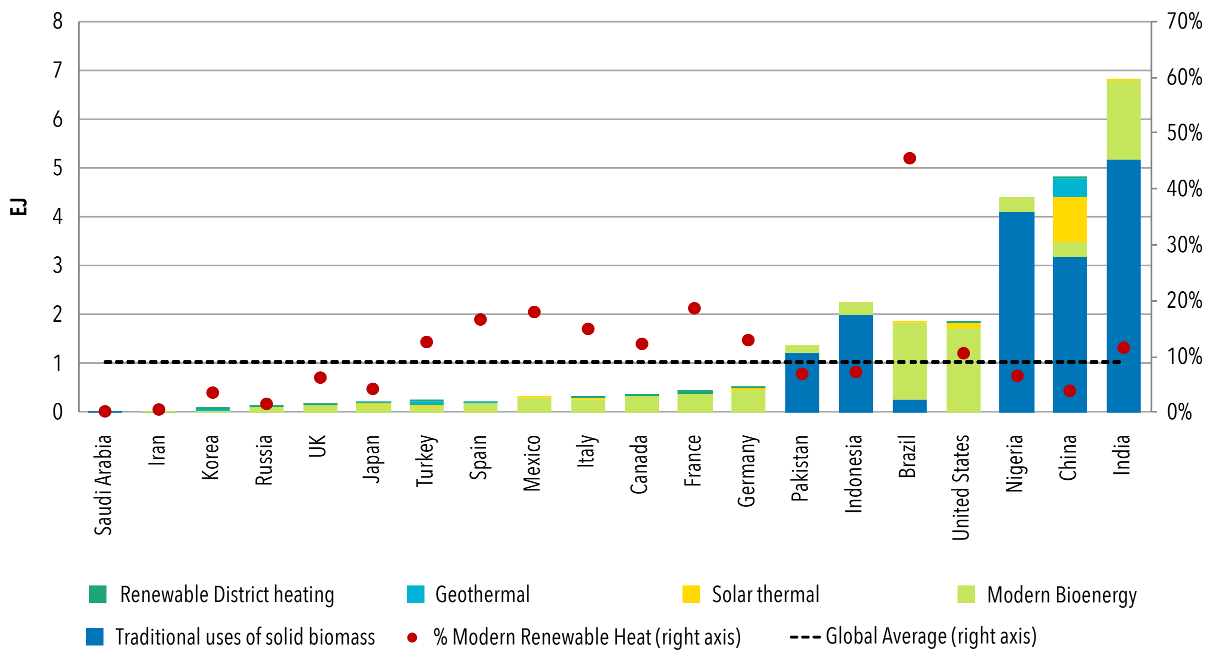
FIGURE 3.9 • RENEWABLE HEAT CONSUMPTION BY REGION, 2016



Source: IEA and UNSD.

Half of the world's renewable heat consumption was concentrated in six countries in 2016: India, China, Nigeria, Indonesia, Brazil, and the United States (figure 3.10). The United States was the largest consumer of modern renewable energy for heat, thanks to the use of bioenergy in the industry sector. China led the world in solar thermal consumption, although growth in new installations had slowed in previous years amid a weakening in policy support for low-cost systems and shifts in end-user preferences to other technologies for hot water. Of the top 20 energy consumers, 10 had a share of modern renewable heat larger than the global average, with the largest share in Brazil, thanks to the widespread use of bagasse from sugar and ethanol production.

FIGURE 3.10 • RENEWABLE HEAT CONSUMPTION BY COUNTRY AND BY TECHNOLOGY, 2016



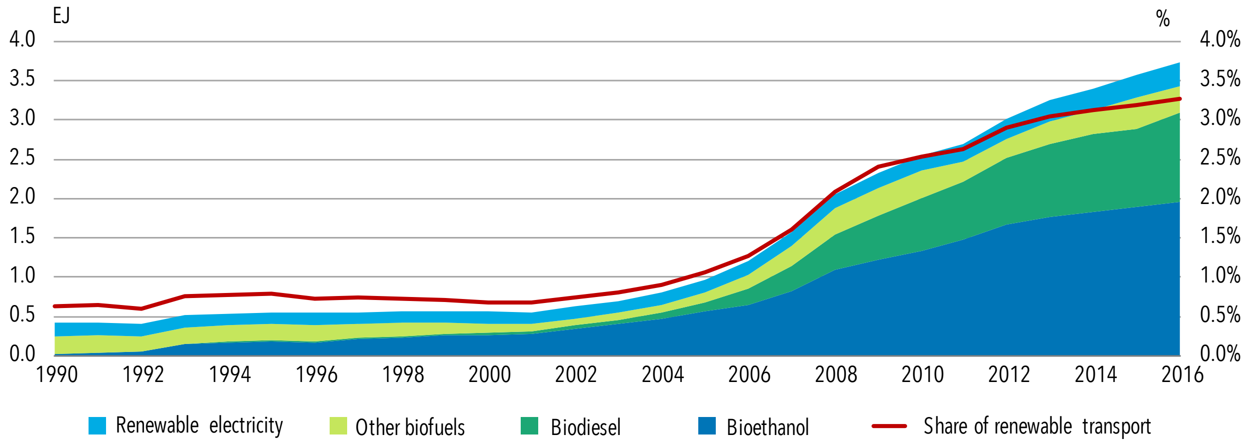
Source: IEA and UNSD.

TRANSPORT

Transport is the end use with the lowest renewable energy share. This increased by 0.1% year on year to reach 3.3% in 2016 (figure 3.11). The majority of renewable energy consumed (92% in 2016) was policy driven and came in the form of biofuels—mainly crop-based ethanol and biodiesel blended with fossil fuels used for transport. The remainder is from renewable electricity.

Renewable energy in transport more than doubled over 2007-2011 (from 1.3% to 2.6%), driven by a robust expansion of ethanol markets in the United States and Brazil, as well as growing biodiesel consumption in the European Union. In the next five-year period, ending in 2016, renewable fuel consumption only marginally outpaced growth in demand for fossil fuels, resulting in a relatively slower increase in the share of renewables in transport. This was primarily due to slower growth in ethanol consumption in the United States.

FIGURE 3.11 • RENEWABLE FUEL CONSUMPTION IN TRANSPORT, 1990-2016

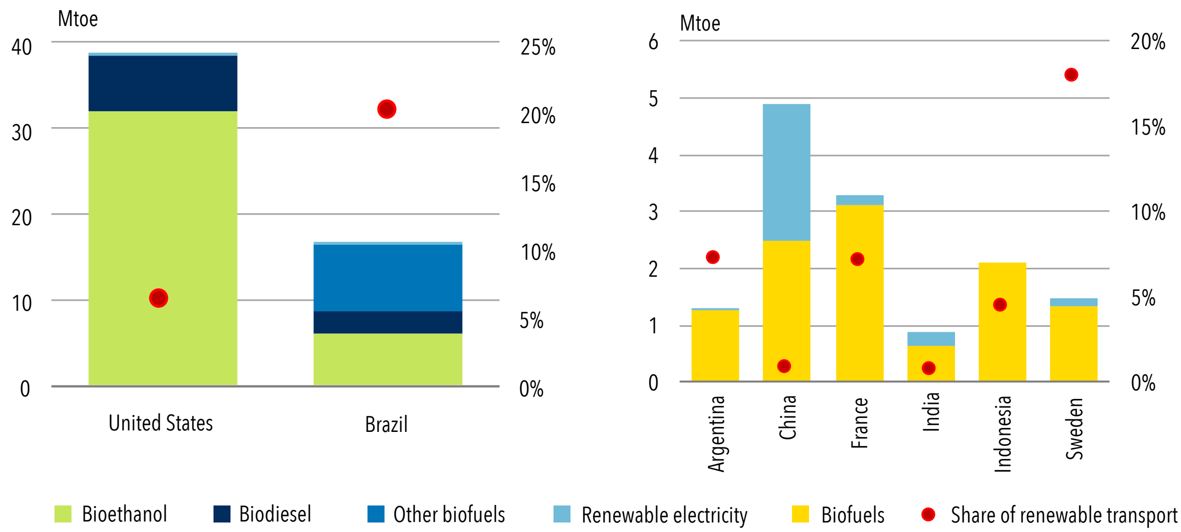


Source: IEA and UNSD.
Note: Biogasoline refers to fuel ethanol blended with gasoline. The significant majority (e.g., 98% in 2016) of "other biofuels" is unblended hydrous ethanol consumption in Brazil.

The most common policy measure employed to encourage renewables in transport is a mandated renewable share of fuel demand, or a biofuel share of gasoline or diesel (termed a "biofuel mandate"). As of 2016 such mandates had been established in around 70 countries. Most mandates stipulate a blending share of less than 10% biofuel with fossil fuels used for transport.[30] Fiscal incentives are also used in many countries to aid the cost-competitiveness of renewable fuels and stimulate demand.

The United States and Brazil combined accounted for over 60% of renewable energy in transport in 2016 (figure 3.12). Brazil is responsible for the lion's share of this: over 70% of its gasoline vehicles are flexible fuel, enabling unblended bioethanol consumption and higher blending shares.

FIGURE 3.12 • RENEWABLE ENERGY IN TRANSPORT AND RENEWABLE SHARE IN SELECTED COUNTRIES, 2016



Source: IEA and UNSD.

Sweden has also achieved a large share of renewable energy in transport. This has been achieved through reductions in energy, carbon dioxide taxation, waivers for biofuel vehicles that favor the consumption of high-level blend fuels, and legislation ensuring that service stations supply renewable fuels. Most renewable fuel consumption is currently in road vehicles, with minimal use in aviation and maritime transport. This is due to there being fewer economical and technically viable renewable fuels, compounded by less policy support for their use in these long-haul sectors.

In 2016, renewable electricity in transport was mostly for rail, with a smaller but growing share for road electric vehicles, including cars, buses, and two- and three-wheeler vehicles. Much of this last category was driven by the pressing need to increase air quality in cities. The global electric car stock surpassed 2 million vehicles in 2016. China is unique in the world for its significant transport fuel demand: half of its share of renewable energy in transport was due to electricity in 2016.

POLICY RECOMMENDATIONS AND CONCLUSIONS

Renewables have experienced remarkable progress over the past decade, driven by policy support, innovation, technological advancement and sharp cost reductions. However, this development has not been homogenous across countries and sectors. Renewables still face persistent policy and financial challenges, and sometimes technological barriers. Policies have so far mostly focused on renewable electricity, while relatively few countries have implemented policies for the use of renewables for heating and transport. Greater effort is still required to increase the share of renewables in the global energy mix, together with energy efficiency, to meet the SDGs. To this end, a combination of policy measures is needed to focus on creating an enabling environment for deployment, integrating renewables into consumers' daily lives and systems, and directly supporting deployment in all end-uses. The long-term stability of targets and policies is key to ensuring investor confidence and continued growth. At the same time, policies need to continuously adapt to changing market conditions, to achieve greater cost-competitiveness and improved integration of renewables into the system. Enabling policies contribute to a wider scope for renewable energy development. These include policies that issue clear signals to stakeholders (e.g., clearly defined targets, environmental and climate policies and regulations), level the playing field for renewables (e.g., fossil fuel subsidy reforms, carbon pricing policies), ensure the reliability of technology (e.g., quality and technical standards, certificates), facilitate access to affordable financing at multiple levels, manage land use, and support labor market needs and new skills (through direct measures, education, and training).

Policies that are driving the energy transition must consider renewables' integration into the broader energy system. Integration policies support the incorporation of renewables and energy efficiency in the heating and cooling, transport, and power end uses; in the larger energy and economic system; and in consumers' daily lives. As such, policies are needed to ensure the development of needed infrastructure (e.g., transmission and distribution networks, charging stations for electric vehicles, district heating infrastructure) to enhance system flexibility (e.g., support for energy storage, demand-side management); to promote sector coupling; and to support research, development, and demonstration.

Some measures can support the processes of both enabling and integrating renewable energy. These include the establishment of a supportive governance and institutional architecture (e.g., streamlined permitting procedures, dedicated institutions for renewables), programs that seek to raise consumers' awareness and induce behavioral change, and the coupling of renewable energy policies with livelihood development.

POLICIES FOR RENEWABLES IN HEATING

The heating end-uses have received little attention from policy makers although they account for half of global energy consumption. Traditional uses of biomass still account for the majority of renewable energy consumption in heating, and are linked to air pollution and negative health impacts. In order to ensure access to affordable, reliable, sustainable, and modern energy for all, policies need to promote modern uses of clean energy especially among energy vulnerable groups in developing countries.

Policies and measures are crucial to decarbonize heat end-uses, starting from dedicated short- and long-term targets and strategies to achieve them. However, approaches will necessarily vary across countries, reflecting specific energy contexts and barriers. For instance, renewable heat policy priorities depend on whether there is a significant district heating infrastructure (as in the Nordic countries and in some Chinese provinces) or whether there is a competing gas infrastructure (as in Italy, the Netherlands, or the United Kingdom).

A range of policy instruments may be adopted, often in combination. Carbon or energy taxes can incorporate externalities and offer important price signals to level the playing field with fossil fuels. They have been critically important to the penetration of renewable heat in the Nordic countries. Fiscal and financial incentives can be used to reduce cost gaps between renewables and fossil fuel technologies to create a level playing field such as in China, Germany, and France. Heat-generation-based incentives have also been applied in the United Kingdom, providing support over longer periods. Mandates and building obligations, such as for solar water heaters in Brazil, China, Italy, and Spain, can provide deployment certainty and create domestic markets. Finally, building codes can support renewable heating and cooling by setting energy performance requirements. They provide an opportunity to align energy efficiency with renewable energy requirements, which is crucial to leverage synergies. Best practice examples include building codes in Canada, India, and Sweden that require both high levels of energy efficiency and low-carbon heat solutions, or incentive schemes, as in Germany, that offer a bonus when energy efficiency and renewable heat measures are deployed together.

POLICIES FOR RENEWABLES IN TRANSPORT

The share of renewable energy for transport is far lower than for heat and electricity end uses. The decarbonization of transport depends on numerous types of policy interventions. These include avoidance strategies (reducing unnecessary travel), improving the modal mix (increasing the use of public transport), enhancing vehicle efficiency, and fuel switching. As such, the use of renewables in the transport sector, whether through biofuels, vehicles powered with renewable electricity, or renewable-energy-based synthetic fuels is part of a larger policy challenge.

In general, transport policies should aim to overcome key barriers, such as the immaturity or relatively higher cost of certain fuels or vehicles, inadequate energy infrastructure, sustainability considerations for certain biofuel production pathways, and the need for consumers to embrace new technologies and systems.

The goal of policy support for biofuels is not limited to decarbonization, and encompasses facilitating demand for agricultural commodities and enhancing security. Governance is essential to ensure that scaling up biofuel consumption delivers tangible social, economic, and environmental benefits, including the reduction of life-cycle greenhouse gas emissions. Policy makers must establish frameworks to ensure that only sustainable biofuels receive policy support.

Blending mandates have been the principal means of policy support for biofuels to date. Notable examples include Brazil, China, and many European Union Member States. Fiscal incentives are also used in many countries to improve renewable fuels' cost-competitiveness and stimulate demand, such as in Brazil, France, and Thailand.

Most mandates stipulate a biofuel blend share with fossil transport fuels of below 10%. To facilitate higher sustainable biofuel blend shares, and therefore more renewable energy in transport, a transition toward a greater proportion of suitable (e.g., flexible fuel) vehicles and the use of "drop in" biofuels are necessary.

A shift toward advanced biofuels over time is desirable. Advanced biofuels are sustainable fuels produced from non-food-crop feedstock (therefore mitigating the impacts of land-use changes), which are capable of significantly reducing life-cycle greenhouse gas emissions compared with fossil fuel alternatives. Advanced biofuel costs are currently high. Policies to encourage technology learning and production scale-up are needed to lower these. Examples include advanced biofuel quotas and financial de-risking measures. Advanced biofuels will be particularly valuable in aviation and shipping, where electrification remains a challenge.

Policy frameworks that stipulate reductions in the average life-cycle carbon intensity of transport fuels have been introduced in some countries and regions. A notable example is California's Low Carbon Fuel Standard. These technology-neutral approaches drive innovation to maximize the reduction of carbon dioxide emissions from renewable fuels relative to cost.

Policies aimed at supporting renewable-powered electric transportation have only recently emerged. These can include targets, regulations, and mandates for concrete goals and policy deliverables, as well as financial incentives to make electric vehicles competitive with conventional vehicles. For instance, a long-term commitment from national policy makers helped Norway (the country with the highest EV penetration in the world to date) successfully deploy electric vehicles, using incentives and tax exemptions to close the purchase price gap in relation to conventional vehicles.

POLICIES FOR RENEWABLE ELECTRICITY

The share of renewable electricity has been growing much faster than renewable heat or transport. Policy has driven much of this growth, with many countries setting targets for renewable electricity and implementing a range of policy measures. While increasingly cost-competitive renewables—especially solar PV and wind—are rapidly transforming power systems worldwide, reforms in market design and policy frameworks will be needed going forward. Such measures are crucial to ensure investment at scale both in the new renewable capacities and in the power system flexibility needed to integrate high shares of variable renewables in a reliable and cost-effective manner.

Different policy instruments have been used to support renewable electricity deployment through different stages of technological maturity. Options include administratively set feed-in tariffs or premiums, renewable portfolio standards, quotas and tradeable green certificate schemes, net metering, tax rebates, and capital grants. Some of these instruments have been introduced in parallel. Recently, auctions (centralized, competitive procurement of renewables) have become increasingly widespread and have been instrumental in discovering renewable energy prices and containing policy costs in many countries, especially for solar PV and wind. However, the success of such policies in achieving deployment and development objectives relies on their design. Careful tailoring of policy to the local context and regulatory framework is needed to accelerate the energy transition. In addition to governmental action, voluntary and corporate purchase programs for renewable energy are becoming an important part of the energy transition.

Increasingly, distributed generation, which can increase the resilience of the electricity system, is supported through net metering and net billing. However, careful consideration is needed to avoid jeopardizing the electricity network's cost-recovery rates and creating cross-subsidization among those customers who self-consume and those who do not.

The most common support mechanisms for renewable electricity today were designed for small shares of renewable energy in the power system, without properly accounting for the interactions between variable technologies and power market design. With the increasing share of wind and solar PV in electricity generation, an appropriate market design is needed to reduce barriers. But system-friendly renewable incentives do exist; examples include Mexico's auction system, which aims to recognize the locational and time value of energy production, and Denmark's support scheme, designed to promote the use of turbines with smoother energy output.

Small shares of variable renewable energy (VRE) do not pose particular challenges at the system level. Priority areas are connection requirements, grid codes, and the updating of system operations. European countries incorporated VRE in their system operations. As VRE shares increase, policies ensuring investment in all forms of flexibility become crucial. Key policies and measures might include to (i) enhance power plant flexibility (China aims for one-fifth of installed coal-fired capacity by 2020); (ii) unlock demand-side management (for example, by allowing the participation of pools of consumers in the system services market, as in California); (iii) support energy storage (as with Germany's offer of low-interest loans and grants for PV-battery systems); and (iv) improve grid infrastructure (the United Kingdom's RIIO program guarantees the best investments for the network at a fair price, setting clear performance targets for operators).

As the transport, heating and cooling, and power sectors become increasingly interdependent, cross-linking decision making and policy design so both are beneficial across sectors will be crucial. For example, the success of EV deployment will critically depend on the strengthening of electricity distribution networks and smart charging systems at the local level. Conversely, these actions will enable the use of EV batteries, and the integration of more solar and wind power in the system.

METHODOLOGY

TABLE 3.1 • DEFINITIONS

Renewable energy sources (RES)	Total renewable energy from: hydro, 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 to have come from renewable energy sources.
Direct renewables	Renewables energy sources that can be used directly: solid biofuels, liquid biofuels, biogases, solar thermal, geothermal energy and renewable municipal waste.
Total final energy consumption (TFEC)	The sum of the final energy consumption in the transport, industry, residential, services and other sectors (also equivalent to the total final consumption minus non-energy use).
Traditional uses of biomass	Final consumption (as estimated, not measured directly) of traditional energy uses of biomass. Biomass energy uses are considered traditional when biomass is consumed in the residential sector in countries that are not a part of the Organisation for Economic Co-operation and Development (OECD). The International Energy Agency accounts for the following categories: primary solid biofuels and charcoal.
Modern renewable energy consumption	Renewable energy consumption minus traditional consumption/uses of biomass.

METHODOLOGY FOR MAIN INDICATOR: SHARE OF RENEWABLE ENERGY IN TOTAL FINAL ENERGY CONSUMPTION

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 3.1, ELE = gross electricity production, HEAT = gross heat production) and their subscripts correspond to the product categories.

The denominator is the TFEC of all energy products (as defined in table 3.1) while the numerator, the renewable energy consumption, is 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, referring to the energy service for which the energy is consumed: electricity, heat, and transport. These are calculated from the energy balance and are defined as follows:

Electricity refers to the amount of electricity consumed in all sectors excluding transport. Electricity used for heat-raising purposes is included because official data on the final energy service are unavailable.

Heat-raising refers to the amount of energy consumed for heating purposes in all sectors excluding transport. 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," heat-raising refers to the purpose and does not refer to the energy product "heat" used in the formula above.

Transport refers to the amounts of energy consumed in the transport sector, including electricity. Electricity used in the transport sector is mostly in 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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ENDNOTES

27 Some of the analysis in this chapter is based on data and analysis in the report Renewables 2018: Market Analysis and Forecast from 2018 to 2023 (IEA 2018).

28 Solid, locally resourced biomass—such as wood, charcoal, agricultural residues, and animal dung—is converted by low-income households into energy through basic techniques, such as a three-stone fire. Its use for heating and cooking in the residential sector is often inefficient and associated with negative impacts on human health and the environment.

29 Heat refers here to the amount of energy consumed for heating purposes in industry and other sectors, not to the final end-use service.

30 The share is measured either by energy potential or volume.

CHAPTER 4

ENERGY EFFICIENCY

Photo: Shutterstock

MAIN MESSAGES

- **Global trend:** Rates of improvement in global primary energy intensity—defined as the percentage drop in global total primary energy supply per unit of gross domestic product (GDP)—were more sustained in 2010-2016 than they had been in 1990-2010.[31] Global primary energy intensity in 2016 was 5.1 megajoules per U.S. dollar (MJ/USD) (2011 purchasing power parity [PPP]), a 2.5% improvement from 2015. This continued a trend of sustained improvement, though the 2016 rate was a drop from the 2.9% observed in 2015.

- **2030 target:** Improvements in energy intensity are not in line with Sustainable Development Goal (SDG) target 7.3. The average annual rate of improvement[32] in global primary energy intensity between 2010 and 2016 was 2.3%. This is better than the rate of 1.3% between 1990 and 2010, but still behind the SDG target 7.3 of 2.6%, which represents a doubling of the historic trend. Annual improvements will now need to average over 2.7% until 2030 to meet SDG target 7.3. This additional progress is unchanged since 2015, although estimates for trends in 2017 and 2018 show further deterioration in the rate of global primary energy intensity improvement.

- **Regional highlights:** Energy intensity improvements were largest in Asia. Between 2010 and 2016, primary energy intensity in Eastern and Southeastern Asia improved by an annual average rate of 3.4%. Similarly, in Central and Southern Asia, the average annual improvement of 2.5% between 2010 and 2016 was above the global average and greater than historic trends. A key factor contributing to this is an increase in energy efficiency driven by concerted policy efforts and economic growth. Rates of improvement are just below the global average in Oceania, and Northern America and Europe, with improvement rates lagging in Latin America and Africa, where absolute levels of energy intensity are less than the global average, reflecting differences in economic structure, energy supply, and access.

- **Top 20 countries:** The annual improvement of primary energy intensity accelerated in 16 of the 20 countries with the largest total primary energy supply in the world. In 9 of these countries, improvement rates exceeded the global average, with China seeing the greatest improvement with an average annual rate of 4.7% between 2010 and 2016. This is linked to greater efforts to improve energy efficiency, such as the introduction of extensive codes, standards, and obligations that have placed more stringent performance requirements on energy-using appliances, vehicles, and companies.

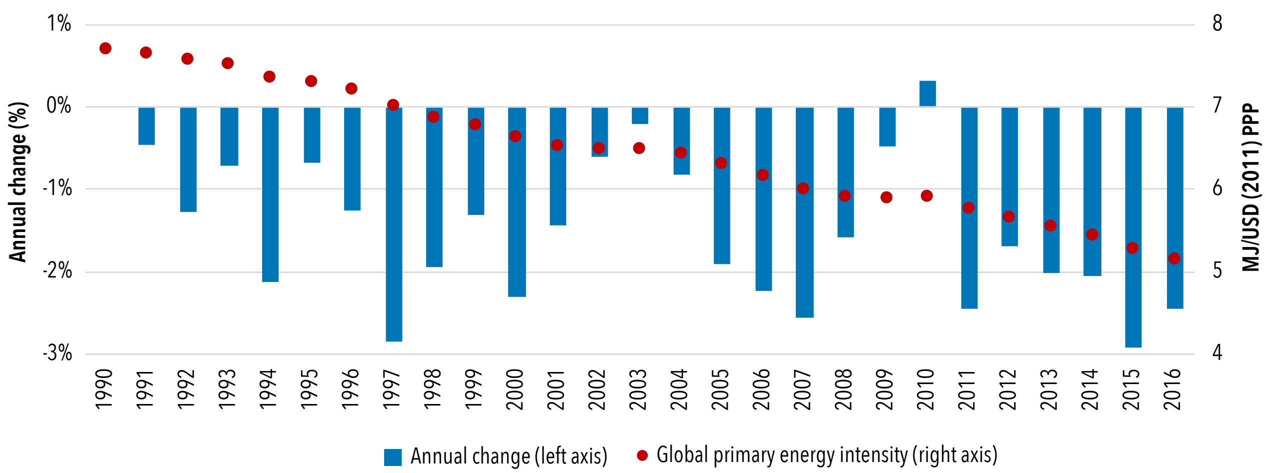
- **End-use trends:** Energy intensity across the major end-use sectors continued to improve, although rates were variable. Between 2010 and 2016 energy intensity in the industry sector improved by an average annual rate of 2.7%, aided by technology improvements and policies supporting energy efficiency in large economies, particularly China. This rate was the highest of any of the major subsectors analyzed. While the introduction of passenger car fuel efficiency standards has driven improvements in passenger transport energy intensity, rates were slowest in freight transport, where fuel efficiency standards have only recently been introduced in some countries.

- **Electricity supply trends:** The average efficiency of electricity generation from fossil fuels is nearly 40% due to more efficient gas-fired generation and the construction of highly efficient coal-fired generation in China and India. Electricity transmission and distribution losses are also falling in many major producing countries, reflecting the increasing rates of electrification and modernization of supply infrastructure.

ARE WE ON TRACK?

Global primary energy intensity—total primary energy supply per unit of GDP (in USD 2011 PPP)—improved by 2.5% in 2016 to 5.13 MJ/USD (2011 PPP) (figure 4.1).

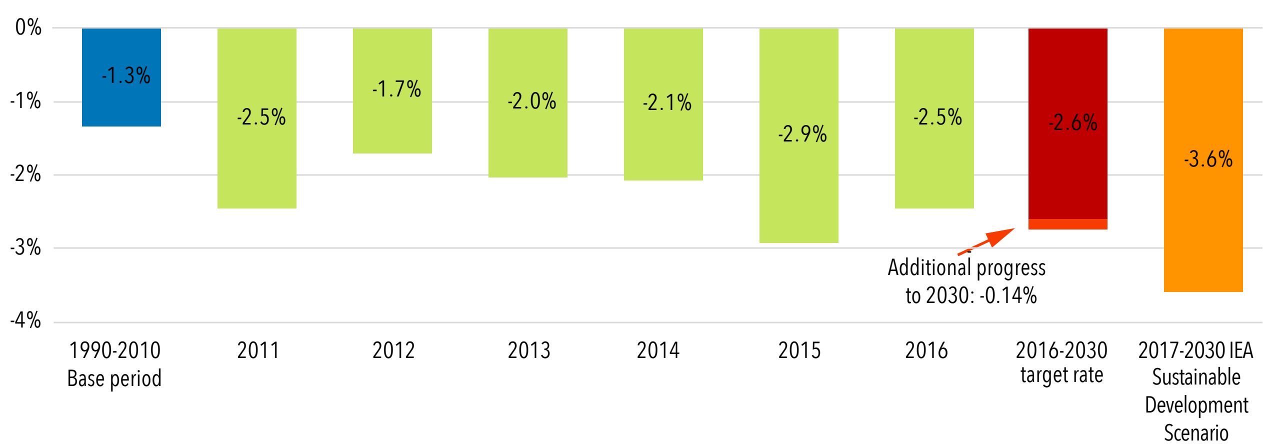
FIGURE 4.1 • GLOBAL PRIMARY ENERGY INTENSITY AND ITS ANNUAL CHANGE, 1990-2016



Source: IEA, UNSD, and WDI.

The 2.5% rate of improvement was less than in 2015, but consistent with the step up in rates of improvement seen since 2010 (figure 4.2). The average rate of progress since 2010 is still lagging behind what is needed to meet the SDG target 7.3 rate, which is now 2.74%.

FIGURE 4.2 • GROWTH RATE OF PRIMARY ENERGY INTENSITY BY PERIOD, AND TARGET RATE FOR 2016-2030



Source: IEA, UNSD, and WDI.

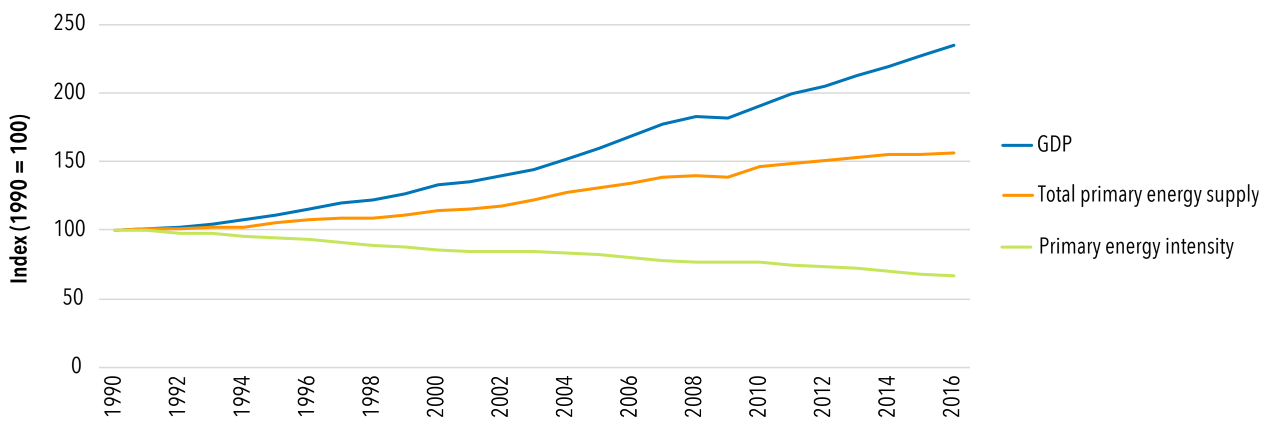
LOOKING BEYOND THE MAIN INDICATORS

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). Since 1990, global GDP has more than doubled. However, total primary energy supply at a global level increased by just over 50%, with growth slowing markedly in 2015 and 2016, after rising steadily after 2010.

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 by over 30% between 1990 and 2016. Since 2010, global primary energy intensity fell by 10%, a slightly higher rate than that observed between 2000 and 2010. These improvements are impacting global emissions (box 4.1), but recent estimates show that they are not being sustained at the same rate (box 4.2).

FIGURE 4.3 • TRENDS IN UNDERLYING COMPONENTS OF GLOBAL PRIMARY ENERGY INTENSITY, 1990-2016



Source: IEA, UNSD, and WDI.

