TRACKING SDG7:
THE ENERGY PROGRESS REPORT
2018

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 development of the *Energy Progress Report* was made possible by the by exceptional collaboration between the five SDG7 custodian agencies, specially constituted in a Steering Group:

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

The Steering Group was supported by an Advisory Group composed as follows.

- Food and Agricultural Organization (FAO)
- Global Alliance for Clean Cookstoves ("the Alliance")
- Global Water Partnership (GWP)
- International Institute for Applied Systems Analysis (IIASA)
- International Network on Gender and Sustainable Energy (ENERGIA)
- International Partnership for Energy Efficiency Cooperation (IPEEC)
- Practical Action
- Renewable Energy Policy Network for the 21st Century (REN21)
- Stockholm International Water Institute (SIWI)
- Sustainable Energy for All (SEforALL)
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- United Nations Development Programme (UNDP)
- United Nations Economic Commission for Africa (UNECA)
- United Nations Economic Commission for Europe (UNECE)
- United Nations Economic Commission for Latin America and the Caribbean (ECLAC)
- United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)
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EXECUTIVE SUMMARY

Photo: SuvraKanti Das/IRENA

OVERALL MESSAGES

The world is not currently on track to meet Sustainable Development Goal 7 (SDG7), which calls for ensuring "access to affordable, reliable, sustainable and modern energy for all" by 2030. Current progress falls short on all four of the SDG7 targets, which encompass universal access to electricity as well as clean fuels and technologies for cooking, and call for a doubling of the rate of improvement of energy efficiency, plus a substantial increase in the share of renewables in the global energy mix.

While overall progress falls short on meeting all targets, real gains are being made in certain areas. Expansion of access to electricity in poorer countries has recently begun to accelerate, with progress overtaking population growth for the first time in sub-Saharan Africa. Energy efficiency continues to improve, driven by advances in the industrial sector. Renewable energy is making impressive gains in the electricity sector, although these are not being matched in transportation and heating – which together account for 80 percent of global energy consumption. Lagging furthest behind is access to clean cooking fuels and technologies – an area that has been typically overlooked by policymakers. Use of traditional cooking fuels and technologies among a large proportion of the world's population has serious and widespread negative health, environmental, climate and social impacts.

More encouraging than global trends, however, are the strong performances evident within specific countries, across both the developed and developing worlds. These national experiences provide valuable lessons for other countries, and evidence is mounting that with holistic approaches, targeted policies and international support, substantial gains can be made in clean energy and energy access that will improve the lives of millions of people.

BOX E1 • WHAT IS *THE ENERGY PROGRESS REPORT?*

The Energy Progress Report provides a global dashboard on progress towards Sustainable Development Goal 7 (SDG7). The report is a joint effort of the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), United Nations Statistics Division (UNSD), the World Bank, and the World Health Organization (WHO), which the United Nations (UN) has named as global custodian agencies, responsible for collecting and reporting on country-by-country energy indicators for reporting on SDG7. This report tracks global, regional and country progress on the four targets of SDG7: energy access (electricity, clean fuels and technologies for cooking), renewable energy and energy efficiency, based on statistical indicators endorsed by the UN. The report updates progress with the latest available data up to 2016 for energy access, and 2015 for clean energy, against a baseline year of 2010. A longer historical period back to 1990 is also provided by way of reference. *The Energy Progress Report* is a successor to the earlier Global Tracking Framework (published in 2013, 2015 and 2017), which was co-led by the IEA and World Bank under the auspices of the UN's Sustainable Energy for All (SE4All) initiative, and builds on the same methodological foundation.

ELECTRIFICATION: HOPEFUL SIGNS OF ACCELERATION IN LAGGING REGIONS

Roughly 1 billion people – or about 13% of the world's population – live without electricity. The number of people gaining access to power has been accelerating since 2010 to around 118 million each year, but progress has been uneven, and needs to become more widespread and ramp up further if the SDG7 goal of universal access to electricity is to be met by 2030. Otherwise, if current policies and population trends continue, as many as 674 million people will continue to live without electricity in 2030.[1]

FIGURE E1 • Percentage of population with access to electricity (%)

Source: World Bank

The regions of sub-Saharan Africa and South Asia continue to have the largest access-deficit. The number of people without access in sub-Saharan Africa has recently begun to fall in absolute terms for the first time, driven by strong performers in East Africa. Electrification also outpaced population growth in South Asia.

About 80 percent of those without electricity live in top 20 largest access deficit countries whose progress has a major influence on global outcomes. While this group made progress overall, access gains were uneven. Some of the strongest gains were Bangladesh, Ethiopia, Kenya and Tanzania, which expanded access by at least 3 percent of their population annually between 2010 and 2016. Over the same period, India continued to make major efforts, providing electricity to 30 million people each year, more than any other country.

The urban-rural chasm in access remains wide, with almost 87% of the world's population without electricity living in rural areas. However, off-grid solar solutions ranging from solar home systems to solar mini-grids are emerging as an important driver of rural energy access, complementing grid electrification in some countries. Emerging evidence suggests that tens of millions of people now have access to electricity through solar home systems. However, these remain concentrated in about a handful of pioneering countries where off-grid solar electricity already reaches as much as 5-15% of the population; even more in some cases. Identifying the barriers to implementation of low-cost, off-grid solar solutions is a crucial priority for policymakers.

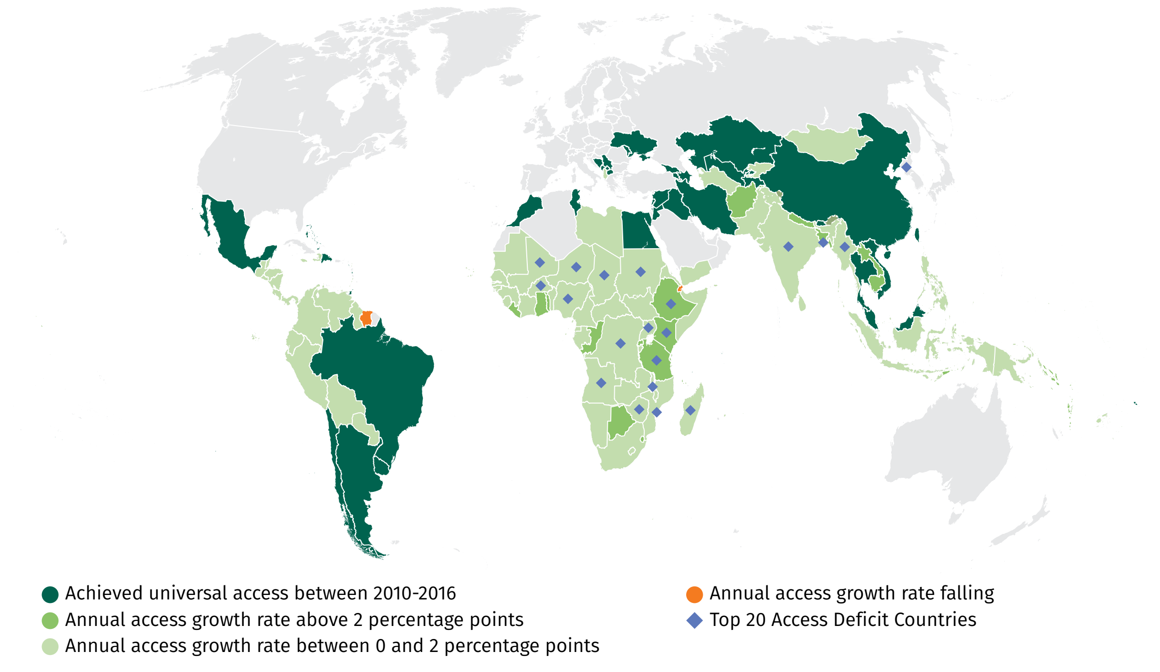
SDG7 calls for access to affordable, reliable, sustainable and modern energy for all. Affordability is an added challenge for countries that are still working to reach universal access to electricity, with the burden of households spending on electricity on average twice as high in these countries.

The experience of countries that have already reached universal access, suggests that this takes strong leadership commitment, backed up by sustained public financing for grid extension. The private sector can increasingly play a role in catalyzing uptake of off-grid solar solutions, underscoring the importance of a suitable enabling environment for new technologies, as well as strategic planning that clearly delineates the role for grid and off-grid approaches.[2]

[1] IEA 2017 *Energy Access Outlook: from Poverty to Prosper*, A World Energy Outlook-2017 special report. OECD/IEA, Paris.
[2] Draws upon Policy Brief No. 1 on Electrification from "Accelerating SDG7 Achievement: Policy Briefs in Support of the First SDG7 Review at the UN High Level Political Forum 2018, UN Department of Economic and Social Affairs, New York, April 2018.

Some 40 countries achieved universal access to electricity since 2010

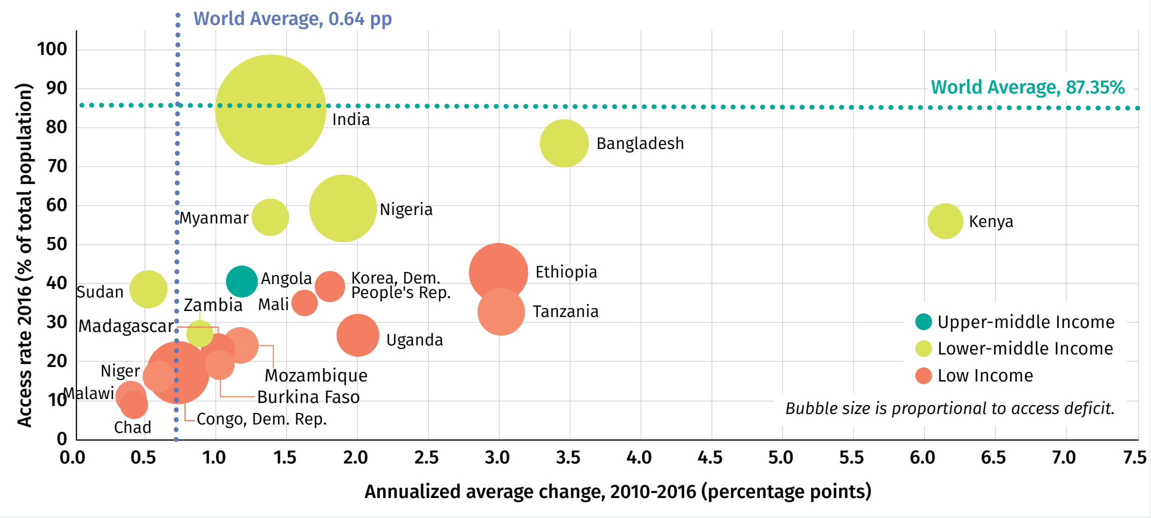
FIGURE E2 • Annual increase in electricity access rate in 2010-2016 (pp) in access deficit countries



Source: World Bank

Bangladesh, together with Ethiopia, Kenya and Tanzania, are moving faster on electrification than other countries with large unserved populations

FIGURE E3 • The 20 countries with the largest access-deficit over the 2010-2016 period

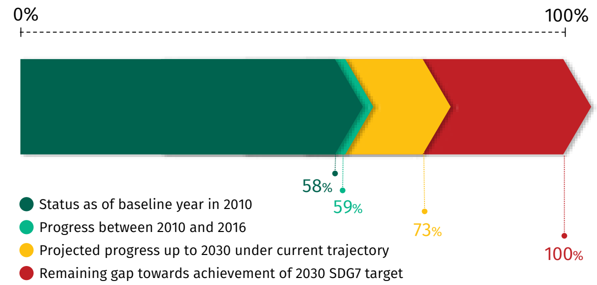


Source: World Bank

CLEAN COOKING: SUCCESS STORIES ARE FEW AND FAR BETWEEN

Three billion people – or more than 40 percent of the world's population – do not have access to clean fuels and technologies for cooking. Household air pollution from the use of inefficient stoves paired with biomass, coal and kerosene for cooking is responsible for some 4 million deaths a year, with women and children at most risk. Progress in access to clean cooking fuels and technologies has barely kept pace with population growth.

FIGURE E4 • Percentage of population with access to clean cooking (%)



Source: World Health Organization, UN Population data

To meet the goal of universal access by 2030, access expansion will need to accelerate dramatically from 0.5 percentage points of population currently each year to an average of 3 percentage points each year between 2017-2030. If the current trajectory continues, 2.3 billion people will continue to use traditional cooking solutions in 2030, perpetuating much of the current negative health, environmental, climate and development impacts.[3]

While parts of Asia have seen access to clean cooking outpace growth in population, in Sub-Saharan Africa, gains have only been marginal, with the region's overall population growing four times faster than the population that gained access to clean cooking technologies between 2014-2016.

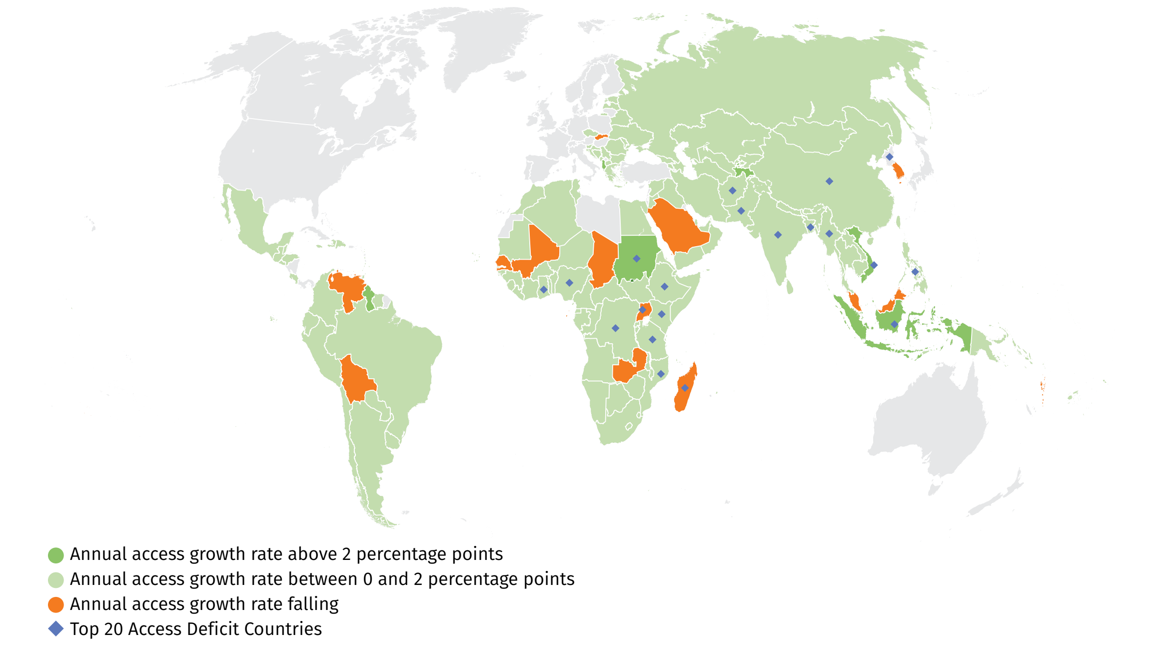
Of the 20 countries with the largest deficit in access to clean cooking, only nine were able to expand access faster than population growth between 2014 and 2016. These positive outcomes were driven largely by widespread dissemination of LPG or piped natural gas cooking solutions in India, Pakistan, Indonesia and Vietnam.

The need for rapid deployment of clean cooking fuels and technologies has not received the attention it deserves from policy-makers, and lags well behind the rate of electrification in almost every country, even in spite of the smaller costs needed to ensure clean cooking solutions for all compared to electrification. High entry costs for many clean cooking solutions, a lack of consumer awareness of their benefits, financing gaps for producers seeking to enter the market, slow progress in the innovation of clean cookstoves, and lack of infrastructure for fuel production and distribution have together kept widespread solutions to this challenge out of reach.[4]

[3] IEA, 2017. *Energy Access Outlook: from Poverty to Prosperity*, A World Energy Outlook-2017 special report. OECD/IEA, Paris.
[4] Draws upon Policy Brief No. 2 on Clean Cooking from "Accelerating SDG7 Achievement: Policy Briefs in Support of the First SDG7 Review at the UN High Level Political Forum 2018, UN Department of Economic and Social Affairs, New York, April 2018.

In contrast to electrification, access to clean cooking is actually falling in some countries

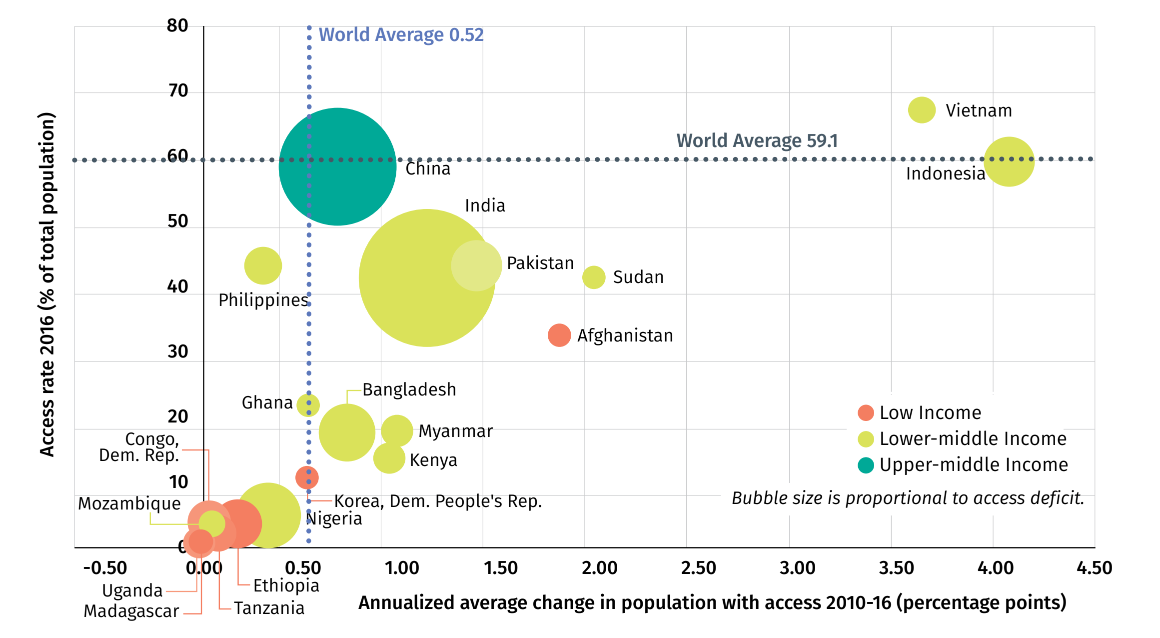
FIGURE E5 • Annual increase in clean cooking access rate in 2010-2016 (pp) in access deficit countries



Source: World Health Organization, UN Population data

Among the top 20 countries with largest unserved populations, Indonesia and Vietnam stand as having made the most rapid progress

FIGURE E6 • The 20 countries with the largest clean cooking access deficit over the 2010-2016 period

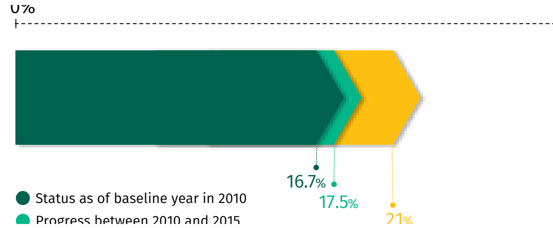


Source: World Health Organization, UN Population data

RENEWABLE ENERGY: PROGRESS ON ELECTRICITY NOT YET MATCHED BY HEATING AND TRANSPORT

As of 2015, the world obtained 17.5% of its total final energy consumption from renewable sources, of which 9.6% came from modern forms of renewable energy such as bioenergy, geothermal, hydropower, solar and wind. The remaining renewable energy is derived from traditional uses of biomass (such as fuelwood and charcoal), of which a significant proportion is used by around 3 billion people in polluting cookstoves. Based on current policies, the renewable share is expected to reach just 21% by 2030, with modern renewables growing to 15% of total final energy consumption, falling short of the substantial increase demanded by the SDG 7 target.[5] The continued rapid growth of total final energy consumption in the developing world, has made it particularly challenging to increase the renewable energy share; even when substantial investment in renewable energy is taking place.

FIGURE E7 • Renewable energy share in total final energy consumption (%)



Source: World Bank

Rapidly falling costs and enabling policy frameworks have allowed solar and wind to compete with conventional power generation sources in multiple geographies, enabling the share of renewables in electricity to rise relatively rapidly reaching 22.8% in 2015. Nevertheless, electricity accounted for only 20% of total final energy consumption that year, highlighting the need to accelerate progress in use of renewables for transport and heating/cooling, sectors of vital importance to reaching the global target. The share of renewable energy in transport is rising quite rapidly, but from a very low base, amounting to only 2.8% in 2015, while the use of renewable energy for heating purposes has barely increased in recent years and stood at 24.8% in 2015, of which only one third was from modern renewables.

Looking at the overall global picture, several countries stand out for salient performances, with China alone accounting for nearly 30% of absolute growth in renewable energy consumption globally in 2015. Brazil was the only country among the top 20 largest energy consumers to substantially exceed the global average renewable share in all end uses: electricity, transport and heating. The UK's share of renewable energy in total final energy consumption grew by 1 percentage point annually on average since 2010 – more than five times the global average over the same period.

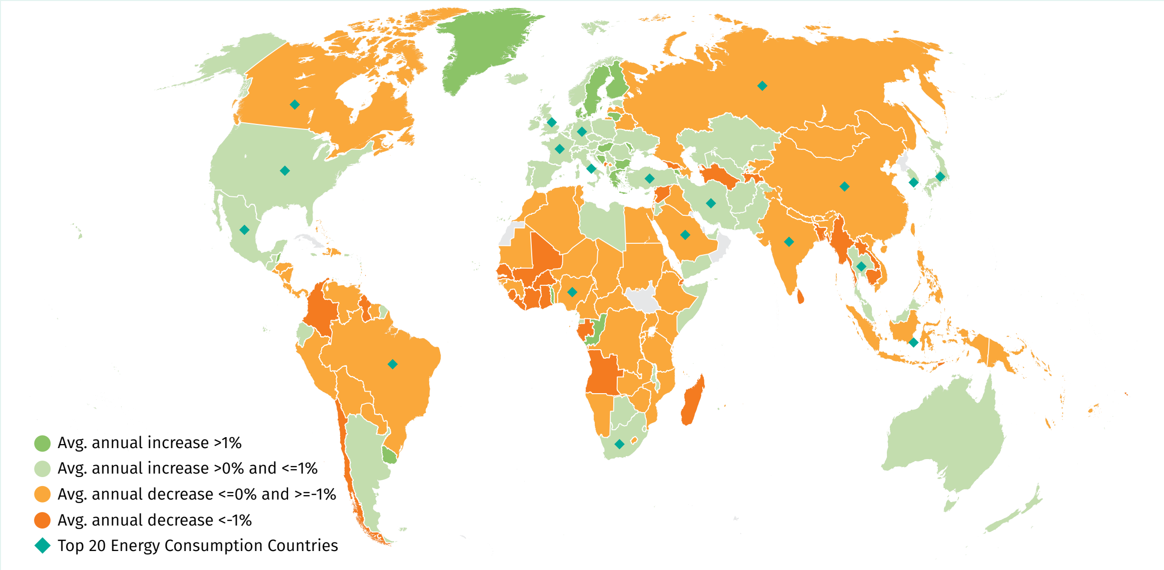
Looking ahead, much greater efforts will be required in end-uses, such as heating/cooling and transport, where renewable penetration remains low yet unexploited potential exists. One avenue would be greater adoption of district energy systems (for heating or cooling) based on biomass, geothermal or solar thermal energy. As the electricity sector decarbonizes, other energy uses can increasingly switch into electricity, such as electric vehicles for instance. A phase out of fossil fuel subsidies would help to encourage such shifts. Sustaining the growth of renewable electricity will further require additional attention to grid integration issues, including the incorporation of battery storage and smart grid technology to support management of variable generation resources. Finally, the more rapid global progress on energy efficiency, the larger will be the impact of renewable energy investments on the overall global energy mix.[6]

5 IEA, 2017. World Energy Outlook-2017. OECD/IEA, Paris.

6 Draws upon Policy Brief No. 3 on Renewable Energy from "Accelerating SDG7 Achievement: Policy Briefs in Support of the First SDG7 Review at the UN High Level Political Forum 2018, UN Department of Economic and Social Affairs, New York, April 2018.

A significant number of countries have seen their renewable energy share decline

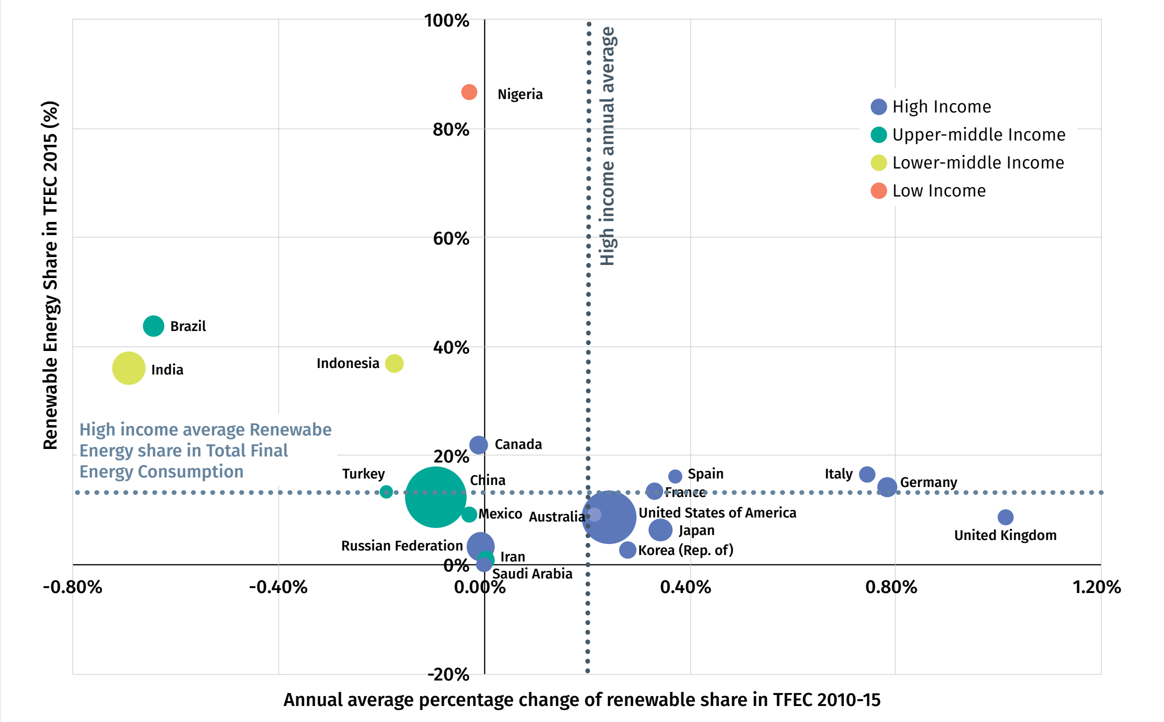
FIGURE E8 • Annual increase in renewable energy share of total final energy consumption (TFEC) in 2010-2015 (pp)



Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

Among larger energy consumers, developed countries tend to have lower renewable energy shares than developing countries, but their shares are increasing more rapidly

FIGURE E9 • Top 20 energy consumption countries plotting renewable energy share in TFEC (2015) against annual average percentage change in renewable energy share in TFEC (2010-2015), with bubbles scaled according to TFEC size

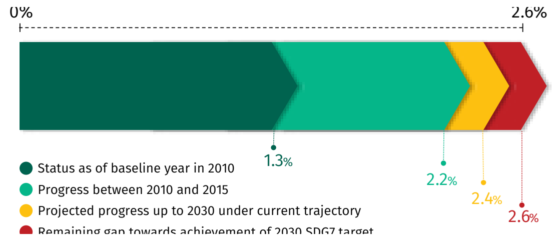


Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

ENERGY EFFICIENCY: ECONOMIC GROWTH OUTSTRIPS ENERGY DEMAND

Globally, energy intensity – the ratio of energy used per unit of GDP – continued to fall at an accelerated pace of 2.8 percent in 2015, the fastest decline since 2010. This improved the average annual decline in energy intensity to 2.2 percent for the period 2010-2015. However, progress still falls short of the 2.6 percent yearly decline needed to meet the SDG7 target of doubling the global rate of improvement in energy efficiency by 2030.[7] Without intensifying efforts, the pace of improvement is not expected to exceed 2.4 percent during 2016-2030.[8]

FIGURE E10 • Compared annual growth rate of improvement in energy intensity (percentage points per year)



Source: World Bank

There is mounting evidence of the uncoupling of growth and energy use. Global gross domestic product (GDP) grew nearly twice as fast as primary energy supply in 2010-15. In fact, economic growth outpaced growth in energy use in all regions, except for Western Asia, and in all income groups.

Improvement in industrial energy intensity, which is the largest energy consuming sector, was particularly encouraging, at 2.7 percent per annum since 2010. However, progress was more modest elsewhere. In high income countries, transportation is the largest energy consuming sector, where there is a need to accelerate efficiency gains, especially for road freight services. In low and middle-income countries, residential energy consumption is high and intensity has been increasing since 2010. Improving efficiency of electricity supply also poses a challenge with thermal power generation presenting unmet potential for efficiency gains, as average fuel conversion efficiency lingered below 39 percent worldwide. In addition, transmission and distribution losses remained high at close to 16 percent in low-income and lower-middle income countries.

The performance of the world's top twenty countries in terms of primary energy supply is critical to achieving the SDG7 target. In 2015, these countries accounted for nearly 80 percent of total primary energy supply. Encouragingly, six of them, including two of the world's top five (Japan and the US), seem to have reached a peak in energy use, reducing their annual primary energy supply in 2010-15 while continuing to grow GDP. Among the large energy-intensive developing economies, China and Indonesia stood out with annual improvement exceeding 3 percent; even as others, notably Brazil and Iran, saw their energy intensity increase.

While progress is encouraging, a host of proven energy efficiency policies remain to be systematically adopted in many countries. Building codes for residential and commercial facilities should include energy performance standards for new construction and major renovation. Increasingly, it would be desirable to adopt ambitious cross-sectoral integrated policy approaches that promote stretch improvements through targets or fiscal incentives, as have been applied with some success in China and Europe.[9]

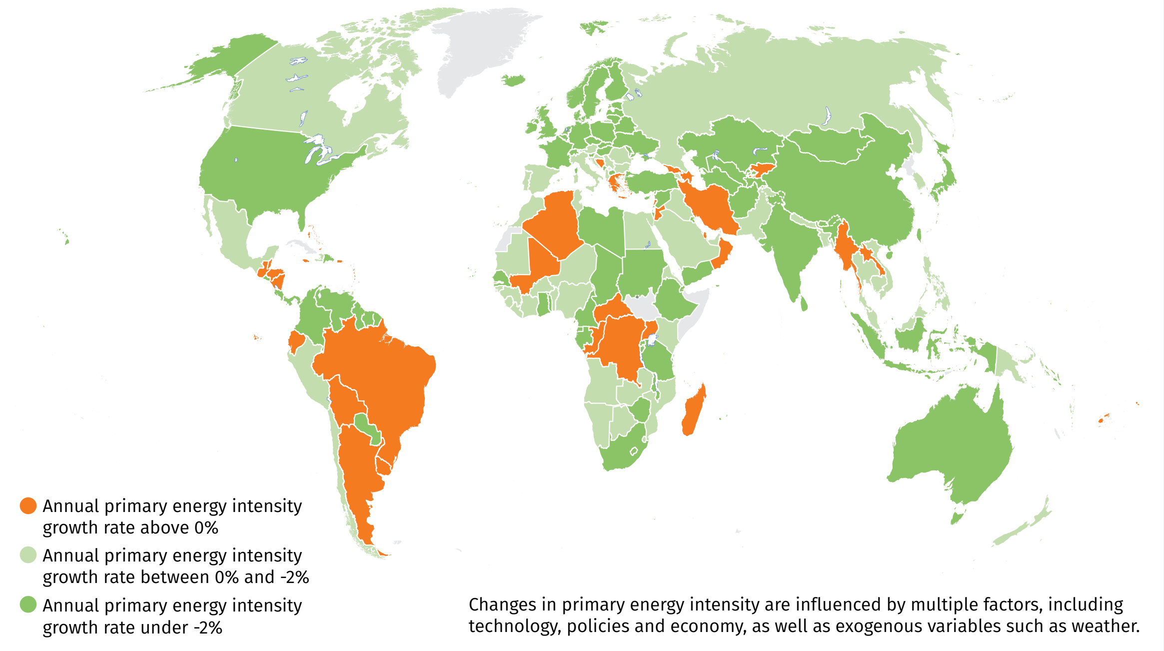
7 Improvements in global energy efficiency slowed down dramatically in 2016 and 2017, with the rate of improvement in 2017 at 1.7% (IEA, 2018 *Global Energy & CO_2 Status Report*, IEA/OECD, 2018; www.iea.org/geco.

8 IEA, 2017b. World Energy Outlook-2017. OECD/IEA, Paris.

9 Draws upon Policy Brief No. 4 on Energy Efficiency from "Accelerating SDG7 Achievement: Policy Briefs in Support of the First SDG7 Review at the UN High Level Political Forum 2018, UN Department of Economic and Social Affairs, New York, April 2018.

Many countries are showing relatively rapid improvement in energy intensity, but others are moving in the opposite direction

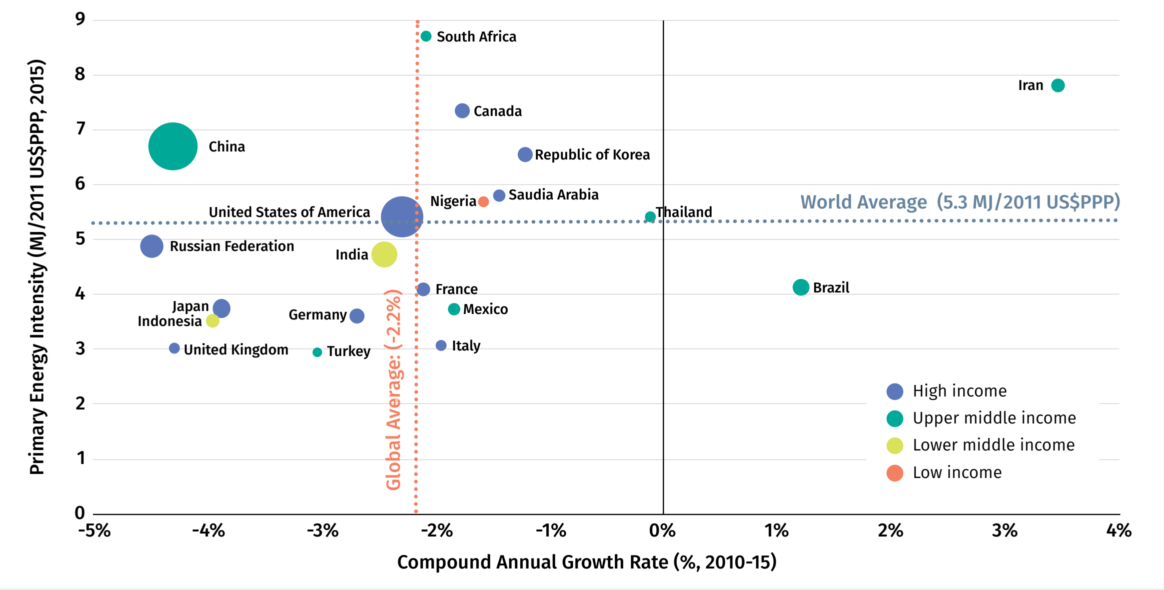
FIGURE E11 • Annualized change in energy intensity in 2010-2015 (pp)



Source: International Energy Agency (IEA), United Nations Statistics Division (UNSD), and World Development Indicators (WDI) data

Strong improvements in energy intensity are evident both among large emerging economies, like China and Indonesia, as well as among developed economies like Japan and the United Kingdom

FIGURE E12 • Top 20 countries' compound annual growth rate of energy intensity, 2010-2015, and energy intensity, 2015



Source: International Energy Agency (IEA), United Nations Statistics Division (UNSD), and World Development Indicators (WDI) data

CONCLUSIONS

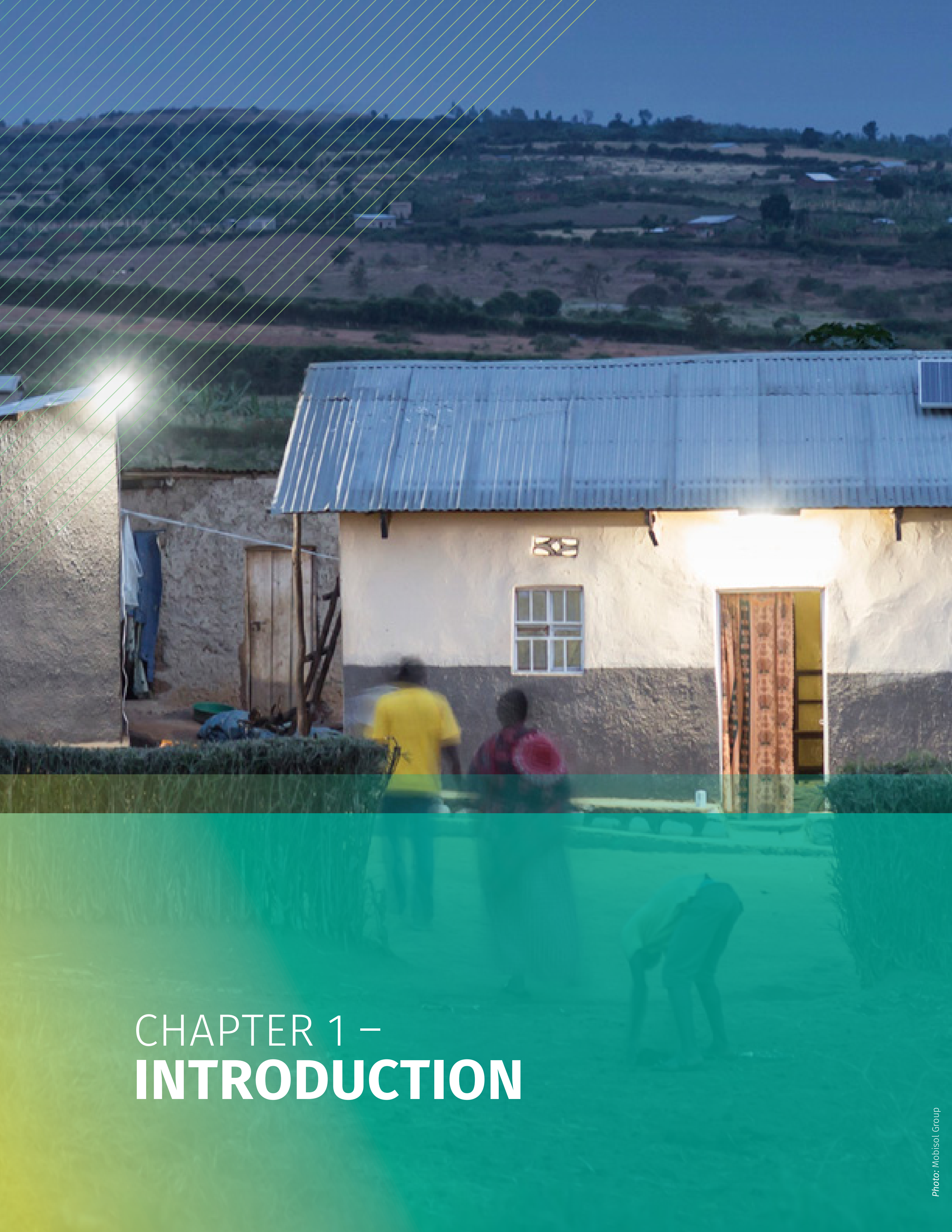
Looking at each of the dimensions of sustainable energy more closely helps us understand why the world still falls short of its goal and what kinds of targeted efforts are needed – across different countries and sectors – to accelerate global progress towards the goal in the coming years. Further improvements on the steady levels of progress so far will require greater policy commitment and increased funding, as well as a willingness to embrace new technologies on a much wider scale. This report helps identify where good policies have been adopted and points to approaches that may deserve greater attention from policy-makers going forward.

BOX E2 • HOW CAN DATA FOR SDG7 TRACKING BE FURTHER IMPROVED?

Many challenges remain in providing a comprehensive picture of the global energy situation, and sustained efforts are needed to improve data quality and availability.

One key area of focus is to improve the coverage and precision of household survey questionnaires to more accurately reflect the nature and quality of service for electricity and clean cooking. Current indicators do not make it possible to capture the affordability and reliability dimensions emphasized by SDG7. While the off-grid solar revolution is making it increasingly challenging to accurately reflect trends in rural electrification.

Equally important is to strengthen statistical capacity to produce accurate energy balances, particularly in the developing countries, where many challenges remain in capturing, for instance, the traditional uses of biomass. Furthermore, there is still relatively little information on the energy efficiency of major consuming sectors outside of the major economies that is critical to inform policy interventions.



CHAPTER 1 –
INTRODUCTION

Photo: Mobisol Group

INTRODUCTION

In September 2015, the global community adopted the Sustainable Development Goals (SDGs) for 2030. For the first time, energy is occupying a central place in the world's development agenda with the adoption of SDG 7, which aims to "ensure access to affordable, reliable, sustainable, and modern energy for all." SDG7 comprises four related targets. Goal 7.1 relating to energy access comprises both 7.1.1 calling for universal electrification and 7.1.2 calling for universal access to clean fuels and technologies for cooking. Goal 7.2 looks for a substantial increase in the share of energy consumption from renewable sources, Goal 7.3 lays down a doubling of the rate of improvement of energy efficiency globally.

SDG 7 builds on the earlier foundation of former United Nations Secretary General's Sustainable Energy for All Initiative, which first adopted targets for energy access and clean energy, which were later adapted to SDGs. Building on this foundation, the UN General Assembly pronounced 2012 the Year of Sustainable Energy for All and later, 2014–24 the Decade of Sustainable Energy for All. With SDG7 one of a handful of SDGs to be reviewed by the UN's High Level Political Forum in July 2018, and with the midpoint of the UN Decade fast approaching in September 2019, SDG7 is currently the subject of considerable political focus.

This report builds on a series of three earlier reports (published in 2013, 2015 and 2017) under the title "Sustainable Energy for All Global Tracking Framework". These reports, co-led by IEA and the World Bank in partnership with a broad consortium of partner agencies[1], built consensus around indicators that could be used to measure progress towards global energy goals, and constructed a database of indicators for all countries in the world going back as far as 1990. These indicators are drawn from official national statistics, primary national energy balances produced by ministries of energy, and household surveys published by national statistical agencies. The data are compiled for almost all countries in the world and, where necessary, adjusted to follow consistent definitions that allow for meaningful comparisons across countries and over time.

The indicators developed by the *Energy Progress Report* were positively evaluated by the Bureau of the UN Statistical Commission in early 2015, and rated as Tier 1, meaning that they performed well on three main characteristics: feasibility, suitability, and relevance. As a result, they were subsequently adopted as the indicators for tracking progress toward SDG7 (Table 1.1). The UN Statistical Commission recognized as Custodian Agencies those international bodies that provide the primary data source for each of the relevant indicators. According to the process established by the UN, the latest values of indicators, together with associated story lines, are reported annually by the respective Custodian Agencies to the UN Statistics Division. This division compiles the information into an integrated annual UN Secretary General's SDG Progress Report, which is presented for discussion at the High-level Political Forum held in July each year in New York.

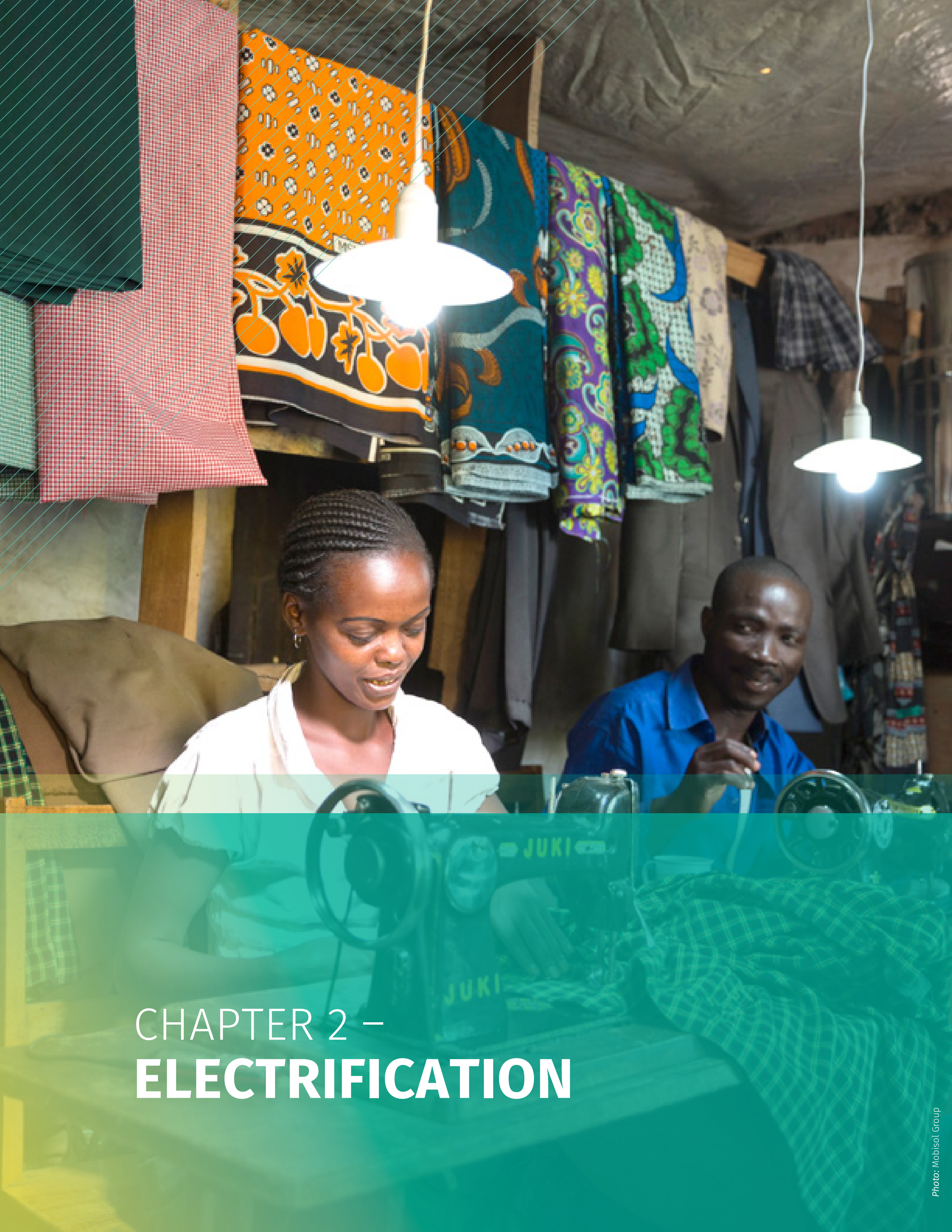
[1] The five organizations that form the consortium of authors for this report are the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the United Nations Statistical Division, the World Bank's Energy Sector Management Assistance Program (ESMAP), and the World Health Organization (WHO). The full list Steering Group member organizations who contributed to this report can be referenced in the contents section.

TABLE 1 • Summary Overview of SDG7 Targets, Indicators and Custodians

SDG7 Targets	Indicator	Custodian Agency
7.1 By 2030, ensure universal access to affordable, reliable and modern energy services	Proportion of population with access to electricity	World Bank (WB)
	Proportion of population with primary reliance on clean fuels and technologies	World Health Organization (WHO)
7.2 By 2030, increase substantially the share of renewable energy in the global energy mix	Renewable energy share in total final energy consumption	International Energy Agency (IEA), International Renewable Energy Agency (IRENA), UN Statistics Division (UNSD)
7.3 By 2030, double the global rate of improvement in energy efficiency	Energy intensity measured in terms of primary energy and GDP	International Energy Agency (IEA), UN Statistics Division (UNSD)

As part of the SDG 7 Review process, the former Global Tracking Framework is being rebranded in 2018 as the SDG 7 Tracking Report. This renaming reflects the fact that the report is now fully aligned with the SDG 7 reporting structure and cycle, with future annual editions planned. In parallel, the governance framework of the report has been updated to reflect more prominently the role of the five Custodian Agencies—IEA, IRENA, UNSD, WB and WHO—while still retaining a broader advisory partnership. In that sense, it can be considered "a joint report of the Custodian Agencies," with Custodian Agencies acting as lead (co-) authors for their respective indicators.

The remainder of the report is organized in a series of chapters that report on progress on each of the four SDG7 targets. All chapters are relatively brief and each follows a common structure, beginning by highlighting the main messages, then providing a pictorial summary of the emerging trends through a series of self-narrating charts, and concluding with a short text reflecting on policy implications of the findings. The final chapter takes stock of recent modeling work to shed light on the feasibility of achieving SDG7 targets by 2030.



CHAPTER 2 – ELECTRIFICATION

Photo: Mobisol Group

MAIN MESSAGES

- **Global trend:** The share of global population with access to electricity edged up from 85.69%[1] in 2014 to 87.35% in 2016. The access-deficit breached the symbolic threshold of 1 billion people unelectrified in 2016. An additional 135.7 million people were electrified each year during 2014-2016. However, after accounting for population growth, the annual net increase in population with access was only 49.3 million during the period.

- **2030 target:** The outlook for access to electricity shows that global efforts between 2016 and 2030 need to step up to 0.8 percentage points a year to reach universal access by 2030. If access-deficit countries do not accelerate their progress, there would still be 674 million people living without access to electricity in 2030 (IEA 2017).

- **Regional highlights[2]:** Over the period 2014–16, the two regions with largest access deficits continued to increase their access rates—reaching 86.7% in Central Asia and Southern Asia and 43% in Sub-Saharan Africa in 2016. The absolute access-deficit in Sub-Saharan Africa peaked in 2015 at 595.3 million people and began to fall for the first time by 28.5 million people in 2016.

- **Urban-rural distribution:** Although 97% of the urban population worldwide has access to electricity, the access rate in rural areas was much lower at 76% in 2016. In 2016, rural areas therefore encompassed 86.6% of the global access-deficit. However, because of slower population growth, rural access rates have been increasing more rapidly than urban ones, albeit from a lower base. Off-grid solar solutions are emerging as an important driver of rural energy access, complementing grid electrification at least in some countries.

- **Off-grid solar:** Emerging evidence suggests off-grid solar electricity reaches about 141 million people in the developing world, of whom only 30 million enjoy a level of service considered to be "access" (IRENA 2018). Uptake is highly concentrated in about a dozen pioneering countries and can be as high as 5–10% for full solar home systems and greater than 10% for solar lanterns.

- **Affordability:** Affordability is potentially an issue not only for countries working toward universal access but also for countries that have already achieved it. Estimates suggest that, even in countries with universal access, affordability concerns affect about 30% of the population; in countries working toward universal access, affordability affects 57% of those who already have access.

- **Top 20 access-deficit countries:** Given that the top 20 access-deficit countries accounted for 79% of the global access deficit in 2016, progress among them is critical to meet the 2030 goal. Although this group made progress overall, access gains across the largest access-deficit countries were uneven over

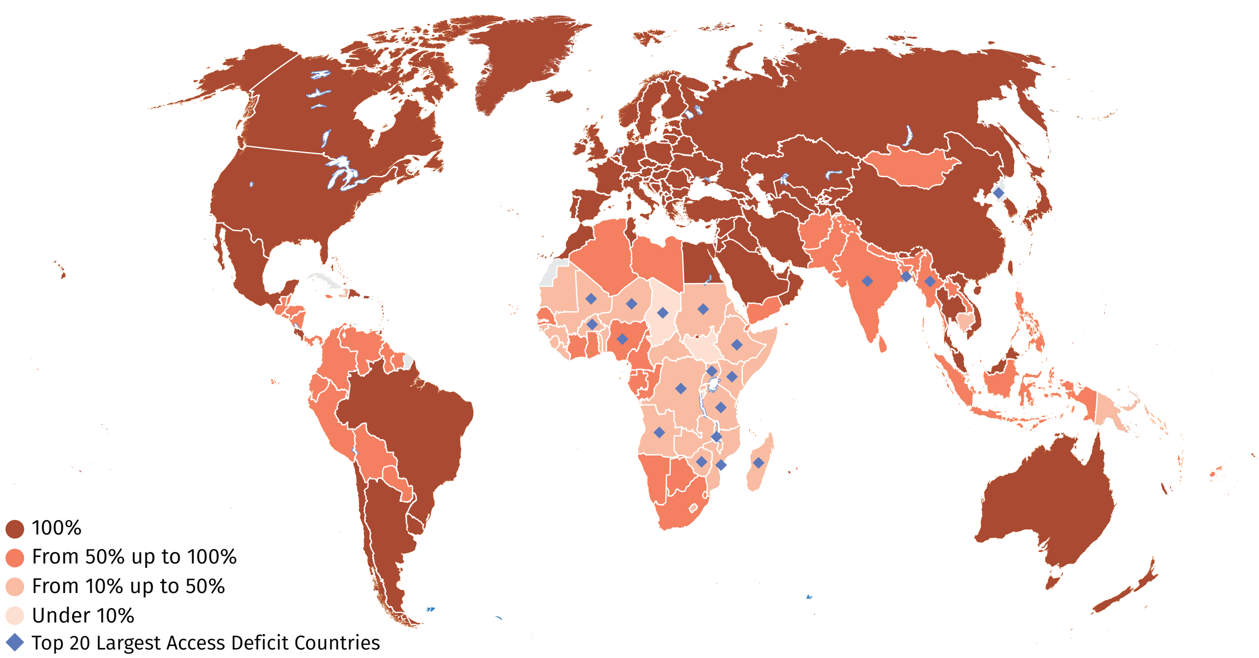
[1] Global Tracking Framework 2017 reported 85.3% of electrification rate in year 2014. The electrification rate is modified mainly due to the new survey data collected for year 2014.
[2] The regions are divided according to UN SDG regions.

2014–16. Among the strongest performers were Bangladesh, Kenya, Ethiopia, and Tanzania, which expanded access by more than 5 percentage points annually between 2014 and 2016.

- **Socioeconomic electrification patterns:** Access to electricity is strongly associated with poverty, with access rates four times higher in the top quintile of household expenditure compared to the bottom quintile across the 20 countries with the largest access deficit. Differences in electricity access by gender of head of household were also found to be material in a minority of the top 20 access-deficit countries.

- **Methodologies to estimate electrification:** Within countries different methodologies can be used to estimate electrification, sometimes on the basis of direct demand-side reports from household surveys, and in other cases using supply-side data including utility connections and, increasingly, off-grid solar sales data. In most cases, demand-side measures of access lead to higher estimates of electrification than supply-side figures because they capture various informal types of electricity access that can be quite prevalent in the developing world—including sharing of utility connections, and various forms of self-provision such as household generators.

FIGURE 2.1 • Share of population with access to electricity in 2016 (%)



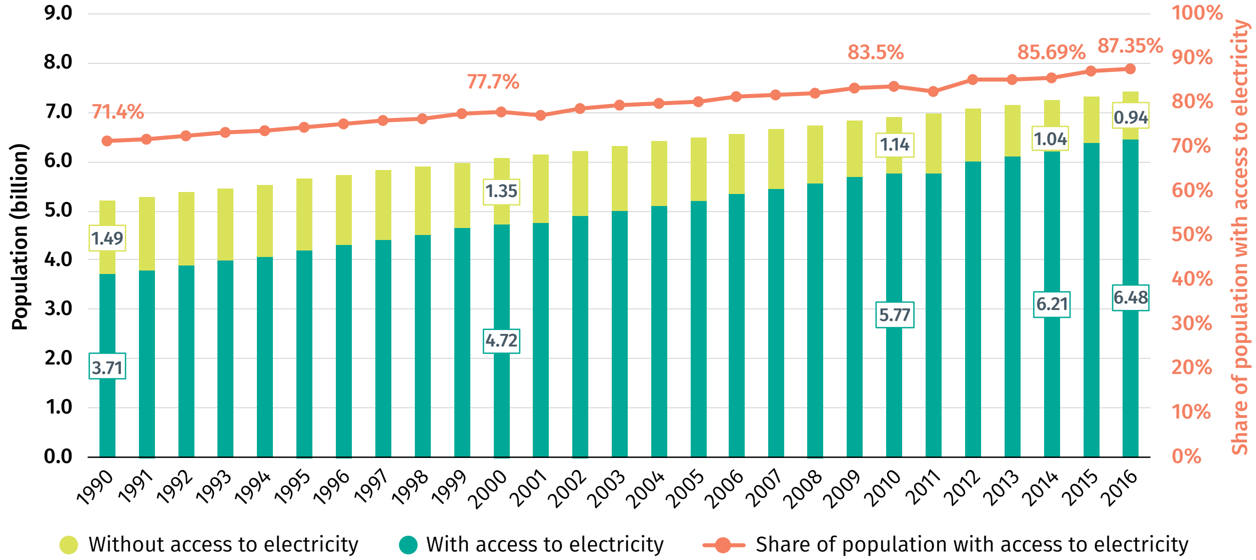
Source: World Bank

THE STORY IN PICTURES

GLOBAL TRENDS

The global electrification rate continued to grow steadily reaching 87.35 percent in 2016

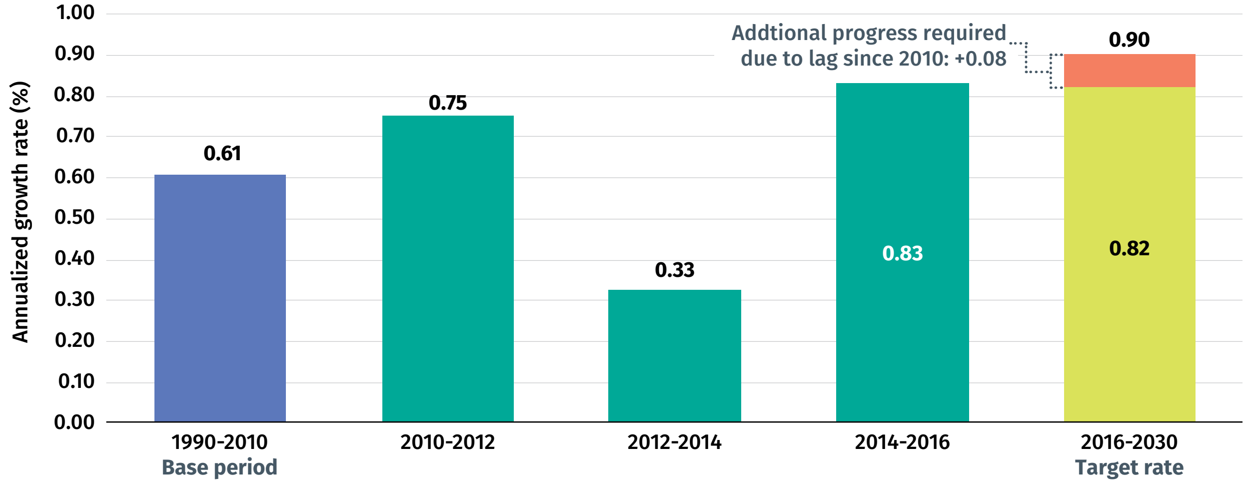
FIGURE 2.2 • Progress in electricity access from 1990 to 2016 (billions of people and share of population with access to electricity)



Source: World Bank

Despite faster progress in electrification in 2014-2016 period, annual gains in the electrified population continue to slightly fall short of the pace required to meet the 2030 target

FIGURE 2.3 • Average annual increase in access rate to electricity (percentage points)

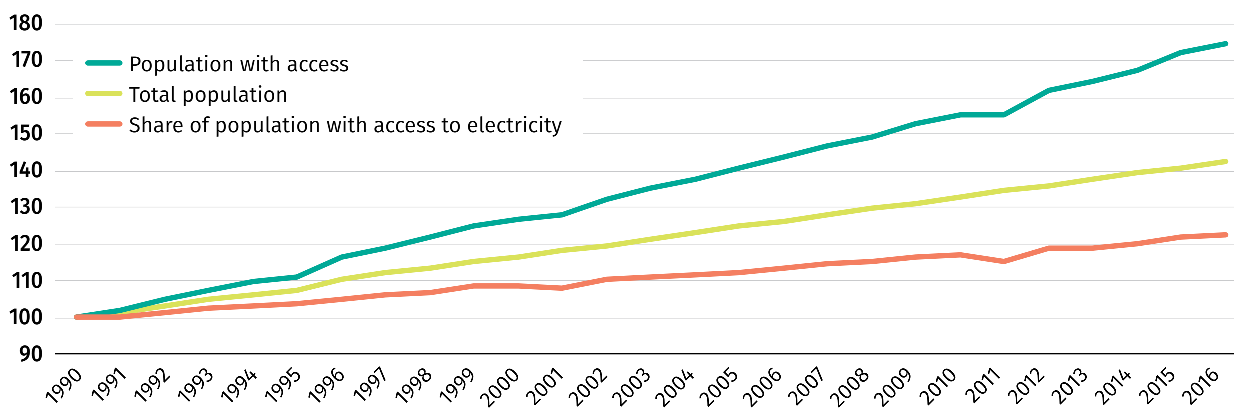


Source: World Bank

ACCESS AND POPULATION

The population with access to electricity is growing at a steady pace, and significantly faster than the population as a whole

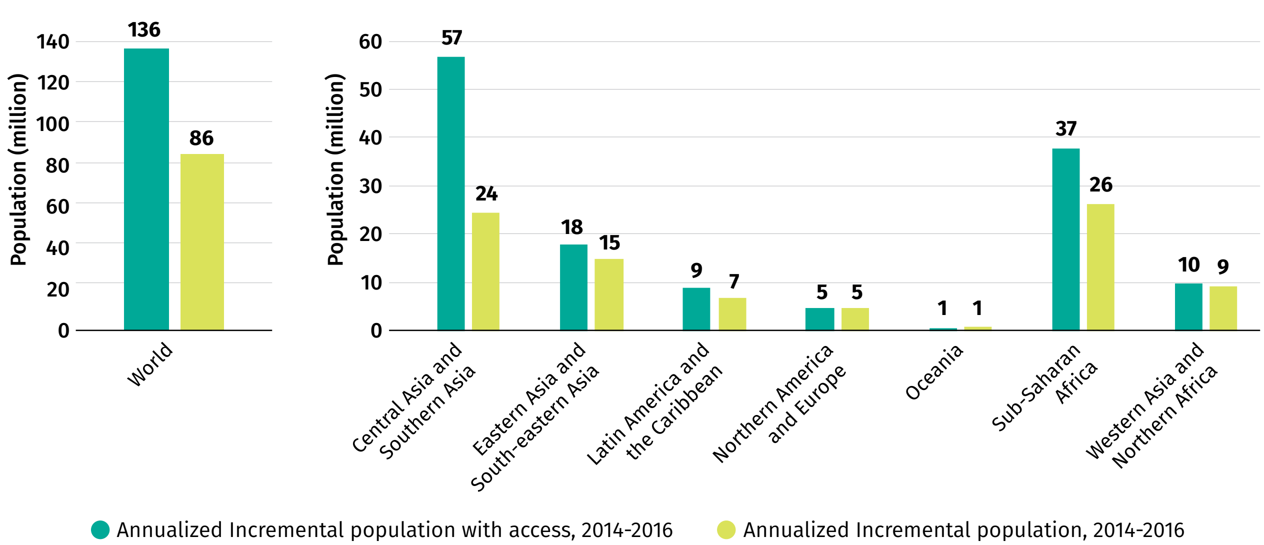
FIGURE 2.4 • Electricity access and population growth from 1990 to 2016, (index, 1990 = 100)



Source: World Bank

In all regions of the world, electricity access grew at least as fast as population growth in 2014-2016

FIGURE 2.5 • Annual incremental access and population growth, 2014-2016, by region

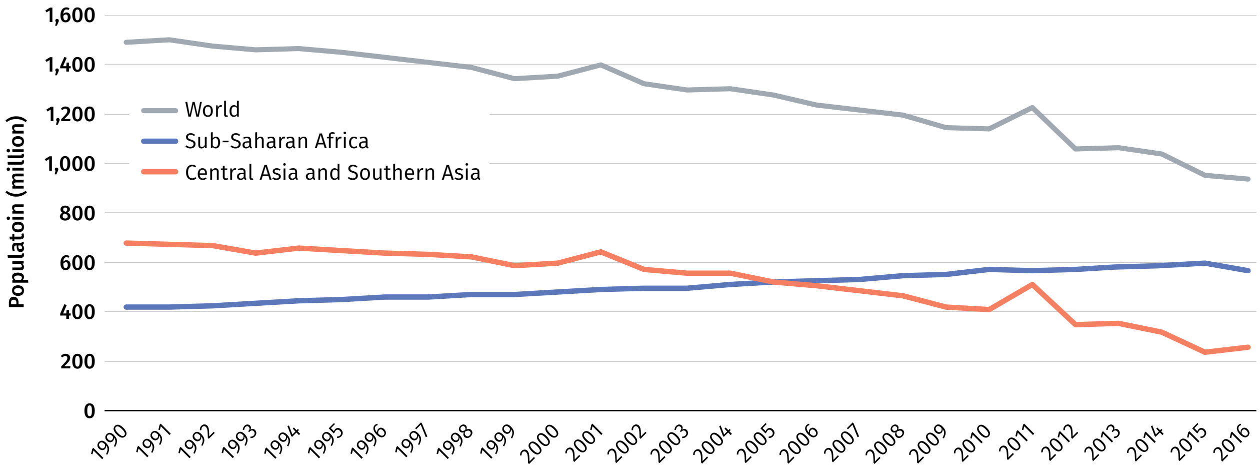


Source: World Bank

THE ACCESS DEFICIT

The number of people living without electricity worldwide dipped below 1 billion for the first time in 2016; notably, Sub-Saharan Africa's access deficit finally started to fall in 2016.

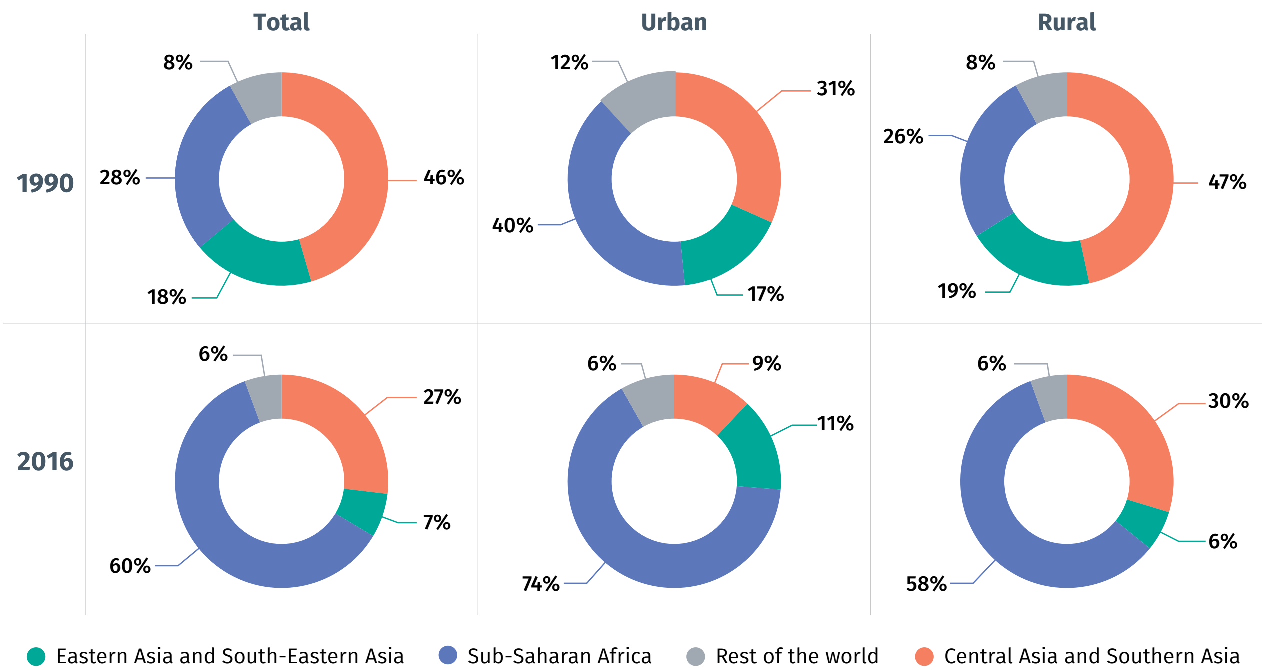
FIGURE 2.6 • Evolution of the access-deficit (millions of people), 1990-2016



Source: World Bank

Nevertheless, Sub-Saharan Africa's share in the global access deficit has more than doubled between 1990 and 2016

FIGURE 2.7 • Share of the regions in the global access-deficit (based on population without access to electricity), 1990 and 2016

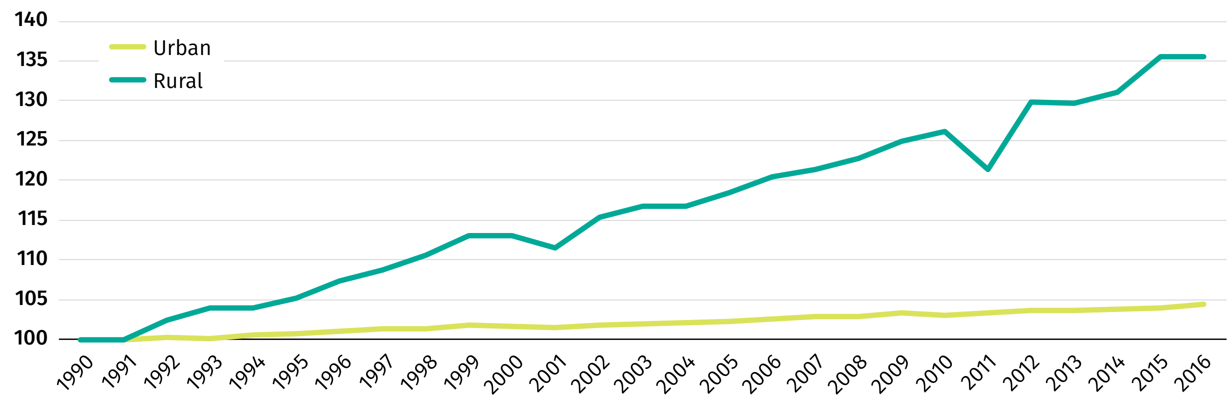


Source: World Bank

URBAN-RURAL DIVIDE

While the pace of access expansion grew rapidly in rural areas, it has remained almost constant in urban areas

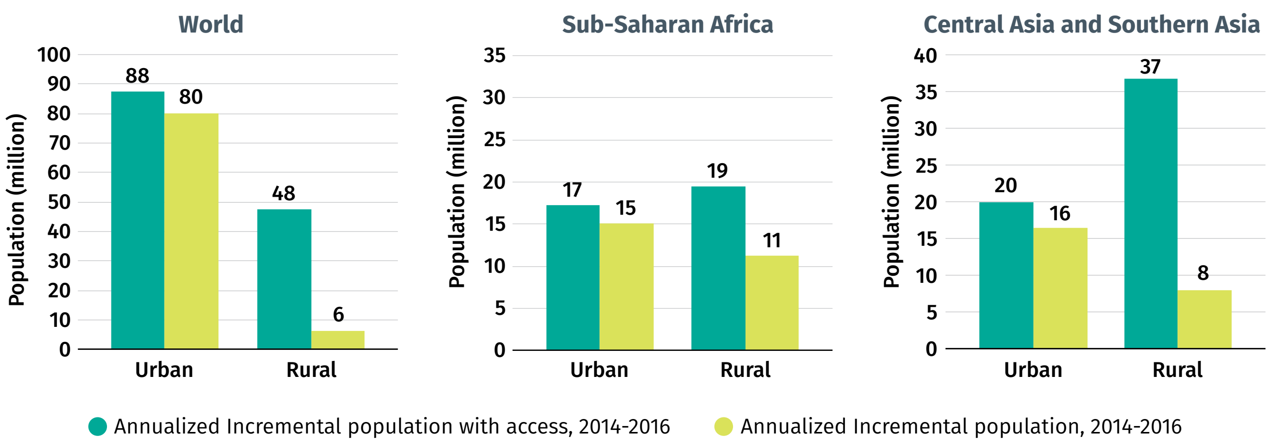
FIGURE 2.8 • Share of population with electricity access in urban and rural areas from 1990 to 2016, (index, 1990 = 100)



Source: World Bank

In Central Asia and Southern Asia, there was substantial progress in rural electrification in 2014-2016

FIGURE 2.9 • Annual incremental access and population in the world, Sub-Saharan African and Central Asia and Southern Asia[3], urban-rural, 2014-2016



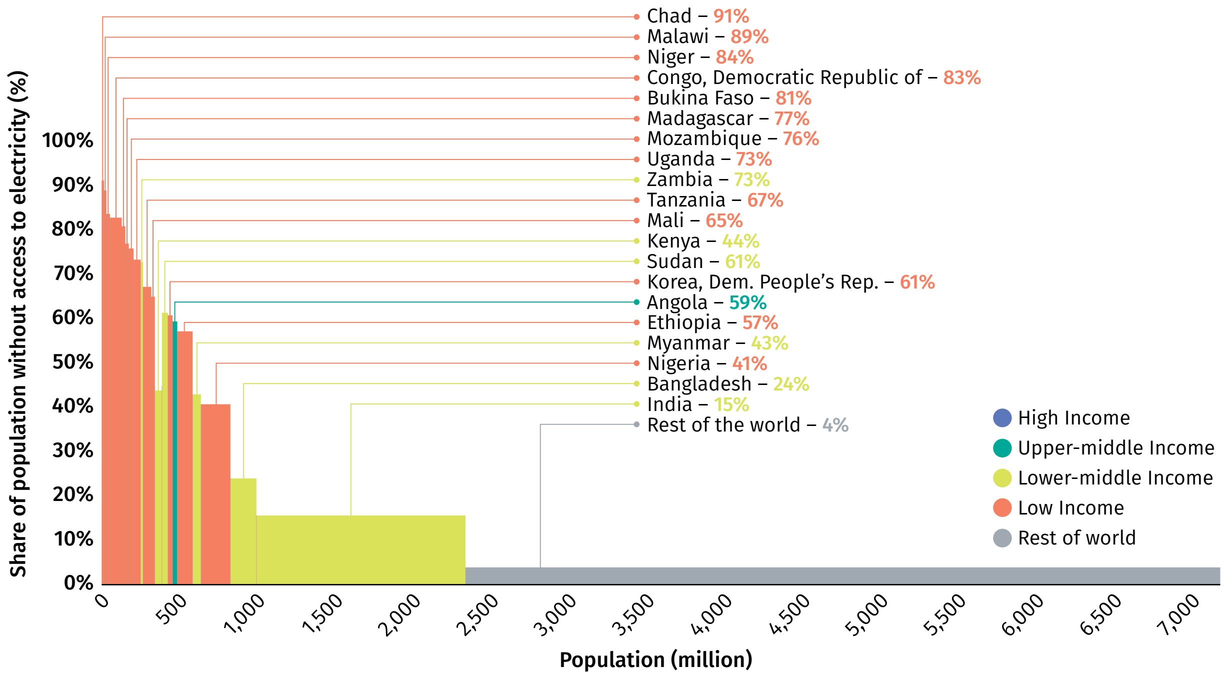
Source: World Bank

[3] The region of Central Asia & Southern Asia has a higher rural incremental population with access than the world because regions including Northern America & Europe, and Eastern Asia & South-eastern Asia, which have mostly achieved universal electrification, have decreasing rural population, and thus have a decreasing rural population with access to offset the progress made in other regions.

