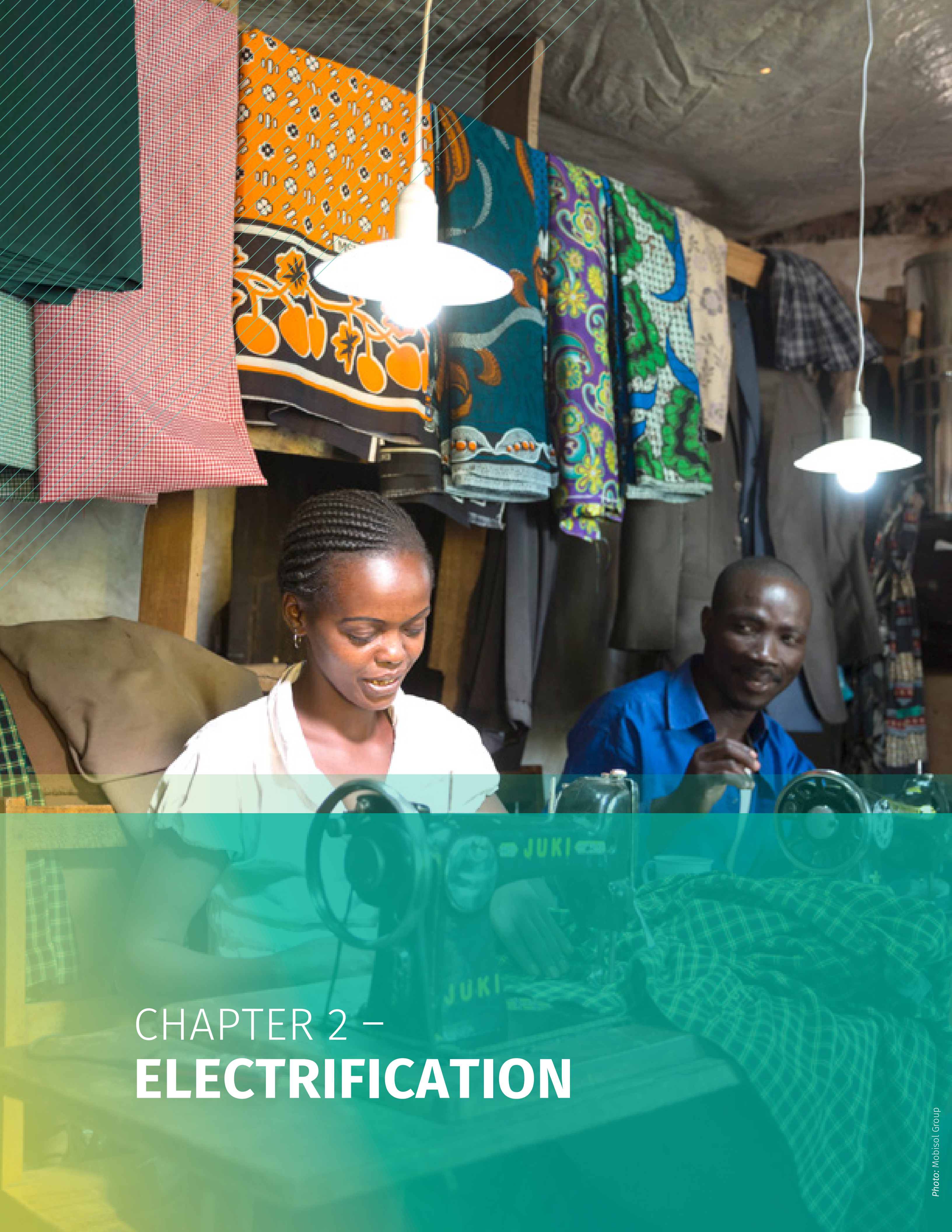


CHAPTER 2 – ELECTRIFICATION

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

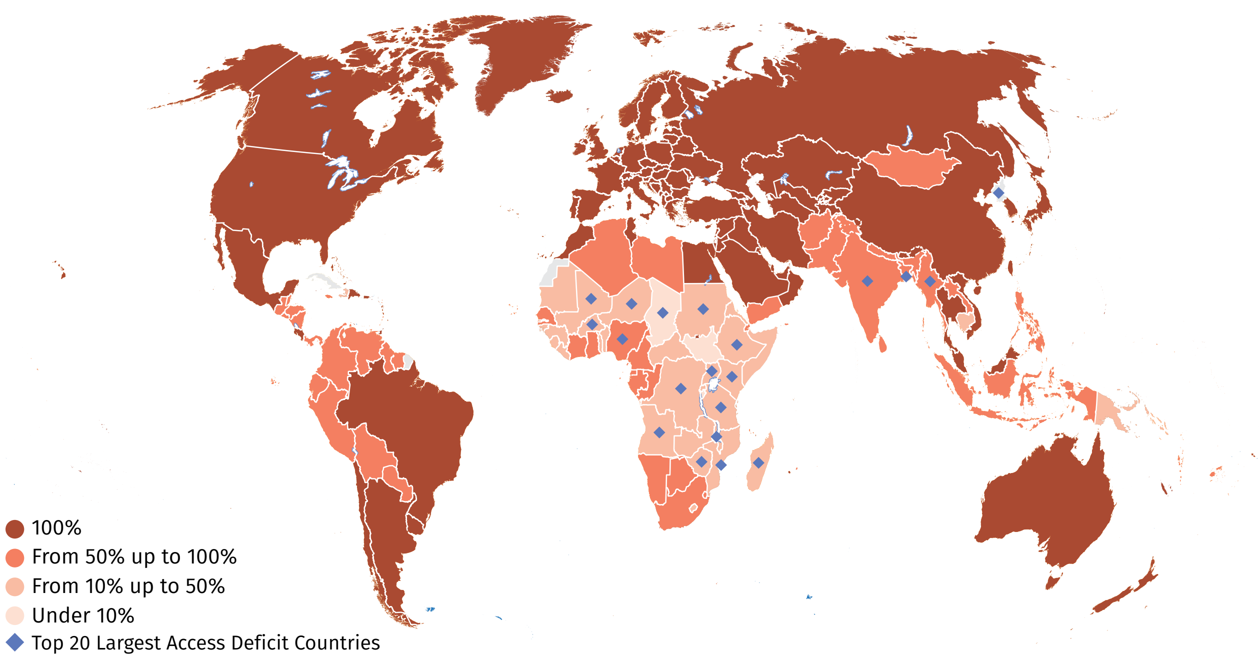
[1] Global Tracking Framework 2017 reported 85.3% of electrification rate in year 2014. The electrification rate is modified mainly due to the new survey data collected for year 2014.
[2] The regions are divided according to UN SDG regions.

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 (%)