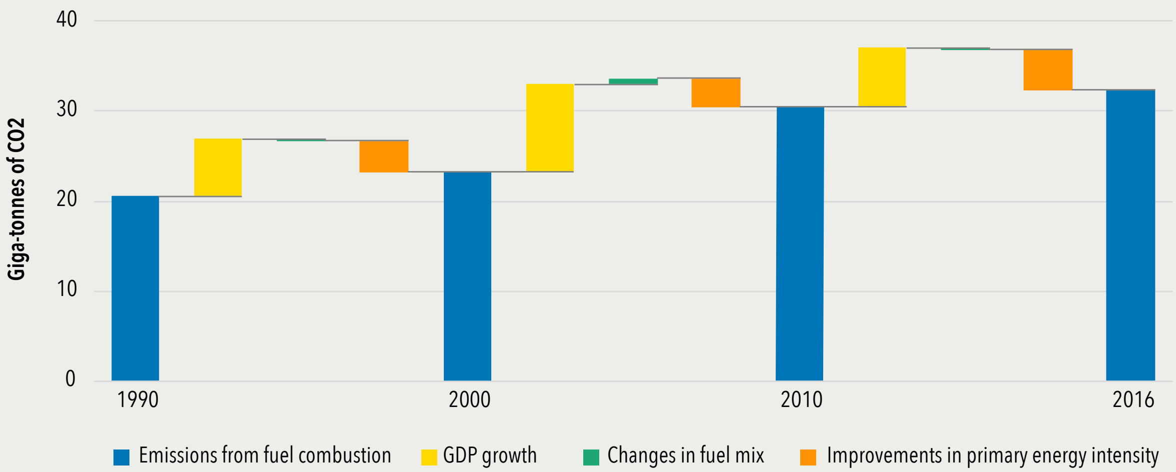
BOX 4.1 • WHAT IS THE IMPACT OF IMPROVEMENTS IN PRIMARY ENERGY INTENSITY ON EMISSIONS?

Improvements in global primary energy intensity are critical to limiting energy-related emissions resulting from fuel combustion. Decomposition analysis undertaken by the International Energy Agency highlights the effects on energy-related emissions of several key factors: gross domestic product (GDP) growth, changes in the global primary fuel mix, and improvements in primary energy intensity (figure B4.1.1).

GDP growth places upward pressure on emissions and since 1990 its total impact was equivalent to over 20 gigatonnes of additional carbon dioxide (CO2) emissions in 2016. Changes in the global primary fuel mix, defined as CO2 emissions per unit of total primary energy supply, can have a varying impact. Shifts toward the use of more emissions-intensive fuels, such as coal and oil, put upward pressure on emissions, whereas movement toward less emissions-intensive fuels, particularly gas and renewables, have the opposite effect. Since 1990 the impact of changes in the global fuel mix has been minimal, although between 2010 and 2016, fuel mix changes avoided nearly 300 million tonnes of CO2 emissions.

Changes in primary energy intensity have done the most to offset the impact of GDP growth on energy-related CO_2 emissions. Between 1990 and 2016, improvements in global primary energy intensity offset nearly half of the impact from GDP growth on emissions, resulting in the avoidance of nearly 11 billion tonnes of additional annual CO_2 emissions.

FIGURE B4.1.1 • DECOMPOSITION OF GLOBAL ENERGY-RELATED CO2 EMISSIONS, 1990-2016

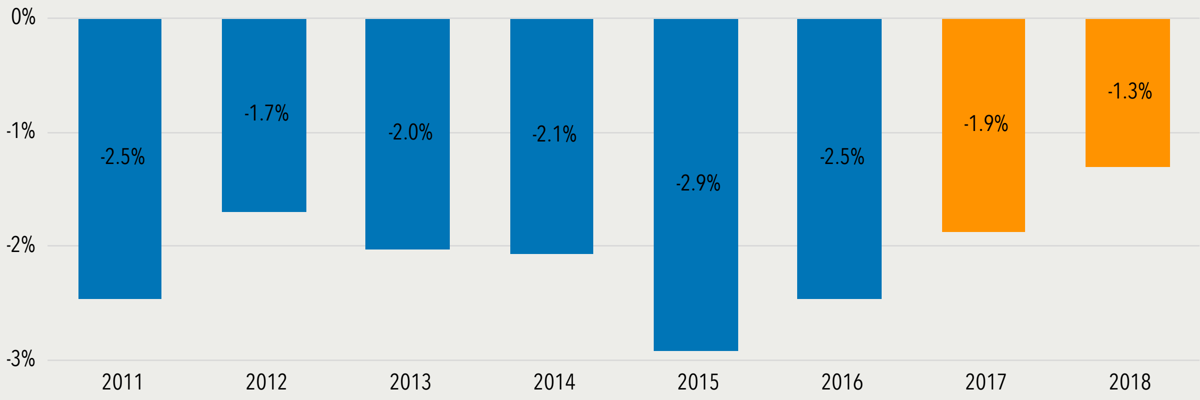


Source: IEA, UNSD, and WDI.

BOX 4.2 • ESTIMATES FOR 2017 AND 2018 INDICATE SLOWING RATES OF PRIMARY ENERGY INTENSITY IMPROVEMENT

Estimates from the International Energy Agency in its Global Energy and CO_2 status report show that the slowing rate of global primary energy intensity improvement observed in 2016 continued into 2017 and 2018 (figure B4.2.1). Global primary energy intensity is estimated to have improved by 1.9% in 2017 and shrunk again in 2018 to just 1.3%.

FIGURE B4.2.1 • GROWTH RATE OF GLOBAL PRIMARY ENERGY INTENSITY, 2011-2018



Source: IEA 2019.

While it is estimated that efficiency continued to improve in 2017 and 2018, its impact has been overwhelmed by factors placing pressure on energy demand. These factors, linked to strong economic growth and low energy prices, have combined with a static energy efficiency policy landscape to shrink primary energy intensity improvements. 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 efforts will be required, on top of those already needed, to reach Sustainable Development Goal target 7.3.

Source: Further information available at www.iea.org/geco.

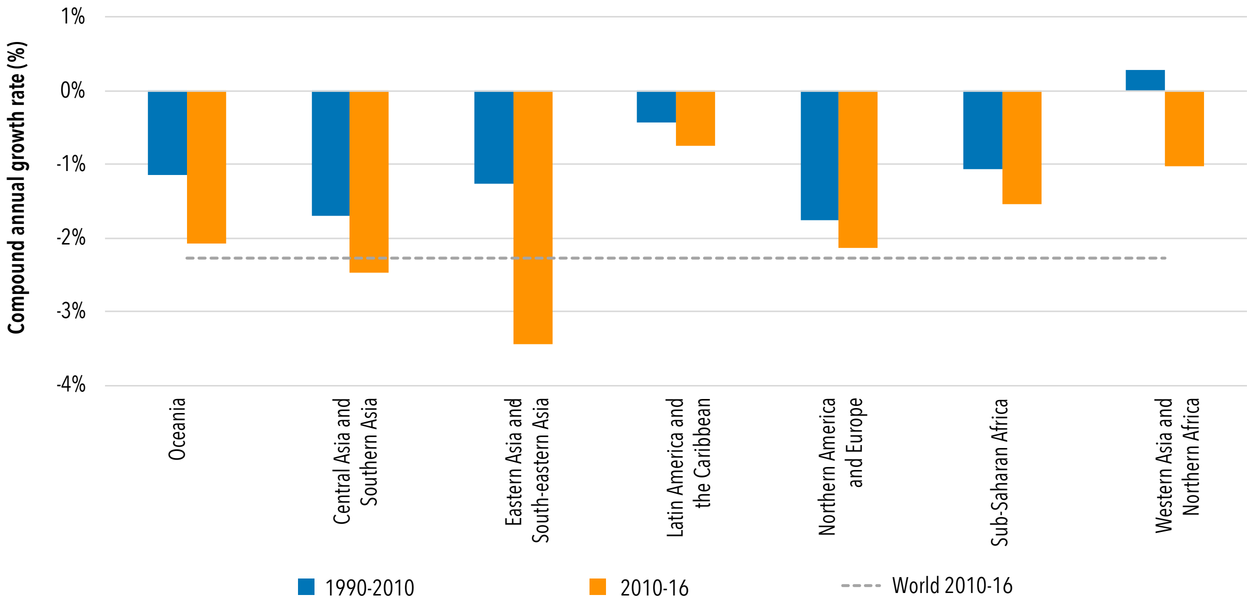
REGIONAL TRENDS

Primary energy intensity improvements have been variable across major regions (figure 4.4). Between 1990 and 2010 improvements were most apparent in Northern America and Europe, as well as Central and Southern Asia. This was linked to economic growth driven by less-energy-intensive service sectors, which benefited from advances in information and communication technologies.

Between 2010 and 2016, primary energy intensity improved across all major regions. Unlike in 1990-2010, improvements were most apparent in East and Southeastern Asia, exceeding the global average. The key factor behind this trend was China's improved primary energy intensity, which drove not only regional but also global trends. Progress was also apparent in Central and Southern Asia, which exceeded the global average rate of improvement. This was linked to strong improvements in India, which has become a growing factor in global trends.

Rates of improvement between 2010 and 2016 in Northern America and Europe, and Oceania, were just below the global average. The rates of improvement in other regions lagged further behind, although Latin America and the Caribbean, Western Asia, and Northern Africa had absolute primary energy intensities below the global average in 2016, reflecting differences in economic structure, energy supply, and access.

FIGURE 4.4 • GROWTH RATE OF PRIMARY ENERGY INTENSITY AT A REGIONAL LEVEL, 1990-2016



Source: IEA, UNSD, and WDI.

MAJOR COUNTRY TRENDS

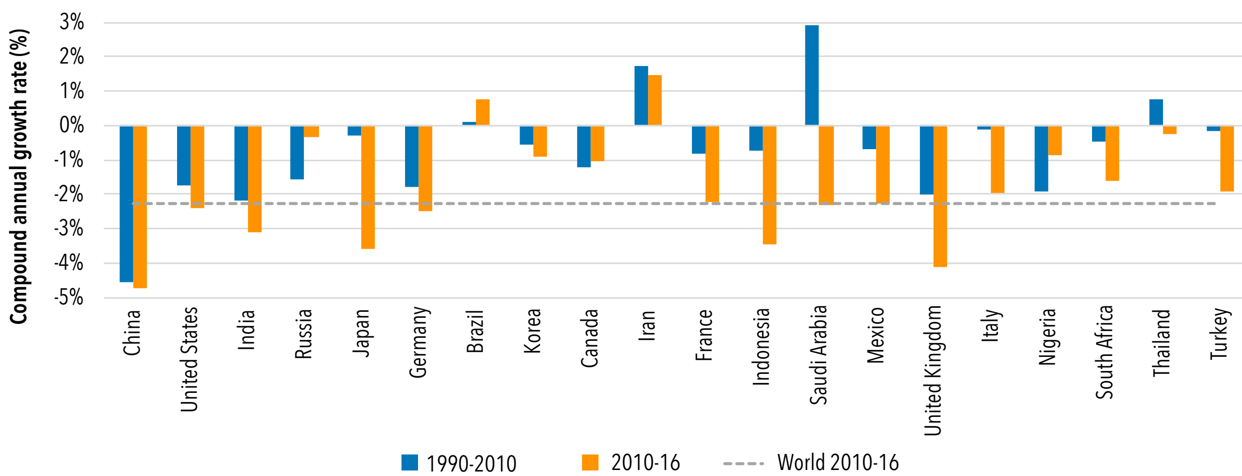
Rates of improvement in primary energy intensity in the 20 countries with the largest total primary energy supply will be central to realizing SDG target 7.3. Sixteen of these countries stepped up their rate of improvement between 2010 and 2016, with nine countries performing better than the global average (figure 4.5).

China has the largest total primary energy supply in the world and the fastest rate of primary energy intensity improvement in the countries analyzed. This is in part linked to China's modernizing economy and changing structure, where more activity is being undertaken in the less-energy-intensive manufacturing and service sectors. The other important driver has been the Chinese government's efforts to implement policies to drive improvements in energy efficiency, including codes and standards for appliances, buildings, and vehicles, and mandatory energy efficiency improvement targets for China's most energy-intensive companies.

India and Indonesia are two other major emerging economies that showed strong rates of improvement in primary energy intensity between 2010 and 2016. In both countries, economic growth, driven by less-energy-intensive manufacturing and service sectors, combined with increased energy efficiency to produce this result. Similar trends are also observed in Japan and the United Kingdom, which have long implemented energy efficiency policies. Brazil and Iran are the two major energy-consuming countries where primary energy intensity is worsening. This is linked to stagnant economic conditions in both countries, which have sizeable energy-intensive industry sectors.

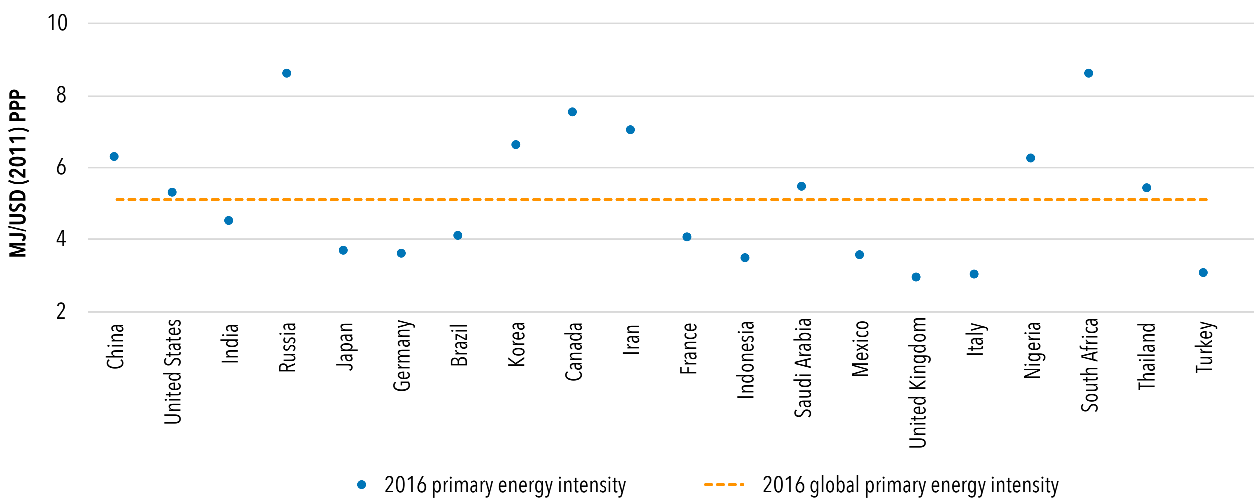
While primary energy intensity is improving in the majority of the world's largest energy-using countries, half of these countries still have absolute levels of energy intensity that are higher than the global average (figure 4.6). Higher primary energy intensity is often due to factors other than levels of energy efficiency. These include the presence of energy-intensive sectors such as iron and steel, cement, aluminum, and pulp and paper manufacturing; climatic factors that increase demand for space heating or cooling; and the fuel mix associated with electricity generation, particularly the presence of fuels that have higher thermal losses.

FIGURE 4.5 • GROWTH RATE OF PRIMARY ENERGY INTENSITY IN THE 20 COUNTRIES WITH THE LARGEST TOTAL PRIMARY ENERGY SUPPLY, 1990-2016



Source: IEA, UNSD, and WDI.
Note: Countries along x-axis ordered by total primary energy supply.

FIGURE 4.6 • PRIMARY ENERGY INTENSITY IN THE 20 COUNTRIES WITH THE LARGEST TOTAL PRIMARY ENERGY SUPPLY, 2016



Source: IEA, UNSD, and WDI.
Note: Countries along x-axis ordered by total primary energy supply.

END-USE TRENDS

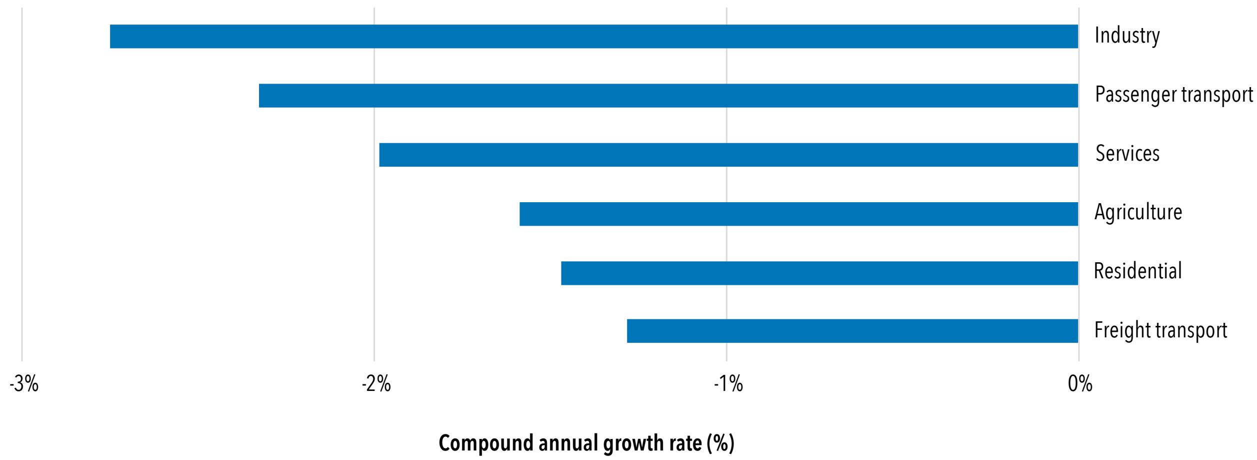
At an end-use level, the rate of improvement in energy intensity since 2010 is greatest in the industry, passenger transport, and service sectors (figure 4.7). Continuing productivity gains within the global industry sector, due to increasing output driven by technological advances, is reflected in an average annual improvement rate of 2.7%. Advances in information and communication technologies, which also drive productivity gains in the global services sector, have combined with improvements in the efficiency of commercial buildings to produce a 2% rate of improvement.

Rates of improvement in the energy intensity of the residential and agricultural sectors are both over 1%. Greater rates of improvement in the residential sector will be important to realizing SDG target 7.3, particularly as living standards and demand for energy services rise, emphasizing the importance of residential building codes and appliance standards.

In passenger transport, the average annual rate of improvement in energy intensity was over 2%. An important factor behind this was passenger car fuel efficiency standards in major markets; these standards helped limit increases in energy use between 2010 and 2016, despite a 30% increase in activity (as measured in passenger-kilometers). Cars are the largest component of the passenger transport sector and while there has been improvement, it is still short of what is required to reach SDG target 7.3 and other global targets (box 4.4).

The limited application of fuel economy standards for trucks is reflected by the low rate of energy intensity improvement in the freight transport sector. Fuel economy standards for trucks have been implemented in five countries (Japan, the United States, Canada, China, and India), and their implementation is planned throughout the European Union. This change to the policy landscape will contribute to greater improvement in the energy intensity of freight transport in the future.

FIGURE 4.7 • GROWTH RATE OF ENERGY INTENSITY BY SECTOR, 2010-2016



Source: IEA, UNSD, and WDI.
Note: Energy intensity of freight transport is defined as final energy use per tonne-kilometer; for passenger transport it is final energy use per passenger-kilometer; for residential it is final energy use per square meter of floor area; and in the services, industry, and agriculture sectors, energy intensity is defined as final energy use per unit of gross value added (in USD 2011 PPP).

BOX 4.3 • TRACKING PASSENGER CAR FUEL EFFICIENCY THROUGH THE GLOBAL FUEL ECONOMY INITIATIVE

The Global Fuel Economy Initiative (GFEI) is a partnership between the International Energy Agency, UN Environment, International Transport Forum, International Council on Clean Transportation, and University of California–Davis, and is coordinated by the FIA Foundation. One of the stated targets of the GFEI is a 50% reduction in the fuel economy (in liters per 100 kilometers [km]) of newly sold passenger cars globally by 2030, compared with a 2005 baseline.

In the recent benchmarking report for the GFEI, the global average fuel economy of passenger cars in 2017 was estimated at 7.2 liters of gasoline equivalent (Lge) per 100 km. The annual rate of improvement between 2015 and 2017 was 1.4%. This was a slowdown compared with the 1.7% observed between 2005 and 2015, and only a third of the 3.7% now required to meet the 2030 GFEI target. Rates of improvement vary widely across countries and regions, depending on fuel prices and development status (table B4.3.1).

There are a number of factors contributing to the slowing rate of improvement in fuel economy. Growth in the market for large, relatively inefficient vehicles, such as sport utility vehicles, grew 11 percentage points between 2014 and 2017, slowing the rate of improvement in fuel economy. Another factor is the rapid decline of diesel car sales, most notably in Europe. While of benefit to air quality, this has impacted improvements in fuel economy, as diesel vehicles are generally more efficient than equivalent gasoline vehicles. Most diesel cars have been replaced by gasoline vehicles, though the market share of electrified vehicles is rapidly growing in several markets.

Fuel economy policies also affect improvement rates. In countries with fuel economy standards or purchase incentives, the rate of improvement was 60% faster than countries without such policies. While historic policy settings did not lead to improvement rates required for the GFEI target, most of the existing standards imply improvement rates that would allow countries to meet the 2030 GFEI target, although only the European Union has set an explicit fuel efficiency target for 2030. Fuel economy policies and incentives also have a significant impact on the adoption of electrified vehicles.

A step-up in policy action will be central to realizing the GFEI target. Critical steps include an increase in the coverage and strength of vehicle fuel economy standards and the tightening of rules for fuel economy testing and on-road compliance. Long-term commitments and targets supported by incentives will also be important to drive greater levels of investment.

TABLE B4.3.1 • PROGRESS IN AVERAGE FUEL ECONOMY IMPROVEMENT IN DIFFERENT REGIONS

<table>
<tr><th colspan="3"></th><th>2005</th><th>2010</th><th>2015</th><th>2017</th><th>2030</th></tr>
<tr><td rowspan="3">Advanced
(Gasoline price ≥ USD 1/L)</td><td colspan="2">average fuel economy (Lge/100km)</td><td>7.4</td><td>6.5</td><td>5.8</td><td>5.8</td><td rowspan="12">**4.4**</td></tr>
<tr><td colspan="2" rowspan="2">annual improvement rate (% per year)</td><td colspan="2">-2.4%</td><td>-2.5%</td><td>-0.1%</td></tr>
<tr><td colspan="4">**-2.0%**</td></tr>
<tr><td rowspan="3">Advanced
(Gasoline price < USD 1/L)</td><td colspan="2">average fuel economy (Lge/100km)</td><td>11.0</td><td>9.5</td><td>8.6</td><td>8.6</td></tr>
<tr><td colspan="2" rowspan="2">annual improvement rate (% per year)</td><td colspan="2">-2.9%</td><td>-1.9%</td><td>-0.4%</td></tr>
<tr><td colspan="4">**-2.0%**</td></tr>
<tr><td rowspan="3">Emerging</td><td colspan="2">average fuel economy (Lge/100km)</td><td>8.6</td><td>8.5</td><td>7.8</td><td>7.5</td></tr>
<tr><td colspan="2" rowspan="2">annual improvement rate (% per year)</td><td colspan="2">-0.2%</td><td>-1.6%</td><td>-2.3%</td></tr>
<tr><td colspan="4">**-1.2%**</td></tr>
<tr><td rowspan="3">Global average</td><td colspan="2">average fuel economy (Lge/100km)</td><td>8.8</td><td>8.0</td><td>7.4</td><td>7.2</td></tr>
<tr><td colspan="2" rowspan="2">annual improvement rate (% per year)</td><td colspan="2">-2.0%</td><td>-1.5%</td><td>-1.4%</td></tr>
<tr><td colspan="4">**-1.7%**</td></tr>
<tr><td rowspan="2">**GFEI target**</td><td rowspan="2">**Required annual improvement rate (% per year)**</td><td>**2005 base year**</td><td colspan="5">**-2.8%**</td></tr>
<tr><td>**2017 base year**</td><td colspan="3"></td><td colspan="2">**-3.7%**</td></tr>
</table>

Source: IEA elaboration and enhancement for broader coverage of IHS Markit database (IHS Markit 2018).
Note: Further information available at https://www.globalfueleconomy.org/.

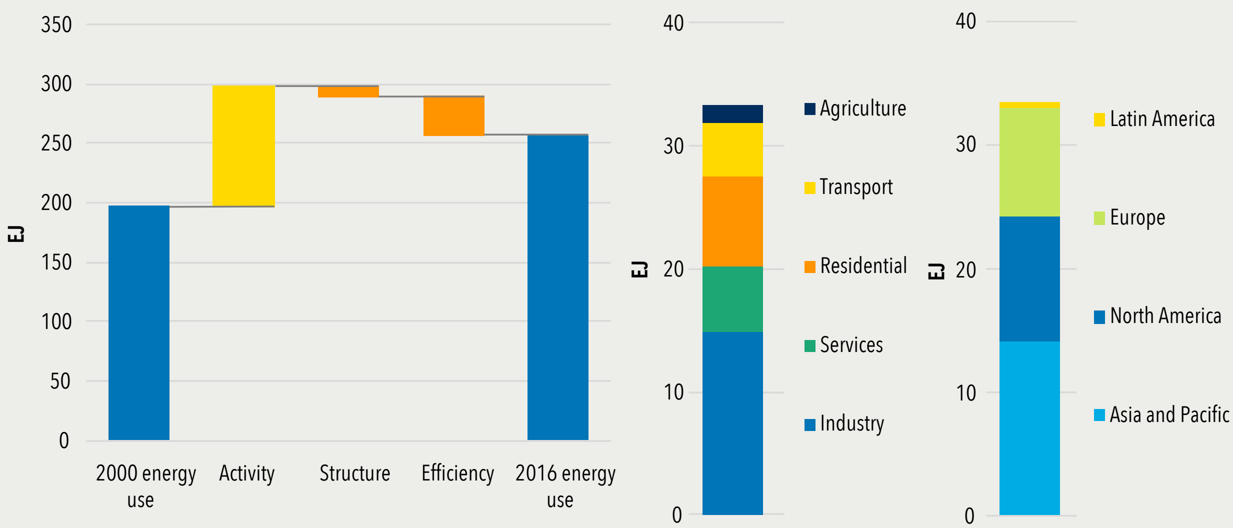
BOX 4.4 • DETERMINING SECTORAL AND REGIONAL CONTRIBUTIONS TO ENERGY SAVINGS

Improvements in energy intensity are not due solely to energy efficiency. Activity levels across energy-using sectors and structural changes also have an impact. Decomposition analysis allows the influence of activity levels, structural change, and energy efficiency improvements in final energy use to be determined. In the process, it is possible to analyze sectoral and regional contributions to efficiency gains (figure B4.4.1).

The factors that influence levels of activity include gross value added in the industry and service sectors, passenger- and tonne-kilometers in transport, and changes in population and climate in the residential sector. These factors all drive demand for energy services and put upward pressure on final energy use. Structural effects can have varying impacts on energy use. A shift of economic activity away from energy-intensive sectors, such as iron and steel and cement manufacturing, toward less-energy-intensive manufacturing or service sectors puts downward pressure on energy use. In the residential sector, increasing levels of appliance ownership and floor area put upward pressure on energy use. Similarly, in transport, shifts to less efficient transport modes and falling vehicle occupancy rates place pressure on energy demand. Separating structural effects from changes in activity allows for the impact of energy efficiency on final energy use to be analyzed.

Decomposition analysis shows that improvements in efficiency between 2000 and 2016 resulted in the avoidance of over 33 exajoules (EJ) of additional final energy use for the economies analyzed, nearly equivalent to the final energy use of India and Japan combined. These gains were complemented by structural effects due to shifts in economic activity toward less-energy-intensive sectors, which avoided an additional 10 EJ of energy use. However, these factors were more than offset by increasing levels of activity across all energy-using sectors. Activity effects are most apparent in the industry and service sectors, where increases in gross value added continued to put pressure on energy use.

FIGURE B4.4.1 • DECOMPOSITION OF FINAL ENERGY USE IN MAJOR ECONOMIES, 2000-2016 (LEFT) AND SECTORAL AND REGIONAL CONTRIBUTIONS TO EFFICIENCY GAINS (RIGHT)



Source: IEA 2018.
Note: Countries covered are IEA members plus China, India, Brazil, Indonesia, Russia, South Africa, and Argentina, covering around 75% of global energy use.

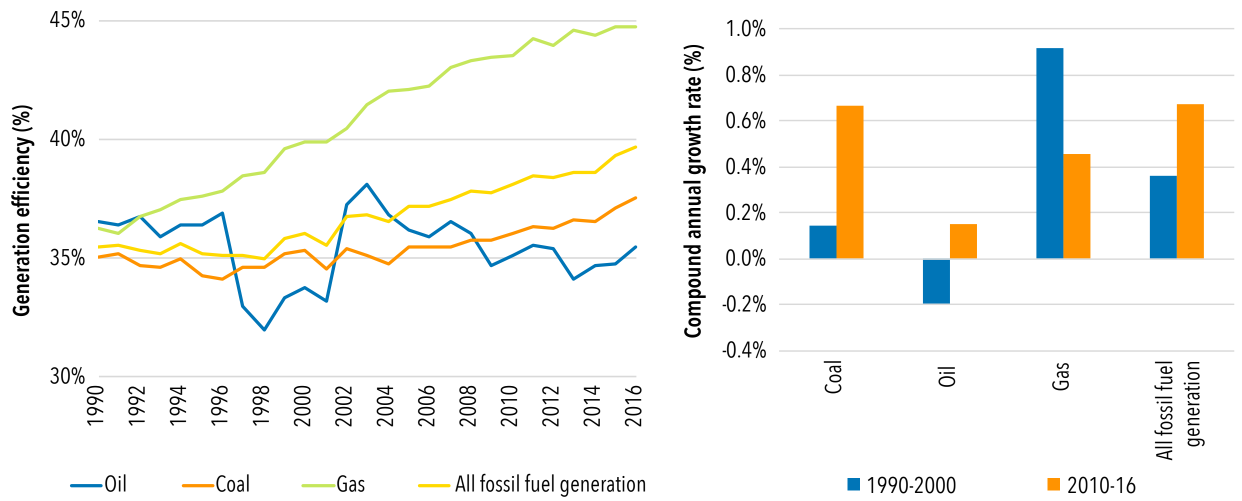
The industry sector made the largest contribution to efficiency gains in the major economies analyzed, followed by the residential, service, and transport sectors. Savings were driven by China, where government policy and new production capacity improved energy efficiency. The influence of China is also apparent in the regional contribution to efficiency gains. The Asia and Pacific region was responsible for over 40% of the energy savings from efficiency improvements in the major economies analyzed. Just over 10 EJ of energy savings were obtained from efficiency gains in Northern America, with the influence of the United States, which has an extended history of policy driven action on energy efficiency, the major factor behind this result.

TRENDS IN THE EFFICIENCY OF ELECTRICITY SUPPLY

The rate of improvement in global primary energy intensity is 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 increased at a steady rate in 2000-2016, reaching nearly 40% (figure 4.8), after showing flat rates of improvement in 1990-2010. Two factors behind this trend were a growing share of more efficient gas-fired generation and the improved efficiency of coal-fired generation.

While the rate of improvement in the efficiency of gas-fired generation slowed, total efficiency levels climbed to nearly 45%, reflecting the presence of more efficient technologies such as combined-cycle gas turbines. The share of gas in total fossil fuel electricity generation rose to over 35%. Construction of new, more efficient, supercritical and ultra-supercritical coal-fired power generation in economies with growing electricity demand, specifically China and India, were reflected in the rising efficiency of overall coal-fired generation, which improved at an average annual rate of nearly 0.7% between 2010 and 2016, the fastest rate observed.