COUNTRY TRENDS

The top 20 access-deficit countries accounted for 79% of the global access-deficit, with India alone accounting for 21.8% in 2016

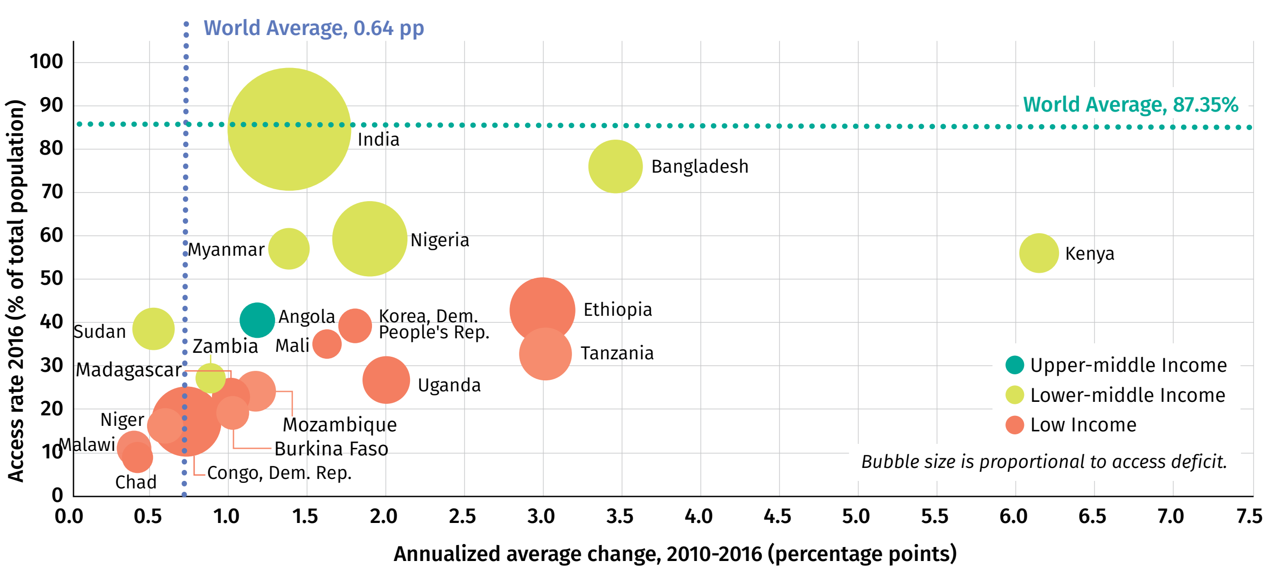
FIGURE 2.10 • Share of population without access and total population, 2016



Source: World Bank

Since 2010, 16 of the world's top 20 access-deficit countries expanded electrification at a rate faster than the global average, but none of them achieved the world average access rate

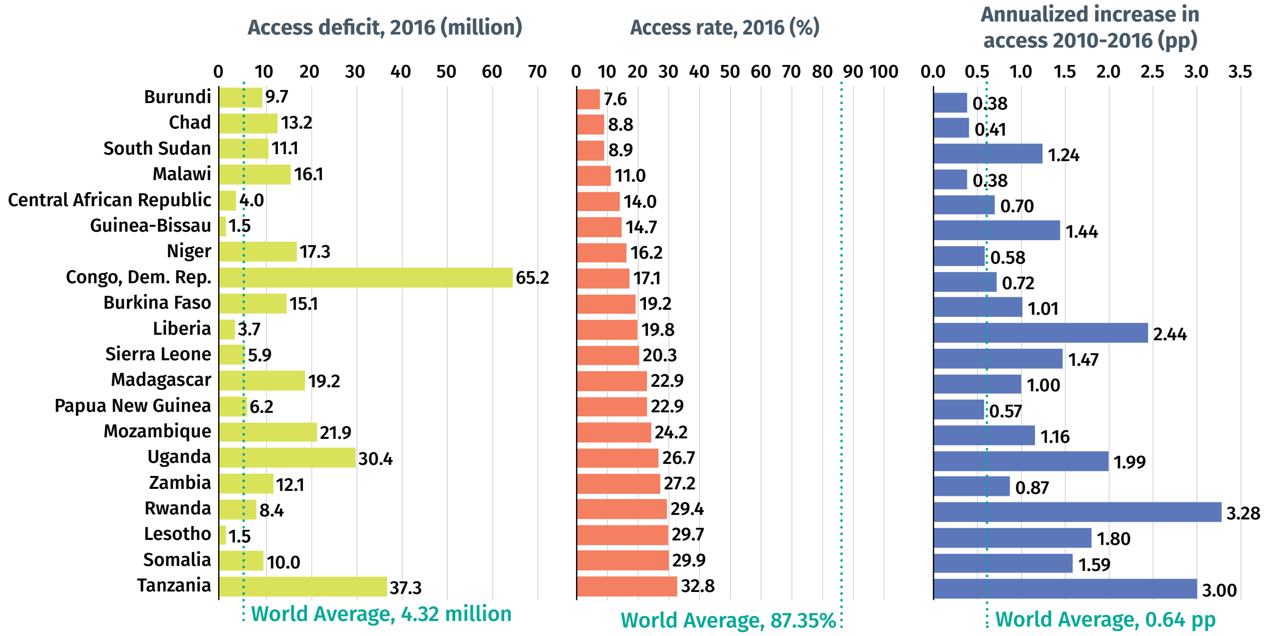
FIGURE 2.11 • The 20 countries with the largest access-deficit over the 2010-2016 period



Source: World Bank

Of the world's 20 least electrified countries, fifteen have been able to expand electrification more rapidly than the world average consistently since 2010

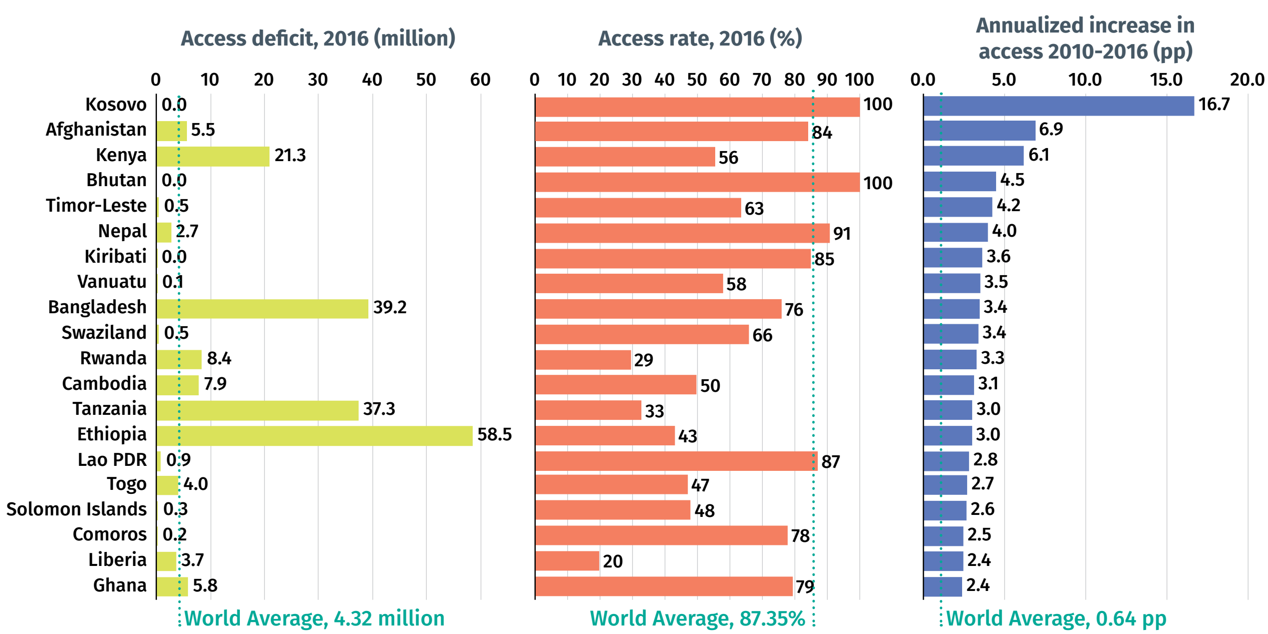
FIGURE 2.12 • The 20 least-electrified countries over the 2010-2016 tracking period



Source: World Bank

The world's 20 fastest-moving countries have consistently managed to electrify 2-5 percent of their population annually since 2010; even more in some cases

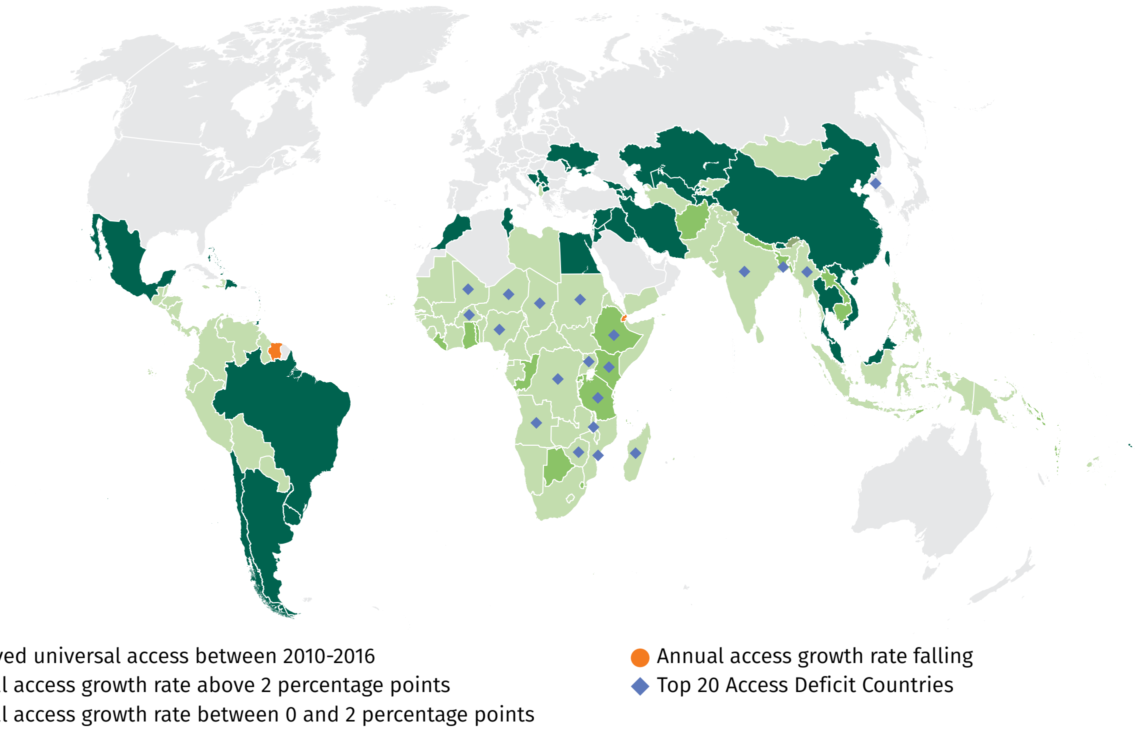
FIGURE 2.13 • The 20 fastest moving countries over the 2010-2016 tracking period



Source: World Bank

Since 2010, 43 countries achieved universal electrification, while a further 20 countries expanded their electrification at a pace that can be considered rapid by historic standards.

FIGURE 2.14 • Annual increase in electricity access rate in 2010-2016 (pp) in access deficit countries



Source: World Bank

POLICY IMPLICATIONS

Energy access is inexorably tied to human well-being—powering household and income-generating activities. SDG 7 sets the target of universal access to affordable, reliable, and modern energy services by 2030. Electricity is a subset of energy services, making universal electrification a national priority in the 98 countries around the world that have yet to reach this objective. SDG 7 is currently under review by the United Nations (UN): Policy Brief #1, "Ensuring Universal Access to Electricity," and Policy Brief #24, "Energy Sector Transformation: Decentralized Renewable Energy for Universal Energy Access," outline priority actions on electrification.

In 2016, the world steadily progressed toward universal access to electricity, with the global electrification rate reaching 87.4%—up from 85.7% in 2014. For the first time since 1990, global access breached the symbolic threshold of 1 billion in 2016—falling slightly from 1.04 billion in 2014[4]. Although this growth is encouraging, the pace of electrification in the coming years will need to further accelerate to meet the 2030 targets. According to the New Policies Scenario of the International Energy Agency (IEA), an estimated 674 million will be without electricity in 2030.

[4] These estimates are based on the World Bank methodology using electrification rates reported in national surveys and modeled estimates for years where surveys are unavailable. IEA's estimate for the global electricity access-deficit in 2016 amounts to 1.06 billion people, with the main difference stemming primarily from estimates for India. A comparison with the IEA's Energy Access Database (IEA 2017; www.iea.org/sdg/), which primarily relies on government estimates based on utility connections, is described in box 2.1.

Consistent with earlier trends, progress has been most rapid in developing Asia, where electrification continues to outstrip population growth by a substantial margin. Electrification also exceeded population growth slightly in Sub-Saharan Africa for the first time in 2014–16.[5] Although urban electrification at 97% is substantially ahead of rural electrification at 76%, rural electrification is rising more rapidly reflecting much lower population growth in rural areas.

These results are consistently derived from official household surveys run by national statistical agencies. The underlying methodological basis is explained briefly in box 2.1, and described in much greater detail in the methodology section.

The figures cited above provide a headline view of electricity access globally, but it is also fair to say that they leave a number of important questions unanswered. As a result, it is increasingly helpful to shed further light on electricity access trends by triangulating between various complementary sources of information. A detailed triangulation exercise was conducted for each of the top 20 access-deficit countries, comparing electrification rates derived from household surveys with utility connection rates and estimated penetration of solar energy, as well as IEA estimates of electricity access. A full report on each of these 20 countries is provided in annex 2, with an overview of results provided below.

BOX 2.1 • MEASURING ELECTRIFICATION: COMPARING WORLD BANK AND IEA ELECTRICITY ACCESS DATABASES

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

Each database gives different and important quantifications of electrification, and the IEA and World Bank together are working on a comparison and reconciliation exercise, toward a joint database of electrification estimates derived from surveys, modeled results, utility connections, and differentiating aspects such as off-grid and informal connections. The IEA and World Bank are endeavoring to present this analysis, and ultimately a fully combined and integrated database, over time; annex 2B presents a rich portrayal that integrates the different measures of electrification over time for the top 20 access-deficit countries globally, and serves to highlight the value of having a variety of complementary measures of electrification analysis.

The high-level finding of this exercise is that the global messages are consistent across the two databases. Most notably, each observes an acceleration in electrification over recent years, driven primarily by progress in Asia. Each also observes promise in Sub-Saharan Africa, where electrification efforts have begun to outpace population growth for the first time. According to IEA measurements, this turning point happened in 2013; in the World Bank database, it happened in 2015. This difference is largely accounted for by differences in recent estimates for Kenya.

A more detailed finding is that estimates for some individual countries can differ significantly. This is especially the case for India, which accounts for the main difference in population without access. Both databases report very rapid progress; however, 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 informality and self-supply. Estimates for some countries in Sub-Saharan Africa also differ significantly, especially for

[5] The World Energy Outlook reported that electrification efforts have been outpacing population growth since 2014 in Sub-Saharan Africa, and estimated slower pace of access gains in developing Asia (IEA 2017).

Kenya, which has also been making rapid progress but where there is divergence between different sources of data. These discrepancies point to the need to invest in better data and statistics within the country.

Finally, the analysis also highlights different strengths associated with each of the two approaches to measuring electrification, underscoring the value of having both types of measures available.

Household surveys, typically conducted by the national statistical agency of each country, offer two distinct advantages when it comes to measuring electrification.

First, because of longstanding international efforts to harmonize questionnaire design, there is a high degree of standardization of electrification questions across country surveys conducted by international development agencies such as the United Nations Children's Fund and the U.S. Agency for International Development. This brings the benefit of consistency, allowing meaningful comparisons of electrification to be made across countries and over time. 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. A salient example is the Multi-Tier Framework surveys maintained in this chapter.

This kind of standardization does not necessarily exist with administrative data on electrification because governments may follow different conventions regarding what kind of electrification is counted in official statistics, whether village-level or household-level electrification is reported, the geographic area for which access is reported, and assumptions about population and household size. All of these issues can significantly affect the comparability of administrative data between countries.

Second, data from surveys convey a user-centric perspective on electrification. Using survey data captures all of the electricity access forms, painting a more complete picture of access than may be possible from service provider data. Households can be expected to respond positively to having electricity, whether they obtain the service from the grid or some other decentralized sources and whether they are formal customers or obtaining electricity informally. In addition, because survey data incorporate information on a wide array of household characteristics, it becomes possible to examine electricity access patterns across different socioeconomic segments of the population: urban and rural, rich and poor, and male- and female-headed households.

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 when available.

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. One prominent example, again, is the case of India, which has put a great level of emphasis on transparency as it seeks to deliver universal electricity access and which reports in real time the number of utility connections at the household and village levels[1].

Second, administrative data are not subject to the challenges that can arise when implementing surveys in the field. Some household surveys may suffer from sampling errors, particularly in remote rural areas, which could lead to a significant underestimation of the access-deficit. For example, India's 2011 census reported an electrification rate of 55% in rural areas, but the parallel National Sample Survey of 2011/2012 reported a 74% rate, implying that the sample survey overestimated electricity access by about 180 million people. In addition, responses to survey questions may be sensitive to the precise language used to pose survey questions. For example, the question "Does your household have an electricity connection?" may elicit a different perspective on the household's electrification status than would another question, such as "What is the primary source of lighting?" Survey has not developed a consistent methodology to treat off-grid access, which is becoming a more significant factor.

This discussion helps to illustrate the complexity of measuring electrification, as well as the value of having multiple sources of information on which to base any assessment of progress toward universal access. Much remains to be done to improve the quality and availability of both survey and administrative data on electrification at the national level, pointing to the importance of investment in data collection systems and statistics capacity building within countries.

[1] For more information, see tp://saubhagya.gov.in/.

TRACKING OFF-GRID SOLAR ELECTRIFICATION

An important trend in electrification today is the upswing of low-cost off-grid solar electricity; one of the most important policy questions is whether solar off-grid access is materially accelerating the pace of electrification, particularly in rural areas. Although sales of small devices have witnessed a stable growth, sales of larger solutions have increased by over 85% annually since 2014, mainly driven by pay-as-you-go (PAYGO) financing (IFC 2018). IEA's Energy for All case estimates about 60% of the people becoming electrified between 2017 and 2030 will do so through decentralized systems, equally distributed between mini-grids and off-grid solutions based on solar photovoltaic (PV).

While it is known anecdotally that off-grid solar is making major strides, at least in some developing countries, the phenomenon remains difficult to measure. In many places, off-grid solar is a decentralized private sector initiative that is not captured in official statistics. Also, with a wide array of solar products available from small lanterns to substantial home systems, it is not always clear which solar products should count toward electricity access.

There are two emerging sources of evidence on the scale of the solar access phenomenon, each with its limitations. First, new work by IRENA, described in box 2.2, presents an initial comprehensive picture of off-grid solar access derived from industry data on the sales of solar panels. The results suggest that the majority of those currently benefitting from off-grid solar electricity—some 115 million in all—use the basic energy services provided by solar lights of under 11-watt capacity. In about nine countries at least 10% of the population benefits from these systems (see figure 2.15).

In addition, a further 26 million obtain the equivalent of Tier 1 energy access either through solar home systems or connection to a solar mini-grid. Confining attention to this more meaningful level of energy access, a handful of countries (Bangladesh, Fiji, Mongolia, Nepal, Rwanda, and Uganda) stand out as having reached 3–9% of their populations with this form of access in 2016 (see figure 2.15). At the same time, the IRENA dataset also highlights 24 other access-deficit countries in which penetration of solar energy at Tier 1 and above remains negligible, indicating that many countries have yet to take advantage of this form of solar access.

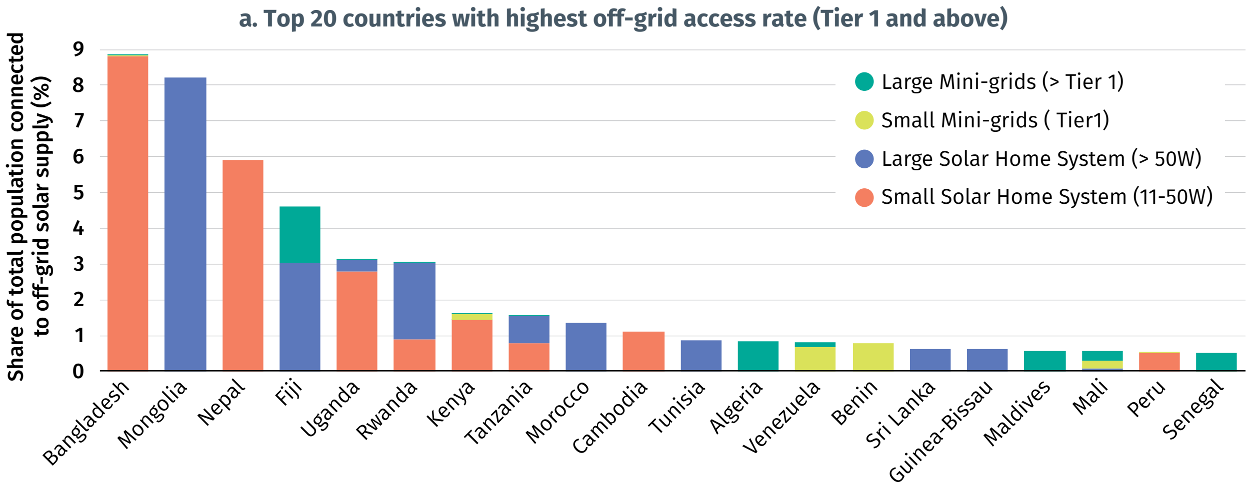
By way of comparison, the IEA estimates that 33 million people currently benefit from electricity access with off-grid renewables and mini-grid solutions (IEA 2017). This is broadly comparable to the number reported by IRENA. The pace of solar electrification has been accelerating: an estimated 5 million people have gained access each year through this route since 2012, compared with about 1 million on average between 2000 and 2012. Although more than double the number of people benefitting from decentralized renewable energy (DRE) live in Asia than in Sub-Saharan Africa, the acceleration is happening most rapidly in Africa. Off-grid solutions, such as solar home systems, make up the bulk of the decentralized systems being deployed, but the role for mini-grids is expected to increase. This first global assessment is based on government reported figures and solar home system sales data, and includes only sales of solar home systems with battery storage to provide a basic bundle of energy services initially[6] and of increasing over time.

Second, although household surveys typically capture electricity from all sources, including solar, only a small proportion of existing household surveys ask specifically about the source of electricity access. This makes it challenging to precisely quantify how much access is provided globally through solar sources. For example, Afghanistan's National Risk and Vulnerability Survey observed that the population obtaining electricity through

[6] A basic bundle of energy services is defined by IEA as, at a minimum, several light bulbs, task lighting (such as a flashlight), phone charging, and a radio.

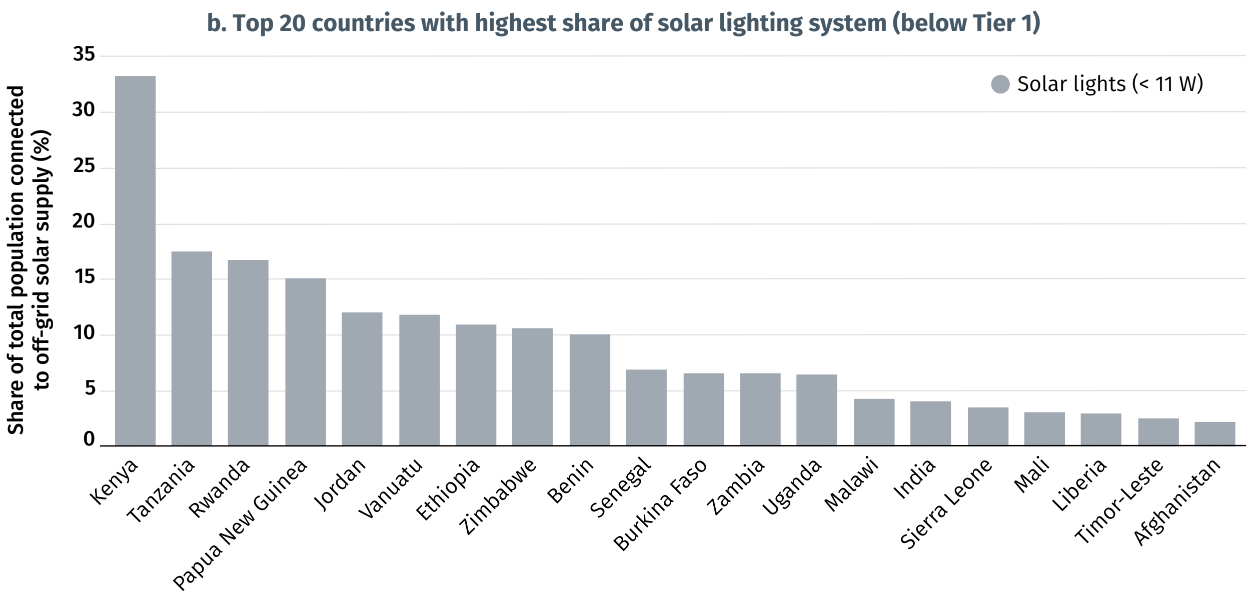
off-grid solar grew from 0.1% in 2005 to 40% in 2014. Because of civil conflicts, the Republic of Yemen's latest 2017 household survey reported 55% of households relied on solar PV as the primary source of lighting, whereas only 0.5% of households relied on electricity through the grid.[7] In addition, Yemen's market survey in 2017 reported solar PV penetration at 75% of households in urban areas and 50% in rural areas (Mahmoud et al. 2017). Kiribati's census found that over 53% of the population in the country used solar home systems in 2015—three times more than in 2010. As these examples illustrate, in small island developing states and in fragile and conflict-affected states, the potential exists to make rapid progress with solar electrification in ways that have not previously been possible with grid extension. Nevertheless, the tier of access being provided to these households is not clearly indicated in the surveys, and may not necessarily correspond to the Tier 1 threshold.

FIGURE 2.15 • Top 20 countries with highest off-grid solar access rate below and above Tier 1, 2016



Source: IRENA 2018. World Bank World Development Indicators database.

FIGURE 2.15 • Top 20 countries with highest off-grid solar access rate below and above Tier 1, 2016 (continued)



Source: IRENA 2018 World Bank World Development Indicators database.

7 Data come from the World Food Program, WFP mobile survey, November 2017.

BOX 2.2 • A NEW DATABASE ON OFF-GRID SOLAR ELECTRIFICATION

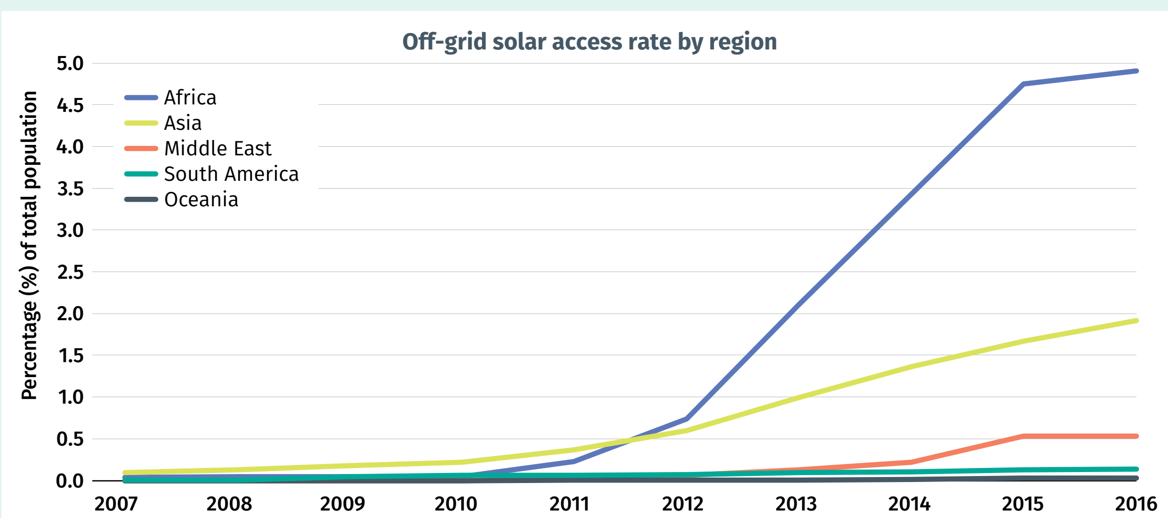
One part of the energy sector that has grown rapidly in recent years is the use of solar panels by households and enterprises to meet their own needs for electricity. These uses are often missing from official supply side energy statistics, but the growth in off-grid solar electricity production can be seen in the solar panel import statistics of many countries. IRENA has been monitoring these statistics and estimates that about 1 918 MW of off-grid solar PV capacity existed at the end of 2016 (IRENA, 2017).

During 2017, IRENA collected more detailed data about off-grid solar power developments to check the reliability of these estimates, identify end-uses and estimate the numbers of people using these sources of renewable energy (IRENA, 2018). Data sources included the Global Off-Grid Lighting Association (GOGLA), surveys of solar light and solar home system (SHS) sales, the OECD-DAC database of development projects, national and regional power plant databases, off-grid data reported on IRENA questionnaires and information obtained through organizations such as REN21 and the Alliance for Rural Electrification. The data collected from these sources included information about 180,000 off-grid solar power plants and 650 records of annual sales of solar devices, with the data covering over 40% of the currently estimated off-grid solar PV capacity (839 MW).

To estimate capacity and the numbers of people using off-grid solar power, these data points were aggregated over time for each country, technology and end-use, with adjustments to the data to avoid over-estimation. So, for example, to estimate the number of solar lights and SHS used in any year, annual sales were aggregated for a limited number of previous years to reflect the lifetime of these products (3 years for solar lights and 6 or 10 years for small or large SHS). Similarly, for mini-grids, the number of household connections was used as the measure of the population served rather than the total population in the location of the mini-grid and, for older plants, checks were made to confirm that these plants are still functioning and could be included in the analysis.

As figure B2.2.1 shows, almost all of the growth in the use of off-grid solar power has occurred in the last five years. Countries in Africa and Asia account for most this growth, with about 60 million people in Africa and 78 million in Asia now using such power sources. While these trends are dominated by the use of solar lights, it's also worth noting that about 10% of the population served in Africa obtain a higher level of energy services from off-grid solar (Tier 1 Access or more) and, in Asia, the share is even higher at 25%. The diversity of energy sources now available also reinforces the need for household surveys to include these technologies in questions about the types of energy used for lighting, cooking and other activities.

FIGURE B2.2.1 • Off-grid solar access rate by region (Tier 1 access and above)



Source: IRENA, 2018

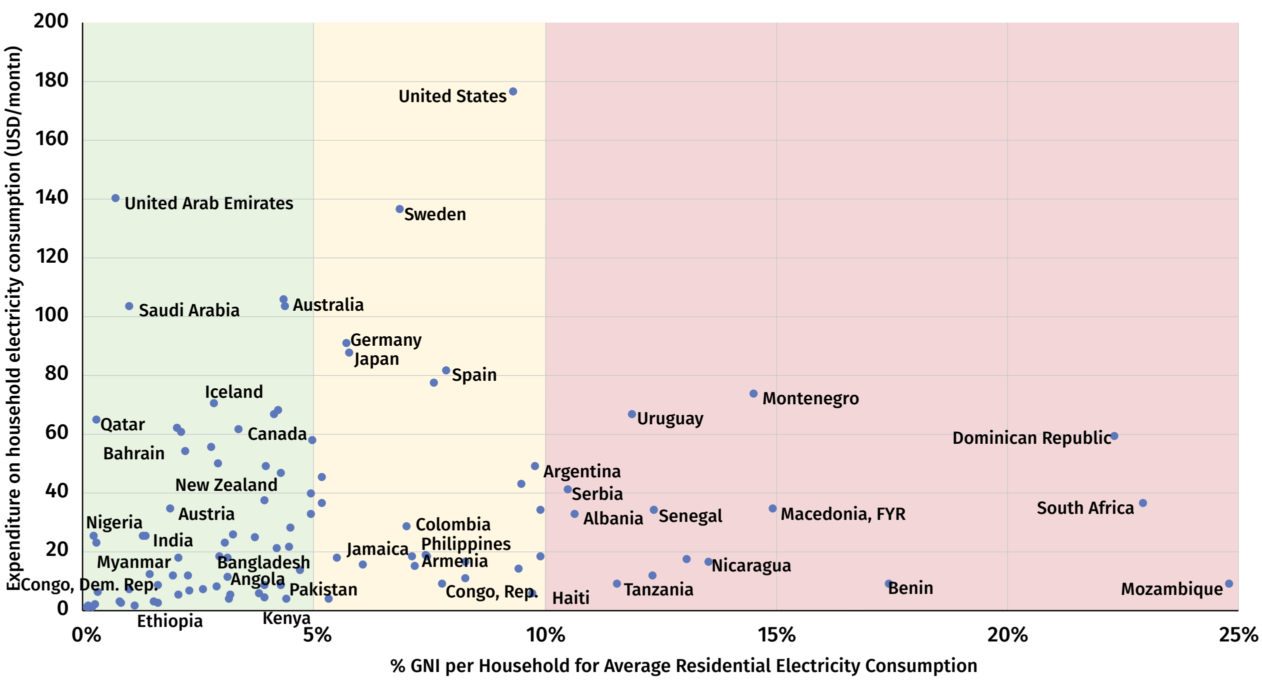
TRACKING AFFORDABILITY AND RELIABILITY

SDG 7 speaks specifically of access to affordable, reliable, modern, and sustainable energy for all. The electrification indicators currently used to report on progress provide the overall status of electrification without being able to shed light on these different attributes of electricity service, which in practice matter a great deal to governments and households alike. Moreover, when service attributes such as affordability and reliability come into focus, the universal access goal becomes relevant to all countries, regardless of whether or not they have yet to achieve universal electrification.

Although affordability is ideally measured at the household level, a preliminary sense of the affordability of electricity supply in any particular country can be obtained by examining the cost of purchasing the average residential electricity consumption for that country, normalized against the total monthly expenditures of the poorest 40% of the population. A widely used benchmark is that electricity is affordable when it accounts for no more than 5% of a household's monthly expenditures in countries with tropical climates; this threshold typically increases to 10% of expenditure in temperate climates where electricity may also be used for heating purposes.

This metric allows for wide variation in access to affordable electricity in both access-deficit and fully electrified countries. In general, electricity is more affordable in fully electrified countries where incomes are typically higher. As a result, electricity expenditures of the bottom 40% in electrified countries amount on average to 4% of their budget, compared to 8% in access-deficit countries. Nevertheless, in 2015, some 30% of the population in universal access countries spent more than 5% of their monthly expenditure on electricity, indicating affordability challenges. These challenges are far greater in access-deficit countries where almost twice as high a share of the population (57%) spent more than 5%. The countries with the least affordable electricity are primarily in Eastern Europe, Latin America, and Sub-Saharan Africa (figure 2.16).

FIGURE 2.16 • Household expenditure on electricity as a share of GNI per household of bottom 40%

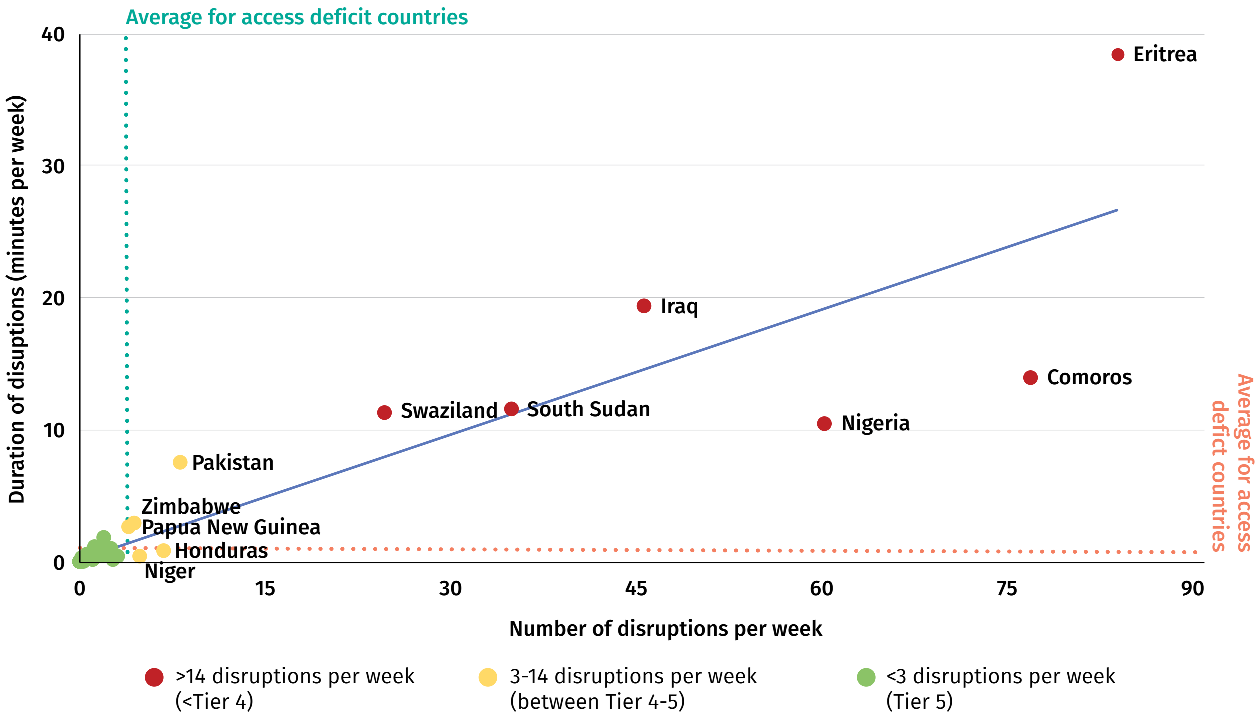


Source: World Bank RISE, WDI, IEA, UN Statistics

Turning to reliability, this is defined as the absence of unpredictable power outages and is an important attribute of the customer experience. Where adequate information systems exist, the impact of reliability on the use of electricity services is typically measured by utilities through a combination of two indexes: frequency of outages using the System Average Interruption Frequency Index (SAIFI) and duration of outages using the System Average Interruption Duration Index (SAIDI).

Evidence on these two attributes is available for 72 universal-access countries and 66 access-deficit countries from the World Bank's Getting Electricity database. The 2015 results show a strong correlation between SAIDI and SAIFI indexes, suggesting that the more frequent the outages the longer they tend to last. Because countries with universal access typically provide a highly reliable service, attention focuses on access-deficit countries. Of the access-deficit countries, about 9% have such unreliable service that their grid electricity would not provide a very meaningful form of electricity access. Some of the most egregious examples are Eritrea, Comoros, Nigeria, and Iraq—each with over 40 disruptions weekly (see figure 2.17).

FIGURE 2.17 • Average number of disruptions and duration in access deficit countries 2015



Source: IFC, Doing Business report, Getting Electricity, 2016
Note: Analysis includes 66 out of 98 access-deficit countries.

TRACKING ELECTRIFICATION PATTERNS

With the growing recognition that no one should be left behind, there is increasing interest not only in capturing national electrification rates but also in reporting disaggregated electrification rates for different vulnerable socioeconomic groups. Such analysis is possible using survey data on a wide range of other household characteristics. The World Bank's Global Poverty Working Group Database (GPWG-DB)[8] compiles harmonized

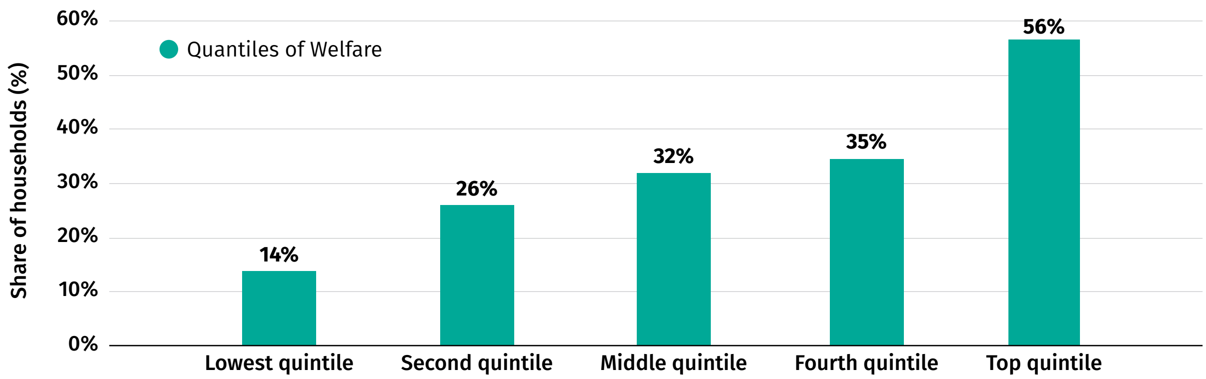
[8] GPWG-DB is an World Bank internal database that enables access to most recent household survey data across World Bank Global Practices.

datasets of household-level microdata, including household electrification status, gender of head of household, and house consumption aggregate (welfare). The GPWG-DB makes it possible to take a systematic look at how access varies—not only across rural and urban space but also between rich and poor and between male- and female-headed households. Detailed results for the top 20 access-deficit countries are provided in the annex 2B, and a quick overview is given below.

Economic inequalities between rich and poor are also reflected in patterns of access to electricity in access-deficit countries. Disaggregating electricity coverage by household welfare quintiles (from poorest to richest) shows that access for the top quintile is four times higher than access in the bottom quintile. Access rises progressively with a jump of about 5 percentage points across the lower quintiles, with the biggest jump of 20 percentage points occurring between the fourth and fifth quintiles (see figure 2.18).

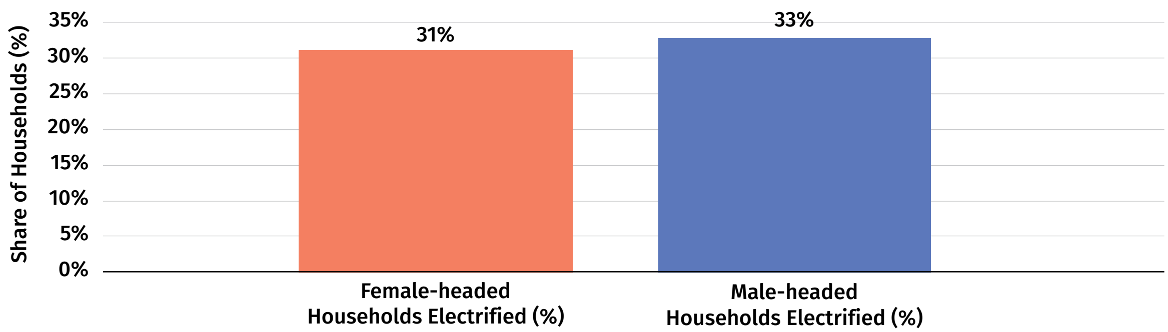
On the other hand, gender-disaggregated data show that electricity access for male- and female headed-households differs only slightly (1.6 percentage points) overall (figure 2.19). Moreover, controlling for poverty level, the disparity in access between male and female households largely disappears, indicating that any disadvantage experienced by female-headed households may be related more to poverty than to gender. In a majority of the 20 largest access deficit countries (referred to in this report as the Top 20), access levels across male- and female-headed households are similar. Exceptions include countries such as Ethiopia, Mali, and Nigeria where access rates for female-headed households are two percentage points higher, and countries such as Angola, Bangladesh, Chad, Sudan, and Zambia, where male-headed households enjoy substantially higher access rates.

FIGURE 2.18 • Access by quintiles of household welfare



Source: World Bank analyses based on World Bank's Global Poverty Working Group Database (GPWG-DB)

FIGURE 2.19 • Access by gender of head of household



Source: World Bank analyses based on World Bank's Global Poverty Working Group Database (GPWG-DB)

TOWARDS IMPROVED FUTURE TRACKING

The growing complexity of measuring electricity access highlights a pressing need to develop a comprehensive framework for tracking progress toward electrification that can integrate all of the elements described above. The Multi-Tier Framework is a new survey-based approach to measuring electrification and addresses many of these concerns.

First, the Multi-Tier Framework collects information on seven attributes of electricity service including capacity, service hours, reliability or service interruptions, quality or voltage fluctuations, affordability, legality, and safety. On the basis of these seven attributes, the Multi-Tier Framework assigns any given household to one of five tiers according to its ability to avail different levels of energy services. Specifically, this could be Tier 0 (no meaningful access), Tier 1 (basic lighting and charging), Tier 2 (a few small appliances), Tier 3 (formal grid connection with limited service), Tier 4 (a service capable of supporting refrigeration), or ultimately Tier 5 (unrestricted continuous service).

Second, the Multi-Tier Framework also collects detailed information on the technology used to supply electricity, whether it be grid or off-grid, and the type of off-grid service provided. This is complemented with a rich array of variables on electricity demand patterns, including the household's inventory of electric appliances.

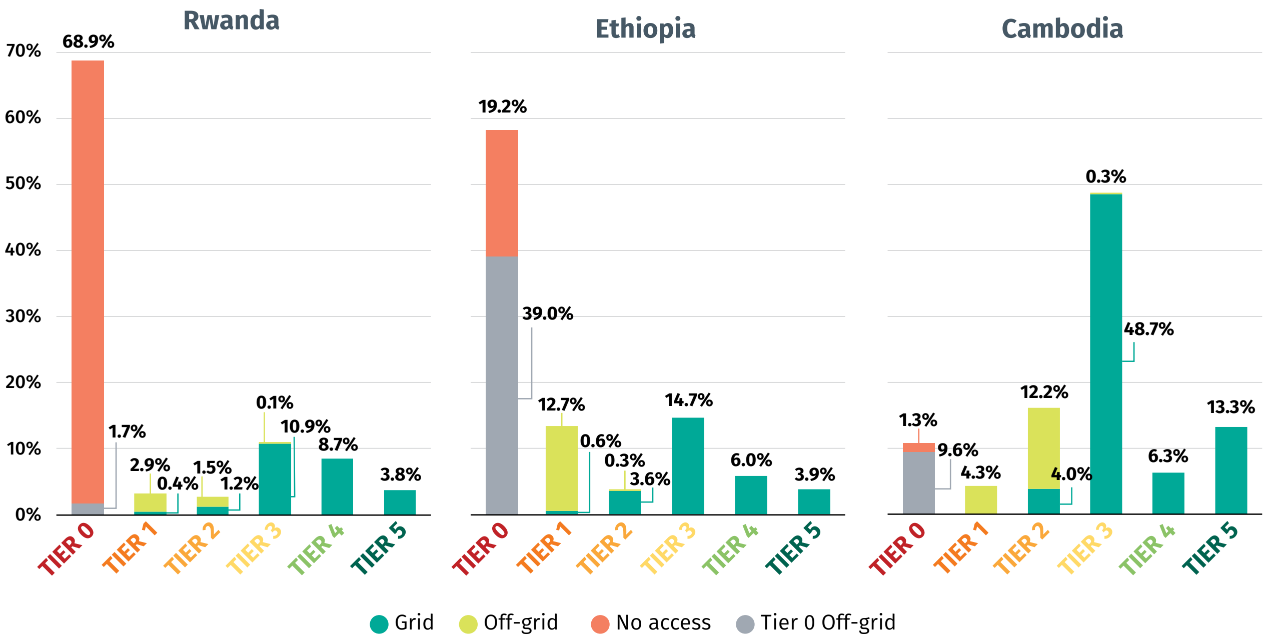
The Multi-Tier Framework has been developed over some time by a broad community of practitioners (Bhatia and Angelou 2015) and is currently being rolled out in 17 access-deficit countries around the world, with a full set of results anticipated early in 2019.

Emerging results from Cambodia, Ethiopia, Rwanda—the first three countries to complete a nationally representative survey based on the Multi-Tier Framework in 2017—providing a wider range of insights that comes from this approach.

In all three countries, the bulk of the population with access obtains electricity through grid connections (figure 2.20), and most of those with grid electricity experience service at the Tier 3 level. The surveys also provide rich information on quality of service. In Rwanda and Ethiopia, limited electricity availability at night is identified as the major issue holding people from moving up from Tier 3, whereas in Cambodia reliability—captured through the number of disruptions—is the main concern.

Off-grid electricity—mainly solar solutions in the form of solar home systems that can deliver Tier 1 service or above—also provides access to a significant share of the population, particularly in Cambodia (16.5%) and Ethiopia (13.0%), although less so in Rwanda (4.4%). It is particularly striking that in Cambodia, the majority of those with solar home systems are actually enjoying Tier 2 access, which begins to approximate the levels of service that can be provided by the grid. Equally significant is the fact that in Cambodia and Ethiopia—though not Rwanda—the majority of households without access do at least benefit from solar lighting products that provide a service level somewhat lower than Tier 1.

FIGURE 2.20 • Multi-Tier Framework: High-level Results of Cambodia, Ethiopia, and Rwanda, 2017



Source: World Bank, MTF 2018 Cambodia, MTF 2018 Ethiopia, MTF 2018 Rwanda.

Multi-Tier Framework data help identify the obstacles to expanding access and designing the most adequate electrification strategy. Although the ultimate goal may be for all households to be in Tier 5, most households, particularly in rural areas, have their basic needs satisfied even if they are in a lower tier. Low-cost off-grid solar solutions are likely to be a good alternative, at least in the short term, for households that are located away from the grid or that cannot afford a grid connection (even with a payment plan). This transition to an improved level of service must, however, be supported by an enabling environment providing clear policies, strong institutions, comprehensive strategic planning, and well-targeted incentives.

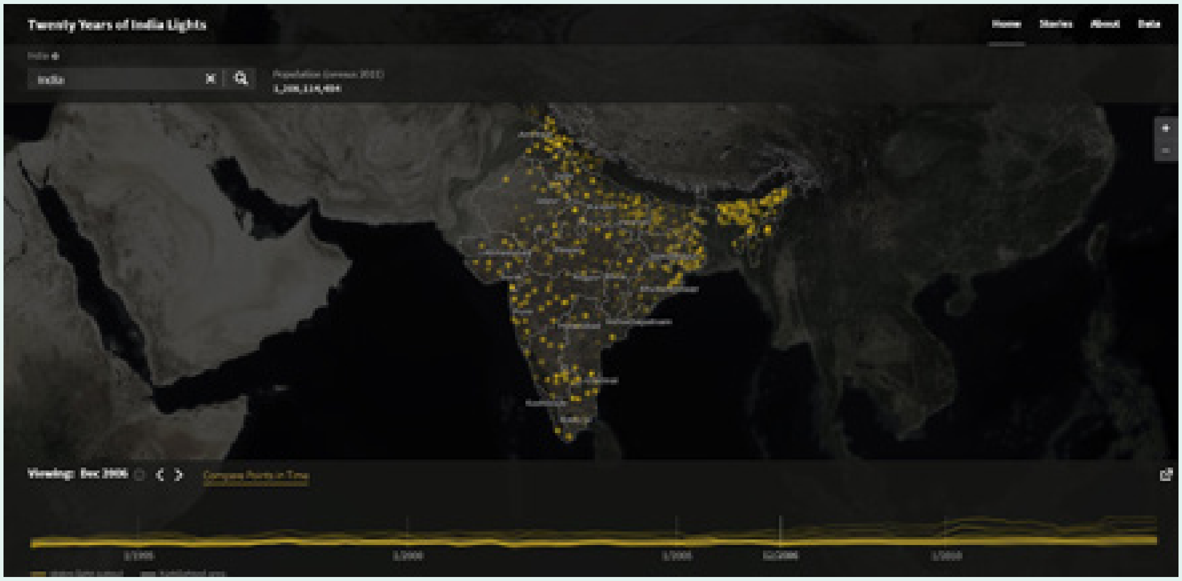
Finally—and looking a little further ahead—the arrival of a multiplicity of big data sources makes it possible to contemplate entirely different methods of tracking electrification in future. Satellite imagery, in particular, offers nightly high-resolution images of the entire world, and algorithms are being developed to interpret what night light images are telling us about expanding electricity access as well as service reliability (see box 2.3). What currently proves difficult to decipher from the ground may eventually be discoverable from the sky.

BOX 2.3 • LIGHTS FROM THE SKY

Tracking the availability and supply of electricity at the local level is critical to improve service provision. Thanks to the development of data processing technologies, the World Bank Group, with University of Michigan and the U.S. National Oceanic and Atmospheric Administration (NOAA), has been exploring the method of tracking reliability of supply using nighttime lights data. The methodology has been piloted in India's 600,000 villages, and the resulting dataset of almost five billion observations represents the most comprehensive database known describing electricity access and variability (see map B2.3.1). Not only can it produce timely tracking information but it also has recorded nighttime light signatures of villages for 8,000 nights in 21 years (1993–2013) (Monroe et al. 2018).

Overall, the project demonstrated that nighttime satellite imagery can reliably indicate the use of electricity in the developing world, even in rural contexts characterized by low power loads, few and dispersed users, limited infrastructure, and erratic service provision. Going forward, the team aims at scaling up the approach across the developing world.

MAP B2.3.1 • Nighttime light map of India.



Source: World Bank photo.
Note: The India Night Lights platform visualizes data from satellite images, so each point on the map represents the light output of a specific village at a specific time.

METHODOLOGY

Data sources

The World Bank's Global Electrification Database (GED) were used for electrification, and compile nationally representative household survey data, and occasionally census data, from sources going back as far as 1990 (table 2A.1). The database also incorporates data from the Socio-Economic Database for Latin America and the Caribbean (SEDLAC) and the Europe and Central Asia Poverty Database (ECAPOV), which are based on similar surveys. At the time of analysis, the GED contained 950 surveys from 144 countries, excluding high-income countries classified as developed by the United Nations, for 1990–2016 (see table 2A.1).

TABLE 2A.1 • Overview of data sources for electricity

Name	Statistical agency	Number of countries	Number of surveys	Question on electrification when standardized across countries
Census	National statistical agencies	65	109 (12%)	Is the household connected to an electricity supply? Or, does the household have electricity?

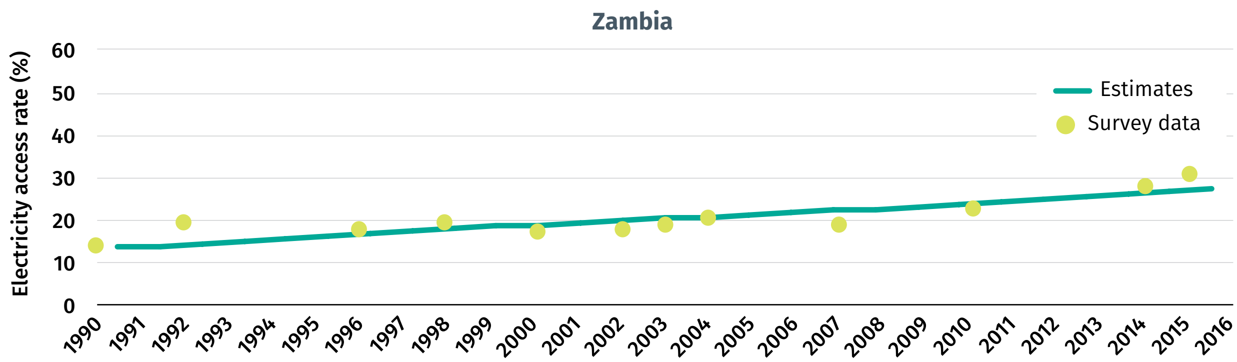
Name	Statistical agency	Number of countries	Number of surveys	Question on electrification when standardized across countries
Demographic and Health Survey	Funded by USAID funded; implemented by ICF International	87	269 (28%)	Does your household have electricity?
Living Standards Measurement Survey	National statistical agencies, supported by the World Bank	19	25 (3%)	
Income expenditure survey, or other national surveys	National statistical agencies, supported by the World Bank	96	424 (45%)	Is the house connected to an electricity supply? Or, what is your primary source of lighting?
Multi-indicator cluster survey	UNICEF	64	100 (11%)	Does your household have electricity?
World Health Survey	World Health Organization	8	8 (<1%)	
Multi-tier Framework	World Bank	3	3 (< 1%)	
Other		12	12 (1%)	

Estimating missing values

A typical frequency of surveys is every two to three years, but for some countries and regions surveys can be irregular in timing and much less frequent. To estimate missing values, a multilevel nonparametric modeling approach, which was 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 1990–2016. Where data are available, access estimates are weighted by population.

In this approach, time series comprise survey data and estimates. Zambia, for example, had 12 surveys in 1990–2016 comprising Demographic and Health Surveys, multi-indicator cluster surveys, and other national surveys; the remaining 14 years are filled in with estimates (see figure 2A.1).

FIGURE 2A.1 • Survey data and model output, Zambia, 1990–2016



Multilevel nonparametric modeling takes into account the hierarchical structure of data (country and regional levels). Regional groupings are based on UN breakdown, with Sub-Saharan Africa further divided into Eastern Africa, Central Africa, Southern Africa, and Western Africa.

The model is applied for all countries with at least one data point. In order to use as much as 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 only to fill in data for years where they are missing and to conduct global and regional analysis. The difference between real data points and estimated values is clearly identified in the database.

Countries considered as “developed” by the UN, and classified as high income are assumed to have an electrification rate of 100% from the first year the country entered the category.

Calculating the annual change in access rate

The annual change in access rate 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.

Methodology for socioeconomic patterns for electrification

Data on welfare, access to electricity, and gender of head of household come from the GPWG-DB, which compiles harmonized datasets of household-level microdata. Harmonized microdata from the latest available survey were included: Angola (*Inquérito Integrado sobre o Bem-Estar da População* 2008–09), Bangladesh (Household Income and Expenditure Survey 2010), Burkina Faso (*Enquête sur les Conditions de Vie des Ménages* 2009), Chad (*Enquête sur la Consommation des Ménages et le Secteur Informel au Tchad* 2011), the Democratic Republic of Congo (Enquete Nationale Du Type 1-2-3 2012), Ethiopia (Household Income, Consumption and Expenditure Survey 2010), India (National Sample Survey 2010–11 [67th round]), Kenya (Integrated Household Budget Survey 2005–06), Madagascar (*Enquête Périodique auprès des Ménages* 2010), Malawi (Third Integrated Household Survey 2010–11), Mali (Household Budget Survey 2010), Mozambique (*Inquérito sobre Orçamento Familiar* 2008–09), Myanmar (Myanmar Poverty And Living Conditions Survey 2015), Nigeria (Living Standards Survey 2009), Pakistan (Social and Living Standards Measurement Survey 2013–14), South Sudan (National Baseline Household Survey 2009), Sudan (National Baseline Household Survey 2009), Tanzania (Household Budget Survey 2011–12), Uganda (National Household Survey 2012–13), and Zambia (Living Conditions Monitoring Survey VI 2010). Microdata were aggregated to derive estimates of household electrification rates and concentration by gender of the head of household, by quintiles of household welfare.

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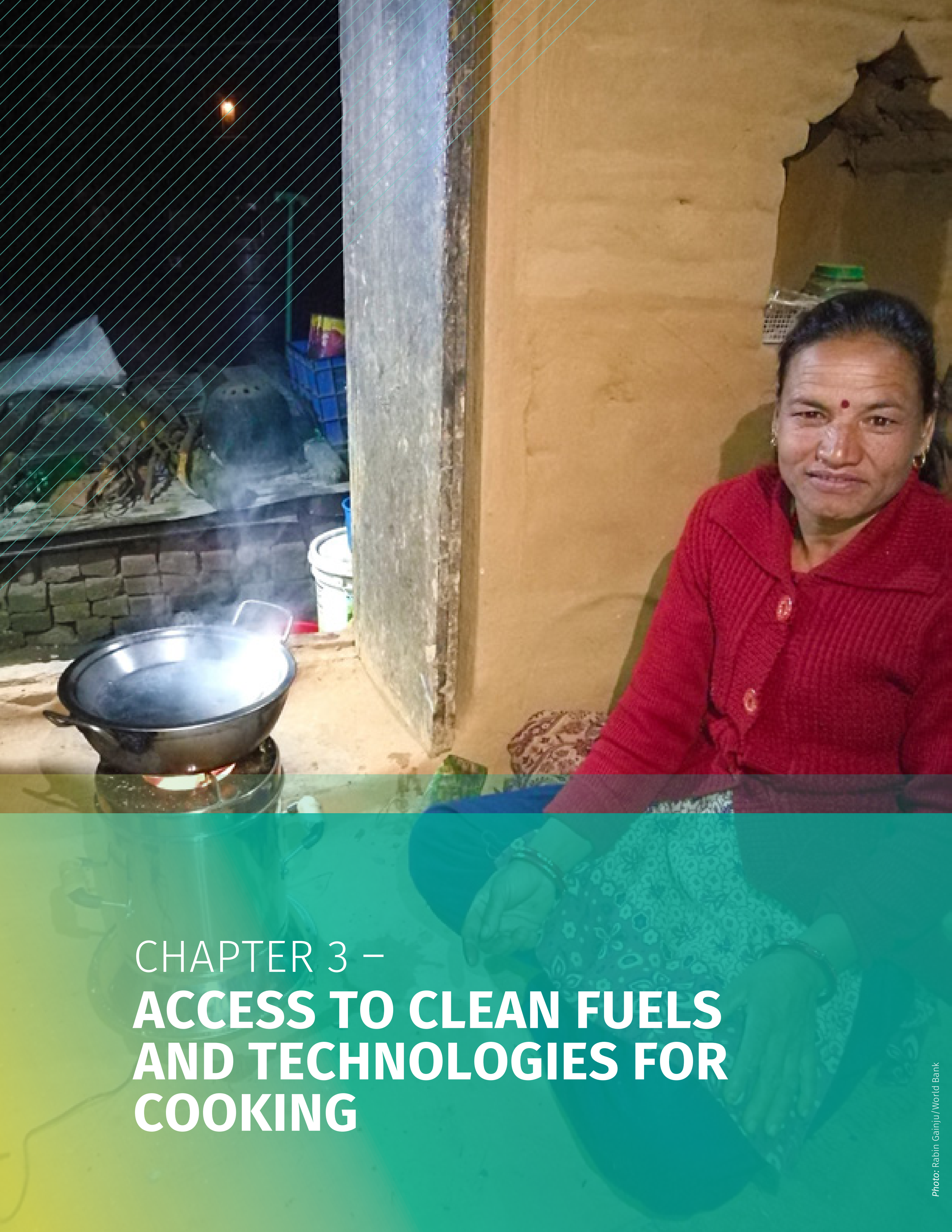


CHAPTER 3 –

ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING

Photo: Rabin Gainju/World Bank

MAIN MESSAGES

- **Global trend:** The share of the global population with access to clean cooking fuels and technologies[1] (hereinafter referred to as "access to clean cooking") increased from 58% in 2014 to 59% in 2016. With an additional 84 million of the global population gaining access annually during 2014–16, the annual expansion of access marginally outpaced population growth. This resulted in a very slight decrease of some two million people in the absolute global deficit in access to clean cooking in 2014–16, still leaving the global access-deficit just short of 3 billion.

- **2030 target:** To reach universal access to clean cooking by 2030, the annual rate of clean cooking access between 2016 and 2030 needs to accelerate to 3 percentage points from an average annual growth rate of 0.5 percentage points that was seen in 2010–16. Owing to slow progress to date, as well as population growth in the access-deficit countries, the 2030 target is unlikely to be met. If the current trajectory of access gains persists, 2.3 billion of the global population will be without access to clean cooking in 2030 (IEA 2017).

- **Regional highlights:** In developing Asia, incremental access to clean cooking outpaced growth in population, although the speed of expansion slowed. In Sub-Saharan Africa, although there was a marginal improvement in the pace of access gains, the growth rate still remained at about 0.3 percentage points annually. Nevertheless, the region's overall population grew four times as fast as the population with access to clean cooking.

- **Urban-rural distribution:** Access to clean cooking remains much higher in urban areas, where 83% have access, than in rural areas, where only 32% have access. The chasm between urban and rural access to clean cooking has marginally decreased (by 0.4 percentage points annually between 2014 and 2016).

- **Top 20 access-deficit countries:** The top 20 access-deficit countries, which cumulatively account for 83% of the global population without access, saw an average annualized growth in access of 0.9 percentage points in 2014–16. However, in only 9 out of the 20 countries did expansion of access outpace population growth. These positive outcomes were driven primarily by widespread dissemination of fuel-efficient stoves and cooking solutions based on liquefied petroleum gas (LPG) in India, Pakistan, Indonesia and Vietnam, all of which increased access by over 1 percentage point annually.

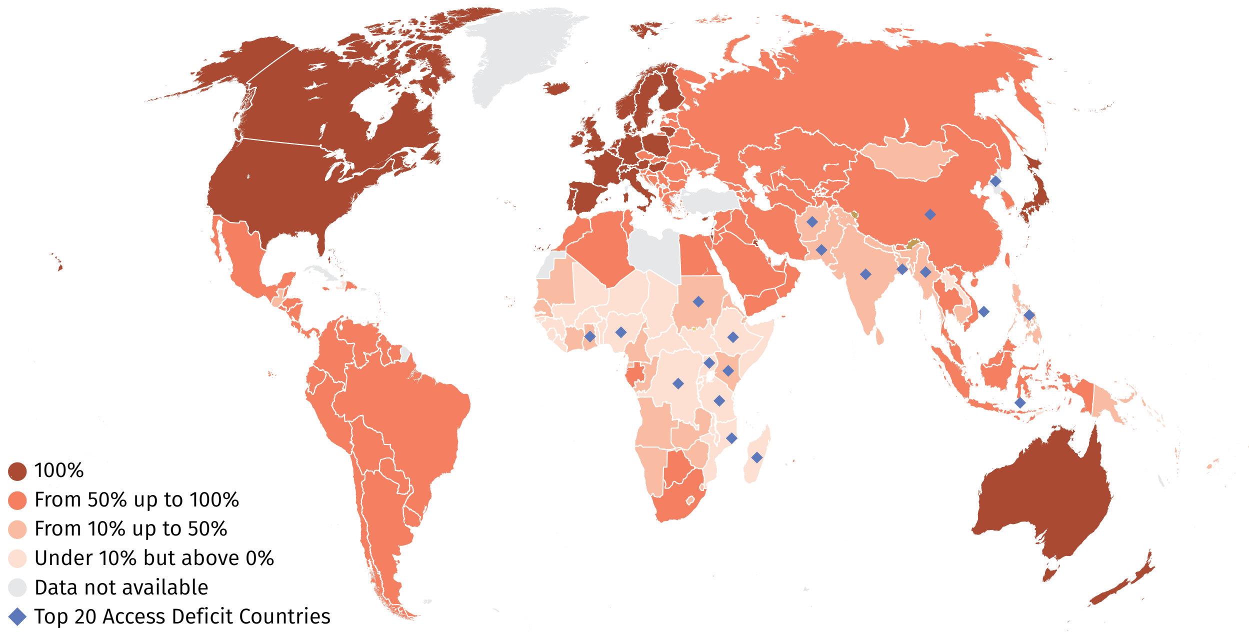
- **Policy implications:** Unfortunately, the rapid deployment of clean cooking fuels and technologies has not received adequate attention from policy makers, and it lags behind the rate of electrification. High entry costs for many clean cooking solutions, the lack of consumer awareness of their benefits, financing gaps for producers seeking to enter clean fuel and stove markets, and slow progress in

[1] The proportion of population with primary reliance on clean fuels and technology is calculated as the number of people using clean fuels and technologies for cooking, heating, and lighting divided by total population, expressed as percentage. "Clean" is defined by the emission rate targets and specific fuel recommendations (that is, against unprocessed coal and kerosene) included in the normative guidance World Health Organization guidelines for indoor air quality: household fuel combustion.

the development of cookstove models and fuel production solutions exacerbate the challenges to uptake of clean cooking solutions (World Bank 2015).