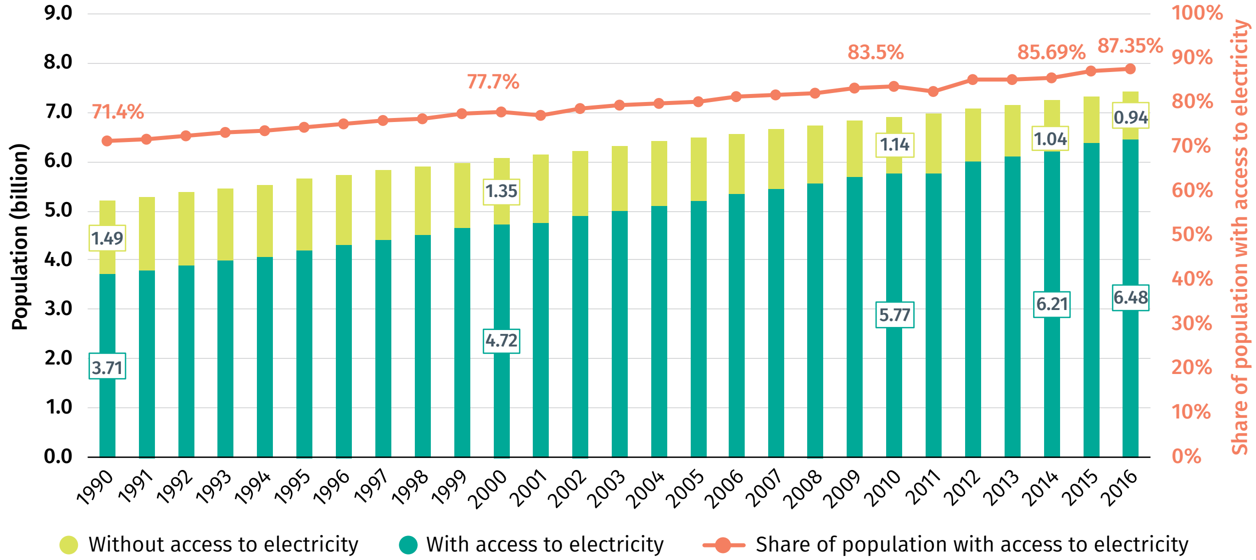
Source: World Bank

THE STORY IN PICTURES

GLOBAL TRENDS

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

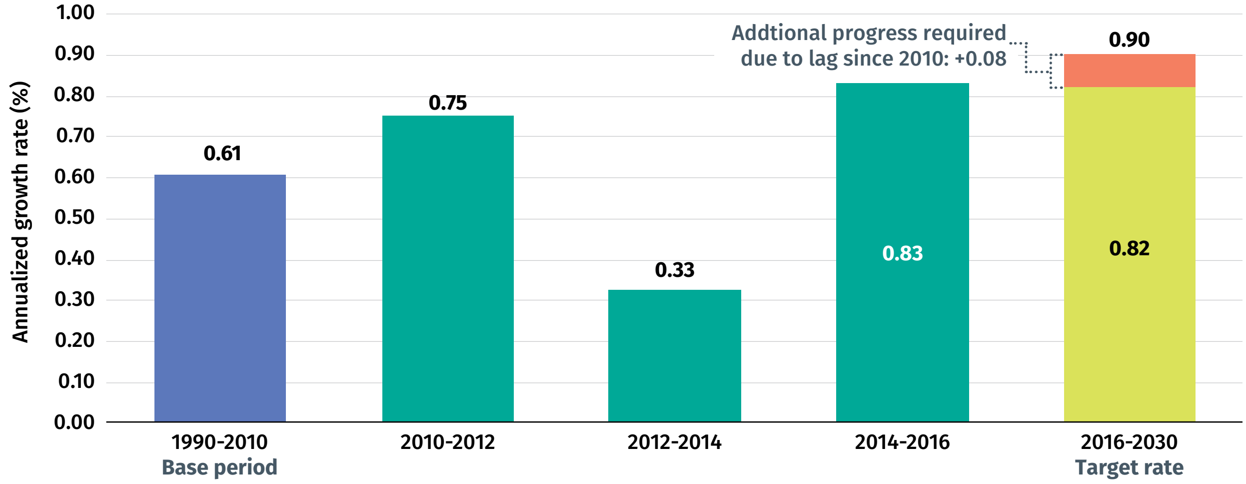
FIGURE 2.2 • Progress in electricity access from 1990 to 2016 (billions of people and share of population with access to electricity)



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)