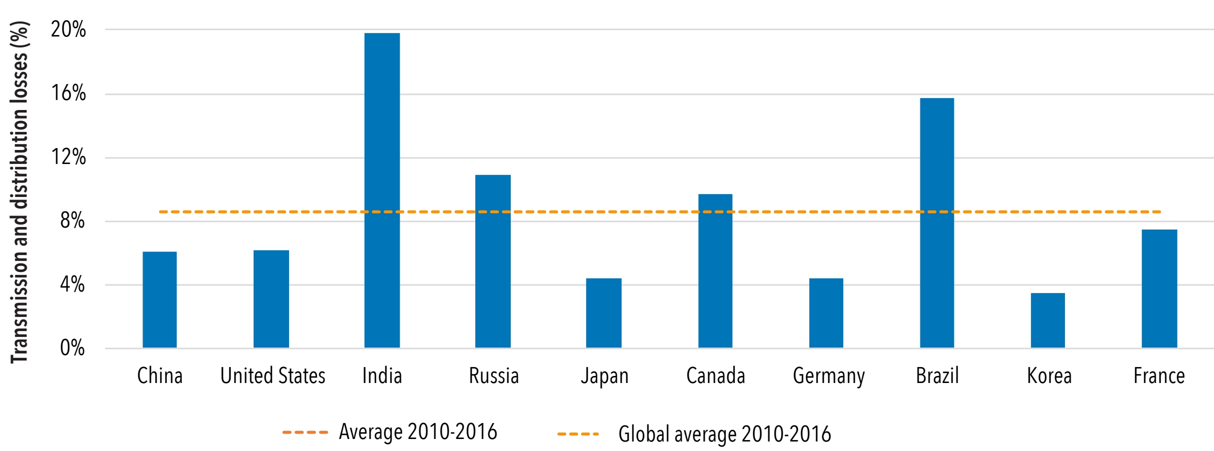
FIGURE 4.8 • TRENDS IN THE EFFICIENCY OF GLOBAL FOSSIL FUEL ELECTRICITY GENERATION (LEFT) AND RATE OF IMPROVEMENT (RIGHT), BY FUEL TYPE, 1990-2016



Source: IEA, UNSD, and WDI.

Increasing levels of energy access and electrification are resulting in the modernization of electricity networks in the world's largest electricity-producing countries. This in turn reduces transmission and distribution losses, which contribute to supply-side efficiency gains. These improvements saw losses in China fall to nearly 5% in 2016. However, in India, losses are still above the global average, reflecting the ongoing modernization of electricity networks (figure 4.9). In other countries with established electricity networks and full access, losses are typically below the global average.

FIGURE 4.9 • TRANSMISSION AND DISTRIBUTION LOSSES FOR THE WORLD'S 10 LARGEST ELECTRICITY PRODUCERS, 2016



Source: IEA, UNSD, and WDI.
Note: Countries along x-axis ordered by electricity production.

POLICY RECOMMENDATIONS AND CONCLUSIONS

The accelerated improvement of global primary energy intensity observed in 2010-2016 was linked to greater energy efficiency in large energy-using countries and regions. China, India, Japan, and Northern America and Europe all stepped up or maintained their policy ambitions regarding energy efficiency. The policy approaches adopted in these countries and regions provide examples to others regarding measures that can drive the efficiency gains needed to meet SDG target 7.3.

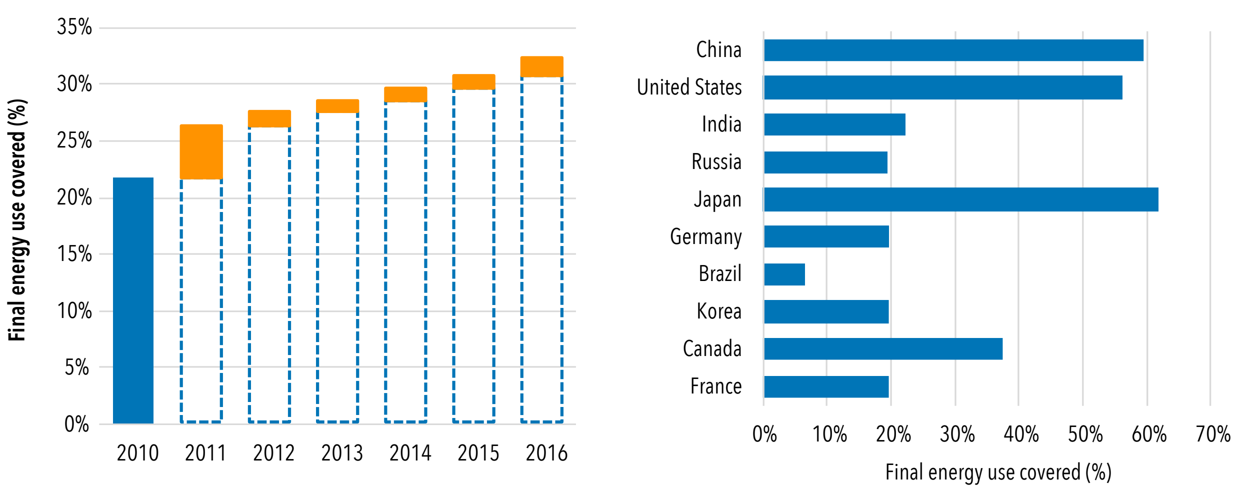
ENERGY EFFICIENCY POLICY

There are three broad types of energy efficiency policy that are used by governments to drive progress:

- *Regulation*—mandatory requirements to improve energy efficiency or to meet specified targets or standards, which include minimum energy performance standards for appliances and equipment, vehicle fuel efficiency standards, building codes, and mandatory energy efficiency improvement targets for industrial firms or sectors;
- *Incentives*—fiscal or financial incentives to energy consumers to improve efficiency; and
- *Information*—labels, websites, training, and capacity building regarding the performance of products or ways to improve energy efficiency.

The scope of energy efficiency regulations at a global and national level is reflected by the percentage of final energy use that is covered by mandatory efficiency codes and standards (figure 4.10). This metric reflects the energy use of appliances, equipment, and vehicles that were required to comply with minimum energy performance standards 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.

FIGURE 4.10 • INCREMENTAL GROWTH IN ENERGY USE COVERED BY MANDATORY EFFICIENCY POLICIES GLOBALLY, 2010-2016 (LEFT), AND COVERAGE IN THE 10 COUNTRIES WITH THE HIGHEST TOTAL PRIMARY ENERGY SUPPLY (RIGHT)

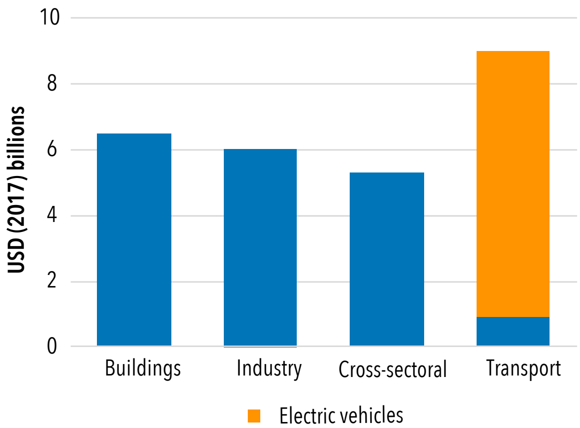


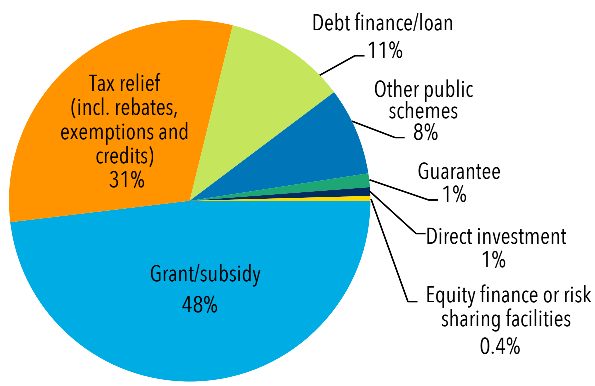
Source: IEA 2018.

In 2016, over 32% of global final energy use was covered by mandatory energy efficiency policies. Coverage rose consistently after a marked increase in 2011 following the implementation of new measures in China. This growth reflects the replacement of old energy-using equipment, appliances, and vehicles with new models. The influence of new policies on coverage growth was minimal after 2012, reflecting a slowdown in the implementation of new mandatory policies; practically all growth in 2016 was due to existing policies.

Fiscal and financial incentives to improve energy efficiency are policy tools being used by governments to complement direct regulation and encourage greater levels of efficiency. In 2017, incentives for energy efficiency in 16 of the world's major economies amounted to $27 billion (figure 4.11). These incentives included grants, subsidies, tax relief, loans, and rebates, with the transport sector being the largest single recipient, thanks to $8 billion in incentives for the adoption of electric vehicles.

FIGURE 4.11 • NATIONAL GOVERNMENT INCENTIVES FOR ENERGY EFFICIENCY BY SECTOR (LEFT) AND TYPE (RIGHT), 2017





Source: IEA 2018.
Note: Countries covered are Australia, Austria, Brazil, China, Estonia, Germany, India, Ireland, Italy, Mexico, Norway, Portugal, Spain, Switzerland, the United Kingdom, and the United States. For China, incentives data for 2016 are used as a proxy for 2017.

Grants, subsidies, and tax relief represent nearly 80% of the energy efficiency incentives in the countries analyzed. Grants and subsidies are used to effectively lower the capital cost of more energy efficient appliances or equipment, making their purchase more appealing to consumers. Fiscal incentives in the form of tax relief are intended to appeal to consumers, particularly businesses, by lowering their tax bills. Although other forms of incentives based on debt or loan finance are less prominent, there are a growing number of governments that use these incentives to reduce the risk associated with energy efficiency projects, thereby encouraging complementary private sector investment.

Financial incentives for energy efficiency are often provided through market-based instruments, in which a government uses regulation to specify a desired outcome, typically energy savings, and then establishes a framework for market actors to deliver the outcome. The most common market-based instruments are:

- Obligation schemes, such as white certificate programs or energy efficiency resource standards, where energy suppliers or utilities are required to deliver a specified amount of savings; and
- Auctions, where companies or service providers bid for government funds to support the implementation of energy efficiency measures.

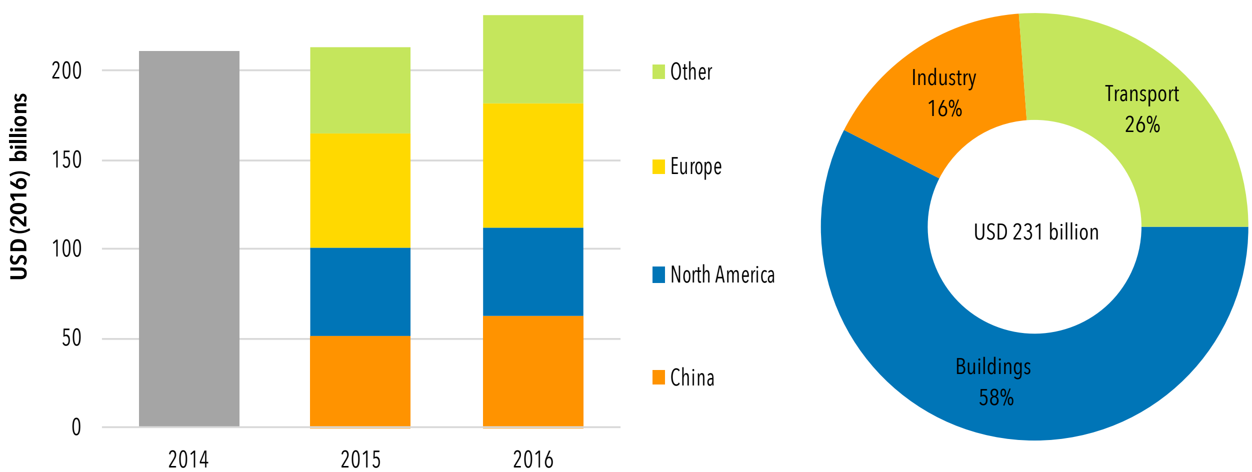
Between 2005 and 2016, the number of market-based instruments in operation quadrupled globally (IEA 2016), reflecting how these measures leverage market forces to deliver energy efficiency.

While regulation- and incentive-based policy measures compel or encourage greater action on energy efficiency, they do not ensure that consumers have the right information to make appropriate decisions. Information- and capacity-building measures are therefore an important complement to other energy efficiency policies. These measures include appliance and equipment labels that inform consumers of energy performance, performance rating tools, and case studies highlighting successful energy efficiency projects. Awareness-raising campaigns aimed at educating and empowering consumers to take action have also been successful in many countries (e.g., campaigns targeting women in developing countries).[33]

ENERGY EFFICIENCY INVESTMENT

In 2016, the incremental amount invested in more efficient buildings, appliances, vehicles, and industrial equipment totaled $231 billion, the majority of which was in the buildings sector (figure 4.12). The presence of low-cost and replicable energy efficiency measures, such as lighting upgrades and improvements to heating, ventilation, and air conditioning system performance, contributes to the buildings sector receiving the most incremental investment.

FIGURE 4.12 • ENERGY EFFICIENCY INVESTMENT BY REGION (LEFT) AND SECTOR (LEFT), 2016



Source: IEA 2017.

CONCLUSIONS

Even with sustained improvements in primary energy intensity since 2010, the average rate of improvement is still lagging behind SDG target 7.3. Improvements in 2016 were close to the target rate although a step down from 2015; estimates for 2017 and 2018 indicate that progress has continued to slow. There is still significant potential to cost-effectively improve energy efficiency—improvement in primary energy intensity could not only meet but even exceed SDG target 7.3 by 2030. Achieving this potential would generate benefits across the entire energy system and significantly improve energy access, since more efficient appliances and equipment reduce the amount and cost of the energy infrastructure required to provide access to modern energy services.

Government policy will continue to be central to global efforts to realize the benefits of improved energy efficiency. Supportive policy measures have been implemented in some form across advanced and major emerging economies, and will provide a basis for global expansion and development. Key actions include:

- Implementing and strengthening mandatory energy efficiency policies, which push appliances, equipment, and vehicles toward the best available technologies.

- Providing targeted and appropriate fiscal or financial incentives to encourage energy users to pursue greater levels of efficiency.
- Leveraging the power of the market, through implementation of market-based mechanisms, to deliver energy efficiency improvements at least cost.
- Providing targeted and high-quality information and capacity-building measures, to maximize market readiness to deliver higher levels of energy efficiency.

Government policy will also need to create an environment that is conducive to the development of new finance and business models, which are needed to raise levels of energy efficiency investment.

One factor that will have an increasing impact on energy efficiency across all sectors is the growth and application of digital technologies. Digitalization encapsulates an increase in the amount and accuracy of energy use data, an enhanced ability to conduct data analysis, and improvements in connectivity, which improve the interaction between consumers and devices, enabling greater control and flexibility of use.

Digitalization is creating new business models for the delivery of energy efficiency, which capture benefits not only for individual consumers but also the broader energy market. This is an active area of analysis that policy makers will need to continue to monitor, not only to establish frameworks that best capture the positive impacts, but to leverage the power of digitalization to improve the development, implementation, and enforcement of energy efficiency policies.

METHODOLOGY

Total primary energy supply (TPES) (in megajoules [MJ])	Equal to Total Energy Supply as defined by the International Recommendations for Energy Statistics (IRES), made up of production plus net imports minus international marine and aviation bunkers plus-stock changes. *Data sources*: Total energy supply is typically calculated in the making of national energy balances. Energy balances are compiled based on data collected for around 150 economies from the International Energy Agency (IEA) and for all countries in the world from the United Nations Statistics Division (UNSD).
Gross domestic product (GDP) (in USD 2011 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. This is calculated without making deductions for the depreciation of fabricated assets or for depletion and degradation of natural resources. GDP is measured in USD 2011 PPP. Purchasing power parities (PPPs) are the rates of currency conversion that equalise the purchasing power of different currencies by eliminating the differences in price levels between countries. In their simplest form, PPPs are simply price relatives which show the ratio of the prices in national currencies of the same good or service in different countries. *Data source:* World Bank's World Development Indicators (WDI).
Primary energy intensity (in MJ/USD 2011 PPP)	$Primary\ Energy\ Intensity = \frac{TPES}{GDP}$ Ratio of TPES to GDP measured in MJ per USD 2011 PPP. Energy intensity indicates how much energy is used to produce one unit of economic output. A lower ratio indicates that less energy is used to produce one unit of economic output. Energy intensity is an imperfect indicator of energy efficiency as changes are impacted by other factors, particularly changes in the structure of economic activity.
Average annual rate of improvement in primary energy intensity (%)	Calculated using compound annual growth rate (CAGR). $CAGR = \left(\frac{PEI_{t2}}{PEI_{t1}}\right)^{\frac{1}{(t2-t1)}}$ -1 Where: $PEI_{t2}PEI_{t2}$ is primary energy intensity in year *t2* $PEI_{t1}PEI_{t1}$ is primary energy intensity in year *t1* 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 in different end-use sectors, excluding non-energy 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 international bunkers are included in the transport sector. *Data sources:* Energy balances from the IEA, supplemented by the UNSD for countries not covered by the 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 the 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 (ISIC), revision 3. *Data source:* World Bank's World Development Indicators (WDI).

Industry energy intensity (in MJ/USD 2011 PPP)	$$Industry\ energy\ intensity = \frac{Industrial\ TFEC}{Industrial\ value\ added}$$ Ratio between industry TFEC and industry value added measured in MJ per USD 2011 PPP. Industry corresponds to ISIC divisions 10-45 and includes manufacturing (ISIC divisions 15-37), non-fuel mining and construction. *Data sources:* Energy balances from the IEA and the UNSD and value added from the WDI.
Services energy intensity (in MJ/USD 2011 PPP)	$$Services\ energy\ intensity = \frac{Services\ TFEC}{Services\ value\ added}$$ Ratio between services TFEC and services value added measured in MJ per USD 2011 PPP. Services correspond to ISIC divisions 50-99. They include wholesale and retail trade (including hotels and restaurants), transport, and government, financial, professional, and personal services such as education, health care, and real estate services. *Data sources:* Energy balances from the IEA and the UNSD and value added from the WDI.
Agriculture energy intensity (in MJ/USD 2011 PPP)	$$Agriculture\ energy\ intensity = \frac{Agriculture\ TFEC}{Agriculture\ value\ added}$$ Ratio between agriculture TFEC and agriculture value added measured in MJ per USD 2011 PPP. Agriculture corresponds to ISIC divisions 1-5 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. *Data sources*: Energy balances from the IEA and the UNSD and value added from the WDI.
Passenger transport energy intensity (in MJ/passenger-kilometer [pkm])	$$Passenger\ transport\ energy\ intensity = \frac{Passenger\ transport\ TFEC}{Passenger\text{-}kilometers}$$ Ratio between passenger transport TFEC and passenger transport activity measured in MJ per passenger-kilometers. *Data source:* IEA Mobility Model.
Freight transport energy intensity (in MJ/tkm)	$$Freight\ transport\ energy\ intensity = \frac{Freight\ transport\ TFEC}{Tonne\text{-}kilometers}$$ Ratio between freight transport TFEC and activity measured in MJ per tonne-kilometers. *Data source:* IEA Mobility Model.
Residential energy intensity (in MJ/unit of floor area)	$$Residential\ energy\ intensity = \frac{Residential\ TFEC}{Residential\ floor\ area}$$ Ratio between residential TFEC and square meters of residential building floor area measured in MJ per m2. *Data source:* IEA Buildings Model.
Fossil fuel electricity generation efficiency (%)	$$Generation\ efficiency = \frac{Electricity\ output}{Fuel\ input}$$ Ratio of the electricity output from fossil fuel power generation (coal, oil, and gas) and the fossil fuel input to power generation. *Data source:* IEA Energy Balances.
Power transmission and distribution (T&D) losses (%)	$$Power\ T\&D\ losses = \frac{Electricity\ \ transmission\ and\ distribution\ losses}{(Electricity\ output\ main + Electricity\ output\ CHP + Electricity\ imports)} (\%)$$ Where: "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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ENDNOTES

31 Some of the analysis in this chapter is based on data and analysis in the report Energy Efficiency 2018 (IEA 2018).

32 Calculated as the compound average annual growth rate.

33 For more information, see http://genderandenvironment.org/resource/agent-energy-webinar-energy-efficiency-as-a-means-to-improve-womens-lives/.

CHAPTER 5
OUTLOOK FOR SDG 7

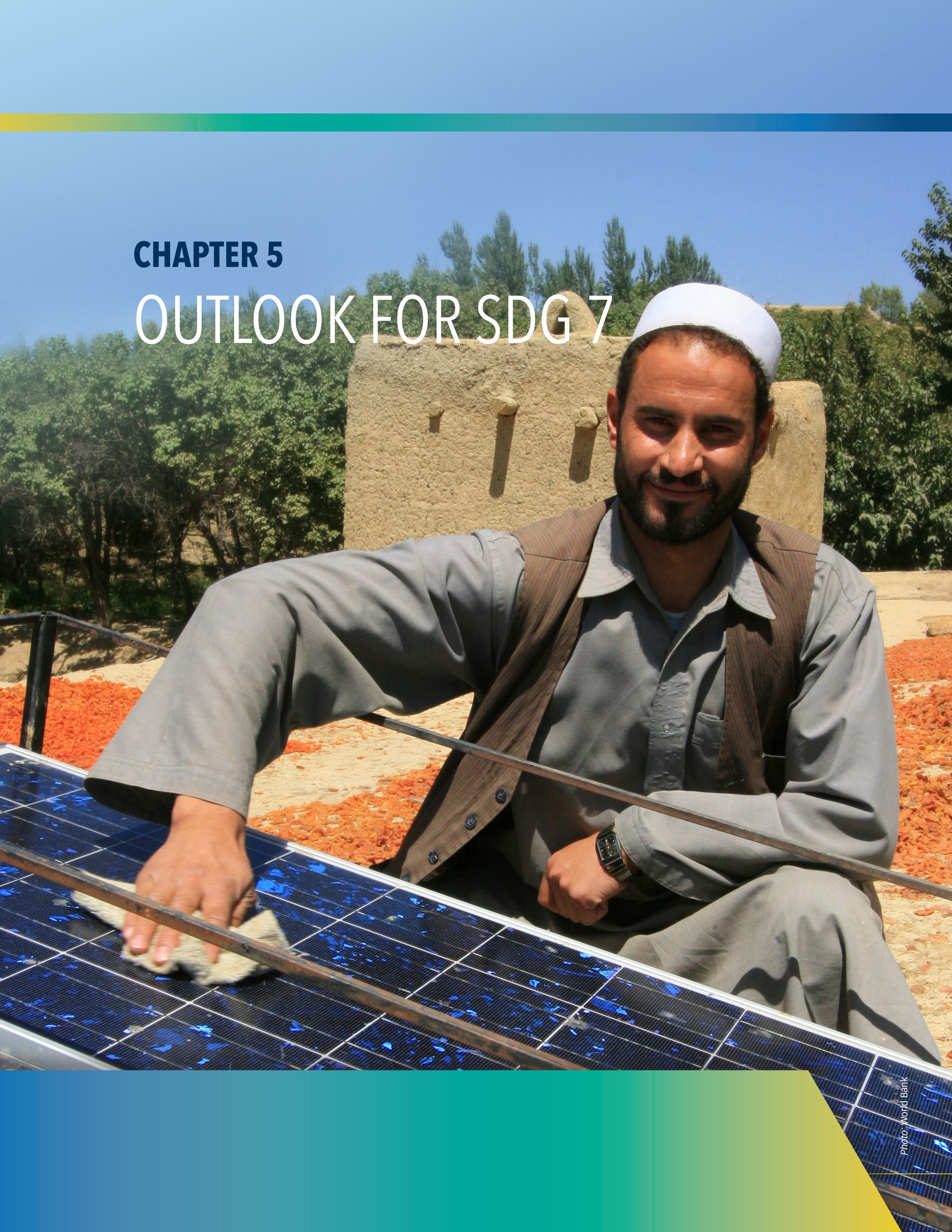


Photo: World Bank

MAIN MESSAGES

- **Outlook for overall progress by 2030:** The world is not on track to achieve Sustainable Development Goal (SDG) 7 at the current rate of progress. Two scenarios developed by the International Energy Agency (IEA) serve as benchmarks for the progress that is expected and that is needed by 2030. The New Policies Scenario, which accounts for current and planned policies, shows that none of the SDG 7 targets will be achieved by 2030. And the Sustainable Development Scenario indicates a possible least-cost pathway by which the world's energy system could be on track to achieve the SDG targets most closely related to energy (SDG target 3.9, and the targets under SDGs 7 and 13).[34]

- **Outlook for access to electricity:** Under current and planned policies, in the IEA's New Policies Scenario, 570 million people are projected to gain access to electricity worldwide between 2018 and 2030, thanks to significant public and private efforts to achieve universal access. Nonetheless, around 650 million people would still be deprived of access to electricity in 2030, of which 9 out of 10 would reside in Sub-Saharan Africa. Further international collaboration in sharing good practices and deploying new technologies will be essential to reach communities and locales otherwise left behind.

- **Outlook for access to clean cooking solutions:** By 2030, under current and planned policies, 2.2 billion people, mainly living in Asia and Sub-Saharan Africa, would still be dependent on inefficient and polluting energy sources for cooking. Several proven solutions are nonetheless expected to help more than 580 million people worldwide move away from traditional uses of biomass between 2018 and 2030. There is an urgent need to further enable the uptake of efficient solutions in order to reach universal access to clean cooking solutions by 2030.

- **Outlook for renewable energy:** Strong policy support combined with the increasingly competitive costs of solar photovoltaic (PV) and wind technologies will bolster the deployment of renewable electricity across all regions, though grid integration challenges will need to be addressed in some countries. However, the use of renewables for transport and heat remains limited. The modern use of renewables overall is projected to reach just 15% by 2030 under current trends and planned policies, compared with the 22% possible under the Sustainable Development Scenario. The International Renewable Energy Agency's (IRENA's) renewable energy roadmap (REmap) outlines a pathway by which the share of modern renewables could rise even more, to 28% by 2030 and 66% by 2050.

- **Outlook for energy efficiency:** A decoupling of energy demand and economic growth has led to significant improvements in energy intensity in recent years. However, such improvements are likely to fall short of SDG target 7.3, leaving a large portion of the world's energy efficiency potential untapped. Between 2017 and 2030, energy intensity improvements are projected to average 2.4% per year versus the 3.5% under a scenario where energy efficiency potentials are maximized.

- **Investment needed to reach SDG 7:** Achieving universal energy access, substantially accelerating the share of renewable energy, and doubling the rate of energy intensity improvements would require annual average investments of approximately around $1320 billion per year between 2018 and 2030, in a variety of technologies. This comprises annual investment of approximately $51 billion to achieve universal electricity access, $4 billion for clean cooking access, over $660 billion for renewable energy, and $600 billion for energy efficient technologies.

- **Synergies between SDG 7 and climate mitigation:** The SDG 7 and climate mitigation (SDG 13) targets are closely related and complementary pursuits. Providing universal energy access can yield net greenhouse gas (GHG) savings, thanks to a reduction in methane emissions from traditional uses of biomass for cooking. Beyond the GHG savings likely to be achieved under current and planned policies, the leading sources of the additional GHG savings that countries need in order to realize their commitments under the Paris Agreement are (i) switching fuels to renewable energy and (ii) enhancing end-use energy efficiency.

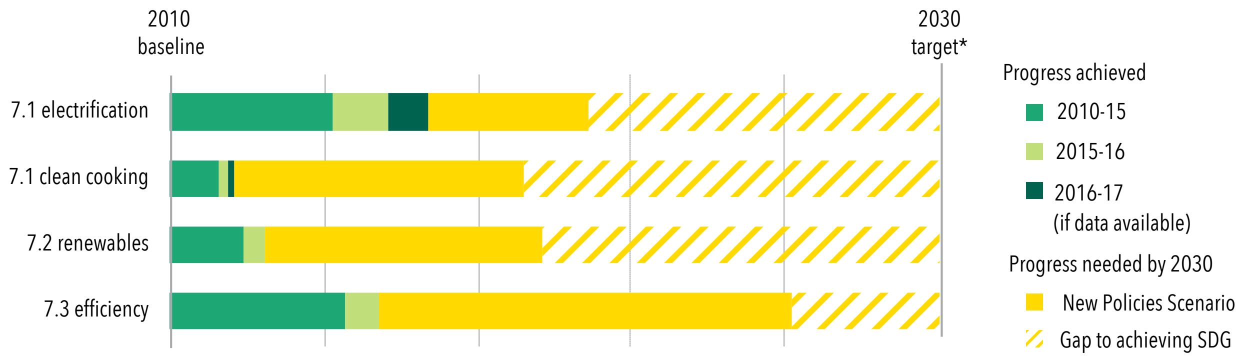
This chapter describes the results of a global modelling exercise to understand whether current policy ambitions are sufficient for meeting SDG 7 and what additional efforts are needed for success. The chapter also includes an evaluation of the investment needs as well as the energy benefits of meeting the relevant SDG targets (as measured by fuel savings), and concludes with an analysis of the interlinkages with SDG 13 on climate action.

Two scenarios derived from the World Energy Outlook, IEA's flagship publication, serve as benchmarks. The New Policies Scenario accounts for current and planned policies with a high likelihood of being implemented, including the GHG- and energy-related components of the nationally determined contributions pledged under the Paris Agreement.

The Sustainable Development Scenario combines the fundamentals of sectoral energy policy with three closely associated but distinct policy objectives related to the SDGs: to ensure universal access to affordable, reliable, sustainable, and modern energy services by 2030 (SDG 7); to substantially reduce air pollution, which causes deaths and illness (SDG 3.9); and to take effective action to combat climate change (SDG 13). The aim is to lay out an integrated least-cost strategy for the achievement of these important policy objectives, alongside energy security, in order to show how efforts toward them can be coordinated so as to realize mutually supportive benefits.

The world is currently not on track to meet SDG 7. Under the assumptions of the New Policies Scenario, despite notable recent progress toward expanding electricity access, particularly in developing Asia, and improvements in energy intensity across major regions, policy efforts are expected to fall short of all four SDG 7 targets. Progress on SDG indicator 7.1.2 (clean cooking) and SDG target 7.2 (renewables) is lagging behind the required pace. Under the New Policies Scenario, an estimated 2.2 billion people would still lack access to clean cooking solutions, and the share of modern renewables would reach 15% by 2030. Progress on SDG indicator 7.1.1 (electricity) and target 7.3 (energy efficiency) is expected to be better, but more efforts are needed to meet the targets in all regions (figure 5.1).

FIGURE 5.1 • PROGRESS TOWARD SDG 7 SINCE 2010, RELATIVE TO 2030 TARGETS, HISTORICALLY AND BY SCENARIO



Source: IEA, IRENA, World Bank, WHO, and UNSD (2018).
Note: The units used as proxies for progress are: the share of population with access to electricity (7.1.1) and to clean cooking fuels and technologies (7.1.2); the share of renewables in total final energy consumption, excluding traditional uses of biomass (7.2); and energy intensity, measured as tonnes of oil equivalent of energy consumed per thousand 2010 USD gross domestic product (purchasing power parity) (7.3).
** Please note that for SDG 7.*2, there is no quantitative target.