STATE OF ACCESS TO CLEAN COOKING IN 2016

FIGURE 3.1 • Share of population with access to clean cooking in 2016 (%)



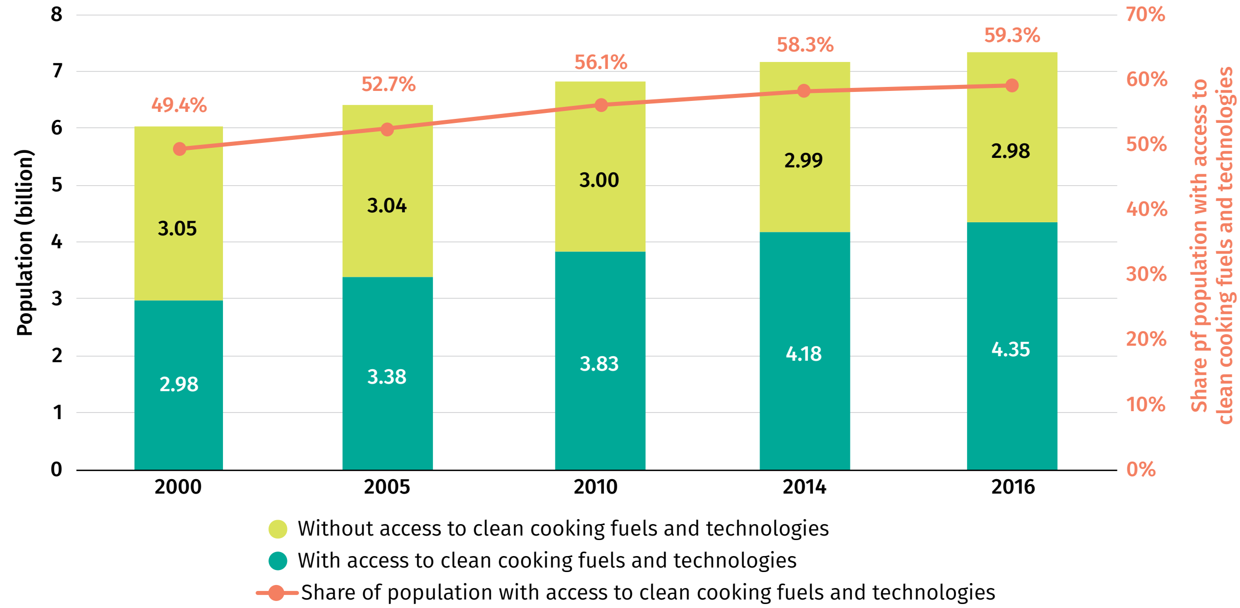
Source: World Health Organization. Population estimates based on the use UN population data

THE STORY IN PICTURES

GLOBAL TRENDS

The global rate of access to clean cooking has improved gradually reaching 59 % in 2016

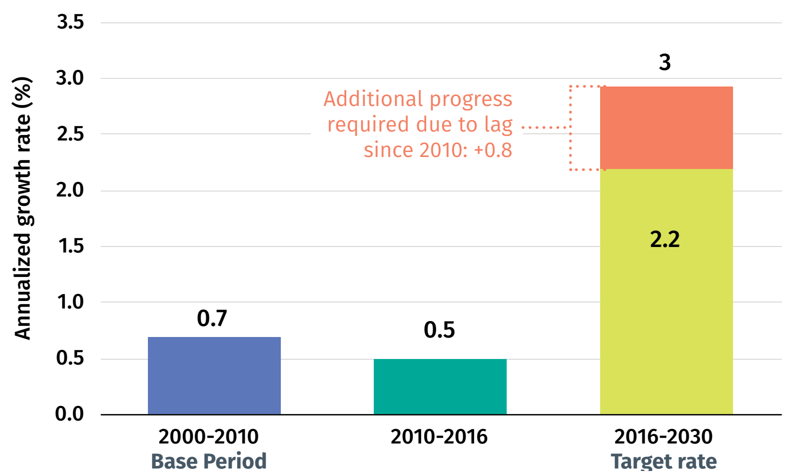
FIGURE 3.2 • Progress in clean cooking access from 2000 to 2016 (billions of people and share of population with access to clean cooking)



Source: World Health Organization. Population estimates based on the use UN population data

Continued deceleration of progress on clean cooking from 2010-2016 puts the 2030 universal target ever further out of reach

FIGURE 3.3 • Average annual increase in access rate to clean cooking (percentage points)

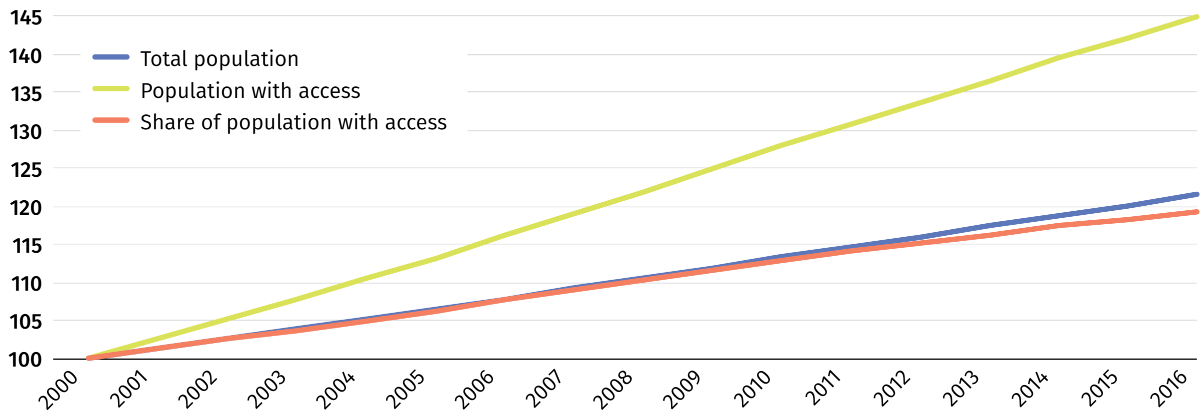


Source: World Health Organization. Population estimates based on the use UN population data

ACCESS AND POPULATION

Progress in population with access to clean cooking marginally outpaced population growth, marking a slight decrease in global clean cooking access-deficit

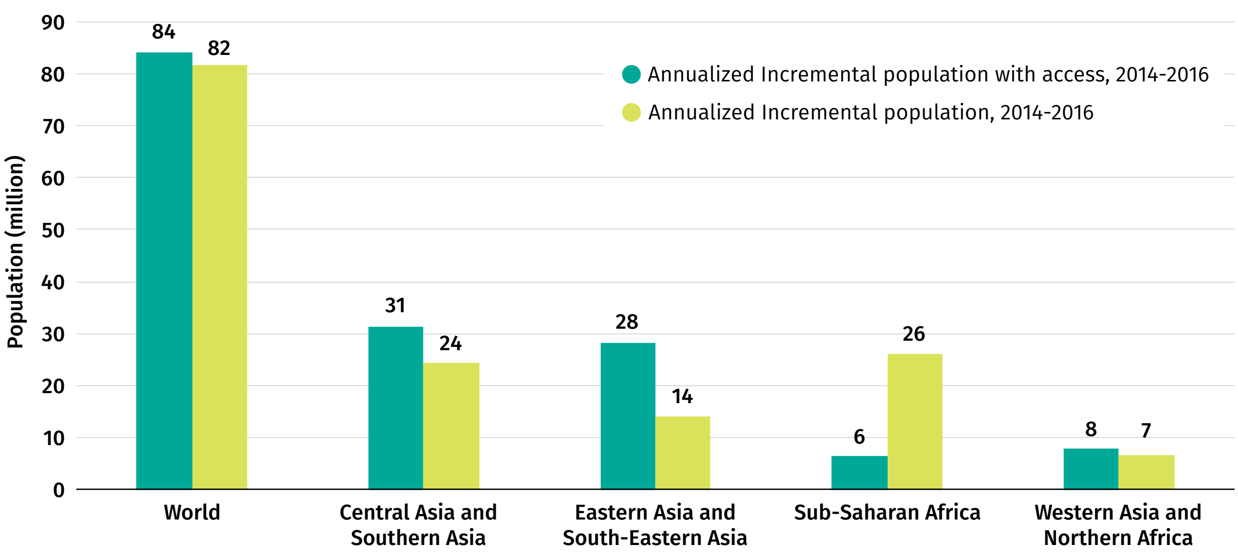
FIGURE 3.4 • Clean cooking access and population growth from 2000 to 2016, (index, 2000 = 100)



Source: World Health Organization. Population estimates based on the use UN population data

Access to clean cooking outpaced population growth in every region except for Sub-Saharan Africa

FIGURE 3.5 • Annual incremental access and population growth, by region, 2014-2016

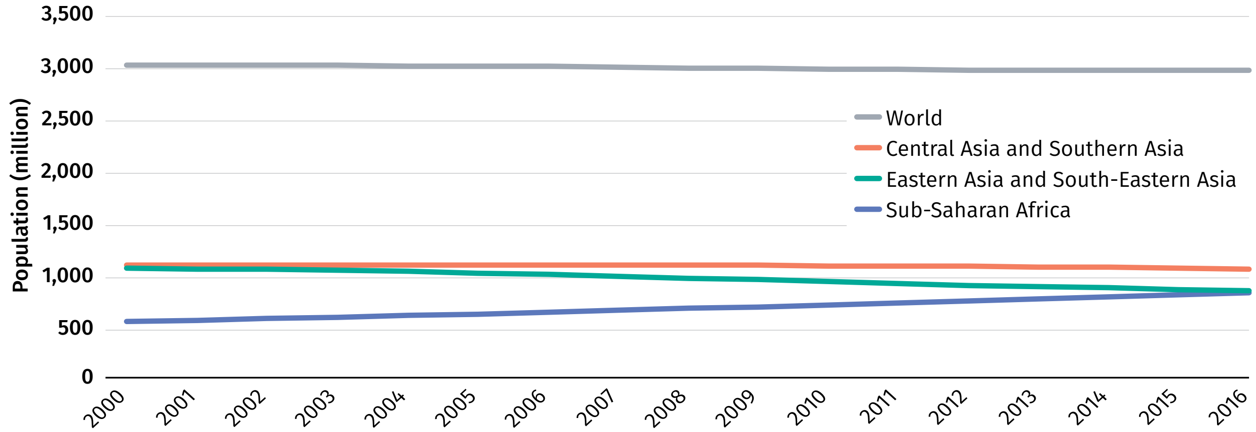


Source: World Health Organization. Population estimates based on the use UN population data

THE ACCESS DEFICIT

Population lacking access to clean cooking has plateaued at just under 3 billion, while the absolute size of the deficit continues to grow in some regions

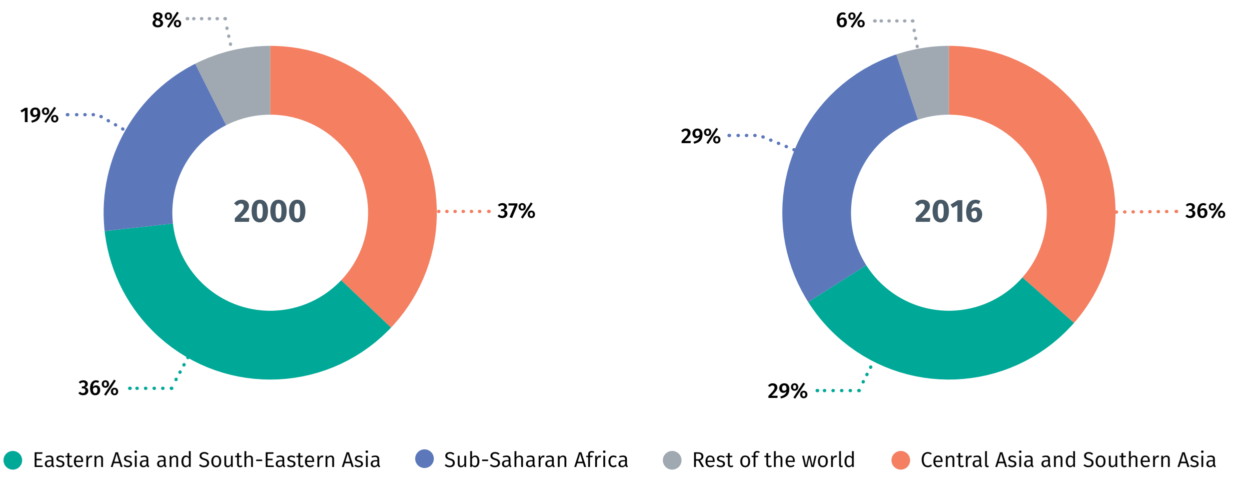
FIGURE 3.6 • Evolution of the access-deficit (millions of people), 1990-2016



Source: World Health Organization. Population estimates based on the use UN population data

While the global access-deficit has remained at around 3 billion since 2000, Sub-Saharan Africa's deficit has not kept up with population growth, rising from 585 million in 2000 to just over 860 million in 2016

FIGURE 3.7 • Share of the regions in the global access deficit, 2000 and 2016

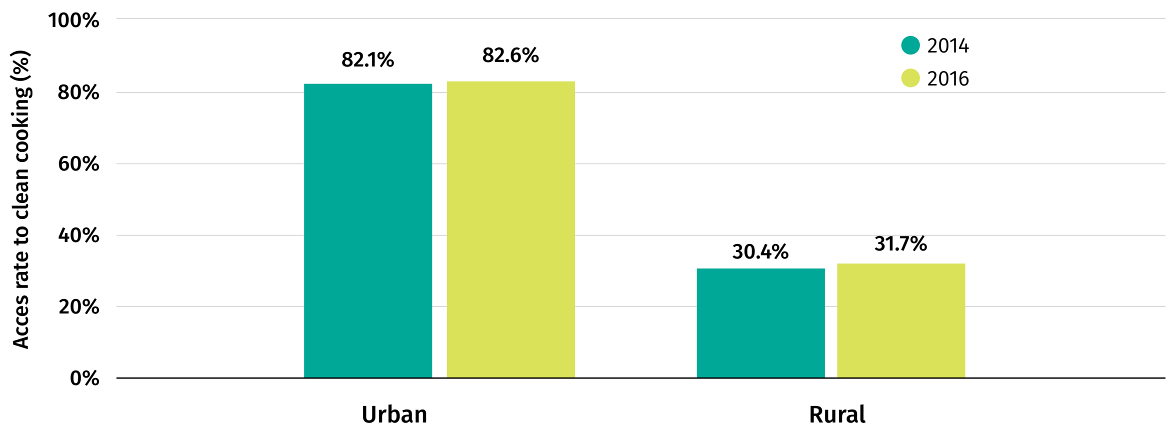


Source: World Health Organization. Population estimates based on the use UN population data

URBAN-RURAL DIVIDE

Access gains was faster in rural areas compared to urban areas

FIGURE 3.8 • Share of population with clean cooking access in urban and rural areas, 2014 and 2016

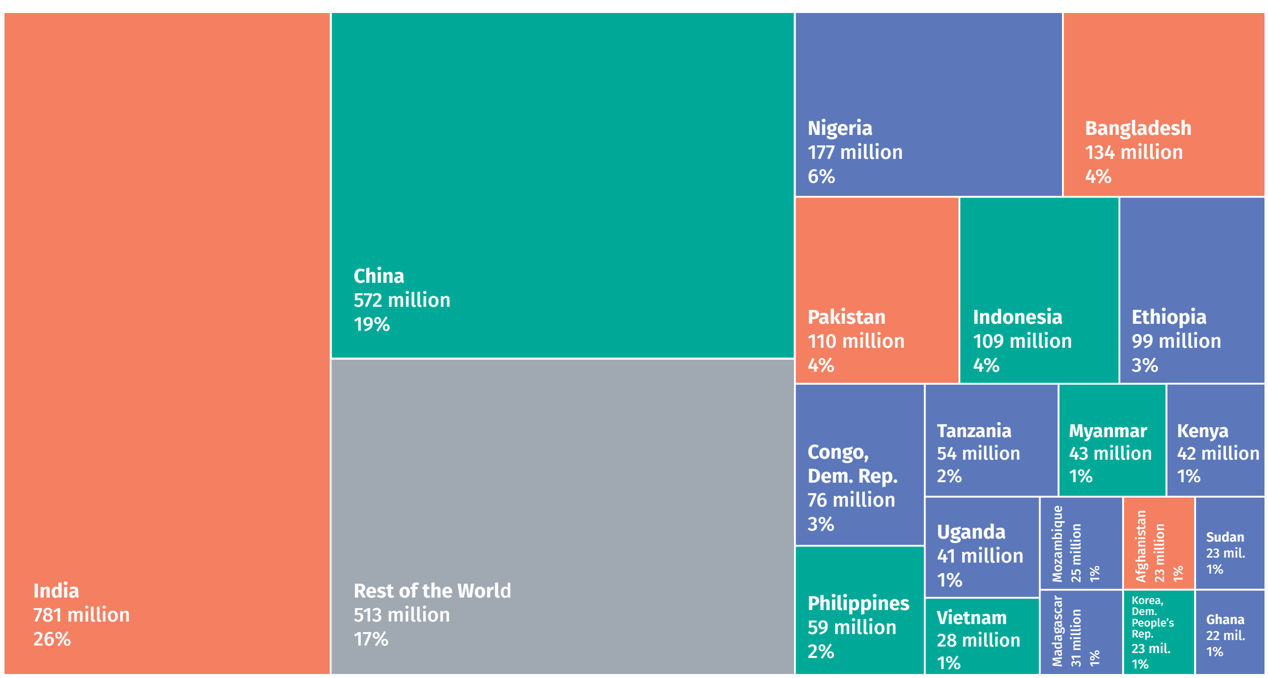


Source: World Health Organization. Population estimates based on the use UN population data

COUNTRY TRENDS

The top 20 access-deficit countries accounted for 83% of the global access-deficit, and India alone accounted for 26% in 2016

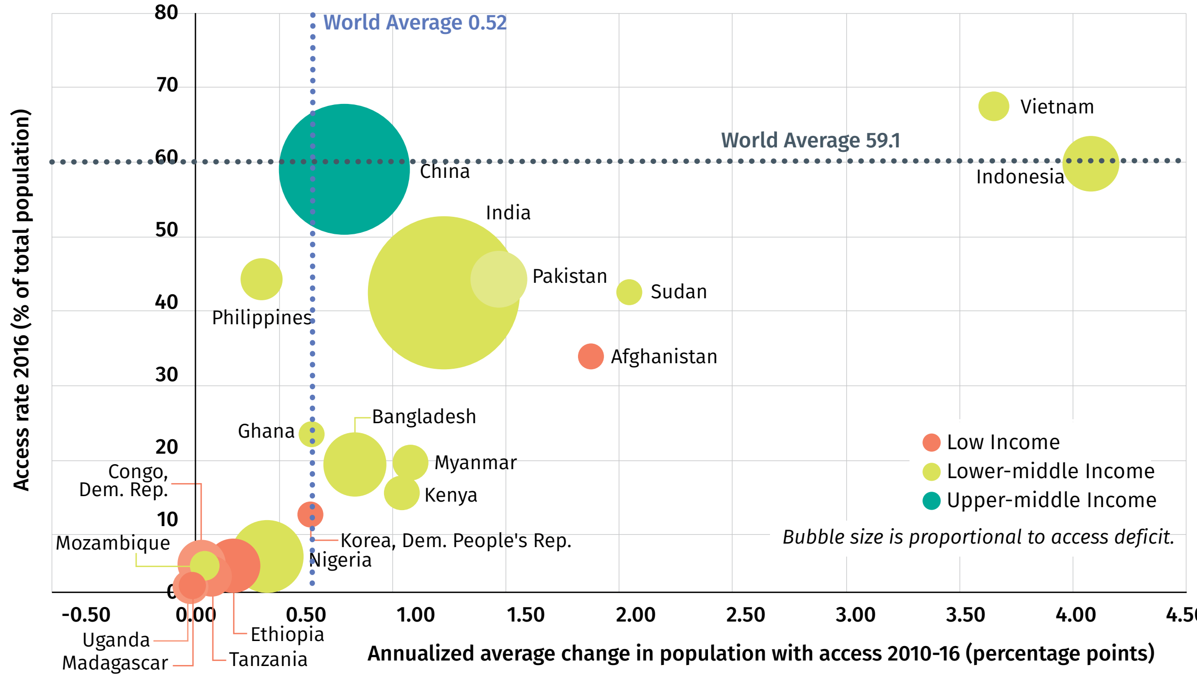
FIGURE 3.9 • Share of the 20 largest access deficit countries in the population without access to clean cooking, 2016



Source: World Health Organization. Population estimates based on the use UN population data

About half of the top 20 access-deficit countries are expanding access to clean cooking more rapidly than the global average, though many of the others are making little, if any progress

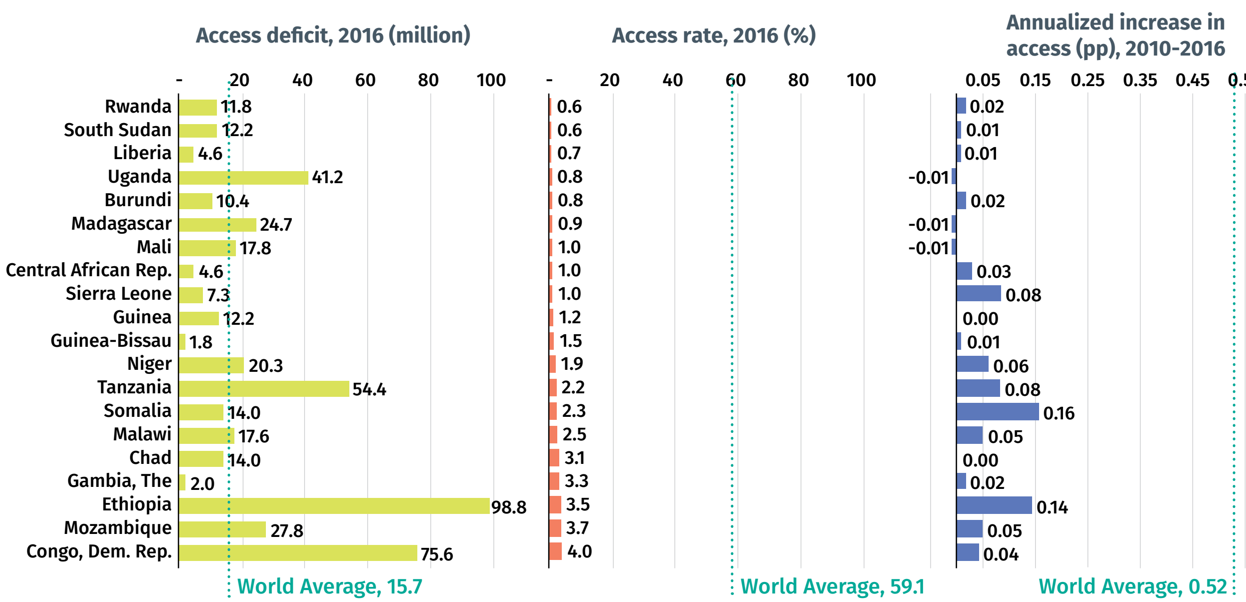
FIGURE 3.10 • The 20 countries with the largest clean cooking access-deficit over the 2010-2016 period



Source: World Health Organization. Population estimates based on the use UN population data

Four out of the world's 20 lowest-access countries did not see any increase in access to clean cooking over 2010 - 2016

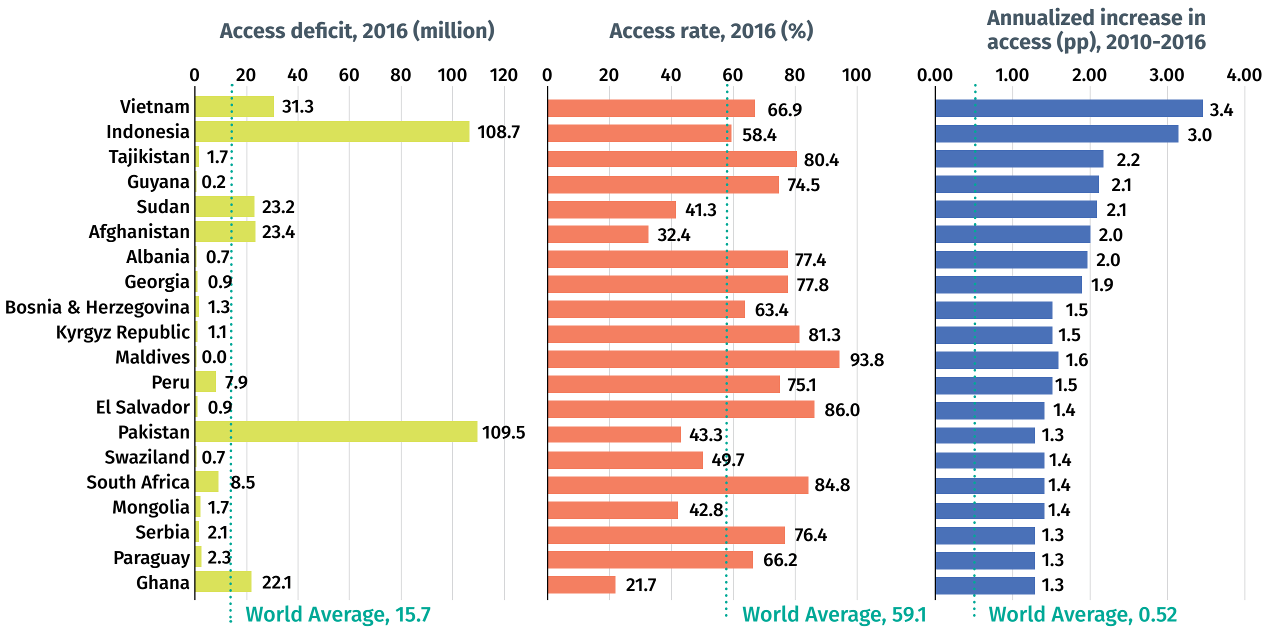
FIGURE 3.11 • The 20 countries with lowest access to clean cooking over the 2010-2016 tracking period



Source: World Health Organization. Population estimates based on the use UN population data

All of the 20 fastest-moving countries[2] gained access over twice as fast as the global average during 2010-2016

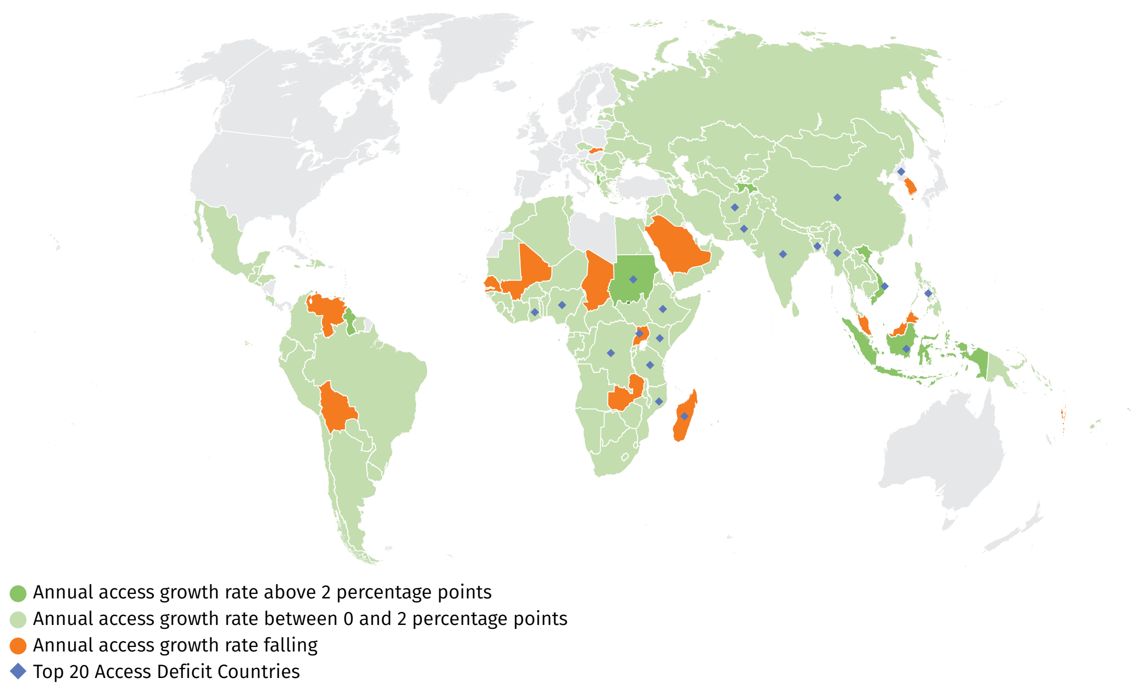
FIGURE 3.12 • The 20 fastest moving countries over the 2010-2016 tracking period



Source: World Health Organization. Population estimates based on the use UN population data

Since 2010, only 7 countries expanded their access to clean cooking at over 2 percentage points annually, and as many as 15 countries saw a decline in access rate from 2010 to 2016

FIGURE 3.13 • Annual increase in clean cooking access rate in 2010-2016 (pp) in access-deficit countries



Source: World Health Organization. Population estimates based on the use UN population data

2 Countries with the highest annual increase over the 2010-2016 period

POLICY IMPLICATIONS

Sustainable Development Goal (SDG) 7 calls for universal access by 2030 to affordable, reliable, and modern energy services, including clean fuels and technologies (hereinafter known as "access to clean cooking"). Clean fuels and technologies are also critical for achieving the goals set by other SDGs that pertain to poverty alleviation, good health, gender equality, and climate action. Thus, providing households with universal access to clean cooking is of vital importance in the 153 countries that are still experiencing access-deficit around the world.

Tracking household energy use, including primary and supplementary fuels and technologies for cooking, heating, and lighting, is nevertheless a complex exercise. To improve data collection, the World Health Organization (WHO) in cooperation with Global Alliance for Clean Cookstoves and the World Bank has worked with national surveying agencies, researchers, countries, and other stakeholder groups to enhance and harmonize national-level survey data collection on energy access. This complements the World Bank's Multi-Tier Framework, which endeavors to capture more detailed information on the cooking system and to distinguish between the various tiers of access on the spectrum of traditional to modern energy services. Further assessment of impacts on health, environment, climate, gender, and livelihood would be crucial to understanding the full burden of traditional fuels and technologies and to fully capture the interactions between the technologies, cooking environment and user's experience.

In 2016, global access to clean cooking reached 59% from 58 % in 2014. The pace of access gains in 2014–16 was 0.5 percentage points annually and has been declining consistently year on year since 2010. Clean cooking access was provided to an additional 84 million annually in 2014–16, marginally outpacing population growth of 83 million annually. As a result, the absolute access-deficit decreased slightly from 2.986 billion people in 2014 to 2.983 billion in 2016.

At the current annual rate of progress, the world is not on track to meet the 2030 target of universal access to clean cooking. In order to meet the target, the annual growth rate needs to accelerate from 0.5 to 3 percentage points annually for the period 2016–30. In the absence of such acceleration, it is estimated that 2.3 billion people will remain without access to clean cooking in 2030, as projected by the New Policies Scenario of the International Energy Agency (IEA). This shortfall will leave one in three people in India, and a little less than one in two people in Sub-Saharan Africa without access to clean cooking in 2030.

GEOGRAPHIC VARIATIONS

The disparity in access to clean cooking across global regions is particularly stark. The global access-deficit of about 3 billion people is heavily concentrated in three geographic regions: 1.08 billion live in Central Asia and Southern Asia; 881 million live in Eastern Asia and Southeastern Asia; and 862 million live in Sub-Saharan Africa. Compared to 2014, Asian regions decreased their access-deficit by 17 million annually, but this progress was largely offset by a 20 million annual increase in the population without access to clean cooking in Sub-Saharan Africa.

Regional disparity in access can be attributed to several factors, including proactive policies, which in turn facilitate adoption of such fuels and technologies in households. On the other hand, uptake of clean cooking solutions can be limited because of issues of affordability, low awareness and willingness to pay for clean cooking solutions, easy access to free and traditional fuels, last-mile distribution constraints, and cultural, technical, and environmental factors.

Sub-Saharan Africa saw an increase in access to clean cooking of 0.3 percentage points annually during 2014–16. The slow progress in the uptake of clean cooking solutions in most of the 48 countries in the region is of grave concern. However, Ghana's success with clean cookstoves and use of clean cooking fuels like LPG, led to an annual increase of close to 1.1 percentage points in its clean cooking access in 2014–16. Uptake of LPG was supported through subsidies from 1990 to 2013, but the improvement in access seen in the recent past is due to Ghana's economic growth. Several programs provide encouraging examples for other countries to emulate: the Ghana Alliance for Clean Cookstoves and Fuels (GHACCO), a stakeholder platform to help convene the clean cooking sector, that has a target to reach 4 million households by 2020; the government's efforts to improve safety, availability, and reliability of LPG for cooking; and local efforts to sensitize households on the merits of clean cooking.

Central Asia and Southern Asia gained access by over 1 percentage point annually during 2014–16, with India and Pakistan emerging as regional leaders. India's expansion of access to clean cooking by over 1 percentage point annually—reaching 41.3% in 2016 from 39.2% in 2014—was supported by policies for increasing clean cooking among the poor. Particularly noteworthy is India's targeted subsidization of LPG stoves and refills for women living below the poverty line through the Pradhan Mantri Ujjwala Yojana (PMUY program). The PMUY program has already provided over 35 million new clean cooking connections to poor households since 2016. This noteworthy scale-up is further complemented by the Give It Up campaign in India. This campaign aims to motivate LPG users who can afford to pay the market price for LPG to voluntarily surrender their LPG subsidy so it can be extended to the poor.

A clean cooking access gain of 0.8 percentage points in Eastern Asia and Southeastern Asia was driven by expansion in China, Indonesia, and Vietnam, with the region expanding its share of access to clean cooking from 59% in 2014 to 60% in 2016. In China, residential biomass use has been declining 6% per year since 2010, largely replaced by natural gas, LPG, biogas, and electricity demand—especially in urban areas driven by policy efforts targeting clean cooking (WHO 2016). Vietnam has made remarkable access gains of over 3 percentage points annually since 2010, mainly driven by nongovernmental organizations with some support from the government in the form of price stabilization for LPG.

It is pertinent to note that countries like China, India, Pakistan, Indonesia, and Vietnam—all of which except China are lower-middle-income countries—have been able to make progress despite their large and growing populations. This progress has been enabled by the growth in per capita income that has helped lower their primary reliance on inefficient solid biomass stoves. However, the lag in progress in low-income countries, some of which have seen a decline in access, indicates that these countries are unable to benefit from advances in clean cooking fuels and technologies. Therefore, they may not be able to leapfrog and replicate, in the short term, what other countries have accomplished. For such countries, the low-emission stoves serve as an important transitional solution—with some benefits for health and livelihoods—until they can graduate to the cleanest solutions.

The factors driving regional disparities also influence urban and rural access to clean cooking. In every region of the world, a significantly higher fraction of the urban population has access to clean cooking compared to the rural population. In 2016, 68% of the rural population relied primarily on traditional fuels for cooking, whereas only 17% of the urban population was exposed to traditional fuels. The disparity in rural-urban population access is most pronounced in Eastern Asia and Southeastern Asia where urban access is 85% and rural access is 15%. In Sub-Saharan Africa, overall access, while low at 13%, has a smaller disparity of 25% between rural and urban distribution of access to clean cooking.

The IEA's New Policies Scenario predicts the urban penetration of clean fuels will reach 95% in 2030; primary reliance on traditional fuels and technology for cooking will predominantly become a rural issue. Of the population without access, 1.8 billion people will be in rural areas and remain reliant on the traditional use of biomass. For achieving universal access to clean cooking, different tailored approaches need to be adopted for rural and urban contexts. Although deployment of LPG, natural gas, and electricity for cooking is the most viable solution in urban areas with high population density, diffusion of cleaner low-emission biomass cookstoves may serve as a transitional solution for very poor and remote rural areas with lower population density.

COUNTRY ANALYSIS

Top 20 access-deficit countries

Universal access to clean cooking in the top 20 access-deficit countries accounted for 83% or 2.47 billion of the global clean cooking access- deficit in 2016. Nine of the 20 countries are in Sub-Saharan Africa, 6 in Eastern Asia and Southeastern Asia, 4 in Central Asia and Southern Asia, and 1 in Western Asia and Northern Africa. In 2014–16, several clean cooking access-deficit countries embarked upon unique journeys to fulfill the targets under SDG 7.

In 2016, 90% of the top 20 access-deficit countries increased their share of access to clean cooking; Vietnam and Indonesia led the group with gains of over 3 percentage points annually. The top 20 access-deficit countries progressed faster than the global average, increasing access by close to 1 percentage point. Eight of 20 countries have been annually increasing access to clean cooking by 1 or more percentage points since 2010. However, in only 9 countries did access expansion outpace population growth. Uganda and Madagascar not only failed to make any improvements in access to clean cooking but their access rates also actually declined since 2010.

Countries with the lowest clean cooking access rate

The 20 countries with the lowest rates of access to clean cooking saw a marginal growth of a little over 0.3 percentage points annually in their combined access rate from 2014 to 2016, although only 16 of these countries showed actual individual increase. The progress in clean cooking access has remained constantly poor in these countries since 2010, with declining access rates in Chad, Madagascar, Mali, and Uganda, and cumulative progress for the group lingering at about 0.3 percentage points annually.

Fastest-moving countries

The 20 fastest-moving countries added 21 million annually to the population with access to clean cooking in 2014–16. These countries made access gains of 1.6 percentage points annually during 201–16, over 1 percentage point higher than the global average growth rate of 0.5 percentage points. Access growth rates in these 20 countries have consistently outpaced the global average by over 1 percentage point since 2010.

CONCLUSIONS

Lack of access to clean cooking disproportionately impacts women compared to men. In many countries, gender roles dictate that women and girls act as the primary procurers and users of cooking fuel, resulting in a gender disparity in exposure to traditional household air pollution and the drudgery of traditional cooking practices. In this context, governments should ensure that policies and programs to promote clean cooking are well-informed by gender considerations. Universal access to modern energy cooking services is predicated on a multi-sectoral approach, from technological development, to awareness raising and behavior change campaign, to private sector development and financing. It is critical to unite all forces and seek guidance from all stakeholders, particularly women, to shift the needle on universal access.

Although an increasing number of countries are beginning to show acceleration in access to clean cooking, the world has shown slow progress and challenges remain, notably in rural areas.

On the demand side, barriers persist because of the prevalence of fuel and stove stacking—when households use a combination of modern and traditional cooking solutions instead of completely transitioning to modern options. Full adoption is further impeded by the lack of affordability of clean solutions; consumer preferences; and poor understanding of the health and environmental benefits and time savings of clean cooking. Cooking practices are entrenched in household culture, and mere access to clean energy fuels and technology does not ensure their use. Therefore, messaging that highlights the benefits in terms of cleanliness, convenience, durability, ease of use and fuel processing, availability and affordability of fuel, and cultural appropriateness must be devised.

Ensuring maximum benefits from the energy transition requires renewed focus on scaling up cooking solutions that are clean for health, as defined by the WHO Guidelines for indoor air quality: household fuel combustion. Maximum benefits can be ensured only if all energy household uses (cooking, heating, and lighting) transition to exclusive use of clean fuels and technologies. During the process of shifting to exclusive use of clean cooking fuels and technologies, transitional options that can provide some health and environmental benefits should be promoted. For example, high-performing biomass stoves can be a transitional or interim solution where infrastructure barriers prevent access to the cleanest options (such as electricity, LPG, and ethanol fuels) Although factors beyond the fuel and technology used for cooking (for example, ventilation, time spent cooking, and so on) can also play an important role in determining the ultimate health impact, certain fuels and technologies are always clean for health at the point of use, including LPG, electricity, natural gas, ethanol, biogas, and solar. In order to ensure that these transitional fuels and technologies are as clean as possible, the performance of these options should be verified with laboratory and field-testing.

A poor enabling environment with policies that limit sector growth, and the lack of cross-sectoral coordination prevent countries from accelerating the adoption of clean cooking solutions. Where clean cooking fuels and technologies are reliably and affordably available, they should be scaled up with the help of enabling government policies and investment that supports enterprise growth. Therefore, equally important is the role of governments—potentially supported by the international community—in increasing investments and overcoming barriers to lift liquidity constraints, improve the access to clean alternatives, crowd in private investments, and increase the reliability of clean fuel delivery and availability. Mainstreaming clean cooking solutions will help accelerate diffusion and shift the needle on universal clean cooking access. In countries with a high reliance on the traditional inefficient cookstove and fuel combinations, the government needs to translate global commitments into concrete, implementable domestic policies and plans that increase access to clean and modern cooking energy. Those that have already taken laudable steps toward national plans must accelerate the implementation of such plans.

With over 40% of the global population continuing to face the health risks and the environmental and climate impacts of cooking fuels and technologies, there is a pressing need for multi-sectoral action to expedite the diffusion of clean cooking solutions. WHO estimates that exposure to traditional cooking fuels causes some 4 million premature deaths each year, and 54% of them are women and children (WHO 2016). Furthermore, emissions from traditional cookstoves and fuels also slow progress on gender, environment, and climate goals. It is therefore imperative to identify synergies where clean and modern household energy could be mainstreamed or incorporated into other programs and policies, including those concerning mitigation of climate change, sanitation improvement, and maternal and child health programs.

METHODOLOGY

Data sources

WHO's Household Energy Database, which collects nationally representative household survey data from various sources (table 3A.1) was used as input for the model. The database contained 1112 surveys collected from 161 countries (including high-income countries) between 1970 and 2016. The countries provided for cooking are only those with underlying data, so there are no estimates for Lebanon, Libya, and Turkey.

TABLE A3.1 • Overview of data sources for clean fuels and technologies

Name	Entity	Number of countries	Distribution of data sources	Question
Census	National statistical agencies	194	17.45%	What is the main source of cooking fuel in your household?
Demographic and Health Survey (DHS)	Funded by USAID; implemented by ICF International	194	17.45%	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	39	3.51%	Which is the main source of energy for cooking?
Multi-indicator cluster survey	UNICEF	127	11.42%	What type of fuel does your household mainly use for cooking?
World Health Survey	WHO	49	4.41%	
Survey on global AGEING (SAGE)[3]	WHO	6	0.54%	
National Survey		369	33.18%	
Other		134	12.05%	

Population data from United Nations Population Division was used.

[3] The WHO SAGE is a national survey related to aging which includes a question on household fuel use. SAGE is "Survey on global AGEING". http://www.who.int/healthinfo/sage/en/

Estimating missing values

As household surveys are conducted irregularly, a multilevel nonparametric modeling approach developed by the WHO was adopted to estimate missing values in between surveys.[4]

For clean cooking fuels, only the model estimates are used because of large variances in survey results.

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. Regional groupings are based on WHO regions.[5]

Calculating the annual growth rate

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

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[4] 4 Ongoing work, will be made available on the WHO website in 2018

[5] WHO regions are African Region, Region of the Americas, South-East Asia Region, European Region, Eastern Mediterranean Region, and Western Pacific Region.

CHAPTER 4 –
RENEWABLE ENERGY

Photo: Aldio Dwi Perkasa – Geothermal Resources Council

MAIN MESSAGES

- **Global trend:** Under Sustainable Development Goal (SDG) 7.2, global progress on renewable energy is measured by its share in total final energy consumption (TFEC). The global share of renewable energy in TFEC reached 17.5% in 2015, up only slightly from of 17.3% in 2014 and less than one percentage point higher than where it stood back in 2010 (16.7%). Even though the absolute level of renewable energy consumption has grown by more than 18% since 2010, only since 2012 has the growth of renewables outpaced the growth of total energy consumption. It is important to note that the renewable energy share includes traditional uses of biomass and is subject to significant yearly variations due to weather, in particular, to the availability of hydro resources, and to demand for renewable heating in a given year.

- **2030 target:** On current trends the world will not achieve the SDG 7.2 target of a substantial increase in world renewable energy share in TFEC by 2030. The average annual progress from 2010 to 2015 has been only 0.09 percentage points and has been slowing down each year since 2012.

- **Baseline share revised down after major data revision:** The renewable energy data underlying this report has changed significantly relative to previous years because of revised data for traditional uses of biomass in China. According to the revised data, the global share of renewable energy in TFEC in 2010, the baseline year, is now 0.6 percentage points lower than before the revision. This revision is a step in the right direction toward data harmonization. It underlines the importance of sound and methodologically consistent energy balances and data collection capacity at the global level across all energy sources, including the complex field of bioenergy.

- **Renewable electricity:** The share of renewable energy in electricity continued to climb to reach an all-time high of 22.8% in 2015. This increase was largely driven by new additions of wind energy, which accounted for approximately half of the growth in renewable electricity consumption in 2014–15.

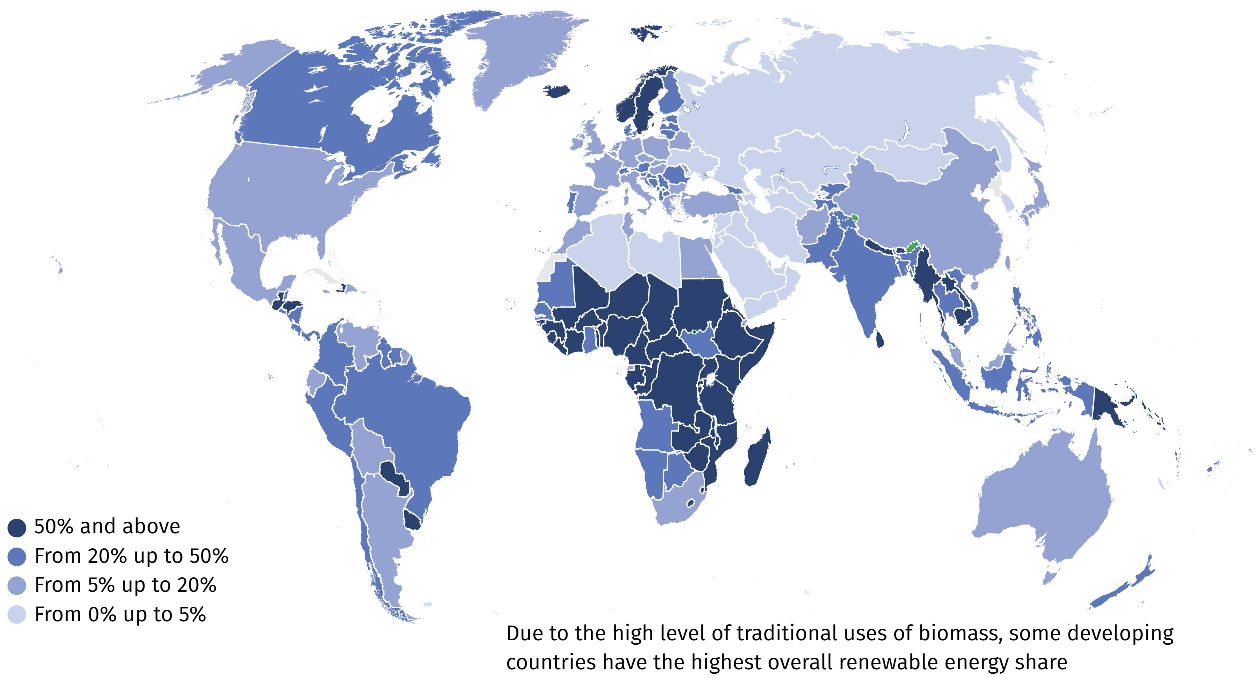
- **Renewable heat:** Although heat accounts for the largest share of TFEC, current efforts to promote renewable heat have been insufficient to achieve the pace needed to reach SDG 7. The share of renewable energy in heat consumption, dominated by 65% of traditional use of biomass, reached 24.8% in 2015, a modest improvement of less than one percentage point since 2010. The slow growth highlights the fact that more policy attention is needed to remove barriers to deployment and increase the role modern renewables play in meeting heat demand. In 2015 the traditional use of biomass was only 3% higher than in 2010, whereas the use of renewables in district heating and modern noncommercial uses of renewable heat grew by 24% and 8%, respectively, over the same period.

- **Renewable transport:** Renewable energy consumption in transport reached 2.8% globally in 2015. The consumption of renewable energy in transportation has proportionally increased faster than in either electricity or heat, but from a very low base. The greatest areas of concern remain in aviation, rail, and maritime transport, where penetration rates of biofuels are negligible at the present time.

- **Regions and income groups:** The economies of high-income countries in North America and Europe are still heavily dependent on fossil fuels. Although their share of renewables in TFEC is the lowest of any region (11.8% in 2015), these countries did achieve the most rapid increase of any region since 1990, principally because their TFEC growth has been very slow (and declining or flat across Europe). By contrast upper-middle-income countries in Asia have seen their RE share in TFEC decline, as the region undergoes economic development and shifts away from traditional uses of biomass. Low-income countries have a large share of renewables because of both a high level of traditional biomass and a significant amount of hydroelectricity production.

- **Top 20 countries:** The top 20 countries, ranked by their TFEC, together account for 65% of TFEC. In 2015 these countries had an average renewable energy share in TFEC of 18%, which is higher than the global average. Overall, they outperformed the global share of renewable energy for transportation and underperformed the global renewable energy share for heat and electricity.

FIGURE 4.1 • Renewable energy share in total final energy consumption by country, 2015



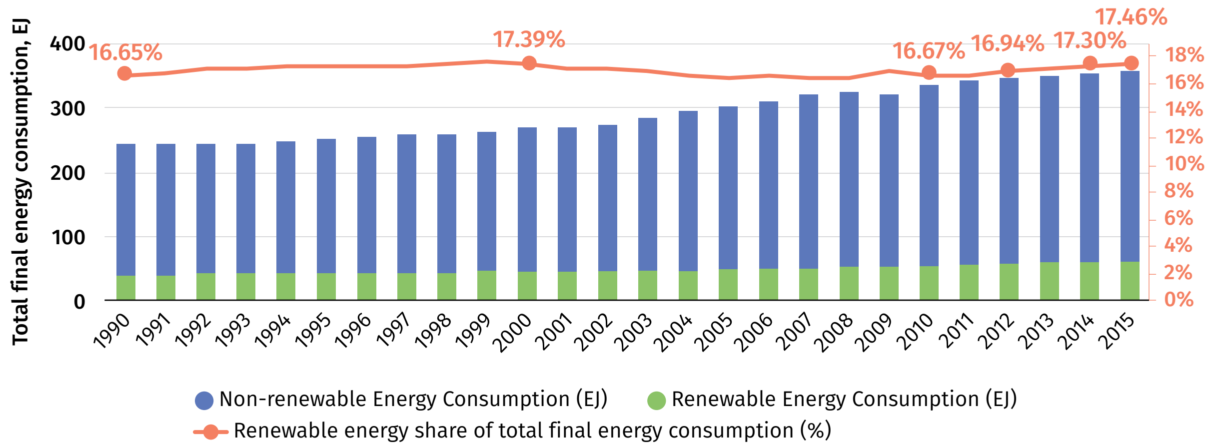
Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

THE STORY IN PICTURES

GLOBAL TRENDS

The global share of renewable energy in total final energy consumption has just increased by about one percentage point since 1990

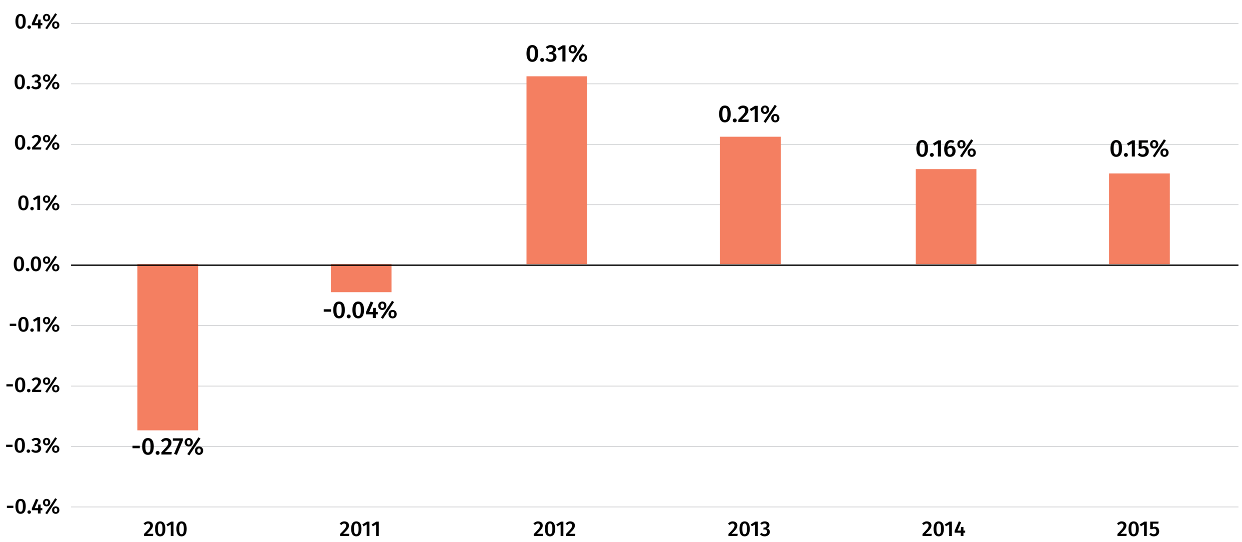
FIGURE 4.2 • Renewable energy share in total final energy consumption, 1990 - 2015



Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

The speed at which the renewable energy share is growing has continued to slow in recent years

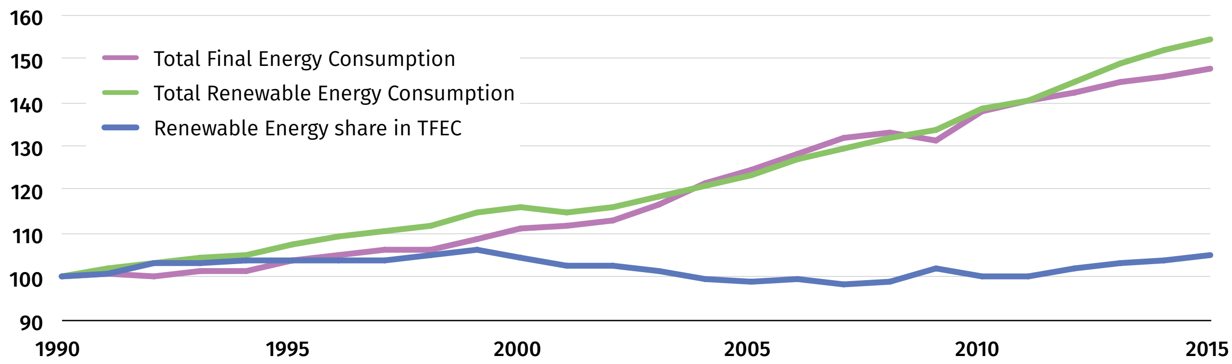
FIGURE 4.3 • Annual percentage point increase in the share of renewable energy in total final energy consumption, 2010 - 2015



Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

Renewable energy share has been mostly stagnant since the world's total final energy consumption has grown almost as fast as its renewable energy consumption

FIGURE 4.4 • Growth in renewable energy consumption and total final energy consumption indexed, 1990-2015 (1990 base)

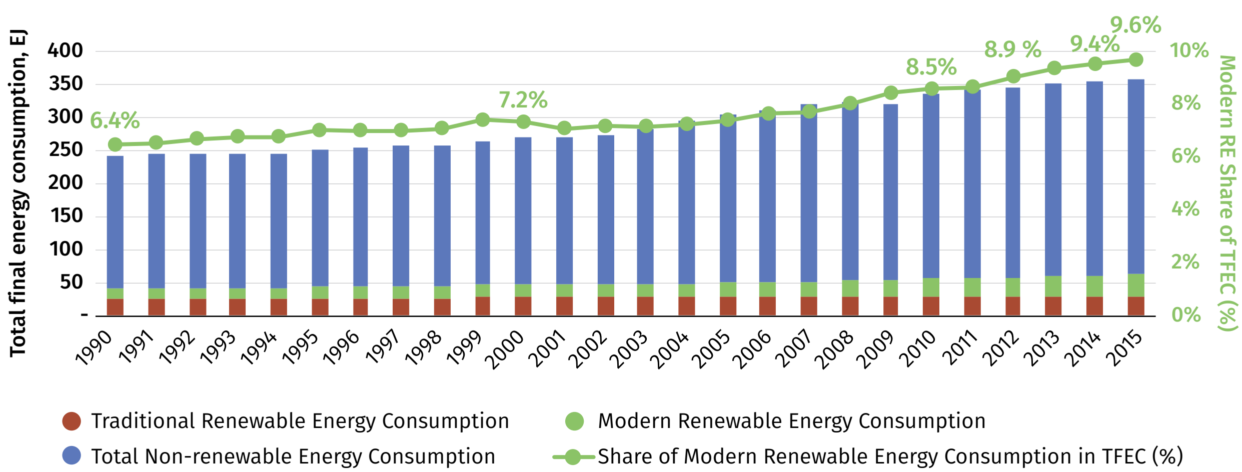


Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

TECHNOLOGY TRENDS

The share of modern renewable energy in total final energy consumption expanded much faster than the share of renewable energy overall

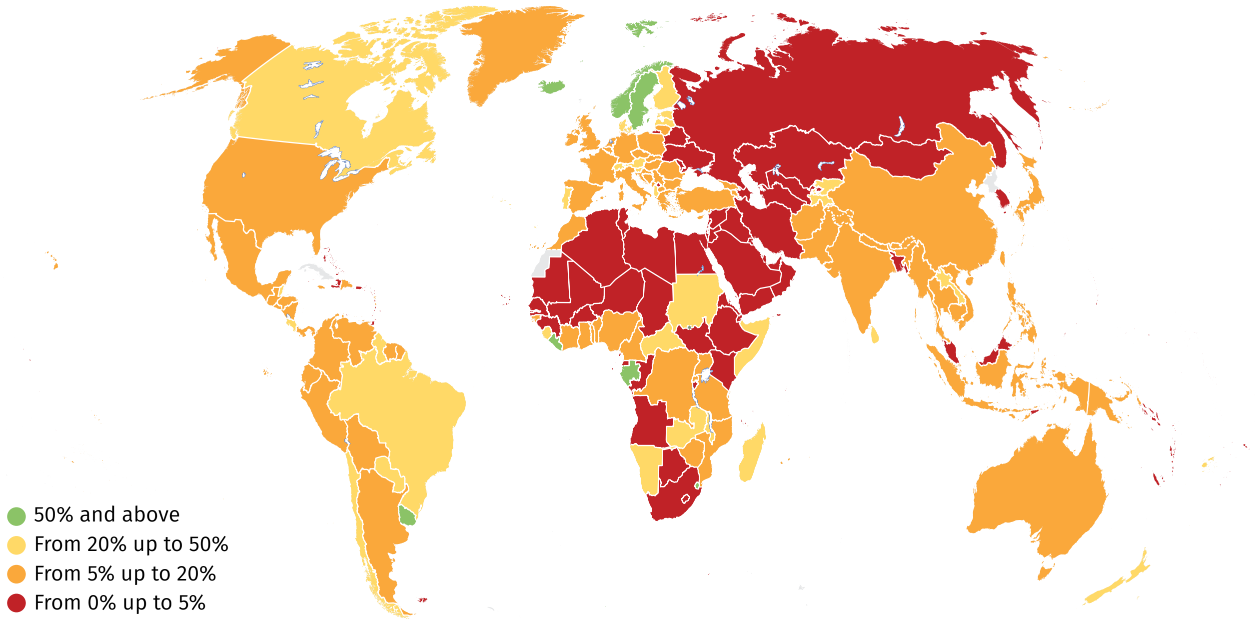
FIGURE 4.5 • Renewable Energy in total final energy consumption, disaggregated by modern vs traditional uses from 1990 to 2015



Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

Countries with the highest *modern* renewable energy shares overall are typically those able to achieve significant penetrations of renewables in heat.

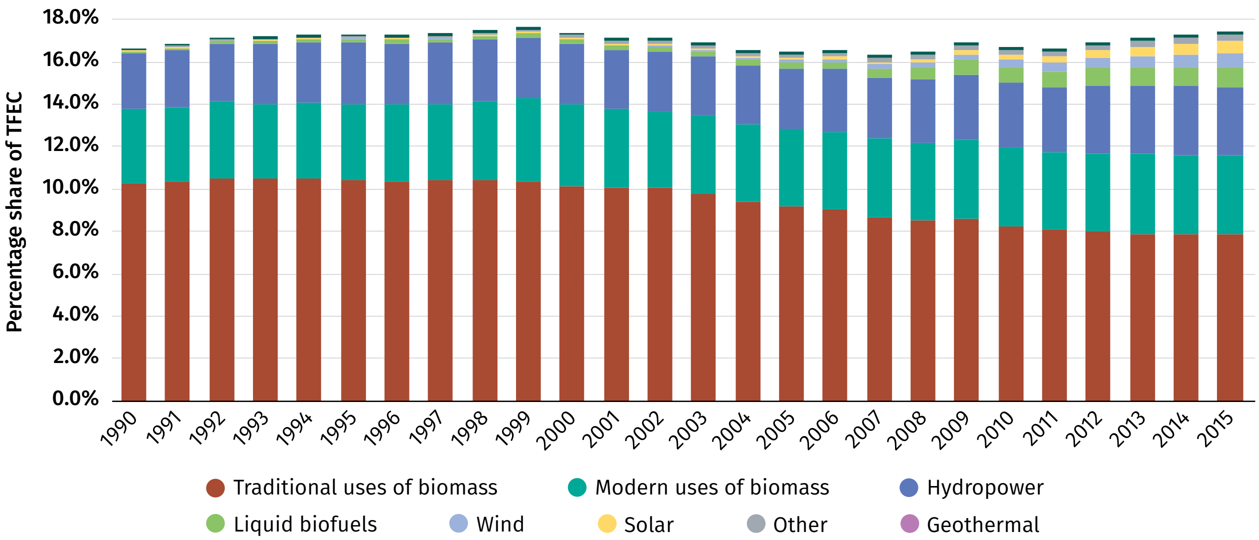
FIGURE 4.6 • Heat map of modern renewable energy share in TFEC, 2015



Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

Biomass and hydropower remain the main sources of renewable energy, but wind and solar are emerging rapidly

FIGURE 4.7 • Share of individual renewable energy sources in global total final energy consumption, 1990 – 2015

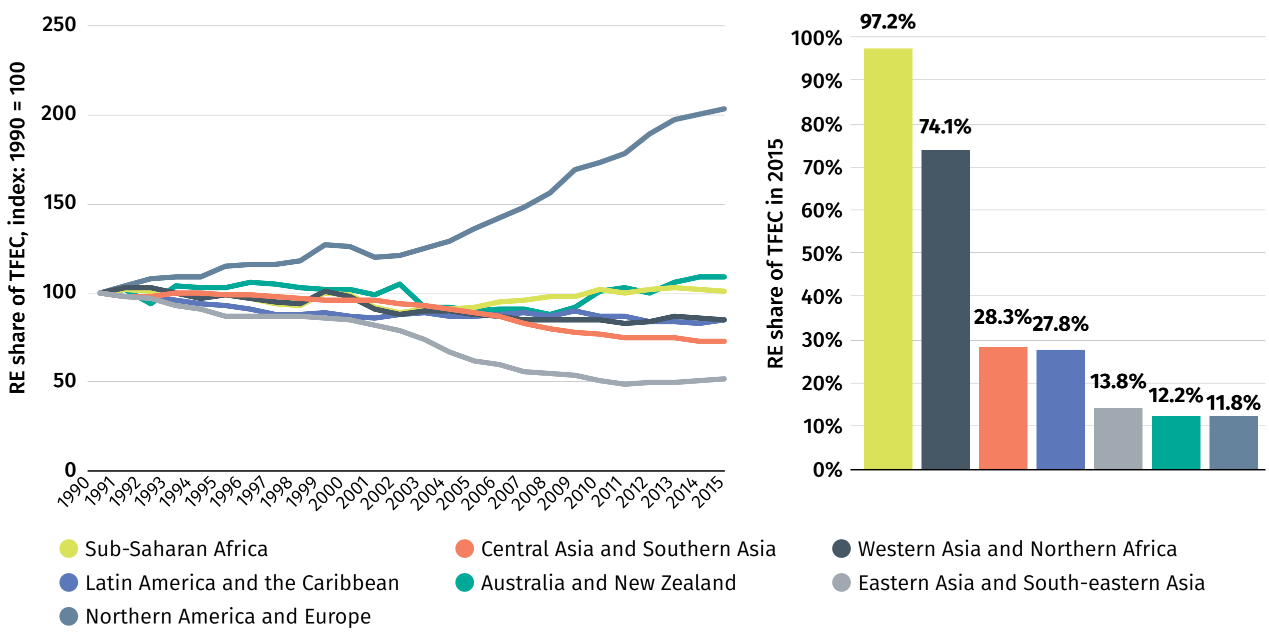


Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

REGIONS AND INCOME GROUPS

Europe and North America started from a low base to double their renewable energy share since 1990, while across the developing world renewable energy shares are high but falling

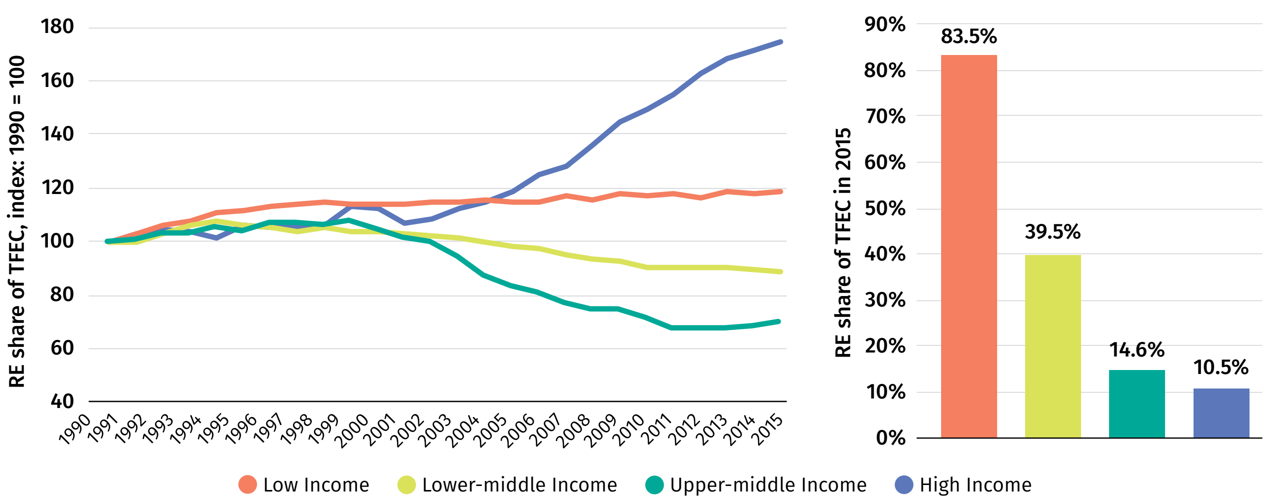
FIGURE 4.8 • Regional share of renewable energy in total final energy consumption indexed from 1990 to 2015



Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

Upper middle income countries are seeing their renewable energy shares decline particularly steeply with renewable energy shares approaching those of top 20 countries

FIGURE 4.9 • Indexed growth of renewable energy share in TFEC in countries grouped by income and their growth of renewable energy as a share of TFEC from 1990 to 2015

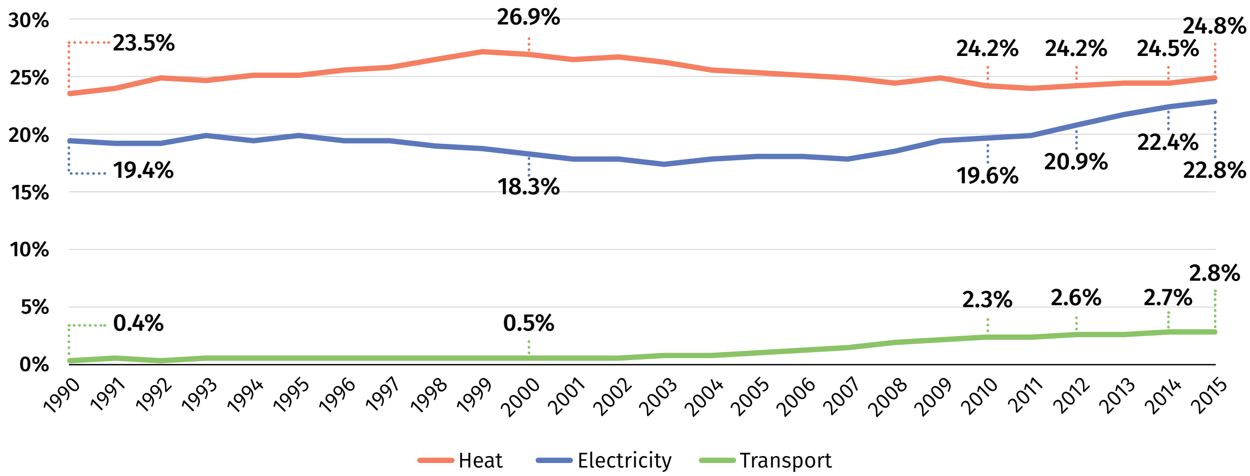


Source: International Energy Agency (IEA) and United Nations Statistics

END USE SECTORS

Since 2000, the renewable energy share of energy consumption in electricity and transport has grown significantly

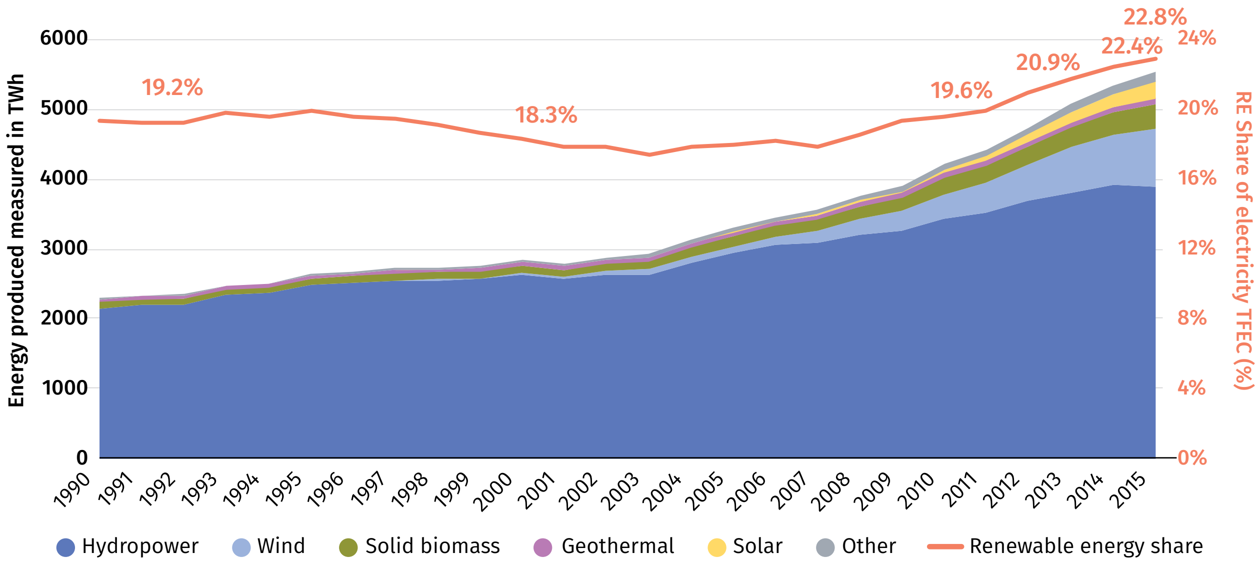
FIGURE 4.10 • The evolution of the renewable energy share in total final energy consumption by end-use sector, 1990-2015



Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

While hydropower remains the dominant source of renewable electricity, wind power grew most rapidly during the period 2010-2015

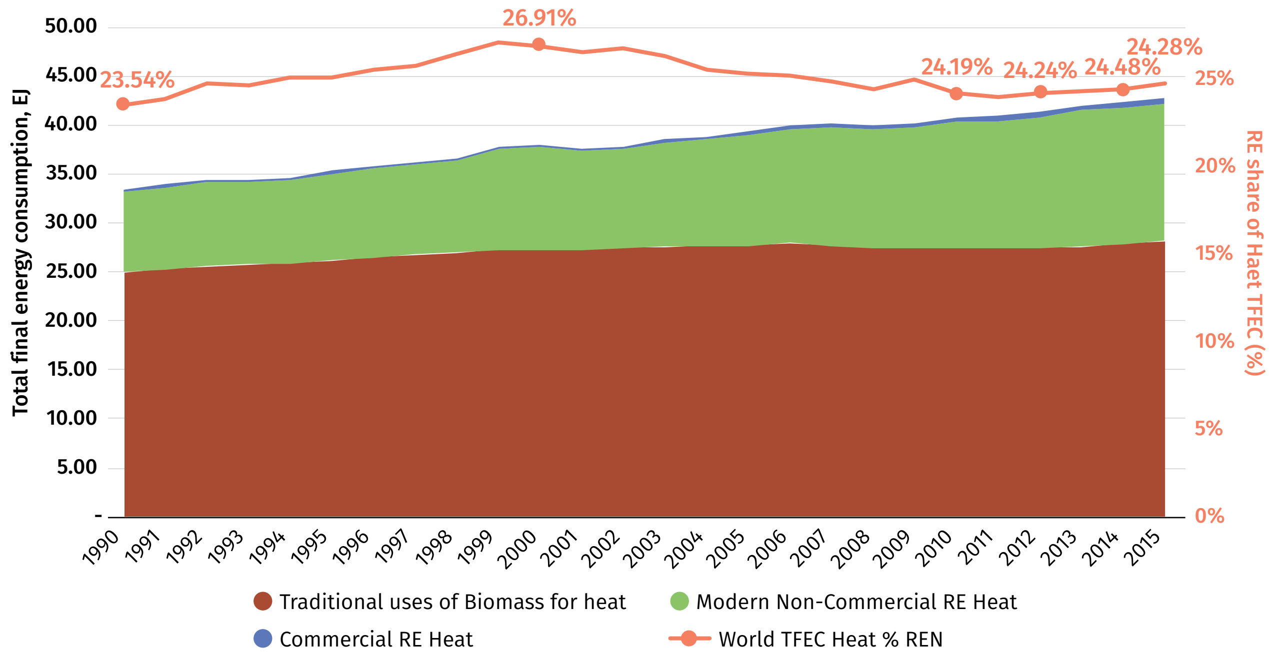
FIGURE 4.11 • Breakdown of global renewable electricity consumption by type of generation technology, 1990-2015



Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

Traditional uses of biomass are the dominant source of renewable energy consumption in the heat end-uses

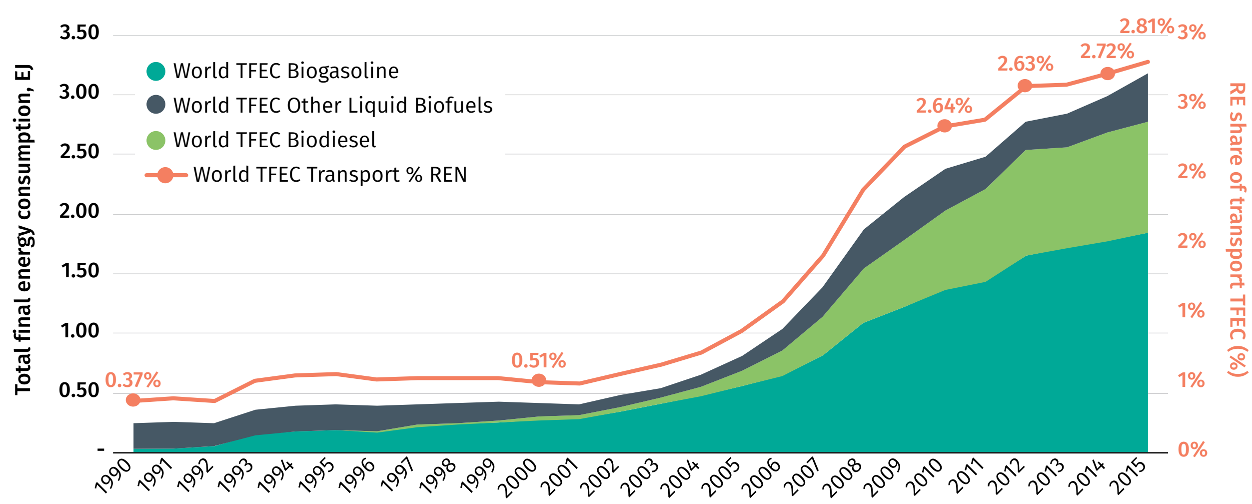
FIGURE 4.12 • Breakdown of global renewable energy consumption for heating by fuel source, 1990-2015



Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

Bio-gasoline remains the major renewable fuel in transport, and bio-diesel is also growing rapidly

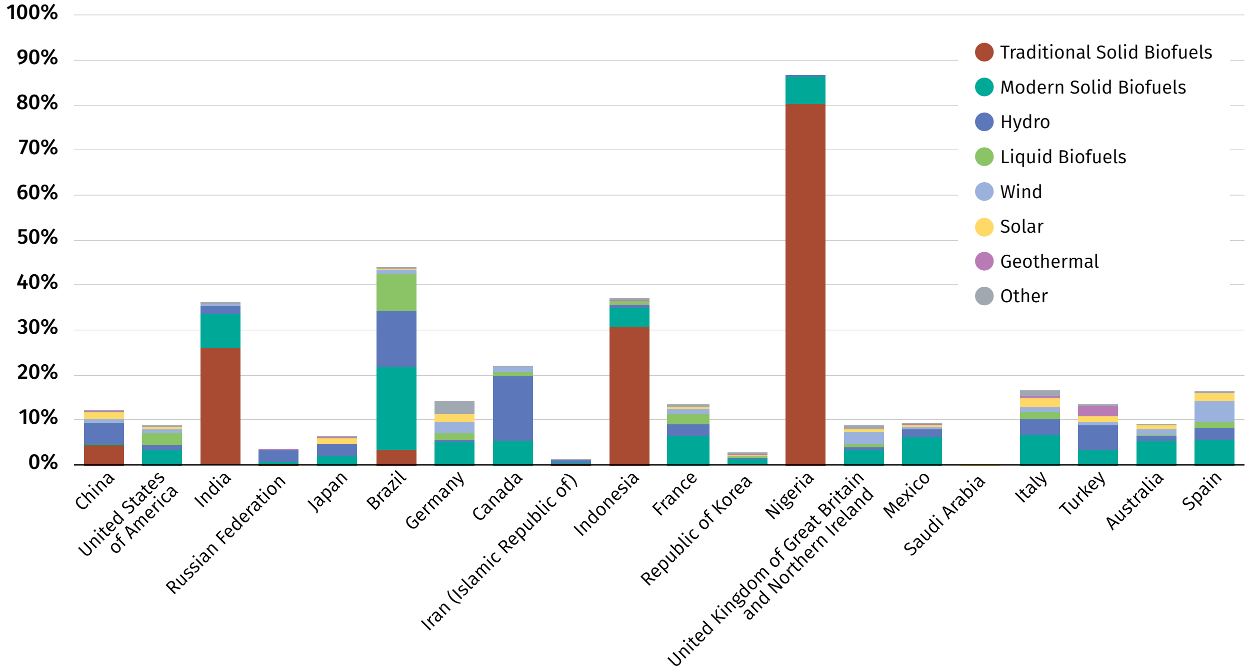
FIGURE 4.13 • Breakdown of global renewable energy consumption for transportation by type of biofuel, 1990 – 2015



Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

Among the top 20 countries, traditional and modern uses of solid biomass remain the largest sources of renewable energy consumption

FIGURE 4.14 • Renewable energy share in TFEC by technology, 2015

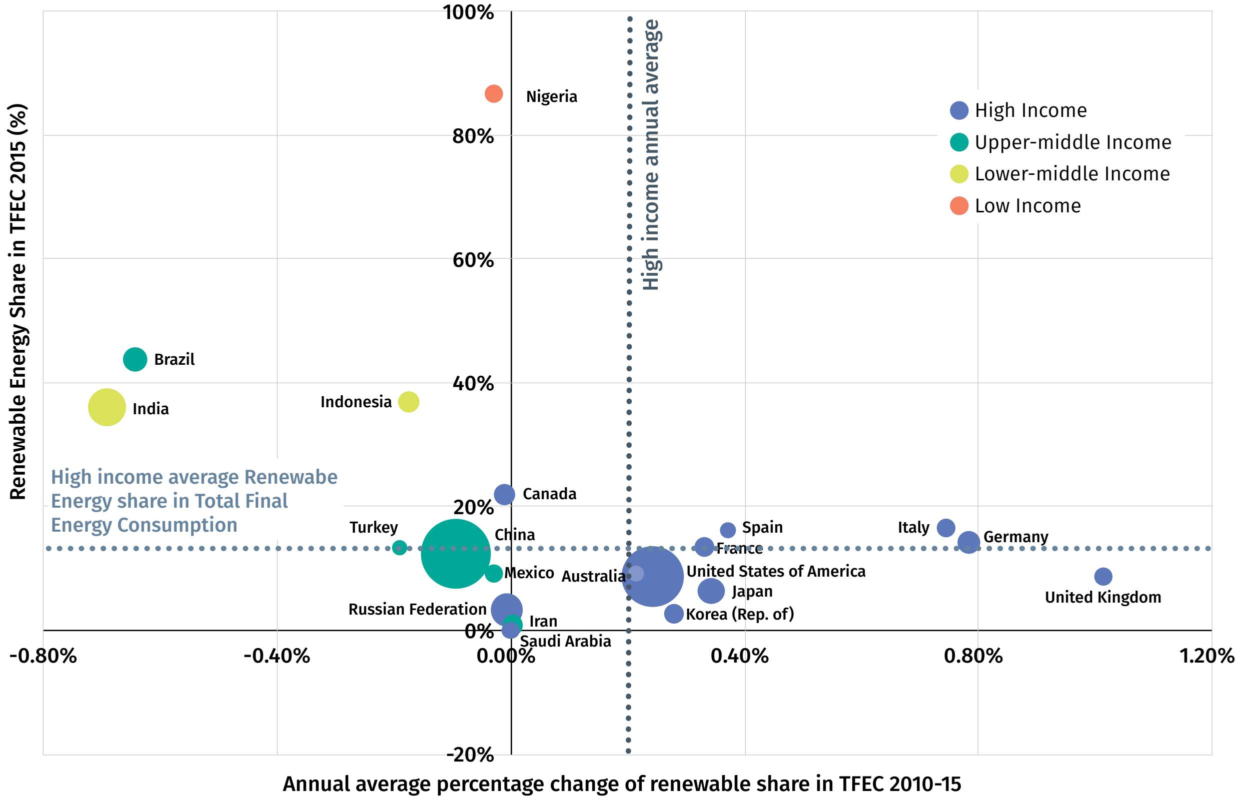


Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

COUNTRY TRENDS

Nine of the 20 largest energy consuming countries have seen their renewable energy shares decline during the period of 2010-2015

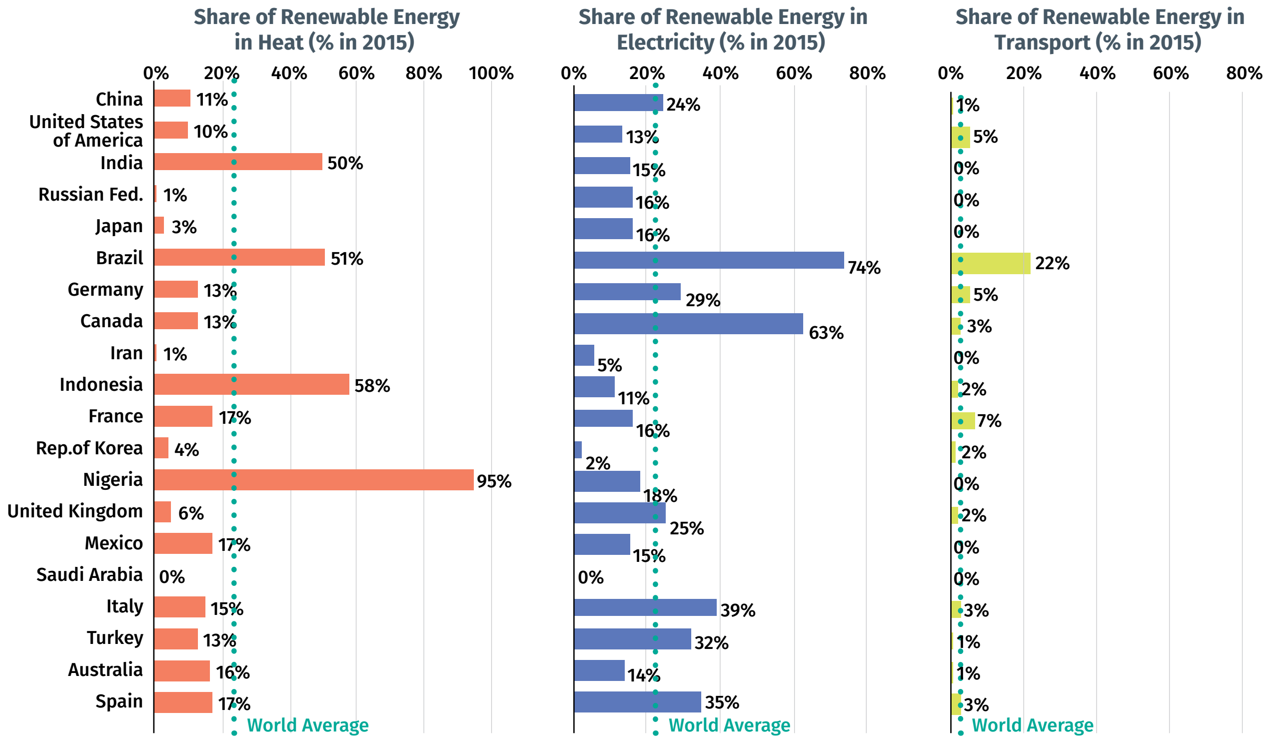
FIGURE 4.15 • Top 20 countries plotting renewable energy share in TFEC (2015) against annual average percentage change in renewable energy share in TFEC (2010-2015), with bubbles scaled according to TFEC size



Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

Brazil stands out as the only one from the top 20 countries to have achieved renewable energy shares substantially above the global average for all uses: electricity, heat and transport

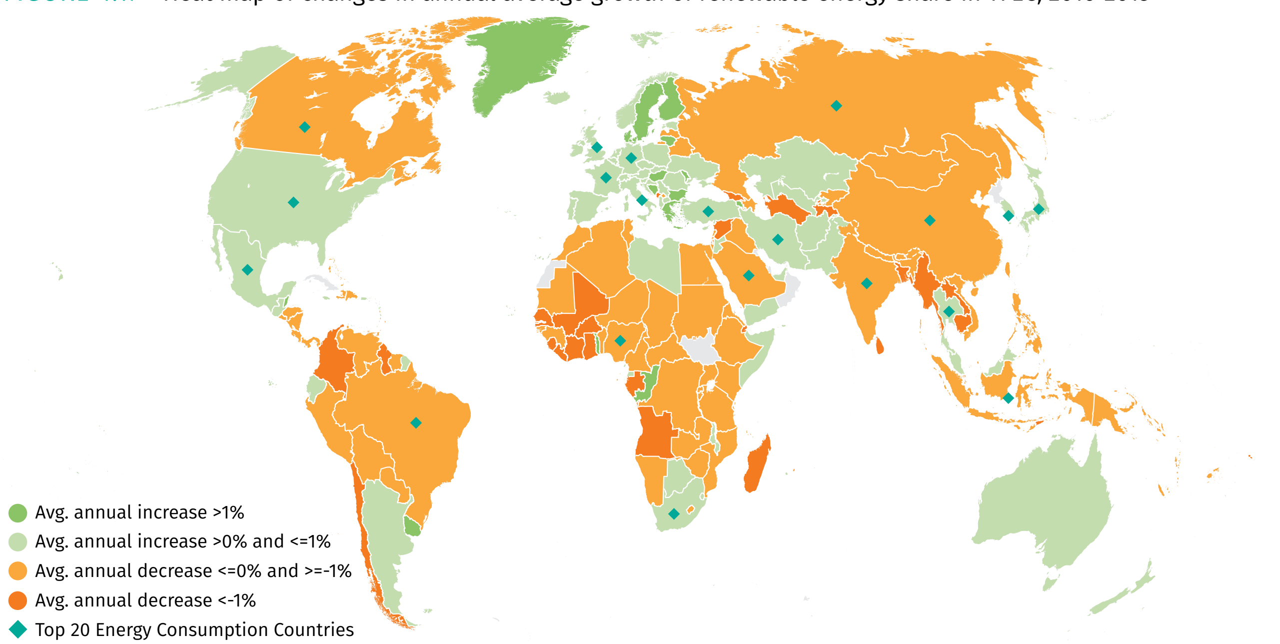
FIGURE 4.16 • Share of renewable energy in heat, electricity and transport in top 20 countries in 2015



Source: International Energy Agency (IEA), United Nations Statistics Division (UNSD) and World Development Indicators (WDI) data

Northern European nations such as Denmark and Sweden experienced the fastest growth in their share of renewable energy consumption during the period 2010-2015

FIGURE 4.17 • Heat map of changes in annual average growth of renewable energy share in TFEC, 2010-2015



Source: International Energy Agency (IEA) and United Nations Statistics Division (UNSD) data

POLICY IMPLICATIONS

Without significant additional effort to deploy renewable energy beyond the electricity sector, the world is unlikely to achieve the goal of substantially increasing the share of renewable energy in global TFEC by 2030 as foreseen under the United Nations SDG 7 commitment.

Although renewable energy's share did outpace total TFEC growth in 2015, the fact that it did so at a slower pace than before is a concern. The slower total renewable energy growth pace was influenced, in part, by declines in global hydropower. However, as 50% of the growth in renewable energy consumption came from bioenergy, of which the majority was driven by traditional uses of biomass, the actual growth rate of modern renewable energy was lower than the headline numbers. This growth is still too low for the world to achieve the SDG 7 target.

Latest results show that the global share of renewable energy in TFEC has barely risen, up by 0.8 of a percentage point between 2010 and 2015, and increased only marginally by 0.15 percentage points since 2014 to reach 17.5% in 2015. In fact, the pace at which the renewable energy share of TFEC is expanding has slowed since 2012. During the 2014–15 period, the share of renewable energy in TFEC actually declined in 114 countries[1]—that is, over half. In 68 of these 114 countries, renewable energy consumption even fell in *absolute* terms. The explanations underlying these trends relate to TFEC growth, traditional use of biomass, and climate fluctuations.

A major reason for the slow increase in the renewable energy share is the continuing steady growth of global TFEC, reinforcing the need for greater progress on energy efficiency and for tighter integration of energy efficiency and renewable energy goals. In 164 countries, an absolute increase in TFEC during 2014–2015 makes it significantly harder to increase the renewable energy share in total TFEC. This helps to explain why the renewable energy share has increased only slowly, despite a major expansion in the world's absolute consumption of renewable energy. During the period 2014–15 the world's renewable energy consumption grew by 1.16 exajoules (EJ)—comparable to the current energy consumption of Bangladesh—despite significant declines in consumption of major fuels such as coal in China, Europe, and the United States in 2015. The second part of the challenge is that renewable energy consumption can sometimes decrease, whether for structural or meteorological reasons.

In structural terms, assessing the overall progress toward SDG 7 can be complicated if the magnitude of traditional biomass uses in a country is large. For example, China's share of renewable energy in TFEC fell from 30% in 2000 to 12% in 2015 because traditional biomass uses decreased; at the same time modern renewable energy in TFEC rose from 2.5% in 2000 to 7.6% in 2015. However, because the magnitude of traditional biomass uses was larger, the overall share of renewables appeared to decline; even though the underlying performance can be considered to represent positive progress toward SDG 7.

Challenges exist also in recording certain energy sources precisely, affecting the accuracy of calculations of the share of renewables (box 5.1). Solid data collection across all energy sources, including diverse bioenergy sources and off-grid renewables, are necessary to develop an accurate national energy balance.[2] In China, efforts to more accurately record traditional uses of biomass led to the significant revision of the 2015 dataset. This change follows an extensive methodological review conducted by the International Energy Agency (IEA) and institutions in China, which has resulted in a notable decrease in Chinese renewable energy consumption. On average, the

[1] IEA/UNSD Data – Renewable energy share in TFEC for 2015 minus renewable energy share in TFEC for 2014. Include all countries where the change was lower than "-0.0000000000001"

[2] Ideally, national energy balances should be consistent with the internationally agreed methodologies of International Recommendations for Energy Statistics (IRES). See https://unstats.un.org/unsd/energy/ires/.

data revision has reduced Chinese traditional uses of biomass by 2.5% per annum from 1990 to the end of 2014. The total difference is a 33.01 EJ decline in traditional use of biomass from 1990 to 2014, which materially affects the entire global renewable energy series since 1990.

Additionally, renewable energy production is sensitive to the consumption levels of biomass for traditional uses in heat, as well as to climatic conditions that can fluctuate year on year. Most notably, hydropower output is strongly affected by precipitation levels, which can be above or below typical levels in any given year. Globally, hydropower production declined by 0.5% in 2015, in part due to droughts caused by the El Niño phenomenon in certain regions. In fact, in 2015, the National Oceanic and Atmospheric Administration (NOAA) reported "a near-record area of global land surfaces in some state of drought," with 14% of land on earth experiencing "Severe Drought" in 2015.[3] However, this decline in hydropower was offset by increases in bioenergy consumption (both in modern and traditional uses), wind, and solar.

Against the backdrop of declining hydro output in 2015 is the significant fact that 70% of new renewable energy consumption in 2014–15 came from non-hydro renewable energy sources, overwhelmingly driven by progress in China, Europe, and North America.

Finally, sector-level analysis shows that, although the expansion of renewable electricity is progressing well, the main bottlenecks to global growth of renewable energy share in TFEC are in the transport and heat end-uses. In 2015, similar to previous years, electricity accounts for only 20% of global TFEC. This illustrates the importance of greater attention by policy makers to the deployment of renewable energy in heat and transport..

BOX 4.1 • **IMPROVING RENEWABLE ENERGY DATA CAPACITY**

Careful data monitoring is essential for policy makers as a basis for their interventions to address the ways to achieve all the targets of SDG 7. For the renewables target, calculating the share of renewables in total energy consumption requires robust data collection processes across all energy sources to develop a solid national energy balance, which in turn leads to well-measured SDG 7 renewables indicators. In this regard, greater resources to enhance renewable energy data collection capacity, in particular for biomass uses and off-grid applications, which are the most difficult to trace, are highly desirable.

One area where statistical approaches could be enhanced is through greater use of surveys—potentially conducted jointly by statistical offices and energy ministries or governmental agencies with specialized knowledge of renewables and off-grid sector—so as to guarantee proper survey design. Given the significant role of solid biomass in renewables consumption and the expanding role of off-grid renewable solutions, and the relation of both of these to energy access (both in electrification and clean cooking), enhanced data collection methods will be essential to strengthen the accuracy of SDG 7 reporting, and toshape future energy policy.

[3] Emily Greenhalgh, 2016, NOAA, "2015 State of the Climate: Drought", https://www.climate.gov/news-features/featured-images/2015-state-climate-drought

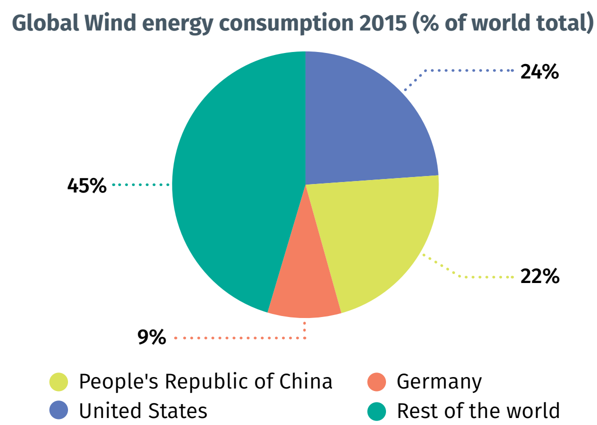
REGIONAL AND INCOME GROUP TRENDS

Improvements in energy efficiency make it easier for renewables to reach a target share of TFEC because greater efficiency lowers the energy demand. Overall, developed economies have a slow average growth of TFEC at 0.7% per annum, and as many as 30 developed economies were consuming less energy in 2015 than in 2010. Under these circumstances, expansion of renewable energy can have a discernible impact on a country's renewable energy share, highlighting the links between SDG targets 7.2 and 7.3. By contrast, developing economies have a much faster growth of TFEC at 3.3% that makes it more difficult to grow their renewable energy share, even where significant efforts are made to promote renewable energy uptake. As of 2015, there were 95 countries experiencing TFEC growth that outpaced their growth in renewable energy. However, China and Brazil had the opposite experience thanks to their significant investments in modern renewable energy, coupled with a simultaneous decrease in fossil fuel consumption.

In structural terms, low-income economies are heavily dependent on traditional uses of biomass for cooking and heating applications. As a result, many countries source as much as 82%[4] of their energy consumption from biomass, of which a significant proportion is neither collected nor consumed in a sustainable manner. As they move into the middle-income bracket, these economies shift toward more modern sources of household energy, often substituting fossil fuels for traditional uses of biomass. This is particularly clear in cooking end uses, where the SDG 7.1.2 indicator emphasizes the importance of clean fuels and technologies for cooking, often achieved by substituting renewable biomass with liquefied petroleum gas (LPG), at the expense of a country's renewable energy share as captured by the SDG 7.2 target.

This also implies that expansion of modern renewable uses in these countries needs to offset reductions in the traditional biomass uses and simultaneously outpace the expansion of TFEC. For example, traditional uses of biomass account for about half of renewable energy consumption in a number of top 20 energy-consuming countries from the developing world, including India, Indonesia, and Nigeria (see Figure 4.17). Moreover, a number of countries experienced a reduction in dependence on traditional uses of biomass between 2014 and 2015. Brazil, China, Indonesia, and Thailand all reduced their consumption of traditional uses of biomass in 2015 compared to their 2014 consumption. Notably, Thailand's reduction in traditional uses of biomass between 2014 and 2015 was greater than its entire consumption of hydroelectric power for 2015.[5].

FIGURE 4.18 • Global wind energy consumption remains concentrated



[4] IEA/UNSD data for Low-Income Group data; see [[AQ: add links here]]. Traditional uses of biomass 2015 data divided by TFEC 2015 data: average for 2015 was 82% from 14 countries.

[5] Thailand consumed 600 PJ of biomass in traditional uses in 2015, against 619PJ in 2014. Thailand's total hydro consumption for 2015 was 16.7 PJ.

RENEWABLE ELECTRICITY

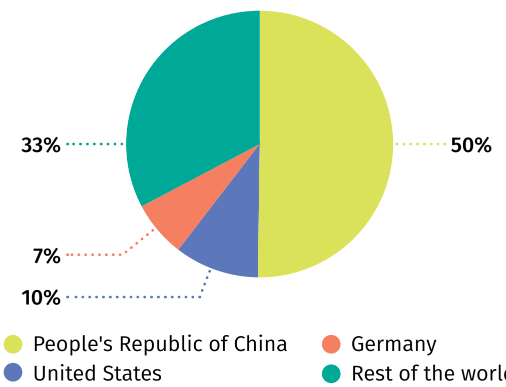
The most encouraging area of progress during 2014–15 has been the continued rapid expansion of the renewable energy share in the electricity sector. Although hydropower remained the dominant source of renewable electricity (accounting for 70% of total renewable electricity consumption), the percentage share of renewable energy in TFEC increased from 22.4% to 22.8% over 2014–15, thanks to wind and solar (see figures 5.18 and 5.19). Combined, these two technologies accounted for 70% of the expansion in renewable electricity. However, the growth has not been equally distributed, with the bulk of global wind and solar electricity growth driven by China, Germany, and the United States.

Thanks to technological improvements and falling costs, wind and solar are now becoming cost-comparable with conventional generation sources in an increasing number of markets. According to the International Renewable Energy Agency (IRENA), the levelized cost of energy for solar photovoltaic (PV) fell 69% between 2010 and 2016, with new solar PV now cheaper than nuclear in developed economies (IRENA 2018). This is also the consequence of the increased role of competitively set remuneration mechanisms, such as auctions. According to the World Bank's RISE data, Chile and South Africa held several renewable energy auctions between 2012 and 2014, which cumulatively secured over 3.5 gigawatts (GW) of capacity. This capacity contributed to growth during 2014–15, with wind consumption increasing by 40% in Chile and 160% in South Africa, and solar consumption increasing by 84% in Chile and 50% in South Africa.[6]

However, despite the growth of market-driven capacity additions, the bulk of modern renewable electricity growth in 2015 was due to the existence of alternative financial incentives including tax credits and feed-in tariffs. These incentives accounted for over 70% of new capacity installed in 2016, according to the International Energy Agency (IEA) (IEA 2017a, 142).

FIGURE 4.19 • Global solar energy consumption is driven by China

Global Solar energy consumption 2015 (% of world total)



The immediate future for Renewable electricity is that growth is expected to continue. IEA's Renewables 2017 report forecasts that over 920 GW of renewable energy will be added to global power systems between 2016 and 2022, with wind and solar accounting for over 80% of new additions (IEA 2017a). A number of new geothermal projects being considered globally may materialize in the coming years, alongside major expansions of new hydro projects and bioenergy solutions.

One previous limitation to the deployment of variable generation technologies, such as wind and solar PV, has been integrating the variable output of these technologies into the grid. As IEA noted in its Renewables 2017 report, "Without a simultaneous increase in system flexibility (grid reinforcement and interconnections, storage, demand-side response, and other flexible supply), variable renewables are more exposed to the risk of losing system value at increasing shares of market penetration" (IEA 2017a). However, in some European countries such as Denmark, Germany, Ireland, and the United Kingdom, grid operators have been able to manage the loads across networks (IEA 2017a). Because of its connection with other Nordic countries, Denmark now generates 44% of its electricity from variable renewable sources (IEA 2017a).

[6] Both sets of auction data are drawn from the World Bank RISE website. http://rise.esmap.org/country/south-africa and http://rise.esmap.org/country/chile

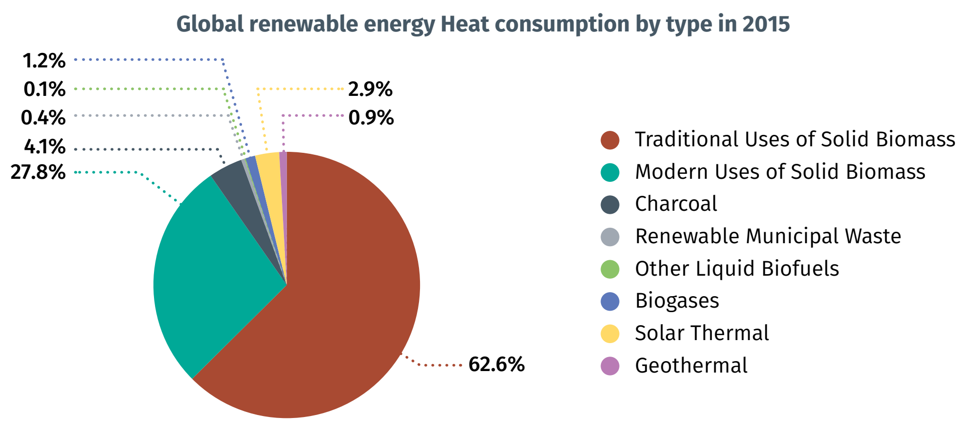
RENEWABLE HEAT

In 2015 heat demand accounted for 48% of global TFEC, and the share of renewable heat reached 25% in 2015, up from 24% in 2014.

Renewable heat[7] can come from either traditional uses of biomass or modern forms of renewable heat, which include modern uses of biomass such as high-efficiency boilers. Within modern renewable heat, renewable energy for heat can be further classified as used for either district heating or direct uses. In 2015, 66.1% of renewable heat came from traditional uses of biomass (Figure 4.20), whereas modern uses represented 1.4% in district heating and 32.5% in direct use.

Traditional uses of biomass accounted for 75% of the absolute increase between 2014 and 2015, and the fastest growth came from modern renewable energy in district heating, which increased by 3.4% over 2014–2015. The renewable energy share also increased because of a small decline in TFEC between 2014 and 2015..

FIGURE 4.20 • Global renewable energy in heat is dominated by traditional uses of biomass.



What constitutes traditional uses of biomass? Traditional uses of biomass include the use of solid biomass for cooking and heating, such as use of wood or animal waste in an open fire, with fuel that is often informally harvested. By contrast, modern renewable heat is produced from bioenergy, solar thermal, or geothermal energy. Most of it is consumed directly in the residential sector or in industry. This can include bioenergy technologies (biomass, biogas), but it may also include other technologies such as solar water heaters and direct use of geothermal heat in industry or district heating. Additionally, a small amount of renewable heat is formally sold as an energy commodity. The most common example is the use of different types of solid biomass for local district heating schemes, notably the use of woodchips or wood pellets.

Because of the significant role of traditional uses of biomass in the heat end uses in developing economies, the world's top 20 countries ranked by total final renewable heat consumption in 2015, were almost exclusively developing economies in Sub-Saharan Africa, with the exceptions of Cambodia, Guatemala, Haiti, and Paraguay.

Since renewable heat comes predominantly from traditional uses of biomass, it is particularly affected by structural trends whereby developing economies are substituting traditional uses of biomass with modern forms

[7] In this report renewable heat refers to the use of biomass, solar thermal, or geothermal energy for heat end uses (space and water heating, cooking, process heat) in the buildings, industry, and agriculture sectors. This can be either through individual applications or in district heating.

of energy, often fossil fuels. In fact, the global growth rate of traditional uses of biomass in the heat end use has fallen from 4% per annum during 1990–2014, to 1% per annum during 2014–15.

BOX 4.2 • IMPROVEMENTS IN CHINA'S BIOMASS STATISTICS

Since 2016, IEA has been working with the Institute of Built Environment of Tsinghua University, Beijing, to improve its understanding and hence data on solid biomass consumption in the residential sector in China. Tsinghua University implemented an initial residential survey in 2006–07, and data were updated thanks to a new survey conducted in 2015.[a]

As a result of these findings and from discussion with staff involved in the surveys, IEA's solid biomass figures for China have therefore been revised in the 2017 edition back to the year 1997 to reflect a decreasing trend in the last decade that was not apparent in previous editions.

The resulting residential consumption of solid biomass is lower than in previous editions for the most recent years. For example, 2014 levels are 56% lower for solid biomass consumption in residential, 26% lower for total energy consumption in residential, and 44% lower for the overall share of renewable energy in total final consumption.

IEA is now working even more closely with its main data provider, the National Bureau of Statistics, and with a wider range of organizations with an aim of improving data for the country. As a result, revisions may occur as the work to improve and understand national energy statistics is further enhanced.

[a] *Short descriptions of the surveys are available at http:*//www.iea.org/eeindicatorsmanual/rsu06.php; http://www.iea.org/eeindicatorsmanual/rsu07.php. More information on the urban survey is available in BERC 2017.

Footnote 1: Short descriptions of the surveys are available at: http://www.iea.org/eeindicatorsmanual/rsu06.php; http://www.iea.org/eeindicatorsmanual/rsu07.php. More information on the urban survey is available in "China Building Energy Use 2017, Building Energy Research Center of Tsinghua University".

Several large developing economies have begun the transition toward modern sources of energy for heat. In 2015, traditional uses of biomass have declined in 33 developing countries compared to their consumption in 2010. Some countries have had significant success in converting their biomass to modern uses[8]: for example, in Brazil, as of 2015, 43% of renewable heat consumption was modern and only 8% based on traditional uses of biomass. Others have taken longer, such as China where 7.8% of renewable heat consumption in 2015 still came from traditional uses and only 3.3% of heat consumption was modern. Importantly though, among the top 20 largest consumers of biomass for traditional uses in 2015, only China, Indonesia and Thailand saw their demand fall between 2014 and 2015.

Although the absolute growth rate of modern renewable energy in heat appears to have slowed during 2014–15, this is largely attributed to the weather (IEA 2017a). The annual average global growth rate of direct renewable energy consumption for heat was 1% during 1990–2014, but this rate fell to 0.96% over 2014–15. A similar pattern is observable for renewable energy in district heating, which grew at an annual average rate of 4.6% per annum from 1990 to the end of 2014, decelerating to 3.4% in 2014–15.

Modern renewable heat lags behind electricity in terms of growth partly because of technological barriers, but the other challenge is securing strong policy support. In developed countries only Finland, Iceland, Latvia, and Sweden had more than 50% renewable energy penetration in total final heat consumption in 2015. This

[8] According to IEA data, from 2010 to 2015, Brazil's traditional biomass consumption fell by about 13%.

was achieved thanks to a combination of strong policy push and significant favorable resource endowments (geothermal in the case of Iceland and biomass in the other countries).

Despite the growth of renewable energy in district heating, that growth remains highly concentrated in a few economies. The world's top 10 largest consumers of renewable energy in district heating are almost all European (8 of 10), and together they consume 77% of total renewable energy in district heating. The single largest consumer is Sweden, which accounts for 18% of global renewable consumption in district heating in TFEC, greater than Austria, Iceland, the Russian Federation, and the United States combined.[9]

The highest percentage levels of direct use of modern renewable heat are concentrated among European economies or emerging countries that have been able to repurpose agricultural by-products by consuming them directly on-site for heat uses—for example, bagasse use in Brazil and several other countries. In emerging countries such as Gabon, biomass can be used for industrial heat purposes: in 2015, 64% of Gabon's heat TFEC came from modern uses of biomass.[10] Other countries have been able to use non-biomass technologies, such as solar water heaters in Greece, diverse solar thermal technologies in China, or geothermal in France and Japan.

RENEWABLE ENERGY FOR TRANSPORT

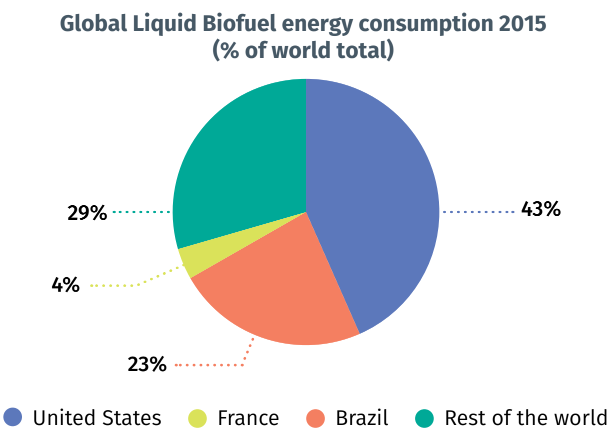
Data from the World Bank's Sustainable Mobility for All report 2017, and from IEA's *World Energy Balances 2017*, shows that transport accounts for about 30% of TFEC on a world average, but it remains the largest sector by final energy consumption for roughly 40 percent of countries worldwide (World Bank 2017; IEA 2017b).

Although the penetration of biofuels in the transport sector is growing, it is starting from a very low base (see Figure 4.12). As a result, the share of renewable energy in TFEC within the transport sector has grown from 2.34% in 2010, to 2.81% in 2015, adding less than 0.1 percentage point to the renewable energy share annually.

The largest factor driving the deployment of biofuels in vehicles has been the use of biofuel blending mandates by policy makers. Accordingly, consumption can fluctuate depending on changes to targets and government provided subsidies.

IEA reported data as of 2015 on biofuels consumption in transport for 59 countries. There were 21 among these that experienced an absolute decline in renewable energy in transport during 2014–15. The top 10 largest consumers, however, added 185 PJ of renewable consumption, which represents 96% of all new globally consumed renewable energy in transport between 2014 and 2015.

FIGURE 4.21 • The United States and Brazil are the major drivers of global renewable energy in transport..



[9] These four countries represent the world's 7th-, 8th-, 9th-, and 10th-largest consumers of renewable energy in district heating (in order: Austria, the United States, Russia, and Iceland).

[10] According to data from the IEA Energy Balances, 73% of solid biomass used for energy in Gabon is consumed by Industry.

Alongside the broad increase in consumption from the world's top 10 largest liquid biofuel consumers, there were significant achievements and setbacks in other nations. Both Iceland and Switzerland grew their share of renewable energy in transport TFEC by over 100% during 2014–15 (306% and 147% respectively),[11] whereas the United Kingdom recorded the largest absolute decline of renewable energy in transport TFEC of any country over the same period, with consumption falling by 9.8 TJ (20%).

Among the world's top 20 energy-consuming countries, consumption of biofuels in India grew by 85% in absolute terms, whereas consumption fell in China by 7% and rose in the United States by 5%, all over the same 2014–15 period.

The success of Brazil, France, Germany, and the United States in increasing their consumption of biofuels in transport has been largely due to the strength of their domestic agriculture and the provision of supportive government policy frameworks (see Figure 4.21). In the United States, the Renewable Fuel Standard set a target of 36 billion gallons of renewable fuel to be blended with transport fuel by 2022.[12] In Brazil, the government has an ethanol-blending mandate of 27%. However, most ethanol consumption is from unblended ethanol because of the country's large flexible fuel vehicle fleet. Brazil also has a 10% biodiesel blending mandate (USDA 2017).

The main sources of renewable energy in transport are bio-gasoline (fuel ethanol) and bio-diesel (biodiesel), which account for 87% of renewable transport TFEC in 2015. These are overwhelmingly consumed by light-duty vehicles in Brazil and the United States.

Although the potential impact of electric vehicles on increasing the share of renewable energy in transport is large, as of 2015 there were fewer than 1 million electric vehicles in the 1.2 billion light-duty vehicle fleet. There are also a number of issues with measuring the contribution of electric vehicles to renewable energy share in transport, which are discussed in annex 4A.

Outside of road transport, the prospect for increasing the global share of renewable energy in transport TFEC remains challenging. As IRENA (2015, 4) noted in its technology brief on shipping, the role of renewable energy will be "limited in the near and medium terms—even under optimistic scenarios." Similarly, the IRENA (2017) technology brief on aviation noted that no alternative propulsion system, other than "biojet" fuels will be able to play a meaningful role in increasing the share of renewable energy in aviation before 2050. Even here, IRENA estimates that the total operational capacity of the world's current HEFA diesel facilities would amount to less than 1.5% of the world's jet fuel requirements. In IEA's (2017c) bioenergy roadmap, biofuels start to notably penetrate the aviation sector by 2025, providing a quarter of demand in 2040, and provide over 40% of energy demand by 2050.

Thus, the current assumptions for global renewable energy in transport by 2030 are that 4.5% of renewable energy in TFEC will come from liquid biofuels and 0.6% from renewable electricity (IRENA 2016).

[11] Iceland consumed 480 TJ of additional biofuels in 2015 vs. 2014, whereas Switzerland consumed 1,124 TJ of additional biofuels over the same period.

[12] For more information on the U.S. Department of Energy's Renewable Fuel Standard program, visit https://www.epa.gov/renewable-fuel-standard-program/overview-renewable-fuel-standard

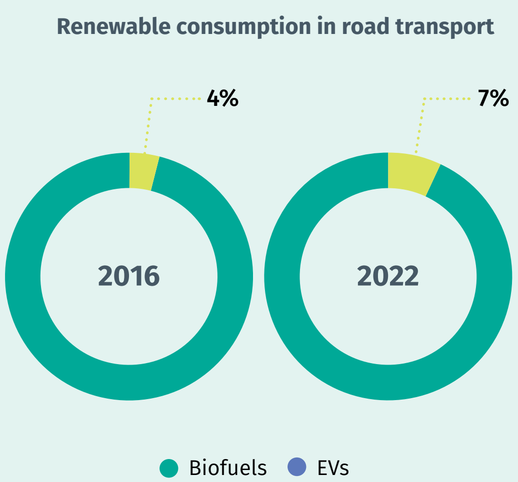
BOX 4.3 • ARE ELECTRIC VEHICLES A SILVER BULLET FOR TRANSPORTATION?

Renewables' penetration into the transport sector has been slow to date, reaching just 3% in 2015, the lowest among all sectors. Most of the renewable consumption is concentrated in road transport and is almost exclusively from biofuels. However, the rapid rise of electric vehicles (EVs), a segment of vehicles comprising electric two- and three wheelers, cars, and buses, is providing a way for renewable electricity to contribute to road transport as well.

In 2016, EVs accounted for an estimated 4% of renewable energy consumption on roads 2016[2] (IEA 2017a, figure 5.3.1). Most of this consumption was in China thanks to the substantial size of its fleet of electric two- and three wheelers coupled with the increasing share of renewables in its power mix (26% in 2016) (figure 5.3.2).

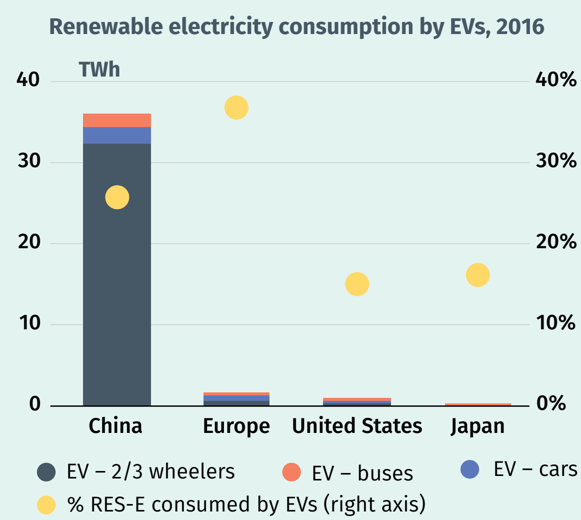
The remaining global consumption of RE electricity in transport was much smaller in comparison and occurred mostly in Europe, Japan, and the United States. Europe had the highest share of renewable EV consumption. This is due to vehicle deployment in markets with high shares of renewable generation such as Norway, Europe's largest electric car market where hydropower accounts for over 90% of total generation. Renewable electricity consumption in transport in Japan and the United States was mostly from electric cars. However, because renewables play a less prominent role in the electricity supply of both Japan and the United States (10% and 15% respectively in 2016), their contribution to the cars' total electricity demand was relatively smaller than in China or Europe.

FIGURE 4.3.1 • Renewable energy in road transport



Source: International Energy Agency, 2017a.

FIGURE 4.3.2 • Renewable energy consumption by EVs, 2016



Going forward, the continuing expansion of EVs in markets with rising shares of renewable generation is expected to help renewable electricity increase its contribution to road transport. By 2022, renewable electricity could account for 7% of the renewable road consumption, compared to just 4% today (see above). System integration policies will be key to maximize renewables' contribution to fuel EVs as well as vice versa: to ensure that EVs contribute to the integration of renewables in a system friendly way.

1.This data is an estimation because real-world observed data regarding the primary energy source of electricity consumed at the point of final end user does not exist. The assumption used to account for this is based on the principle of allocating the final energy consumption of a secondary energy source (electricity) to it primary source (renewables) based on the shares in gross production. This convention is in line with the renewable energy statistical accounting frameworks established by the Sustainable Energy For All Global Tracking Framework (SE4ALL, 2013; SE4ALL, 2015) and the European Commission Renewable Energy Directive 2009/28/ED (European Commission 2009).

2.The shares of biofuels and renewable electricity are based at the end-user consumption level and do not account for the efficiencies of each motor. EVs have two to three times higher fuel economy than internal combustion engines.

CONCLUSIONS

In recent years, the world has made encouraging progress in deploying renewable energy, particularly renewable electricity, which has accounted for well over 50% of net global power capacity additions over the past five years. Yet more needs to do be done. Biomass for power, hydropower, geothermal, solar PV, and onshore wind technologies now can in many circumstances provide electricity that is competitively priced compared to fossil-based electricity generation. This development should help convince investors and utilities to expand their deployment of renewable energy generation.

Still, analysis presented in this report suggests that, without significant additional effort, the world is unlikely to achieve the goal of substantially increasing the share of renewable energy in global TFEC by 2030 as foreseen under the UN SDG 7 commitment. The needed acceleration is technically and economically feasible but requires strong and concerted policy action.

Institutional, financial, and policy measures for a sustainable energy transition need to be tailored to the different regional, national, and local contexts, so they can support socioeconomic objectives such as employment, welfare, social equity, and community cohesion. The Policy Brief #3, part of Policy Briefs in support of the first SDG7 Review at the UN High-Level Political Forum 2018, addresses priority actions that could help to achieve a substantial increase of the share of renewable energy in the global energy mix.

Although the transformation of the electricity sector is already under way, the bulk of deployment is still concentrated in a relatively small number of countries. The potential is great elsewhere but more progress is needed, particularly in many developing countries, where perceived investment risks are a barrier. Public finance can catalyze private investments, but its role extends to such important tasks as direct financing, especially in the context of expanding access to modern energy services (SDG 7.1 target) in poor rural communities, as well as providing alternative sources of funding, such as social financing.

It is important to highlight that investments are needed in both on-grid and off-grid solutions. Furthermore, national, regional, and global action plans need to strive toward more equitable access to energy and greater convergence of energy use between the rich and the poor. An emphasis on energy services for productive end uses helps achieve the transformative impacts of modern energy access on poverty alleviation and other SDGs.

Efforts of a much greater magnitude are also required in end uses such as heating/cooling and transport. With proper policy support and guidance, the use of renewable energy technologies for these purposes can indeed be stepped up significantly. An emphasis on energy services for productive end uses helps achieve the transformative impacts of modern energy access on poverty alleviation and other SDGs (IRENA 2017b).

In heating, district energy systems using biomass, geothermal, or solar thermal (often in combination with storage and excess heat use) are an option in many cities and can be pursued through public investment, changes in fiscal and financial policies (including carbon taxes, grants, and incentives), and policies such as heat zoning (IRENA 2017b). Grants and subsidies can also support the greater deployment of renewables for industrial heat applications. The deployment of solar thermal technologies and other renewable heat options for households can be facilitated though rebate programs with free or low-cost installations for low-income households, mandates and building codes, and financial incentives.

In the transport sector, phasing out fossil fuel subsidies is essential to incentivize greater use of biofuels and electric vehicles. The production, distribution, and use of biofuels can be encouraged through obligations/ mandates, tax incentives, and research and development and demonstration programs. Tax incentives and purchase subsidies can support the adoption of electric vehicles, especially if paired with investments to create a dense network of charging stations and parallel investments into the rapid increase in renewable energy penetration in the electricity sector. The energy transition also depends on a rebalancing of transportation modes, including a major expansion of urban public transit systems running on renewable energy. Such choices can be reinforced by land-use policies that favor dense, mixed-use development.

Although advances in the power sector have been strong, progress has been uneven and further growth will require tailored efforts to address deployment barriers across different country contexts. In emerging renewable energy markets, access to affordable finance and predictable policy frameworks will play an important role in supporting the development of the sector. In this context, innovative public financing instruments and de-risking tools have a crucial role to play in catalyzing investments in technology innovation and deployment. In mature markets, where the share of variable renewables has reached significant levels, a focus on system integration and adaptation of market design and regulations becomes central for continuing growth of the sector and its transformation. Indeed, renewables also play a key role in expanding access to electricity in unconnected areas (linked to the SDG 7.1 target), requiring targeted efforts to support deployment.

Renewable energy and energy efficiency need to be promoted and accelerated in tandem to ensure that the transition to sustainable energy is not undermined by uncontrolled growth in TFEC. Together, renewables and efficiency will need to account for the vast majority of the decarbonization required to stay within the Paris Agreement boundaries. Tapping into synergies between them, together with the increased electrification of end-use sectors, will also permit greater overall energy system flexibility.

A final policy area concerns the socioeconomic dimension—the energy transition discourse has thus far been largely technology-oriented and disconnected from the socioeconomic aspects upon which it is built and upon which its long-term sustainability depends. To ensure that the energy transition accelerates in a just, timely, and equitable way, greater attention is needed to the transformative impacts on society, institutions, financing, ownership structures, and the wider economy. This requires not only aligning private and public-sector policies but also supporting effective participation by all stakeholders. The transformation must be aimed at enabling active social involvement in energy system planning and operation, creating new businesses and jobs, pursuing a just transition, and helping citizens and industries to flourish while respecting climate and sustainability constraints.

METHODOLOGY

Renewable Energy for Transport

Recently policy makers have asked what impact electric vehicles (EVs) may have on the transportation sector and whether EVs could significantly improve the share of renewable energy in global transport. However, the answer is complex and a significant reason for this complexity is due to energy accounting practices.

From an energy accounting perspective, EVs are treated similarly to any other electric appliance because they do not produce energy themselves, rather they consume and store energy provided from another electric source. As a result, the main effect of substituting internal combustion engine light duty vehicles for EVs would be a decline in TFEC in Transport and an increase in TFEC in electricity, though due to higher electric motor efficiencies, this will not be a "one for one" increase.

In theory it is possible to allocate electricity to transport in statistics. However, country data must be reported accurately and as of today there is also no universally agreed methodology in energy statistics to compute the percentage of renewables in sectors.

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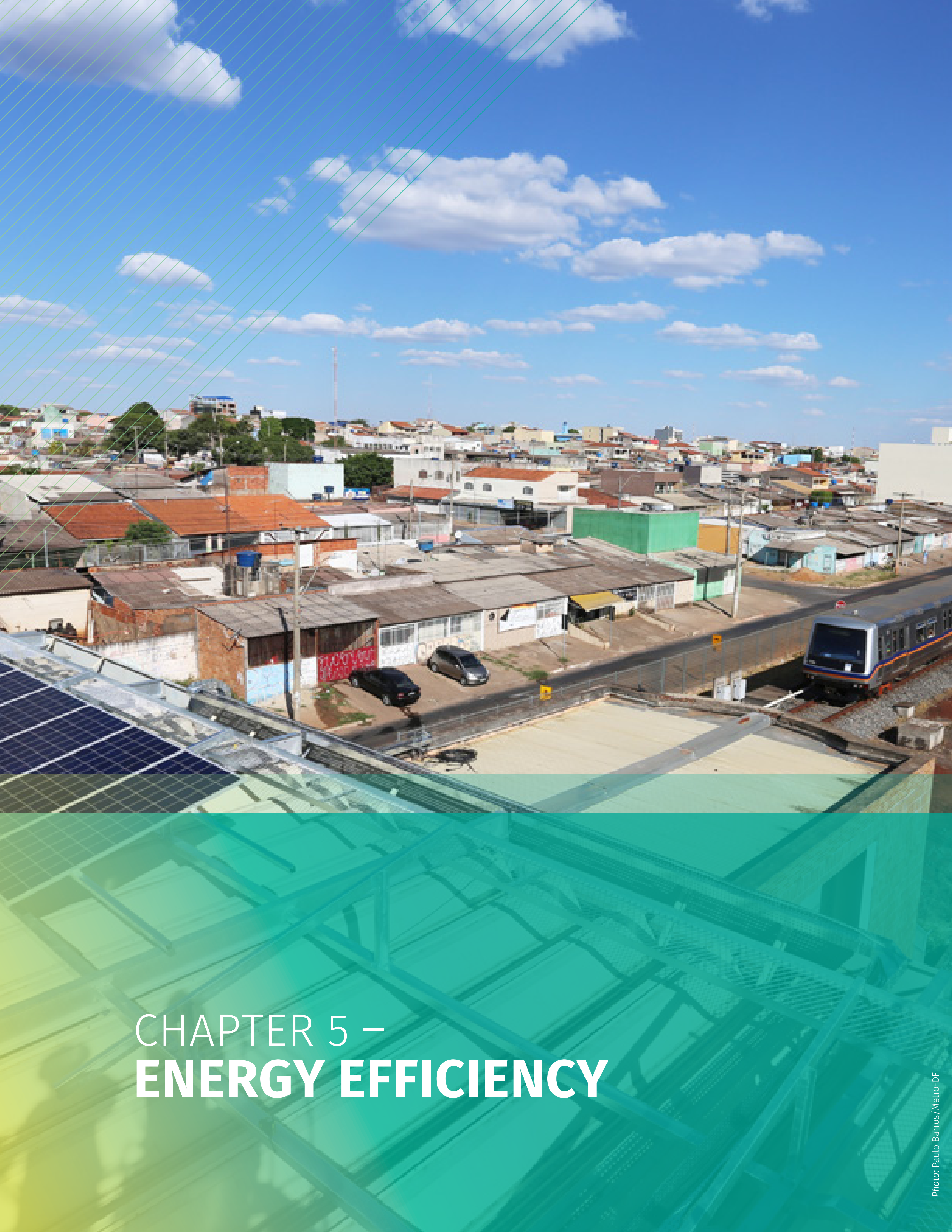


CHAPTER 5 –
ENERGY EFFICIENCY

Photo: Paulo Barros/Metro-DF

MAIN MESSAGES

- **Global trend:** During the period 2014-15, global primary energy intensity fell by 2.8%, reaching 5.3 megajoules (MJ) per 2011 purchasing power parity dollar (PPP $). This is the fastest decline since 2010, the start of the tracking period. Thus, the headline indicator for energy efficiency, which is the compound annual growth rate of primary energy intensity since 2010, improved from -2.0% (2010-14) to -2.2% (2010-15).

- **2030 target:** However, this rate is still short of the -2.6% target needed to meet the 2030 Sustainable Development Goal (SDG) 7.3 target for energy efficiency. Historical trends show that a 2.6% annual improvement was achieved in only three individual years since 1990, making the goal challenging. Each year that the improvement rate is not met raises the effective target for the remaining years to 2030, and this now stands at -2.7%.

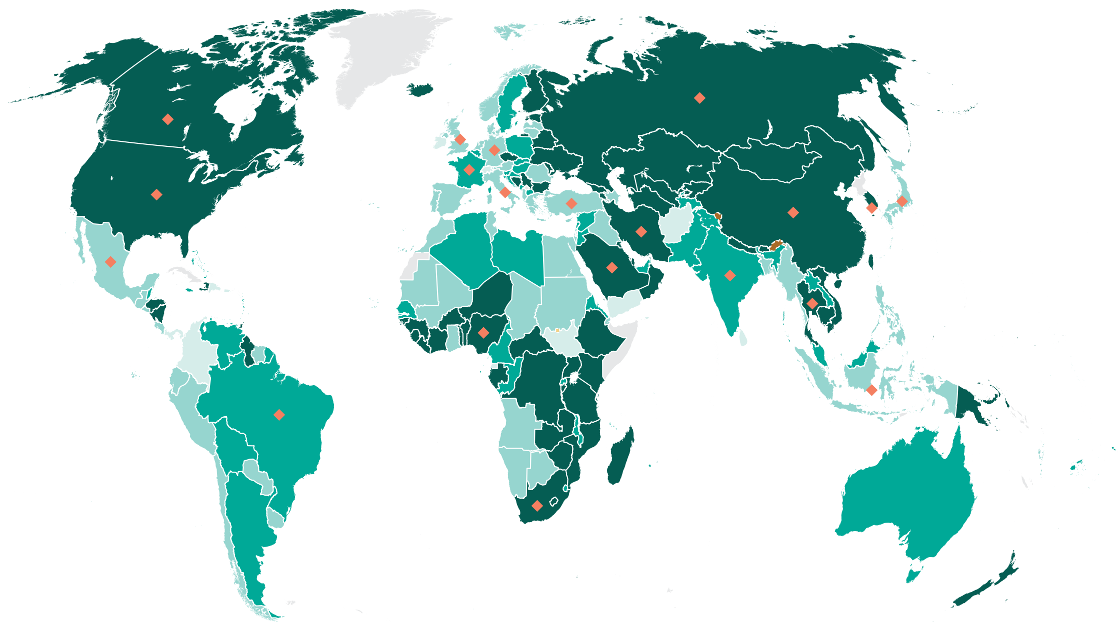
- **Regions and income groups:** On a global level, GDP grew nearly twice as fast as primary energy supply1 in 2010–15, but results were mixed among regions and income groups. A lack of consistent progress was noticeable in the Western Asia and Northern Africa region and the Latin America and Caribbean region, with Western Asia and Northern Africa being the only region where GDP growth did not outpace energy supply. All income groups achieved faster GDP growth than energy supply, but progress continues to be slow in low-income countries, where energy intensity is higher than the global average.

- **Demand-side intensity:** Globally, although the industry sector still consumes the most energy, it made the most progress toward improved efficiency, which was especially noticeable in the upper- and lower-middle-income groups. Among high-income countries, transport remains the highest energy-consuming sector. Recent innovations in digitalization and electric mobility represent a key opportunity for policy makers to drive reductions in transport energy intensity, especially for freight transport. Residential energy intensity increased in low- and middle-income countries since 2010. As housing demand and service levels grow with economic development in low- and lower-middle-income countries, energy efficiency in the residential sector is critical to avoid costly lock-ins of inefficient buildings and appliances.

- **Supply-side intensity:** The average thermal efficiency of fossil fuel powered electricity generation continues to increase, reaching 39% in 2015. This increase is driven primarily by more efficient natural gas power plants. By contrast, the average efficiency of coal-fired plants remained relatively stagnant, suggesting limited uptake of supercritical technology. There was a similar lack of progress in the thermal efficiency of oil-fired power generation. Power transmission and distribution losses remained unchanged, and continue to show a strong correlation with income levels, highlighting the potential for improvement in developing countries.

- **Largest energy suppliers:** The performance of the world's top twenty countries in terms of energy supply is critical to achieving the SDG 7.3 target. In 2015, these countries accounted for nearly 80% of total primary energy supply. Encouragingly, six of them, including two of the world's top five (Japan and the United States), seem to have reached a peak in energy demand, and reduced their annual primary energy supply in 2010–15 while continuing to grow GDP. Eight of the largest countries also outperformed the world average in reducing their energy intensity during the tracking period, with China, Indonesia, Japan, and the United Kingdom exceeding 3% improvement.