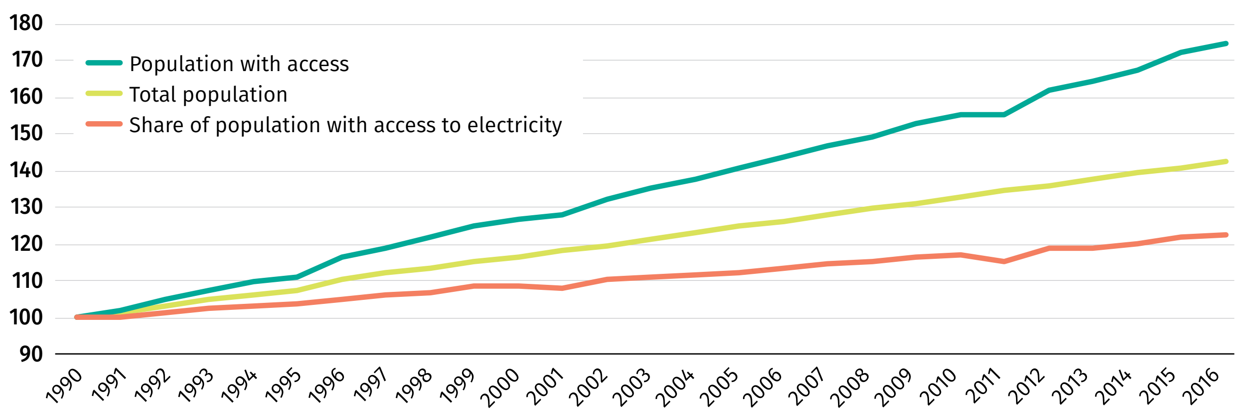


Source: World Bank

ACCESS AND POPULATION

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

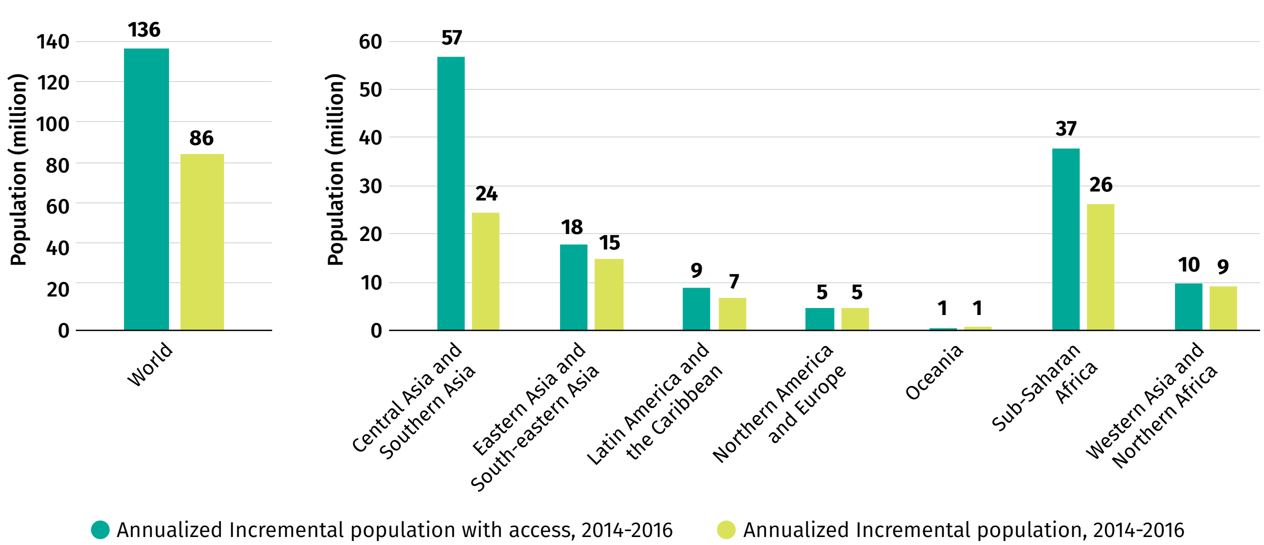
FIGURE 2.4 • Electricity access and population growth from 1990 to 2016, (index, 1990 = 100)



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

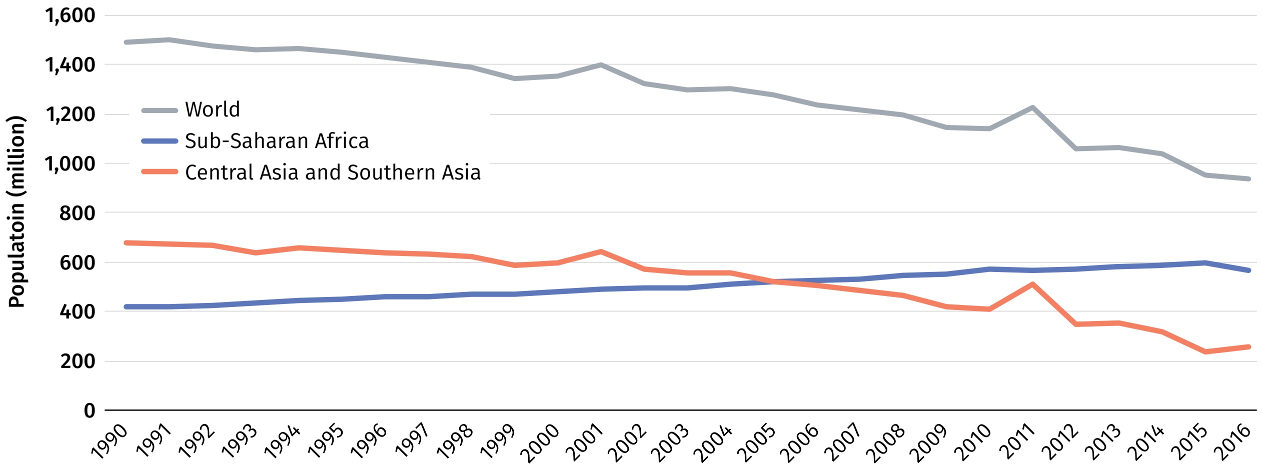


Source: World Bank

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.