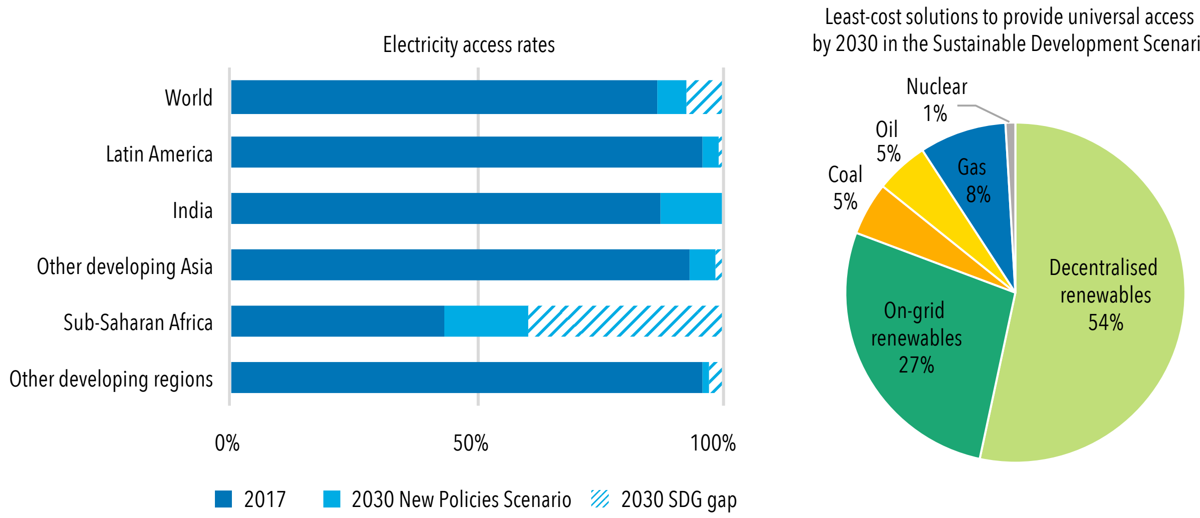
While the outlook under the New Policies Scenario falls short of SDG 7, the Sustainable Development Scenario works backward to identify what it would take to deliver this goal in a cost-effective way. In the Sustainable Development Scenario, by 2030 universal access to both electricity and clean cooking solutions is achieved, the share of modern renewables reaches 22% of total final energy consumption (TFEC), and annual energy intensity improvements accelerate to an average rate of 3.6% per year.

OUTLOOK FOR ELECTRICITY ACCESS

Great progress has been made recently in furthering access to electricity, at an annual global rate of 0.8 percentage points. But while several countries are about to reach full electrification by 2030, the world as a whole is not on track to achieve SDG indicator 7.1.1. People deprived of electricity services will be increasingly concentrated in Sub-Saharan Africa. Under current and planned policies, 8% of the world's population (about 650 million people) would still lack access to electricity, with 89% of them living in Sub-Saharan Africa (figure 5.2).

Different regions have different paths. In Latin America and the Caribbean, where 98% of the population had access to electricity in 2017, only Haiti is left behind. Haiti is not expected to achieve an electrification level greater than 90% of the population by 2030. Progress in developing Asia[35] is expected to be the fastest in the world, with more than 320 million people connected between 2018 and 2030, and an electrification rate rising from 91% in 2017 to 99% in 2030. This progress reflects a tremendous effort in India, where the government announced that electricity had reached every village in April 2018 and that it was aiming to provide reliable electricity supply, 24/7, to every household by the early 2020s. Thanks to similarly ambitious efforts, and building on significant recent progress, Indonesia and Bangladesh are also expected to achieve universal access by 2030. In the rest of Asia, the majority of countries would attain electrification levels greater than 90% by 2030. Additional efforts in the few countries left behind would get the entire region on track.

FIGURE 5.2 • ELECTRICITY ACCESS RATES BY REGION IN 2017 AND 2030, AND THE LEAST-COST SOLUTIONS TO PROVIDING UNIVERSAL ACCESS TO ELECTRICITY BY 2030



Source: IEA 2018a.
Note: SDG = Sustainable Development Goal.

Progress is slower in Sub-Saharan Africa. In 2030, under current and planned policies, 89% of the global population without access to electricity would live in this region. More than 220 million people would gain access between 2018 and 2030, increasing the electrification rate from 44% in 2017 to 61% in 2030, as electrification outpaces population growth. Ghana and Kenya stand out as successes and are projected to achieve universal access before 2030, but progress in the region is highly uneven. In 2030, around 80% of those without access to electricity would be from rural areas (while rural populations would represent about 50% of the total population).

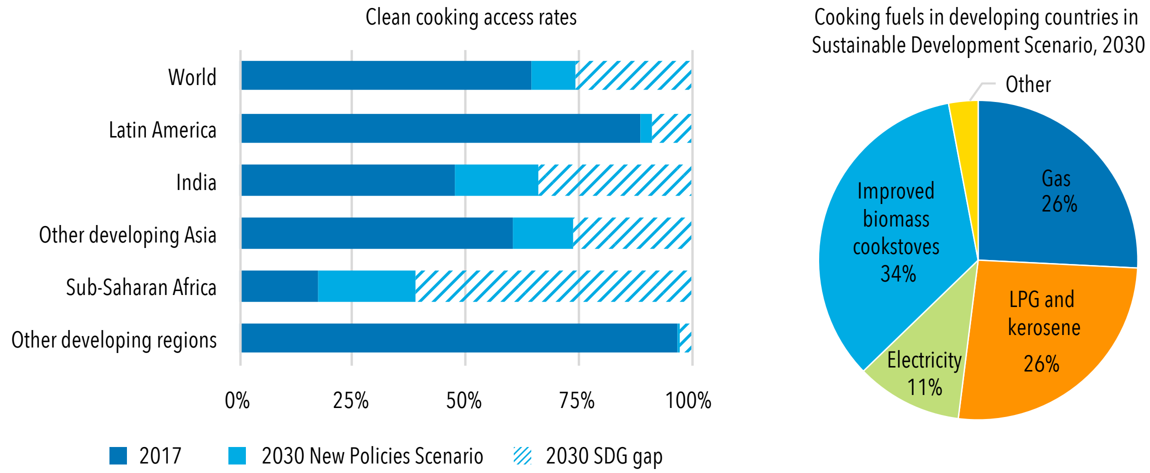
Reaching universal access in the least-cost way requires further policy support for certain technologies. The unprecedented cost advantage of renewables, in particular decentralized renewables, will help efforts to reach the most remote locations. As such, 51% of the 1.2 billion people[36] who should gain access by 2030 could be electrified in a least-cost way through clean decentralized systems; in rural areas, this share reaches 77%. Grid-based connections are still essential worldwide, as they offer a least-cost solution for 42% of people who need to gain a connection by 2030. Nonetheless, thanks to declining clean technology costs, on-grid renewables surpass fossil fuels in providing people with new connections.

Achieving universal access by 2030 requires a paradigm shift. The main mode by which people gained access over the past decade was through on-grid fossil fuels, as India's recent experience illustrates (IEA 2017). Holistic programs that make the most of both decentralized and centralized solutions are needed, including transparent grid extension plans and regulatory frameworks that protect against financial losses if the grid arrives in areas connected via decentralized modes. Furthermore, a strong emphasis on developing decentralized systems that can address the variety of energy needs required for economic development is necessary. Energy efficient appliances are essential to provide more substantial energy services with off-grid electricity supply, and could reduce electricity demand for typical energy services by up to two-thirds (IEA 2017).

OUTLOOK FOR ACCESS TO CLEAN COOKING

The world is not on track to meet SDG indicator 7.1.2 and provide universal access to clean cooking solutions. In the New Policies Scenario, 26% of the global population would still be cooking with polluting fuels in 2030 (figure 5.3), down from around 40% in 2017; the number of people relying primarily on highly inefficient fuels such as biomass, kerosene, or coal would decrease to 2.2 billion, of which 1.7 billion would be in rural areas. In developing Asia, more than 1.2 billion people would be without access to clean cooking solutions in 2030. In India, 500 million people would still rely primarily on traditional uses of biomass for cooking. Since biomass can often be collected for free, it would remain the least-cost solution for households, particularly in rural areas. In Sub-Saharan Africa, around 900 million people would still rely on polluting fuels and technologies for cooking in 2030. While rural populations represent two-thirds of the population without access by 2030, 290 million city dwellers would also lack access.

FIGURE 5.3 • CLEAN COOKING ACCESS RATES IN 2017 AND 2030, AND COOKING FUELS IN THE SUSTAINABLE DEVELOPMENT SCENARIO, 2030



Source: IEA 2018a.
Note: SDG = Sustainable Development Goal; LPG = liquefied petroleum gas.

Despite the challenges that lie ahead, it is noteworthy that more than 580 million people would move away from traditional uses of biomass for cooking by 2030, and these are equally split between developing Asia and Sub-Saharan Africa. As in the case of electricity access, population growth outpaces the provision of access to clean cooking facilities in Sub-Saharan Africa.

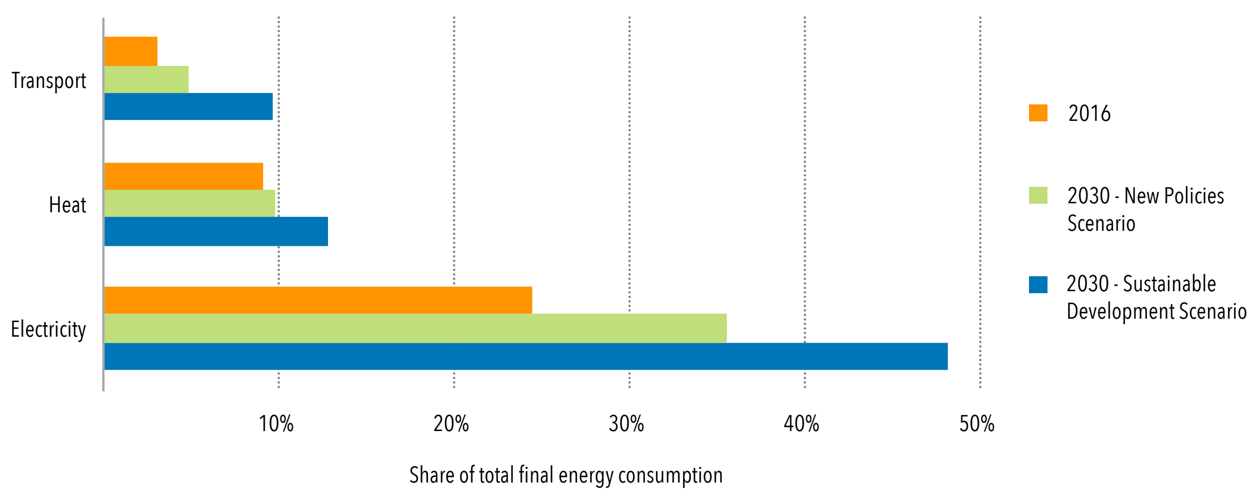
The Sustainable Development Scenario highlights two least-cost solutions for providing access to clean cooking: liquefied petroleum gas (LPG) and improved biomass cookstoves. Considering technology costs, historical progress, population growth, urbanization levels, and the availability of fuel, LPG is the predominant solution for urban households by 2030, as population density justifies investment in the necessary LPG infrastructure. In India, LPG is promoted by the government via the Pradhan Mantri Ujjwala Yojana (PMUY) scheme, which targets women in low-income households. The government has pledged to provide 50 million free LPG connections by 2019, and aims to target 80 million by 2020. Meanwhile, improved biomass cookstoves are particularly suited for rural areas, where they are the least-cost clean cooking solution for over half of households. The uptake of clean cooking solutions is essential to drive down indoor air pollution levels, and efforts to leverage effective technologies need to be elevated on the international political agenda. Engaging with local women in the design, uptake, and sale of clean cookstoves would significantly boost their adoption.

OUTLOOK FOR RENEWABLES

Unlike the targets for electricity access and energy efficiency, SDG target 7.2 does not include a numerical figure, making progress evaluation difficult. In the New Policies Scenario, the share of total renewables would rise to 21% of total final energy consumption by 2030, up from 17.5% in 2016, while that of modern renewables would increase to 15%, a moderate increase from 2016 levels of 10% (IEA 2018b). Electricity generation from renewables would expand the most, overtaking coal in the next decade to supply around 36% of electricity by 2030. The use of direct renewables for heating[37] and transport would also expand, though at substantially lower rates of 10% and 5%, respectively.

The Sustainable Development Scenario outlines the important role renewables can play in achieving a sustainable energy sector. In this scenario, modern renewables reach 22% of final energy consumption (total renewables[38] reach 24%). The share of electricity generation would increase the most, more than doubling the current share to reach 48% by 2030, which is more than 10 percentage points higher than in the New Policies Scenario (figure 5.4). The use of renewables in transport would increase substantially in the Sustainable Development Scenario, reaching 10% by 2030. Greater efforts are needed to move away from fossil fuel use in other transport modes as well, such as trucking, aviation, and shipping. The use of modern renewables for heat would increase less than for electricity and transport, reaching 13% by 2030.

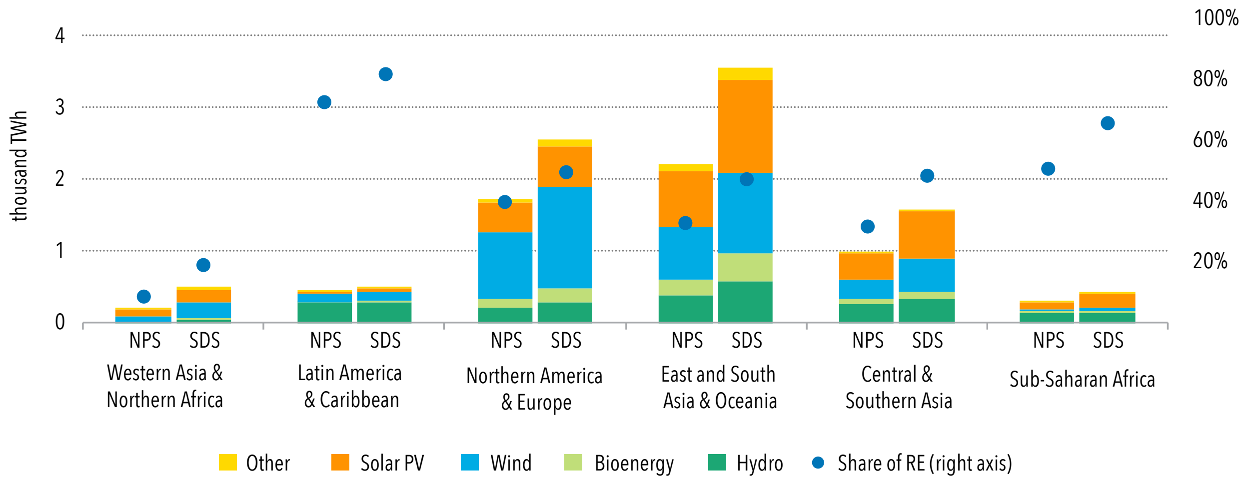
FIGURE 5.4 • SHARE OF MODERN RENEWABLE ENERGY IN TOTAL FINAL ENERGY CONSUMPTION, BY END USE



Source: IEA (2018a), UNSD (2018), and World Development Indicators.

The outlook for renewable electricity generation is by far the most encouraging thanks to the rapidly declining costs of wind and solar PV, and competitive procurement processes. Globally a total 5,860 terawatt-hours (TWh) of additional renewable electricity generation is projected for 2030, equal to the current electricity generation of Canada, Japan, and the United States combined. Much of this growth is expected to occur in Asia and Northern America and Europe. In the New Policies Scenario, the share of renewable electricity consumption rises from 24% in 2016 to 36% in 2030. While this growth in renewable electricity is encouraging, fossil fuels and coal in particular still account for the vast majority of electricity generation globally, which is unsustainable in relation to climate change, air pollution, and, for certain regions, energy security. To support the broader sustainable development agenda, a more rapid decarbonization of the electricity sector is needed.

FIGURE 5.5 • GROWTH IN RENEWABLE ELECTRICITY GENERATION, 2017-2030, AND THE SHARE OF RENEWABLES BY SCENARIO IN 2030

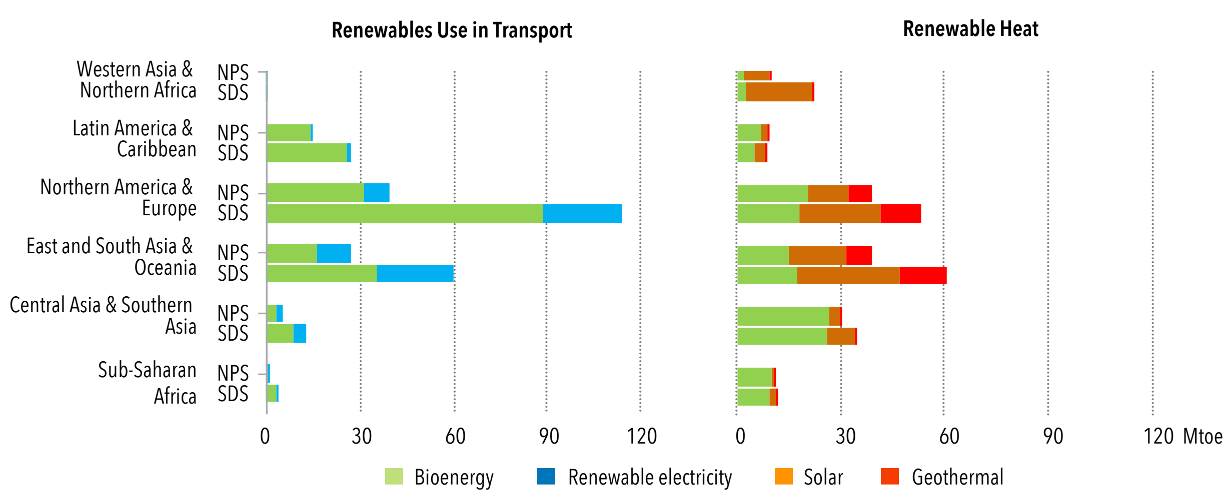


Source: IEA 2018a.
Note: NPS = New Policies Scenario; PV = photovoltaic; RE = renewable energy; SDS = Sustainable Development Scenario; TWh = terawatt-hours.

At a regional level, the outlook for renewable electricity generation varies substantially. Different energy resource potentials across regions play a key role in influencing the use of renewables. In the New Policies Scenario, the outlook for the share of electricity generation in 2030 varies from 8% in the oil- and gas-rich regions of Western Asia and Northern Africa to as high as 72% in Latin America and the Caribbean thanks to an abundant hydropower potential (figure 5.5). In the Sustainable Development Scenario, the share of renewable electricity generation increases in all regions. In many, the share of renewables is set to approach or even surpass half of all electricity generation by 2030.

East Asia and Southeastern Asia together with Northern America and Europe expect the largest additions to renewable electricity generation, largely enabled by wind and solar PV. Rapidly declining costs, good resource potential, and a supportive policy environment make solar PV attractive in East Asia and Southeastern Asia. These factors are even more pronounced in Central and Southern Asia, where solar PV drives the largest increase among all regions—to 32% by 2030 in the New Policies Scenario and 46% in the Sustainable Development Scenario.

FIGURE 5.6 • GROWTH IN RENEWABLES USED IN HEAT AND TRANSPORT, BY SCENARIO, 2017-2030



Source: IEA 2018a.
Note: Mtoe = million tonnes of oil equivalent; NPS = New Policies Scenario; SDS = Sustainable Development Scenario. Traditional uses of biomass are excluded from the "renewable heat" category.

The use of renewables in transport and for heat in buildings and industry represents a significant opportunity to increase the share of renewables in final energy use, although growth is expected to be substantially less than in the electricity sector. In transport, biofuels would represent 11% of the growth in energy use in the New Policies Scenario; renewable electricity, consumed mainly for passenger cars and rail, would account for 15% of the increase in transport energy demand between 2016 and 2030. In the Sustainable Development Scenario, the total use of renewables in transport would be more than double that in the New Policies Scenario. Increased use of renewable electricity would rise sharply in regions where the deployment of electric vehicles is high (figure 5.6). Latin America and the Caribbean have the highest share of renewables used in transport thanks in part to high levels of biofuel deployment in Brazil.

Bioenergy accounts for the bulk of renewables used in transport in both the New Policies Scenario and Sustainable Development Scenario in 2030. In contrast, modern bioenergy for heat represents a smaller share of the total renewable heat used in buildings and industry. In the Sustainable Development Scenario, traditional uses of biomass are completely phased out as Africa and Central and Southern Asia shift to modern technologies. Asia and Northern America and Europe represent the largest markets for renewable heat. In the Sustainable Development Scenario, heat consumption from solar thermal (84 million tonnes of oil equivalent [Mtoe] in 2030) surpasses that of modern bioenergy use (79 Mtoe in 2030).

BOX 5.1 • RENEWABLE ENERGY TO 2050: A VIEW FROM IRENA'S REMAP ANALYSIS

There is broad consensus that renewable energy will play an increasingly important part in the world's energy mix over the coming decades. In this context, the International Renewable Energy Agency (IRENA) is focused on further advancing understanding of the global energy transformation, and setting forth a vision for how it could unfold. This transformation involves more than the energy sector to encompass key elements identified in the larger group of Sustainable Development Goals. Importantly, it involves a transformation of national economies that will bring new opportunities, greater prosperity, and jobs all while improving the air quality in cities, preserving the environment, and protecting the world's climate (IRENA 2016, 2018a). IRENA's renewable energy roadmap (REmap) outlines one possible route forward.

If IRENA's REmap were followed, growth in renewable electricity would be the single-largest driver of change. The share of electricity in final energy would increase from 20% in 2017 to 30% in 2030 and 49% by 2050. The share of electricity consumed in final energy in the industry and buildings sectors would double by 2050, while in the transport sector it would increase from 1% in 2017 to 11% in 2030 and over 40% in 2050. This increasingly electric energy system would transform how the power sector addresses demand. By 2030, 57% of electricity could be renewable (of which 34% would come from solar and wind) and this share could reach 86% by 2050 (of which 60% would come from solar and wind). Gross generation in 2050 is foreseen to be more than double what it was in 2017, with wind and solar dominating the expansion.

This acceleration in the deployment of renewables, combined with increased electrification and energy efficiency, could achieve over 90% of the reductions in energy-related carbon dioxide emissions needed by 2050 to set the world on a pathway to the "well below 2°C" aim of the Paris Agreement. Electrification via renewables is key, making up around 60% of the mitigation potential. However, the world is far from this path—the last two years saw emissions rise by around 2% per year, and IRENA analysis shows that in a Reference Case scenario, which considers current and planned policies (including Nationally Determined Contributions), emissions would peak slightly by 2030 and remain flat thereafter. This trend risks putting the world on a path toward warming by 3°C or higher.

If the REmap were followed, global energy demand in 2030 and 2050 would be slightly lower than today's level, despite significant population and economic growth. The share of modern renewable energy (which excludes traditional uses of bioenergy) would meanwhile rise from about 10% of final energy in 2016 to about 28% in 2030 and 66% by 2050. To achieve this, there would need to be a sixfold acceleration in renewable energy growth compared with recent years, and the rate of energy intensity improvement would need to rise by 3.1% every year over the period. Fossil fuel consumption would need to continuously decline from 2020 onward—by 2030 demand for fossil fuels would need to decline by 21%, and by 2050 this would need to decline by 66%.

Variable renewable energy (VRE) technologies, particularly solar photovoltaic and wind, will play a central role in the energy transition. If the REmap were followed, VRE capacity would increase from just over 900 gigawatts (GW) in 2017 to over 5,700 GW in 2030 and to over 14,500 GW in 2050. With rising shares of VRE in electricity generation, maintaining the balance between supply and demand in a cost-effective manner is necessary. To maximize the value of low-cost but variable renewable energy sources requires more flexible and integrated power systems and an overall shift toward using more electricity in a smarter manner in end-use sectors.

To achieve both the medium- and longer-term milestones set out in the REmap would require fostering the development and deployment of innovative solutions that create the flexibility needed to integrate a high share of VRE. For example, in the transport sector, smart charging of electric vehicles can improve the flexibility of power systems and is crucial to enable optimal renewable energy integration while avoiding network congestion. Smart charging of electric vehicles allows charging demand to be matched with network capacity—charging levels can be adjusted to flatten peak demand, fill load valleys, and support real-time balancing of grids (IRENA 2019a). An important new energy vector that would emerge is renewable hydrogen, produced from renewable electricity, that can be used as a feedstock in industry, and also in end uses. Renewable hydrogen production would be double the level of today's hydrogen production from fossil fuels.

Despite the progress of recent years, the world is at a critical point. Accelerated action is needed to support the energy transformation, particularly in the near term: emissions need to decrease by 3.5% per year over the next decade—not increase as has happened in the last couple of years and is forecasted to continue under current and planned policies. The REmap analysis shows that energy-related emissions would need to decline by 25% by 2030, and by 70% by 2050.

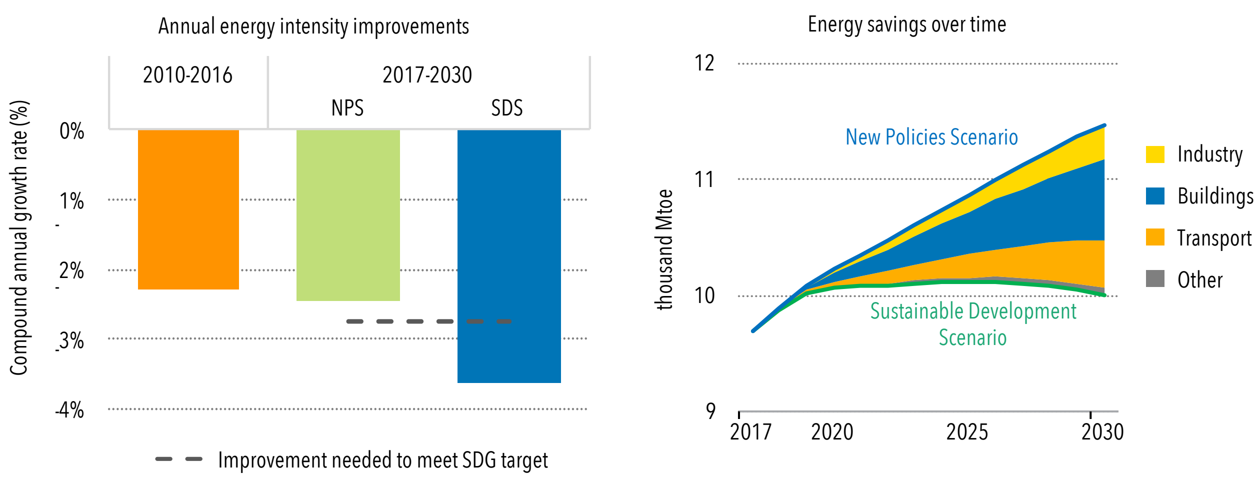
In addition to wide-sweeping societal and market change, the transformation requires adjusting the traditional way energy is consumed and shifting toward a more decentralized energy system, which would require new infrastructure investments, further development of innovative technologies, new business models, and new energy market designs. The transition touches on topics beyond energy and enshrined in the wider aims of the Sustainable Development Goals, particularly as these relate to ensuring universal access to modern energy services, the water-energy nexus, and potential geopolitical implications of the transition.

OUTLOOK FOR EFFICIENCY

Global energy intensity improved by 2.3% on average per year between 2010 and 2016, slightly short of the 2.6% indicated in SDG target 7.3. To make up for this shortfall, the average rate needs to rise to 2.7% between 2017 and 2030. In the New Policies Scenario, only a 2.4% annual improvement is anticipated and global final energy consumption continues to rise, reaching almost 11,500 Mtoe in 2030 or 18% higher than 2017 levels (figure 5.7).

In the Sustainable Development Scenario, an acceleration of energy efficiency measures across all end-use sectors fulfills the potential for global energy demand to peak by about 2025 and decline thereafter. The enhanced efforts yield additional energy savings of nearly 1,500 Mtoe or a reduction of 13% compared with energy consumption in the New Policies Scenario. The annual energy intensity improvement in the Sustainable Development Scenario of 3.6% actually surpasses SDG target 7.3, and demonstrates the key role energy efficiency plays in helping to meet sustainability goals.

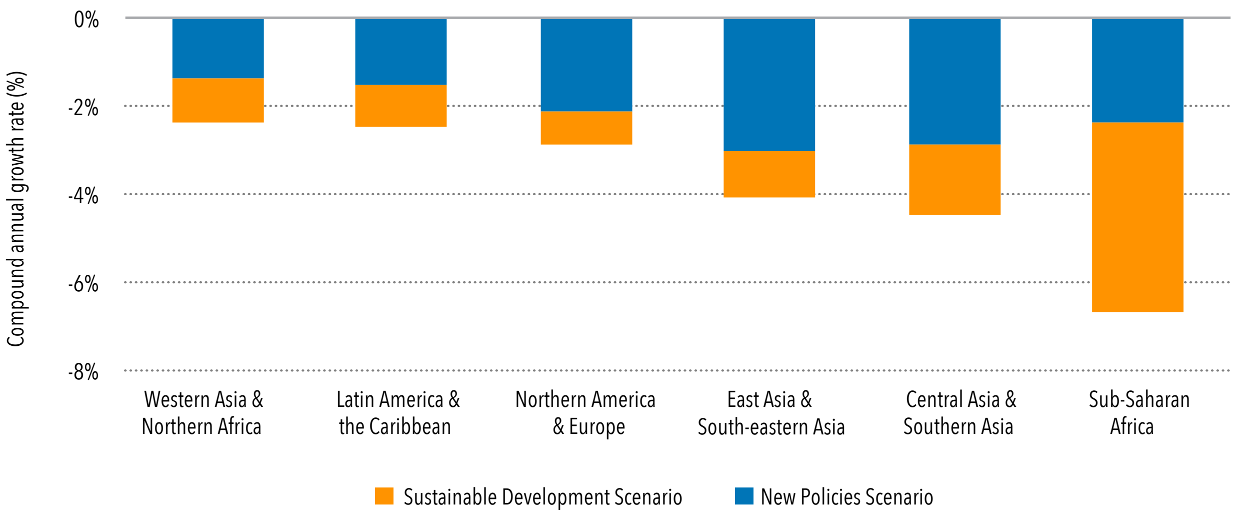
FIGURE 5.7 • GLOBAL ENERGY INTENSITY IMPROVEMENTS AND TOTAL ENERGY SAVINGS IN THE SUSTAINABLE DEVELOPMENT SCENARIO COMPARED WITH THE NEW POLICIES SCENARIO



Source: IEA (2018c), UNSD (2018), and World Development Indicators.
Note: Mtoe = million tonnes of oil equivalent; NPS = New Policies Scenario; SDG = Sustainable Development Goal; SDS = Sustainable Development Scenario.

At a sectoral level, about half of the global savings identified in the Sustainable Development Scenario come from the buildings sector, where more stringent building codes as well as energy efficiency standards for appliances and other electrical devices are lacking in many regions. Transport accounts for the second-largest contribution as fuel economy standards for both passenger and freight transport are assumed to be implemented across a growing number of regions. Industry makes up the remainder through the adoption of more efficient processes and systems.

FIGURE 5.8 • AVERAGE ANNUAL CHANGE IN ENERGY INTENSITY BY SCENARIO, 2017-2030



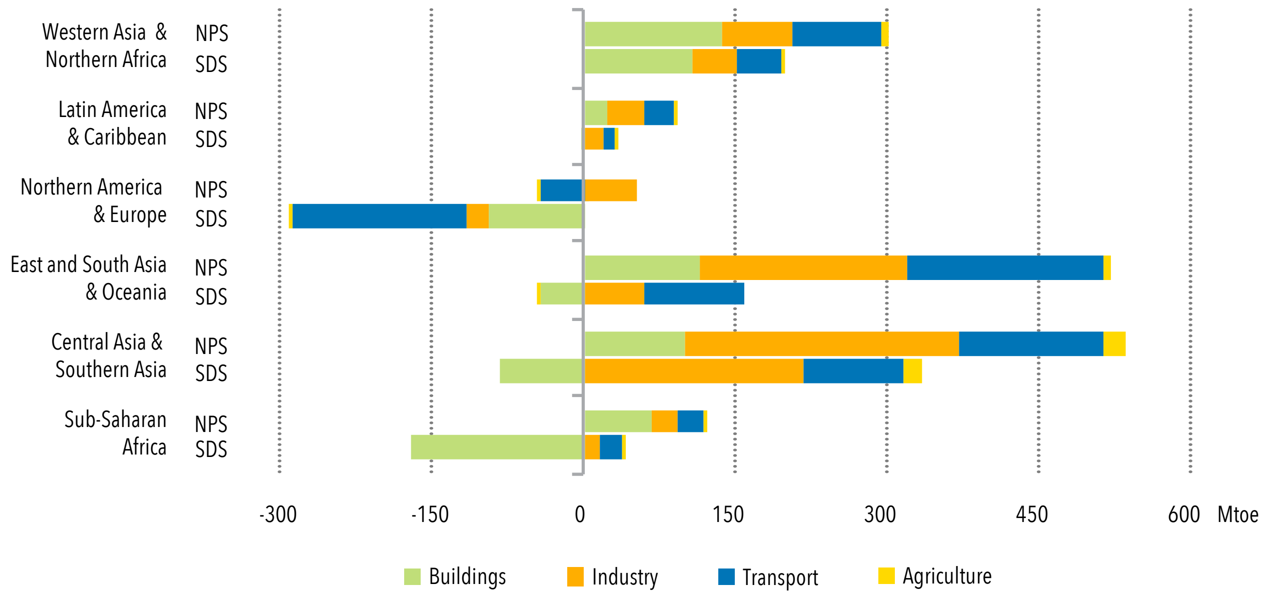
Source: IEA 2018a.