FIGURE 5.1 • Primary energy intensity in 2015 (MJ/2011 $US PPP)



- 100% of the global average and above
- From 75% up to 100% of the global average
- From 50% up to 75% of the global average
- Under 50% of the global average
- Top 20 Energy Supply Countries

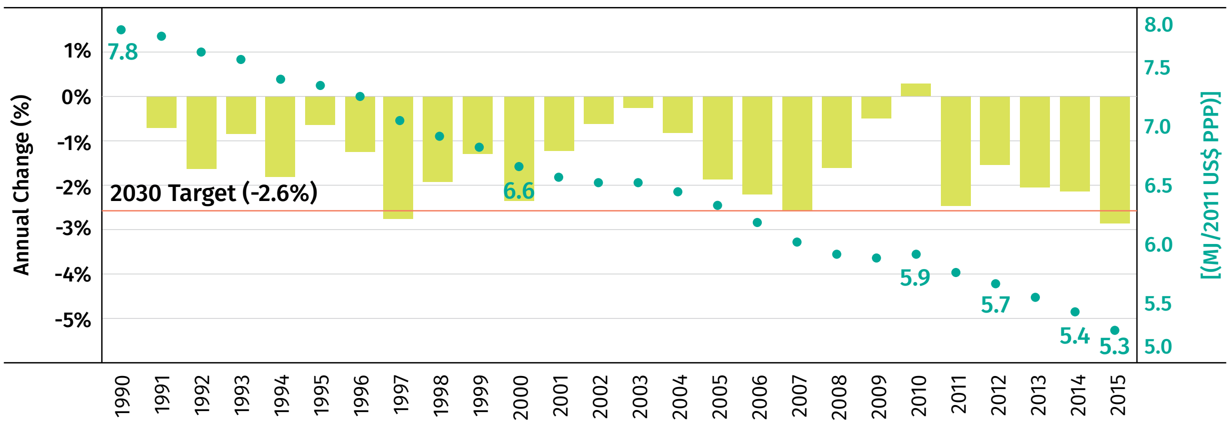
Source: International Energy Agency (IEA), World Development Indicators (WDI) and United Nations Statistics Division (UNSD) data

THE STORY IN PICTURES

GLOBAL TRENDS

Global primary energy intensity is declining consistently, but at a variable and insufficient pace, making the SDG7 target challenging

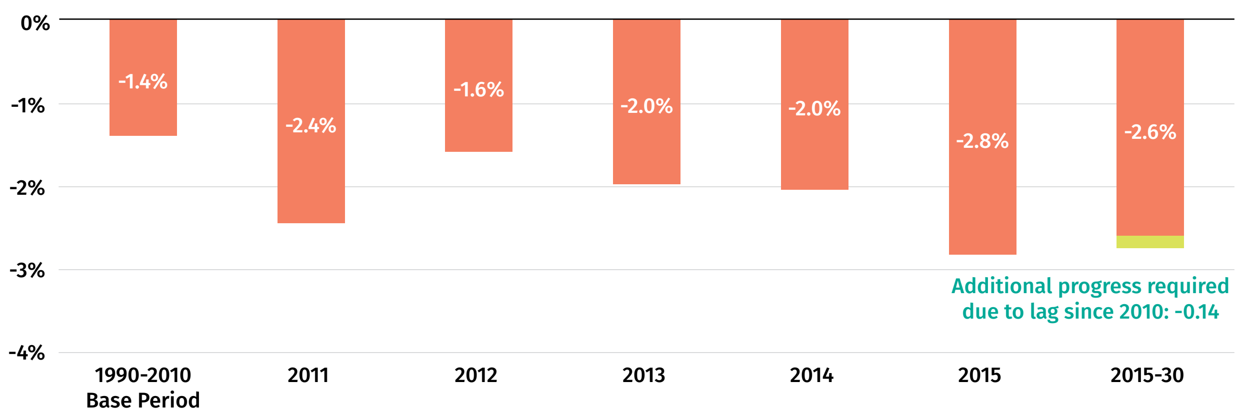
FIGURE 5.2 • Global primary energy intensity and its annualized change, 1990-2015



Source: International Energy Agency (IEA), United Nations Statistics Division (UNSD) and World Development Indicators (WDI) data

Due to underperformance in 2010-15, more rapid improvements beyond the original target will be required in the remaining years 2016-2030

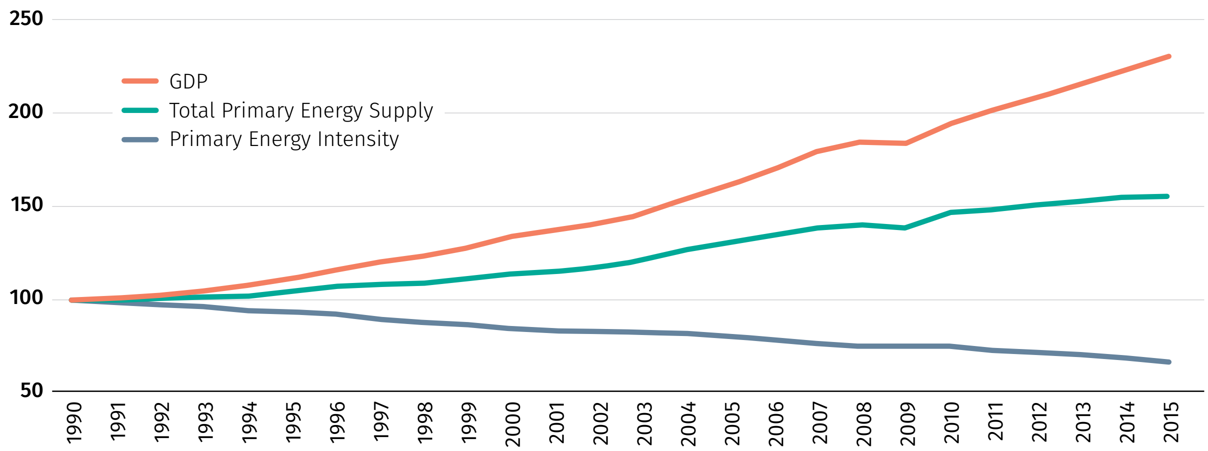
FIGURE 5.3 • Compound annual growth rate of primary energy intensity by period, and target rate for 2015-30 (%)



Source: International Energy Agency (IEA), United Nations Statistics Division (UNSD) and World Development Indicators (WDI) data

The decrease in total primary energy intensity means that in 2015, each unit of energy produced nearly 1.5 times more gross domestic product (GDP) than in 1990

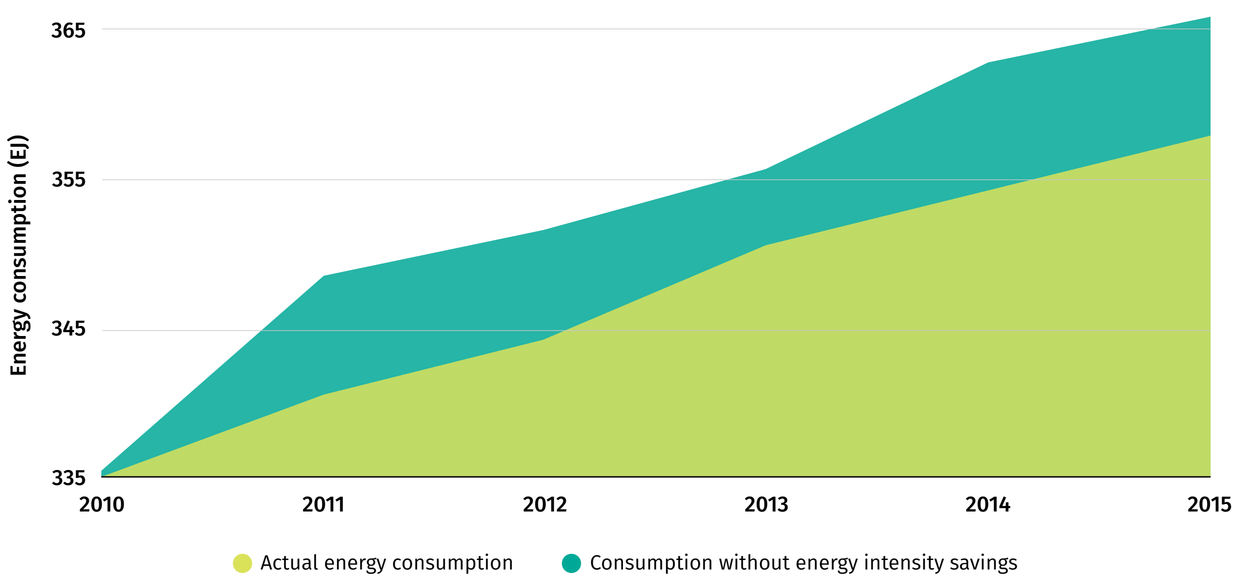
FIGURE 5.4 • Trends in underling components of primary energy intensity at a global level, 1990-2015 (Index, 1990=100)



Source: International Energy Agency (IEA), United Nations Statistics Division (UNSD) and World Development Indicators (WDI) data

Cumulative energy savings from intensity improvements since 2010 are large enough to meet India's energy needs in 2015

FIGURE 5.5 • Final energy consumption with and without energy savings from intensity improvements

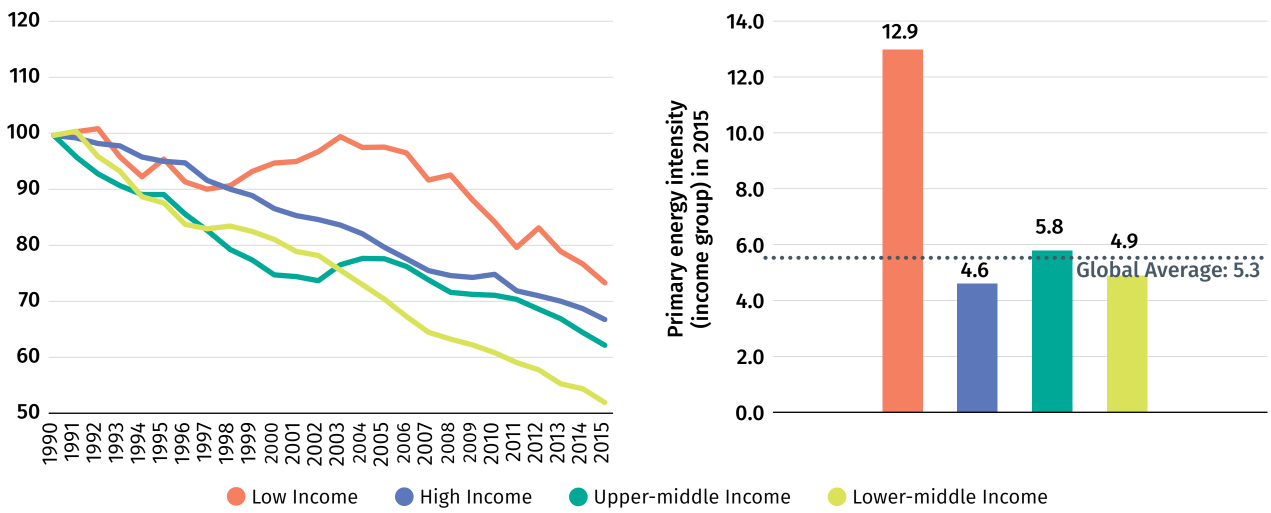


Source: WHO Global Health Observatory; WDI data

REGIONS AND INCOME GROUPS

All income groups are making progress in reducing energy intensity, particularly lower-middle income and upper-middle income countries

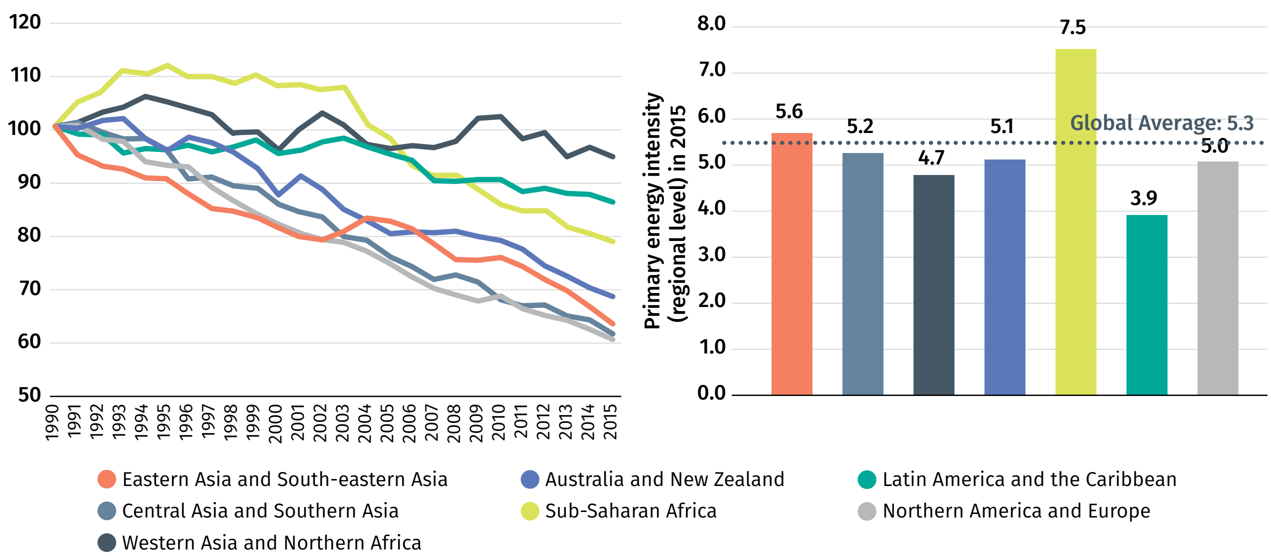
FIGURE 5.6 • Primary energy intensity by income group, as an index (1990=100) for 1990-2015 and in absolute terms for 2015



Source: International Energy Agency (IEA), United Nations Statistics Division (UNSD) and World Development Indicators (WDI) data

However, regional progress is uneven, with Western Asia and Northern Africa, in particular, barely having reduced primary energy intensity since 1990

FIGURE 5.7 • Primary energy intensity at a regional level, as an index (1990=100) for 1990-2015 and in absolute terms for 2015

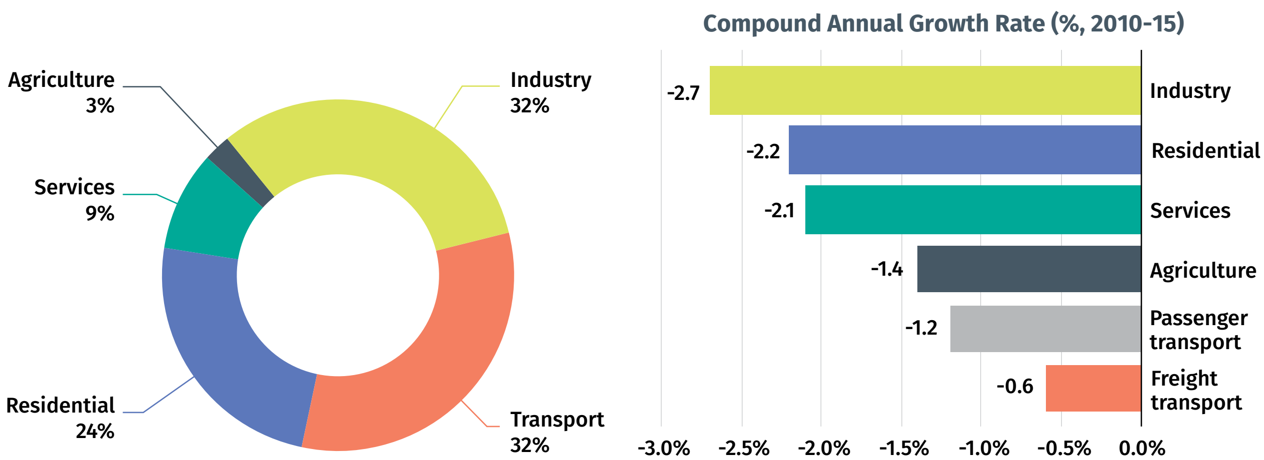


Source: International Energy Agency (IEA), United Nations Statistics Division (UNSD) and World Development Indicators (WDI) data

DEMAND-SIDE EFFICIENCY

Energy intensity reductions were driven primarily by industry, which has the largest share in final energy consumption and the fastest rate of improvement among all end-use sectors

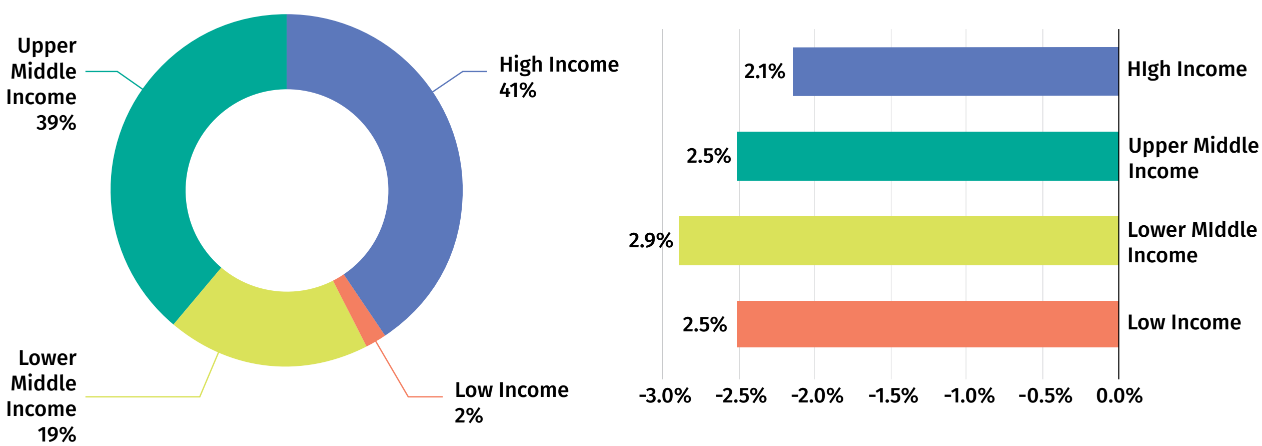
FIGURE 5.8 • Breakdown of total final energy consumption by sector, 2015; and compound annual growth rate of energy intensity by sector, 2010-2015



Source: International Energy Agency (IEA), United Nations Statistics Division (UNSD) and World Development Indicators (WDI) data

High income and upper-middle income countries account for more than three quarters of energy savings

FIGURE 5.9 • Breakdown of total final energy consumption by income group, 2015; and compound annual growth rate of energy intensity by income group, 2010-2015

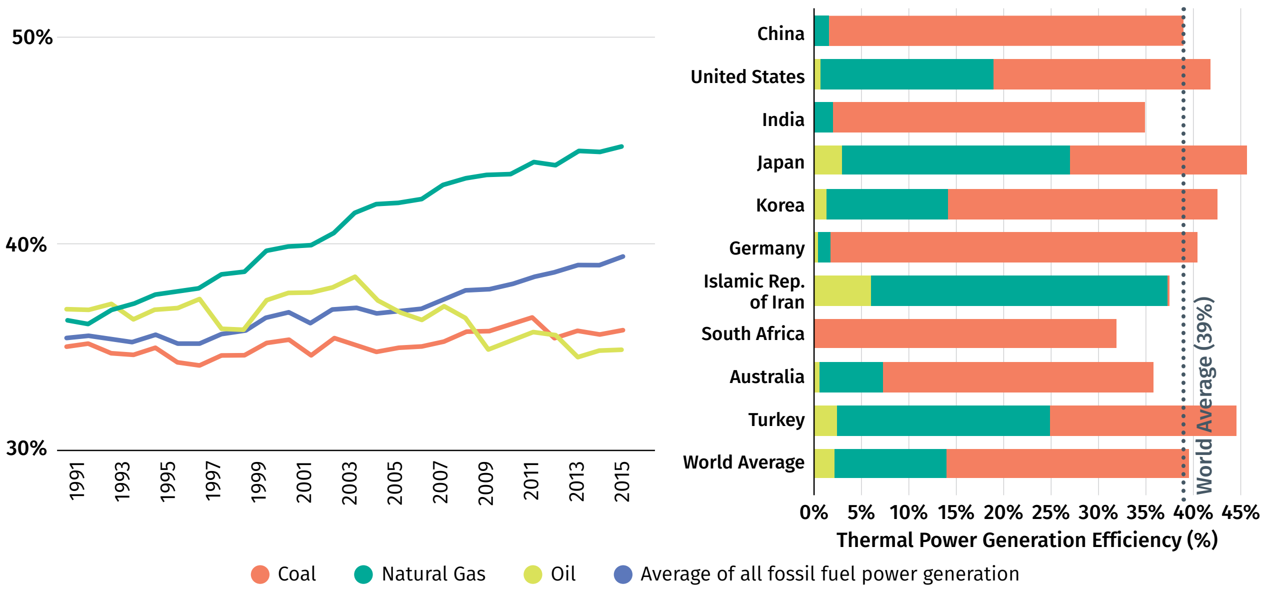


Source: International Energy Agency (IEA), United Nations Statistics Division (UNSD) and World Development Indicators (WDI) data

SUPPLY-SIDE EFFICIENCY

Rising global thermal power generation efficiency reflects greater efficiency and adoption of natural gas power plants, but more widely used coal-fired plant has not raised its efficiency

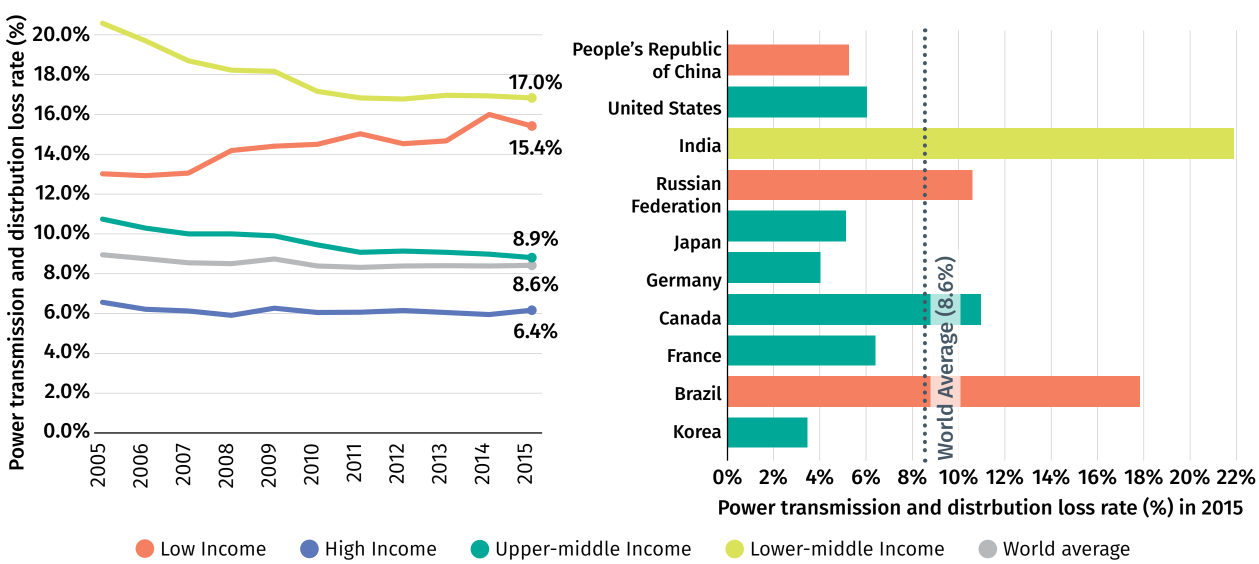
FIGURE 5.10 • Thermal efficiency of fossil fuel power generation by fuel, 1990-2015; and by top 10 thermal power producers, 2015



Source: International Energy Agency (IEA)

Power transmission and distribution loss rates of income groups suggest a significant improvement potential as income levels rise, particularly in Brazil and India

FIGURE 5.11 • Power transmission and distribution loss rates by income group, 2005-2015; and by top 10 power producers, 2015

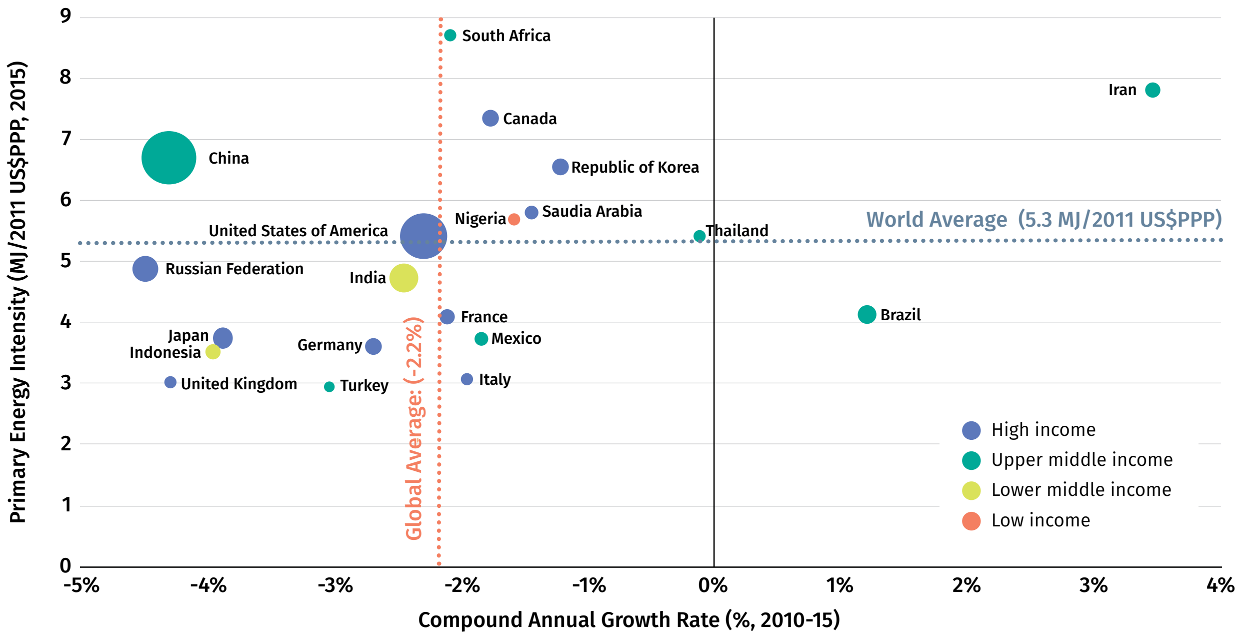


Source: International Energy Agency (IEA)

COUNTRY TRENDS

Eight of the world's largest energy users reduced their energy intensity more rapidly than the world as a whole

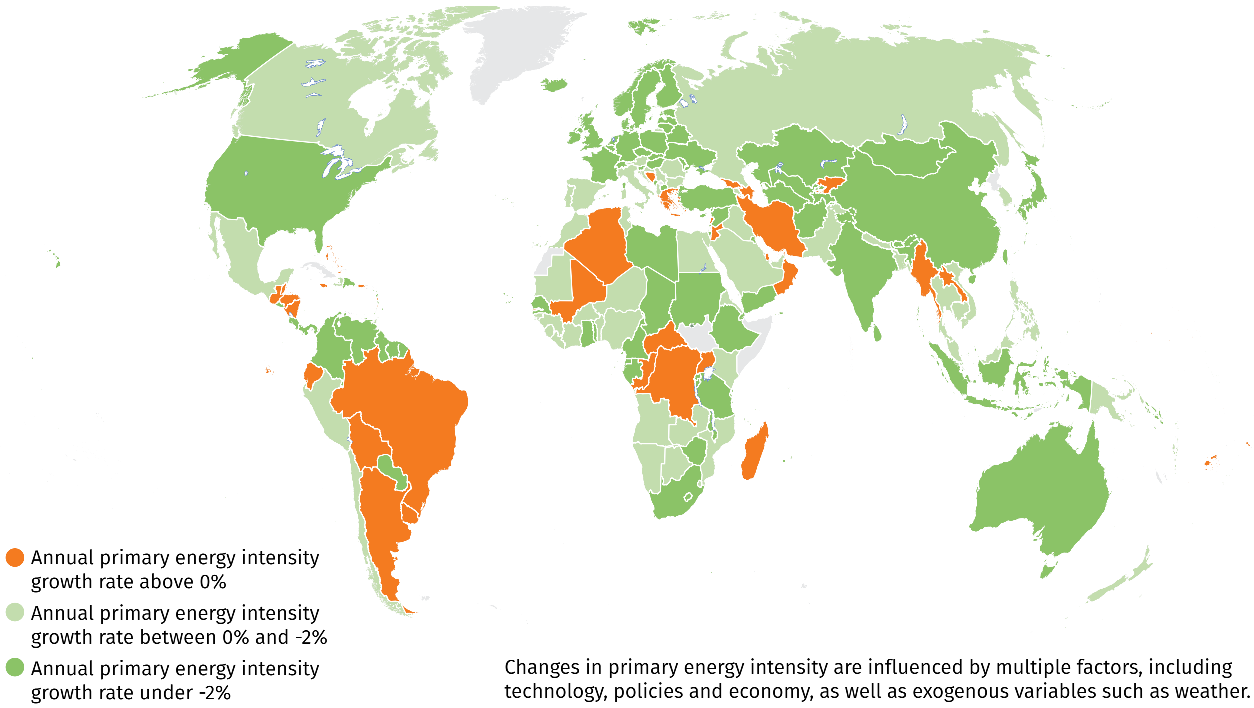
FIGURE 5.12 • Top 20 energy supply countries' compound annual growth rate of energy intensity, 2010-2015, and primary energy intensity, 2015, with bubbles scaled to energy supply



Source: International Energy Agency (IEA), United Nations Statistics Division (UNSD) and World Development Indicators (WDI) data

Despite strong progress in many large economies, a number of countries have seen their energy intensity systematically increase during the 2010-2015 period

FIGURE 5.13 • Compound annual growth rate of primary energy intensity, 2010-15



Changes in primary energy intensity are influenced by multiple factors, including technology, policies and economy, as well as exogenous variables such as weather.

Source: International Energy Agency (IEA), United Nations Statistics Division (UNSD) and World Development Indicators (WDI) data

POLICY IMPLICATIONS

Energy efficiency is imperative to sustainable development – it can narrow energy access gaps, minimize growing energy demands, improve service levels, and lower costs for all sectors of the economy.

The Sustainable Development Goal 7.3 target of doubling the global rate of improvement in energy efficiency by 2030 is tracked through improvements in energy intensity. Reducing energy supply relative to GDP growth decreases energy intensity and creates significant economic, environmental, and social benefits. Energy intensity is the direct inverse of energy productivity. A reduction in energy intensity is directly correlated with an increase in energy productivity, meaning that more economic output is achieved for every unit of energy consumed. As SDG 7 is currently under review by the United Nations (UN), Policy Brief #1 on ensuring universal access to electricity, and Policy Brief #4 on "Doubling the Global Rate of Improvement in Energy Efficiency" outline priority actions on energy efficiency.

In 2015, the global economy continued its long-term trend of decreasing its primary energy intensity by achieving its highest rate of annual improvement since 1990. This was the first time since the start of the tracking period in 2010, that the SDG7 target rate of improvement (2.6%) was surpassed. Global energy demand decreased by 0.8% while GDP grew over 3%. Continuing this trend through 2030 will remain a challenge given the growing energy demands of many emerging economies. Policymakers can benefit from a wealth of proven policies and available technologies, prioritizing the most impactful sectors in their respective countries.

The impacts of energy intensity improvements cannot be ignored. In terms of economic expenditures, energy intensity improvements between 2000-2015 have avoided over $4 trillion in global spending.[1] The global economy produced an additional $40,000 (USD PPP 2011) per MJ of energy in 2015 compared to 2000. Energy intensity improvements have avoided a billion tonnes of greenhouse gas emissions per year since 2014.[2]

1 IEA World Energy Statistics and Balances 2017 (database)
2 IEA Energy Efficiency 2017, adapted from World Energy Statistics and Balances 2017 and CO2 Emissions from Fuel Combustion (databases)

REGIONAL AND INCOME GROUP VARIATIONS

BOX 5.1 • TRACKING ENERGY EFFICIENCY

Energy efficiency policy development requires a sound national energy balance, with detailed demand-side data, in order to understand the dynamics of energy-use across various sectors. Energy intensity (energy use per unit of activity) is a key metric used in efficiency analysis and policy development. However, in addition to improvements in energy efficiency, energy intensity is also influenced by other factors, including the electricity generation mix, structure of an economy, the exchange rate, the affordability of energy services, the size of a country, climate and behaviour.

To generate a greater understanding of energy efficiency, data relating energy use to specific activities at a subsector level are required. Examples include lighting energy use per unit of floor area in buildings, or energy use per unit of production in an industry subsector. The availability of data necessary for a more detailed understanding of energy efficiency trends is variable across countries. Therefore, a critical need is to increase the quantity and quality of data necessary for analysis of energy efficiency trends in order to better understand the impact of policy measures and areas where further action is needed. Further information about the development of energy efficiency indicators has been published by the World Bank's Regulatory Indicators for Sustainable Energy (RISE)index,[1] and the International Energy Agency (IEA)[2] with training courses also available for policymakers and statisticians.[3]

[1] *https:*//rise.worldbank.org
[2] *https:*//www.iea.org/publications/freepublications/publication/energy-efficiency-indicators-essentials-for-policy-making.html
[3] *https:*//edx.iea.org/

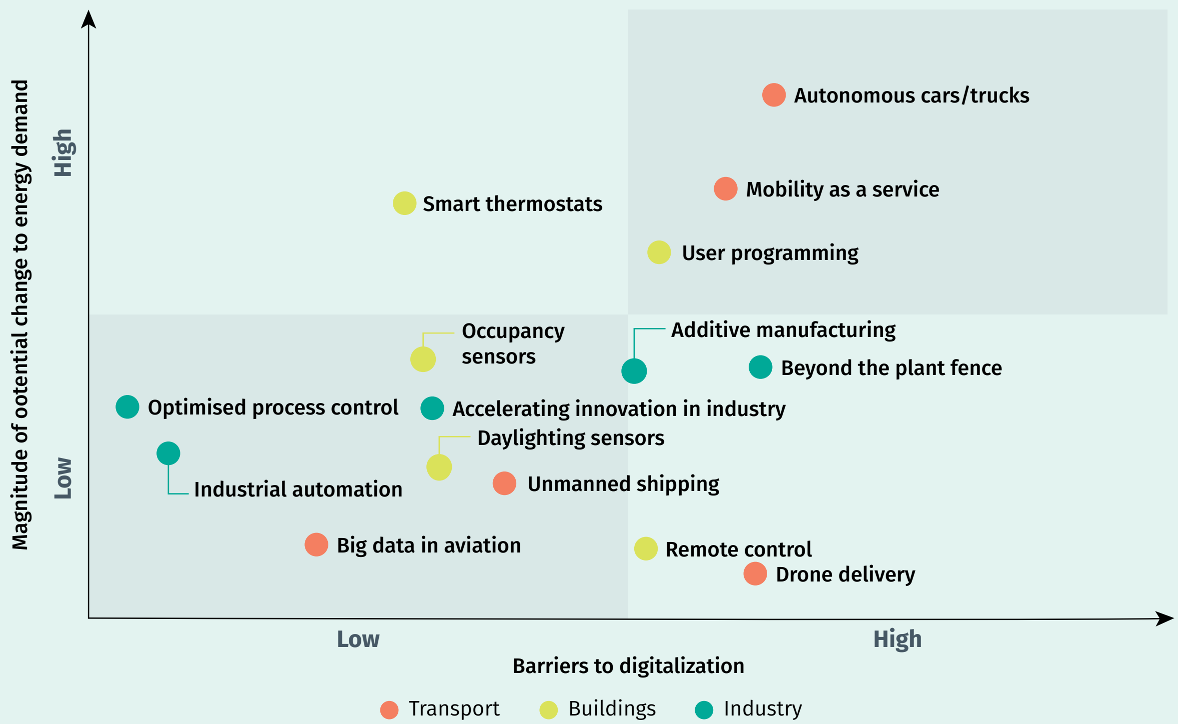
Since the start of the tracking period in 2010, energy intensity improved each year in all regions other than the Western Asia and Northern Africa region, where a yearly regression occurred on two separate occasions. The GDP growth of most countries in this region is tied heavily to energy intensive oil and gas extraction. The sharp decline in oil and gas prices throughout most of the tracking period partly explains the modest pace of GDP growth relative to energy supply. Despite large increases in energy demand, emerging economies in the Asia and the Pacific and the Africa regions have now surpassed the global rate of improvement in energy intensity, but intensity levels continue to be higher than the world average. High income countries throughout Europe and the Americas are also showing consistent decline in energy intensity during the tracking period, but at a slower rate than low and middle income countries.

The performance of the world's 20 largest energy supply countries is critical to achieving the SDG7 target. In 2015, these countries accounted for nearly 80% of total primary energy supply worldwide. The pace of energy intensity improvement in eight of the world's twenty largest energy supply countries (referred to as the Top 20) surpassed the world average of 2.2% during the 2010-2015 tracking period. China, the world's largest energy consumer, led the way with an energy intensity improvement rate of over 4%. Brazil and Iran were the only two top 20 countries that did not improve energy intensity since 2010. According to the World Bank's Regulatory Indicators for Sustainable Energy (RISE) index, top 20 countries score significantly higher than the world average on energy efficiency policies and regulations, which may provide a possible explanation for performance on reducing energy intensity.

BOX 5.2 • INNOVATIVE TRENDS: DIGITALIZATION CAN IMPROVE ACCESS TO ENERGY SERVICES AND ENABLE SYSTEMS EFFICIENCY

Improvements in data collection, analytics and connectivity, which form the fundamental elements of digitalization, are set to have a big impact on energy systems across the buildings, industry and transport sectors. There is however high uncertainty on the potential impacts of digitalization given the speed of technology developments and the extent to which barriers are overcome.

FIGURE 5.15. • Digitalization's potential impact on transport, buildings, and industry



Source: IEA (2017), *Digitalization and Energy*, IEA/OECD, Paris, www.iea.org/digital

In industry, digital metering, monitoring and process controls are already helping many businesses identify and implement efficiency improvements. Advances in digital technologies such as 3D printing and greater connectivity across supply chains and markets offer further opportunities for efficiency gains. In the transport sector, vehicle automation and shared mobility services could revolutionise how people and goods are moved, but the energy implications are unclear, with energy consumption having the potential to increase or decrease substantially, depending on the how these technologies are used. In buildings, digitalization is bringing new energy services to consumers, such as smart thermostats, occupancy sensors, remote control and enhanced safety features. IEA modelling estimates that these advances have the potential to cut global buildings energy use by 10% by 2040. However, digitalization also comes with an energy cost, in particular the greater use of standby power by connected devices, which could offset much of the potential savings.

Source: IEA (2017), *Digitalization and Energy*, IEA/OECD, Paris, www.iea.org/digital

An important emerging trend to note is that some developed countries seem to have reached a peak in total primary energy supply, and have even experienced reductions on a yearly basis. Traditionally, reductions in energy supply have occurred only in conjunction with lower output in large economies, for example during economic recessions. Thanks in part to energy efficiency improvements, six of the top 20 energy supply countries – France, Germany, Italy, Japan, the UK and the US – managed to reduce annual energy supply and still continue to grow GDP steadily. It should be noted that all six are high income countries that are not experiencing the same kind of rapid economic growth as emerging economies in the top 20 group such as China, India, Indonesia, and South Africa. Evidently, reducing energy supply should not be the prescribed universal goal to meet the SDG7 target. Rather, improving energy intensity will enable countries to increase the productivity of each unit of energy used.

DEMAND-SIDE EFFICIENCY

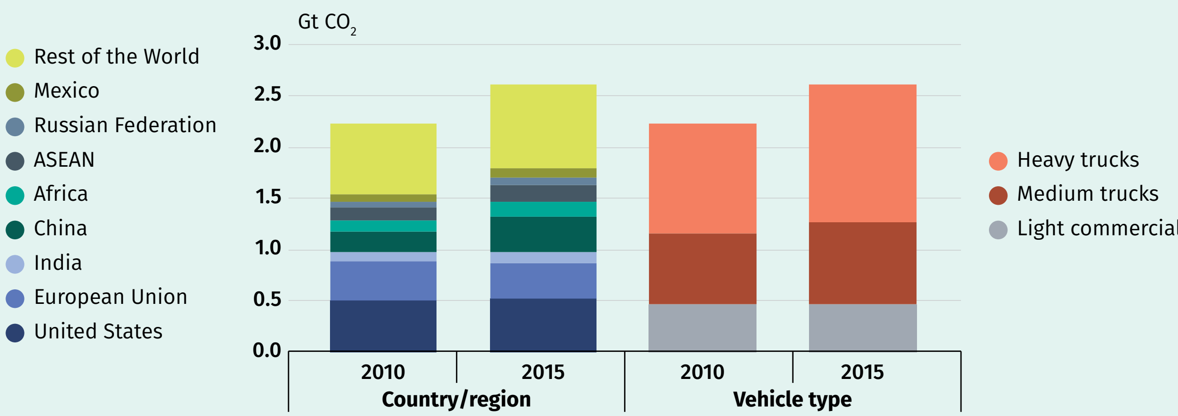
Analyzing the industry, transport and residential sectors is key to evaluate demand-side efficiency since these sectors account for the majority of the world's total final energy consumption. While the industry sector continues to consume the most energy, it has also made the most progress towards improved efficiency. Industrial energy intensity improved by 2.7% per year during the 2010-2015 tracking period, accounting for the largest share of energy savings during that period. Upper middle income and high income countries accounted for 39% and 41% of global energy savings respectively, a combined share of 80%. Amongst individual countries, China had the largest contribution, accounting for more than a third (35%) of global energy savings. The United States accounted for 13%, India for 8%, Japan, the Russian Federation and the United Kingdom of Great Britain and Northern Ireland accounted for 3% each. Savings in the industry sector accounted for the largest contribution in all of these countries. In addition to China and India, other emerging economies such as Malaysia, and Vietnam were also among the world's top 10 highest savings in industrial energy consumption. Efficiency improvements in industry can be attributed to key policy actions and the addition of new and more efficient production technologies in energy-intensive industry processes. Of particular relevance is China's Top 10,000 Energy-Consuming Enterprises Program, which covers two-thirds of the country's energy consumption, and focuses primarily on the industrial sector. It imposes a mandatory absolute energy-saving target of 250 million tonnes of coal equivalent (approximately 7,327 TJ) by 2015, as part of China's 12th Five-Year Plan.

Globally, transport has also improved its energy intensity, but at a slower pace for both passengers and freight. Passenger transport improved its energy intensity by 1.2% per annum in 2010-2015, less than the 1.9% improvement in 2000-2010, while freight transport improved by 0.5% per annum in 2010-2015, less than the 0.8% improvement in 2000-2010. High income and upper middle income countries need to prioritize the transport sector given their growing transport demands, particulary for freight transport. These two income groups are responsible for 90% of transport energy consumption since 2010. Increased freight transport in these advanced economies is an important factor. Although freight transport accounts for 43% of global energy consumption in the transport sector, its share of global emissions from the transport sector is more than 50% and growing (see Box 5.3). This is particularly worrying, considering that only 16% of energy consumption by trucks is covered by fuel economy standards worldwide.

BOX 5.3 • THE SUSTAINABILITY OF ROAD FREIGHT TRANSPORT REQUIRES URGENT POLICY ACTION

In 2015, road freight oil demand grew to 17 million barrels per day – a 50% increase since 2000. Over the period between 2010 and 2015, CO2 emissions from road freight transport increased by 17%, driven by strong growth in China and India, and the continued expansion of the heavy-duty vehicle fleet. The amount of goods transported by heavy-duty vehicles increased by 65% and truck sales grew by 60%.

FIGURE 5.16 • Global road freight transport CO_2 emissions



Source: IEA (2017), The Future of Trucks – Implications for Energy and the Environment, IEA/OECD, Paris, https://www.iea.org/publications/freepublications/publication/the-future-of-trucks---implications-for-energy-and-the-environment.html

Despite the large and growing impact of road freight transport, regulatory policy has only recently begun to catch up. While more than 55% of energy consumption by cars was covered by fuel economy standards in 2016, only 16% of consumption by trucks was covered, with standards limited to Canada, China, Japan and the United States, and under development in the European Union, India, Korea, Mexico, and Saudi Arabia. Other policy approaches are available and are having significant impacts in some jurisdictions. Non-regulatory measures such as road tolls, scrappage programmes and voluntary green freight programmes are in place in many markets. Various member states of the European Union have experimented with these types of measures as well as having the highest fuel taxes in the world. In 2016, trucks in Europe were 14% more efficient per tonne-kilometre than those of the United States and 22% more efficient than those in China.

Sources: IEA (2017), *The Future of Trucks – Implications for Energy and the Environment*, IEA/OECD, Paris, https://www.iea.org/publications/freepublications/publication/the-future-of-trucks---implications-for-energy-and-the-environment.html

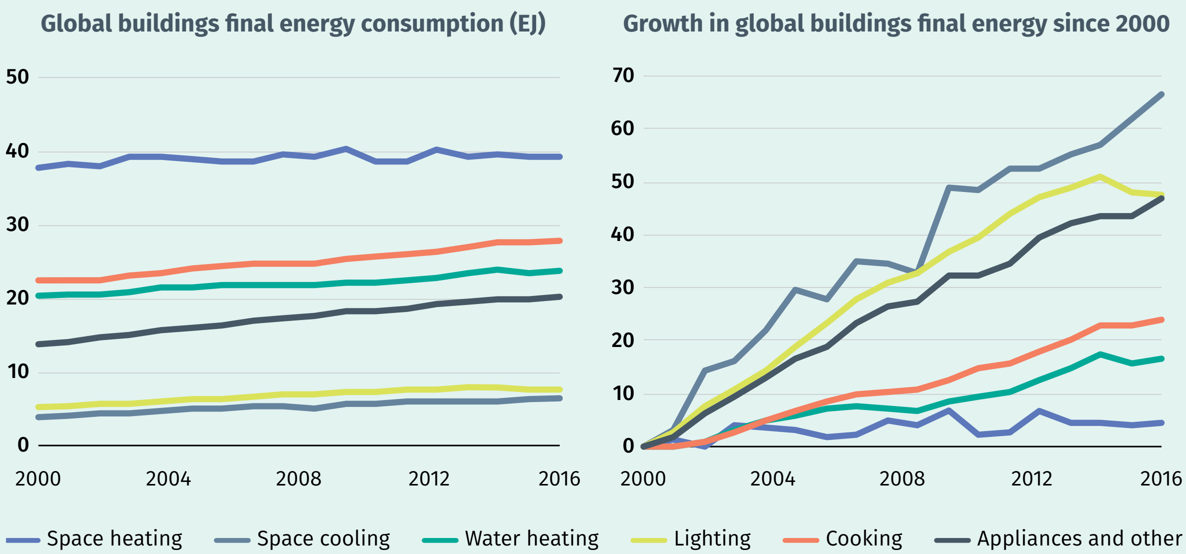
IEA (2017), *Energy Efficiency 2017*, IEA/OECD, Paris, http://www.iea.org/efficiency/

Low and lower middle income economies also showed improvements in industrial and transport energy intensity since 2010, but the residential sector should remain the most pressing priority for the lower income groups. Residential energy intensity increased by 2.4% per annum and 1.8% per annum for low income and lower middle income countries, respectively, in 2010-2015. An increase in housing energy demand due to economic development makes the residential sector the highest energy consuming sector among these countries. Households often cannot afford newer, more efficient appliances and heating/cooling systems, which coupled with poor building design and lack of sufficient insulation, result in poor service levels and high cost for energy. Innovations in the lighting sector that produced affordable, energy efficient lighting products are applicable to all income groups. Similar technology innovations for key household appliances and cooling equipment would address the growing residential energy demands in lower income countries. (see Box 4.4)

BOX 5.4 • BUILDING ENERGY USE IN THE 21ST CENTURY: SPACE HEATING IS THE LARGEST BUILDING END-USE BUT SPACE COOLING IS GROWING THE FASTEST

Final energy consumption in buildings continues to grow, with all buildings end-uses increasing since 2000. Space heating, cooking and water heating are the largest buildings end-uses, however they have risen relatively slowly, with less than 25% growth since 2000. Space cooling, lighting and appliances grew the fastest, with each increasing by more than 45% since 2000.

FIGURE 5.17 • Trends in global buildings final energy by end-use



Source: IEA (2017), *Energy Efficiency 2017*, IEA/OECD, Paris, http://www.iea.org/efficiency/

Cooling appears to have peaked in the Global North (cold and temperate countries) in 2010 with a slight decrease in space cooling energy consumption, largely driven by efficiency gains in Japan and the United States. However, globally, cooling continues to be the fastest growing building end-use, owing to growth in the Global South (mostly hot countries), where residential buildings have seen more than 300% growth, driven by increased wealth and comfort demands for cooling.

Residential buildings in the Global South also have the largest growth in appliances energy demand with nearly 170% growth since 2000. Lighting energy consumption growth is largest in non-residential buildings, growing by two-thirds since 2000. Lighting appears to have hit a global tipping point in 2015, with higher efficiency lighting enabling growing energy service demand to be met by flat or even decreasing energy consumption for the first time.

Source: IEA (2017), *Energy Efficiency 2017*, IEA/OECD, Paris, http://www.iea.org/efficiency/

SUPPLY-SIDE EFFICIENCY

Although the growth of clean renewable power generation has been significant in recent years, thermal power generation with fossil fuels still maintains a majority share in the electricity sector throughout the world. Natural gas is the only source that improved thermal power efficiency considerably since 2010, while coal and oil power efficiency remain stagnant. On a global level, despite the improvement of natural gas efficiency to surpass 45% as of 2015, thermal power efficiency remains below 39% on average worldwide. Coal still accounts for the vast majority of thermal power generation in many large energy consumers such as China, India, Korea, Germany, South Africa and Australia. Among the top 20 countries, half of them had thermal power efficiencies below the world average of 39% in 2015. Thermal efficiency trends clearly dictate that natural gas-powered options should be prioritized over coal-powered or oil-powered options as a long-term investment when thermal generation is necessary.

Losses in natural gas transmission and distribution have maintained a consistent declining trend since 1990. From 2012-2015, however, losses increased slightly. This reversal seems to be caused by loss increases in Malaysia, Pakistan and the Russian Federation, which together account for nearly two-thirds of global losses during this period. In 2015, average global electricity transmission and distribution (T&D) losses stayed relatively constant at 8.6%. This amounted to nearly 2,000 terawatt-hours (TWh) of electricity, equivalent to the entire electricity consumption of India and Japan combined. Although this remains a large amount, it is encouraging not to see any increase in T&D losses given the large amount of renewable energy generation capacity additions during the tracking period, which can put heavy strains on grid operations. The quality of grid infrastructure needs to keep up with the complex demands of new capacity additions. It is not surprising that loss rates remain correlated to income levels. Losses in high income countries have been consistently below the world average and have exhibited an overall downward trend, while those of upper middle income countries have been rapidly declining towards the world average. Lower middle income countries improved the most, reducing losses to 17% in 2015 from above 20% before 2005. Low income countries were the only group that showed an upward trend in T&D loss rate, jumping to 15.4% in 2015 from below 14% before 2005. As low income countries add generation capacity to meet growing energy demands, grid infrastructure needs to be upgraded concurrently to avoid further increases in losses.

CONCLUSIONS

Sustainable Development Goal 7.3 is crucial to the sustainable energy agenda. Energy efficiency will continue to address critical issues in the production, delivery, and consumption of energy for all income levels and geographical constraints. Tracking energy intensity toward the SDG7 target has revealed important priorities for policymakers to focus on. Transport energy intensity needs to improve, especially in high income and upper middle income countries. The residential sector is regressing in energy efficiency, particularly in developing countries with growing heating and cooling needs. On the supply side, the transition to more efficient and clean energy sources, such as renewables and natural gas, is not scaling up fast enough to keep up with 2030 target projections

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CHAPTER 6 –

GLOBAL PROSPECTS FOR SDG 7

Photo: Supriya Biswas /Irena

MAIN MESSAGES

- **The world fails to achieve all Sustainable Development Goal (SDG) 7 targets under current levels of ambition.** The New Policies Scenario of the International Energy Agency (IEA) shows that current and planned policies fall short of delivering universal access to affordable, reliable, sustainable, and modern energy for all by 2030. This means that in 2030 nearly 675 million people are projected to be without access to electricity, 2.3 billion people will not have clean cooking facilities, global energy-related CO2 emissions will continue to rise, and millions of premature deaths will still be caused by harmful indoor and outdoor local air pollution each year.

- **The outlook for electricity access:** Despite progress in all world regions, the world is not on track to achieve universal electricity access by 2030, with Sub-Saharan Africa at great risk of being left behind. The country-by-country analysis of policies, investment, and technologies that underpins the New Policies Scenario shows a projected electrification rate of 92% globally by 2030. Most countries in Asia are on track to deliver near-universal access by 2030, meaning that 90% of the population without access to electricity at that time is projected to live in Sub-Saharan Africa.

- **The outlook for access to clean cooking:** The world is far from being on track to achieve universal access to clean cooking facilities. Of the global population, 27%—or 2.3 billion people—are projected to remain without access to clean-cooking facilities in 2030. Even though near-universal access to electricity is achieved in Asia, 1.3 billion people are still projected to be without clean cooking access by 2030. Despite this slowly falling number, strong population growth hides some success: 900 million people are expected to gain clean cooking access over the period.

- **The outlook for renewable energy:** By 2030, the share of renewables is expected to grow to 21% of total final energy consumption (TFEC) under current and planned policies, from 17.5% today. Traditional uses of biomass are projected to remain a large component of renewable energy consumption; however, its share of total renewable consumption falls from 45% in 2015 to 25% in 2030. Therefore, the share of modern renewables grows at a faster relative pace than total renewables, from 10% in 2015 to 15% in 2030. Although renewable power generation is progressing rapidly, supportive policies for renewable transport and heat remain limited, preventing greater overall renewables penetration.

- **The outlook for energy efficiency:** Energy efficiency policies are expected to contribute to further reductions in global energy intensity, but at a rate not fast enough to bring the world on a sustainable pathway or to reach the SDG 7.3 target. Global energy intensity is expected to decrease by 2.4% per year on average between 2015 and 2030 in the New Policies Scenario, faster than the 2.2% improvement seen over 2010–15 but still short of the 2.6% annual improvement required to meet the SDG 7.3 target.

- **Achieving a sustainable energy future:** The IEA's Sustainable Development Scenario, released in 2017, describes an integrated 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 air pollution which causes deaths and illness (SDG target 3.9); and to take effective action to combat climate change (SDG 13). A central finding is that universal access to modern energy can be delivered without putting the climate objective at risk, bringing substantial co-benefits. Renewables and efficiency are the key mechanisms to drive forward the low-carbon transition and reduce pollutant emissions.

This chapter describes the results of global modeling exercises to understand whether current policy ambitions are sufficient for meeting the targets of SDG 7, and what additional actions are needed for success. The main two scenarios described are derived from the World Energy Outlook, IEA's flagship publication.

The New Policies Scenario—the central scenario—takes into account the policies and implementing measures affecting energy markets that had been adopted as of mid-2017, with relevant policy proposals, even though specific measures to put them into effect may yet to be fully developed. Because of the many institutional, political, and economic obstacles involved, and in some cases the lack of detail in announced intentions on how current commitments and plans will be implemented, this scenario assumes only cautious implementation. It includes, for example, the greenhouse gas and energy–related components of the Nationally Determined contributions pledged under the Paris Agreement (COP21).

The Sustainable Development Scenario (introduced in 2017; see box 6.1) lays out an integrated least-cost strategy for the achievement of three interlinked and important policy objectives related to access to energy services (SDG 7), reducing air pollution (SDG target 3.9), and combatting climate change (SDG 13). The Energy for All case is separate from the Sustainable Development Scenario and describes a pathway for delivering only on the target of SDG 7.1, universal access to modern energy.

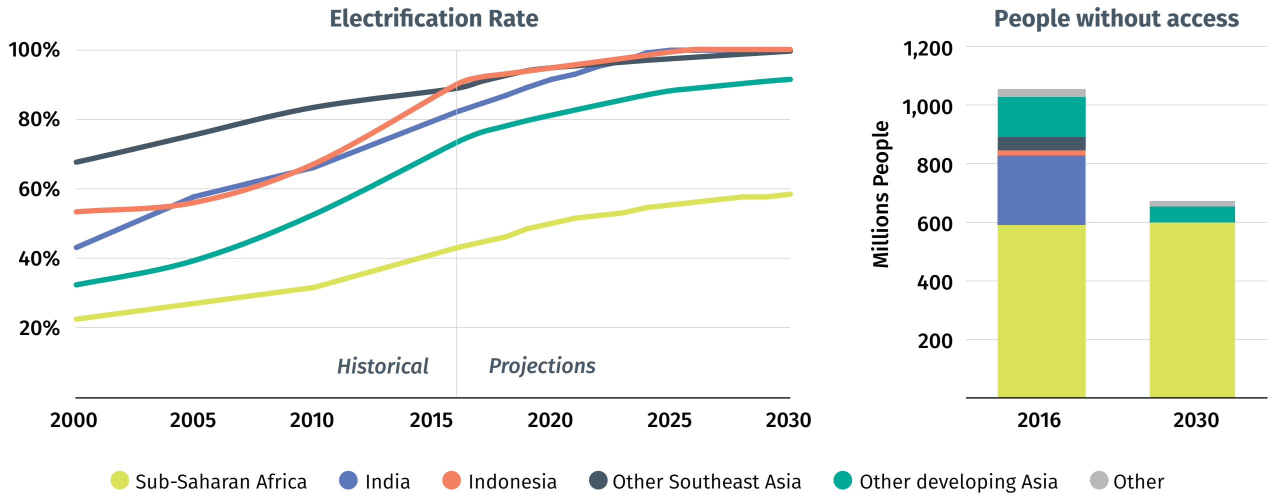
ELECTRICITY ACCESS

Despite progress in all world regions, the world is not on track to achieve universal electricity access by 2030, and Sub-Saharan Africa is at great risk of being left behind. The country-by-country analysis of policies, investment, and technologies that underpins IEA's New Policies Scenario shows a projected electrification rate of 92% globally by 2030, leaving about 675 million people without access by that date.

Despite this failure to achieve the indicator of SDG 7.1.1, many countries are on track to achieve universal electricity access, and over 600 million people will gain access over the period. Sustained progress and policy commitments in Asia mean that the region is projected to reach a 99% rate of electrification in 2030. This achievement is largely the result of India's tremendous electrification effort, which sees 250 million people gaining electricity access between now and the early 2020s, when the country reaches full access. In Latin America, nearly three-quarters of countries are on track to attain universal access by 2020, and by 2030 the region achieves near universal access, with Haiti the only country with an access rate below 90%.

The access deficit continues to become more concentrated in Sub-Saharan Africa. Despite a projected 15 percentage point increase in the access rate, bringing the access rate to almost 60% of the population, 600 million people still are projected to remain without access in 2030, as progress struggles to keep pace with population growth in many countries: Recent progress in Sub-Saharan Africa has been unevenly distributed, and in these projections, population growth overtakes progress—which is saturated by 2030.

FIGURE 6.1 • Electricity access rate and population without electricity by region in the New Policies Scenario



Source: IEA 2017a; www.iea.org/sdg
Note: The geographical groupings presented here are derived from the World Energy Outlook and are described in Annex 1 of the World Energy Model documentation: https://www.iea.org/media/weowebsite/2017/WEM_Documentation_WEO2017.pdf. They do not necessarily correspond to regional groupings used in other chapters of this report.

Analysis of energy balances and resources, population distribution, and infrastructure shows that energy and technology sources are changing rapidly, and are set to be transformative in the future. Since 2000, fossil fuels have been the source of 70% of new electricity access, and the centralized grid is the source for 99% of connections. In the New Policies Scenario, more than 60% of those who gain access by 2030 are projected to do so through generation from renewables, mostly solar and hydro. Grid extensions serve half of the newly connected, but in rural areas decentralized power systems are the most cost-effective solutions for more than two-thirds of those who gain access.

In the Energy for All Case, where universal access to electricity is achieved by 2030, the greatest challenge is to provide access to people living in the most remote areas in Sub-Saharan Africa. Geospatial analysis shows that decentralized systems are the least-cost option to supply electricity for nearly three-quarters of those concerned, but that grid expansion also has an important part to play. The analysis also shows that almost 90% of those gaining access over and above the projections in the New Policies Scenario do so through generation from renewables. The additional annual investment cost is $28 billion per year to 2030, equivalent to 1.7% of total global energy investment. Overcoming this challenge requires better policies: these include setting up dedicated institutions with the responsibility for electricity access, a focus on electrifying productive uses and public services, ensuring an enabling environment to allow the private sector to flourish, and allowing decentralized solutions to play a role.

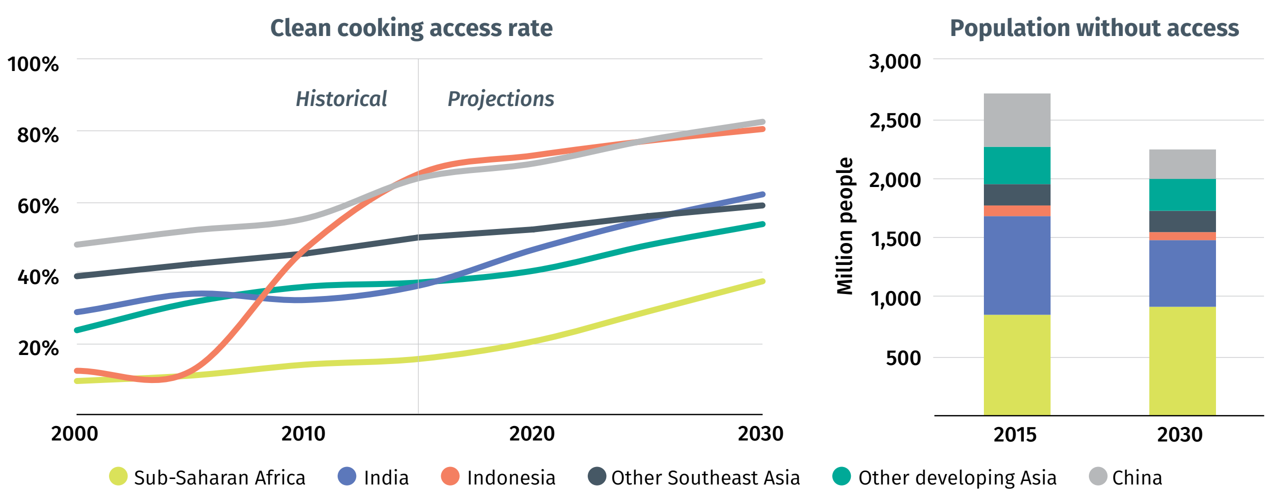
ACCESS TO CLEAN COOKING

The world is far from being on track to achieve universal access to clean cooking facilities. In 2030, 2.3 billion people—or 27% of the global population—are projected to remain without access to clean cooking facilities. Despite this slowly falling number, strong population growth hides some success: 900 million people are expected to gain access by 2030.

Unlike the case for electricity access, the clean cooking access deficit remains geographically dispersed. Although most countries in Asia are on track to achieve universal electricity access by 2030, over 1.3 billion people—31% of the population—will remain reliant on basic biomass cooking facilities, as well as coal and kerosene at that time. This represents some progress, although far from enough to achieve the target. Significant reductions in the population without access to clean fuels and stoves for cooking come from countries with dedicated policy initiatives—in particular China, India, and Indonesia—and from a switch in urban areas to liquefied petroleum gas (LPG).

In Sub-Saharan Africa, about 320 million people gain access to clean cooking facilities during the period to 2030, an estimated 100 million of them as a result of the intentions related to clean cooking pledges in countries' Nationally Determined Contributions. However, the population of Sub-Saharan Africa grows by 450 million people by 2030, and clean cooking efforts do not keep pace. Therefore, the number of people cooking with traditional uses of biomass is projected to increase to 820 million people by 2030, increasing demand.

FIGURE 6.2 • Clean cooking access rate and population without electricity by region in the New Policies Scenario



Source: IEA 2017a, based on WHO Household Energy Survey Database and IEA Energy Balances; www.iea.org/sdg.
Note: The geographical groupings presented here are derived from the World Energy Outlook and are described in Annex 1 of the World Energy Model documentation: https://www.iea.org/media/weowebsite/2017/WEM_Documentation_WEO2017.pdf.
They do not necessarily correspond to regional groupings used in other chapters of this report.

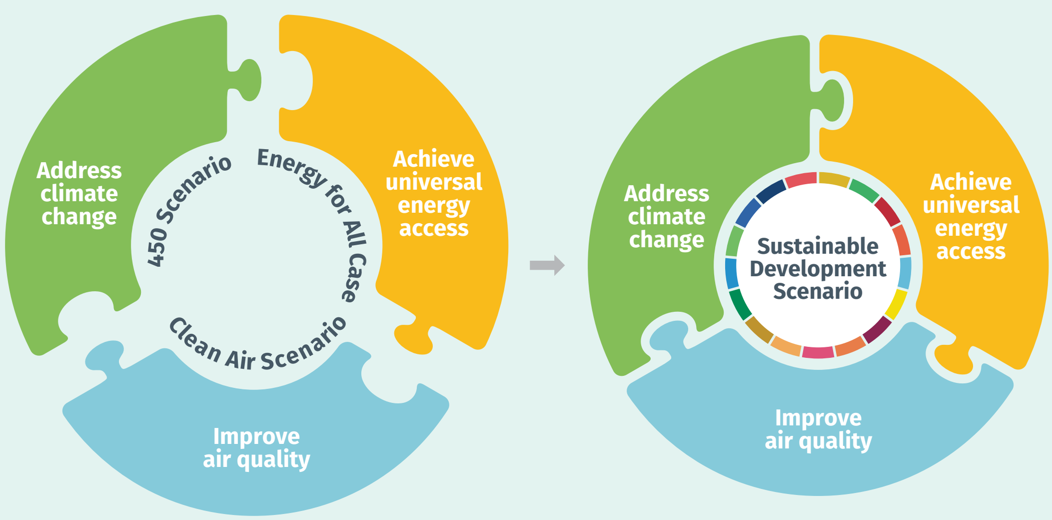
The IEA's Energy for All case describes what would be needed to deliver universal clean cooking to those 2.3 billion people who would be left without access under current trends (1.3 billion in Asia and over 900 million in Sub-Saharan Africa). This requires a major shift in the cooking fuel mix, with LPG the main source of access in urban areas and a mix of technologies, depending on geography and resources, in rural areas. Improved biomass cookstoves are likely to play an important role: although this solution is relatively low cost, there are significant challenges in scaling up their use and in ensuring that they perform to higher emissions standards.

The costs associated with delivering universal clean cooking access, \$3 billion per year, are about one-tenth of those associated with delivering universal access to electricity, and the benefits are very significant. An estimated 1.8 million premature deaths related to household air pollution are avoided in 2030 by providing access to clean cooking for all, even though the effects of pollution in earlier years mean there are still about 700,000 premature deaths in 2030. Analysis also shows significant time savings: over 100 billion hours each year are currently spent gathering wood for fuel, mostly by women, and this time could be used for more productive purposes. Importantly, the SDG 7.1 target can be met without additional net greenhouse gas (GHG) emissions. The small rise in CO2 emissions arising from additional fossil fuel demand (0.2%) is more than offset by the net reduction in GHG emissions from reducing dependence on traditional uses of biomass for cooking, which largely result in methane. The actions policy makers need to take in order to achieve this target, outlined in Policy Brief #2, include translating commitments into concrete, implementable, and evidence-based domestic policies; improving coordination between the energy, education, development, and health sectors; and prioritizing better monitoring of household fuel use to measure the impact of interventions.

BOX 6.1 • A PATH FOR THE ENERGY SECTOR TO ACHIEVE ENERGY-RELATED SDG'S: THE IEA'S SUSTAINABLE DEVELOPMENT SCENARIO

The *World Energy Outlook 2017* introduced a new forward-looking, normative scenario—the Sustainable Development Scenario—that provides an energy sector pathway combining the fundamentals of sectoral energy policy with three closely associated but distinct policy objectives related to the SDGs: (1) to ensure universal access to affordable, reliable, sustainable, and modern energy services by 2030 (SDG 7); (2) to substantially reduce the air pollution that causes deaths and illness (SDG target 3.9); and (3) to take effective action to combat climate change (SDG 13). The objective 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 the respective objectives can be reconciled, dealing with potentially conflicting priorities, so as to realize mutually supportive benefits. The new scenario provides a benchmark for measuring progress toward a more sustainable energy future, in contrast with the New Policies Scenario, which tracks current and planned policies.

FIGURE B6.1.1 • The Sustainable Development Scenario integrates main energy-related SDG targets



Source: IEA 2017b.

In the Sustainable Development Scenario, low-carbon sources double their share in the energy mix to 40% in 2040, all avenues to improve efficiency are pursued, coal demand goes into an immediate decline, and oil consumption peaks soon thereafter. Power generation is all but decarbonized, relying by 2040 on generation from renewables (over 60%) and nuclear power (15%) as well as a contribution from carbon capture and storage (6%)—a technology that plays an even more significant role in cutting emissions from the industry sector. Electric cars move into the mainstream quickly, but decarbonizing the transport sector also requires much more stringent efficiency measures across the board, notably for road freight. Renewables and efficiency are the key mechanisms to drive forward the low-carbon transition and reduce pollutant emissions.

Considering the interlinkages between them and aligning policy and market frameworks—notably in the residential sector—is essential to ensure cost-efficient outcomes. The provision of highly efficient appliances, combined with decentralized renewables, also plays a major role in extending full access to electricity and clean cooking, especially in rural communities and isolated settlements that are hard to reach with the grid. Looking to 2030, modern renewables reach 21% of TFEC, more than doubling today's share; and achieving the goal of universal access to clean cooking facilities reduces significantly traditional uses of biomass from the energy mix. SDG target 7.3 is exceeded in the Sustainable Development Scenario, with average annual improvements in global energy intensity need accelerating to 3.4% annually to achieve critical energy sector objectives

RENEWABLE ENERGY

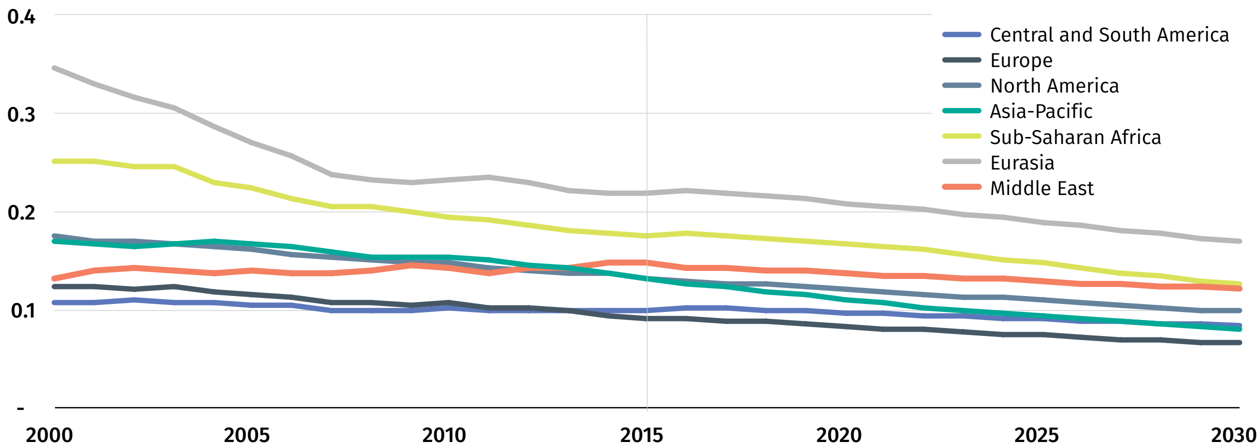
By 2030, the share of renewables is expected to grow to 21% of TFEC under current and planned policies, from 17.5% today. Traditional uses of biomass are projected to remain a large component of renewable energy consumption; however their share of total renewable consumption falls from 45% in 2015 to 25% in 2030. Therefore, the share of modern renewables grows at a faster relative pace than total renewables, increasing significantly from 8.6% in 2010 to 15% in 2030.

Modern renewable energy sources are anticipated to supply 35% of the incremental total final energy demand to 2030, more than any other fuel, backed by strong policy commitments and falling costs. Electricity generation from renewables is expected to overtake that from coal in the 2020s to supply 34% of electricity by 2030, from 23% in 2015. Power generation from wind and solar photovoltaic (PV) are the fastest-growing sources of renewable generation and are anticipated to contribute 35% and 26%, respectively, of the absolute increase in renewable electricity to 2030. Hydropower is projected still to account for nearly half of all renewable power generation in 2030.

Growth in renewables is not confined to the power sector. The direct use of renewables for heat and transport is also set to increase on the basis of current and planned policies, but at a much more limited pace: supportive policies are often fewer, costs sometimes higher, and adoption generally slower. In the New Policies Scenario, the share of renewables in transport grows to 5% in 2030 from 3% in 2015, and direct renewables used in buildings grows to 7% in 2030 from 5% in 2015 (excluding the traditional uses of biomass for cooking).

In IEA's central outlook, renewables contribute an increasing share of total primary energy demand in all regions, and grow in almost all sectors. China continues to be the leading country in renewable energy use and increases its share of global modern renewable energy supply from 15% in 2015 to nearly 20% in 2030. China is followed by the United States, the European Union, and India in renewable energy use in this outlook.

FIGURE 6.3 • Share of modern renewables in TFEC in the New Policies Scenario



Source: IEA 2017a, based on WHO Household Energy Survey Database and IEA Energy Balances; www.iea.org/sdg.
Note: The geographical groupings presented here are derived from the World Energy Outlook and are described in Annex 1 of the World Energy Model documentation: https://www.iea.org/media/weowebsite/2017/WEM_Documentation_WEO2017.pdf.
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While there are many positive developments for renewables, especially for power generation, this progress is not sufficient to put the world on a sustainable track. The IEA's Sustainable Development Scenario shows a pathway for the global energy system to deliver on the main energy-related SDGs (See Box 1). In this scenario, modern renewables reach 21% of TFEC by 2030 and are especially instrumental in delivering universal electricity access, especially to rural access, to reduce air pollution and to bring about an early peak in CO_2 emissions.

BOX 6.2 • THE POTENTIAL OF RENEWABLE ENERGY TO 2050: A VIEW FROM IRENA'S REMAP ANALYSIS

The global imperative to achieve sustainable growth and limit climate change, combined with a rapid decline in costs and rising investment into renewable energy, has put in motion a transition of the way that energy is produced, distributed, and consumed. This Energy Transition will transform the energy system, from one largely based on fossil fuels to one based largely on renewable energy sources. When combined with significant improvements in energy efficiency, the new system will accelerate the decoupling of economic growth and energy demand.

We have now a good understanding that the accelerated deployment of renewable energy and energy efficiency measures are the key elements of the Energy Transition. According to the REmap analysis of the International Renewable Energy Agency (IRENA), the accelerated deployment of renewables and energy efficiency can achieve over 90% of the emissions reductions needed by 2050 to reach the below 2°C mark with 66% probability. Energy demand in 2050 would remain around today's level thanks to intensive energy efficiency improvements, despite significant population and economic growth. The share of renewable energy would meanwhile rise from about 15% of the primary energy supply in 2015 to about 66% by 2050.

Improvements in the energy intensity of the global economy would be achieved by a mix of measures. The most important ones would be energy efficiency measures in heating and fuel use, followed by energy efficiency measures in power generation and electrification of transport. Interestingly, some of the incremental energy intensity improvements could be attributed to renewable energy, highlighting the important synergies between energy efficiency and renewable energy. This includes efficiency gains from renewable energy–based heating, cooling, transport, and electrification coupled with renewable power.

The energy supply mix would change substantially. Under IRENA's REmap analysis, total global primary energy supply in 2050 would be below 500 exajoules (EJ) per year in 2050, slightly below today's level and 30% less than a scenario with continued use of current and planned policies in business as usual (reference case). The share of renewable energy in the total primary energy supply grows to about 66% by 2050. Total fossil fuel use in 2050 would be a third of today's level, with the use of coal declining the most and natural gas becoming the most important fossil fuel. The world would not run out of fossil fuels, but it would stop using the most challenging resources that have high production costs.

The power sector is currently on track to achieve the necessary emissions reductions. The world has witnessed accelerated deployment of solar and wind power on a global scale in recent years, based on technology innovations and dramatic cost reductions. But these ongoing efforts must continue, and more focus should be placed on power systems flexibility as the share of variable renewable power rises. Worldwide, electricity generation would increase to about 47,000 terawatt-hours (TWh) per year by 2050. Total electricity generation capacity would reach more than 18,000 gigawatts (GW) in the same year. Renewable energy technologies would generate an increasing share of that electricity. The renewable share would rise from an estimated 25% of total electricity generation in 2017 to 85% by 2050.

In IRENA's REmap analysis, the share of electricity in TFEC would need to increase to 40% by 2050. Electricity accounts for only about 20% of final energy use today. This would require a broader coupling between the power sector and end-use sectors such as transport, buildings, and industry. In transport, the number of electric vehicles would need to grow. It is critical that new buildings be of the highest efficiency and that existing ones be retrofitted and refurbished at an accelerating rate. Buildings and city designs should facilitate renewable electricity integration. Governments will have an important role in facilitation of enabling infrastructure such as recharging stations and smart grids.

As regards TFEC in end-use sectors (buildings, transport, and industry), under IRENA's REmap analysis, demand would remain flat compared to today's level, at about 340 EJ per year (but almost a third less than the reference case). Direct uses of renewable energy would grow from 10% to 50%. Notably, the share of final bioenergy use in TFEC would rise; at the same time, the use of traditional bioenergy would drop to almost zero and be partly replaced by modern bioenergy and electrification. Solar water heater use would see 10-fold growth for industry and buildings. Growth would also be observed in direct uses of geothermal heating. The oil share would decrease significantly, with transport relying more on biofuels and electricity.

Such an energy transition is affordable but will require additional investments in low-carbon technologies compared to the reference case. Further significant cost reductions will be major drivers for increased investments across the range of renewables and enabling technologies, but cumulative investment in all energy supply would need to increase from 93 trillion to 120 trillion over the 2015–50 timeframe.

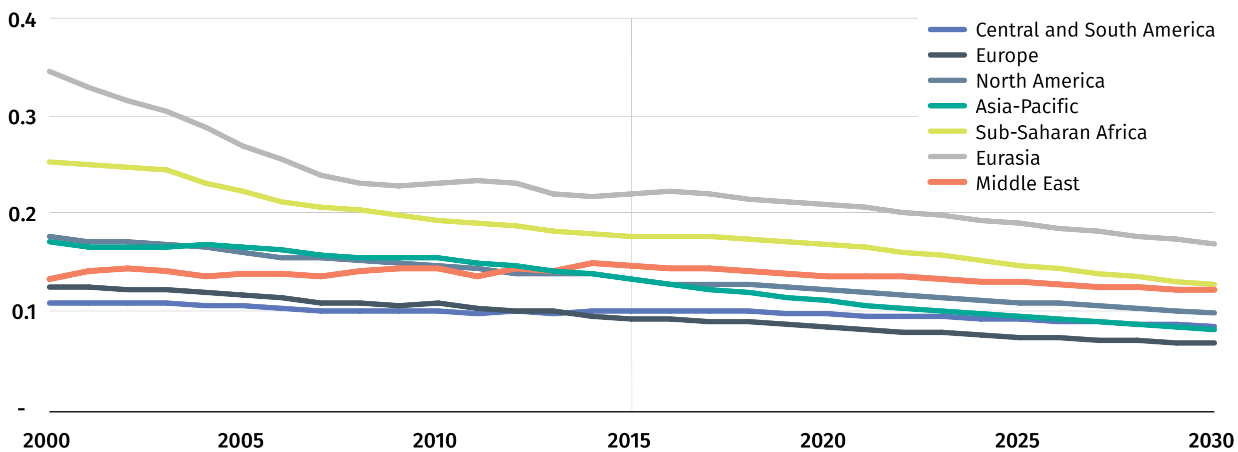
From a macroeconomic perspective, the energy transition can fuel economic growth, create new employment opportunities and enhance human health and welfare. Gross domestic product (GDP) would be boosted about 1% in 2050 compared to the reference case. Important structural economic changes would take place. Whereas fossil fuel industries would incur the largest reductions in sectoral output, those related to capital goods, services, and bioenergy would experience the highest increases. The energy sector (including energy efficiency) would create millions of additional jobs in 2050 compared to the reference case. Job losses in fossil fuels would be completely offset by new jobs in renewables, with more jobs being created by energy efficiency activities. The overall GDP improvement would induce further job creation in other economic sectors.