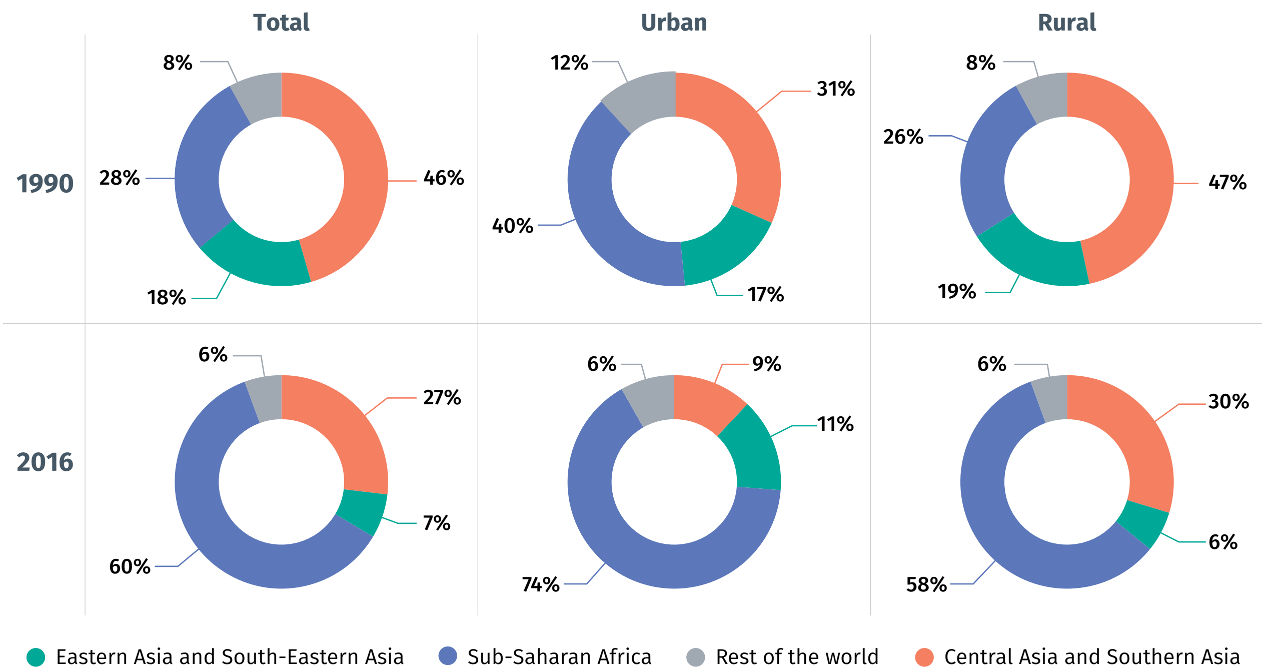
FIGURE 2.6 • Evolution of the access-deficit (millions of people), 1990-2016