Improvements in energy intensity promise to accelerate in all regions, with the largest improvements seen in Asia as many emerging economies rebalance, shifting toward less-energy-intensive services and higher-value-added manufacturing. In the New Policies Scenario, average intensity improvements across regions vary from 1.3% in Western Asia and Northern Africa to 3% in East Asia and Southeastern Asia (figure 5.8). The additional improvements needed to realize the energy savings potential in the Sustainable Development Scenario highlight where energy efficiency measures are most needed. Sub-Saharan Africa stands out in particular: only a third of the energy savings potential identified in the Sustainable Development Scenario would be realized in the New Policies Scenario, versus 80% of the potential in Northern America and Europe.

To harness all potential energy intensity reductions, a fuller understanding of how and where current energy is used as well as expected future trends is needed. While energy efficiency measures are needed across all sectors, trends in energy demand vary significantly across regions, with certain sectors playing a larger role than others. In the New Policies Scenario, all regions would see energy demand continue to rise. In Asia, industry followed by transport would account for the majority of future demand growth, while in Africa and Western Asia, growth in energy demand would be dominated by the buildings sector.

In the Sustainable Development Scenario, all regions show significant potential for energy savings compared with the New Policies Scenario. Northern America and Europe and Sub-Saharan Africa can expect lower energy use than today. In Northern America and Europe, all sectors show a decline in energy consumption. Sixty percent of savings would come from transport, thanks to a combination of fuel economy policies together with the electrification of transport. Total energy consumption in these regions would decrease by about 300 Mtoe to drop nearly 9%. In Sub-Saharan Africa, a shift away from traditional uses of biomass, which have very low efficiency levels, to modern and clean fuels means that total energy consumption in buildings would decline by more than 150 Mtoe, and total energy use would fall by 28%. As noted earlier, the buildings sector stands out. In the Sustainable Development Scenario, energy use in this sector would fall or remain the same in all but one region.

FIGURE 5.9 • CHANGES IN ENERGY USE BY END-USE SECTOR IN THE NEW POLICIES SCENARIO AND SUSTAINABLE DEVELOPMENT SCENARIO, BETWEEN 2017 AND 2030



Source: IEA 2018a.
Note: Mtoe = million tonnes of oil equivalent; NPS = New Policies Scenario, SDS = Sustainable Development Scenario.

Government policies—in the form of both regulations and incentives to leverage the power of the market—are essential for realizing the savings possible due to improved energy efficiency. However, only about one-third of global energy consumption is currently covered by mandatory efficiency codes and standards.

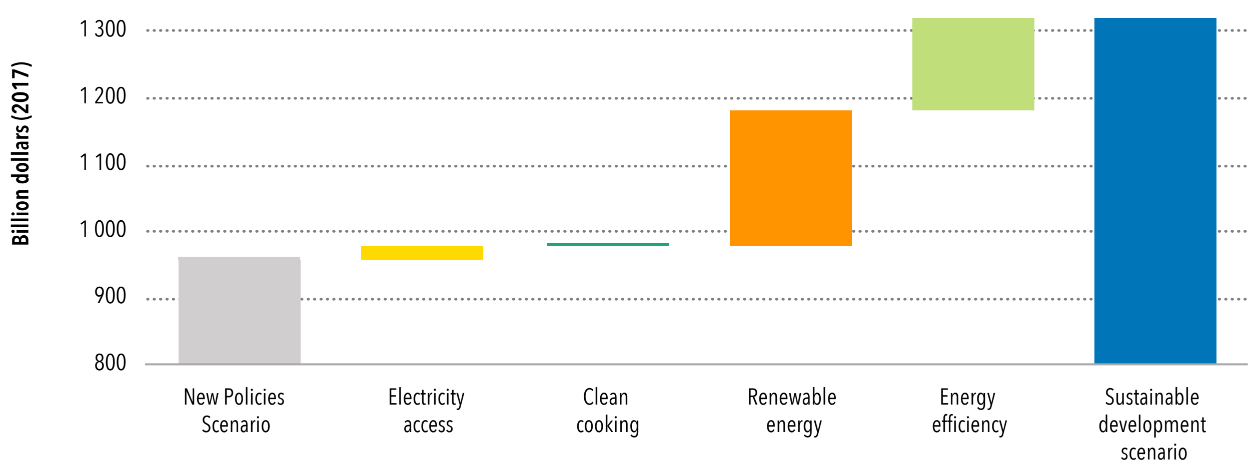
To achieve the energy savings potential outlined above requires a broad range of efficiency measures across all end uses. In transport, key measures include fuel economy standards for cars and trucks, global targets and measures for aviation and shipping, incentives for electrification, and information to support efficient vehicle uptake and mode shifts. While many countries have implemented building energy codes and standards, achieving the large savings identified in the Sustainable Development Scenario requires codes to be strengthened and expanded to cover new and existing buildings. Minimum energy performance standards for key equipment not currently covered, such as electric heat pumps and air conditioners, also need to be strengthened and expanded. In industry, mandatory policy-driven energy efficiency targets and standards cover less than 36% of total energy use. Increasing coverage and stringency is important, as are incentives to shift production toward the best available technologies.

INVESTMENTS NEEDED TO ACHIEVE SDG 7

In the New Policies Scenario, total energy sector investments in energy access, renewable energy, and energy efficiency are estimated to average $950 billion per year between 2018 and 2030 (IEA 2018a). Investments in energy access represent just $31 billion of this total, with investments in electricity access accounting for the vast majority (97%) of the spending; the remainder would go toward clean cooking. However, achieving universal energy access by 2030 would require $55 billion per year, with $4 billion going toward expanding access to universal clean cooking solutions. At a regional level the greatest attention would need to be on Sub-Saharan Africa, where 82% of the additional investment for energy access is needed in the Sustainable Development Scenario compared with the New Policies Scenario is needed.

Total additional spending for meeting SDG 7 is estimated in the Sustainable Development Scenario at an average of around $400 billion per year, of which over $200 billion per year is needed to increase the share of renewables in total final energy consumption to 22%, and another $140 billion per year for end-use efficiency. These additional investments are partially offset by $45 billion capital savings in other electricity generation investments thanks to a combination of lower electricity consumption from energy efficiency and a switch to renewable generation. The combination of lower energy use from efficiency and higher shares of renewables leads to a reduction in fossil fuel use of about 2,350 Mtoe and total fuel savings of $280 billion per year. The higher up-front investments in energy efficiency and renewables are only marginally higher than the resulting savings in fuel purchases, highlighting the economic viability of meeting SDG 7.

FIGURE 5.10 • ADDITIONAL ANNUAL AVERAGE NEEDED INVESTMENTS TO ACHIEVE SDG 7 TARGETS, 2018-2030



Source: IEA 2018a.
Note: New Policies Scenario and Sustainable Development Scenario investments in this figure only include those related to SDG 7.

SDG 7 AND CLIMATE ACTION (SDG 13)

Minimizing the potential future damages of climate change has become a central concern for the energy sector, with a large portion of nationally determined contributions reflecting energy-sector-specific commitments and increasing private sector commitment to environmental sustainability. SDG 13, to take urgent action to combat climate change and its impacts, will be reviewed at the 2019 High-Level Political Forum.

As the energy sector emits around 75% of global GHG emissions, transformative changes in the energy sector, such as realizing the SDG 7 targets, inevitably have implications for global climate mitigation. The Sustainable Development Scenario, in modelling the integrated pursuit of both SDGs (as well as the reduction of health costs from air pollution—SDG target 3.9), finds that the changes implicit in each of the SDG 7 targets are compatible with climate mitigation efforts. Given the energy sector's large share of GHG emissions, SDG 7 can be seen as a prerequisite for achieving SDG 13.

Achieving universal access to modern energy does not increase the (already very small) climate burden imposed by the population living in Sub-Saharan Africa. Though providing access to more people increases energy service demand, it does not necessarily increase GHG emissions.

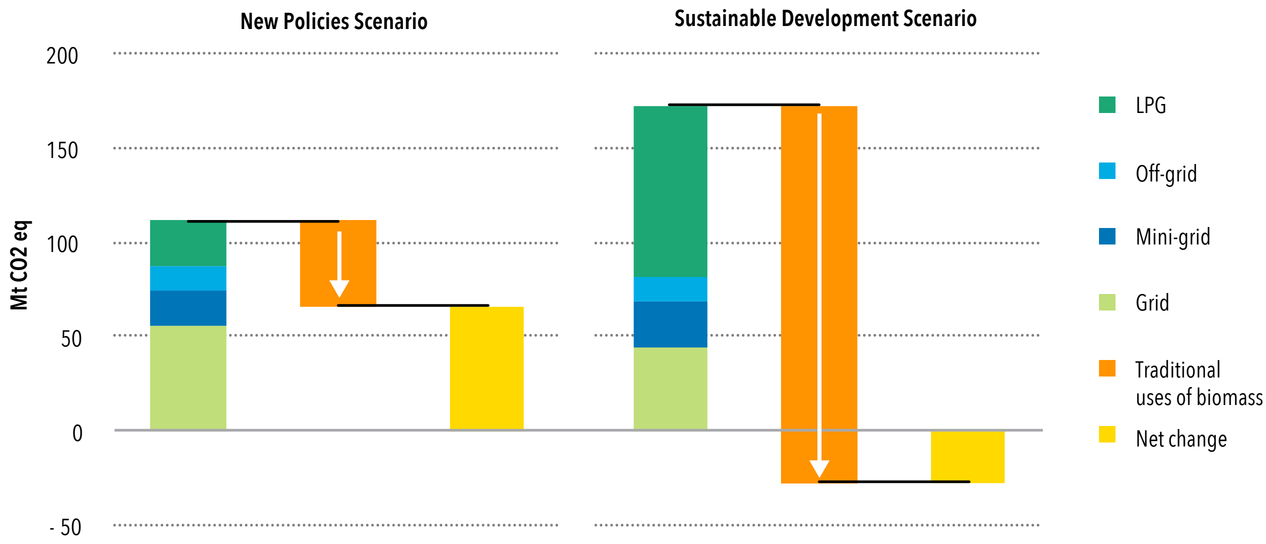
First, the change in energy demand associated with access is relatively minor. Per capita energy consumption among households who are gaining access for the first time tends to be quite low. For example, in Africa, per capita energy consumption is still six times lower than the average of advanced economies. Even assuming that every household's energy consumption reaches the regional average 8 to 12 years after gaining access, additional electricity demand amounts to only 338 TWh in 2030 in the Sustainable Development Scenario, or 1.1% of the global total. The use of LPG for clean cooking requires around 1 million barrels per day (mb/d), or 0.8% of global oil demand in 2030.

Energy demand also stays relatively low because of an increased proliferation of energy efficient appliances with new connections. Energy efficient technologies free up capacity in the power grid, such that the same capacity can provide energy services to more consumers.

Other factors lessen the carbon intensity of households gaining access, making the goals of universal access and climate mitigation compatible. The Sustainable Development Scenario involves a greener fuel mix of electricity generation. In the New Policies Scenario, 33% of connections are provided by fossil fuels, increasing GHG emissions by 90 tonnes of carbon dioxide equivalent (Mt CO2eq). In the Sustainable Development Scenario, 600 million more people gain access to electricity access, but this is accompanied by greater deployment of decentralized renewable solutions. In this context, only 25% of connections are provided by fossil fuels, such that GHG emissions from electricity access are lower, at 80 Mt CO2eq.

The simultaneous pursuit of universal access to both electricity and clean cooking solutions yields net savings of GHG emissions. Though the uptake of LPG as a clean cooking fuel does increase GHG emissions, significant emissions are avoided when people switch away from the use of solid biomass in traditional cookstoves, which is associated with high levels of methane and to a lesser extent nitrous oxide. Taking into account the high equivalent warming effect of methane and nitrous oxide relative to CO2, even a conservative calculation shows a net climate benefit from switching to LPG and other modern cooking fuels such as natural gas and electricity. Where solid biomass remains, it is used in improved, relatively efficient cookstoves.

FIGURE 5.11 • ENERGY-ACCESS RELATED CO_2 AND METHANE EMISSIONS DUE TO EXPANDED ACCESS TO ELECTRICITY AND CLEAN COOKING SOLUTIONS, BY SCENARIO, BY 2030



Source: IEA 2018a.
Note: LPG = liquefied petroleum gas; Mt CO2 eq= tonnes of carbon dioxide equivalent.

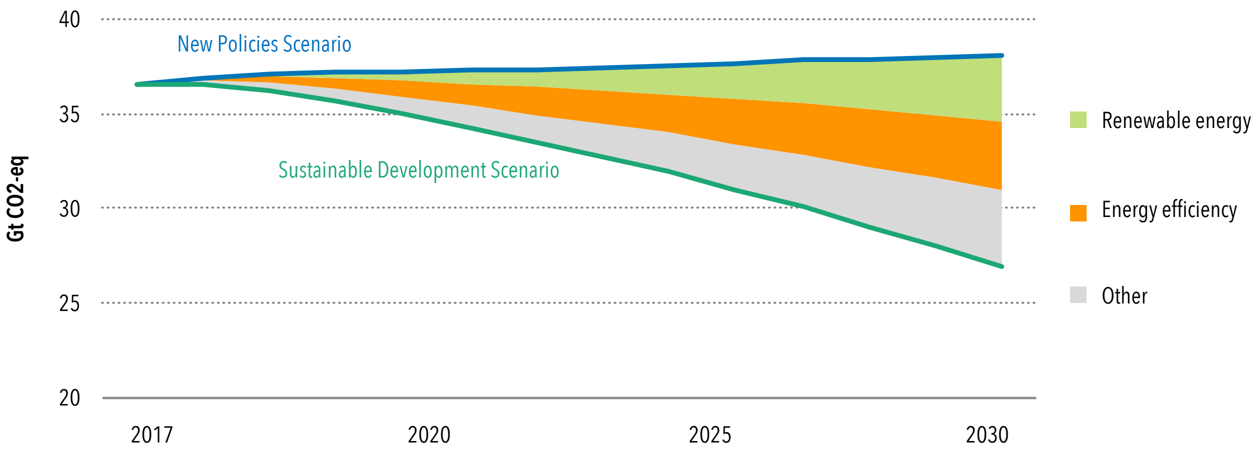
In the New Policies Scenario, in which around 580 million people gain access to clean cooking solutions, the switch away from traditional uses of biomass for cooking saves 45 Mt CO2eq. In the Sustainable Development Scenario, in which nearly 2 billion more people gain access to clean cooking solutions, there is a 75% reduction in these uses by 2030 relative to the New Policies Scenario, and the relevant fuel switch saves 200 Mt CO2eq (figure 5.11).

The complementary link between (i) renewable energy and energy efficiency, and (ii) climate mitigation is comparatively clear. The two SDG 7 targets of increasing renewable energy and energy efficiency are the largest sources of the emissions reductions needed to realize the Paris Agreement. Both contribute around 33% each of the greater CO2 and methane savings to be achieved in the Sustainable Development Scenario relative to the New Policies Scenario (figure 5.12).

Importantly, the deployment of renewables is not an isolated effort; instead, phasing out the most inefficient fossil fuel power plants must be part of any strategy to reduce the overall carbon intensity of power generation. The cumulative additional CO2 and methane savings to be realized by 2030 in the Sustainable Development Scenario total around 18 gigatonnes (Gt) CO2eq, around three-quarters of which come from the deployment of renewables for electricity generation.

Energy efficiency reduces the fuel intensity of energy service demand in the end-use sectors. Correspondingly, the cumulative CO2 and methane savings expected by 2030 in the Sustainable Development Scenario are 4.7 Gt CO2eq in the buildings sector, 6.0 Gt CO2eq in the industry sector, and 3.8 Gt CO2eq in the transport sector. Energy efficiency tempers the peak loads that the grid must be able to support, ruling out the necessity to rely on higher-cost and often more carbon intensive peaking capacity.

FIGURE 5.12 • CO2 AND METHANE EMISSIONS REDUCTIONS FROM SDG 7 TARGETS IN THE SUSTAINABLE DEVELOPMENT SCENARIO RELATIVE TO THE NEW POLICIES SCENARIO



Source: IEA 2018a.
Note: Gt CO_2 eq= gigatonnes of carbon dioxide equivalent.

Beyond the benefits that achieving the two SDG 7 targets contribute to climate mitigation, the energy sector has a broader role in furthering the sustainable development agenda (box 5.2).

BOX 5.2: SDG 7 AND THE BROADER SUSTAINABLE DEVELOPMENT AGENDA

SDG 7 has important cobenefits for wide-ranging aspects of the sustainable development agenda, particularly health, air pollution, and sustainable cities; gender equality; education, work, and economic growth; as well as the sustainable use of forestry and water resources (figure B5.2.1).

FIGURE B5.2.1 • SDG 7'S WIDE-RANGING CONTRIBUTIONS TO THE SUSTAINABLE DEVELOPMENT AGENDA

Health, air pollution, and sustainable cities: Electricity connections are vital for hospital operations and the cold storage of vaccinations. SDG 7 is also essential for reducing both indoor and outdoor air pollution: the use of solid biomass and coal for cooking in enclosed spaces causes indoor air pollution associated with millions of premature deaths. Outdoor air pollution also improves where renewable energy replaces fossil-fuel-fired power plants. Energy efficiency that lowers the energy demand of urban areas decreases the demand placed on polluting power plants near population-dense areas.

Gender equality: In developing countries, women tend to bear primary responsibility for collecting and preparing fuel for cooking, as well as for cooking itself (Practical Action 2016), such that they are disproportionately exposed to the harms of cooking without clean fuels. Women collect and carry loads of wood that weigh as much as 25-50 kilograms (UNEP 2017). Households dedicate an average of 1.4 hours a day to collecting fuel, a burden mainly borne by women and children. This is time that could be spent on education and income-generating work. Energy access is also a necessary input for women's productive activities in agriculture and small businesses.

Education, meaningful work, and economic growth: Access to affordable, reliable, and sustainable modern energy can have a transformative impact on productivity and incomes (IRENA 2019b). Global renewable energy employment reached 10.3 million jobs in 2017, an increase of 5.3% over the year before (IRENA 2018b). Access to adequate and reliable energy services enables economic productivity. Access to electricity also improves the operation of schools and other community services by providing lights, cooling, and so on.

Sustainable consumption: While the use of solid biomass is not the leading cause of deforestation, wood is exhaustible unless stocks are managed sustainably. The overall extent of forested areas continues to decline (FAO 2015), while the global population depending on biomass for cooking continues to rise. Increased energy efficiency, the move away from coal-fired power generation, and the increased deployment of solar photovoltaic and wind power all contribute to overall lower water withdrawals in the energy sector (IEA 2018a).

CONCLUSION

Achieving SDG 7 requires a rapid and far-reaching transformation of the energy sector. While notable progress has been made in the past few years, enabled by the declining costs of renewable energy technologies and concerted government efforts in certain regions, the world is not yet on track to achieve SDG 7 by 2030.

Investment in and careful planning of electrification need to be stepped up in Sub-Saharan Africa, and the world needs to see amplified political momentum in expanding access to clean cooking solutions. Commercially viable solutions for renewables, especially for heat and transport, and renewed commitment to improving the coverage and stringency of efficiency regulations are urgently needed. The benefits of achieving the energy transformation are countless. Energy and climate goals are closely interlinked and complementary pursuits. SDG 7 is an essential component of several other SDGs, a golden thread in the sustainable development agenda.

METHODOLOGY

The analysis presented in this chapter is based on results from the World Energy Model (WEM) and International Energy Agency (IEA) analysis in the World Energy Outlook (WEO). A detailed documentation on the WEM methodology can be found at https://www.iea.org/media/weowebsite/energymodel/WEM2018.pdf.

IEA SCENARIOS

The analyses outlined in this chapter are built on two main scenarios:

- The **New Policies Scenario** aims to provide a sense of where today's policy ambitions seem likely to take the energy sector. It incorporates not just the policies and measures that governments around the world have already put in place, but also the likely effects of announced policies, including the nationally determined contributions that are part of the Paris Agreement.
- The **Sustainable Development Scenario** is a forward-looking, normative scenario that involves 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 number of deaths and illnesses attributable to air pollution, among other hazards (SDG target 3.9); and to take effective action to combat climate change (SDG 13). It shows how efforts toward these objectives can be accomplished simultaneously so as to realize mutually supportive benefits. In this scenario, looking toward 2030, universal access to both electricity and clean cooking is achieved; and modern renewables reach 21% of total final energy consumption, more than doubling today's share. SDG target 7.3—to double the global rate of improvement in energy efficiency—is exceeded in the Sustainable Development Scenario, with average annual improvements in global energy intensity accelerating to 3.4% to achieve critical energy sector objectives. More information about this scenario can be found at https://www.iea.org/weo/weomodel/sds/.

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's Household Energy Database and the IEA Energy Balances. Both databases are regularly updated and form the baseline for WEO energy access scenarios in 2040.

The projections shown in the New Policies Scenario take into account current and planned policies, recent progress, as well as population growth, economic growth, the 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. This is done by incorporating a Geographic Information Systems (GIS) 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, Sweden.

Further details about the IEA methodology for energy access projections can be found at https://www.iea.org/energyaccess/methodology/.

METHODOLOGY FOR RENEWABLE ENERGY PROJECTIONS

The annual updates to WEO projections reflect the broadening and strengthening of policies over time, including for renewables. The projections of renewable electricity generation are derived in the renewables submodule of the WEM, 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. By including financial incentives for the use of renewables and nonfinancial barriers in each market, as well as technical and social constraints, 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 gross domestic product and total final energy demand.

Economic growth assumptions for the short to medium term are based largely on those prepared by the Organisation for Economic Co-operation and Development, International Monetary Fund, and World Bank. Over the long term, growth in each WEM region is assumed to converge to an annual long-term rate. 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 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, naphtha, gasoline, kerosene, diesel, heavy fuel oil, and ethane—are modelled separately for each final 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, gross domestic product and population are important drivers of sectoral activity variables.
- End-user prices: Historical time-series data for coal, oil, gas, electricity, heat, and biomass prices are compiled based on the IEA Energy Prices and Taxes database and several external sources. Average end-user prices are then used as a further explanatory variable—directly or as a lag.

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

- Industry is separated into six subsectors.
- Buildings' energy demand is separated into six end uses.
- Transport demand is separated into nine modes with considerable detail for road transport.

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ENDNOTES

34 The analysis in this chapter is based on results from the World Energy Model and IEA analysis in the World Energy Outlook (WEO).

35 Geographical groupings presented in this chapter are derived from the World Energy Outlook and are described in annex 1 of the World Energy Model (WEM) documentation: https://www.iea.org/media/weowebsite/energymodel/WEM2018.pdf. Developing Asia refers to non-OECD Asia in the WEM.

36 This figure includes projected population growth by 2030.

37 Heat in this chapter refers to the amount of energy consumed for heat-raising purposes in industry and other sectors. It is not equivalent to the final energy end-use service.

38 Given that traditional uses of biomass are linked with significant pollution and deforestation, and must be phased out to achieve the SDG indicator for clean cooking, among others, the discussion in this section focuses on the use of modern renewables.

CHAPTER 6

DATA

Photo: World Bank

TOTAL ELECTRICITY ACCESS RATE (%)

Country	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%) b	
	1990		2000		2010		2015		2017		2017		2017	
Afghanistan					43	*d*	72	d	98	*g*	100	*g*	97	
Albania	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Algeria					99		100		100		100		100	
American Samoa														
Andorra	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Angola					33		42	d	42		73		0	
Anguilla			95		98		100		100		100			
Antigua and Barbuda					98		100	m	100	*m*	100	*m*	100	*m*
Argentina					99	*e*	100		100	*m*	100	*m*	100	*m*
Armenia			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			99	*c*	100		100		100		100		100	
Bahamas	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Bahrain					100	*m*	100	m	100	*m*	100	*m*	100	*m*
Bangladesh			32	*d*	55	*g*	73		88	*l*	100	*l*	81	
Barbados			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			79	*e*	90	*e*	92	c	98		98		98	
Benin			21		34	*g*	40		43		73		17	
Bermuda	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Bhutan			31	*g*	73	*c*	96		98	*e*	99	*e*	97	
Bolivia (Plurinational State of)			70	*h*	88		92	h	92	*h*	99	*h*	75	

Country	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%) b	
	1990		2000		2010		2015		2017		2017		2017	
Bosnia and Herzegovina	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Botswana			27		53		58		63		80		24	
Brazil	87	*h*	94		99		100	h	100		100		100	
British Virgin Islands							100	m	100	*m*	100	*m*	100	*m*
Brunei Darussalam	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Bulgaria	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Burkina Faso			9		13	*d*	22		25		65		10	
Burundi			3		5	*d*	8		9	*d*	62	*d*	2	
Cambodia			17	*d*	31	*d*	69		89	*l*	99	*l*	86	
Cameroon			41	*c*	53		59		61		93		21	
Canada	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Cabo Verde					81	*e*	88		93		94		90	
Cayman Islands			100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Central African Republic			6	*c*	10	*c*	24		30		52		15	
Chad			3		6	*c*	8	d	11		39		2	
Channel Islands														
Chile	92	*h*	98	*h*	99		100	h	100	*m*	100	*m*	100	*m*
China					100	*k*	100		100		100		100	
Colombia	90	*d*	95	*d*	97	*h*	98	h	100		100		98	
Comoros			40		70		75		80		95		74	
Democratic Republic of the Congo			7	*c*	13		17		19		49		0	
Congo					42		60	c	66		87		24	
Cook Islands					99		100		100		100			
Costa Rica					99	*h*	99	h	100	*h*	100	*h*	99	
Côte d'Ivoire			48		58		63		66		94		37	
Croatia	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Cuba			97	*k*	98		99		100		100		100	

Country	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%) b	
	1990		2000		2010		2015		2017		2017		2017	
Curaçao					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*
Denmark	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Djibouti			56		56		58		60	*j*	70	*j*	26	
Dominica			81		94		100		100		100		100	
Dominican Republic			89	*h*	98	*h*	99	h	100		100		100	
Ecuador			93		97	*h*	99	h	100		100		100	
Egypt			98	*d*	100		100		100		100		100	
El Salvador			85	*h*	92	*h*	95	h	99		99		100	
Equatorial Guinea							67		67		91		6	
Eritrea			29		40		46		48		77		30	
Estonia	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Ethiopia			13	*d*	33		29	d	44	*l*	97	*l*	31	
Faroe Islands	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Fiji			76		89		95		96	*e*	100		91	
Finland	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
France	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
French Polynesia	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Gabon			74	*d*	92		90		92		98		49	
Gambia			34	*c*	48		54		56	*d*	79	*d*	21	
Georgia					99		100		100		100		100	
Germany	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Ghana			44	*e*	64	*e*	76		79	*d*	90	*d*	65	
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*

Country	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%) b	
	1990		2000		2010		2015		2017		2017		2017	
Grenada			86		90		93		95		93		96	
Guam			100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Guatemala			73	*h*	84		91		93		97		89	
Guinea			17		26		32		35		83		9	
Guinea-Bissau					6	*g*	20		26		48		9	
Guyana			75		82		88		91		97		89	
Haiti			34	*d*	37		41		44		78		3	
Honduras			67		81	*h*	90	h	87	*l*	98	*l*	72	
China, Hong Kong Special Administrative Region	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Hungary	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Iceland	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
India			59		76	*g*	88	d	93		99		89	
Indonesia			86	*g*	94	*g*	98	g	98	*g*	100		96	
Iran (Islamic Republic of)			98	*d*	99		100		100		100		100	
Iraq					98		100		100		100		100	
Ireland	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Isle of Man	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Israel	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Italy	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Jamaica	70	*h*	85		93		97		100		100		99	
Japan	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Jordan	97	*d*	99		99		100		100		100		100	
Kazakhstan			99		99		100	c	100		100		100	
Kenya			15		19	*d*	42	d	64		81		58	
Kiribati					63	*e*	91	e	99		89		100	
Democratic People's Republic of Korea					29		40		44		39		52	

Country	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%) b	
	1990		2000		2010		2015		2017		2017		2017	
Republic of Korea			100		100	*m*	100	m	100	*m*	100	*m*	100	*m*
Kosovo	100	*m*	100	*m*	99	*0*	100	m	100	*m*	100	*m*	100	*m*
Kuwait	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Kyrgyzstan			100		99	*i*	100		100		100		100	
Lao People's Democratic Republic			43		71		90	e	94	*c*	100	*c*	91	
Latvia	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Lebanon					100		100		100		100		100	
Lesotho			4	*c*	21		30		34		70		20	
Liberia					5		15		21		36		7	
Libya			100	*k*	81		73		70		70		70	
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*
China, Macao Special Administrative Region			100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
The former Yugoslav Republic of Macedonia	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Madagascar			14		17		20		24		69		0	
Malawi			5	*d*	9	*d*	11	d	13	*d*	58	*d*	4	
Malaysia					99		100		100		100		100	
Maldives			84	*e*	99		100		100	*d*	100	*d*	100	
Mali			10		25		38	d	43		87		12	
Malta	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Marshall Islands			69		89		93		95		96		92	
Mauritania					34		40	c	43		83		0	
Mauritius			99	*e*	100		98		98		90		100	
Mexico			98	*h*	99	*h*	99	d	100		100		100	

Country	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%) b	
	1990		2000		2010		2015		2017		2017		2017	
Micronesia (Federated States of)			46	e	65	e	76		81		94		77	
Republic of Moldova	100	m	100	m	100	m	100	m	100	m	100	m	100	m
Monaco	100	m	100	m	100	m	100	m	100	m	100	m	100	m
Mongolia			67	e	79	c	83		86		100		56	
Montenegro	100	m	100	m	100	m	100	m	100	m	100	m	100	m
Morocco			70		91		100		100		100		100	
Mozambique			7		18		24	d	27		73		2	
Myanmar					49	g	61	g	70	l	93	l	60	
Namibia			37	d	44		50		53		77		29	
Nauru					99		99	g	100		100			
Nepal			27		65		87		96		99		95	
Netherlands	100	m	100	m	100	m	100	m	100	m	100	m	100	m
New Caledonia			100	m	100	m	100	m	100	m	100	m	100	m
New Zealand	100	m	100	m	100	m	100	m	100	m	100	m	100	m
Nicaragua			73		78		84		87		100		68	
Niger			6	c	13		17	g	20		67		11	
Nigeria	27	d	43		48	d	53	d	54	c	87	c	23	
Niue							100		100		100			
Northern Mariana Islands			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	m	100	m	100	m	100	m	100	m
Pakistan			70		70		71		71	e	100		54	
Palau					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			11		20	g	45		54		81		50	
Paraguay			89		97	h	99	h	99	h	100	h	99	

Country	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%) b	
	1990		2000		2010		2015		2017		2017		2017	
Peru			72	h	88	h	94	h	96		100		84	
Philippines			75		85		89	f	93	d	96	d	90	
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	m	100	m	100	m	100	m	100	m
Qatar	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	100	m	100	m	100	m	100	m
Rwanda			6	d	10	d	23	d	34	d	85	d	24	
Samoa			87		97		100		97	e	100		96	
San Marino	100	m	100	m	100	m	100	m	100	m	100	m	100	m
Sao Tome and Principe			53	c	60		68		73		83		45	
Saudi Arabia					100	m	100	m	100	m	100	m	100	m
Senegal			38	c	55		61	d	62	d	92	d	35	
Serbia	100	m	100	m	100	c	100	m	100	m	100	m	100	m
Seychelles			94		97	e	100	m	100	m	100	m	100	m
Sierra Leone					11	c	19		23	c	49	c	5	
Singapore	100	m	100	m	100	m	100	m	100	m	100	m	100	m
Sint Maarten (Dutch part)					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			7		33		55	d	63		74		60	
Somalia					21		29		33		63		9	
South Africa			72		83	g	86	g	84	g	93		67	
South Sudan					2	e	19		25		42		21	
Spain	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		2017		2017		2017	
Sri Lanka					85	g	94		98		100		97	
Saint Kitts and Nevis					100		100	m	100	m	100	m	100	m
Saint Lucia					94	e	97		99		97		99	
Sint Maarten (Dutch part)					100	m	100	m	100	m	100	m	100	m
Saint Vincent and the Grenadines			80		93		99		100		98		100	
Sudan	33	d	23	c	36		49		56		83		43	
Suriname			97		91	c	95		97		100		91	
Swaziland					46	c	66		74		93		67	
Sweden	100	m	100	m	100	m	100	m	100	m	100	m	100	m
Switzerland	100	m	100	m	100	m	100	m	100	m	100	m	100	m
Syrian Arab Republic					93	g	90		90		100		78	
Tajikistan			98	c	99		100		99	d	99	d	99	
United Republic of Tanzania			10		15	d	27		33		65		17	
Thailand			82	d	100	f	100	c	100		100		100	
Timor-Leste					38	d	67	e	80		100		72	
Togo			17	c	31	c	45		48	d	89	d	19	
Tonga			85		92		96		98		99		98	
Trinidad and Tobago			91	e	100	m	100	m	100	m	100	m	100	m
Tunisia			95	g	100	j	100		100		100		100	
Turkey					100	i	100		100		100		100	
Turkmenistan			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					97		99		100		100		100	
Uganda			8		12	g	19	d	22	g	57	g	11	
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

Country	Total electricity access rate (%)										Urban electricity access rate (%)		Rural electricity access rate (%) b	
	1990		2000		2010		2015		2017		2017		2017	
United Kingdom of Great Britain and Northern Ireland	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
United States of America	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
Uruguay					99		100	h	100	*m*	100	*m*	100	*m*
Uzbekistan			100		100		100		100		100		100	
Vanuatu			22		37		48		63		93		53	
Venezuela (Bolivarian Republic of)			99	*h*	99		100		100		100		100	
Viet Nam			86		98		100		100		100		100	
United States Virgin Islands	100	*m*	100	*m*	100	*m*	100	m	100	*m*	100	*m*	100	*m*
State of Palestine			100	*g*	100	*g*	100		100		100		100	
Yemen			50		66		74		79	*g*	98		69	
Zambia	14	*e*	17	*e*	22	*e*	31	g	40	*l*	75	*l*	14	
Zimbabwe			34		40		34	d	40		86		19	

Source: World Bank

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.