Improvements in human welfare, including economic, social, and environmental aspects, would generate benefits far beyond those captured by GDP. Savings from reduces externalities related to damages to human health and the environment would outweigh additional costs by as much as five times. However, today's markets are distorted: fossil fuel consumption is still subsidized in many countries and the true cost of burning fossil fuels, in the absence of a carbon price, is not accounted for. To unlock these benefits, the private sector needs clear and credible long-term policy frameworks that provide the right market incentives.

ENERGY EFFICIENCY

Energy efficiency policies are expected to contribute to further reductions in global energy intensity, but not at a rate fast enough to bring the world on a sustainable pathway or to reach the SDG 7.3 target. Global energy intensity is expected to decrease by 2.4% per year on average between 2015 and 2030 in the New Policies Scenario, faster than the 2.2% improvement seen over the 2010–15 period but still short of the 2.6% annual improvement required to meet the SDG 7.3 target. Although intensity improvements accelerate in nearly all world regions, emerging economies make the fastest improvements, with the Asia Pacific region decreasing energy intensity at a rate of 3.3% annually. A number of significant energy efficiency policies currently under development are expected to boost energy intensity reduction in the New Policies Scenario. These include the strengthening of mandatory energy performance regulations in various regions, as well as the implementation of new policy packages announced in the European Union and China. In absolute terms, the largest savings come from avoided coal use in industry in China, which can in large part be attributed to policies to phase out older, more inefficient coal-based capacity and reduce pollutant emissions. The next largest contributions come from reduced oil demand in the transport sectors of the United States and the European Union, where passenger light-duty vehicle (PLDV) fuel-economy standards are set to become more stringent.

FIGURE 6.4 • Energy intensity by region (TPES/GDP (toe per thousand 2010 USD PPP)) in the New Policies Scenario



Source: IEA 2017a, based on WHO Household Energy Survey Database and IEA Energy Balances; www.iea.org/sdg.
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The Sustainable Development Scenario shows that, in order to bring the world on a sustainable energy path, average annual improvements in global energy intensity need to accelerate to 3.4% annually to achieve critical energy sector objectives, bringing about an early peak in CO2 emissions (SDG 13), delivering universal modern energy access by 2030, and reducing harmful air pollution.

CONCLUSIONS

Overall, the prospects for achieving the targets of SDG 7 have improved. The falling cost of renewable electricity is accelerating the deployment of low-carbon electricity and making decentralized electricity more affordable and accessible than ever before, and new policies are raising ambitions and improving the energy intensity of the global economy. However, global energy scenarios reflecting current and planned policies show that the world is far from being on track to achieve the targets of SDG 7. The IEA's Sustainable Development Scenario shows that delivering on energy-related SDGs—universal energy access, climate mitigation, and reduction of local air pollution—in an integrated manner is achievable, and would cost an additional $8 trillion, relative to current ambitions, through 2040. The objective is achievable; however, delivering on these goals, which are a prerequisite for many other SDGs, requires immediate and dramatic changes to the global energy system, including a peak in coal demand by 2020, a near-complete decarbonization of the power sector, and rapid electrification of many end uses.

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DATA ANNEX

ENERGY ACCESS

Country	Access to electricity (% of population [a])							Access to Clean Cooking (% of population)			
	Total					Urban	Rural [b]	Total			
	1990	2000	2010	2014	2016	2016	2016	2000	2010	2014	2016 [l]
Afghanistan			43 [d]	90 [g]	84	98	79	9	21	28	32
Albania	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	40	65	74	77
Algeria			99	99	99	100	99	86	92	93	93
American Samoa											
Andorra	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Angola			34	32 [e]	41	71	16	37	44	47	48
Anguilla		96	100	100	100						
Antigua and Barbuda			94	96	97	100	97	97	98	99	99
Argentina			99 [e]	100	100			95	98	98	98
Armenia		99 [d]	100 [d]	100	100	100	100	82	94	96	97
Aruba		92 [e]	93 [e]	95	96	100	92				
Australia	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Austria	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Azerbaijan		99 [c]	100	100	100	100	100	73	91	94	96
Bahamas			100	100	100	100	100	100	100	100	100
Bahrain			100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Bangladesh		32 [d]	55 [g]	62 [d]	76 [g]	94 [g]	69 [g]	7	13	16	18
Barbados		100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	97	99	99	99
Belarus	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	94	97	98	98
Belgium	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Belize			90 [e]	92	92	97	88	78	83	85	85
Benin		21	34 [g]	34 [c]	41	71	18	2	5	6	6
Bermuda	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
Bhutan			73 [c]	97	100	100	100	32	46	51	53
Bolivia (Plurinational State of)		70 [h]	84	90 [h]	93	99	79	65	77	80	64
Bosnia and Herzegovina			100	100	100	100	100	38	54	60	63
Botswana		27	48	56	61	78	37	45	58	62	64
Brazil	87 [h]	94	99	100 [h]	100	100	100	87	94	95	96
British Virgin Islands											
Brunei Darussalam	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Bulgaria	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	65	86	88	89
Burkina Faso		9	13 [d]	19 [d]	19	61	1	3	6	8	9
Burundi		3	5 [d]	7 [g]	8	50	2	1	1	1	1
Cambodia		17 [d]	31 [d]	56 [d]	50	100	36	5	11	15	18
Cameroon		41 [c]	53	57 [c]	60	92	21	10	18	21	23

Country	Access to electricity (% of population [a])							Access to Clean Cooking (% of population)			
	Total					Urban	Rural [b]	Total			
	1990	2000	2010	2014	2016	2016	2016	2000	2010	2014	2016 [l]
Canada	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Cabo Verde			81 [e]	88	93	93	92	57	67	70	71
Cayman Islands	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	0	0	0	0
Central African Republic		6 [c]	10 [c]	13	14	34	0	1	1	1	1
Chad		3	6 [c]	8	9	31	2	3	3	3	3
Channel Islands	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
Chile	92 [h]	98 [h]	99	100	100	100	100	86	91	92	92
China			100 [g]	100	100	100	100	47	55	58	59
Colombia	90 [d]	95 [d]	97 [h]	98 [h]	99	100	96	80	88	91	92
Comoros		40	63	73	78	92	72	1	4	7	9
Democratic Republic of the Congo		7 [c]	13	14 [d]	17	47	0	4	4	4	4
Congo			43	52	57	74	23	10	18	22	24
Cook Islands			99	100	100	100	100	83	85	85	84
Costa Rica			99 [h]	99 [h]	100	100	100	88	92	93	93
Cote d'Ivoire		49	59	62 [e]	64 [c]	92 [c]	38 [c]	18	18	18	18
Croatia	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	80	90	92	93
Cuba		97 [g]	100	100	100	100	100	68	77	79	79
Curaþao	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
Cyprus	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Czech Republic	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	93	97	97	97
Denmark	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Djibouti		57	53	52	52	67	0	5	8	10	12
Dominica		81	95	100	100			78	87	90	91
Dominican Republic		89 [h]	98 [h]	98 [h]	100	100	100	80	87	90	90
Ecuador		93	97 [h]	99 [h]	100	100	100	87	94	95	96
Egypt		98 [d]	100	100 [d]	100	100	100	83	96	97	98
El Salvador		85 [h]	92 [h]	95 [h]	99	99	99	57	78	84	86
Equatorial Guinea				67	68	91	53	23	31	34	34
Eritrea		29	40	44	47	75	39	6	12	15	16
Estonia	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	79	90	92	93
Ethiopia		13 [d]	25	27 [f]	43 [f]	85 [f]	27 [f]	1	3	3	4
Faeroe Islands	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
Fiji		75	90	96	99	99	98	31	37	39	40
Finland	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
France incl. Monaco	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
French Polynesia	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
Gabon		74 [d]	85	89	91	97	55	59	74	77	79
Gambia		34 [c]	40	45	48	69	16	3	3	3	3
Georgia			99	100 [l]	100	100	100	41	66	74	78
Germany	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Ghana		45	65	78 [d]	79 [d]	90 [d]	67 [d]	6	14	19	22
Gibraltar	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
Greece	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	88	94	94	94

Country	Access to electricity (% of population [a])							Access to Clean Cooking (% of population)			
	Total					Urban	Rural [b]	Total			
	1990	2000	2010	2014	2016	2016	2016	2000	2010	2014	2016 [i]
Greenland	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
Grenada		86	90	91	92			93	96	96	97
Guam		100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
Guatemala		73 [h]	84	85 [h]	92	97	86	39	43	45	45
Guinea		17	26	30	34 [c]	82 [c]	7 [c]	1	1	1	1
Guinea-Bissau			6 [g]	17 [c]	15	30	0	1	1	2	2
Guyana		75	80	87 [c]	84	90	82	36	62	71	74
Haiti		34 [d]	36	38	39	65	0	3	4	4	4
Honduras		68	81 [h]	89 [h]	88	100	72	30	46	51	53
Hong Kong (SAR, China)	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
Hungary	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Iceland	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
India		59	76 [g]	81	85	98	78	22	34	39	41
Indonesia		86 [g]	94 [g]	97 [g]	98 [g]	100 [g]	95 [g]	5	40	54	58
Iran (Islamic Republic of)		98 [d]	99	100 [g]	100	100	100	86	97	98	98
Iraq			98	100	100	100	100	75	95	97	98
Ireland	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Isle of Man	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
Israel	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Italy and San Marino	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Jamaica	70 [h]	85	93	96	98	100	96	73	86	89	91
Japan	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Jordan	97 [d]	99	100	100	100	100	100	97	99	99	99
Kazakhstan		99	100	100	100	100	100	83	93	95	95
Kenya		16	19 [d]	36 [d]	56 [f]	78 [f]	39 [f]	2	8	12	13
Kiribati			63 [e]	81	85	88	82	2	3	4	6
Democratic People's Republic of Korea			29	36	39			3	7	10	11
Republic of Korea		100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	96	97	97	97
Kosovo			99	100	100						
Kuwait	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Kyrgyzstan		100	99 [l]	100 [c]	100	100	100	52	72	78	81
Lao People's Democratic Republic		43	70	81	87	97	80	4	5	5	6
Latvia	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	86	93	95	95
Lebanon			100	100	100	100	100				
Lesotho		4 [c]	19	28 [d]	30	66	16	18	30	34	36
Liberia			5	9 [g]	20 [d]	34 [d]	1 [d]	1	1	1	1
Libya		100	99	99	99	99	96	100	100	100	100
Liechtenstein	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
Lithuania	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Luxembourg	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
China, Macao Special Administrative Region		100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
The former Yugoslav Republic of Macedonia			100	100	100	100	100	44	59	64	66
Madagascar		14	17	19	23 [d]	67 [d]	17 [d]	1	1	1	1
Malawi		5 [d]	9 [d]	12 [d]	11 [g]	42 [g]	4 [g]	2	2	2	3

Country	Access to electricity (% of population [a])							Access to Clean Cooking (% of population)			
	Total					Urban	Rural [b]	Total			
	1990	2000	2010	2014	2016	2016	2016	2000	2010	2014	2016 [l]
Malaysia			99	100	100	100	100	95	96	96	96
Maldives		84 [e]	97	100 [e]	100	100	100	32	84	92	94
Mali		10	25	32	35	84	2	1	1	1	1
Malta	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Marshall Islands		68	83	90	93	95	89	13	55	64	65
Mauritania			33	39 [g]	42	81	0	29	40	44	47
Mauritius		99 [e]	99	99	99	92	100	87	92	93	93
Mexico		98 [h]	99 [h]	99 [h]	100	100	100	81	84	85	85
Micronesia, Federated States of		46 [e]	65 [e]	72	75	92	71	11	12	12	12
Republic of Moldova			100	100	100	100	100	68	87	91	92
Monaco	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Mongolia		67 [e]	79 [c]	81	82	96	44	22	34	40	43
Montenegro			100	100	100	100	100	55	65	68	69
Morocco		70	91	92 [e]	100	100	100	90	96	96	97
Mozambique		7	17	22	24	64	5	3	3	4	4
Myanmar			49 [g]	52 [e]	57	89	40	5	11	15	18
Namibia		37 [d]	45	50	52	77	29	33	39	41	42
Nauru			99	99	99	99		74	89	91	91
Nepal		28	67	85 [c]	91 [d]	95 [d]	85 [d]	15	22	26	28
Netherlands	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
New Caledonia		100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
New Zealand	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Nicaragua		73	78	82 [h]	82	99	57	34	46	50	52
Niger		6 [c]	13	15	16	65	5	1	2	2	2
Nigeria	27 [d]	43	48 [d]	56	59 [g]	86 [g]	41 [g]	1	2	4	5
Niue				100	100	100					
Northern Mariana Islands		100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
Norway including Svalbard and Jan Mayen Islands	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Oman			100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	85	94	95	95
Pakistan		75	90	96	99	100	99	23	36	41	43
Palau			99	100 [g]	99	100	97	64	83	86	87
Panama	70 [e]	81 [e]	87 [e]	92	93	99	81	79	86	88	89
Papua New Guinea		12	20 [g]	21	23	73	15	7	11	12	13
Paraguay		89	97 [h]	99 [h]	98 [c]	100 [c]	96 [c]	44	58	64	66
Peru		72 [h]	88 [h]	93 [h]	95	100	76	35	66	72	75
Philippines		73	84	89	91	97	86	36	42	43	43
Poland	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Portugal	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Puerto Rico			100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
Qatar	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	92	98	98	98
Romania	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	65	81	85	86
Russian Federation	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	93	97	98	98
Rwanda		6 [d]	10 [d]	20 [g]	29 [j]	80 [j]	18 [j]	0	0	1	1
Samoa		88	97	98 [d]	100	100	100	20	29	32	32

Country	Access to electricity (% of population [a])							Access to Clean Cooking (% of population)			
	Total					Urban	Rural [b]	Total			
	1990	2000	2010	2014	2016	2016	2016	2000	2010	2014	2016 [l]
San Marino	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Sao Tome and Principe		53 [c]	60	69 [c]	65	73	51	18	22	19	17
Saudi Arabia			100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	95	96	96	96
Senegal		38 [c]	54	61 [d]	65 [d]	88 [d]	38 [d]	32	32	32	32
Serbia			100	100 [c]	100	100	100	52	69	74	76
Seychelles		94	97 [e]	99	100	99	100	77	88	90	90
Sierra Leone			11 [c]	16	20 [d]	47 [d]	3 [d]	0	1	1	1
Singapore	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Sint Maarten (Dutch part)	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
Slovak Republic	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	94	97	97	97
Slovenia	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	89	95	96	96
Solomon Islands		7	32	43	48	70	42	6	8	8	8
Somalia			20	27	30	57	12	1	1	2	2
South Africa		71	83 [g]	86 [g]	84 [g]	93 [g]	68 [g]	56	77	82	85
South Sudan			2 [e]	7	9	22	6	1	1	1	1
Spain	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Sri Lanka			85 [g]	92	96	100	95	16	22	25	26
Saint Kitts and Nevis			98	100	100	100	100	100	100	100	100
Saint Lucia			94 [e]	97	98	95	98	86	95	97	97
Sint Maarten (French part)			64 [e]	70	72	90	100				
Saint Vincent and the Grenadines		80	93	99	100	97	100	95	96	96	96
Sudan	33 [d]	23 [c]	35	45 [c]	39	70	22	14	29	37	41
Suriname		97	91 [c]	88	87	96	69	80	87	89	90
Swaziland			46 [c]	65 [c]	66	83	61	27	42	47	50
Sweden	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Switzerland-Liechtenstein	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
Syrian Arab Republic			93 [g]	99	100	100	100	97	99	99	99
Tajikistan		98 [c]	99	100	100	100	100	39	67	77	80
Tanzania		10	15 [d]	19	33 [g]	65 [g]	17 [g]	1	2	2	2
Thailand		82 [d]	100 [f]	100	100	100	100	68	72	74	74
Timor-Leste			38 [d]	58	63	92	49	2	5	6	7
Togo		17 [c]	31 [c]	46 [d]	47	87	19	0	4	6	7
Tonga		85	92	95	97 [e]	99 [e]	97 [e]	48	56	58	59
Trinidad and Tobago		91 [e]	99	100	100	100	100	99	99	99	99
Tunisia		95 [g]	100 [g]	100 [e]	100	100	100	93	98	99	99
Turkey			100 [l]	100	100	100	100				
Turkmenistan		100 [d]	100 [l]	100	100	100	100	96	99	99	99
Turks and Caicos Islands	89 [e]	96 [e]	94	95	96	100	43				
Tuvalu			97	99	99	100	99	19	38	47	50
Uganda		8	15	20 [e]	27 [d]	58 [d]	18 [d]	1	1	1	1
Ukraine			100	100	100	100	100	88	94	95	96
United Arab Emirates	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	97	98	99	99
United Kingdom	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100
United States	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100	100	100	100

Country	Access to electricity (% of population [a])							Access to Clean Cooking (% of population)			
	Total					Urban	Rural [b]	Total			
	1990	2000	2010	2014	2016	2016	2016	2000	2010	2014	2016 [l]
Uruguay			99	100 [h]	100	100	100	96	98	98	98
Uzbekistan		100	100	100	100	100	100	80	89	91	92
Vanuatu		22	37	43	58 [e]	91 [e]	46 [e]	12	13	13	13
Venezuela (Bolivarian Republic of)		98	99	99	100	100	96	96	97	97	96
Viet Nam		86	98	99 [c]	100	100	100	14	47	61	67
United States Virgin Islands	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]	100 [k]				
Palestine (State of)		100 [g]	100 [g]	100 [c]	100	100	100				
Yemen		50	63	66 [g]	72	97	58	52	61	64	65
Zambia	14 [e]	17 [e]	22 [e]	28 [d]	27	62	3	14	15	16	16
Zimbabwe		34	36	32 [c]	38	86	16	32	30	30	29
World	70	77	80	84	87	97	76	50	56	58	59
High income	93	97	100	100	100	100	100	97	98	99	99
Low income	4	13	16	23	35	65	22	4	5	6	7
Lower middle income	48	63	69	76	84	96	76	33	38	42	47
Upper middle income	91	95	96	98	99	100	97	67	73	78	81
Central Asia and Southern Asia	45	60	68	77	87	98	80	26	37	41	43
Eastern Asia and South-eastern Asia	82	91	93	96	97	99	95	45	55	59	60
Latin America and the Caribbean	85	91	94	96	98	99	91	78	85	87	87
Northern America and Europe	100	100	100	100	100	100	100	96	98	98	99
Oceania	80	81	82	82	83	99	46	78	78	78	78
Sub-Saharan Africa	15	26	29	33	43	76	23	9	11	13	13
Western Asia and Northern Africa	76	80	89	92	93	99	85	77	87	88	89

Note: Unless otherwise noted, data are World Bank estimates based on the statistical model described in chapter 2 in the main report.

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. 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 Multi-Tier Framework (MTF)

k. Based on assumption for countries considered "developed" by the UN or which are classified as High Income Countries (HIC)

l. Based on the World Health Organization Global Health Observatory

ENERGY EFFICIENCY

Country	Energy Intensity (MJ/USD 2011 PPP)					Compound annual growth rate of Energy Intensity (%)				
	1990	2000	2010	2014	2015	1990-2000	2000-2010	2010-2014	2014-2015	
Afghanistan	1.9	1.7	2.9	2.3	2.5	-1.1%	5.7%	-5.8%	6.1%	a
Albania	7.5	4.4	3.1	3.2	2.9	-5.1%	*-3.6%*	0.7%	-8.6%	b
Algeria	3.5	3.5	3.6	4.1	4.1	0.1%	0.2%	3.2%	0.7%	b
Andorra										
Angola	4.6	5.2	3.7	3.6	3.6	1.3%	*-3.4%*	-0.4%	-1.1%	b
Anguilla										
Antigua and Barbuda	3.8	3.2	4.1	4.0	3.9	-1.8%	2.6%	-1.2%	-1.6%	a
Argentina	5.4	4.7	4.3	4.3	4.3	-1.5%	-0.9%	0.4%	-0.1%	b
Armenia	24.4	9.4	5.4	5.3	5.4	-9.1%	-5.4%	-0.2%	0.7%	b
Aruba	2.4	7.6	7.6	3.3	3.3	12.4%	0.0%	-19.1%	1.4%	a
Australia	7.4	6.4	5.9	5.2	5.0	-1.5%	-0.9%	-3.2%	-2.3%	b
Austria	4.3	3.9	3.9	3.6	3.6	-1.2%	*0.2%*	-2.4%	1.5%	b
Azerbaijan	15.6	13.2	3.4	3.8	3.7	-1.7%	*-12.8%*	2.9%	-0.9%	b
Bahamas	4.1	3.5	4.2	4.0	4.0	-1.5%	1.8%	-1.2%	1.3%	a
Bahrain	12.4	11.0	10.4	9.9	9.8	-1.2%	-0.6%	-1.3%	-1.4%	b
Bangladesh	3.9	3.5	3.4	3.1	3.1	-1.0%	*-0.3%*	-2.3%	0.3%	b
Barbados	4.6	4.2	4.7	3.8	3.8	-1.0%	1.1%	-5.0%	-0.6%	a
Belarus	22.4	13.6	7.5	6.8	6.5	-4.8%	*-5.8%*	-2.2%	-5.3%	b
Belgium	6.6	6.4	5.6	4.8	4.7	-0.3%	*-1.2%*	-4.0%	-0.9%	b
Belize	8.5	6.4	5.1	4.6	5.1	-2.9%	*-2.3%*	-2.5%	11.5%	a
Benin	9.6	7.3	9.3	8.6	9.1	-2.7%	2.5%	-1.8%	5.3%	b
Bermuda	2.9	2.3	2.4	2.4	2.0	-2.5%	0.5%	-0.3%	-14.9%	a
Bhutan	30.0	21.8	12.6	11.2	10.4	-3.1%	*-5.4%*	-2.7%	-7.4%	a
Bolivia	4.3	5.6	4.9	5.2	4.9	2.6%	-1.3%	1.2%	-4.2%	b
Bosnia and Herzegovina	39.1	7.6	7.5	8.8	8.7	-15.1%	-0.2%	3.9%	-0.3%	b
Botswana	4.6	4.2	3.4	3.3	3.4	-0.9%	-2.2%	-0.5%	1.7%	b
Brazil	3.8	3.9	3.9	4.0	4.1	0.4%	-0.1%	1.0%	2.1%	b
Brunei Darussalam	3.3	3.7	4.3	4.7	3.7	1.0%	1.7%	2.3%	-23.1%	b
Bulgaria	14.6	10.6	6.6	6.4	6.4	-3.1%	-4.6%	-1.0%	0.4%	b
Burkina Faso	12.9	6.8	6.5	6.1	6.0	-6.2%	*-0.4%*	-1.7%	-1.1%	a
Burundi	9.8	11.3	13.3	7.5	7.7	1.5%	*1.6%*	-13.4%	3.0%	a
Cambodia		8.5	6.2	5.6	5.8		-3.2%	-2.5%	3.3%	b
Cameroon	6.2	6.9	5.5	4.9	4.8	1.0%	-2.2%	-3.1%	-1.7%	b
Canada	10.2	9.2	8.0	7.6	7.3	-1.0%	-1.4%	-1.2%	-4.0%	b
Cabo Verde	4.0	2.7	3.2	2.8	2.8	-4.0%	1.7%	-3.3%	0.4%	a
Cayman Islands										
Central African Republic	11.3	7.3	5.7	8.5	8.1	-4.3%	-2.4%	10.4%	-4.4%	a
Chad	6.8	6.9	3.2	2.8	2.8	0.2%	*-7.5%*	-3.2%	-0.2%	a
Channel Islands										
Chile	4.9	4.8	3.9	3.8	3.8	-0.2%	-2.1%	-0.9%	0.2%	b
China	21.0	10.1	8.3	7.1	6.7	-7.1%	*-1.9%*	-3.9%	-5.8%	b
Colombia	3.9	3.2	2.6	2.3	2.3	-2.0%	-2.1%	-2.7%	-3.6%	b
Comoros	3.2	4.0	4.8	4.5	4.7	2.3%	1.7%	-1.4%	4.2%	a

Country	Energy Intensity (MJ/USD 2011 PPP)					Compound annual growth rate of Energy Intensity (%)				
	1990	2000	2010	2014	2015	1990-2000	2000-2010	2010-2014	2014-2015	
Democratic Republic of the Congo	11.1	23.4	21.1	22.6	20.9	7.7%	-1.0%	1.7%	-7.3%	*b*
Congo	2.6	2.1	3.1	4.1	4.0	-2.4%	4.1%	7.2%	-1.5%	*b*
Cook Islands										
Costa Rica	2.9	3.1	3.3	3.0	2.9	0.6%	0.6%	-2.2%	-4.4%	*b*
Côte d'Ivoire	4.6	5.8	7.8	8.4	7.2	2.2%	3.0%	2.1%	-14.3%	*b*
Croatia	6.8	5.0	4.4	3.9	4.1	-2.9%	-1.3%	-2.8%	2.7%	*b*
Cuba	5.0	4.2	2.5	2.1	2.1	-1.7%	-5.2%	-3.7%	-1.2%	*b*
Curaçao										
Cyprus	4.2	4.3	3.6	3.3	3.3	0.1%	-1.6%	-2.7%	0.4%	*b*
Czechia	10.1	8.0	6.4	5.7	5.5	-2.4%	*-2.2%*	-2.6%	-3.9%	*b*
Denmark	4.2	3.5	3.3	2.7	2.6	-1.9%	*-0.3%*	-5.6%	-1.7%	*b*
Djibouti	3.5	5.2	4.8	4.1	3.4	4.0%	*-0.9%*	-3.5%	-17.4%	*a*
Dominica	2.0	2.9	3.4	3.3	3.6	3.6%	*1.5%*	-0.5%	9.3%	*a*
Dominican Republic	4.4	4.4	2.8	2.4	2.5	0.0%	-4.5%	-3.7%	1.3%	*b*
Ecuador	3.5	4.0	3.5	3.4	3.6	1.3%	-1.1%	-0.8%	6.0%	*b*
Egypt	4.0	3.3	3.7	3.7	3.5	-1.9%	1.2%	0.1%	-5.5%	*b*
El Salvador	4.3	4.4	4.1	3.5	3.6	0.2%	-0.9%	-3.5%	3.8%	*b*
Equatorial Guinea	11.8	1.4	2.1	2.1	2.2	-19.3%	4.4%	-0.8%	7.2%	*a*
Eritrea		5.2	5.0	4.7	4.8		-0.4%	-1.3%	1.8%	*b*
Estonia	31.3	9.0	7.8	7.1	6.3	-11.7%	-1.5%	-2.3%	-10.7%	*b*
Ethiopia	30.6	32.3	19.0	14.7	13.7	0.5%	-5.2%	-6.2%	-6.8%	*b*
Faroe Islands										
Fiji	4.8	4.0	3.5	4.0	4.9	-1.8%	-1.5%	3.9%	20.3%	*a*
Finland	8.2	7.5	7.2	6.7	6.4	-0.9%	*-0.5%*	-1.7%	-5.0%	*b*
France	5.4	5.0	4.6	4.1	4.1	-0.9%	-0.8%	-2.7%	0.5%	*b*
French Polynesia										
Gabon	2.7	2.8	8.4	6.7	6.5	0.5%	*11.6%*	-5.6%	-2.4%	*b*
Gambia	5.0	4.9	4.4	4.6	4.5	-0.2%	*-1.0%*	1.2%	-2.6%	*a*
Georgia	13.5	8.3	4.9	5.6	5.8	-4.7%	-5.1%	3.3%	2.5%	*b*
Germany	5.9	4.7	4.1	3.6	3.6	-2.4%	-1.2%	-3.1%	-1.0%	*b*
Ghana	7.9	6.1	4.2	3.6	3.7	-2.5%	-3.7%	-4.2%	5.0%	*b*
Gibraltar										
Greece	4.3	4.2	3.6	3.7	3.7	-0.1%	-1.5%	0.6%	0.5%	*b*
Greenland										
Grenada	2.3	3.0	3.4	2.9	3.0	2.5%	*1.4%*	-3.8%	0.9%	*a*
Guam										
Guatemala	3.9	4.2	4.3	4.9	4.5	0.6%	0.4%	2.9%	-7.8%	*b*
Guinea	15.5	12.8	11.4	10.2	10.6	-1.9%	*-1.2%*	-2.8%	4.1%	*a*
Guinea-Bissau	12.6	13.7	12.9	12.4	12.0	0.8%	-0.6%	-1.0%	-2.9%	*a*
Guyana	11.6	9.3	7.4	6.6	6.4	-2.2%	-2.3%	-2.6%	-3.8%	*a*
Haiti	5.2	5.7	10.6	9.9	10.1	0.8%	6.5%	-1.5%	1.6%	*b*
Honduras	6.3	5.8	5.9	6.0	6.2	-0.9%	0.2%	0.6%	2.3%	*b*
Hong Kong (SAR, China)	2.3	2.5	1.7	1.6	1.5	0.7%	-3.9%	-2.1%	-4.2%	*b*
Hungary	8.4	5.7	5.0	4.2	4.3	-3.8%	-1.4%	-4.1%	2.6%	*b*
Iceland	12.8	13.6	18.4	18.1	16.6	0.6%	*3.0%*	-0.4%	-8.6%	*b*
India	8.4	7.0	5.4	5.0	4.7	-1.8%	*-2.7%*	-1.9%	-4.6%	*b*
Indonesia	4.9	5.3	4.3	3.7	3.5	0.8%	*-2.1%*	-3.9%	-4.3%	*b*
Iran (Islamic Republic of)	5.1	6.6	6.6	7.7	7.8	2.6%	0.0%	4.0%	1.3%	*b*
Iraq	4.2	3.8	4.0	4.0	3.7	-1.0%	0.6%	0.1%	-7.7%	*b*

Country	Energy Intensity (MJ/USD 2011 PPP)					Compound annual growth rate of Energy Intensity (%)				
	1990	2000	2010	2014	2015	1990-2000	2000-2010	2010-2014	2014-2015	
Ireland	5.3	3.7	2.9	2.4	1.9	-3.5%	-2.5%	-4.9%	-17.6%	b
Isle of Man										
Israel	5.2	4.7	4.3	3.4	3.6	-1.1%	*-0.8%*	-5.5%	4.4%	b
Italy	3.5	3.5	3.4	3.0	3.1	-0.1%	*-0.2%*	-3.2%	3.2%	b
Jamaica	6.6	7.6	5.0	5.1	5.2	1.4%	*-4.1%*	0.7%	2.0%	b
Japan	4.9	5.0	4.6	3.9	3.7	0.3%	*-1.0%*	-4.0%	-3.3%	b
Jordan	6.1	5.5	4.4	4.5	4.6	-1.0%	-2.3%	0.8%	3.0%	b
Kazakhstan	14.4	10.1	8.8	7.9	7.9	-3.5%	*-1.3%*	-2.8%	0.7%	b
Kenya	8.1	8.7	8.0	7.8	7.8	0.8%	-0.9%	-0.5%	0.3%	b
Kiribati	3.3	2.8	4.8	4.0	4.1	-1.7%	5.7%	-4.4%	2.6%	a
Democratic People's Republic of Korea										
Republic of Korea	7.8	8.1	7.0	6.6	6.5	0.3%	-1.5%	-1.2%	-1.2%	b
Kosovo										
Kuwait	4.9	5.5	6.0	5.0	5.3	1.1%	*0.9%*	-4.4%	7.0%	b
Kyrgyzstan	20.5	9.6	7.6	9.2	8.6	-7.4%	-2.3%	5.0%	-6.2%	b
Lao People's Democratic Republic	8.7	5.6	4.8	3.9	5.2	-4.3%	*-1.6%*	-4.7%	31.3%	a
Latvia	21.4	6.1	4.9	4.1	3.9	-11.8%	-2.1%	-4.5%	-4.4%	b
Lebanon	3.9	5.1	3.8	4.2	4.2	2.8%	-2.9%	2.4%	0.6%	b
Lesotho	16.4	14.4	10.8	10.3	9.7	-1.3%	*-2.8%*	-1.2%	-5.7%	a
Liberia	20.7	20.2	27.0	25.4	26.0	-0.2%	3.0%	-1.6%	2.4%	a
Libya	5.2	5.6	4.8	4.4	4.2	0.9%	-1.7%	-1.7%	-5.3%	b
Liechtenstein										
Lithuania	28.9	7.0	4.5	3.8	3.9	-13.2%	-4.3%	-4.2%	1.4%	b
Luxembourg	6.4	3.9	3.8	3.1	2.9	-4.8%	*-0.3%*	-5.2%	-6.3%	b
Macao (SAR, China)	1.0	1.3	0.6	0.4	0.7	2.2%	*-7.8%*	-6.9%	50.5%	a
Macedonia, FYR	5.4	6.4	5.1	4.4	4.2	1.7%	*-2.2%*	-3.6%	-4.1%	b
Madagascar	4.4	5.2	5.1	5.3	5.4	1.6%	*-0.1%*	0.7%	1.8%	a
Malawi	9.1	6.6	4.9	4.3	4.1	-3.2%	-2.9%	-3.2%	-5.6%	a
Malaysia	4.8	5.4	5.2	5.1	4.7	1.2%	-0.4%	-0.2%	-8.8%	b
Maldives	17.2	3.6	3.5	4.0	3.8	-14.5%	-0.3%	3.3%	-2.9%	a
Mali	4.0	3.5	2.8	2.9	2.8	-1.3%	-2.4%	0.9%	-1.6%	a
Malta	5.1	2.9	3.0	2.3	1.8	-5.3%	0.1%	-5.9%	-22.9%	b
Marshall Islands		10.6	11.8	10.9	11.3		1.1%	-1.9%	3.7%	a
Mauritania	4.0	3.9	3.7	3.6	3.6	-0.4%	*-0.3%*	-0.6%	-1.6%	a
Mauritius	3.6	3.2	2.8	2.5	2.6	-1.0%	-1.5%	-2.0%	0.1%	b
Mexico	4.8	4.1	4.1	3.9	3.7	-1.5%	-0.1%	-1.5%	-3.0%	b
Micronesia (Federated States of)										
Moldova	81.2	14.3	10.5	8.2	8.4	-16.0%	-3.0%	-6.2%	2.8%	b
Monaco										
Mongolia	12.8	9.0	7.9	6.7	6.1	-3.4%	-1.3%	-4.1%	-8.5%	b
Montenegro			5.4	4.4	4.4			-5.4%	2.1%	b
Morocco	3.2	3.5	3.4	3.2	3.2	0.8%	-0.4%	-1.1%	-2.6%	b
Mozambique	49.4	29.6	18.8	16.6	17.3	-5.0%	-4.5%	-3.0%	4.4%	b
Myanmar	14.8	8.9	3.0	3.1	3.1	-4.9%	-10.2%	0.8%	-0.2%	b
Namibia		3.7	3.5	3.3	3.3		-0.5%	-1.4%	-1.5%	b
Nauru										
Nepal	10.8	9.3	8.0	7.6	7.4	-1.5%	-1.5%	-1.2%	-2.4%	b
Netherlands	5.9	4.8	4.6	4.0	3.9	-2.1%	-0.3%	-3.8%	-0.7%	b

Country	Energy Intensity (MJ/USD 2011 PPP)					Compound annual growth rate of Energy Intensity (%)				
	1990	2000	2010	2014	2015	1990-2000	2000-2010	2010-2014	2014-2015	
New Caledonia										
New Zealand	6.7	6.6	5.5	5.5	5.4	-0.2%	-1.8%	0.2%	-1.7%	b
Nicaragua	6.8	6.1	5.4	5.2	5.4	-1.1%	-1.2%	-0.5%	3.5%	b
Niger		7.2	7.0	7.1	6.9		-0.3%	0.3%	-1.8%	b
Nigeria	9.6	10.3	6.1	5.6	5.7	0.7%	-5.1%	-2.2%	0.9%	b
Niue										
Northern Mariana Islands										
Norway	4.9	4.2	4.7	3.6	3.8	-1.4%	1.0%	-6.4%	4.8%	b
Oman	2.8	3.2	5.7	6.4	6.3	1.3%	6.0%	2.9%	-1.3%	b
Pakistan	5.5	5.5	4.8	4.5	4.4	0.1%	-1.3%	-1.6%	-2.5%	b
Palau		11.1	11.4	11.7	10.2		0.2%	0.6%	-12.2%	a
Panama	3.2	3.4	2.7	2.3	2.2	0.4%	-2.2%	-4.1%	-4.4%	b
Papua New Guinea	13.2	9.9	9.5	7.7	9.3	-2.9%	-0.4%	-5.0%	20.1%	a
Paraguay	5.1	5.0	4.4	3.9	4.0	-0.1%	-1.2%	-3.3%	1.8%	b
Peru	3.5	3.0	2.8	2.8	2.8	-1.5%	-0.7%	-0.1%	0.3%	b
Philippines	4.8	5.1	3.2	3.0	3.1	0.5%	-4.4%	-1.5%	2.9%	b
Poland	11.0	6.6	5.1	4.3	4.1	-5.0%	-2.6%	-4.3%	-2.8%	b
Portugal	3.5	3.8	3.4	3.3	3.3	1.0%	-1.2%	-1.1%	2.1%	b
Puerto Rico	0.0	0.1	0.2	0.4	0.4	24.5%	7.8%	15.9%	5.2%	a
Qatar	9.3	7.1	5.2	6.5	6.4	-2.7%	-3.1%	5.7%	-1.1%	b
Romania	47093.5	6.4	4.1	3.4	3.3	-58.9%	-4.5%	-4.5%	-2.5%	b
Russian Federation	12.0	5.0	8.7	8.3	8.4	-8.5%	5.8%	-1.1%	0.8%	b
Rwanda	5.6	8.5	6.1	5.2	4.9	4.2%	-3.3%	-3.6%	-6.6%	a
Samoa	4.3	4.4	4.5	4.3	5.2	0.2%	0.2%	-1.4%	21.6%	a
San Marino										
Sao Tome and Principe	32.4	5.9	5.2	4.7	4.7	-15.6%	-1.3%	-2.5%	-1.1%	a
Saudi Arabia	3.5	4.6	6.2	5.8	5.8	2.7%	3.1%	-1.7%	-0.2%	b
Senegal	5.1	5.3	5.7	5.1	5.0	0.5%	0.7%	-2.9%	-1.6%	b
Serbia	18.9	9.6	7.1	5.9	6.6	-6.6%	-3.0%	-4.3%	10.5%	b
Seychelles	2.2	5.4	3.3	2.6	2.6	9.2%	-4.6%	-6.4%	2.9%	a
Sierra Leone	9.3	13.1	7.6	5.8	7.0	3.5%	-5.3%	-6.7%	20.8%	a
Singapore	4.6	3.8	2.9	2.5	2.4	-2.0%	-2.5%	-3.8%	-3.6%	b
Sint Maarten (Dutch part)										
Slovak Republic	18.6	8.8	5.5	4.5	4.5	-7.2%	-4.6%	-4.8%	-1.0%	b
Slovenia	7.1	5.9	5.2	4.7	4.6	-1.8%	-1.3%	-2.4%	-3.4%	b
Solomon Islands	9.4	7.7	6.3	5.2	5.0	-2.0%	-2.0%	-4.5%	-3.7%	a
Somalia										
South Africa	10.5	10.5	9.7	9.0	8.7	0.0%	-0.8%	-1.7%	-3.7%	b
South Sudan				1.3	1.1				-16.3%	b
Spain	4.1	4.2	3.5	3.3	3.3	0.3%	-1.7%	-1.6%	0.6%	b
Sri Lanka	3.7	3.3	2.4	2.0	2.1	-1.0%	-3.4%	-3.7%	1.5%	b
Saint Kitts and Nevis	3.7					-100.0%				
Saint Lucia	2.0	3.1	3.1	3.2	3.2	4.7%	0.1%	0.6%	-1.3%	a
Sint Maarten (Dutch part)										
Saint Vincent and the Grenadines	2.2	2.8	3.1	2.9	2.9	2.4%	1.1%	-1.3%	-0.5%	a
Sudan	9.8	7.2	4.7	4.0	4.0	-3.1%	-4.2%	-4.0%	-0.3%	b
Suriname		5.7	4.0	3.4	3.4		-3.5%	-3.8%	-1.4%	b
Swaziland	4.3	6.6	5.0	4.5	4.6	4.5%	-2.8%	-2.5%	2.3%	a

Country	Energy Intensity (MJ/USD 2011 PPP)					Compound annual growth rate of Energy Intensity (%)				
	1990	2000	2010	2014	2015	1990-2000	2000-2010	2010-2014	2014-2015	
Sweden	7.5	6.1	5.3	4.7	4.3	-2.0%	-1.4%	-2.9%	-9.4%	b
Switzerland	3.2	2.9	2.5	2.3	2.2	-0.9%	-1.4%	-2.7%	-2.9%	b
Syrian Arab Republic	11.6	10.4	10.0	4.4	4.0	-1.1%	*-0.5%*	-18.3%	-9.5%	b
Tajikistan	11.5	12.3	5.7	5.1	5.0	0.6%	*-7.4%*	-2.7%	-1.1%	b
Tanzania	11.2	11.5	9.2	8.5	8.3	0.2%	-2.1%	-2.0%	-2.2%	b
Thailand	4.7	5.2	5.4	5.6	5.4	1.1%	0.4%	0.5%	-2.6%	b
Timor-Leste										
Togo	10.3	13.9	16.6	14.6	14.3	3.0%	1.8%	-3.1%	-1.9%	b
Tonga	3.3	3.2	3.2	3.0	3.0	-0.1%	-0.1%	-1.8%	1.5%	a
Trinidad and Tobago	16.7	17.7	20.2	19.1	19.1	0.6%	1.3%	-1.4%	-0.3%	b
Tunisia	4.5	4.2	3.9	3.7	3.8	-0.7%	**-0.7%**	-1.2%	2.0%	b
Turkey	3.6	3.6	3.4	2.9	2.9	0.1%	-0.5%	-3.8%	0.0%	b
Turkmenistan	23.9	25.9	18.8	14.3	13.9	0.8%	-3.2%	-6.6%	-3.0%	b
Turks and Caicos Islands										
Tuvalu	3.5	3.3	3.9	3.7	3.9	-0.3%	1.5%	-1.3%	6.0%	a
Uganda	20.6	12.4	10.0	9.7	9.6	-4.9%	-2.1%	-0.9%	-0.2%	a
Ukraine	19.4	23.7	15.4	12.5	11.8	2.0%	-4.2%	-5.2%	-5.5%	b
United Arab Emirates	4.1	4.1	5.5	5.3	5.1	-0.2%	3.1%	-1.2%	-3.6%	b
United Kingdom	5.6	4.8	3.8	3.1	3.0	-1.6%	-2.4%	-4.9%	-1.7%	b
United States	8.7	7.3	6.1	5.6	5.4	-1.7%	*-1.9%*	-1.9%	-3.8%	b
Uruguay	3.1	3.0	3.0	2.9	3.1	-0.2%	*-0.2%*	-0.6%	6.9%	b
Uzbekistan	30.8	34.5	14.9	11.1	10.0	1.1%	*-8.0%*	-7.2%	-9.7%	b
Vanuatu	3.1	4.0	3.9	4.3	3.9	2.4%	-0.3%	2.4%	-9.3%	a
Venezuela	5.8	6.1	6.3	5.5	4.7	0.5%	0.4%	-3.5%	-13.7%	b
Vietnam	7.5	5.8	6.3	5.7	5.9	-2.5%	**0.8%**	-2.4%	3.5%	b
United States Virgin Islands										
Palestine (State of)										
Yemen	2.6	2.9	3.1	3.2	2.1	0.9%	*0.8%*	1.0%	-36.2%	b
Zambia	12.1	12.0	7.8	7.4	7.3	-0.1%	-4.2%	-1.2%	-0.7%	b
Zimbabwe	14.7	13.3	19.5	15.7	15.8	-1.0%	3.9%	-5.3%	0.3%	b
World	7.8	6.6	5.9	5.4	5.3	-1.6%	-1.2%	-2.1%	-2.9%	c
High income	7.1	6.2	5.4	5.0	4.8	-1.3%	-1.4%	-2.1%	-2.3%	c
Low income	12.9	13.1	10.9	10.0	9.8	0.2%	-1.8%	-2.2%	-2.3%	c
Lower middle income	8.5	7.0	5.3	4.8	4.6	-2.0%	-2.7%	-2.6%	-3.8%	c
Upper middle income	9.0	6.9	6.5	6.0	5.8	-2.7%	-0.5%	-2.2%	-3.8%	c
Central Asia and Southern Asia	8.2	7.1	5.7	5.4	5.2	-1.4%	-2.2%	-1.4%	-3.6%	c
Eastern Asia and South-eastern Asia	8.7	7.1	6.7	5.9	5.6	-2.0%	-0.7%	-3.0%	-4.4%	c
Latin America and the Caribbean	4.5	4.3	4.1	3.9	3.9	-0.5%	-0.5%	-0.8%	-1.4%	c
Northern America and Europe	8.1	6.7	5.6	5.2	5.0	-1.9%	-1.7%	-2.1%	-2.6%	c
Oceania	7.4	6.4	5.9	5.2	5.1	-1.3%	-1.0%	-2.7%	-1.8%	c
Sub-Saharan Africa	9.2	9.8	7.8	7.3	7.2	0.6%	-2.2%	-1.6%	-1.5%	c
Western Asia and Northern Africa	4.5	4.4	5.0	4.4	4.8	-0.3%	1.2%	-3.2%	8.6%	c

a. Source: Energy Balances, UN Statistics Division (2017)
b. Source: World Energy Balances, IEA (2017)
c. Sources: World Bank analysis based on World Energy Statistics and Balances, IEA (2017); Energy Balances, UN Statistics Division (2017)

RENEWABLE ENERGY

Country		Share in total final energy consumption (%)												Final use of renewable energy (petajoules)			Total final energy consumption (petajoules)
		Renewable Energy				Solid biofuels: Traditional use	Solid biofuels: Modern use	Hydro	Liquid Biofuels	Wind	Solar	Geothermal	Other (Biogas, renewable waste, marine)	Electricity	Heat	Transport	
		1990	2010	2014	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Afghanistan	a	15.92%	14.84%	19.31%	18.42%	9.60%	0.00%	8.83%	0.00%	0.00%	0.00%	0.00%	0.00%	12.04	13.09	-	136
Albania	b	25.52%	37.12%	38.69%	38.62%	8.20%	*2.27%*	25.98%	1.53%	0.00%	0.63%	0.00%	0.00%	21.23	9.07	1	82
Algeria	b	0.18%	0.26%	0.07%	0.06%	0.01%	0.01%	0.03%	0.00%	0.00%	0.01%	0.00%	0.00%	0.58	0.25	-	1,414
American Samoa	a	0.00%	0.00%	0.70%	0.89%	0.00%	0.00%	0.00%	0.00%	0.00%	0.89%	0.00%	0.00%	0.00	-	-	1
Andorra	a	14.27%	19.09%	19.89%	19.75%	0.27%	*0.00%*	18.02%	0.00%	0.00%	0.00%	0.00%	1.45%	1.50	0.14	-	8
Angola	b	72.26%	54.19%	50.80%	49.57%	45.19%	1.10%	3.28%	0.00%	0.00%	0.00%	0.00%	0.00%	16.13	227.64	-	492
Anguilla	a	0.30%	0.12%	0.13%	0.11%	0.11%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	0.00	-	2
Antigua and Barbuda	a	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	-	-	5
Argentina	b	8.92%	8.96%	10.90%	10.04%	0.50%	2.28%	5.14%	2.04%	0.08%	0.00%	0.00%	0.00%	131.36	59.50	49	2,385
Armenia	b	2.12%	9.36%	7.72%	15.79%	9.35%	0.00%	6.43%	0.00%	0.01%	0.00%	0.00%	0.00%	5.48	7.96	-	85
Aruba	a	0.27%	5.46%	6.93%	6.73%	0.33%	0.00%	0.00%	0.00%	6.40%	0.00%	0.00%	0.00%	0.42	0.02	-	7
Australia	b	8.01%	8.11%	9.28%	9.18%	0.00%	*5.31%*	1.25%	0.32%	1.07%	1.02%	0.00%	0.22%	103.77	182.77	10	3,233
Austria	b	25.14%	30.66%	35.39%	34.39%	0.00%	*15.74%*	12.47%	2.72%	1.63%	1.05%	0.08%	0.71%	167.49	167.80	27	1,054
Azerbaijan	b	0.72%	4.45%	2.12%	2.31%	0.66%	0.31%	1.27%	0.00%	0.00%	0.00%	0.00%	0.07%	4.47	3.21	0	332
Bahamas	a	0.00%	1.66%	1.09%	1.21%	0.00%	1.21%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	0.31	-	26
Bahrain	b	0.00%	0.00%	0.00%	0.00%	0.00%	*0.00%*	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	-	-	192
Bangladesh	b	71.66%	41.05%	37.63%	34.75%	34.55%	0.00%	0.15%	0.00%	0.00%	0.04%	0.00%	0.00%	2.15	383.91	-	1,111
Barbados	a	18.94%	9.03%	3.16%	2.79%	0.09%	*2.70%*	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	0.32	-	11
Belarus	b	0.82%	7.02%	6.63%	6.77%	2.11%	*4.44%*	0.05%	0.12%	0.01%	0.00%	0.00%	0.03%	0.86	43.58	0	658
Belgium	b	1.27%	5.84%	9.07%	9.20%	0.00%	*4.66%*	0.10%	0.84%	1.69%	1.00%	0.00%	0.91%	61.20	56.21	11	1,395
Belize	a	38.01%	33.71%	36.91%	35.02%	0.18%	26.99%	7.85%	0.00%	0.00%	0.00%	0.00%	0.00%	0.96	3.32	-	12
Benin	b	93.70%	48.12%	52.54%	50.86%	42.08%	8.64%	0.11%	0.00%	0.00%	0.04%	0.00%	0.00%	0.22	76.25	-	150
Bermuda	a	0.00%	2.39%	1.99%	2.36%	0.00%	*0.00%*	0.00%	0.00%	0.00%	0.00%	0.00%	2.36%	-	0.12	-	5
BES Islands	a	0.00%	0.00%	3.03%	2.97%	0.10%	0.00%	0.00%	0.00%	2.87%	0.00%	0.00%	0.00%	0.11	0.00	-	4
Bhutan	a	95.90%	90.89%	87.03%	86.90%	74.98%	0.15%	11.78%	0.00%	0.00%	0.00%	0.00%	0.00%	7.41	47.21	-	63
Bolivia	b	37.36%	20.07%	16.82%	17.54%	6.96%	7.61%	2.94%	0.00%	0.01%	0.01%	0.00%	0.00%	8.90	39.93	-	278
Bosnia and Herzegovina	b	7.30%	19.57%	41.75%	40.75%	31.88%	1.29%	7.58%	0.00%	0.00%	0.00%	0.00%	0.00%	13.65	59.70	-	180
Botswana	b	47.58%	30.19%	28.80%	28.88%	28.87%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00	23.15	-	80
British Virgin Islands	a	1.45%	0.85%	1.22%	1.23%	0.88%	0.00%	0.00%	0.00%	0.21%	0.13%	0.00%	0.00%	0.01	0.01	-	2
Brazil	b	49.86%	47.01%	41.84%	43.79%	3.21%	*18.60%*	12.33%	8.55%	0.74%	0.33%	0.00%	0.02%	1,309.41	1,819.04	759	8,877
Brunei Darussalam	b	0.67%	0.00%	0.01%	0.01%	0.00%	*0.00%*	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.01	0.00	-	39
Bulgaria	b	1.92%	14.37%	16.97%	17.65%	7.66%	3.13%	3.03%	1.53%	0.78%	0.97%	0.36%	0.19%	18.35	44.71	6	391
Burkina Faso	a	93.16%	81.45%	75.24%	74.17%	73.46%	0.43%	0.28%	0.00%	0.00%	0.00%	0.00%	0.00%	0.40	108.52	-	147
Burundi	a	95.20%	96.76%	94.60%	95.68%	93.07%	1.12%	1.49%	0.00%	0.00%	0.00%	0.00%	0.00%	0.77	48.69	-	52
Cambodia	b	0.00%	68.52%	68.01%	64.92%	46.47%	15.13%	3.32%	0.00%	0.00%	0.00%	0.00%	0.00%	8.33	151.48	-	246
Cameroon	b	81.59%	78.60%	76.98%	76.54%	64.49%	*6.55%*	5.49%	0.00%	0.00%	0.00%	0.00%	0.00%	15.85	201.72	-	284
Canada	b	22.02%	22.08%	22.02%	22.03%	0.00%	5.46%	14.26%	1.03%	0.99%	0.13%	0.00%	0.14%	1,141.36	371.38	74	7,206
Cape Verde	a	36.63%	21.74%	26.20%	26.58%	22.91%	*0.26%*	0.00%	0.00%	3.16%	0.25%	0.00%	0.00%	0.22	1.51	-	6

Country		Share in total final energy consumption (%)												Final use of renewable energy (petajoules)			Total final energy consumption (petajoules)
						Solid biofuels											
		Renewable Energy				Traditional use	Modern use	Hydro	Liquid Biofuels	Wind	Solar	Geothermal	Other (Biogas, renewable waste, marine)	Electricity	Heat	Transport	
		1990	2010	2014	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Cayman Islands																	5
Central African Republic	a	93.49%	79.81%	76.90%	76.57%	38.13%	35.17%	3.26%	0.00%	0.00%	0.00%	0.00%	0.00%	0.58	12.94	-	18
Chad	a	98.16%	90.79%	89.24%	89.36%	88.02%	*1.33%*	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	59.32	-	66
Channel Islands																	
Chile	b	34.03%	27.04%	26.72%	24.88%	0.00%	16.35%	7.31%	0.00%	0.65%	0.50%	0.00%	0.07%	104.94	154.67	-	1,043
China	b	34.08%	12.88%	12.22%	12.41%	4.61%	0.23%	4.58%	0.12%	0.76%	1.40%	0.28%	0.43%	4,201.42	4,797.34	86	73,183
Chinese Taipei	b	1.94%	1.55%	2.04%	2.12%	0.00%	0.31%	0.74%	0.15%	0.25%	0.37%	0.00%	0.30%	29.34	12.20	0	1,967
Christmas Island																	
Cocos Islands																	
Colombia	b	38.25%	27.93%	24.44%	23.56%	5.73%	6.37%	11.35%	0.10%	0.01%	0.00%	0.00%	0.00%	127.39	123.48	1	1,069
Comoros	a	49.84%	46.41%	46.62%	45.33%	45.33%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	1.61	-	4
Congo, Dem. Rep.	b	92.05%	96.83%	92.87%	95.82%	78.68%	14.24%	2.90%	0.00%	0.00%	0.00%	0.00%	0.00%	26.12	836.40	-	900
Congo, Rep.	b	65.41%	55.15%	62.40%	62.40%	59.81%	*0.80%*	1.80%	0.00%	0.00%	0.00%	0.00%	0.00%	1.53	51.62	-	85
Cook Islands	a	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01	(0.01)	-	1
Costa Rica	b	45.38%	42.31%	37.84%	38.73%	3.43%	*13.52%*	16.69%	0.00%	2.23%	0.01%	2.85%	0.00%	33.60	25.16	-	152
Côte d'Ivoire	b	73.58%	75.37%	72.22%	64.53%	56.93%	*6.41%*	1.19%	0.00%	0.00%	0.00%	0.00%	0.00%	3.62	178.65	-	282
Croatia	b	21.92%	29.78%	33.65%	33.13%	17.98%	*0.90%*	11.62%	0.37%	1.45%	0.26%	0.17%	0.39%	36.92	51.68	1	270
Cuba	b	42.89%	13.16%	18.80%	19.28%	0.13%	*15.93%*	0.05%	3.13%	0.02%	0.03%	0.00%	0.00%	2.30	55.44	-	299
Curaçao	b	0.00%	0.24%	0.35%	0.35%	0.00%	0.00%	0.00%	0.00%	0.35%	0.00%	0.00%	0.00%	0.09	0.00	-	25
Cyprus	b	0.50%	6.35%	9.36%	9.94%	0.56%	0.65%	0.00%	0.69%	1.22%	5.52%	0.11%	1.20%	1.29	4.16	0	59
Czech Republic	b	3.57%	10.92%	14.83%	14.83%	0.00%	10.78%	0.44%	1.29%	0.14%	0.64%	0.00%	1.54%	22.37	107.99	12	963
Denmark	b	7.04%	21.35%	30.27%	33.17%	0.00%	16.93%	0.01%	1.85%	9.87%	0.65%	0.01%	3.85%	72.41	99.29	10	547
Djibouti	a	26.59%	34.43%	34.15%	15.38%	15.38%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	0.76	-	5
Dominica	a	14.60%	8.91%	8.61%	7.83%	4.13%	0.00%	3.70%	0.00%	0.00%	0.00%	0.00%	0.00%	0.06	0.06	-	1
Dominican Republic	b	28.01%	16.98%	18.02%	16.48%	9.13%	4.35%	1.57%	0.00%	0.97%	0.46%	0.00%	0.00%	6.51	30.84	-	227
Ecuador	b	24.20%	12.11%	12.22%	13.82%	1.80%	3.36%	8.44%	0.11%	0.06%	0.02%	0.02%	0.00%	43.48	24.31	1	495
Egypt	b	8.50%	5.72%	5.87%	5.71%	1.72%	*1.79%*	1.96%	0.00%	0.20%	0.04%	0.00%	0.00%	45.86	73.24	-	2,086
El Salvador	b	67.14%	30.77%	28.27%	24.40%	10.57%	4.00%	4.52%	0.00%	0.00%	0.00%	5.15%	0.16%	11.94	13.23	-	103
Equatorial Guinea	a	84.71%	5.95%	7.64%	7.82%	5.65%	*0.00%*	2.17%	0.00%	0.00%	0.00%	0.00%	0.00%	1.46	3.81	-	67
Eritrea	b	0.00%	81.25%	79.93%	79.77%	75.84%	3.90%	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.01	18.74	-	23
Estonia	b	3.36%	25.13%	25.33%	27.48%	0.00%	*25.49%*	0.06%	0.12%	1.47%	0.00%	0.00%	0.34%	3.56	27.88	0	115
Ethiopia	b	96.64%	94.52%	92.07%	92.16%	89.53%	*0.87%*	1.62%	0.01%	0.13%	0.00%	0.00%	0.00%	29.92	1,544.11	0	1,708
Falkland Islands (Malvinas)	a	1.13%	3.71%	3.87%	3.89%	0.86%	*0.00%*	0.00%	0.00%	3.03%	0.00%	0.00%	0.00%	0.02	0.01	-	1
Faroe Islands		2.54%	3.38%	6.54%	7.51%	0.00%	0.00%	5.29%	0.00%	2.22%	0.00%	0.00%	0.00%	0.62	0.00	-	8
Fiji	a	53.09%	29.61%	34.57%	31.26%	1.15%	24.53%	5.51%	0.00%	0.08%	0.00%	0.00%	0.00%	1.34	6.15	-	24
Finland	b	24.51%	33.58%	41.24%	43.24%	0.00%	31.67%	7.14%	2.18%	0.99%	0.01%	0.00%	1.25%	125.72	271.83	21	968
France	b	10.41%	11.85%	13.35%	13.50%	0.00%	*6.60%*	2.62%	2.19%	1.02%	0.42%	0.07%	0.57%	242.62	394.21	123	5,632
French Guiana	a	5.73%	29.55%	30.03%	32.44%	10.02%	3.71%	16.89%	0.00%	0.00%	1.82%	0.00%	0.00%	1.69	1.24	-	9
French Polynesia	a	4.73%	11.57%	10.16%	9.83%	0.41%	*0.00%*	8.97%	0.00%	0.00%	0.45%	0.00%	0.00%	0.73	0.03	-	8
Gabon	b	78.28%	85.88%	81.35%	82.01%	21.98%	*58.57%*	1.46%	0.00%	0.00%	0.00%	0.00%	0.00%	2.92	159.26	-	198
Gambia	a	61.44%	54.71%	51.93%	51.51%	51.51%	*0.00%*	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	5.26	-	10
Georgia	b	12.77%	39.15%	31.89%	28.66%	10.37%	0.20%	17.65%	0.00%	0.00%	0.06%	0.38%	0.00%	27.84	17.36	-	158
Germany	b	2.10%	10.29%	13.38%	14.21%	0.00%	*5.00%*	0.66%	1.38%	2.75%	1.68%	0.05%	2.69%	541.77	533.79	107	8,328
Ghana	b	80.63%	49.78%	45.05%	41.41%	27.88%	7.94%	5.59%	0.00%	0.00%	0.00%	0.00%	0.00%	15.85	101.41	-	283

Country		Share in total final energy consumption (%)												Final use of renewable energy (petajoules)			Total final energy consumption (petajoules)
		Renewable Energy				Solid biofuels											
						Traditional use	Modern use	Hydro	Liquid Biofuels	Wind	Solar	Geothermal	Other (Biogas, renewable waste, marine)	Electricity	Heat	Transport	
		1990	2010	2014	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Gibraltar	a	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	-	-	6
Greece	b	7.81%	11.09%	16.09%	17.17%	0.00%	6.73%	3.28%	1.04%	2.48%	3.35%	0.06%	0.22%	52.40	54.23	6	657
Greenland	a	0.00%	9.83%	14.90%	15.53%	0.00%	0.00%	15.41%	0.00%	0.00%	0.00%	0.00%	0.12%	1.23	0.01	-	8
Grenada	a	8.34%	10.50%	11.08%	10.92%	10.23%	0.69%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	0.31	-	3
Guadeloupe	a	6.75%	1.97%	4.99%	4.68%	0.47%	0.00%	0.35%	0.00%	0.85%	1.66%	1.36%	0.00%	0.78	0.09	-	19
Guam	a	0.00%	0.00%	0.00%	0.00%	0.00%	*0.00%*	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	-	-	6
Guatemala	b	74.97%	66.59%	59.90%	63.65%	57.12%	*3.49%*	2.70%	0.00%	0.07%	0.10%	0.18%	0.00%	19.97	253.70	-	430
Guinea	a	89.30%	75.71%	78.52%	76.27%	73.85%	*0.44%*	1.98%	0.00%	0.00%	0.00%	0.00%	0.00%	2.74	102.50	-	138
Guinea-Bissau	a	88.58%	87.81%	87.06%	86.85%	79.07%	7.78%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	23.67	-	27
Guyana	a	42.23%	33.84%	24.02%	25.26%	4.42%	20.83%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	6.72	-	27
Haiti	b	81.12%	79.02%	78.39%	76.07%	72.06%	3.93%	0.09%	0.00%	0.00%	0.00%	0.00%	0.00%	0.12	103.87	-	137
Honduras	b	70.13%	53.16%	54.04%	51.54%	40.49%	6.30%	3.70%	0.00%	1.05%	0.00%	0.00%	0.00%	11.89	90.38	-	198
Hong Kong (SAR, China)	b	1.07%	0.83%	0.86%	0.85%	0.61%	*0.04%*	0.00%	0.08%	0.00%	0.00%	0.00%	0.12%	0.44	2.44	0	372
Hungary	b	3.86%	13.46%	15.67%	15.56%	0.00%	*12.85%*	0.14%	1.04%	0.42%	0.14%	0.51%	0.47%	13.79	88.95	7	707
Iceland	b	54.67%	75.42%	76.34%	77.03%	0.00%	*0.00%*	38.87%	0.48%	0.03%	0.00%	37.60%	0.06%	62.89	27.87	1	119
India	b	58.65%	39.48%	36.65%	36.02%	26.09%	*7.47%*	1.66%	0.07%	0.51%	0.19%	0.00%	0.02%	567.34	7,428.26	16	22,241
Indonesia	b	58.60%	37.75%	37.45%	36.88%	30.71%	4.36%	0.66%	0.67%	0.00%	0.00%	0.48%	0.00%	77.79	2,282.80	42	6,514
Iran (Islamic Republic of)	b	1.24%	0.90%	0.94%	0.91%	0.16%	*0.16%*	0.58%	0.00%	0.01%	0.00%	0.00%	0.00%	38.80	21.14	-	6,565
Iraq	b	1.60%	1.71%	0.91%	0.80%	0.00%	0.15%	0.65%	0.00%	0.00%	0.00%	0.00%	0.00%	4.78	1.09	-	734
Ireland	b	2.28%	5.27%	8.52%	9.08%	0.00%	2.03%	0.60%	0.86%	4.91%	0.13%	0.00%	0.55%	25.24	10.12	4	430
Isle of Man	a	0.00%	4.05%	3.81%	4.21%	0.00%	0.00%	0.48%	0.00%	0.00%	0.00%	0.00%	3.72%	0.01	0.08	-	2
Israel	b	5.80%	8.50%	3.68%	3.71%	0.00%	0.07%	0.01%	0.00%	0.00%	3.58%	0.00%	0.04%	3.70	15.29	-	512
Italy	b	3.78%	12.79%	17.09%	16.52%	0.00%	6.74%	3.55%	1.45%	1.16%	1.96%	0.60%	1.07%	400.38	329.48	49	4,715
Jamaica	b	7.63%	13.72%	16.12%	16.77%	9.34%	*5.01%*	0.42%	1.60%	0.40%	0.00%	0.00%	0.00%	1.12	11.34	1	82
Japan	b	4.55%	4.59%	5.63%	6.30%	0.00%	2.00%	2.66%	0.00%	0.16%	1.25%	0.15%	0.07%	546.34	118.65	-	10,560
Jordan	b	2.77%	2.97%	3.13%	3.23%	0.07%	*0.00%*	0.07%	0.00%	0.16%	2.92%	0.00%	0.01%	0.56	6.84	-	229
Kazakhstan	b	1.41%	1.38%	1.31%	1.56%	0.18%	0.00%	1.35%	0.00%	0.02%	0.01%	0.00%	0.00%	21.79	2.93	-	1,587
Kenya	b	77.50%	76.27%	75.52%	72.66%	68.85%	0.06%	1.71%	0.00%	0.03%	0.00%	2.02%	0.00%	24.98	450.97	-	655
Kiribati	a	5.22%	3.46%	3.47%	4.25%	3.41%	*0.00%*	0.00%	0.00%	0.00%	0.85%	0.00%	0.00%	0.01	0.02	-	1
Democratic People's Republic of Korea	b	7.19%	13.47%	21.03%	23.12%	1.82%	11.54%	9.76%	0.00%	0.00%	0.00%	0.00%	0.00%	26.90	36.83	-	276
Republic of Korea	b	1.63%	1.31%	2.84%	2.71%	0.00%	1.38%	0.13%	0.40%	0.07%	0.26%	0.11%	0.36%	33.79	92.54	18	5,312
Kosovo	b	0.00%	20.92%	21.46%	20.45%	18.11%	1.64%	0.68%	0.00%	0.00%	0.03%	0.00%	0.00%	0.38	11.04	-	56
Kuwait	b	0.17%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	-	-	617
Kyrgyzstan	b	7.93%	25.59%	26.61%	23.31%	0.07%	*0.01%*	23.22%	0.00%	0.00%	0.00%	0.00%	0.00%	32.47	0.12	-	140
Lao People's Democratic Republic	a	88.45%	71.51%	60.47%	59.32%	35.89%	*12.64%*	10.79%	0.00%	0.00%	0.00%	0.00%	0.00%	13.18	59.30	-	122
Latvia	b	17.57%	33.06%	40.24%	38.10%	0.00%	*30.18%*	5.07%	0.67%	0.40%	0.00%	0.00%	1.78%	11.67	46.06	1	154
Lebanon	b	11.34%	5.20%	3.23%	3.65%	2.02%	*0.37%*	0.77%	0.00%	0.00%	0.49%	0.00%	0.00%	1.56	5.82	-	202
Lesotho	a	52.03%	53.45%	51.39%	52.14%	47.65%	0.00%	4.49%	0.00%	0.00%	0.00%	0.00%	0.00%	2.50	26.54	-	56
Liberia	a	88.82%	89.21%	83.94%	83.85%	10.10%	73.75%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	68.92	-	82
Libya	b	3.13%	1.57%	1.75%	1.97%	1.97%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	6.35	-	323
Liechtenstein	a	0.00%	58.69%	62.59%	63.13%	7.29%	0.00%	34.52%	0.00%	0.00%	14.72%	0.00%	6.61%	1.38	0.44	-	3
Lithuania	b	3.10%	21.46%	27.71%	28.96%	10.28%	11.52%	1.38%	1.43%	3.20%	0.29%	0.01%	0.85%	13.26	41.76	3	200
Luxembourg	b	1.72%	3.66%	6.88%	9.03%	0.00%	1.88%	1.12%	2.33%	1.16%	1.23%	0.00%	1.30%	7.25	2.68	3	148

Country		Share in total final energy consumption (%)												Final use of renewable energy (petajoules)			Total final energy consumption (petajoules)
		Renewable Energy				Solid biofuels											
						Traditional use	Modern use	Hydro	Liquid Biofuels	Wind	Solar	Geothermal	Other (Biogas, renewable waste, marine)	Electricity	Heat	Transport	
		1990	2010	2014	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Macao (SAR, China)	a	0.66%	5.81%	10.02%	7.05%	0.00%	*0.09%*	0.00%	0.00%	0.00%	0.00%	0.00%	6.96%	-	2.41	-	34
Macedonia, FYR	b	2.41%	22.33%	21.20%	24.22%	12.24%	0.58%	10.11%	0.00%	0.66%	0.12%	0.40%	0.11%	8.58	10.31	-	78
Madagascar	a	85.65%	81.93%	72.03%	70.17%	31.59%	36.79%	1.79%	0.00%	0.00%	0.00%	0.00%	0.00%	2.35	89.60	-	131
Malawi	a	84.03%	79.47%	79.95%	83.65%	36.36%	38.94%	8.36%	0.00%	0.00%	0.00%	0.00%	0.00%	5.07	45.66	-	61
Malaysia	b	11.98%	3.82%	4.77%	5.19%	1.86%	0.11%	2.32%	0.85%	0.00%	0.05%	0.00%	0.01%	47.52	35.51	16	1,912
Maldives	a	4.46%	1.16%	0.90%	1.01%	0.91%	0.00%	0.00%	0.00%	0.00%	0.10%	0.00%	0.00%	0.02	0.14	-	16
Mali	a	88.64%	69.13%	64.59%	61.53%	57.20%	1.62%	2.71%	0.00%	0.00%	0.00%	0.00%	0.00%	2.11	45.71	-	78
Malta	b	0.00%	1.39%	3.93%	5.36%	0.25%	*0.00%*	0.00%	0.96%	0.00%	3.77%	0.00%	0.37%	0.58	0.26	0	19
Marshall Islands	a	0.00%	13.31%	12.02%	11.16%	11.13%	0.00%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.00	0.19	-	2
Martinique	a	2.13%	2.63%	2.43%	2.45%	0.31%	0.97%	0.00%	0.00%	0.03%	0.75%	0.00%	0.38%	0.14	0.30	-	18
Mauritania	a	47.00%	34.00%	32.02%	32.16%	31.08%	0.00%	0.00%	0.00%	0.83%	0.24%	0.00%	0.00%	0.45	12.97	-	42
Mauritius	b	47.07%	13.66%	10.63%	11.54%	0.65%	9.19%	1.21%	0.00%	0.03%	0.26%	0.00%	0.20%	2.27	1.59	-	33
Mayotte	a	33.41%	9.96%	10.55%	10.24%	8.45%	0.00%	0.00%	0.00%	0.00%	1.79%	0.00%	0.00%	0.05	0.28	-	3
Mexico	b	14.41%	9.36%	9.76%	9.22%	0.00%	6.15%	1.92%	0.00%	0.54%	0.20%	0.39%	0.01%	142.70	299.02	-	4,793
Micronesia (Federated States of)	a	0.00%	1.50%	1.16%	1.20%	0.36%	0.66%	0.02%	0.00%	0.00%	0.16%	0.00%	0.00%	0.00	0.02	-	2
Moldova	b	1.14%	8.44%	13.05%	14.27%	12.21%	1.14%	0.86%	0.00%	0.01%	0.01%	0.00%	0.05%	0.88	12.84	-	96
Monaco																	
Mongolia	b	1.89%	4.35%	3.27%	3.43%	2.08%	*0.89%*	0.00%	0.00%	0.45%	0.00%	0.00%	0.00%	0.59	3.88	-	130
Montenegro	b	0.00%	49.09%	45.99%	43.00%	23.35%	*2.33%*	17.29%	0.00%	0.00%	0.03%	0.00%	0.00%	4.79	7.12	-	28
Montserrat	a	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	-	-	1
Morocco	b	19.48%	14.41%	11.72%	11.32%	4.04%	4.73%	1.09%	0.00%	1.46%	0.00%	0.00%	0.00%	15.42	52.94	-	604
Mozambique	b	93.10%	91.30%	88.86%	86.40%	67.84%	8.96%	9.60%	0.00%	0.00%	0.00%	0.00%	0.00%	41.84	334.86	-	436
Myanmar	b	90.91%	84.40%	66.13%	61.53%	55.84%	1.80%	3.88%	0.00%	0.00%	0.00%	0.00%	0.00%	28.39	421.60	-	731
Namibia	b	0.00%	26.37%	27.62%	26.47%	6.00%	*1.65%*	18.68%	0.00%	0.00%	0.15%	0.00%	0.00%	13.32	5.55	-	71
Nauru	a	0.00%	0.08%	0.08%	0.08%	0.00%	*0.00%*	0.00%	0.00%	0.00%	0.08%	0.00%	0.00%	0.00	-	-	0
Nepal	b	95.12%	87.29%	84.37%	85.26%	78.91%	*1.04%*	2.90%	0.00%	0.00%	0.00%	0.00%	2.42%	14.03	398.30	-	484
Netherlands	b	1.20%	3.87%	5.66%	5.89%	0.00%	1.92%	0.02%	0.74%	1.40%	0.27%	0.13%	1.42%	46.19	48.73	12	1,823
New Caledonia	a	10.16%	4.48%	3.98%	4.76%	0.01%	0.00%	3.60%	0.00%	0.65%	0.50%	0.00%	0.00%	1.44	0.14	-	33
New Zealand	b	30.03%	31.32%	30.32%	30.79%	0.00%	8.21%	14.75%	0.02%	1.42%	0.09%	6.11%	0.20%	112.84	50.31	0	530
Nicaragua	b	68.77%	52.64%	51.84%	48.20%	36.46%	7.02%	0.76%	0.00%	2.23%	0.00%	1.74%	0.00%	6.12	43.92	-	104
Niger	b	0.00%	80.71%	78.14%	78.94%	78.92%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.03	89.80	-	114
Nigeria	b	87.78%	86.78%	87.30%	86.64%	80.49%	5.81%	0.33%	0.00%	0.00%	0.00%	0.00%	0.00%	16.44	4,304.33	-	4,987
Niue	a	0.57%	26.70%	23.14%	22.37%	0.56%	0.00%	0.00%	0.00%	0.00%	21.80%	0.00%	0.00%	0.00	0.02	-	0
Northern Mariana Islands	a	0.00%	0.00%	0.00%	0.00%	0.00%	*0.00%*	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	-	-	1
Norway	b	59.17%	56.42%	57.20%	57.77%	0.00%	*4.64%*	50.54%	0.79%	0.92%	0.00%	0.00%	0.88%	389.70	40.89	6	756
Oman	b	0.00%	0.00%	0.00%	0.00%	0.00%	*0.00%*	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	-	-	754
Pakistan	b	57.50%	46.72%	46.60%	46.48%	38.44%	*4.80%*	3.15%	0.00%	0.08%	0.00%	0.00%	0.00%	100.57	1,345.67	-	3,112
Palau	a	0.00%	0.00%	0.00%	0.00%	0.00%	*0.00%*	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	-	-	2
Palestine (State of)	a	22.08%	14.06%	10.53%	10.47%	6.01%	*0.25%*	0.00%	0.00%	0.00%	4.21%	0.00%	0.00%	-	6.70	-	64
Panama	b	43.59%	19.94%	19.77%	21.23%	4.87%	2.55%	12.91%	0.00%	0.86%	0.03%	0.00%	0.00%	20.08	10.64	-	145
Papua New Guinea	a	71.70%	55.25%	52.55%	52.50%	43.53%	5.03%	2.78%	0.00%	0.00%	0.00%	1.15%	0.00%	4.55	56.19	-	116
Paraguay	b	78.51%	64.25%	63.12%	61.68%	17.94%	*22.60%*	18.59%	2.55%	0.00%	0.00%	0.00%	0.00%	38.08	83.10	5	205
Peru	b	39.43%	30.80%	26.00%	25.50%	11.49%	1.08%	10.14%	2.25%	0.25%	0.24%	0.00%	0.04%	80.34	93.53	15	739
Philippines	b	50.95%	28.81%	28.58%	27.45%	13.42%	*7.44%*	2.15%	1.49%	0.19%	0.03%	2.74%	0.00%	62.05	249.51	17	1,195

Country		Share in total final energy consumption (%)												Final use of renewable energy (petajoules)			Total final energy consumption (petajoules)
		Renewable Energy				Solid biofuels: Traditional use	Solid biofuels: Modern use	Hydro	Liquid Biofuels	Wind	Solar	Geothermal	Other (Biogas, renewable waste, marine)	Electricity	Heat	Transport	
		1990	2010	2014	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Poland	b	2.50%	9.49%	11.57%	11.91%	0.00%	**8.80%**	0.20%	1.29%	1.20%	0.08%	0.04%	0.31%	63.52	206.10	33	2,538
Portugal	b	26.94%	27.83%	30.46%	27.16%	0.00%	13.01%	4.45%	2.31%	5.97%	0.95%	0.12%	0.36%	78.40	77.73	14	625
Puerto Rico	a	1.75%	0.57%	1.63%	1.84%	0.00%	0.00%	0.26%	0.00%	1.13%	0.44%	0.00%	0.00%	1.16	(0.00)	-	63
Qatar	b	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	-	-	578
Reunion	a	37.52%	16.45%	16.79%	17.49%	1.42%	*7.32%*	4.12%	0.00%	0.13%	4.16%	0.00%	0.33%	2.50	4.47	-	40
Romania	b	3.36%	24.10%	24.33%	23.70%	13.82%	*2.01%*	4.37%	0.95%	1.86%	0.52%	0.11%	0.05%	61.58	141.72	8	894
Russian Federation	b	3.75%	3.34%	3.42%	3.30%	0.28%	*0.40%*	2.61%	0.00%	0.00%	0.01%	0.01%	0.00%	414.66	107.71	-	15,809
Rwanda	a	80.09%	90.66%	88.18%	86.66%	78.45%	*7.13%*	1.03%	0.00%	0.00%	0.05%	0.00%	0.00%	0.86	68.07	-	80
Saint Helena	a	15.07%	9.17%	8.74%	12.60%	5.19%	0.00%	0.00%	0.00%	7.05%	0.36%	0.00%	0.00%	0.01	0.01	-	0
Samoa	a	46.20%	46.75%	42.34%	34.32%	29.53%	1.73%	2.44%	0.00%	0.02%	0.61%	0.00%	0.00%	0.13	1.30	-	4
San Marino																	
São Tomé and Principe	a	50.93%	43.76%	41.81%	41.06%	40.03%	0.00%	1.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02	0.78	-	2
Saudi Arabia	b	0.04%	0.01%	0.01%	0.01%	0.01%	*0.00%*	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00	0.28	-	4,774
Senegal	b	55.55%	50.26%	43.36%	42.71%	40.07%	1.71%	0.92%	0.00%	0.00%	0.01%	0.00%	0.00%	1.26	47.51	-	114
Serbia	b	15.49%	20.60%	23.43%	21.17%	10.74%	2.39%	7.91%	0.00%	0.00%	0.01%	0.08%	0.05%	26.23	43.71	-	330
Seychelles	a	4.25%	0.63%	1.30%	1.35%	0.70%	0.00%	0.00%	0.00%	0.51%	0.14%	0.00%	0.00%	0.03	0.03	-	4
Sierra Leone	a	91.28%	84.18%	73.05%	77.66%	53.45%	23.77%	0.44%	0.00%	0.00%	0.00%	0.00%	0.00%	0.24	42.31	-	55
Singapore	b	0.19%	0.48%	0.62%	0.71%	0.00%	0.17%	0.00%	0.00%	0.00%	0.05%	0.00%	0.49%	3.12	0.00	-	440
Slovak Republic	a	2.23%	10.28%	12.24%	13.41%	0.00%	6.86%	3.38%	1.60%	0.01%	0.50%	0.04%	1.02%	19.90	24.59	6	377
Slovenia	b	12.35%	19.50%	22.30%	20.88%	0.00%	12.21%	6.06%	0.64%	0.01%	0.67%	0.90%	0.38%	13.53	26.00	1	195
Solomon Islands	a	59.01%	63.49%	62.99%	63.31%	63.17%	0.00%	0.00%	0.00%	0.00%	0.13%	0.00%	0.00%	0.01	3.21	-	5
Somalia	a	87.20%	93.57%	94.43%	94.29%	60.51%	*33.78%*	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	98.91	-	105
South Africa	b	16.63%	17.08%	16.59%	17.15%	13.59%	*2.88%*	0.08%	0.00%	0.22%	0.38%	0.00%	0.00%	16.11	488.60	-	2,943
South Sudan	b	0.00%	0.00%	29.83%	39.07%	36.56%	2.48%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.01	6.89	-	18
Spain	b	10.54%	14.40%	17.35%	16.25%	0.00%	5.62%	2.68%	1.30%	4.70%	1.69%	0.02%	0.25%	292.00	181.21	40	3,159
Sri Lanka	b	78.09%	61.84%	57.59%	52.88%	28.90%	**19.08%**	4.61%	0.00%	0.27%	0.02%	0.00%	0.00%	20.49	198.86	-	415
Saint Barthelemy	a	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	-	-	-
St. Kitts and Nevis	a	40.03%	0.99%	1.70%	1.64%	0.01%	0.00%	0.00%	0.00%	1.27%	0.36%	0.00%	0.00%	0.03	0.00	-	2
St. Lucia	a	5.47%	2.20%	2.15%	2.13%	2.13%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	0.08	-	4
Sint Maarten (Dutch part)	a	0.00%	0.00%	0.05%	0.05%	0.05%	**0.00%**	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	0.00	-	8
St. Martin (French part)	a	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	-	-	-
Saint Pierre and Miquelon	a	0.00%	1.34%	1.14%	1.12%	0.74%	0.00%	0.00%	0.00%	0.38%	0.00%	0.00%	0.00%	0.00	0.01	-	1
St. Vincent and the Grenadines	a	15.44%	5.49%	5.80%	5.81%	2.32%	0.00%	3.48%	0.00%	0.00%	0.00%	0.00%	0.00%	0.08	0.06	-	2
Sudan	b	73.27%	61.44%	62.44%	61.60%	36.88%	19.08%	5.64%	0.00%	0.00%	0.00%	0.00%	0.00%	24.58	244.03	-	436
Suriname	b	0.00%	24.54%	25.38%	24.91%	6.15%	1.76%	17.00%	0.00%	0.00%	0.00%	0.00%	0.00%	4.28	1.99	-	25
Swaziland	a	85.25%	62.68%	67.69%	66.10%	15.32%	45.72%	5.06%	0.00%	0.00%	0.00%	0.00%	0.00%	1.80	21.72	-	36
Sweden	b	34.06%	45.98%	49.69%	53.25%	0.00%	26.83%	16.38%	3.59%	3.54%	0.06%	0.00%	2.85%	284.41	347.32	48	1,277
Switzerland	b	17.12%	21.46%	23.42%	25.29%	0.00%	4.90%	15.71%	0.24%	0.05%	0.76%	1.86%	1.76%	130.43	63.05	2	772
Syrian Arab Republic	b	2.36%	1.41%	2.35%	0.52%	0.00%	*0.09%*	0.43%	0.00%	0.00%	0.00%	0.00%	0.00%	1.08	0.22	-	249
Tajikistan	b	29.64%	61.83%	45.76%	44.66%	0.00%	*0.00%*	44.66%	0.00%	0.00%	0.00%	0.00%	0.00%	44.13	(0.00)	-	99
Tanzania	a	94.78%	90.32%	86.67%	85.71%	65.95%	*19.08%*	0.67%	0.00%	0.00%	0.01%	0.00%	0.00%	6.46	798.08	-	939
Thailand	b	33.64%	22.65%	24.10%	22.86%	8.50%	10.50%	0.53%	2.03%	0.04%	0.27%	0.00%	0.99%	53.76	604.11	64	3,158
Timor-Leste	a	0.00%	34.69%	18.42%	18.22%	18.22%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	0.89	-	5

Country		Share in total final energy consumption (%)												Final use of renewable energy (petajoules)			Total final energy consumption (petajoules)
						Solid biofuels											
		Renewable Energy				Traditional use	Modern use	Hydro	Liquid Biofuels	Wind	Solar	Geothermal	Other (Biogas, renewable waste, marine)	Electricity	Heat	Transport	
		1990	2010	2014	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
Togo	b	78.70%	65.83%	72.16%	71.26%	58.55%	**9.45%**	3.26%	0.00%	0.00%	0.00%	0.00%	0.00%	3.28	62.68	-	93
Tokelau																	
Tonga	a	1.49%	1.01%	1.70%	1.88%	1.05%	0.00%	0.00%	0.00%	0.00%	0.82%	0.00%	0.00%	0.01	0.01	-	1
Trinidad and Tobago	b	1.19%	0.33%	0.28%	0.28%	0.28%	*0.00%*	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	0.49	-	172
Tunisia	b	14.48%	12.69%	12.93%	12.56%	11.29%	0.16%	0.06%	0.00%	0.40%	0.65%	0.00%	0.00%	1.58	38.41	-	318
Turkey	b	24.51%	14.33%	11.61%	13.37%	0.00%	3.26%	5.47%	0.12%	0.95%	0.97%	2.46%	0.15%	247.17	233.73	5	3,630
Turkmenistan	b	0.28%	0.07%	0.04%	0.04%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	0.31	-	753
Turks and Caicos Islands	a	1.79%	0.52%	0.58%	0.57%	0.57%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	0.01	-	1
Tuvalu	a	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01	(0.01)	-	0
Uganda	a	96.02%	91.61%	90.22%	89.06%	70.33%	16.97%	1.77%	0.00%	0.00%	0.00%	0.00%	0.00%	9.34	461.67	-	529
United Kingdom	b	0.65%	3.64%	7.40%	8.71%	0.00%	3.48%	0.41%	0.79%	2.65%	0.54%	0.00%	0.83%	270.87	119.23	39	4,926
Ukraine	b	0.65%	2.88%	3.50%	4.14%	2.31%	0.82%	0.72%	0.07%	0.14%	0.06%	0.00%	0.02%	18.77	62.25	1	1,989
United Arab Emirates	b	0.00%	0.11%	0.15%	0.14%	0.00%	0.09%	0.00%	0.00%	0.00%	0.04%	0.00%	0.00%	0.93	1.94	-	2,093
Uruguay	b	44.81%	52.82%	55.39%	58.02%	6.64%	34.09%	12.38%	1.75%	3.09%	0.07%	0.00%	0.00%	33.61	70.54	3	184
United States Virgin Islands	a	0.00%	0.00%	2.76%	3.88%	0.00%	0.00%	0.00%	0.00%	0.00%	3.88%	0.00%	0.00%	0.09	-	-	2
United States	a	4.18%	7.51%	8.75%	8.72%	0.00%	3.24%	1.36%	2.41%	1.05%	0.36%	0.12%	0.18%	1,800.87	1,910.77	1,386	58,483
Uzbekistan	b	1.33%	2.64%	2.90%	2.97%	0.00%	0.01%	2.96%	0.00%	0.00%	0.00%	0.00%	0.00%	34.56	0.17	-	1,169
Vanuatu	a	24.16%	38.38%	32.14%	36.11%	33.54%	0.00%	0.95%	0.73%	0.75%	0.14%	0.00%	0.00%	0.04	0.83	-	2
Venezuela	b	11.98%	11.44%	12.32%	12.84%	0.61%	1.42%	10.81%	0.00%	0.00%	0.00%	0.00%	0.00%	164.58	30.89	-	1,522
Vietnam	b	76.08%	34.80%	37.04%	35.00%	21.70%	5.01%	8.27%	0.00%	0.02%	0.00%	0.00%	0.00%	189.78	610.41	-	2,286
Wallis and Futuna Islands	a	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	-	-	0
Western Sahara	a	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	-	-	-
Yemen	b	2.15%	0.96%	0.97%	2.28%	0.00%	2.28%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-	2.43	-	107
Zambia	b	82.98%	92.10%	88.03%	87.99%	56.73%	19.60%	11.66%	0.00%	0.00%	0.00%	0.00%	0.00%	39.99	261.69	-	343
Zimbabwe	b	63.98%	82.88%	81.05%	81.80%	72.77%	5.53%	3.21%	0.29%	0.00%	0.00%	0.00%	0.00%	13.05	310.22	1	397
World	c	16.65%	16.67%	17.30%	17.46%	7.88%	3.67%	3.26%	0.91%	0.70%	0.56%	0.18%	0.29%	16,595.98	42,690.54	3,182	357,871
High Income	c	6%	10%	11%	11%	0.06%	4.41%	2.75%	1.51%	1.19%	0.60%	0.16%	0.49%	7,376	6,439	2,081	142,272
Low Income	c	69%	81%	82%	82%	69.44%	9.85%	2.62%	0.02%	0.03%	0.00%	0.00%	0.16%	200	5,961	1	7,505
Lower Middle Income	c	45%	40%	40%	40%	31.02%	5.77%	2.14%	0.15%	0.27%	0.09%	0.16%	0.01%	1,490	19,814	76	53,983
Upper Middle Income	c	19%	14%	13%	13%	3.84%	2.36%	4.42%	0.75%	0.53%	0.83%	0.24%	0.26%	7,380	9,799	1,016	137,623
Central Asia and Southern Asia	c	39.06%	30.03%	28.57%	28.38%	21.01%	5.03%	1.83%	0.04%	0.31%	0.11%	0.00%	0.04%	885.99	9,849.93	16.05	37,890.91
Eastern Asia and South-eastern Asia	c	27.49%	14.02%	13.98%	14.09%	6.49%	1.29%	3.79%	0.23%	0.55%	1.11%	0.28%	0.35%	5,378.17	9,384.93	242.21	106,515.63
Latin America and Caribbean	c	32.64%	28.48%	27.20%	27.73%	4.41%	10.76%	8.14%	3.56%	0.51%	0.20%	0.13%	0.02%	2,381.48	3,372.55	832.75	23,757.27
Northern America and Europe	c	5.79%	10.08%	11.68%	11.87%	0.35%	4.40%	3.06%	1.64%	1.26%	0.50%	0.14%	0.50%	7,006.59	6,253.05	2,066.72	129,134.81
Oceania	c	13.37%	12.83%	13.57%	13.51%	1.41%	5.72%	3.15%	0.26%	1.07%	0.85%	0.85%	0.20%	220.91	305.16	10.42	3,972.40
Sub-Saharan Africa	c	71.04%	71.26%	70.14%	69.98%	60.05%	7.97%	1.76%	0.01%	0.05%	0.07%	0.07%	0.00%	321.30	12,184.62	1.39	17,907.79
Western Asia and Northern Africa	c	9.30%	6.20%	5.05%	5.42%	1.45%	1.35%	1.54%	0.02%	0.24%	0.35%	0.44%	0.03%	377.82	731.32	4.93	20,550.68

a. Source: Energy Balances, UN Statistics Division (2017)

b. Source: World Energy Balances, IEA (2017)

c. Sources: World Bank analysis based on World Energy Statistics and Balances, IEA (2017); Energy Balances, UN Statistics Division (2017)

ANNEX 2 • SHEDDING LIGHT ON ELECTRIFICATION DATA: TRENDS AND PATTERNS OF ELECTRIFICATION

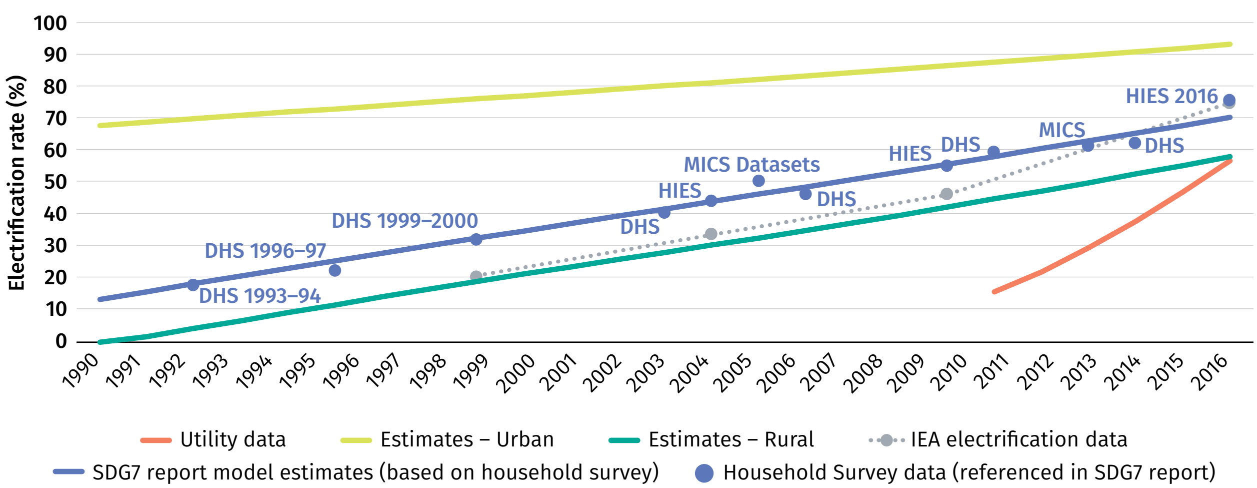
For 20 countries with the largest electricity access deficit, we undertook a triangulation exercise to bring together complementary sources of data on electrification so as to improve the understanding of electrification trends. The exercise entailed collection and comparative analysis of government-reported access rates, household survey–reported, utility-reported data, and industry data on solar panel sales and their estimated impact on electrification.

Further, using a range of historic surveys that bring together data on electrification and socioeconomic characteristics, household survey data from these countries were disaggregated to identify patterns of electricity access across different socioeconomic groups—by household consumption quintiles (from poorest to richest) and by gender of the head of household. Because of the limited availability of surveys that support full analysis of household poverty level, our analysis may not be based on the most recent surveys that are used to report on overall electrification trends in this report.

BANGLADESH

Electrification trends

Share of population with access to electricity (%), comparative analysis, 1990-2016



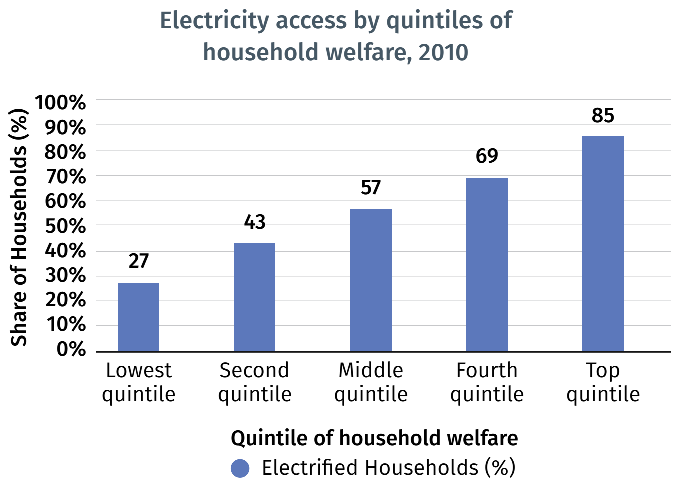
Source: World Bank 2018, Annual reports of Bangladesh Utilities, WEO 2017, World Bank WDI

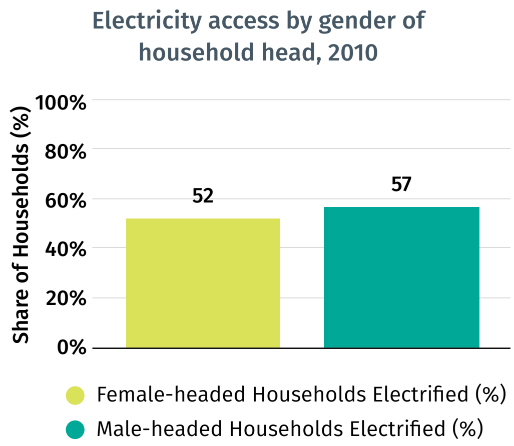
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
–	No government report available	57.1	Utility – Formal: Aggregated from DESCI, DPDC, REB and WZDPDC annual report, 2016
75.9	Tracking SDG 7 report: based on HIES 2016	–	Utility – Informal
75	World Energy Outlook 2017: based on Power Development Board, 2015 (grid connections) and IDCOL, 2016	11.6	Solar (Tier 1 and above): IDCOL Annual report, 2016

Bangladesh's latest household survey (HIES, 2016) reported that 75.9% of the population has access to electricity, ranging from 94% in urban areas to 69% in rural areas. At the same time, Bangladesh's utilities reported a total of 20.7 million household connections. On the basis of the connections reported and an average household size of 4.5, the grid connection rate is estimated at 57.1%. Grid connections have been rising steeply in recent years, with the Rural Electrification Board adding, on average, 3.5 million new rural connections annually since 2015, with a view to meeting the country's goal of universal access by 2021. The gap of 18.8% between the electrification rate reported by the HIES and the grid connection rate can be partially explained by the rapid development of off-grid solar solutions, mainly through Infrastructure Development Company Limited (IDCOL). According to IDCOL, 11.6% of the population relied on solar home systems, providing service at Tier 1 and above, in 2016. The utility connection rate and the off-grid access rate together account for 68.7% of the total electricity access rate, leaving a gap of 7.2% compared to HIES results. Informal connections and other forms of self-supply like diesel generators or rechargeable batteries could explain the difference. Assuming Bangladesh's average household consumption is 671.3 kWh/year, even an illustrative 1% of nontechnical loss from informal connections would provide access to 0.82% of the population.

Patterns of electrification

Household survey data can also be disaggregated to identify patterns of electricity access across different socioeconomic groups. In Bangladesh, disaggregating access by consumption quintiles (from poorest to richest) shows a steady increase in electrification as overall household welfare rises. Access rates improve by more than three times from the bottom quintile to the top quintile, rising by about 14 percentage points from one quintile to the next. Compared to other large access deficit countries in developing Asia, where the top quintile has 1.6 times the access rate of the bottom quintile, disparity in access by consumption quintiles is more pronounced in Bangladesh. Gender-disaggregated access rates show that male-headed households have higher levels of access compared to female-headed households by about five percentage points, whereas other large access deficit countries in Asia have gender parity in this respect. Overall, household consumption drives access disparity in Bangladesh to a greater extent than gender.



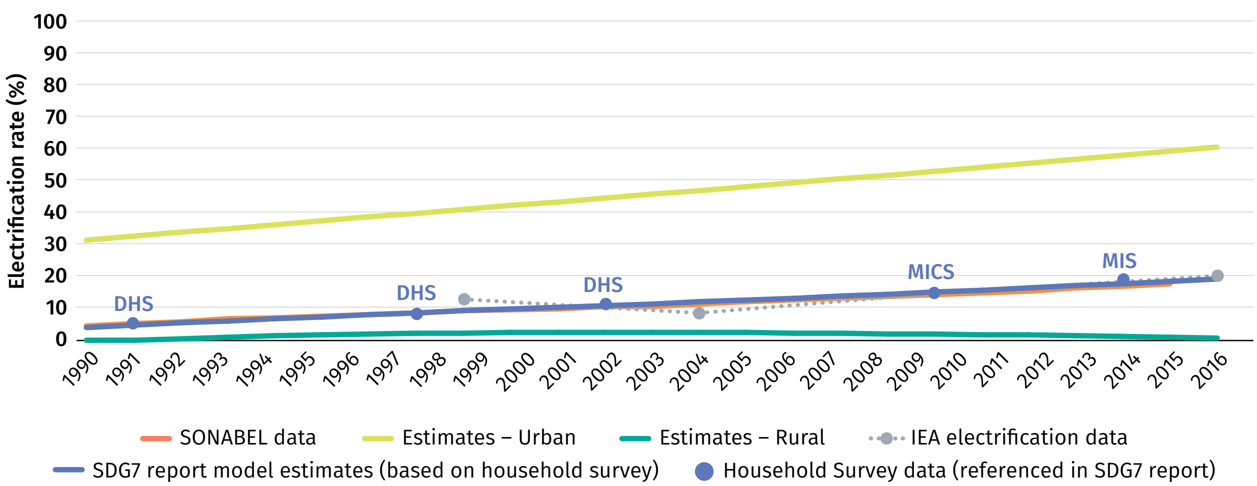


Source: [GMD] ([SAR]TSD/World Bank – latest year available)

BURKINA FASO

Electrification trends

Share of population with access to electricity (%), comparative analysis, 1990-2016



Source: World Bank 2018, SONABEL reports, WEO 2017, World Bank WDI

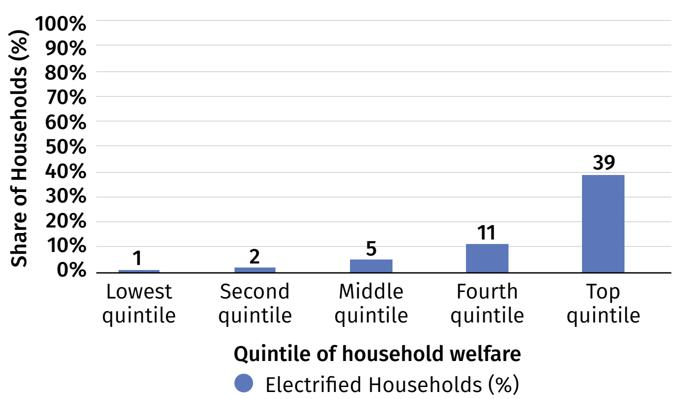
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
–	No government report available	17.7	Utility – Formal: SONABEL report, 2015
19.2	Tracking SDG 7 report: based on model estimate, 2016	–	Utility – Informal
20.3	World Energy Outlook 2017: based on Ministere de l'Energie, Burkino Faso, 2015	0.1	Solar (Tier 1 and above): IRENA, 2016

Burkina Faso's latest household survey (MIS, 2014) reported that 19.2% of the population has access to electricity, ranging from 58% in urban areas to 3% in rural areas. Model estimates, based on historical progress, suggest the access rate should have reached about 19.2% by 2016. In parallel, the latest utility report from SONABEL reported 0.55 million of household connections in 2015. On the basis of the connections reported and a household size of 5.9, the grid connection rate is estimated at 17.7%. The gap of two percentage points between electrification rates estimated from household surveys and those attributable to grid electrification by the utility can scarcely be explained by the development of off-grid solar solutions because—according to IRENA—only 0.1% of the population relied on solar home systems, solar mini-grids, and solar lighting systems providing Tier 1 and above services in 2016. Informal connections and other forms of self-supply like diesel generators or rechargeable batteries could potentially explain the remaining gap.

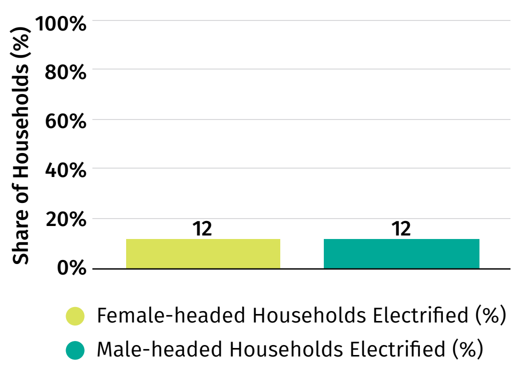
Patterns of electrification

Disaggregated patterns of electricity access across different socioeconomic groups in Burkina Faso show stark differences in access rates across consumption quintiles. There is a striking increase in electrification as overall household welfare rises, with access rates improving by more than 38 times from the bottom quintile to the top quintile. Electricity access is seen to double from one quintile to the next in the bottom three quintiles, and almost quadruples from the fourth quintile to the fifth. Disparity in access across consumption quintiles in Burkina Faso is greater than that of other large access deficit countries in Sub-Saharan Africa, where the access rate of the top quintile is about 6.5 times that of the bottom quintile. Gender-disaggregated access rates show that female-headed households have similar levels of access as male-headed households in Burkina Faso, which is typical of the largest access deficit countries in Sub-Saharan Africa. Overall, household consumption, not gender, drives access disparity in Burkina Faso.

Electricity access by quintiles of household welfare, 2009



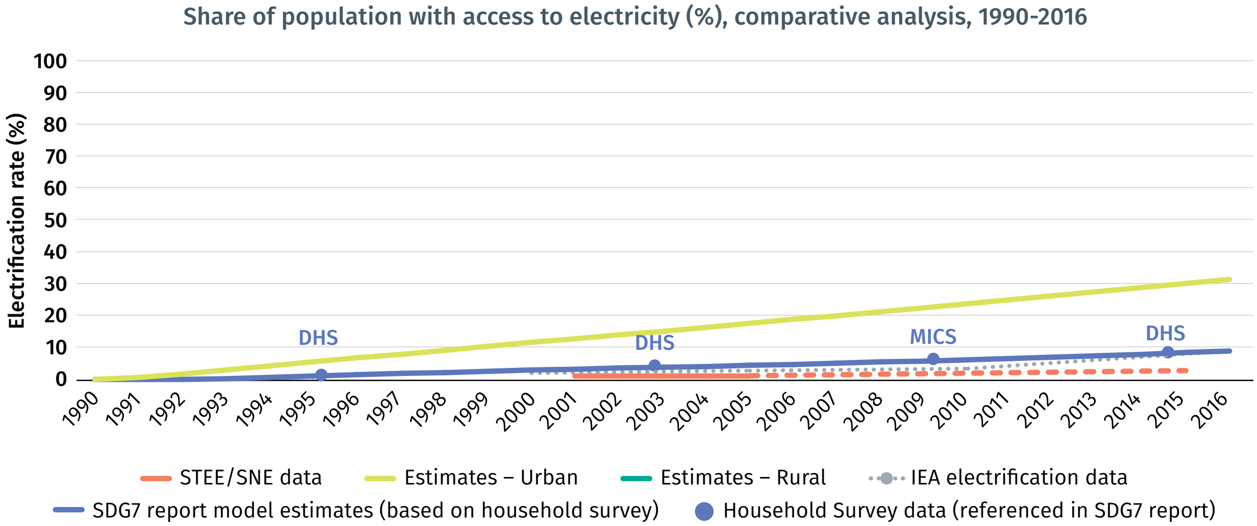
Electricity access by gender of household head, 2009



Source: [GMD] ([SSA]TSD/World Bank – latest year available)

CHAD

Electrification trends



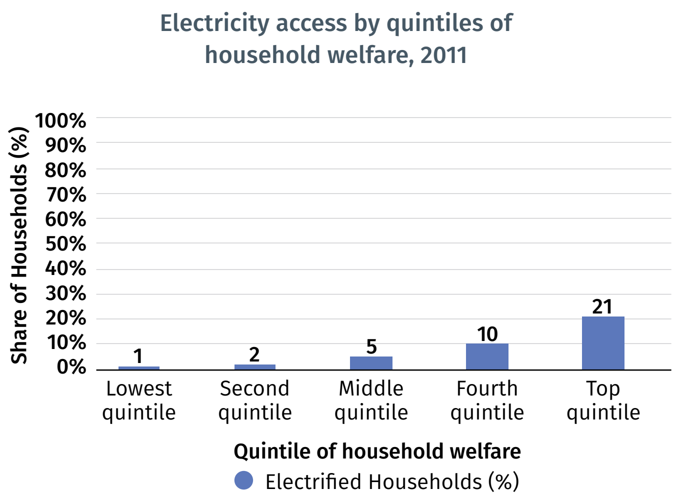
Source: World Bank 2018, SNE, WEO 2017, World Bank WDI

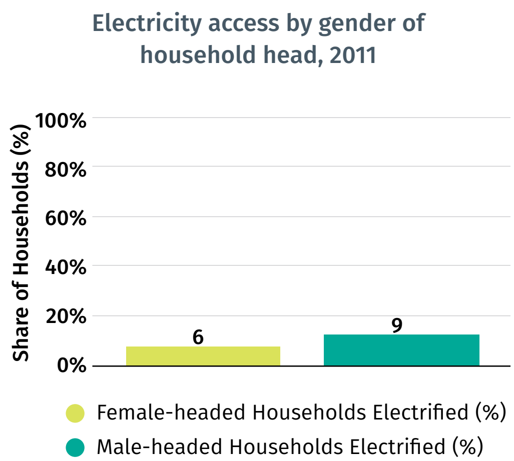
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
6.4	Government report based on Ministry of Energy, 2017	2.8	Utility – Formal: SNE, 2015
8.8	Tracking SDG 7 report: based on model estimate, 2016	3.6	Utility – Informal: SNE, 2016
8.8	World Energy Outlook 2017: based on DHS survey 2014/15	0.01	Solar (Tier 1 and above): IRENA, 2016

Chad's latest household survey (DHS 2014–15) reported that 7.7% of the population has access to electricity, ranging from 32.4% in urban areas to 0.7% in rural areas. Model estimates, based on historical progress, suggest the access rate should have reached about 8.8% by 2016. In parallel, the latest utility report from SNE reported 0.67 million household connections for 2015. On the basis of the connections reported and a household size of 5.8, the formal grid connection rate is estimated at 2.8%. Meanwhile, the utility estimated nontechnical losses at 27%. Assuming Chad's average household consumption is 448 kWh/year, an estimated additional population of 3.6% may be obtaining grid electricity through informal connections. Overall, the (formal and informal) utility connection rate would then account for 6.4% of the population in 2016, leaving a gap of 2.4% compared to household survey's results. Because—according to IRENA—only 0.01% of the population relied on solar home systems, solar mini-grids, and solar lighting systems providing Tier 1 and above services in 2016, the bulk of the difference is likely accounted for by other forms of self-supply like diesel generators or rechargeable batteries.

Patterns of electrification

Disaggregating household survey data by consumption quintiles (from poorest to richest) to identify patterns of electricity access in Chad shows significant increase in electrification as overall household welfare rises. Access rates improve by more than 21 times from the bottom quintile to the top quintile, doubling from one quintile to the next. Disparity in access across consumption quintiles is more pronounced in Chad compared to other large access deficit countries in Sub-Saharan Africa. Gender-disaggregated access rates show that male-headed households have higher levels of access compared to female-headed households, and outperform by about three percentage points; which is relatively unusual compared to other large access deficit countries in Sub-Saharan Africa. However, overall, household consumption drives access disparity in Chad to a greater extent than gender.



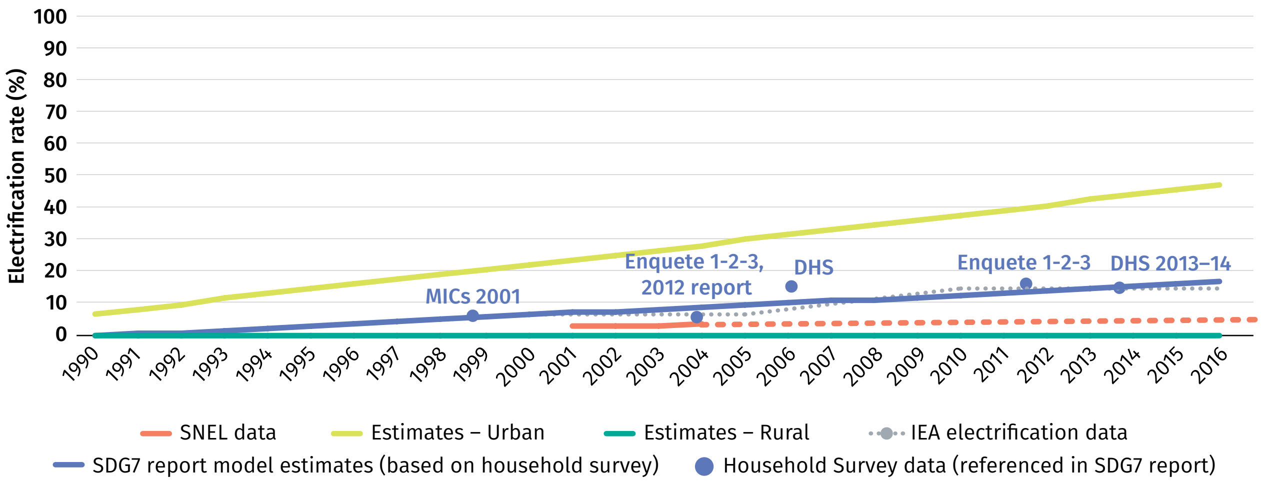


Source: [GMD] ([SSA]TSD/World Bank – latest year available)

CONGO, (DEM, REP, OF)

Electrification trends

Share of population with access to electricity (%), comparative analysis, 1990-2016



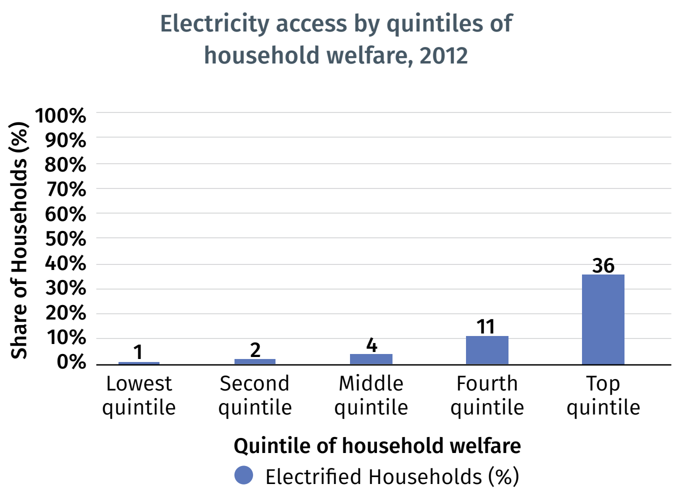
Source: World Bank 2018, SNEL, WEO 2017, World Bank WDI

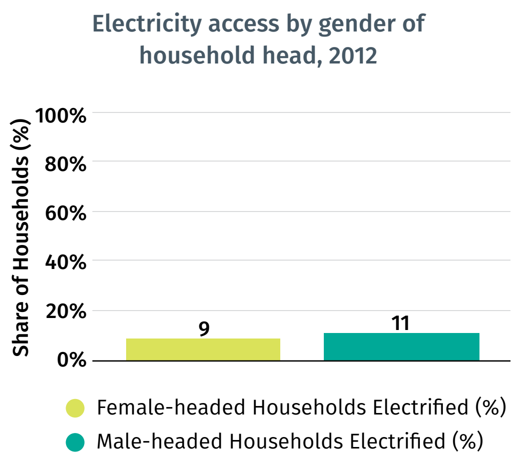
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
–	No government report available	5.2	Utility – Formal: Societe Nationale d'Electricite – SNEL, 2017
17.1	Tracking SDG 7 report: based on model estimate, 2016	–	Utility – Informal
15.2	World Energy Outlook 2017: based on SNEL, 2016	0	Solar (Tier 1 and above): IRENA, 2016

The latest household survey (DHS 2013–14) in the Democratic Republic of Congo reported that 13.5% of the population has access to electricity, ranging from 42% in urban areas to 0.4% in rural areas. Model estimates, based on historical progress, suggest the access rate should have reached about 17.1% by 2016. The national utility SNEL reported 0.8 million household connections in 2017. On the basis of the connections reported and a household size of 5.3, the formal grid connection rate is estimated at 5.2%, leaving a gap of 11.9% compared to household survey results, which can be explained in a number of ways. First, the utility SNEL has limited capacity to record and track actual grid connections. Second, given DRC's vast territory, small scale independent operators are also providing service in provincial centers. Third, informal connections and other forms of self-supply like diesel generators or rechargeable batteries could potentially also explain the gap. Assuming an average household consumption of 1304 kWh/year, an illustrative calculation of 1% of nontechnical loss would mean that 0.15% of population had electricity access through informal connections in 2016. According to IRENA's statistics, there are no reported sales of solar panels capable of providing Tier 1 service or above.

Patterns of electrification

In the Democratic Republic of Congo, disaggregating access by consumption quintiles (from poorest to richest) shows a massive increase in electrification as overall household welfare rises. Access rates improve by more than 60 times from the bottom quintile to the top quintile, a steeper gradient than that found in most other large access deficit countries in Sub-Saharan Africa. Access rates in the lowest quintile barely register, and triple from one quintile to the next. Gender-disaggregated access rates show that male-headed households have higher levels of access compared to female-headed households, and outperform by 1.7 percentage points. Overall, household consumption drives access disparity in the Democratic Republic of Congo to a greater extent than gender.



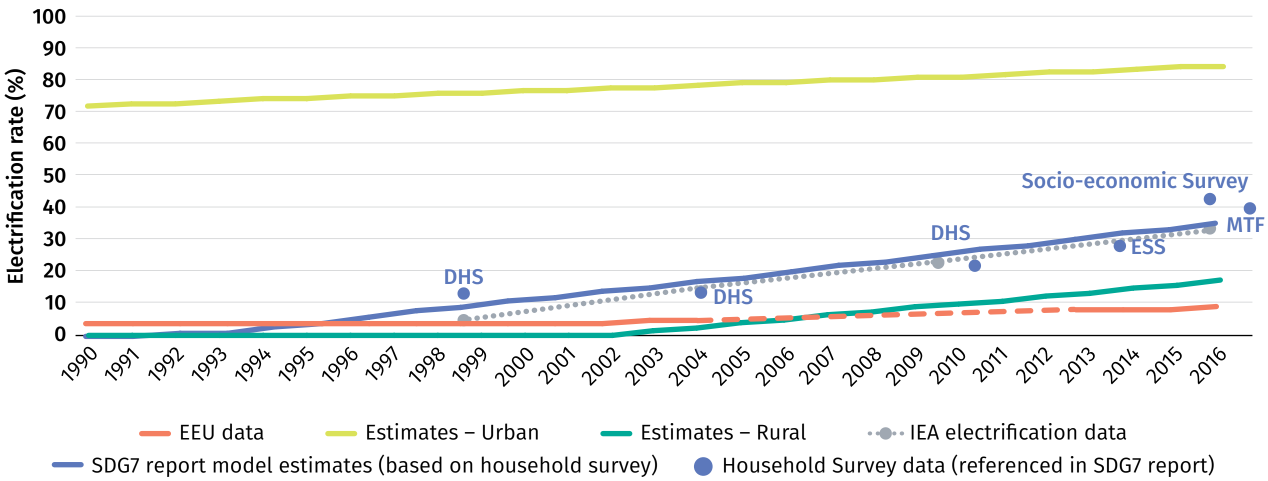


Source: [GMD] ([SSA]TSD/World Bank – latest year available)

ETHIOPIA

Electrification trends

Share of population with access to electricity (%), comparative analysis, 1990-2016



Source: World Bank 2018, EEU, WEO 2017, World Bank WDI

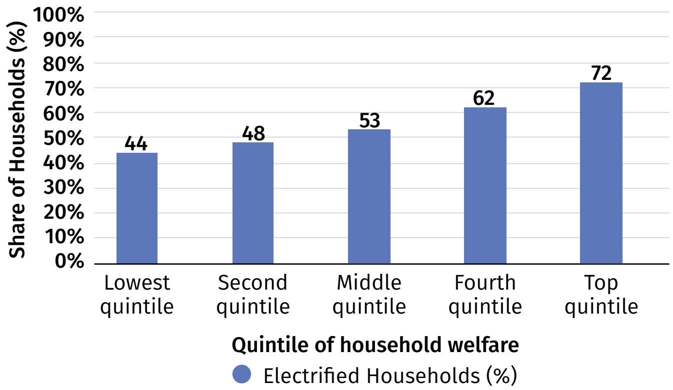
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
33	Government Report: National Electrification Program, 2017	10.5	Utility – Formal: estimated by Ethiopian Electric Utility - EEU, 2017
		0.5	Utility – Informal: estimated by EEU, 2017
42	Tracking SDG 7 report: based on MTF, 2017	29	Utility - Total: MTF (tier 1 and above), 2017
33	World Energy Outlook 2017: based on National Electrification Program, Implementation Road Map and Financing Prospectus, 2017	13	Solar: MTF (tier 1 above), 2017

Ethiopia's latest household survey (MTF, 2017) reported that 42% of the population has access to electricity above Tier 1, ranging from 96.5% in urban areas to 27.7% in rural areas. In parallel, the utility EEU reported 2.4 million household connections in 2017. On the basis of the connections reported and a household size of 4.6, the formal grid connection rate is estimated at 10.5%. Furthermore, the utility estimated nontechnical losses of 1.2% representing informal connections to the grid. Assuming Ethiopia's average household consumption is 444 kWh/year, an estimated additional 0.5% of the population may be obtaining grid electricity through such informal connections. However, the MTF survey reported a much higher rate of grid connection for 2017, at 29%. The gap between grid access rates from the utility and from the MTF survey can be explained by the fact that in Ethiopia—because of relatively high connection charges—many households share a single metered connection and divide the utility bill among themselves (Kojima and Trimble 2016). This phenomenon is captured by MTF and results in a much higher grid connection rate of 29.0%. According to MTF, the difference between the utility connection rate of 29.0% and the overall access rate of 42.0% is explained by the fact that 13% of the population relies on solar home systems and solar lighting systems that provide service at Tiers 1 and 2.

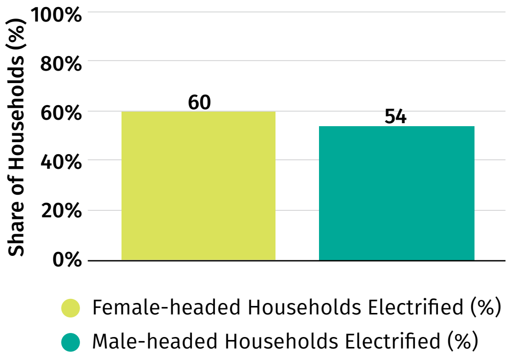
Patterns of electrification

In Ethiopia, disaggregating access by consumption quintiles (from poorest to richest) shows a steady increase in electrification as overall household welfare rises, although the disparity between rich and poor is smaller than what is found in the largest access deficit countries of Sub-Saharan African. Access rates improve by close to 40% from the bottom quintile to the top quintile, rising by 5 percentage points in the bottom three quintiles, and 10 percentage points in the top two quintiles. Gender-disaggregated access rates reveal a notable characteristic: female-headed households have higher levels of access when compared to male-headed households, and outperform by about 6.5 percentage points. Overall, household consumption drives access disparity in Ethiopia to a greater extent than gender.

Electricity access by quintiles of household welfare, 2010



Electricity access by gender of household head, 2010

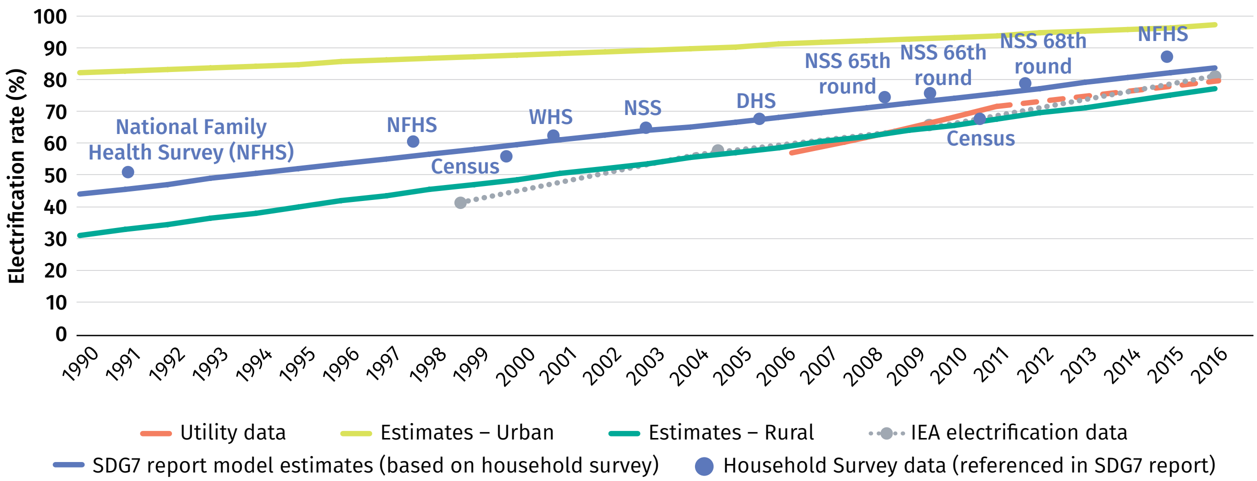


Source: [GMD] ([SSA]TSD/World Bank – latest year available)

INDIA

Electrification trends

Share of population with access to electricity (%), comparative analysis, 1990-2016



Source: World Bank 2018,, Saubhagya Dashboard, WEO 2017, World Bank WDI

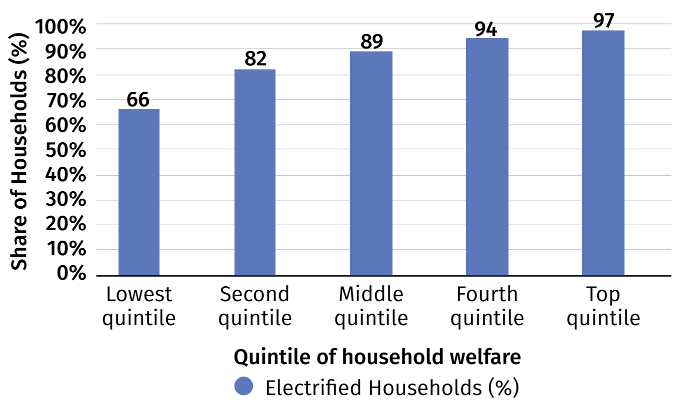
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
80.3	Government report: Saubhagya Dashboard, Oct. 2017	80.3	Utility – Formal: Saubhagya Dashboard, Oct. 2017
		–	Utility – Informal
84.5	Tracking SDG 7 report: based on model estimate, 2016	0.4	Solar (home lighting systems): MNRE, 2015-2016
82	World Energy Outlook 2017: Urban: based on Power for All agreements for states; Rural: GARV (31 Dec 2016). Includes population with access to SHS (around 1 million)	0.25	Solar (Tier1 and above): IRENA, 2016

The rapid growth of electricity access in India is propelled by the country's $2.5 billion electrification program to reach universal electrification by December 2018. India's latest household survey (NFHS, 2015) reported that 88% of its population has access to electricity, ranging from 97.5% in urban areas to 83.2% in rural areas. Model estimates, based on the full series of historical progress, suggest the access rate should have reached about 84.5% for 2016. In parallel, the utilities combined reported 145.1 million of household connections in 2017. On the basis of the connections reported and a household size of 4.8, the formal grid connection rate is estimated at 80.3%. The gap in electrification rates reported by household surveys, and those attributable to grid electrification by the utility, may be due to a number of factors. First, there are no official statistics on nontechnical losses, so the exact extent of informality is unknown. An illustrative calculation simulating the impact of 1% nontechnical losses, on the basis of India's average household consumption of 1144 kWh/year, suggest that this level of losses could provide informal access to 1.05% of population. Second, households in rural areas can use a variety of non-grid-based solutions, including solar electricity, diesel generation, or rechargeable batteries. Of these options, solar electricity is the only one for which official statistics are available from two sources, both of which give quite consistent results. First, India's Ministry of New and Renewable Energy reported 1.29 million solar home lighting systems in 2016, which translates to 0.4% of population. Second, according to IRENA's global database, 0.25% of the population relied on solar home systems, solar mini-grids, and solar lighting systems providing Tier 1 and above service in 2016.

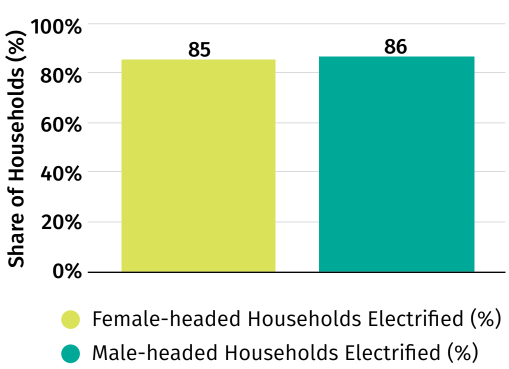
Patterns of electrification

Disaggregated household survey data by consumption quintiles (from poorest to richest) in India shows a steady improvement in access rates as overall household welfare rises. The access rate of the top quintile is 1.5 times that of the bottom quintile, in line with the average for the largest access deficit countries in Asia. Access rates are seen to increase by 16 percentage points from the bottom quintile to the second quintile and by about 5 percentage points after that. Gender-disaggregated access rates show that female-headed households have similar levels of access when compared to male-headed households, which is also typical of the largest access deficit countries in Asia. Overall, household consumption, not gender, drives access disparity in India.

Electricity access by quintiles of household welfare, 2011



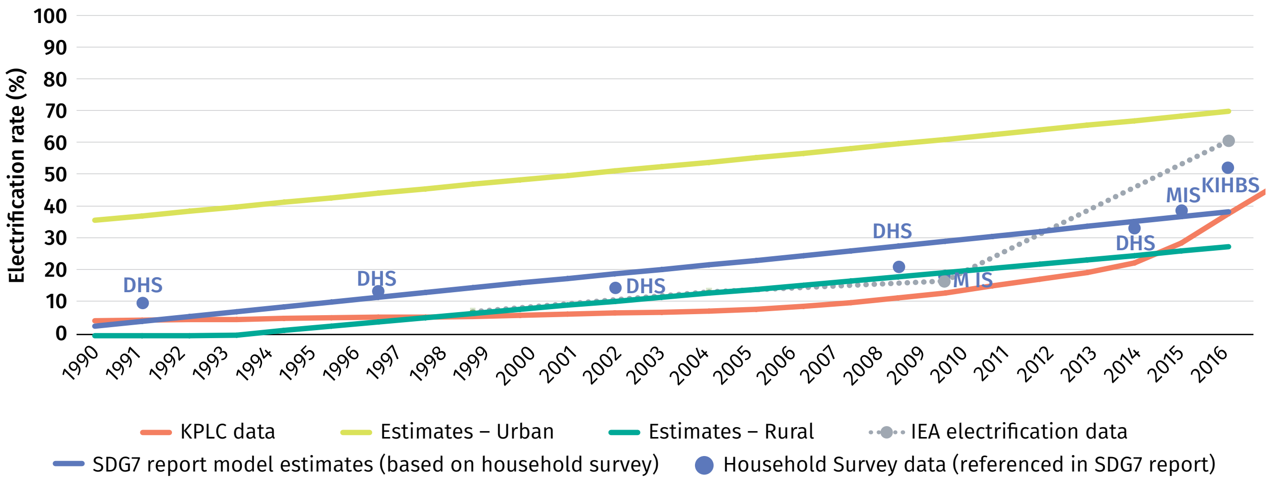
Electricity access by gender of household head, 2011



Source: [GMD] ([SAR]TSD/World Bank – latest year available)

KENYA

Electrification trends Share of population with access to electricity (%), comparative analysis, 1990-2016



Source: World Bank 2018, KPLC, WEO 2017, World Bank WDI

Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
70.3	Government Report: based on KPLC Annual report, 2016-2017[1]	40.4	Utility – Formal: Kenya Power (KPLC Annual Report, 2016
		–	Utility – Informal
56	Tracking SDG 7 report: based on KIHBS 2015-2016	41.4	Utility - Total: KIHBS 2015-2016
64.5	World Energy Outlook 2017: based on Grid connections reported by Kenya Power, 2016. Includes 2% access rate from SHS based on sales	1.6	Solar (Tier1 and above): IRENA, 2016
		14.1	Solar: KIHBS 2015-2016

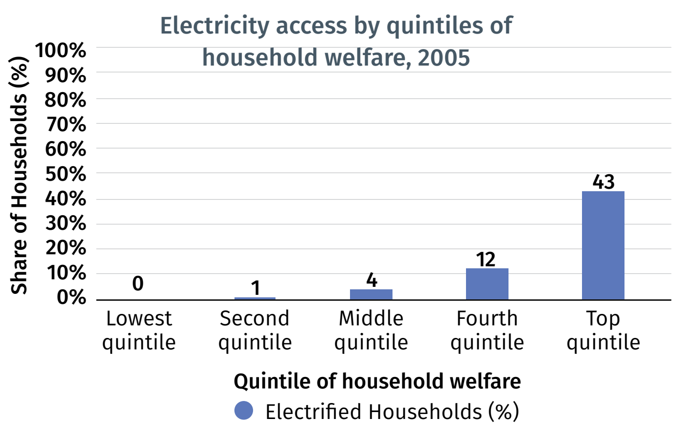
Kenya's latest household survey (KIHBS, 2015-16) reported that 56% of its population has access to electricity, ranging from 78% in urban areas to 16% in rural areas. Model estimates, based on the full series of historical progress, suggest that the access rate should have reached around 35.4% for 2016. In parallel, the utility KPLC reported 4.9 million of household connections in 2016. Based on the connections reported and a household size of 4, the formal grid connection rate is estimated at 40.4%. There are no official statistics on non-technical losses that reflect the presence of informal connections. An illustrative simulation of 1% nontechnical losses, given Kenya's average household consumption of 539 KWh/year, could potentially provide informal access to 0.55% of the population. The grid connection rate from the utility is aligned with the findings from the latest household survey, which reported that 41.4% of the population obtain electricity through grid connections. The gap in electrification rates reported by household surveys, and those attributable to grid electrification by the utility, can be partially explained by the use of a variety of off-grid solutions, including diesel generators, rechargeable batteries and solar systems. Statistics are only available regarding penetration of solar systems. According to

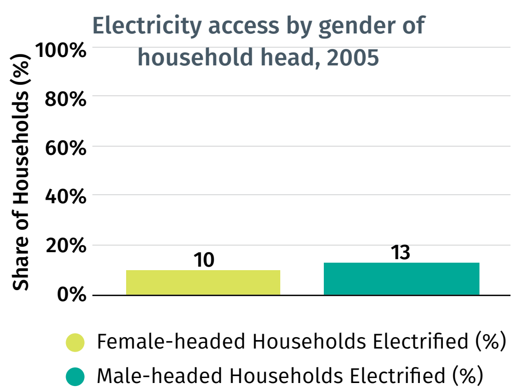
[1] The government reported electrification rate is based on the 6.06 million utility connections as of September 30th, 2017. These numbers are converted into an access rate using a household size of 5.5 and a population estimate of 46.9 million. These diverge from the household size of 3.6 reported in the most recent DHS survey, and the population of 49.7 million in the World Development Indicators. These differences account for the divergence in the overall electrification rate.

the household survey, 14.1% of the population relied on off-grid solar power, and IRENA reported 1.6% of the population of Kenya relied on solar home systems, solar mini-grids, and solar lighting systems providing Tier 1 and above service in 2016..

Patterns of electrification

Using household survey data to identify patterns of electricity access across different socio-economic groups in Kenya shows that there is substantial increase in access rates as overall household welfare rises. Access rates in the top quintile is 40 percentage points higher than that in the bottom quintile, with over 30 percentage point jump from the fourth quintile to the fifth. The disparity in the top quintiles that is seen in Kenya is more pronounced than the average for the largest access deficit countries in Sub-Saharan Africa. Gender-disaggregated access show that male-headed households have higher levels of access when compared to female-headed households, and outperform by two percentage points, departing from the gender parity in access seen in other large access deficit countries in Sub-Saharan Africa. Overall, household consumption drives access disparity in Kenya to a farther extent than gender.

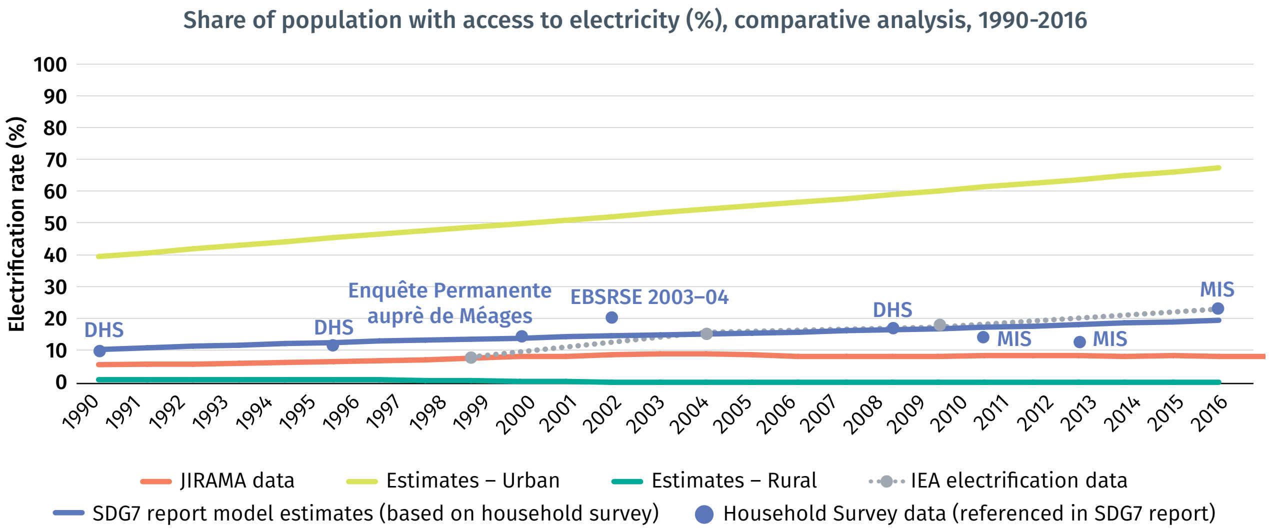




Source: [GMD] ([SSA]TSD/World Bank – latest year available)

MADAGASCAR

Electrification trends



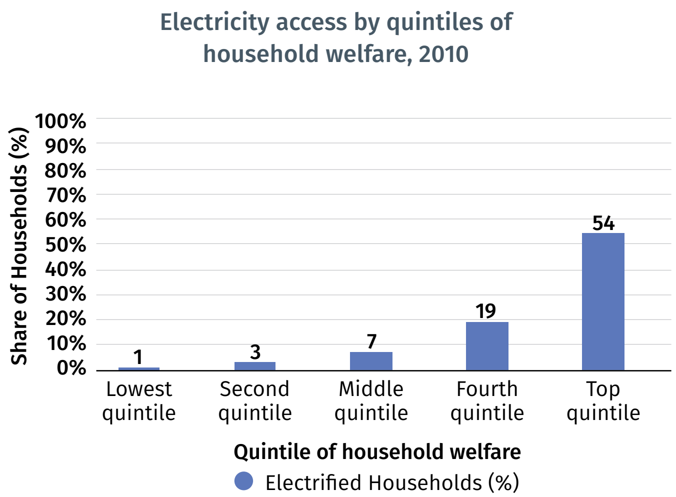
Source: World Bank 2018, JIRAMA, WEO 2017, World Bank WDI

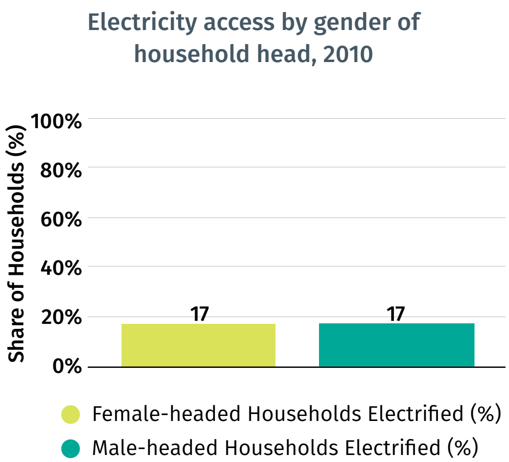
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
15	Government Report: based on National Electrification Strategy, Energy Ministry, 2014	8.2	Utility – JIRAMA, 2016
22.9	Tracking SDG 7 report: based on MTF, 2017	–	Utility – Informal
22.9	World Energy Outlook 2017: based on National Electrification Program, Implementation Road Map and Financing Prospectus, 2017	0.03	Solar (Tier 1 and above): IRENA, 2016

Madagascar's latest household survey (MIS, 2016) reported that 22.9% of the population has access to electricity, ranging from 67.3% in urban areas to 17.3% in rural areas. In parallel, the utility JIRAMA reported 0.5 million household connections in 2016. On the basis of the connections and a household size of 4.2, the formal grid connection rate is estimated at 8.2%. The substantial gap in electrification rates reported by household surveys, and those attributable to grid electrification by the utility, could be due to a variety of causes, including informal connections to the utility as well as off-grid supply from diesel generators, rechargeable batteries, or solar systems. Available data from IRENA suggest that the penetration of solar is negligible, with only 0.03% of the population relying on solar home systems, solar mini-grids, and solar lighting systems providing Tier 1 access and above in 2016. A more comprehensive off-grid market analysis is being conducted nationally and results are expected in Spring 2018.

Patterns of electrification

Household survey data can also be disaggregated to identify patterns of electricity access across different socioeconomic groups. In Madagascar, disaggregating access by consumption quintiles (from poorest to richest) shows a striking increase in access rates as overall household welfare rises. The access rate of the top quintile is 52 percentage points higher than that of the bottom quintile (the average difference between top and bottom quintiles for the largest access deficit countries in Sub-Saharan Africa is 37 percentage points), and doubles from one quintile to the next in the bottom three quintiles, and triples in the next two quintiles. Gender-disaggregated access rates show that male-headed households have similar levels of access as female-headed households. Overall, household consumption, not gender, drives access disparity in Madagascar.