TOTAL ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Afghanistan	7	19	32	21	34	45	71	88	>95	<5	12	28
Albania	41	65	78	49	80	95	70	92	>95	21	65	95
Algeria	88	>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	34	44	48	36	49	62	64	78	90	<5	8	15
Anguilla												
Antigua and Barbuda	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Argentina	>95	>95	>95	94	>95	>95	95	>95	>95	66	93	>95
Armenia	83	95	>95	88	>95	>95	95	>95	>95	76	>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	73	93	>95	89	>95	>95	94	>95	>95	73	95	>95
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	7	13	19	13	19	28	31	50	70	<5	6	15
Barbados	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Belarus	92	>95	>95	68	>95	>95	76	>95	>95	63	>95	>95
Belgium	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Belize	78	84	86	78	87	93	92	>95	>95	57	78	92
Benin	<5	<5	6	<5	6	13	<5	9	18	<5	<5	<5
Bermuda												
Bhutan	27	61	76	55	79	94	77	>95	>95	46	75	92
Bolivia (Plurinational State of)	63	76	81	74	83	90	94	>95	>95	32	52	71

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Bosnia and Herzegovina	39	53	62	43	63	80	45	70	92	23	58	89
Botswana	42	53	58	31	59	74	42	73	93	21	41	63
Brazil	87	94	>95	88	>95	>95	94	>95	>95	56	79	92
British Virgin Islands												
Brunei Darussalam	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Bulgaria	66	84	90	61	91	>95	30	94	>95	13	85	>94
Burkina Faso	<5	6	9	<5	10	17	17	30	44	<5	<5	<5
Burundi	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cambodia	<5	11	18	11	20	30	53	66	77	<5	7	16
Cameroon	10	18	24	9	25	36	33	46	60	<5	<5	7
Canada	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Cabo Verde	58	69	75	37	75	83	71	92	>95	27	40	49
Cayman Islands												
Central African Republic	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	<5
Chad	<5	<5	<5	<5	<5	6	5	14	25	<5	<5	<5
Channel Islands												
Chile	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
China	49	54	58	30	58	83	66	82	91	12	32	60
Colombia	79	90	94	84	94	>95	94	>95	>95	37	61	80
Comoros	<5	<5	8	<5	10	23	<5	20	43	<5	<5	17
Democratic Republic of the Congo	<5	<5	<5	<5	<5	11	<5	9	20	<5	<5	5
Congo	9	17	24	11	25	43	20	37	55	<5	<5	13
Cook Islands	84	85	84	54	84	>95	57	95	>95	<5	62	>95
Costa Rica	88	92	94	85	95	>95	93	>95	>95	58	83	>95
Côte d'Ivoire	16	18	20	8	21	40	32	47	62	<5	<5	8
Croatia	84	90	92	79	93	>95	80	>95	>95	50	89	>95
Cuba	77	86	89	10	90	>95	31	94	>95	<5	77	>95

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
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
Denmark	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Djibouti	5	8	10	<5	10	37	17	18	19	<5	<5	14
Dominica	78	87	91	79	91	>95	88	>95	>95	46	81	>95
Dominican Republic	80	87	90	83	91	>95	90	>95	>95	46	74	93
Ecuador	88	95	>95	91	>95	>95	>95	>95	>95	66	91	>95
Egypt	85	>95	>95	>95	>95	>95	>95	>95	>95	86	>95	>95
El Salvador	57	79	88	79	89	95	89	95	>95	52	79	95
Equatorial Guinea	14	29	37	<5	37	70	11	42	76	<5	9	34
Eritrea	<5	12	17	<5	18	45	15	31	51	<5	<5	9
Estonia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Ethiopia	<5	<5	<5	<5	<5	10	7	16	29	<5	<5	<5
Faroe Islands												
Fiji	32	43	48	7	51	82	18	67	93	<5	17	50
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	60	76	81	33	81	94	75	92	>95	24	43	60
Gambia	<5	<5	<5	<5	<5	9	<5	<5	16	<5	<5	<5
Georgia	41	66	78	60	79	93	89	>95	>95	6	33	73
Germany	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Ghana	6	16	23	16	25	36	30	41	51	<5	8	18
Gibraltar												
Greece	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Greenland												

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Grenada	94	>95	>95	91	>95	>95	63	>95	>95	73	>95	>95
Guam												
Guatemala	37	41	43	33	43	53	7	50	94	2	32	81
Guinea	<5	<5	<5	<5	<5	<5	<5	<5	24	<5	<5	5
Guinea-Bissau	<5	<5	<5	<5	<5	<5	<5	<5	28	<5	<5	<5
Guyana	36	62	75	59	77	90	57	84	>95	50	71	87
Haiti	<5	<5	<5	<5	<5	11	<5	12	46	<5	<5	18
Honduras	30	45	52	37	54	70	40	82	>95	6	25	53
China, Hong Kong Special Administrative Region												
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	22	36	44	26	45	65	63	78	88	12	22	35
Indonesia	7	42	63	42	65	82	70	85	93	38	51	64
Iran (Islamic Republic of)	87	>95	>95	95	>95	>95	>95	>95	>95	87	>95	>95
Iraq	72	>95	>95	94	>95	>95	>95	>95	>95	84	>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	72	86	91	84	92	>95	86	>95	>95	62	85	>95
Japan	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Jordan	>95	>95	>95	>95	>95	>95	94	>95	>95	91	>95	>95
Kazakhstan	85	94	>95	88	>95	>95	88	>95	>95	71	95	>95
Kenya	<5	7	13	6	14	26	12	28	48	<5	<5	6
Kiribati	<5	<5	6	<5	6	29	<5	14	48	<5	<5	16
Democratic People's Republic of Korea	<5	6	10	<5	11	33	5	15	33	<5	<5	14

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Republic of Korea	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Kosovo												
Kuwait	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Kyrgyzstan	53	73	81	58	83	>95	67	95	>95	48	74	94
Lao People's Democratic Republic	<5	<5	5	<5	5	21	5	14	27	<5	<5	7
Latvia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Lebanon												
Lesotho	16	27	32	17	33	51	67	82	92	9	17	28
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
China, Macao Special Administrative Region												
The former Yugoslav Republic of Macedonia	41	59	65	47	66	83	70	87	95	15	45	76
Madagascar	<5	<5	<5	<5	<5	<5	<5	<5	5	<5	<5	<5
Malawi	<5	<5	<5	<5	<5	5	6	10	16	<5	<5	<5
Malaysia	95	>95	>95	37	>95	>95	84	>95	>95	14	95	>95
Maldives	32	87	>95	72	>95	>95	82	>95	>95	85	>95	>95
Mali	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	<5
Malta	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Marshall Islands	7	57	65	36	66	87	61	91	>95	<5	7	29
Mauritania	30	39	44	30	46	58	39	71	85	8	21	29
Mauritius	94	>95	>95	89	>95	>95	84	>95	>95	88	>95	>95
Mexico	81	84	86	79	86	91	88	93	>95	40	55	72
Micronesia (Federated States of)	11	12	12	5	12	27	6	75	>95	<5	9	49

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Republic of Moldova	68	89	94	81	94	>95	92	>95	>95	62	92	>95
Monaco	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Mongolia	15	29	38	6	41	60	25	57	78	<5	11	29
Montenegro	55	62	65	44	66	87	51	77	>95	18	50	83
Morocco	91	>95	>95	93	>95	>95	>95	>95	>95	74	94	>95
Mozambique	<5	<5	<5	<5	<5	7	<5	9	21	<5	<5	<5
Myanmar	<5	10	19	7	20	38	28	54	74	<5	6	22
Namibia	32	40	44	<5	44	58	49	75	89	5	12	21
Nauru	72	89	92	35	92	>95	69	91	>95	<5	27	>95
Nepal	14	22	29	18	29	43	41	65	84	7	15	25
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	45	52	44	54	63	69	79	87	<5	13	32
Niger	<5	<5	<5	<5	<5	8	<5	8	22	<5	<5	<5
Nigeria	<5	<5	6	<5	7	12	6	14	26	<5	<5	5
Niue	75	89	93	81	93	>95	67	>95	>95	73	94	>95
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	23	35	43	29	44	62	77	92	>95	<5	14	35
Palau	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Panama	79	86	89	82	90	>95	95	>95	>95	53	75	92
Papua New Guinea	6	9	11	<5	12	30	19	47	74	<5	<5	22
Paraguay	46	58	65	56	66	75	73	83	90	25	38	53
Peru	35	66	74	66	76	84	80	90	>95	17	29	43
Philippines	36	42	44	29	44	61	42	64	83	11	21	33

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
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
Romania	67	83	88	59	89	>95	74	>95	>95	45	80	95
Russian Federation	93	>95	>95	91	>95	>95	93	>95	>95	74	>95	>95
Rwanda	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Samoa	16	26	31	17	31	45	42	65	81	12	24	43
San Marino	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Sao Tome and Principe	<5	<5	<5	<5	<5	12	<5	<5	15	<5	<5	5
Saudi Arabia	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Senegal	34	33	31	17	31	46	34	55	74	<5	6	13
Serbia	52	67	74	43	74	93	63	86	>95	18	57	89
Seychelles	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Sierra Leone	<5	<5	<5	<5	<5	<5	<5	<5	9	<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	6	8	8	<5	8	20	21	39	59	<5	<5	15
Somalia	<5	<5	<5	<5	<5	6	<5	5	14	<5	<5	11
South Africa	55	76	84	72	86	93	85	95	>95	56	73	85
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	14	22	27	14	28	43	48	66	80	8	20	36
Saint Kitts and Nevis	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Saint Lucia	87	95	>95	92	>95	>95	84	>95	>95	85	>95	>95

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Sint Maarten (Dutch part)												
Saint Vincent and the Grenadines	>95	>95	>95	91	>95	>95	84	>95	>95	80	>95	>95
Sudan	13	29	41	30	44	57	56	70	83	7	30	58
Suriname	80	87	90	79	91	>95	86	95	>95	60	81	95
Swaziland	27	42	50	39	51	64	74	87	94	20	33	46
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	84	>95	>95
Tajikistan	38	68	81	61	83	95	90	>95	>95	37	74	95
United Republic of Tanzania	<5	<5	<5	<5	<5	7	5	11	22	<5	<5	<5
Thailand	65	73	78	61	78	90	76	88	>95	60	73	84
Timor-Leste	<5	5	10	<5	11	21	15	25	36	<5	5	13
Togo	<5	<5	7	<5	8	14	8	18	28	<5	<5	<5
Tonga	49	54	55	34	55	74	68	85	>95	23	49	74
Trinidad and Tobago	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Tunisia	93	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Turkey	90	94	>95	91	>95	>95	>95	>95	>95	71	88	>95
Turkmenistan	>95	>95	>95	>95	>95	>95	>95	>95	>95	59	>95	>95
Turks and Caicos Islands												
Tuvalu	20	44	52	12	52	77	18	75	>95	<5	32	95
Uganda	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	<5
Ukraine	89	95	>95	82	>95	>95	94	>95	>95	74	93	>95
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 States of America	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95
Uruguay	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95

Country	Total (%)						Urban (%)			Rural (%)		
	2000	2010	2016	2017 (L)	2017 (M)	2017(U)	2017 (L)	2017 (M)	2017 (U)	2017 (L)	2017 (M)	2017 (U)
Uzbekistan	80	89	92	77	92	>95	90	>95	>95	60	91	>95
Vanuatu	12	12	11	<5	11	22	16	35	57	<5	<5	11
Venezuela (Bolivarian Republic of)	>95	>95	>95	92	>95	>95	92	>95	>95	64	88	>95
Viet Nam	14	46	67	55	70	81	80	92	>95	35	60	76
United States Virgin Islands												
State of Palestine												
Yemen	55	60	63	52	63	75	90	>95	>95	26	48	71
Zambia	14	15	16	10	16	24	24	38	55	<5	<5	7
Zimbabwe	32	30	29	19	29	37	61	78	90	<5	5	11
World	50	57	60	54	61	67	29	34	40	79	83	85
Northern America (M49) and Europe (M49)	>95	>95	>95	>95	>95	>95	92	>95	>95	>95	>95	>95
Latin America and the Caribbean (MDG=M49)	78	85	88	85	88	90	55	62	68	92	94	>95
Central Asia (M49) and Southern Asia (MDG=M49)	26	38	45	33	46	60	16	23	32	70	79	87
Eastern Asia (M49) and South-eastern Asia (MDG=M49)	46	55	60	44	61	77	25	38	55	73	82	89
Sub-Saharan Africa (M49)	9	11	13	12	14	15	3	4	5	27	30	33
Oceania (MDG) / Oceania (M49) excluding Australia and New Zealand (M49)	11	14	16	8	17	30	2	7	21	34	52	70
Western Asia (M49) and Northern Africa (M49)	78	87	90	83	90	93	76	81	86	>95	>95	>95
Australia and New Zealand (M49)	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95	>95

Source: World Health Organization
Note:
L = 95% confidence interval lower bound
M = point estimate
U = 95% confidence interval upper bound

RENEWABLE ENERGY

UN Country Name	Share in total final energy consumption (%)													Final consumption of renewable energy (PJ) (4)			Total final energy consumption (PJ)	
	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Wind	Solar	Geothermal	Tide	Municipal waste (renew)	Electricity consump-tion (2)	Heat raising (3)	Transport (4)		
	1990	2010	2015	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	
Afghanistan	15.9%	14.8%	18.4%	20.8%	10.3%	0.0%	0.0%	10.5%	0.0%	0.0%	0.0%	0.0%	0.0%	13.5	13.3	0.0	129.3	a
Åland Islands	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Albania	25.5%	37.1%	38.6%	40.0%	10.2%	4.3%	0.0%	24.9%	0.0%	0.7%	0.0%	0.0%	0.0%	19.8	8.6	3.4	79.6	b
Algeria	0.2%	0.3%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9	0.3	0.0	1415.6	b
American Samoa	0.0%	0.0%	0.9%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.5	a
Andorra	14.1%	18.7%	19.3%	19.3%	0.3%	0.0%	0.0%	17.6%	0.0%	0.0%	0.0%	0.0%	1.5%	1.6	0.0	0.0	8.6	a
Angola	72.3%	56.5%	53.2%	54.7%	51.1%	0.0%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%	18.1	258.5	0.0	506.1	b
Anguilla	0.3%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	1.6	a
Antigua and Barbuda	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	4.8	a
Argentina	8.9%	9.0%	10.1%	10.0%	2.7%	2.2%	0.0%	5.1%	0.1%	0.0%	0.0%	0.0%	0.0%	127.6	59.1	53.2	2390.7	b
Armenia	2.1%	9.4%	15.8%	14.0%	7.0%	0.0%	0.0%	7.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.1	6.1	0.1	87.7	b
Aruba	0.3%	5.5%	6.7%	6.7%	0.3%	0.0%	0.0%	0.0%	6.4%	0.0%	0.0%	0.0%	0.0%	0.4	0.0	0.0	6.5	a
Australia	8.0%	8.1%	9.2%	9.3%	5.3%	0.2%	0.2%	1.4%	1.1%	1.0%	0.0%	0.0%	0.0%	107.4	181.9	10.0	3210.7	b
Austria	25.1%	30.4%	34.5%	34.7%	16.4%	2.2%	0.5%	12.5%	1.7%	1.1%	0.1%	0.0%	0.3%	164.4	180.5	31.1	1084.5	b
Azerbaijan	0.7%	4.5%	2.3%	1.9%	0.4%	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	0.1%	5.2	1.3	0.1	344.5	b
Bahamas	0.0%	1.7%	1.4%	1.4%	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.3	0.0	20.0	a
Bahrain	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	192.7	b
Bangladesh	71.7%	41.1%	34.6%	34.0%	33.8%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	2.2	387.8	0.0	1148.4	b
Barbados	19.6%	9.0%	2.8%	2.8%	2.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.3	0.0	11.5	a
Belarus	0.9%	7.3%	6.8%	6.7%	6.4%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	1.2	43.3	0.2	666.7	b
Belgium	1.3%	5.8%	9.3%	9.1%	4.8%	1.3%	0.5%	0.1%	1.3%	0.8%	0.0%	0.0%	0.3%	48.5	61.4	19.5	1414.8	b
Belize	38.0%	33.7%	30.2%	30.3%	21.8%	0.0%	0.0%	8.4%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0	1.5	0.0	11.3	a
Benin	93.7%	48.1%	50.9%	50.0%	49.8%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2	78.4	0.0	157.4	b

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	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Wind	Solar	Geothermal	Tide	Municipal waste (renew)	Electricity consump-tion (2)	Heat raising (3)	Transport (4)		
	1990	2010	2015	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	
Bermuda	0.0%	2.4%	2.4%	2.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%	0.1	0.0	0.0	5.9	a
Bhutan	95.9%	90.6%	86.4%	84.8%	73.5%	0.0%	0.0%	11.3%	0.1%	0.0%	0.0%	0.0%	0.0%	7.3	47.1	0.0	64.1	a
Bolivia (Plurinational State of)	37.4%	19.7%	17.5%	15.7%	13.7%	0.0%	0.0%	1.9%	0.0%	0.0%	0.0%	0.0%	0.0%	6.5	38.5	0.0	286.9	b
Bonaire, Sint Eustatius and Saba	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	3.9	a
Bosnia and Herzegovina	7.3%	19.6%	27.1%	24.8%	16.4%	0.0%	0.0%	8.4%	0.0%	0.0%	0.0%	0.0%	0.0%	12.6	24.9	0.1	151.6	b
Botswana	47.6%	29.9%	28.4%	28.4%	28.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	23.1	0.0	81.5	b
Brazil	49.9%	47.0%	43.8%	45.5%	22.8%	7.9%	0.0%	13.3%	1.2%	0.4%	0.0%	0.0%	0.0%	1413.1	1882.5	699.4	8776.5	b
British Indian Ocean Territory	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
British Virgin Islands	1.5%	0.7%	0.8%	0.9%	0.7%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0	0.0	0.0	1.9	a
Brunei Darussalam	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	36.9	b
Bulgaria	1.9%	14.4%	17.7%	17.7%	10.7%	1.7%	0.4%	2.3%	0.8%	1.1%	0.4%	0.0%	0.3%	16.4	46.7	6.9	396.2	b
Burkina Faso	93.3%	81.5%	72.7%	72.3%	71.8%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7	109.5	0.0	152.6	a
Burundi	95.2%	95.3%	91.2%	89.2%	88.0%	0.0%	0.0%	1.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7	48.7	0.0	55.3	a
Cabo Verde	36.6%	21.7%	27.0%	25.2%	22.1%	0.0%	0.0%	0.0%	2.9%	0.2%	0.0%	0.0%	0.0%	0.2	1.5	0.0	6.7	a
Cambodia	..	68.5%	64.9%	62.7%	58.8%	0.0%	0.0%	3.9%	0.0%	0.0%	0.0%	0.0%	0.0%	10.4	155.8	0.0	265.1	b
Cameroon	81.6%	78.6%	78.0%	78.1%	73.9%	0.0%	0.0%	4.2%	0.0%	0.0%	0.0%	0.0%	0.0%	12.8	224.4	0.0	303.5	b
Canada	22.0%	22.5%	21.4%	21.6%	5.0%	1.0%	0.1%	14.1%	1.1%	0.1%	0.0%	0.0%	0.0%	1094.2	330.3	87.9	7018.2	b
Cayman Islands	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	4.7	a
Central African Republic	94.1%	81.3%	78.0%	77.7%	73.0%	0.0%	0.0%	3.3%	1.5%	0.0%	0.0%	0.0%	0.0%	0.8	12.9	0.0	17.6	a
Chad	89.7%	81.6%	85.4%	85.3%	85.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	60.0	0.0	70.3	a
Channel Islands	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Chile	34.0%	27.0%	25.0%	24.5%	16.1%	0.0%	0.0%	6.8%	0.7%	0.9%	0.0%	0.0%	0.0%	107.8	156.9	1.5	1085.6	b
China	33.9%	12.4%	12.2%	12.6%	4.5%	0.1%	0.4%	4.6%	0.9%	1.5%	0.5%	0.0%	0.0%	4536.7	4802.8	200.6	75657.9	b

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	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Wind	Solar	Geothermal	Tide	Municipal waste (renew)	Electricity consump-tion (2)	Heat raising (3)	Transport (4)		
	1990	2010	2015	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	
China, Hong Kong Special Administrative Region	1.1%	0.8%	0.8%	0.8%	0.6%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4	2.4	0.2	378.3	b
China, Macao Special Administrative Region	0.7%	5.8%	4.6%	4.5%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.5%	1.6	0.0	0.0	35.0	a
Christmas Island	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Cocos (Keeling) Islands	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Colombia	38.3%	27.9%	28.6%	28.5%	17.2%	0.1%	0.0%	11.2%	0.0%	0.0%	0.0%	0.0%	0.0%	142.5	206.3	1.6	1229.8	b
Comoros	49.8%	46.4%	45.4%	41.9%	41.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	1.6	0.0	3.9	a
Congo	65.4%	54.8%	62.2%	63.3%	61.5%	0.0%	0.0%	1.9%	0.0%	0.0%	0.0%	0.0%	0.0%	1.6	52.6	0.0	85.5	b
Cook Islands	0.0%	0.0%	1.3%	1.9%	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.7	a
Costa Rica	45.4%	42.3%	38.9%	37.2%	15.7%	0.0%	0.0%	16.4%	2.3%	0.0%	2.7%	0.0%	0.0%	34.6	24.5	0.0	158.9	b
Côte d'Ivoire	73.6%	75.4%	64.5%	62.7%	61.5%	0.0%	0.0%	1.2%	0.0%	0.0%	0.0%	0.0%	0.0%	4.0	183.9	0.0	299.8	b
Croatia	21.9%	29.8%	33.1%	31.9%	18.3%	0.0%	0.5%	11.0%	1.6%	0.3%	0.1%	0.0%	0.0%	35.9	50.2	0.6	272.3	b
Cuba	42.9%	14.6%	20.1%	17.5%	13.7%	3.6%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	2.3	43.4	0.0	261.3	b
Curaçao	0.0%	0.5%	2.5%	2.5%	0.0%	0.0%	0.0%	0.0%	2.2%	0.4%	0.0%	0.0%	0.0%	0.6	0.0	0.0	24.8	b
Cyprus	0.5%	6.4%	9.9%	9.8%	1.2%	0.6%	0.6%	0.0%	1.2%	5.5%	0.1%	0.0%	0.7%	1.4	4.3	0.4	61.7	b
Czechia	3.6%	10.9%	14.8%	14.7%	10.6%	1.3%	1.4%	0.5%	0.1%	0.6%	0.0%	0.0%	0.2%	22.4	110.1	13.3	989.2	b
Democratic People's Republic of Korea	7.2%	13.5%	23.1%	23.1%	12.0%	0.0%	0.0%	11.1%	0.0%	0.0%	0.0%	0.0%	0.0%	34.4	37.0	0.0	309.2	b
Democratic Republic of the Congo	92.1%	96.8%	95.8%	97.0%	94.3%	0.0%	0.0%	2.7%	0.0%	0.0%	0.0%	0.0%	0.0%	25.2	865.8	0.0	918.2	b
Denmark	7.0%	21.4%	33.5%	33.1%	17.9%	1.8%	1.4%	0.0%	8.3%	0.8%	0.0%	0.0%	2.9%	66.9	109.2	10.8	565.3	b
Djibouti	26.6%	32.5%	14.2%	28.5%	28.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	1.8	0.0	6.2	a
Dominica	14.6%	10.1%	8.6%	10.7%	3.6%	0.0%	0.0%	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1	0.1	0.0	1.7	a
Dominican Republic	28.0%	17.7%	16.4%	17.5%	13.5%	0.0%	0.0%	2.4%	1.0%	0.5%	0.0%	0.0%	0.0%	9.2	32.4	0.0	237.9	b
Ecuador	24.2%	12.1%	14.1%	15.2%	4.5%	0.2%	0.0%	10.4%	0.1%	0.0%	0.0%	0.0%	0.0%	50.9	20.0	0.8	471.9	b

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	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Wind	Solar	Geothermal	Tide	Municipal waste (renew)	Electricity consump-tion (2)	Heat raising (3)	Transport (4)		
	1990	2010	2015	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	
Egypt	8.5%	5.7%	5.8%	5.7%	3.5%	0.0%	0.0%	1.9%	0.3%	0.0%	0.0%	0.0%	0.0%	47.0	76.6	0.2	2173.9	b
El Salvador	67.1%	31.3%	23.5%	21.4%	11.9%	0.0%	0.1%	4.1%	0.0%	0.0%	5.2%	0.0%	0.0%	12.0	10.4	0.0	104.7	b
Equatorial Guinea	84.6%	5.9%	10.2%	12.7%	11.0%	0.0%	0.0%	1.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6	3.8	0.0	34.8	a
Eritrea	..	81.3%	80.1%	80.1%	80.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	19.8	0.0	24.7	b
Estonia	3.5%	25.1%	27.5%	26.6%	25.0%	0.1%	0.3%	0.1%	1.1%	0.0%	0.0%	0.0%	0.0%	3.2	27.8	0.1	117.3	b
Eswatini	57.9%	63.7%	66.3%	60.9%	56.8%	0.0%	0.0%	4.1%	0.0%	0.0%	0.0%	0.0%	0.0%	4.5	17.0	0.0	35.2	a
Ethiopia	96.6%	94.5%	92.2%	91.9%	90.0%	0.0%	0.0%	1.7%	0.1%	0.0%	0.0%	0.0%	0.0%	31.7	1585.4	0.3	1760.8	b
Falkland Islands (Malvinas)	1.1%	0.7%	0.9%	0.9%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.7	a
Faroe Islands	2.5%	2.8%	5.3%	4.2%	0.0%	0.0%	0.0%	4.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4	0.0	0.0	8.3	a
Fiji	58.1%	27.8%	29.8%	24.4%	17.1%	0.0%	0.0%	7.2%	0.0%	0.0%	0.0%	0.0%	0.0%	1.6	3.8	0.0	22.2	a
Finland	24.5%	33.6%	43.1%	42.0%	32.0%	0.8%	0.3%	6.6%	1.3%	0.0%	0.0%	0.0%	1.0%	127.6	290.0	8.5	1013.7	b
France	10.5%	12.1%	13.6%	14.7%	7.1%	2.2%	0.3%	3.0%	1.1%	0.5%	0.1%	0.0%	0.5%	274.0	445.7	136.9	5811.8	b
French Guiana	5.7%	29.6%	33.2%	30.2%	13.1%	0.0%	0.0%	15.0%	0.0%	2.1%	0.0%	0.0%	0.0%	1.7	1.2	0.0	9.6	a
French Polynesia	4.7%	12.6%	10.2%	11.1%	0.4%	0.0%	0.0%	10.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.8	0.0	0.0	7.5	a
French Southern and Antarctic Territories	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Gabon	78.3%	85.9%	82.0%	82.1%	80.6%	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0	163.7	0.0	203.2	b
Gambia	61.4%	54.7%	51.3%	51.3%	51.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	5.3	0.0	10.2	a
Georgia	12.8%	39.2%	28.7%	28.1%	9.6%	0.0%	0.0%	18.0%	0.0%	0.1%	0.4%	0.0%	0.0%	29.6	16.9	0.9	168.7	b
Germany	2.1%	10.3%	14.2%	14.2%	5.1%	1.4%	2.0%	0.7%	2.7%	1.6%	0.1%	0.0%	0.7%	532.7	548.0	120.0	8475.1	b
Ghana	80.6%	49.8%	41.4%	42.0%	36.3%	0.0%	0.0%	5.6%	0.0%	0.0%	0.0%	0.0%	0.0%	15.6	101.3	0.0	278.7	b
Gibraltar	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	7.1	b
Greece	7.8%	11.1%	17.2%	16.1%	5.7%	1.1%	0.2%	3.0%	2.7%	3.4%	0.1%	0.0%	0.0%	52.4	47.6	6.6	662.4	b
Greenland	0.5%	10.1%	15.8%	15.7%	0.0%	0.0%	0.0%	15.3%	0.0%	0.0%	0.0%	0.0%	0.5%	1.2	0.0	0.0	8.0	a
Grenada	8.3%	10.5%	10.9%	11.2%	11.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.3	0.0	2.8	a