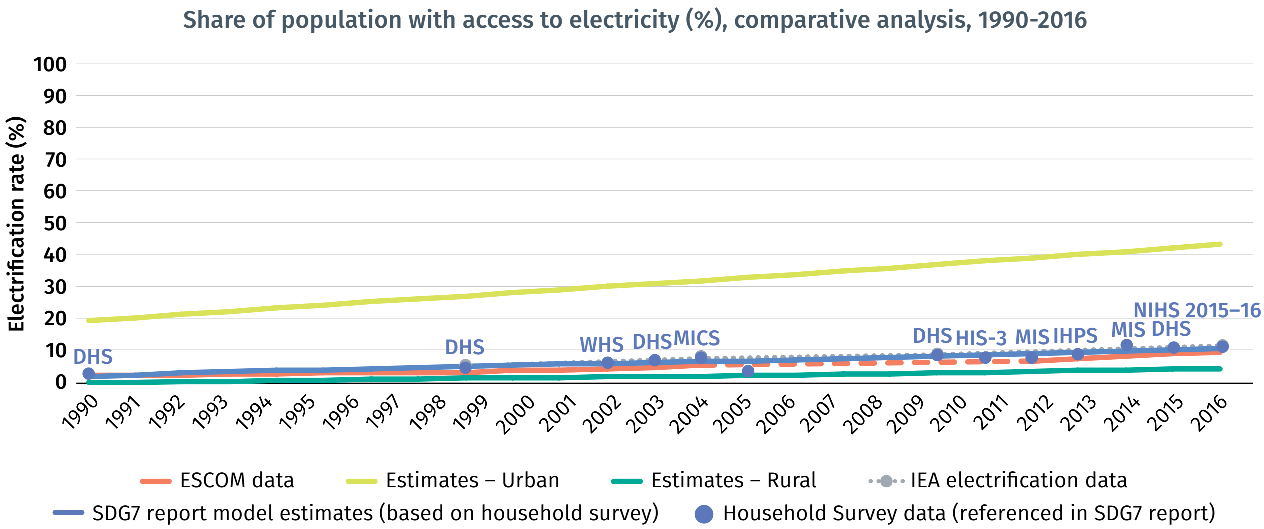




Source: [GMD] ([SSA]TSD/World Bank – latest year available)

MALAWI

Electrification trends



Source: World Bank 2018, ESCOM, WEO 2017, World Bank WDI

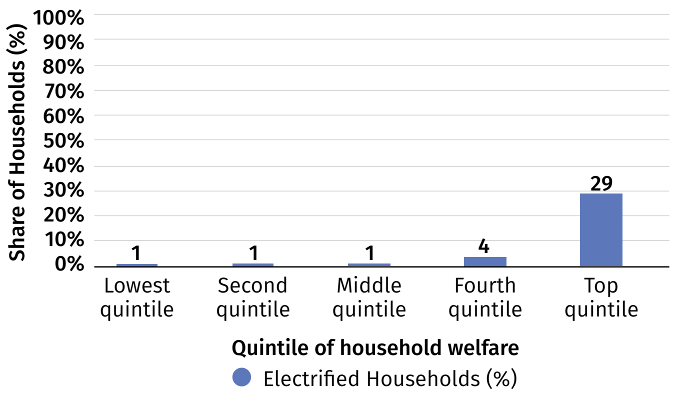
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
-	No government report available	9.3	Utility – Formal: ESCOM, 2016
11	Tracking SDG 7 report: based on DHS 2015-16	–	Utility – Informal
11.3	World Energy Outlook 2017: based on DHS survey, 2016 with off-grid estimates	0	Solar (Tier 1 and above): IRENA, 2016

Malawi's latest household survey (DHS, 2015–16) reported that 11% of the population has access to electricity, ranging from 42% in urban areas to 4% in rural areas. In parallel, the utility ESCOM reported 0.37 million household connections in 2016. On the basis of the connections and a household size of 4.5, the formal grid connection rate is estimated at 9.3%. There are no official data on nontechnical losses to gauge the extent of informal connections. An illustrative simulation of 1% nontechnical losses, given Malawi's average household consumption is 1224 kWh/year, could potentially provide informal access to 0.27% of the population in 2016. The relatively small gap between the utility connection rate and the access recorded by the household survey could be attributable to off-grid solutions, such as diesel generators and rechargeable batteries. According to IRENA, none of the population relied on solar home systems, solar mini-grids, or solar lighting systems capable of providing Tier 1 and above service in 2016.

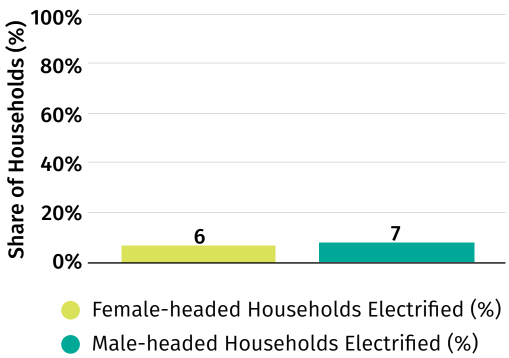
Patterns of electrification

Disaggregated household survey data reveal patterns of electricity access across different socioeconomic groups in Malawi. Access by consumption quintiles (from poorest to richest) shows material increase in access rates as overall household welfare rises. The access rate of the top quintile is 28 percentage points higher than that of the bottom quintile, and 23 percentage points higher than the fourth quintile, with only marginal improvements in access rates from one quintile to the next in the bottom four quintiles, and a massive sevenfold jump in access rates between quintiles four and five. Gender-disaggregated access rates show that male-headed households have higher levels of access compared to female-headed households by 1.3 percentage points. Overall, household consumption drives access disparity in Malawi to a greater extent than gender.

Electricity access by quintiles of household welfare, 2010



Electricity access by gender of household head, 2010

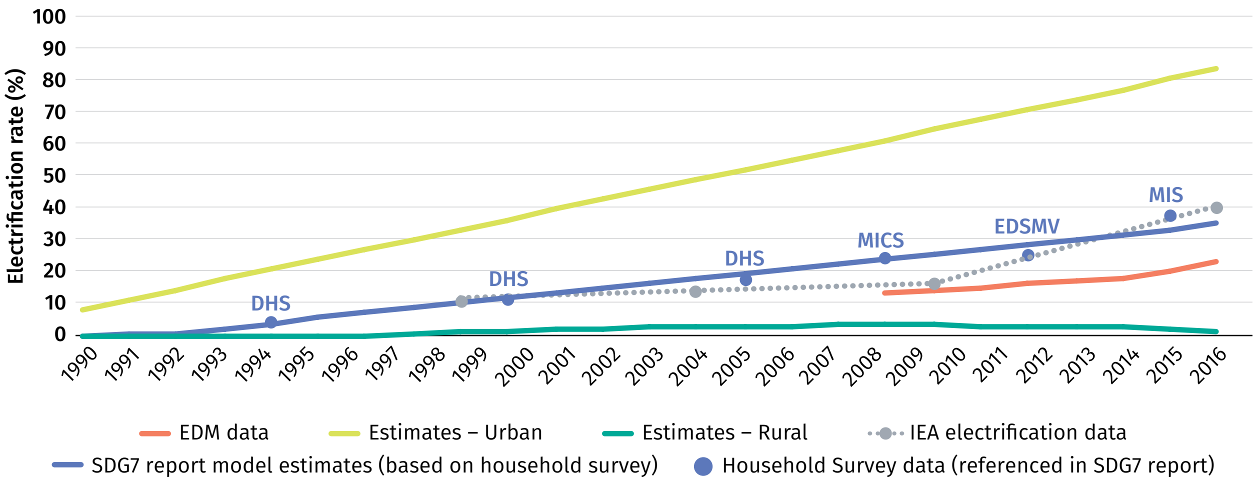


Source: [GMD] ([SSA]TSD/World Bank – latest year available)

MALI

Electrification trends

Share of population with access to electricity (%), comparative analysis, 1990-2016



Source: World Bank 2018, EDM, WEO 2017, World Bank WDI

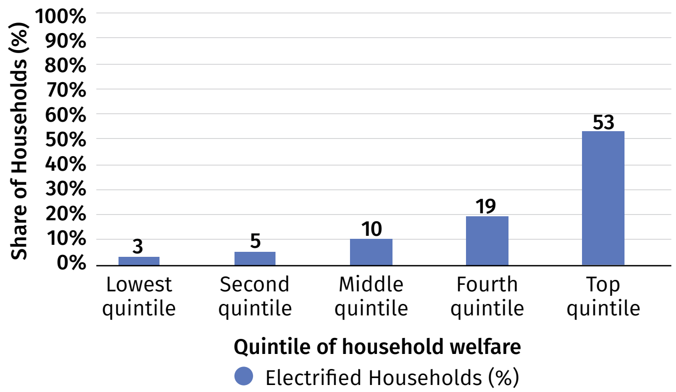
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
39	Government Report: based on SPC indicator statistic, 2016	23	Utility – Formal: Electricite Du Mali - EDM, 2016
35.1	Tracking SDG 7 report: based on model estimate, 2016	–	Utility – Informal
40.5	World Energy Outlook 2017: based on MIS 2015	0.6	Solar (Tier 1 and above): IRENA, 2016

Mali's latest household survey (MIS, 2015) reported that 37.6% of the population has access to electricity, ranging from 83.1% in urban areas to 23.4% in rural areas. Model estimates, based on the full series of historical progress, suggest the access rate should have reached about 35.1% for 2016. In parallel, the utility EDM reported 0.46 million household connections in 2016. On the basis of the connections and a household size of 9, the formal grid connection rate is estimated at 23%. The substantial gap between electrification rates reported by household surveys and those attributable to grid electrification by the utility could have various causes, including informal connections to the utility, as well as off-grid supply from diesel generators, rechargeable batteries, or solar systems. According to IRENA, only 0.6% of the population relied on solar home systems, solar mini-grids, or solar lighting systems capable of providing Tier 1 and above service in 2016.

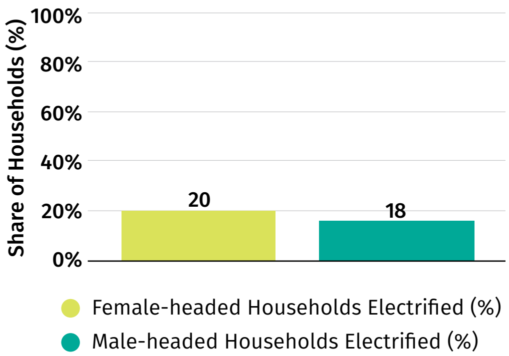
Patterns of electrification

Patterns of electricity access across different socioeconomic groups in Mali that can be extracted from household survey data show a material increase in access rates as overall household welfare rises. The access rate of the top quintile is 50 percentage points higher than that of the bottom quintile, and 33 percentage points higher than the fourth quintile, with only marginal improvements in access rates from one quintile to the next in the bottom four quintiles, and a jump in access rates of over 2.5 times between quintiles four and five. Gender-disaggregated access rates show that female-headed households have higher levels of access compared to male-headed households by 1.7 percentage points. Overall, household consumption drives access disparity in Mali to a greater extent than gender.

Electricity access by quintiles of household welfare, 2010



Electricity access by gender of household head, 2010

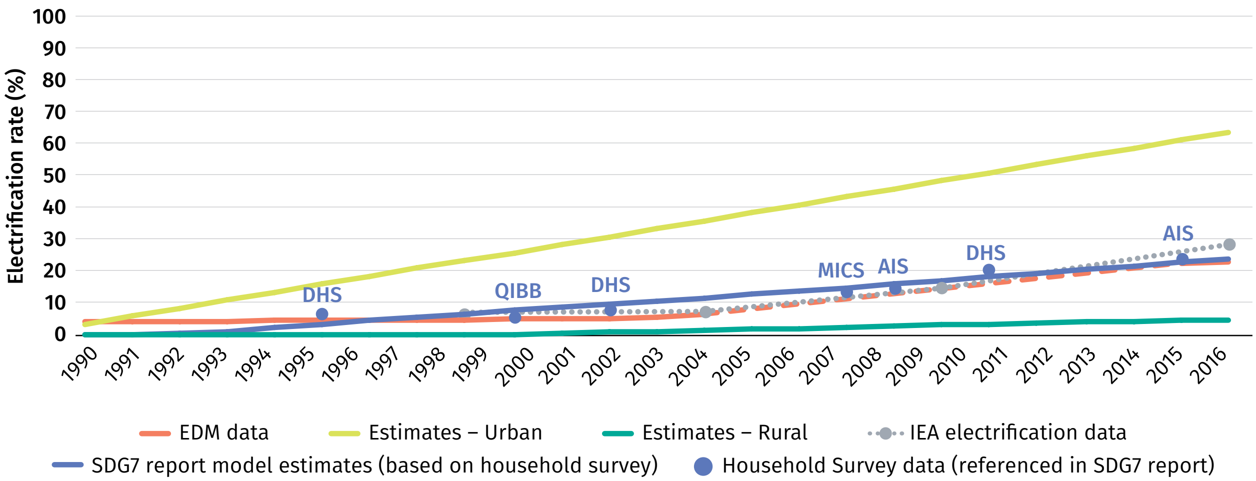


Source: [GMD] ([SSA]TSD/World Bank – latest year available)

MOZAMBIQUE

Electrification trends

Share of population with access to electricity (%), comparative analysis, 1990-2016



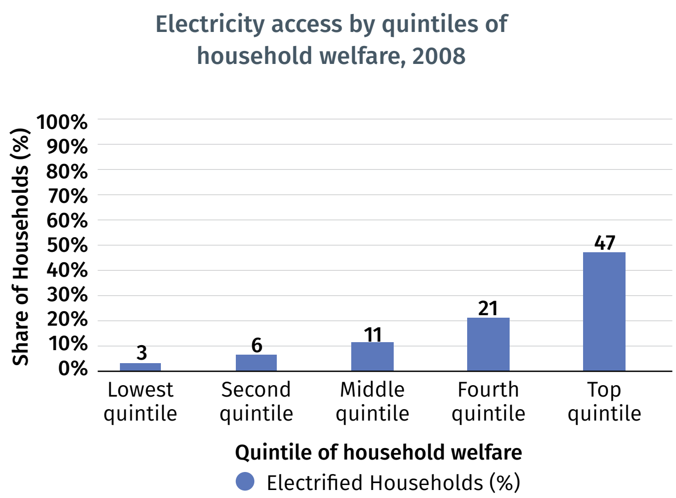
Source: World Bank 2018, EDM, WEO 2017, World Bank WDI

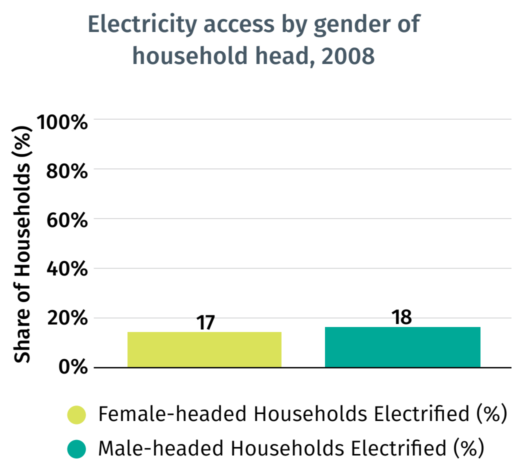
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
25.8	Government Report; based on Electricidade de Moçambique (EDM) statistics, 2016	23.1	Utility – Formal: EDM, 2016
24.2	Tracking SDG 7 report: based on model estimate, 2016	-	Utility – Informal
28.6	World Energy Outlook 2017: based on Directorate of Studies and Planning, Ministry of Energy based on grid connections and off-grid access, 2016	1.5	Solar (Tier 1 and above): IRENA, 2016

Mozambique's latest household survey (AIS, 2015) reported that 24% of the population has access to electricity, ranging from 68% in urban areas to 5% in rural areas. Model estimates, based on the full series of historical progress, suggest that the access rate should have reached about 24.2% for 2016. In parallel, the utility EDM reported 1.51 million household connections in 2016. On the basis of the connections and a household size of 4.4, the formal grid connection rate is estimated at 23.1%. The utility does not report nontechnical losses from which the extent of informal connections could be gauged. An illustrative simulation based on 1% nontechnical losses indicates that, with average household consumption of 1224 kWh/year, informal connections would only supply about 0.03% of the population in 2016. The substantial gap between electrification rates reported by household surveys and those attributable to grid electrification by the utility could be explained by off-grid solutions such as diesel generators, rechargeable batteries, and solar systems. According to household surveys (IOF, 2014/15), 1.5% of the population relied on solar home systems, solar mini-grids, and solar lighting systems providing Tier 1 and above service in 2015. In addition, 2.1% of population relied on rechargeable batteries (below Tier 1) in 2015.

Patterns of electrification

Patterns of electricity access across different socioeconomic groups through disaggregated household survey data shows a striking increase in access rates as overall household welfare rises. The access rate of the top quintile is 13 times that of the bottom quintile (the average for the largest access deficit countries in Sub-Saharan Africa is a jump of 6.5 times from the bottom quintile to the top quintile), and doubles from one quintile to the next. Notably, gender-disaggregated access rates show that male-headed households have higher levels of access compared to female-headed households by 1 percentage point. Overall, household consumption drives access disparity in Mozambique to a greater extent than gender.



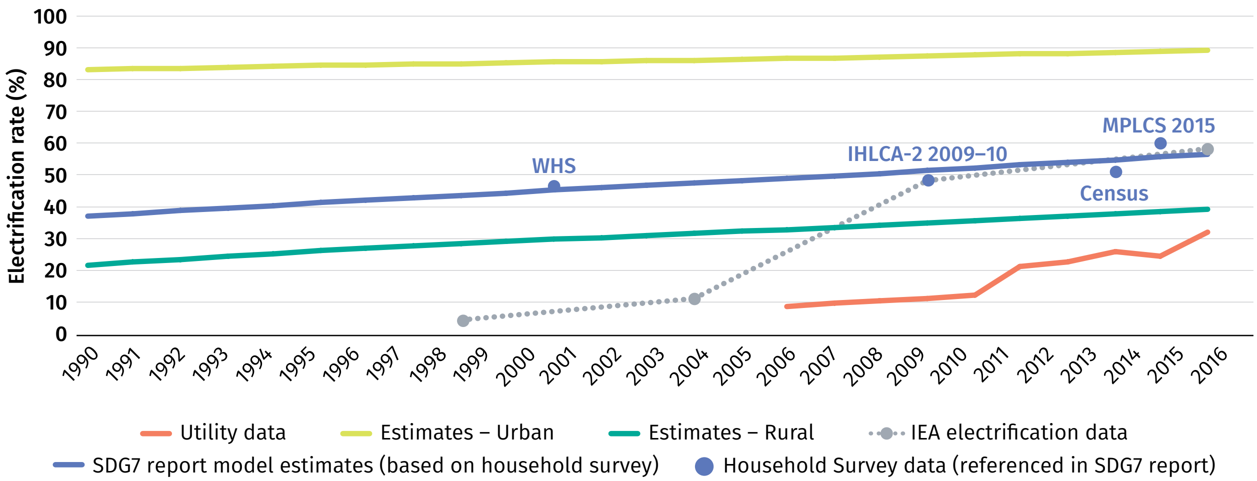


Source: [GMD] ([SSA]TSD/World Bank – latest year available)

MYANMAR

Electrification trends

Share of population with access to electricity (%), comparative analysis, 1990-2016



Source: World Bank 2018, Utility Statistics book, WEO 2017, World Bank WDI

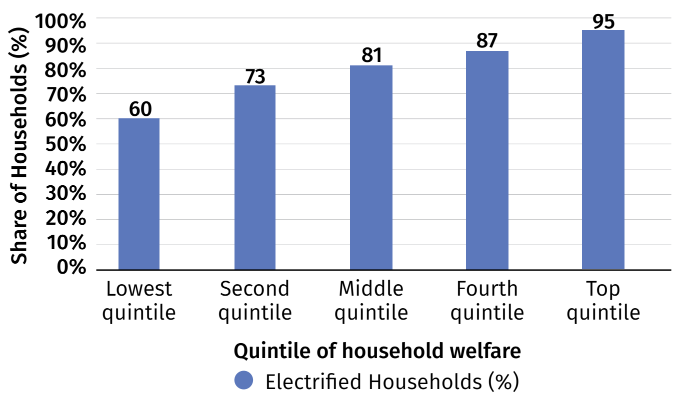
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
–	No government report available	32.6	Utility – Formal: Utility Statistic book, 20016 (not public)
		–	Utility – Informal
57	Tracking SDG 7 report: based on model estimate, 2016	17.4	Solar (Solar home systems): MPLCS 2015
58.8	World Energy Outlook 2017: based on DHS 2015-2016, includes off-grid estimates	10.6	Mini-grids: MPLCS 2015

Myanmar's latest household survey (MPLC, 2015) reported that 60.5% of the population has access to electricity, ranging from 90.8% in urban areas to 48.9% in rural areas. Model estimates, based on historical progress, suggest that the access rate should have reached about 57% by 2016. In parallel, all utilities combined reported 3.1 million connections in 2016. On the basis of the connections and a household size of 5, the formal grid connection rate is estimated at 32.6%. The substantial gap between electrification rates reported by household surveys and those attributable to grid electrification by the utility can be partially explained by the rapid development of off-grid solutions. According to the household survey (MPLC, 2015), 28% of the population relied on solar home systems and mini-grids. Overall, the utility connection rate and the off-grid access rate together reported 60.6% of total electricity access, which aligns with household survey's results.

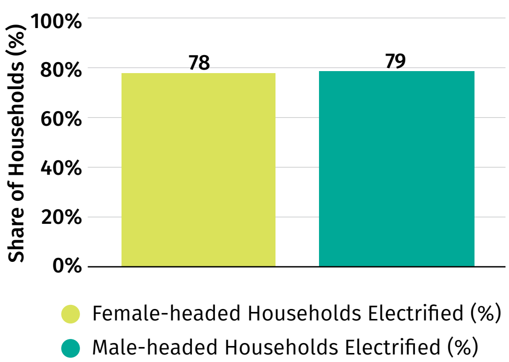
Patterns of electrification

Household survey data can also be disaggregated to identify patterns of electricity access across different socioeconomic groups. In Myanmar, disaggregating access by consumption quintiles (from poorest to richest) shows a steady improvement in access rates as overall household welfare rises. The access rate of the top quintile is 1.6 times that of the bottom quintile, and the access rates of the middle three quintiles differ by about 7 percentage points. The disparity in access rates across consumption quintiles is less pronounced in Myanmar and in line with the average for the largest access deficit Asian countries. Gender-disaggregated access rates show that access rates for male-headed households are marginally higher compared to female-headed households by 1.5 percentage points, which is a departure from the gender parity in access rates seen in the largest access deficit countries in Asia.

Electricity access by quintiles of household welfare, 2015



Electricity access by gender of household head, 2015

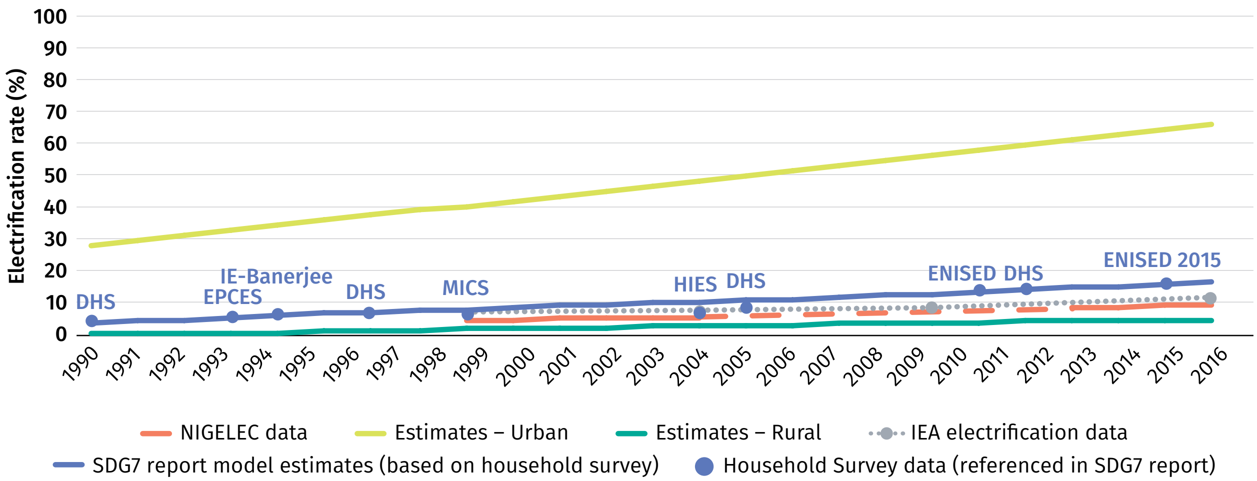


Source: [GMD] ([EAP]TSD/World Bank – latest year available)

NIGER

Electrification trends

Share of population with access to electricity (%), comparative analysis, 1990-2016



Source: World Bank 2018, NIGELEC, WEO 2017, World Bank WDI

Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
11.7	Government Report: based on Ministère de l'Energie, République du Niger, 2016	9.2	Utility – Formal: NIGELEC, 2016
16.2	Tracking SDG 7 report: based on model estimate, 2016	-	Utility – Informal
11.2	World Energy Outlook 2017: based on Ministère de l'Energie, Direction de l'Electricité Nucléaire , 2016	0.003	Solar (Tier 1 and above): IRENA, 2016

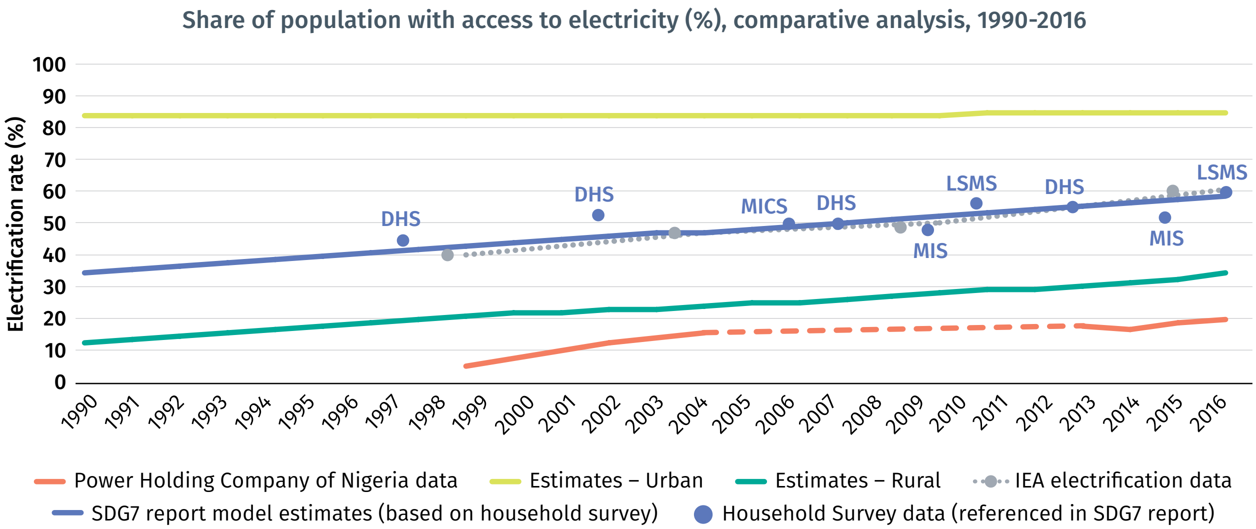
Niger's latest household survey (ENISED, 2015) reported that 16.6% of the population has access to electricity, ranging from 60.2% in urban areas to 7.1% in rural areas. Model estimates, based on historical progress, suggest the access rate should have reached about 16.2% by 2016. In parallel, the utility NIGELEC reported 0.32 million household connections in 2016. On the basis of the connections and a household size of 5.9, the formal grid connection rate is estimated at 9.21%. There are no official statistics for nontechnical losses from which the extent of informal connections could be gauged. An illustrative simulation based on 1% nontechnical losses and average household consumption of 1,210 kWh/year in 2016 suggests that this could provide informal access to 0.19% of the population. The substantial gap between electrification rates reported by household surveys and those attributable to grid electrification by the utility can be explained by reliance on off-grid solutions, such as diesel generators, rechargeable batteries, and solar systems. However, according to IRENA, the penetration of solar electricity in Niger is negligible with only 0.003% of the population relying on solar home systems, solar mini-grids, and solar lighting systems providing Tier 1 and above service in 2016.

Patterns of electrification

Disaggregated household survey data is not available for Niger within the Global Poverty Working Group Database (GPWG-DB), World Bank.

NIGERIA

Electrification trends



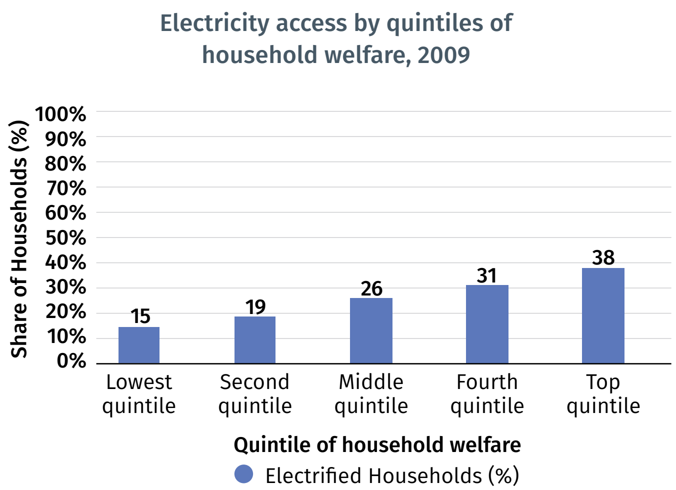
Source: World Bank 2018, NERC, WEO 2017, World Bank WDI

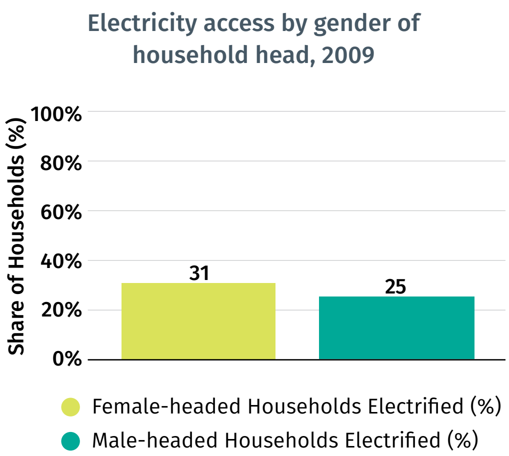
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
–	No government report available	19.4	Utility – Formal: KPI data collected by NERC, 2016
		7.1	Utility – Informal: KPI data collected by NERC, 2016
59.3	Tracking SDG 7 report: based on LSMS, 2016	0.1	Solar (Tier 1 and above): IRENA, 2016
60.6	World Energy Outlook 2017: based on GHS Panel Survey Report, 2015	5.2	Self-generation: LSMS, 2016

Nigeria's latest household survey (LSMS, 2016) reported that 59.3% of the population has access to electricity, ranging from 86% in urban areas to 41.1% in rural areas. In parallel, the aggregated connections across all distribution utilities amounted to 7.7 million household connections in 2017. On the basis of the connections and a household size of 4.9, the formal grid connection rate is estimated at 19.4%. The government also reported an estimated 11.1% of nontechnical losses relating to informal connections. Assuming Nigeria's average household consumption is 740.6 kWh/year, it is estimated that an additional 7.1% of population may be obtaining grid electricity through informal connections. Even considering both formal and informal connections together at 26.5%, there remains a substantial gap with the electrification rates reported by household surveys at 59.3%. This is attributable to a variety of factors, including self-supply through diesel generation, which according to the household survey provides access to a further 5.2% of the population. However, off-grid solar systems do not appear to provide much of an explanation for this divergence, since according to IRENA, only 0.1% of the population relied on solar home systems, solar mini-grids, and solar lighting systems in 2016.

Patterns of electrification

Household survey data disaggregated to identify patterns of electricity access across different socioeconomic groups in Nigeria show a steady improvement in access rates as overall household welfare rises. The access rate of the top quintile is 2.5 times that of the bottom quintile, and the access rates of the middle three quintiles differ by about 6 percentage points, indicating a lower degree of disparity in access rates across consumption quintiles than is seen in the largest access deficit countries in Sub-Saharan Africa. Notably, gender-disaggregated access rates show that access rates for female-headed households are higher compared to male-headed households by 5.5 percentage points, compared to a more equal distribution in the largest access deficit countries in Sub-Saharan Africa. Overall, household consumption drives access disparity in Nigeria to a greater extent than gender.

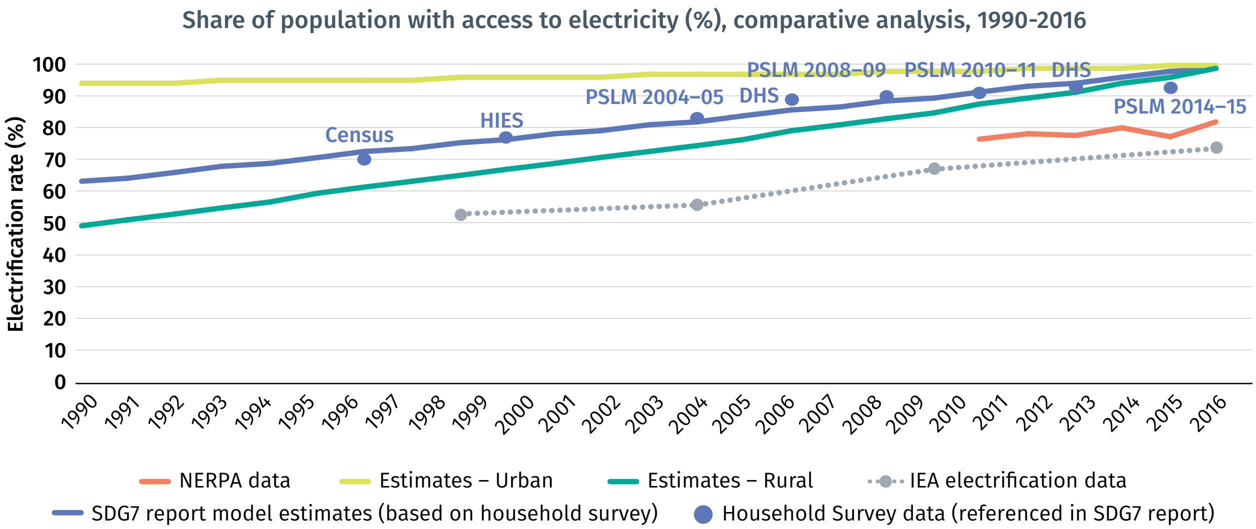




Source: [GMD] ([SSA]TSD/World Bank – latest year available)

PAKISTAN

Electrification trends



Source: World Bank 2018, NERPA, WEO 2017, World Bank WDI

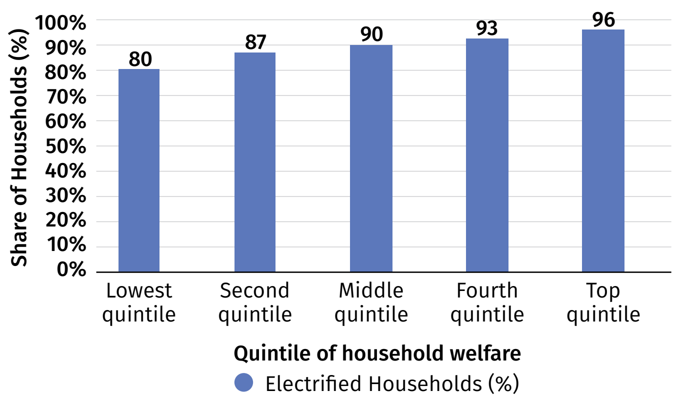
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
74	Government Report based on Census 2017	82.4	Utility – Formal: NEPRA State of Industry Report, 2016
99	Tracking SDG 7 report: based on model estimate, 2016	1.7	Utility – Informal
73.6	World Energy Outlook 2017: Grid connections: based on Power System Statistics 2016, National Transmission and Dispatch Company. Off-grid: based on Alternate Energy Development Board (AEDB), Islamabad	0	Solar (Tier 1 and above): IRENA, 2016

Pakistan's latest household survey (PSLM, 2014–15) reported that 93.5% of the population has access to electricity, ranging from 98.7% in urban areas to 90.4% in rural areas. Model estimates, based on historical progress, suggest that the access rate should have reached about 99% by 2016. In parallel, the regulator NERPA reported aggregated connections across all distribution utilities at 25.6 million in 2016. On the basis of the number of connections and a household size of 6.2, the formal grid connection rate is estimated at 82.4%. Meanwhile, the regulator reports nontechnical losses of 1.58%. Using Pakistan's average household consumption of 1,628.7 kWh/year, it is estimated that an additional 1.7% of population may be obtaining grid electricity through informal connections, notably through shared metered connections. The small remaining margin between formal and informal utility coverage at 92.1% and access rates of 93.5% reported in the household survey could be attributable to off-grid options such as diesel generation and rechargeable batteries. According to IRENA, in Pakistan, none of the population relied on solar home systems, solar mini-grids, or solar lighting systems providing Tier 1 and above service in 2016.

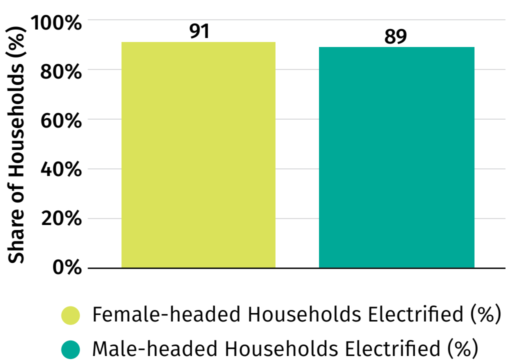
Patterns of electrification

Disaggregated household survey data by socio-economic groups in Pakistan shows that there is a steady improvement in access rates as overall household welfare rises. The difference in access rate of 1.2 times between the top quintile and the bottom quintile, is lower than the average of 1.6 times difference for the largest access deficit countries in Asia. The access rates of the middle three quintiles differ by about 3 percentage points. Notably, gender-disaggregated access show that access rates for female-headed households are higher compared to male-headed households by over 2 percentage points, which is not typical of the largest access deficit countries in Asia. Overall, household consumption drives access disparity in Pakistan to a greater extent than gender.

Electricity access by quintiles of household welfare, 2013



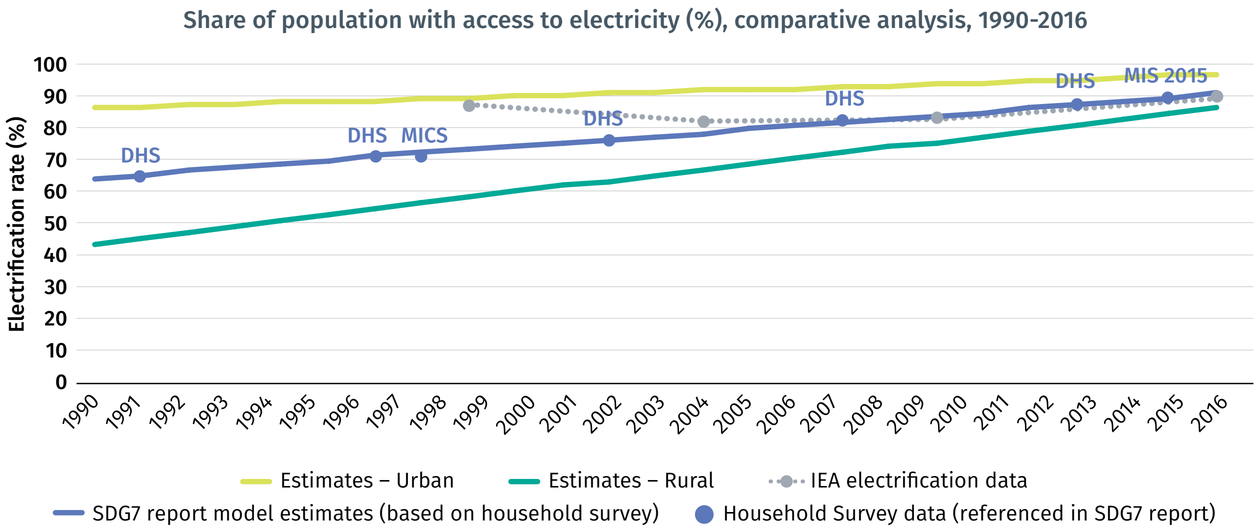
Electricity access by gender of household head, 2013



Source: [GMD] ([SAR]TSD/World Bank – latest year available)

PHILIPPINES

Electrification trends



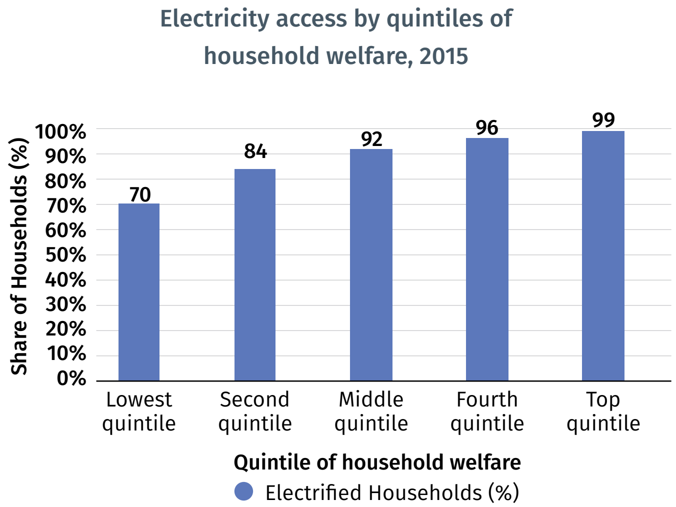
Source: World Bank 2018, WEO 2017, World Bank WDI

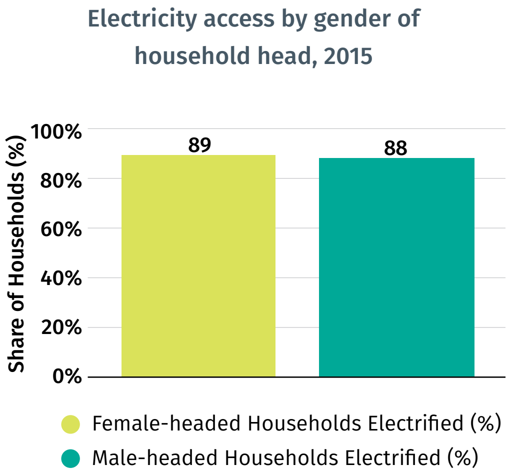
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
–	No government report available	–	Utility – Formal
91	Tracking SDG 7 report: based on model estimate, 2016	–	Utility – Informal
89.6	World Energy Outlook 2017: based on Department of Energy Philippines, 2015	0	Solar (Tier 1 and above): IRENA, 2016

The Philippines' latest household survey (World Bank Poverty Global Practice, 2015) reported that 89.1% of the population has access to electricity, ranging from 95.9% in urban areas to 85.1% in rural areas. Model estimates, based on historical progress, suggest the access rate should have reached about 91% by 2016. Information on utility connections is highly disaggregated because the country's power system is unbundled, with more than 100 DISCOs and cooperatives. According to IRENA, no population relied on solar home systems, solar mini-grids, or solar lighting systems providing Tier 1 and above service in 2016.

Patterns of electrification

In the Philippines, disaggregating household survey data on access by consumption quintiles (from poorest to richest) shows an improvement in access rates as overall household welfare rises. The access rate of the top quintile is 1.4 times the access rate of the bottom quintile, with the access rate increasing by 14 percentage points from the bottom quintile to the second quintile. These trends are in line with those seen in the largest access deficit countries in Asia. Notably, gender-disaggregated access rates show that access rates for female-headed households are higher than for male-headed households by over 1 percentage point. Overall, household consumption drives access disparity in Philippines to a greater extent than gender.



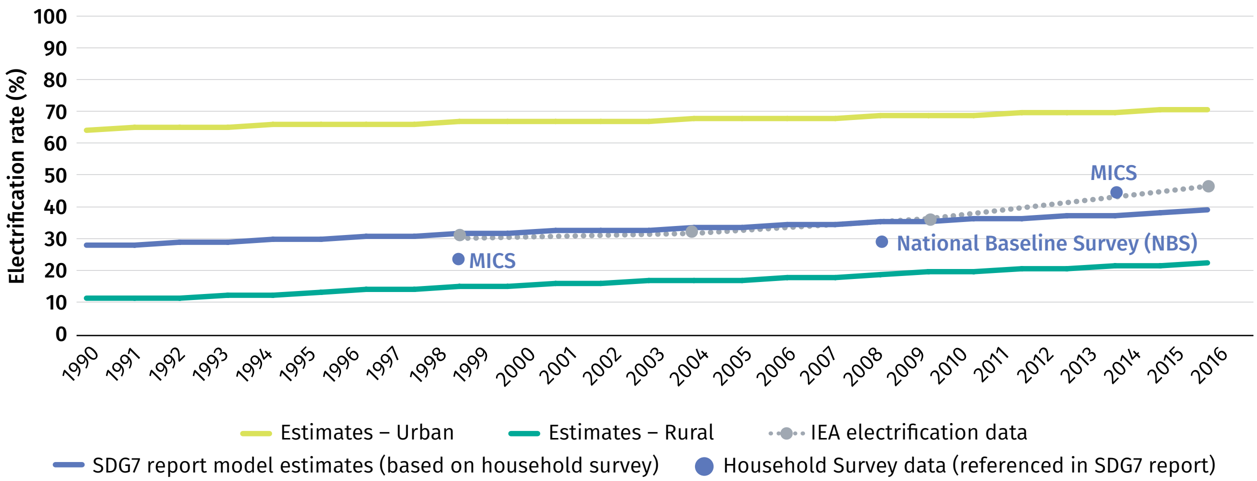


Source: [GMD] ([EAP]TSD/World Bank – latest year available)

SUDAN

Electrification trends

Share of population with access to electricity (%), comparative analysis, 1990-2016



Source: World Bank 2018, WEO 2017, World Bank WDI

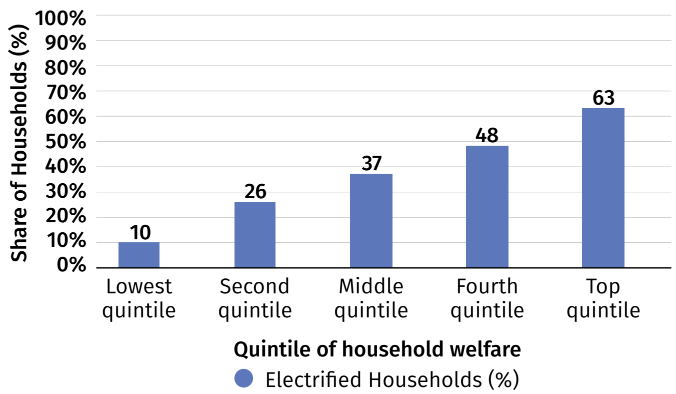
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
42.6	Government Report: GoS 2017	-	Utility – Formal
38.5	Tracking SDG 7 report: based on model estimate, 2016	-	Utility – Informal
46.2	World Energy Outlook 2017: based on MICS (2014) with off-grid estimates	-	Solar

Sudan's latest household survey (MICS, 2014) reported that 44.9% of the population has access to electricity, ranging from 76.3% in urban areas to 31.7% in rural areas. Model estimates, based on historical progress, suggest the access rate should have reached about 38.5% by 2016. No data is available from the utility or on the development of solar off-grid in the country.

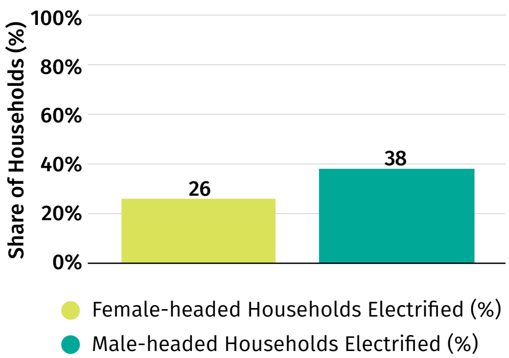
Patterns of electrification

Household survey data can also be disaggregated to identify patterns of electricity access across different socioeconomic groups. In Sudan, disaggregating access by consumption quintiles (from poorest to richest) shows a steady improvement in access rates as overall household welfare rises. The access rate of the top quintile is 6 times that of the bottom quintile, and the access rates of the middle three quintiles differ by about 11 percentage points. These trends are in line with the average of the largest access deficit. Particularly, gender-disaggregated access rates show that access rates for male-headed households are higher compared to female-headed households by 12 percentage points, significantly different from the gender parity in access seen in Sub-Sahara Africa. Overall, household consumption as well as gender could be driving access disparity in Sudan.

Electricity access by quintiles of household welfare, 2009



Electricity access by gender of household head, 2009

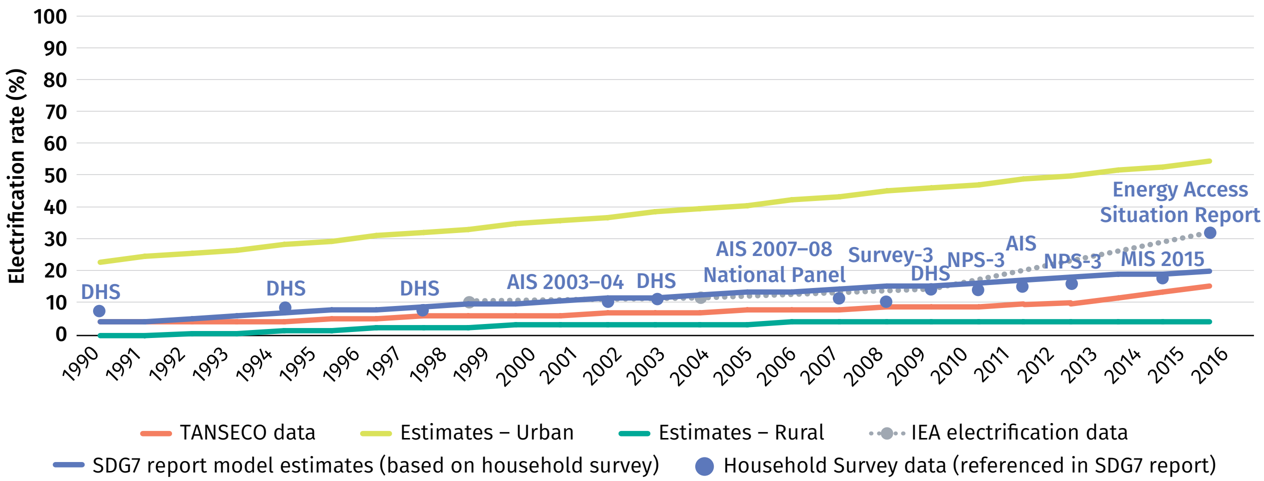


Source: [GMD] ([SSA]TSD/World Bank – latest year available)

TANZANIA

Electrification trends

Share of population with access to electricity (%), comparative analysis, 1990-2016



Source: World Bank 2018, EWURA annual reports, WEO 2017, World Bank WDI

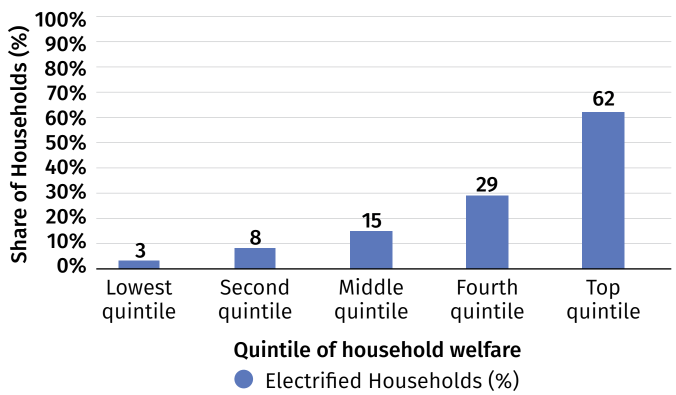
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
33	Government Report: Tanzania Energy Access Situation Report 2016	15.4	Utility – Formal: Energy and Water Utility Regulatory Authority (EWURA) annual report, 2016
		0.2	Utility – Informal: TANESCO Financial Statement, 2015
32.8	Tracking SDG 7 report: based on Tanzania Energy Access Situation Report, 2016	24.6	Utility - Total: Tanzania Energy Access Situation Report, 2016
32.7	World Energy Outlook 2017: based on Tanzania Energy Access Situation Report 2016 and off-grid rate reported by government, 2016	8.1	Solar (Tier 1 and above): Tanzania Energy Access Situation Report, 2016

Tanzania's latest household survey (Energy Access Situation Report, 2016) reported that 32.8% of the population has access to electricity, ranging from 65.3% in urban areas to 16.9% in rural areas. In parallel, the Energy and Water Utility Regulatory Authority (EWURA) reported 1.7 million household connections in 2016. On the basis of the connections and a household size of 4.9, the formal grid connection rate is estimated at 15.4%. Meanwhile, the utility estimated 0.8% of nontechnical loss in 2015. Assuming Tanzania's average household consumption is 1,392 kWh/year, an estimated additional 0.2% of the population may be obtaining grid electricity through informal connections. However, the 2016 Energy Access Situation Report, using household survey data, reported a much higher rate of grid connection at 24.6%. According to that report, 8.1% of the population relied on solar home systems, solar mini-grids, and solar lighting systems providing Tier 1 and above service in 2016.

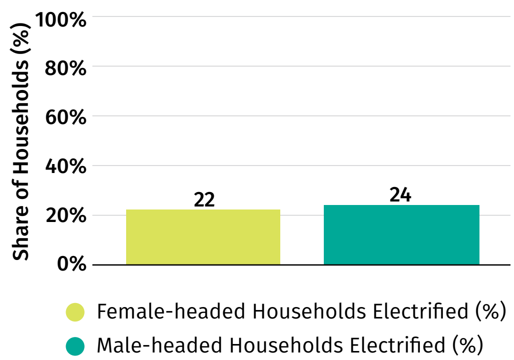
Patterns of electrification

In Tanzania, disaggregating access by consumption quintiles (from poorest to richest) shows a significant increase in access rates as overall household welfare rises. The access rate of the top quintile is 19 times that of the bottom quintile, and the access rate of the fourth quintile is half that of the top quintile. This disparity is more significant than what is seen in other large access deficit countries in Sub-Saharan Africa. Gender-disaggregated access rates show that access rates for male-headed households are higher compared to female-headed households by 1.3 percentage points. Overall, household consumption drives access disparity in Tanzania to a greater extent than gender.

Electricity access by quintiles of household welfare, 2011



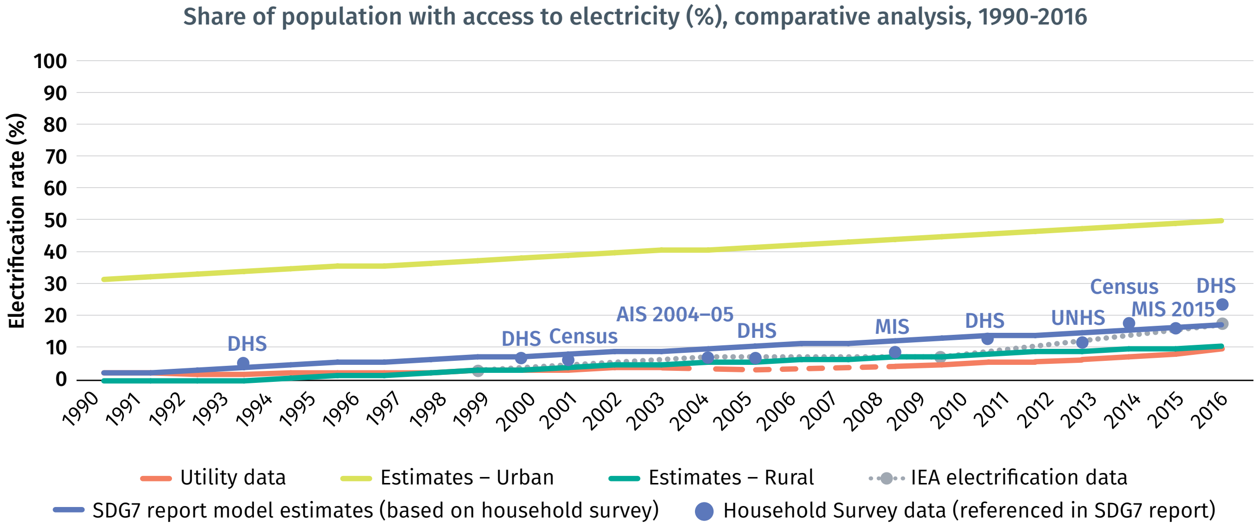
Electricity access by gender of household head, 2011



Source: [GMD] ([SSA]TSD/World Bank – latest year available)

UGANDA

Electrification trends



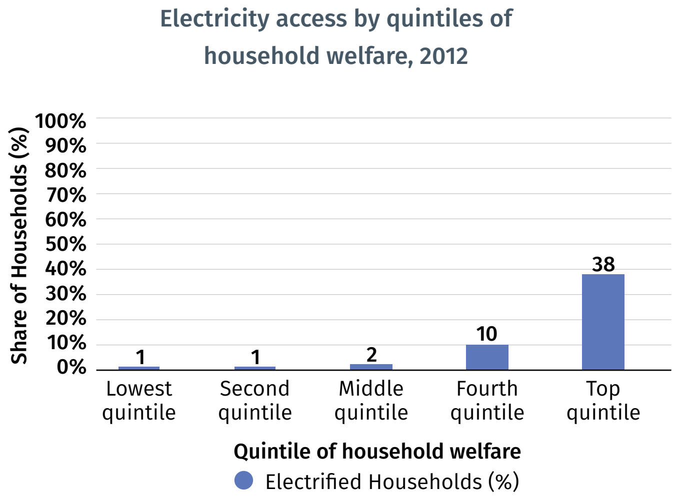
Source: World Bank 2018, UMEME Annual reports, WEO 2017, World Bank WDI

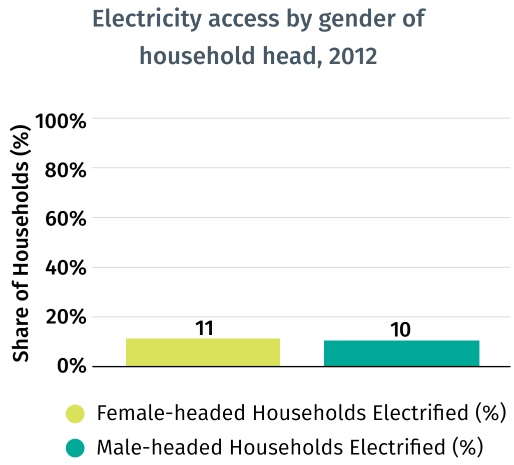
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
-	No government report available	11.2	Utility – Formal: UMEME Annual Report, 2016
26.7	Tracking SDG 7 report: based on DHS 2016	-	Utility – Informal
19.4	World Energy Outlook 2017: based on Contact at Ministry of Energy and Mineral Development, 2016	3.1	Solar (Tier 1 and above): IRENA, 2016

Uganda's latest household survey (DHS, 2016) reported that 26.7% of the population has access to electricity, ranging from 57.5% in urban areas to 18% in rural areas. In parallel, the utility UMEME, whose market share is 90%, reported 0.95 million connections in 2016. On the basis of the connections and a household size of 4.9, the formal grid connection rate is estimated at 11.2%. There are no official statistics on nontechnical losses that could be used to gauge the extent of informal connections. An illustrative simulation of 1% nontechnical losses, based on Uganda's average household consumption of 1,054 kWh/year, would translate into informal access of 0.2% of the population. The substantial gap between electrification rates reported by household surveys and those attributable to grid electrification by the utility can be partially explained by the development of off-grid solutions. According to IRENA, 3.1% of the population relied on solar home systems, solar mini-grids, and solar lighting systems providing Tier 1 and above service in 2016. Other forms of self-supply like diesel generators or rechargeable batteries may help to explain the remaining difference.

Patterns of electrification

Disaggregated household survey data by socioeconomic groups in Uganda show a striking increase in access rates as overall household welfare rises. The access rate of the top quintile is 36 percentage points higher than that of the bottom quintile, and the access rate of the fourth quintile is one-fourth that of the top quintile. The difference between the top quintile and the bottom four quintiles is more pronounced in Uganda compared to the average for the largest access deficit countries in Sub-Saharan Africa. Notably, gender-disaggregated access rates show that access rates for female-headed households are marginally higher than male-headed households. Overall, household consumption, not gender, drives access disparity in Uganda.



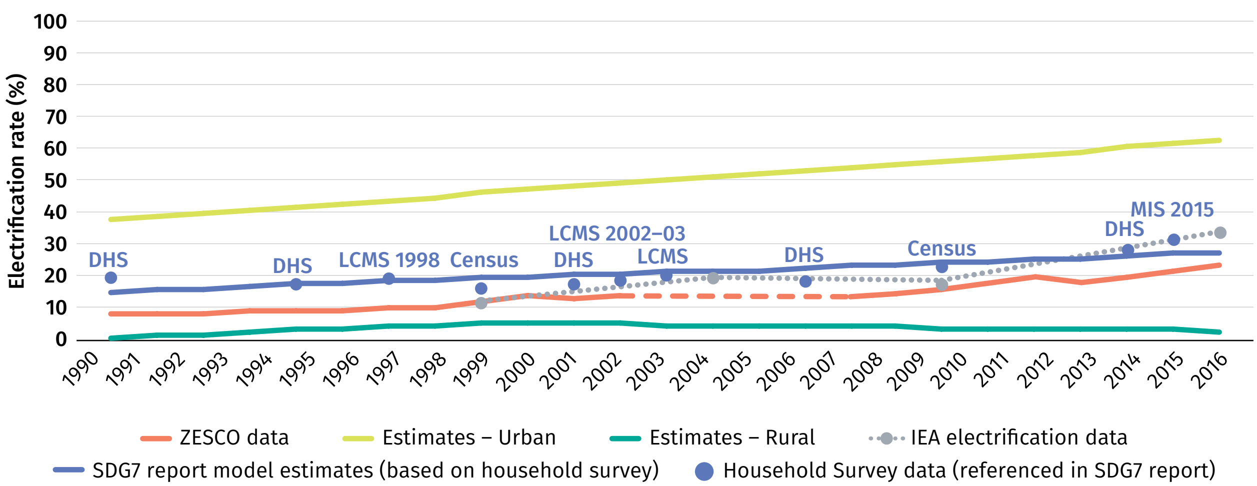


Source: [GMD] ([SSA]TSD/World Bank – latest year available)

ZAMBIA

Electrification trends

Share of population with access to electricity (%), comparative analysis, 1990-2016



Source: World Bank 2018, Energy Regulatory Board Energy Sector Reports, WEO 2017, World Bank WDI

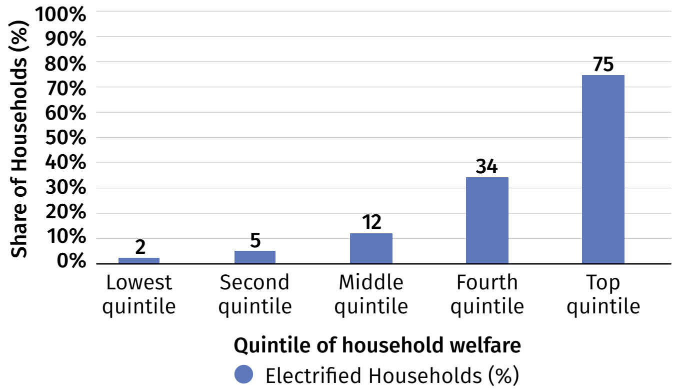
Headline Electrification Rate (% of total population)		Electrification Sub-Categories (% of total population)	
–	No government report available	23.4	Utility – Formal: Energy Regulation Board, Energy Sector Report, 2016
27.2	Tracking SDG 7 report: based on model estimate, 2016	–	Utility – Informal
33.7	World Energy Outlook 2017: based on Department of Planning and Information, Ministry of Energy, Zambia, 2016	0.003	Solar (Tier 1 and above): IRENA, 2016

Zambia's latest household survey (Living Condition Measurement Survey, 2015) reported that 31.1% of the population has access to electricity, ranging from 67.7% in urban areas to 3.7% in rural areas. Model estimates, based on historical progress, suggest that the access rate should have reached about 27.2% by 2016. In parallel, the Energy Regulatory Board reported 0.76 million household connections in 2016. Based on the connections and a household size of 5.1, the formal grid connection rate is estimated at 23.4%. There are no official statistics on nontechnical losses to gauge the prevalence of informal connections. An illustrative simulation shows that nontechnical losses of 1%, given Zambia's average household consumption is 3,953 kWh/year, could potentially provide informal access to 0.31% of population in 2016. Otherwise, the gap between utility connection rates and access reported in household surveys could potentially be attributed to off-grid solutions, including diesel generation and rechargeable batteries. According to IRENA, only a negligible share of 0.003% of the population relied on solar home systems, solar mini-grids, and solar lighting systems providing Tier 1 and above service in 2016.

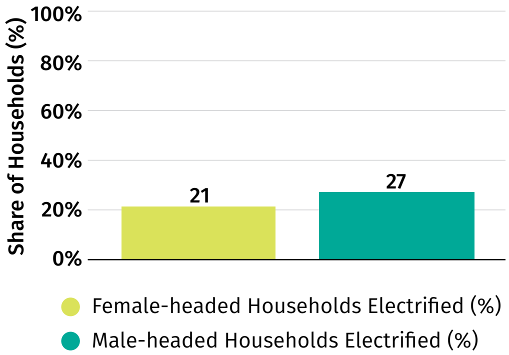
Patterns of electrification

In Zambia, disaggregating access by consumption quintiles (from poorest to richest) shows a stark increase in access rates as overall household welfare rises. The access rate of the top quintile is 36 times that of the bottom quintile, and twice that of the fourth quintile. This disparity in the top quintiles is similar to what is seen in countries with the largest access deficit in Sub-Saharan Africa. Notably, gender-disaggregated access rates show that access rates for male-headed households are higher than female-headed households by over 5 percentage points, in contrast to the gender parity in access seen in Sub-Saharan Africa. Overall, household consumption, not gender, drives access disparity in Zambia.

Electricity access by quintiles of household welfare, 2010



Electricity access by gender of household head, 2010



Source: [GMD] ([SSA]TSD/World Bank – latest year available)

ACKNOWLEDGMENTS

Partnership

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

The Steering Group was supported by an Advisory Group composed as follows.

- Food and Agricultural Organization (FAO)
- Global Alliance for Clean Cookstoves ("the Alliance")
- Global Water Partnership (GWP)
- International Institute for Applied Systems Analysis (IIASA)
- International Network on Gender and Sustainable Energy (ENERGIA)
- International Partnership for Energy Efficiency Cooperation (IPEEC)
- Practical Action
- Renewable Energy Policy Network for the 21st Century (REN21)
- Stockholm International Water Institute (SIWI)
- Sustainable Energy for All (SEforALL)
- United Nations Department of Economics and Social Affairs (UNDESA)
- United Nations Development Programme (UNDP)
- United Nations Economic Commission for Africa (UNECA)
- United Nations Economic Commission for Europe (UNECE)
- United Nations Economic Commission for Latin America and the Caribbean (ECLAC)
- United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)
- United Nations Economic and Social Commission for Western Asia (ESCWA)
- United Nations Environment Programme (UNEP)
- Copenhagen Centre on Energy Efficiency
- UN Energy
- United Nations Foundation (UNF)
- United Nations Industrial Development Organization (UNIDO)
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Authorship

The technical co-leadership of the project by the Custodian Agencies was the responsibility of Laura Cozzi and Hannah Daly (IEA), Rabia Ferroukhi (IRENA), Ralf Becker (UNSD), Vivien Foster (World Bank), Heather Adair-Rohani (World Health Organization).

- The chapter on electrification was prepared by the World Bank (Juliette Besnard, Yi Xu, Sharmila Bellur, Malcolm Cosgrove-Davies) and benefited from substantive contributions from IEA (Hannah Daly) and IRENA (Adrian Whiteman).
- The chapter on clean cooking was prepared by the World Bank (Juliette Besnard, Sharmila Bellur, Yi Xu, Yabei Zhang) with substantive contributions from the World Health Organization (Heather Adair-Rohani, Jessica Lewis).
- The chapter on renewable energy was prepared by the World Bank (Zuzana Dobrotkova, Tigran Paravanyan, Christopher Jackson, Olivier Lavagne d'Ortigues) with substantial contributions from IEA (Paolo Frankl, Yasmina Abdelilah, Roberta Quadrelli, Ute Collier, Pharoah Le Feuvre), IRENA (Rabia Ferroukhi, Michael Renner, Divyam Nagpal, Adrian Whiteman) and UNSD (Ralf Becker, Leonardo Souza, Agnieszka Koscielniak).
- The chapter on energy efficiency prepared by the World Bank (Ivan Jaques, Daron Bedrosyan, Hua Du, Sarah Moin) with substantial contributions from IEA (Samuel Thomas, Kathleen Gaffney, Roberta Quadrelli) and UNSD (Ralf Becker, Leonardo Souza, Agnieszka Koscielniak).
- The chapter on prospects was led by IEA (Hannah Daly) with substantive contributions from IRENA (Ricardo Gorini)

Data sources

The report draws on two metadatabases of global household surveys, the Global Electrification Database managed by the World Bank, and a database on access to clean fuels and technologies for cooking managed by WHO. Energy balance statistics and indicators for renewable energy and energy efficiency were prepared by IEA (Roberta Quadrelli, Remi Gigoux and Francesco Mattion) and UNSD.

Gross domestic product and value-added data are provided by the World Development Indicators of the World Bank. Population data comes the United Nations Population Division.

Review and consultation

The public consultation and peer review process was coordinated by Vivien Foster (World Bank) and Hannah Murdock (REN21) and benefited from use of the REN21 online consultation platform. Substantive comments were also provided by Alexander Kauer (BMZ), Bertrand Magne (SEforALL), Flavia Guerra (REN21), Deger Saygin, Dr (SHURA Energy Transition Centre), Andries Hof (PBL Netherlands Environmental Assessment Agency), Anteneh Dagnachew (PBL Netherlands Environmental Assessment Agency), Gianluca Sambucini (UNECE), Iqbal Akbar (Technische Universität Berlin), Jonathan Guerrero (Independent), Michael Taylor (IRENA), Samuel Mwangi (Virunga Power), Stephen Schuck (Stephen Schuck and Associates Pty Ltd), Tatiana Khanberg (IGU), Utkarsh Shukla (Independent), William Blyth (Oxford Energy Associate), Zahra Molavi (Shahr Petro Energy Group).

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The communications process was coordinated by Nicholas Keyes, Anita Rozowska and Mariana Kaipper Ceratti (World Bank), Jad Mouawad (IEA), Elizabeth Press and Sasha Ramirez-Hughes (IRENA). The online platform (http://tracking SDG7.esmap.org) was developed by Sreejith K.S., Narayanan R., and Ram Prasad of Advanced Software Systems Inc. The report was edited, designed, and typeset by Nora Mara, Lauren Kaley Johnson, and Jeffrey Dean Lawrence (World Bank).

ABBREVIATIONS AND ACRONYMS

CAGR	Compound annual growth rate
COP21	2015 United Nations Climate Change Conference (Paris Agreement)
DHS	Demographic and Health Survey
DISCO	Distribution Utility
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
HIES	Household Income Expenditure Survey
GDP	Gross domestic product
GED	Global Electrification Database
GHACCO	Ghana Alliance for Clean Cookstoves and Fuels
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
LSMS	Living Standards Measurement Survey
LPG	Liquified Petroleum Gas
MEPS	Minimum Energy Performance Standards
MICS	Multi-Indicator Cluster Survey
MIS	Malaria Indicator Survey
MJ	Megajoules
MTF	Multi-Tier Framework
MW	Megawatt
NOAA	The National Oceanic and Atmospheric Administration
NSS	National Sample Survey
OECD	Organization 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
WB	World Bank
WDI	World Development Indicators
WEO	World Energy Outlook
WHO	World Health Organization

Visit the SDG7 Tracking website to download data and reports, as well as customized maps, comparative graphics, timelines, and country reports.

http://trackingSDG7.esmap.org

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