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	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Wind	Solar	Geothermal	Tide	Municipal waste (renew)	Electricity consump-tion (2)	Heat raising (3)	Transport (4)		
	1990	2010	2015	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	
Guadeloupe	6.8%	3.8%	7.3%	7.6%	3.3%	0.0%	0.0%	0.6%	0.9%	1.5%	1.4%	0.0%	0.0%	1.4	0.1	0.0	19.3	a
Guam	0.0%	0.0%	1.3%	3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	0.2	0.0	0.0	5.7	a
Guatemala	75.0%	67.4%	63.1%	63.1%	60.2%	0.0%	0.0%	2.5%	0.1%	0.1%	0.2%	0.0%	0.0%	20.7	265.7	0.0	453.8	b
Guernsey	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	1.3	a
Guinea	89.3%	75.7%	76.3%	75.1%	72.7%	0.0%	0.0%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	3.4	102.6	0.0	141.2	a
Guinea-Bissau	88.6%	87.8%	86.9%	86.5%	86.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	23.9	0.0	27.7	a
Guyana	42.2%	33.8%	25.3%	21.6%	21.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1	6.2	0.0	29.1	a
Haiti	81.1%	79.0%	76.1%	76.1%	76.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1	105.4	0.0	138.6	b
Heard Island and McDonald Islands	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Holy See	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Honduras	70.1%	50.4%	53.5%	55.2%	49.8%	0.0%	0.0%	3.3%	0.8%	1.2%	0.0%	0.0%	0.0%	12.9	100.4	0.0	205.4	b
Hungary	3.9%	13.5%	15.5%	15.1%	12.2%	1.1%	0.3%	0.2%	0.4%	0.2%	0.6%	0.0%	0.2%	13.1	89.4	8.3	732.1	b
Iceland	54.7%	75.4%	77.0%	78.1%	0.0%	0.5%	0.1%	36.4%	0.0%	0.0%	41.1%	0.0%	0.0%	62.1	34.2	0.9	124.4	b
India	58.7%	40.7%	34.7%	34.0%	31.4%	0.1%	0.0%	1.7%	0.6%	0.3%	0.0%	0.0%	0.0%	637.2	6823.7	35.0	22023.2	b
Indonesia	58.5%	39.1%	35.8%	37.2%	34.4%	1.4%	0.0%	0.9%	0.0%	0.0%	0.5%	0.0%	0.0%	99.6	2264.7	88.1	6589.0	b
Iran (Islamic Republic of)	1.2%	0.9%	0.9%	1.0%	0.3%	0.0%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0	21.2	0.1	6842.4	b
Iraq	1.6%	1.7%	0.8%	0.9%	0.2%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	5.9	1.2	0.0	761.8	b
Ireland	2.3%	5.3%	9.1%	8.7%	2.1%	1.1%	0.2%	0.5%	4.2%	0.1%	0.0%	0.0%	0.4%	22.9	10.6	5.0	445.4	b
Isle of Man	0.0%	5.4%	4.8%	4.3%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	3.7%	0.1	0.0	0.0	2.3	a
Israel	5.8%	8.6%	3.7%	3.9%	0.2%	0.0%	0.1%	0.0%	0.0%	3.7%	0.0%	0.0%	0.0%	5.0	17.0	0.0	561.7	b
Italy	3.8%	12.8%	16.6%	16.1%	6.6%	1.3%	0.8%	3.3%	1.4%	1.9%	0.6%	0.0%	0.3%	371.2	321.9	58.7	4672.1	b
Jamaica	4.6%	9.7%	13.4%	12.7%	9.8%	1.7%	0.0%	0.4%	0.6%	0.0%	0.0%	0.0%	0.0%	1.4	7.3	1.4	80.4	b
Japan	4.5%	4.8%	6.3%	6.6%	1.9%	0.2%	0.0%	2.4%	0.2%	1.7%	0.2%	0.0%	0.1%	504.4	174.3	25.6	10754.5	b
Jersey	0.0%	11.0%	15.9%	14.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14.1%	0.9	0.0	0.0	6.2	a

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	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Wind	Solar	Geothermal	Tide	Municipal waste (renew)	Electricity consump-tion (2)	Heat raising (3)	Transport (4)		
	1990	2010	2015	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	
Jordan	2.8%	3.0%	3.2%	4.6%	0.7%	0.0%	0.0%	0.1%	0.5%	3.3%	0.0%	0.0%	0.0%	2.8	8.7	0.0	251.8	b
Kazakhstan	1.4%	1.4%	1.6%	2.0%	0.3%	0.0%	0.0%	1.7%	0.0%	0.0%	0.0%	0.0%	0.0%	25.3	3.8	1.3	1555.0	b
Kenya	77.3%	76.5%	72.9%	71.9%	68.5%	0.0%	0.0%	1.5%	0.0%	0.0%	1.9%	0.0%	0.0%	23.6	468.9	0.0	685.4	b
Kiribati	65.3%	48.3%	47.6%	45.4%	44.2%	0.0%	0.0%	0.0%	0.0%	1.2%	0.0%	0.0%	0.0%	0.0	0.5	0.0	1.2	a
Kuwait	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	682.4	b
Kyrgyzstan	7.9%	25.6%	23.3%	21.9%	0.0%	0.0%	0.0%	21.9%	0.0%	0.0%	0.0%	0.0%	0.0%	31.6	0.0	0.1	144.7	b
Lao People's Democratic Republic	88.4%	64.9%	53.9%	51.9%	42.2%	0.0%	0.0%	9.8%	0.0%	0.0%	0.0%	0.0%	0.0%	12.0	52.0	0.0	123.2	a
Latvia	17.6%	33.1%	38.1%	38.5%	30.3%	0.3%	1.7%	5.9%	0.3%	0.0%	0.0%	0.0%	0.0%	12.4	46.5	0.7	155.0	b
Lebanon	11.3%	5.2%	3.6%	3.4%	2.3%	0.0%	0.0%	0.6%	0.0%	0.5%	0.0%	0.0%	0.0%	1.2	5.8	0.0	206.6	b
Lesotho	52.0%	53.5%	53.4%	51.0%	46.2%	0.0%	0.0%	4.8%	0.0%	0.0%	0.0%	0.0%	0.0%	2.8	26.6	0.0	57.5	a
Liberia	88.8%	89.4%	84.0%	82.9%	82.8%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1	71.1	0.0	85.9	a
Libya	3.1%	1.6%	2.0%	1.6%	1.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	6.4	0.0	393.4	b
Liechtenstein	0.0%	56.6%	62.5%	62.9%	7.8%	0.0%	0.8%	41.7%	0.0%	12.0%	0.0%	0.0%	0.7%	1.4	0.2	0.0	2.6	a
Lithuania	3.1%	21.5%	29.0%	31.4%	21.6%	1.1%	0.8%	2.1%	5.2%	0.3%	0.0%	0.0%	0.4%	19.8	43.4	2.5	209.1	b
Luxembourg	1.7%	3.7%	9.1%	13.5%	2.2%	2.5%	1.6%	2.3%	2.0%	2.0%	0.0%	0.0%	0.8%	13.0	2.9	4.1	148.1	b
Madagascar	85.7%	81.9%	68.9%	68.1%	66.6%	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1	92.0	0.0	138.2	a
Malawi	84.0%	81.2%	80.9%	78.5%	70.5%	0.0%	0.0%	8.1%	0.0%	0.0%	0.0%	0.0%	0.0%	5.2	45.3	0.0	64.4	a
Malaysia	12.0%	3.8%	5.2%	6.2%	1.9%	0.8%	0.0%	3.4%	0.0%	0.1%	0.0%	0.0%	0.0%	69.7	35.5	16.4	1977.0	b
Maldives	4.5%	1.3%	1.3%	1.1%	1.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0	0.1	0.0	15.1	a
Mali	88.6%	67.3%	58.9%	59.4%	55.8%	0.0%	0.0%	3.7%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0	45.7	0.0	82.0	a
Malta	0.0%	1.4%	5.4%	8.9%	0.2%	1.3%	0.5%	0.0%	0.0%	6.7%	0.0%	0.0%	0.0%	1.2	0.3	0.3	19.2	b
Marshall Islands	0.0%	13.3%	11.3%	11.8%	11.4%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0	0.2	0.0	1.7	a
Martinique	1.9%	2.9%	6.0%	6.2%	2.3%	0.0%	0.0%	0.0%	0.0%	3.1%	0.0%	0.0%	0.8%	0.4	0.4	0.0	17.1	a
Mauritania	47.0%	34.0%	32.8%	34.6%	33.5%	0.0%	0.0%	0.0%	0.9%	0.2%	0.0%	0.0%	0.0%	0.4	13.6	0.0	40.7	a

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	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Wind	Solar	Geothermal	Tide	Municipal waste (renew)	Electricity consump-tion (2)	Heat raising (3)	Transport (4)		
	1990	2010	2015	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	
Mauritius	47.1%	13.7%	11.5%	10.3%	8.7%	0.0%	0.2%	1.0%	0.2%	0.3%	0.0%	0.0%	0.0%	2.2	1.3	0.0	34.3	b
Mayotte	33.4%	10.0%	10.2%	9.9%	8.1%	0.0%	0.0%	0.0%	0.0%	1.8%	0.0%	0.0%	0.0%	0.1	0.3	0.0	3.4	a
Mexico	14.4%	9.4%	9.2%	9.2%	6.0%	0.0%	0.0%	1.9%	0.7%	0.2%	0.4%	0.0%	0.0%	148.1	300.0	0.6	4872.4	b
Micronesia (Federated States of)	0.0%	1.7%	1.5%	1.6%	1.3%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0	0.0	0.0	1.3	a
Monaco	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Mongolia	1.9%	4.5%	3.6%	3.3%	2.8%	0.0%	0.0%	0.2%	0.4%	0.0%	0.0%	0.0%	0.0%	0.8	3.9	0.0	139.1	b
Montenegro	..	49.1%	43.0%	43.9%	24.3%	0.0%	0.0%	19.6%	0.0%	0.0%	0.0%	0.0%	0.0%	5.6	7.0	0.0	28.8	b
Montserrat	0.0%	0.0%	22.6%	51.2%	0.0%	0.0%	0.0%	0.0%	51.2%	0.0%	0.0%	0.0%	0.0%	0.1	0.0	0.0	0.3	a
Morocco	19.5%	13.9%	11.2%	11.0%	8.4%	0.0%	0.0%	0.7%	1.7%	0.2%	0.0%	0.0%	0.0%	16.2	52.2	0.2	622.6	b
Mozambique	93.1%	91.3%	86.5%	79.9%	72.3%	0.0%	0.0%	7.6%	0.0%	0.0%	0.0%	0.0%	0.0%	34.1	323.3	0.0	447.2	b
Myanmar	90.9%	84.4%	69.4%	68.0%	63.5%	0.0%	0.0%	4.5%	0.0%	0.0%	0.0%	0.0%	0.0%	30.1	423.5	0.0	667.3	b
Namibia	..	29.0%	28.3%	27.2%	9.4%	0.0%	0.0%	17.7%	0.0%	0.2%	0.0%	0.0%	0.0%	13.5	7.3	0.0	76.1	b
Nauru	9.9%	37.8%	33.5%	31.4%	0.0%	0.0%	0.0%	0.0%	31.3%	0.2%	0.0%	0.0%	0.0%	0.1	0.0	0.0	0.5	a
Nepal	95.1%	87.3%	85.0%	79.2%	73.7%	0.0%	2.2%	3.3%	0.0%	0.0%	0.0%	0.0%	0.0%	17.7	402.2	0.0	530.3	b
Netherlands	1.2%	3.9%	5.9%	5.8%	1.9%	0.6%	0.4%	0.0%	1.5%	0.3%	0.2%	0.0%	0.9%	47.8	49.2	11.0	1866.4	b
New Caledonia	12.3%	5.2%	5.3%	4.0%	0.3%	0.0%	0.0%	2.4%	0.8%	0.5%	0.0%	0.0%	0.0%	1.1	0.1	0.0	33.8	a
New Zealand	30.0%	31.3%	30.6%	32.8%	10.1%	0.0%	0.2%	15.2%	1.4%	0.1%	5.8%	0.0%	0.0%	116.0	61.9	0.3	544.0	b
Nicaragua	68.8%	52.5%	48.1%	46.8%	42.2%	0.0%	0.0%	1.1%	1.8%	0.0%	1.7%	0.0%	0.0%	6.3	43.4	0.0	106.2	b
Niger	..	80.7%	78.9%	79.7%	79.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	92.8	0.0	116.5	b
Nigeria	87.8%	87.0%	82.4%	82.4%	82.1%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	16.5	4402.5	0.0	5362.6	b
Niue	0.6%	26.7%	22.4%	22.1%	0.5%	0.0%	0.0%	0.0%	0.0%	21.6%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.1	a
Norfolk Island	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Northern Mariana Islands	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	1.1	a
Norway	59.2%	56.5%	58.3%	59.5%	4.4%	1.9%	0.2%	51.5%	0.8%	0.0%	0.0%	0.0%	0.8%	396.7	40.6	17.9	764.8	b

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	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Wind	Solar	Geothermal	Tide	Municipal waste (renew)	Electricity consump-tion (2)	Heat raising (3)	Transport (4)		
	1990	2010	2015	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	
Oman	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	749.6	b
Pakistan	57.5%	46.8%	45.3%	45.6%	42.1%	0.0%	0.0%	3.3%	0.1%	0.0%	0.0%	0.0%	0.0%	113.5	1373.9	0.0	3264.8	b
Palau	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	2.2	a
Panama	43.6%	19.9%	21.2%	21.2%	7.2%	0.0%	0.0%	12.7%	1.2%	0.1%	0.0%	0.0%	0.0%	20.6	10.5	0.0	146.4	b
Papua New Guinea	71.7%	55.3%	50.9%	50.3%	46.5%	0.0%	0.0%	2.7%	0.0%	0.0%	1.1%	0.0%	0.0%	4.6	56.1	0.0	120.7	a
Paraguay	78.5%	64.3%	61.7%	59.4%	38.4%	2.8%	0.0%	18.2%	0.0%	0.0%	0.0%	0.0%	0.0%	39.6	83.7	6.1	218.0	b
Peru	39.4%	30.8%	25.5%	25.3%	12.4%	2.0%	0.1%	10.1%	0.4%	0.3%	0.0%	0.0%	0.0%	82.0	95.5	13.8	755.8	b
Philippines	51.0%	28.8%	25.9%	24.0%	17.5%	1.5%	0.0%	1.9%	0.2%	0.3%	2.6%	0.0%	0.0%	64.5	223.6	18.1	1277.4	b
Pitcairn	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Poland	2.5%	9.5%	11.9%	11.4%	8.6%	0.7%	0.3%	0.2%	1.3%	0.1%	0.0%	0.0%	0.1%	64.0	224.1	20.8	2718.5	b
Portugal	27.0%	27.8%	27.2%	29.1%	13.2%	1.9%	0.2%	7.1%	5.6%	0.9%	0.1%	0.0%	0.1%	90.3	79.7	11.8	624.2	b
Puerto Rico	1.8%	0.6%	1.8%	1.9%	0.0%	0.0%	0.0%	0.3%	0.9%	0.6%	0.0%	0.0%	0.0%	1.2	0.0	0.0	62.3	a
Qatar	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	556.2	b
Republic of Korea	1.6%	1.3%	2.7%	2.6%	1.0%	0.5%	0.1%	0.2%	0.1%	0.3%	0.1%	0.0%	0.3%	52.7	63.8	21.0	5390.7	b
Republic of Moldova	1.1%	19.6%	25.0%	25.5%	24.9%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6	28.7	0.0	115.3	b
Réunion	37.5%	16.9%	18.2%	18.0%	9.3%	0.0%	0.4%	3.8%	0.2%	4.3%	0.0%	0.0%	0.0%	3.6	3.6	0.0	40.6	a
Romania	3.4%	24.1%	23.7%	24.4%	16.0%	1.2%	0.1%	4.8%	1.8%	0.5%	0.1%	0.0%	0.0%	63.4	145.9	12.3	907.5	b
Russian Federation	3.8%	3.3%	3.3%	3.5%	0.7%	0.0%	0.0%	2.8%	0.0%	0.0%	0.0%	0.0%	0.0%	406.5	111.3	50.7	16232.5	b
Rwanda	80.1%	90.7%	86.7%	86.0%	84.8%	0.0%	0.0%	1.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.9	68.1	0.0	80.2	a
Saint Barthélemy	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Saint Helena	11.7%	9.2%	12.6%	14.2%	4.8%	0.0%	0.0%	0.0%	7.1%	2.3%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.1	a
Saint Kitts and Nevis	40.0%	1.0%	1.6%	1.8%	0.0%	0.0%	0.0%	0.0%	1.2%	0.6%	0.0%	0.0%	0.0%	0.0	0.0	0.0	1.9	a
Saint Lucia	5.5%	2.2%	2.1%	2.1%	2.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.1	0.0	3.9	a
Saint Martin (French Part)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	

UN Country Name	Share in total final energy consumption (%)													Final consumption of renewable energy (PJ) (4)			Total final energy consumption (PJ)	
	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Wind	Solar	Geothermal	Tide	Municipal waste (renew)	Electricity consump-tion (2)	Heat raising (3)	Transport (4)		
	1990	2010	2015	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	
Saint Pierre and Miquelon	0.0%	0.8%	0.7%	0.7%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.7	a
Saint Vincent and the Grenadines	15.4%	5.5%	5.8%	6.3%	2.3%	0.0%	0.0%	4.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1	0.1	0.0	2.5	a
Samoa	45.9%	36.0%	26.9%	27.3%	23.3%	0.0%	0.0%	2.7%	0.0%	1.3%	0.0%	0.0%	0.0%	0.2	0.9	0.0	3.9	a
Sao Tome and Principe	50.9%	43.8%	40.2%	39.2%	38.3%	0.0%	0.0%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.8	0.0	2.1	a
San Marino	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Saudi Arabia	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.3	0.0	4641.4	b
Senegal	55.6%	50.3%	39.9%	37.6%	36.7%	0.0%	0.0%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%	1.3	46.1	0.0	126.2	b
Serbia	15.5%	20.6%	21.2%	20.8%	12.7%	0.0%	0.1%	8.0%	0.0%	0.0%	0.1%	0.0%	0.0%	27.3	43.8	0.4	343.7	b
Seychelles	4.3%	0.6%	0.8%	1.2%	0.6%	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0	0.0	0.0	5.1	a
Sierra Leone	91.0%	84.2%	78.1%	77.6%	77.2%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3	42.4	0.0	54.9	a
Singapore	0.2%	0.5%	0.7%	0.7%	0.2%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.4%	3.1	0.0	0.2	467.1	b
Sint Maarten (Dutch part)	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	8.2	a
Slovakia	2.2%	10.3%	13.4%	13.1%	6.2%	1.6%	0.9%	3.8%	0.0%	0.5%	0.0%	0.0%	0.1%	21.7	22.6	6.4	388.6	b
Slovenia	12.4%	19.5%	20.8%	20.8%	12.1%	0.4%	0.4%	6.4%	0.0%	0.6%	0.9%	0.0%	0.0%	14.4	26.8	1.0	203.2	b
Solomon Islands	61.0%	63.5%	63.3%	65.7%	65.6%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0	3.2	0.0	4.9	a
Somalia	87.2%	93.6%	94.4%	94.7%	94.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	105.0	0.0	110.9	a
South Africa	16.6%	14.6%	14.1%	14.4%	13.5%	0.0%	0.0%	0.1%	0.4%	0.5%	0.0%	0.0%	0.0%	21.2	377.3	0.4	2762.6	b
South Georgia and the South Sandwich Islands	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
South Sudan	..	..	26.2%	28.5%	28.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	6.5	0.0	22.9	b
Spain	10.6%	14.4%	16.3%	17.1%	5.6%	1.5%	0.2%	3.5%	4.7%	1.7%	0.0%	0.0%	0.1%	315.4	184.2	53.3	3238.2	b
Sri Lanka	78.1%	61.9%	52.9%	50.9%	47.3%	0.0%	0.0%	3.3%	0.3%	0.0%	0.0%	0.0%	0.0%	14.9	192.5	0.0	407.3	b
State of Palestine	22.1%	14.1%	10.5%	10.1%	6.0%	0.0%	0.0%	0.0%	0.0%	4.1%	0.0%	0.0%	0.0%	0.0	6.8	0.0	67.6	a
Sudan	73.3%	61.6%	64.5%	61.6%	56.7%	0.0%	0.0%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%	25.1	287.6	0.0	507.3	b

UN Country Name	Share in total final energy consumption (%)													Final consumption of renewable energy (PJ) (4)			Total final energy consumption (PJ)	
	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Wind	Solar	Geothermal	Tide	Municipal waste (renew)	Electricity consump-tion (2)	Heat raising (3)	Transport (4)		
	1990	2010	2015	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	
Suriname	..	22.4%	22.7%	21.8%	5.2%	0.0%	0.0%	16.6%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6	1.1	0.0	21.8	b
Svalbard and Jan Mayen Islands	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Sweden	34.1%	46.0%	53.1%	51.4%	27.1%	4.1%	0.5%	14.0%	3.5%	0.1%	0.0%	0.0%	2.1%	256.9	352.5	60.7	1305.0	b
Switzerland	17.1%	21.5%	25.3%	25.5%	5.2%	0.4%	0.4%	15.1%	0.1%	0.9%	2.0%	0.0%	1.5%	122.6	67.7	10.2	786.5	b
Syrian Arab Republic	2.4%	1.4%	0.5%	1.1%	0.1%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4	0.2	0.0	243.0	b
Tajikistan	29.6%	61.8%	48.1%	43.9%	0.0%	0.0%	0.0%	43.9%	0.0%	0.0%	0.0%	0.0%	0.0%	45.3	0.0	0.1	103.3	b
Thailand	33.6%	22.7%	22.6%	21.8%	17.5%	2.2%	0.9%	0.8%	0.0%	0.4%	0.0%	0.0%	0.1%	106.2	508.8	67.5	3124.2	b
The former Yugoslav Republic of Macedonia	2.4%	22.3%	24.0%	21.7%	10.7%	0.0%	0.2%	9.8%	0.6%	0.1%	0.3%	0.0%	0.0%	8.2	8.4	0.0	76.8	b
Timor-Leste	0.0%	34.7%	18.2%	19.2%	19.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.8	0.0	4.4	a
Togo	78.7%	65.8%	71.3%	71.6%	67.5%	0.0%	0.0%	4.1%	0.0%	0.0%	0.0%	0.0%	0.0%	4.0	64.4	0.0	95.5	b
Tokelau	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Tonga	1.5%	1.0%	1.9%	2.0%	0.9%	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0	0.0	0.0	1.4	a
Trinidad and Tobago	1.2%	0.3%	0.3%	0.3%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.5	0.0	168.7	b
Tunisia	14.5%	12.7%	12.6%	12.5%	11.3%	0.0%	0.0%	0.0%	0.4%	0.7%	0.0%	0.0%	0.0%	1.6	38.5	0.0	322.4	b
Turkey	24.4%	14.2%	13.3%	13.2%	2.9%	0.1%	0.2%	5.4%	1.2%	1.0%	2.5%	0.0%	0.0%	269.0	223.6	5.8	3765.5	b
Turkmenistan	0.3%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.4	0.0	751.8	b
Turks and Caicos Islands	1.8%	0.5%	0.6%	0.6%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	1.2	a
Tuvalu	0.0%	0.0%	8.2%	11.8%	0.0%	0.0%	0.0%	0.0%	0.0%	11.8%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.1	a
Uganda	96.0%	91.6%	89.1%	88.6%	87.0%	0.0%	0.0%	1.6%	0.0%	0.0%	0.0%	0.0%	0.0%	9.4	473.4	0.0	545.0	a
Ukraine	0.7%	2.9%	4.2%	5.5%	4.2%	0.1%	0.0%	1.0%	0.1%	0.1%	0.0%	0.0%	0.0%	22.6	86.2	2.9	2040.6	b
United Arab Emirates	0.0%	0.1%	0.1%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	1.1	1.9	0.0	2053.9	b
United Kingdom of Great Britain and Northern Ireland	0.7%	3.7%	8.6%	8.8%	3.6%	0.8%	0.7%	0.4%	2.4%	0.7%	0.0%	0.0%	0.2%	266.5	132.5	43.8	5046.0	b

UN Country Name	Share in total final energy consumption (%)													Final consumption of renewable energy (PJ) (4)			Total final energy consumption (PJ)	
	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Wind	Solar	Geothermal	Tide	Municipal waste (renew)	Electricity consump-tion (2)	Heat raising (3)	Transport (4)		
	1990	2010	2015	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	
United Republic of Tanzania	94.8%	90.4%	85.7%	86.1%	85.4%	0.0%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	6.9	829.1	0.0	970.6	b
United States minor outlying islands	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
United States of America	4.2%	7.4%	9.1%	9.5%	3.2%	2.9%	0.1%	1.5%	1.3%	0.4%	0.1%	0.0%	0.1%	2025.4	1852.7	1624.0	57718.7	b
United States Virgin Islands	0.0%	0.0%	3.9%	3.8%	0.0%	0.0%	0.0%	0.0%	0.0%	3.8%	0.0%	0.0%	0.0%	0.1	0.0	0.0	2.3	a
Uruguay	44.8%	52.8%	58.9%	59.7%	40.7%	1.8%	0.0%	12.3%	4.7%	0.2%	0.0%	0.0%	0.0%	38.7	73.5	3.2	193.1	b
Uzbekistan	1.3%	2.6%	3.2%	3.2%	0.0%	0.0%	0.0%	3.2%	0.0%	0.0%	0.0%	0.0%	0.0%	33.2	0.2	1.1	1076.0	b
Vanuatu	28.4%	38.4%	36.1%	33.7%	31.5%	0.3%	0.0%	0.9%	0.7%	0.3%	0.0%	0.0%	0.0%	0.1	0.8	0.0	2.6	a
Venezuela (Bolivarian Republic of)	11.7%	11.5%	12.8%	13.3%	2.3%	0.0%	0.0%	11.0%	0.0%	0.0%	0.0%	0.0%	0.0%	146.3	30.6	0.5	1338.4	b
Viet Nam	76.1%	34.8%	34.7%	32.7%	24.0%	0.0%	0.0%	8.7%	0.0%	0.0%	0.0%	0.0%	0.0%	223.1	617.2	0.0	2569.1	b
Wallis and Futuna Islands	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.2	a
Western Sahara	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Yemen	2.2%	1.0%	3.1%	4.5%	2.5%	0.0%	0.0%	0.0%	0.0%	2.1%	0.0%	0.0%	0.0%	2.1	2.5	0.0	101.6	b
Zambia	83.0%	92.4%	88.6%	88.5%	78.4%	0.0%	0.0%	10.0%	0.0%	0.0%	0.0%	0.0%	0.0%	36.8	288.0	0.1	367.3	b
Zimbabwe	64.0%	82.6%	81.8%	82.9%	79.9%	0.3%	0.0%	2.8%	0.0%	0.0%	0.0%	0.0%	0.0%	11.5	321.7	1.2	403.4	b
World	16.5%	16.6%	17.2%	17.5%	11.2%	1.0%	0.2%	3.4%	0.8%	0.6%	0.2%	0.0%	0.1%	17522.0	41792.9	3739.6	360756.1	c
Northern America (M49) and Europe (M49)	5.8%	10.0%	12.1%	12.3%	4.7%	1.8%	0.3%	3.3%	1.3%	0.5%	0.1%	0.0%	0.2%	7227.8	6312.2	2455.5	129582.8	c
Latin America and the Caribbean (MDG=M49)	32.4%	28.6%	28.2%	28.8%	15.7%	3.3%	0.0%	8.8%	0.7%	0.3%	0.1%	0.0%	0.0%	2519.0	3601.8	782.7	23941.6	c
Central Asia (M49) and Southern Asia (MDG=M49)	39.2%	30.7%	27.3%	27.1%	24.5%	0.1%	0.0%	1.9%	0.3%	0.2%	0.0%	0.0%	0.0%	987.8	9266.3	38.7	38055.8	c
Eastern Asia (M49) and South-eastern Asia (MDG=M49)	27.5%	13.8%	14.0%	14.3%	7.3%	0.3%	0.3%	4.0%	0.7%	1.3%	0.4%	0.0%	0.0%	5855.0	9365.9	433.6	109640.1	c

UN Country Name	Share in total final energy consumption (%)													Final consumption of renewable energy (PJ) (4)			Total final energy consumption (PJ)	
	Renewable energy				Solid biofuels	Liquid biofuels	Biogases	Hydro	Wind	Solar	Geothermal	Tide	Municipal waste (renew)	Electricity consump-tion (2)	Heat raising (3)	Transport (4)		
	1990	2010	2015	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	2016	
Sub-Saharan Africa (M49)	71.0%	71.6%	69.3%	69.5%	67.7%	0.0%	0.0%	1.5%	0.1%	0.1%	0.1%	0.0%	0.0%	308.1	12162.3	4.6	17959.8	c
Oceania (M49)	13.4%	12.7%	13.4%	13.8%	7.4%	0.2%	0.2%	3.3%	1.1%	0.9%	0.8%	0.0%	0.0%	224.0	309.6	12.4	3964.1	c
Western Asia (M49) and Northern Africa (M49)	9.2%	6.2%	5.6%	5.6%	2.9%	0.0%	0.0%	1.5%	0.3%	0.4%	0.5%	0.0%	0.0%	409.3	759.3	6.2	20927.4	c

Note:
a. Source: Energy Balances, UN Statistics Division (2018)
b. Source: IEA (2018), World Energy Balances
c. Sources: IEA (2018), World Energy Balances; Energy Balances, UN Statistics Division (2018)
1: To establish the total consumption of each renewable energy source, direct final consumption is summed with back-calculated electricity and commercial heat based on generation shares (GTF 2013). For instance, if final consumption is 150 TJ for biogases, 400 TJ for electricity and 100 TJ for heat; and if the share of biogases is 10 percent in electricity generation and 5 percent in heat generation, the total biogases consumption will be 195 TJ , derived as 150 TJ+400TJ*10%+100TJ*5%.
2: Covers final consumption of renewable electricity in all sectors excluding transport.
3: Covers final consumption of renewable energy for heat raising purposes (excluding electricity) in all sectors excluding transport: manufacturing industries, construction and non fuel mining industries, residential, commercial and public services, agriculture, forestry, fishing and not elsewhere specified.
4: Covers final consumption of renewable energy (including electricity) in the transport sector.

ENERGY EFFICIENCY

UN country name	Energy intensity (MJ/USD 2011 PPP) (1)					Compound annual growth rate of Energy intensity (%)				
	1990	2000	2010	2015	2016	1990-2000	2000-2010	2010-2015	2015-2016	
	Energy intensity (MJ/USD 2011 PPP) (1)					Compound annual growth rate of Energy intensity (%)				
UN country name	1990	2000	2010	2015	2016	1990-2000	2000-2010	2010-2015	2015-2016	
Afghanistan	1.9	1.7	2.9	2.4	2.3	-1.1%	5.7%	-4.1%	-4.5%	*a*
Åland Islands	..	..	..	..	..					
Albania	7.2	4.3	3.1	2.9	2.9	-5.1%	-3.3%	-1.2%	-0.4%	*b*
Algeria	3.5	3.6	3.6	4.2	4.0	0.1%	0.2%	2.8%	-4.2%	*b*
American Samoa	..	..	..	..	..					
Andorra	..	..	..	..	..					
Angola	5.9	6.4	3.9	4.1	4.0	0.8%	-4.8%	1.1%	-3.7%	*b*
Anguilla	..	..	..	..	..					
Antigua and Barbuda	3.8	3.2	4.1	3.9	3.8	-1.8%	2.6%	-1.2%	-3.4%	*a*
Argentina	5.4	4.7	4.3	4.3	4.4	-1.5%	-0.9%	0.2%	2.7%	*b*
Armenia	24.4	9.4	5.4	5.4	5.3	-9.1%	-5.4%	-0.1%	-1.6%	*b*
Aruba	2.9	6.7	7.8	3.4	3.3	8.6%	1.6%	-15.5%	-1.4%	*a*
Australia	7.4	6.7	5.8	5.0	5.0	-1.0%	-1.3%	-3.0%	0.8%	*b*
Austria	4.3	3.8	3.9	3.6	3.6	-1.2%	0.1%	-1.5%	-0.3%	*b*
Azerbaijan	15.6	13.2	3.4	3.7	3.8	-1.7%	-12.8%	2.1%	2.2%	*b*
Bahamas	3.2	2.8	3.3	2.6	2.4	-1.5%	1.8%	-4.2%	-9.9%	*a*
Bahrain	12.6	11.2	10.6	9.9	9.6	-1.2%	-0.6%	-1.2%	-3.6%	*b*
Bangladesh	3.9	3.6	3.4	3.1	3.1	-0.8%	-0.6%	-1.5%	-2.3%	*b*
Barbados	4.3	3.8	4.4	3.5	3.5	-1.2%	1.5%	-4.2%	-0.4%	*a*
Belarus	22.4	13.7	7.5	6.5	6.6	-4.8%	-5.9%	-2.9%	1.8%	*b*
Belgium	6.6	6.4	5.6	4.7	5.0	-0.3%	-1.3%	-3.3%	4.5%	*b*
Belize	8.5	6.4	5.1	4.7	4.7	-2.9%	-2.3%	-1.3%	-0.2%	*a*
Benin	9.6	7.3	9.3	8.5	8.5	-2.7%	2.5%	-1.7%	0.4%	*b*

UN country name	Energy intensity (MJ/USD 2011 PPP) (1)					Compound annual growth rate of Energy intensity (%)				
	1990	2000	2010	2015	2016	1990-2000	2000-2010	2010-2015	2015-2016	
Bermuda	2.9	2.3	2.4	2.5	2.7	-2.5%	0.5%	0.7%	9.7%	*a*
Bhutan	30.0	21.8	12.2	10.5	10.0	-3.2%	-5.7%	-2.9%	-4.7%	*a*
Bolivia (Plurinational State of)	4.3	5.6	4.9	5.0	5.1	2.7%	-1.3%	0.2%	1.7%	*b*
Bonaire, Sint Eustatius and Saba	..	..	..	..	..					
Bosnia and Herzegovina	46.6	7.6	7.5	6.7	7.1	-16.5%	-0.2%	-2.3%	6.0%	*b*
Botswana	4.6	4.2	3.3	3.3	3.1	-0.9%	-2.2%	0.0%	-7.7%	*b*
Brazil	3.8	3.9	3.9	4.1	4.1	0.4%	-0.1%	1.0%	-0.2%	*b*
British Indian Ocean Territory	..	..	..	..	..					
British Virgin Islands	..	..	..	..	..					
Brunei Darussalam	3.3	3.7	4.3	3.7	4.1	1.0%	1.7%	-3.4%	11.6%	*b*
Bulgaria	14.6	10.8	6.6	6.4	6.0	-3.0%	-4.8%	-0.7%	-6.0%	*b*
Burkina Faso	12.6	6.6	6.5	6.0	5.7	-6.2%	-0.1%	-1.8%	-3.7%	*a*
Burundi	9.8	11.3	13.5	8.1	8.3	1.5%	1.8%	-9.8%	2.7%	*a*
Cabo Verde	4.0	2.7	3.2	2.8	2.8	-4.0%	1.7%	-2.6%	2.8%	*a*
Cambodia	..	8.5	6.2	5.8	5.8		-3.1%	-1.4%	0.7%	*b*
Cameroon	5.9	6.6	5.0	5.1	4.9	1.2%	-2.8%	0.4%	-2.7%	*b*
Canada	10.2	9.2	8.0	7.6	7.5	-1.0%	-1.5%	-0.9%	-1.6%	*b*
Cayman Islands	2.6	2.6	2.9	2.6	2.5	0.1%	1.0%	-1.9%	-3.3%	*a*
Central African Republic	11.4	7.3	5.8	8.2	7.8	-4.3%	-2.4%	7.3%	-4.1%	*a*
Chad	7.3	7.4	3.5	2.9	3.1	0.2%	-7.3%	-3.7%	8.2%	*a*
Channel Islands	..	..	..	..	..					
Chile	4.9	4.8	3.9	3.7	3.9	-0.2%	-2.1%	-1.0%	5.1%	*b*
China	21.1	10.1	8.3	6.7	6.2	-7.1%	-1.9%	-4.2%	-7.3%	*b*
China, Hong Kong Special Administrative Region	2.3	2.5	1.7	1.5	1.5	0.7%	-3.9%	-2.6%	2.3%	*b*
China, Macao Special Administrative Region	1.0	1.3	0.6	0.7	0.7	2.2%	-7.7%	3.1%	2.4%	*a*
Christmas Island	..	..	..	..	..					

UN country name	Energy intensity (MJ/USD 2011 PPP) (1)					Compound annual growth rate of Energy intensity (%)				
	1990	2000	2010	2015	2016	1990-2000	2000-2010	2010-2015	2015-2016	
Cocos (Keeling) Islands	..	..	..	..	..					
Colombia	3.9	3.2	2.6	2.6	2.6	-2.0%	-2.1%	-0.3%	2.2%	*b*
Comoros	3.2	4.0	4.8	4.7	5.0	2.3%	1.7%	-0.3%	7.1%	*a*
Congo	2.6	2.1	3.1	4.1	4.2	-2.4%	4.1%	5.6%	3.4%	*b*
Cook Islands	..	..	..	..	..					
Costa Rica	2.9	3.1	3.3	2.9	2.9	0.6%	0.6%	-2.4%	-0.8%	*b*
Côte d'Ivoire	4.6	5.8	7.8	7.3	6.5	2.2%	3.0%	-1.3%	-11.1%	*b*
Croatia	4.9	5.0	4.4	4.0	3.9	0.3%	-1.3%	-2.0%	-2.2%	*b*
Cuba	5.0	4.2	2.3	1.9	1.6	-1.7%	-6.1%	-3.2%	-16.4%	*b*
Curaçao	..	..	..	..	..					
Cyprus	4.2	4.3	3.6	3.3	3.4	0.1%	-1.6%	-2.2%	3.3%	*b*
Czechia	10.1	7.9	6.4	5.5	5.3	-2.4%	-2.2%	-3.0%	-3.7%	*b*
Democratic People's Republic of Korea	8.1	6.9	5.7	3.0	3.4	-1.6%	-1.8%	-12.0%	11.4%	*b*
Democratic Republic of the Congo	10.3	21.6	19.5	19.5	19.6	7.7%	-1.0%	0.0%	0.1%	*b*
Denmark	4.2	3.5	3.3	2.6	2.6	-1.9%	-0.3%	-4.7%	0.3%	*b*
Djibouti	5.2	5.4	4.7	2.3	2.6	0.3%	-1.3%	-13.5%	11.3%	*a*
Dominica	2.0	2.9	3.5	3.6	3.6	3.6%	1.9%	0.8%	-0.1%	*a*
Dominican Republic	4.3	4.4	2.9	2.5	2.4	0.3%	-4.1%	-3.0%	-1.6%	*b*
Ecuador	3.5	4.0	3.5	3.6	3.5	1.3%	-1.1%	0.6%	-3.6%	*b*
Egypt	4.0	3.3	3.7	3.5	3.7	-2.0%	1.3%	-1.0%	4.1%	*b*
El Salvador	4.3	5.0	4.7	4.1	4.0	1.5%	-0.6%	-2.9%	-0.5%	*b*
Equatorial Guinea	11.7	1.4	2.5	1.7	1.5	-19.0%	5.8%	-7.0%	-15.2%	*a*
Eritrea	..	5.2	5.0	4.5	4.4		-0.4%	-2.1%	-1.5%	*b*
Estonia	17.2	9.0	7.8	6.3	6.2	-6.3%	-1.4%	-4.1%	-1.1%	*b*
Eswatini	..	..	..	..	..	-0.5%	-2.6%	-1.1%	-14.4%	*a*
Ethiopia	30.6	32.3	19.0	13.7	13.1	0.5%	-5.2%	-6.3%	-4.3%	*b*
Falkland Islands (Malvinas)	..	..	..	..	..					

UN country name	Energy intensity (MJ/USD 2011 PPP) (1)					Compound annual growth rate of Energy intensity (%)				
	1990	2000	2010	2015	2016	1990-2000	2000-2010	2010-2015	2015-2016	
Faroe Islands	..	..	..	..	..					
Fiji	5.3	4.0	3.4	4.8	4.4	-2.9%	-1.6%	7.3%	-9.7%	*a*
Finland	8.2	7.5	7.2	6.4	6.5	-0.9%	-0.5%	-2.2%	2.1%	*b*
France	5.4	5.0	4.6	4.1	4.0	-0.9%	-0.8%	-2.1%	-2.9%	*b*
French Guiana	..	..	..	..	..					
French Polynesia	..	..	..	..	..					
French Southern and Antarctic Territories	..	..	..	..	..					
Gabon	2.7	2.8	8.4	6.7	6.7	0.5%	11.6%	-4.5%	0.0%	*b*
Gambia	5.0	4.9	4.4	4.6	4.5	-0.2%	-1.0%	0.5%	-1.4%	*a*
Georgia	13.5	8.3	4.9	5.8	5.8	-4.7%	-5.1%	3.2%	0.6%	*b*
Germany	5.9	4.7	4.1	3.6	3.5	-2.4%	-1.2%	-2.8%	-1.3%	*b*
Ghana	7.9	6.2	4.2	3.6	3.5	-2.4%	-3.7%	-3.0%	-4.1%	*b*
Gibraltar	..	..	..	..	..					
Greece	4.3	4.2	3.6	3.7	3.6	-0.1%	-1.5%	0.5%	-2.0%	*b*
Greenland	..	..	..	..	..					
Grenada	2.3	3.0	3.4	3.0	2.9	2.5%	1.4%	-2.9%	-1.9%	*a*
Guadeloupe	..	..	..	..	..					
Guam	..	..	..	..	..					
Guatemala	3.9	4.2	4.7	4.5	4.8	0.6%	1.2%	-1.0%	8.3%	*b*
Guernsey	..	..	..	..	..					
Guinea	12.3	10.2	8.7	7.1	6.7	-1.9%	-1.6%	-3.8%	-6.8%	*a*
Guinea-Bissau	12.6	13.7	12.8	11.8	11.3	0.8%	-0.6%	-1.6%	-4.2%	*a*
Guyana	11.6	9.3	7.3	6.4	6.6	-2.2%	-2.3%	-2.8%	4.0%	*a*
Haiti	4.4	5.7	10.6	10.1	10.1	2.6%	6.5%	-0.9%	0.0%	*b*
Heard Island and McDonald Islands	..	..	..	..	..					
Holy See	..	..	..	..	..					

UN country name	Energy intensity (MJ/USD 2011 PPP) (1)					Compound annual growth rate of Energy intensity (%)				
	1990	2000	2010	2015	2016	1990-2000	2000-2010	2010-2015	2015-2016	
Honduras	6.3	5.8	5.9	6.3	6.1	-0.9%	0.2%	1.3%	-3.5%	*b*
Hungary	6.8	5.7	5.0	4.3	4.3	-1.7%	-1.4%	-2.9%	-0.5%	*b*
Iceland	12.9	13.6	18.3	16.4	14.5	0.6%	3.0%	-2.1%	-11.9%	*b*
India	8.4	7.0	5.4	4.6	4.5	-1.8%	-2.6%	-3.0%	-3.8%	*b*
Indonesia	4.9	5.3	4.2	3.5	3.4	0.8%	-2.2%	-3.6%	-2.7%	*b*
Iran (Islamic Republic of)	4.5	5.9	6.4	7.5	7.0	2.7%	0.8%	3.3%	-7.1%	*b*
Iraq	4.2	3.8	4.0	3.7	3.9	-1.0%	0.6%	-1.7%	4.7%	*b*
Ireland	5.5	3.9	3.0	1.9	1.9	-3.4%	-2.6%	-8.3%	-0.3%	*b*
Isle of Man	..	..	..	..	..					
Israel	5.0	4.5	4.3	3.5	3.4	-1.0%	-0.5%	-3.7%	-2.9%	*b*
Italy	3.5	3.5	3.4	3.1	3.0	-0.1%	-0.2%	-2.0%	-1.9%	*b*
Jamaica	6.2	6.9	4.6	4.9	5.2	1.1%	-4.0%	1.1%	6.1%	*b*
Japan	4.9	5.0	4.6	3.7	3.7	0.4%	-1.0%	-3.9%	-2.1%	*b*
Jersey	..	..	..	..	..					
Jordan	6.1	5.5	4.4	4.6	4.7	-1.0%	-2.3%	1.2%	2.0%	*b*
Kazakhstan	14.4	10.1	8.8	7.9	8.2	-3.5%	-1.3%	-2.1%	3.4%	*b*
Kenya	8.0	8.7	8.1	7.9	7.7	0.9%	-0.8%	-0.4%	-3.0%	*b*
Kiribati	5.4	5.5	7.5	6.2	6.5	0.1%	3.3%	-3.8%	4.2%	*a*
Kuwait	1.9	5.5	6.0	5.2	5.4	10.9%	0.9%	-2.6%	2.8%	*b*
Kyrgyzstan	20.5	9.6	7.6	8.6	8.0	-7.4%	-2.3%	2.6%	-7.1%	*b*
Lao People's Democratic Republic	8.2	4.4	3.8	4.4	5.9	-6.1%	-1.3%	2.9%	35.0%	*a*
Latvia	8.0	6.1	4.9	3.9	3.8	-2.7%	-2.1%	-4.5%	-2.5%	*b*
Lebanon	3.9	5.1	3.7	4.1	4.1	2.8%	-3.0%	1.9%	-0.4%	*b*
Lesotho	16.4	14.4	10.9	9.8	10.1	-1.3%	-2.8%	-2.0%	2.4%	*a*
Liberia	20.7	20.2	27.1	26.0	27.9	-0.2%	3.0%	-0.8%	7.0%	*a*
Libya	4.7	5.6	4.7	6.6	7.0	1.9%	-1.8%	7.0%	6.5%	*b*
Liechtenstein	..	..	..	..	..					

UN country name	Energy intensity (MJ/USD 2011 PPP) (1)					Compound annual growth rate of Energy intensity (%)				
	1990	2000	2010	2015	2016	1990-2000	2000-2010	2010-2015	2015-2016	
Lithuania	11.5	7.0	4.5	3.8	3.8	-4.8%	-4.3%	-3.6%	0.3%	*b*
Luxembourg	6.4	3.9	3.8	2.9	2.8	-4.8%	-0.3%	-5.2%	-4.0%	*b*
Madagascar	4.4	5.2	5.1	5.4	5.3	1.6%	-0.1%	0.9%	-0.9%	*a*
Malawi	9.1	6.6	4.8	4.2	4.2	-3.2%	-3.1%	-2.8%	0.0%	*a*
Malaysia	4.8	5.4	5.2	4.7	4.7	1.2%	-0.4%	-2.0%	-0.6%	*b*
Maldives	1.7	2.4	3.1	3.3	3.4	3.1%	2.6%	1.3%	4.4%	*a*
Mali	4.0	3.5	2.8	2.8	2.7	-1.3%	-2.4%	0.3%	-4.9%	*a*
Malta	5.1	2.9	3.0	1.8	1.6	-5.3%	0.1%	-9.9%	-11.0%	*b*
Marshall Islands	..	10.5	11.7	11.4	11.2		1.1%	-0.5%	-1.5%	*a*
Martinique	..	..	..	..	..					
Mauritania	4.0	3.9	3.7	3.6	3.4	-0.4%	-0.3%	-0.6%	-5.6%	*a*
Mauritius	3.6	3.2	2.8	2.6	2.6	-1.2%	-1.3%	-1.1%	-0.1%	*b*
Mayotte	..	..	..	..	..					
Mexico	4.6	4.0	4.1	3.6	3.5	-1.6%	0.2%	-2.2%	-2.7%	*b*
Micronesia (Federated States of)	..	5.6	4.5	6.2	6.3		-2.1%	6.6%	1.7%	*a*
Monaco	..	..	..	..	..					
Mongolia	12.8	9.0	7.9	5.7	6.0	-3.4%	-1.3%	-6.2%	5.5%	*b*
Montenegro	..	..	5.4	4.4	4.1			-3.9%	-6.8%	*b*
Montserrat	..	..	..	..	..					
Morocco	3.2	3.5	3.4	3.2	3.1	0.8%	-0.4%	-1.2%	-1.4%	*b*
Mozambique	49.5	29.6	18.8	17.4	17.0	-5.0%	-4.4%	-1.5%	-2.6%	*b*
Myanmar	14.8	8.9	3.0	2.8	2.9	-4.9%	-10.2%	-1.5%	2.6%	*b*
Namibia	..	3.8	3.6	3.3	3.5		-0.6%	-1.6%	4.4%	*b*
Nauru	7.6	17.1	8.8	4.4	4.1	8.4%	-6.4%	-13.2%	-5.6%	*a*
Nepal	10.8	9.3	8.0	7.4	8.1	-1.5%	-1.5%	-1.5%	9.0%	*b*
Netherlands	5.9	4.8	4.7	3.9	3.9	-2.1%	-0.2%	-3.5%	-0.9%	*b*
New Caledonia	..	..	..	..	..					

UN country name	Energy intensity (MJ/USD 2011 PPP) (1)					Compound annual growth rate of Energy intensity (%)				
	1990	2000	2010	2015	2016	1990-2000	2000-2010	2010-2015	2015-2016	
New Zealand	6.8	6.7	5.5	5.3	5.2	-0.1%	-2.0%	-0.7%	-1.5%	*b*
Nicaragua	6.8	6.1	5.4	5.4	5.2	-1.1%	-1.2%	0.0%	-3.0%	*b*
Niger	..	7.2	7.0	6.9	6.4		-0.3%	-0.3%	-6.2%	*b*
Nigeria	9.6	10.5	6.5	5.9	6.2	0.9%	-4.6%	-2.0%	5.1%	*b*
Niue	..	..	..	..	..					
Norfolk Island	..	..	..	..	..					
Northern Mariana Islands	..	..	..	..	..					
Norway	4.9	4.2	4.0	3.6	3.4	-1.4%	-0.4%	-2.4%	-5.2%	*b*
Oman	2.8	3.2	5.7	6.3	5.7	1.3%	6.0%	2.0%	-9.0%	*b*
Pakistan	5.5	5.5	4.8	4.4	4.3	0.1%	-1.3%	-1.9%	-3.1%	*b*
Palau	..	12.2	11.9	10.3	10.4		-0.3%	-2.9%	1.0%	*a*
Panama	3.2	3.3	2.7	2.2	2.2	0.4%	-2.3%	-4.0%	0.1%	*b*
Papua New Guinea	8.6	6.5	6.2	6.1	6.0	-2.9%	-0.4%	-0.3%	-2.5%	*a*
Paraguay	5.1	5.0	4.4	4.0	4.1	-0.1%	-1.2%	-2.3%	4.9%	*b*
Peru	3.5	3.0	2.8	2.7	2.6	-1.5%	-0.8%	-0.8%	-1.3%	*b*
Philippines	4.8	5.1	3.2	3.1	3.1	0.5%	-4.4%	-0.9%	-0.5%	*b*
Pitcairn	..	..	..	..	..					
Poland	11.0	6.6	5.1	4.1	4.2	-5.0%	-2.6%	-4.0%	1.7%	*b*
Portugal	3.5	3.8	3.4	3.3	3.3	1.0%	-1.2%	-0.4%	-1.0%	*b*
Puerto Rico	0.0	0.1	0.2	0.4	0.5	23.5%	7.5%	14.9%	16.7%	*a*
Qatar	8.1	7.1	5.2	6.2	5.8	-1.3%	-3.1%	3.5%	-5.7%	*b*
Republic of Korea	7.8	8.1	7.0	6.5	6.6	0.3%	-1.5%	-1.2%	0.6%	*b*
Republic of Moldova	17.1	14.3	11.5	9.2	9.0	-1.8%	-2.1%	-4.4%	-2.0%	*b*
Réunion	..	..	..	..	..					
Romania	9.8	6.5	4.1	3.3	3.1	-4.1%	-4.4%	-4.5%	-4.9%	*b*
Russian Federation	12.0	12.6	8.7	8.3	8.6	0.5%	-3.6%	-1.1%	3.4%	*b*
Rwanda	5.6	8.4	6.0	4.8	4.6	4.2%	-3.3%	-4.2%	-4.8%	*a*

UN country name	Energy intensity (MJ/USD 2011 PPP) (1)					Compound annual growth rate of Energy intensity (%)				
	1990	2000	2010	2015	2016	1990-2000	2000-2010	2010-2015	2015-2016	
Saint Barthélemy	..	..	..	..	..					
Saint Helena	..	..	..	..	..					
Saint Kitts and Nevis	3.7	3.2	2.9	2.6	2.6	-1.4%	-1.0%	-2.4%	0.8%	*a*
Saint Lucia	1.8	3.0	2.8	2.7	2.7	5.1%	-0.7%	-0.7%	-0.6%	*a*
Saint Martin (French Part)	..	..	..	..	..					
Saint Pierre and Miquelon	..	..	..	..	..					
Saint Vincent and the Grenadines	2.2	2.8	3.1	2.9	2.9	2.4%	1.1%	-1.1%	-1.8%	*a*
Samoa	4.3	4.2	3.9	4.2	4.1	-0.2%	-0.9%	1.9%	-3.2%	*a*
Sao Tome and Principe	6.1	5.9	5.2	4.7	4.6	-0.2%	-1.3%	-2.2%	-1.5%	*a*
San Marino	..	..	..	..	..					
Saudi Arabia	3.5	4.6	6.2	5.8	5.4	2.7%	3.1%	-1.4%	-6.7%	*b*
Senegal	5.1	5.3	5.9	5.3	4.9	0.5%	1.0%	-2.1%	-6.7%	*b*
Serbia	7.0	9.6	7.1	6.6	6.6	3.2%	-3.0%	-1.5%	0.7%	*b*
Seychelles	2.2	5.4	3.3	2.9	3.5	9.2%	-4.6%	-2.6%	18.7%	*a*
Sierra Leone	9.3	13.1	7.7	7.0	6.7	3.5%	-5.2%	-2.0%	-4.7%	*a*
Singapore	4.6	3.8	2.9	2.5	2.5	-2.0%	-2.5%	-3.2%	-0.1%	*b*
Sint Maarten (Dutch part)	..	..	..	9.3	9.3				0.8%	*a*
Slovakia	11.6	8.8	5.5	4.5	4.4	-2.6%	-4.6%	-4.1%	-2.6%	*b*
Slovenia	6.3	5.9	5.2	4.6	4.6	-0.6%	-1.3%	-2.6%	0.4%	*b*
Solomon Islands	9.0	7.3	6.0	4.8	4.4	-2.0%	-2.0%	-4.3%	-9.2%	*a*
Somalia	..	..	..	..	..					
South Africa	10.3	10.6	9.4	8.3	8.5	0.3%	-1.2%	-2.4%	2.7%	*b*
South Georgia and the South Sandwich Islands	..	..	..	..	..					
South Sudan	..	..	..	1.6	1.7				6.2%	*b*
Spain	4.1	4.2	3.5	3.3	3.2	0.3%	-1.7%	-1.2%	-2.4%	*b*
Sri Lanka	3.7	3.3	2.4	2.1	2.0	-1.0%	-3.4%	-2.7%	-2.0%	*b*

UN country name	Energy intensity (MJ/USD 2011 PPP) (1)					Compound annual growth rate of Energy intensity (%)				
	1990	2000	2010	2015	2016	1990-2000	2000-2010	2010-2015	2015-2016	
State of Palestine	4.7	3.1	3.4	3.5	3.6	-4.2%	1.0%	0.6%	2.5%	*a*
Sudan	9.9	7.2	4.7	4.6	4.5	-3.1%	-4.2%	-0.2%	-4.1%	*b*
Suriname	..	5.6	3.9	3.3	3.2		-3.4%	-3.4%	-3.9%	*b*
Svalbard and Jan Mayen Islands	..	..	..	..	..					
Sweden	7.5	6.1	5.3	4.3	4.5	-2.0%	-1.4%	-4.3%	4.9%	*b*
Switzerland	3.2	2.9	2.5	2.2	2.1	-0.9%	-1.3%	-2.9%	-3.9%	*b*
Syrian Arab Republic	7.9	7.3	6.6	11.3	11.8	-0.8%	-1.0%	11.4%	4.6%	*b*
Tajikistan	11.5	12.3	5.7	5.1	5.0	0.6%	-7.4%	-2.0%	-2.1%	*b*
Thailand	4.7	5.2	5.4	5.4	5.4	1.1%	0.4%	-0.2%	-0.5%	*b*
The former Yugoslav Republic of Macedonia	5.4	6.4	5.1	4.2	4.1	1.7%	-2.2%	-4.0%	-2.2%	*b*
Timor-Leste	..	..	0.5	0.9	0.8			14.0%	-3.0%	*a*
Togo	10.3	13.9	16.6	14.2	13.9	3.0%	1.8%	-3.0%	-2.3%	*b*
Tokelau	..	..	..	..	..					
Tonga	3.3	3.2	3.2	3.0	3.2	-0.1%	-0.1%	-1.2%	4.9%	*a*
Trinidad and Tobago	16.7	17.7	20.2	18.5	19.0	0.6%	1.3%	-1.8%	2.6%	*b*
Tunisia	4.5	4.2	3.9	3.7	3.8	-0.7%	-0.7%	-0.7%	0.1%	*b*
Turkey	3.5	3.6	3.4	2.9	3.0	0.4%	-0.7%	-2.9%	2.9%	*b*
Turkmenistan	23.9	25.9	18.8	13.9	13.0	0.8%	-3.2%	-5.9%	-6.0%	*b*
Turks and Caicos Islands	..	..	..	..	..					
Tuvalu	3.5	3.4	3.9	3.8	3.8	-0.3%	1.5%	-0.5%	-0.7%	*a*
Uganda	20.9	12.6	10.2	9.8	9.7	-4.9%	-2.1%	-0.8%	-0.7%	*a*
Ukraine	19.4	23.7	15.4	12.2	12.1	2.0%	-4.2%	-4.7%	-0.7%	*b*
United Arab Emirates	4.2	4.1	5.4	5.3	5.0	-0.2%	2.8%	-0.4%	-6.3%	*b*
United Kingdom of Great Britain and Northern Ireland	5.6	4.8	3.7	3.0	2.9	-1.6%	-2.4%	-4.3%	-3.4%	*b*
United Republic of Tanzania	11.2	11.5	9.3	8.4	8.0	0.2%	-2.1%	-2.1%	-4.7%	*b*
United States minor outlying islands	..	..	..	..	..					

UN country name	Energy intensity (MJ/USD 2011 PPP) (1)					Compound annual growth rate of Energy intensity (%)				
	1990	2000	2010	2015	2016	1990-2000	2000-2010	2010-2015	2015-2016	
United States of America	8.7	7.3	6.1	5.4	5.3	-1.7%	-1.9%	-2.4%	-2.4%	*b*
United States Virgin Islands	..	..	..	..	..					
Uruguay	3.1	3.0	3.0	3.1	3.2	-0.2%	-0.2%	0.8%	2.4%	*b*
Uzbekistan	30.8	34.5	14.9	9.1	8.2	1.1%	-8.0%	-9.4%	-10.5%	*b*
Vanuatu	3.3	4.0	3.9	3.9	4.0	2.0%	-0.3%	0.0%	3.3%	*a*
Venezuela (Bolivarian Republic of)	5.8	6.1	6.3	5.2	5.8	0.5%	0.4%	-3.8%	12.1%	*b*
Viet Nam	7.5	5.8	6.3	6.1	6.1	-2.5%	0.8%	-0.6%	0.1%	*b*
Wallis and Futuna Islands	..	..	..	..	..					
Western Sahara	..	..	..	..	..					
Yemen	2.6	2.9	3.1	2.5	3.0	0.9%	0.8%	-4.3%	22.0%	*b*
Zambia	12.1	11.9	8.0	7.8	7.7	-0.2%	-3.8%	-0.7%	-0.8%	*b*
Zimbabwe	14.7	13.3	19.4	15.7	15.4	-1.0%	3.9%	-4.2%	-1.9%	*b*
World	7.7	6.6	5.9	5.3	5.1	-1.5%	-1.2%	-2.2%	-2.5%	*c*
Northern America (M49) and Europe (M49)	8.0	6.6	5.6	5.0	4.9	-1.8%	-1.7%	-2.3%	-1.3%	*c*
Latin America and the Caribbean (MDG=M49)	4.3	4.1	4.0	3.8	3.8	-0.5%	-0.4%	-0.9%	-0.2%	*c*
Central Asia (M49) and Southern Asia (MDG=M49)	8.1	7.0	5.7	5.1	4.9	-1.4%	-2.0%	-2.2%	-3.8%	*c*
Eastern Asia (M49) and South-eastern Asia (MDG=M49)	8.5	7.1	6.6	5.6	5.4	-1.9%	-0.7%	-3.1%	-4.9%	*c*
Sub-Saharan Africa (M49)	9.9	10.3	8.0	7.2	7.3	0.4%	-2.5%	-2.0%	0.9%	*c*
Oceania (M49)	7.3	6.7	5.8	5.1	5.1	-0.9%	-1.4%	-2.6%	0.4%	*c*
Western Asia (M49) and Northern Africa (M49)	4.3	4.3	4.6	4.4	4.3	0.0%	0.6%	-0.8%	-2.0%	*c*

Note:
a. Source: Energy Balances, UN Statistics Division (2018); World Bank, World Development Indicators
b. Source: IEA (2018), World Energy Balances; World Bank, World Development Indicators
c. Sources: IEA (2018), World Energy Balances; Energy Balances, UN Statistics Division (2018); World Bank, World Development Indicators
1: Energy intensity is defined as the energy supplied to the economy per unit value of economic output.

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PARTNERSHIP

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- International Energy Agency (IEA) (2019 chair)
- International Renewable Energy Agency (IRENA)
- United Nations Statistics Division (UNSD)
- World Bank (WB)
- World Health Organization (WHO)

Technical Advisory Group chaired by United Nations Department of Economics and Social Affairs (UN DESA), and composed as follows:

- African Development Bank (AfDB)
- Clean Cooking Alliance
- Denmark (Ministry of Foreign Affairs)
- European Commission
- FIA Foundation
- Food and Agricultural Organization (FAO)
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- International Network on Gender and Sustainable Energy
- Islamic Development Bank
- Kenya (Ministry of Energy)
- Latin American Energy Organization (OLADE)
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ABBREVIATIONS AND ACRONYMS

CAGR	Compound annual growth rate
COP21	2015 United Nations Climate Change Conference (Paris Agreement)
DHS	Demographic and Health Survey
ECAPOV	Europe and Central Asia Poverty Database
EJ	Exajoules
ESMAP	Energy Sector Management Assistance Program
EU	European Union
EVs	Electric Vehicles
FiT	Feed-in tariff
HEART	Household energy assessment rapid tool
HIC	High income country
HIES	Household Income Expenditure Survey
GDP	Gross domestic product
GED	Global Electrification Database
GHACCO	Ghana Alliance for Clean Cookstoves and Fuels
GHG	Greenhouse gas
GNI	Gross national income
GOGLA	Global Off-Grid Lighting Association
GPWG-DB	Global Poverty Working Group Database
GW	Gigawatt
ICT	Information and communications technology
IEA	International Energy Agency
IFC	International Finance Corporation
IRENA	International Renewable Energy Agency
IRES	International Recommendations for Energy Statistics
LDC	Least developed country
LMIC	Low-middle income country
LSMS	Living Standards Measurement Survey
LPG	Liquified petroleum gas
Mb/d	Million barrels per day
MEPS	Minimum Energy Performance Standards
MICS	Multi-Indicator Cluster Survey
MIS	Malaria Indicator Survey
MJ	Megajoules
MNAPOV	Middle East and North Africa Poverty Database
MTF	Multi-Tier Framework
Mtoe	Million tonnes of oil equivalent
MW	Megawatt
NOAA	The National Oceanic and Atmospheric Administration
NSS	National Sample Survey
OECD	Organisation of Economic Co-operation and Development
PAYGO	Pay-as-you-go
PPA	Power purchase agreement
PPP	Purchasing power parity
PV	Photovoltaic
RE	Renewable energy
REN21	Renewable Energy Policy Network for the 21st Century
RISE	Regulatory Indicators for Sustainable Energy
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index

SDG	Sustainable Development Goal
SEDLAC	Socio-Economic Database for Latin America and the Caribbean
T&D	Transmission and distribution
TFEC	Total final energy consumption
TPES	Total primary energy supply
TJ	Terajoules
TWh	Terawatt-hours
UN	United Nations
UNSD	United Nations Statistics Division
USAID	United States Agency for International Development
VAT	Value added tax
WB	World Bank
WDI	World Development Indicators
WEO	World Energy Outlook
WHO	World Health Organization

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