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

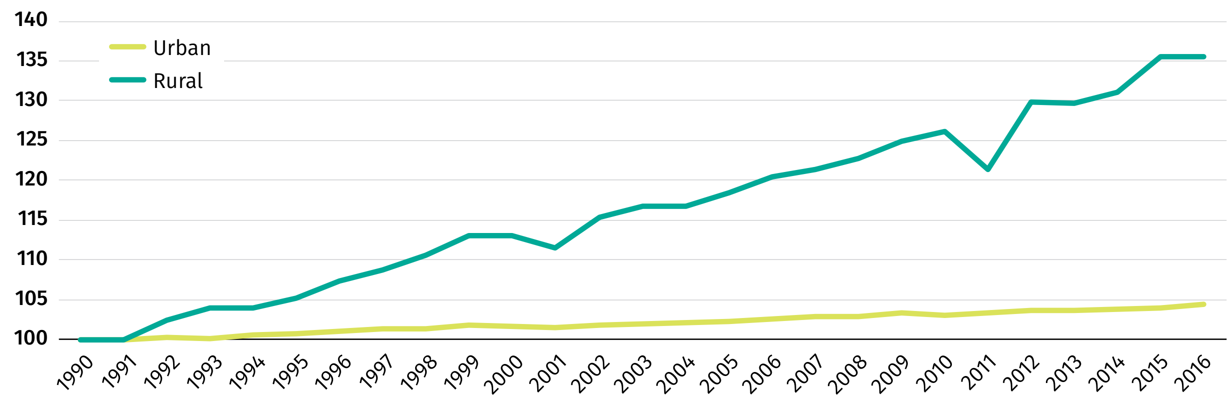


Source: World Bank

URBAN-RURAL DIVIDE

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

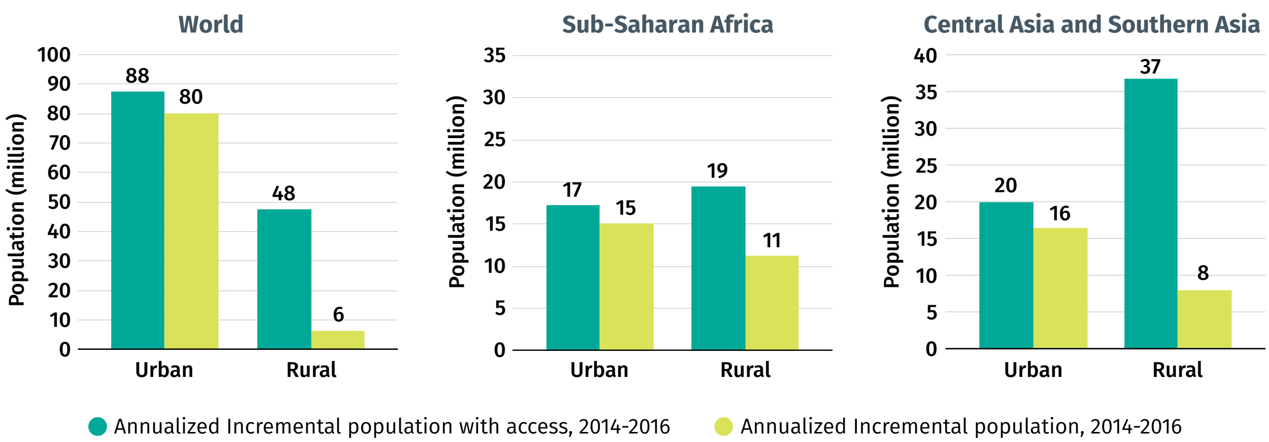
FIGURE 2.8 • Share of population with electricity access in urban and rural areas from 1990 to 2016, (index, 1990 = 100)



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



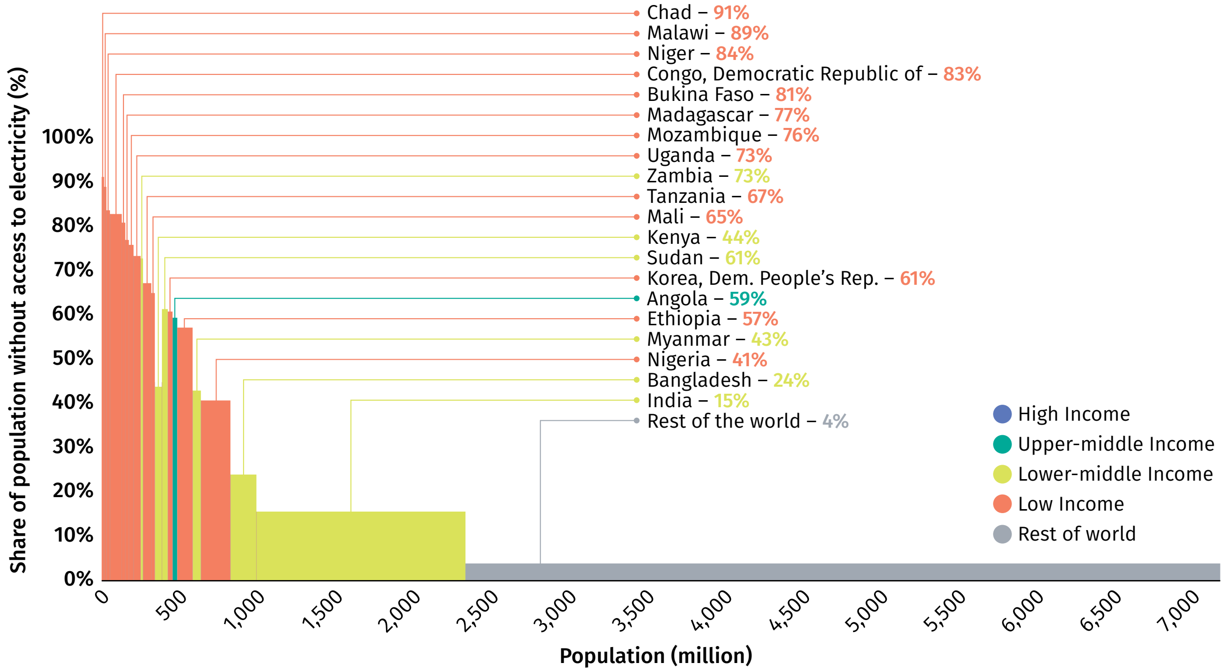
Source: World Bank

[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

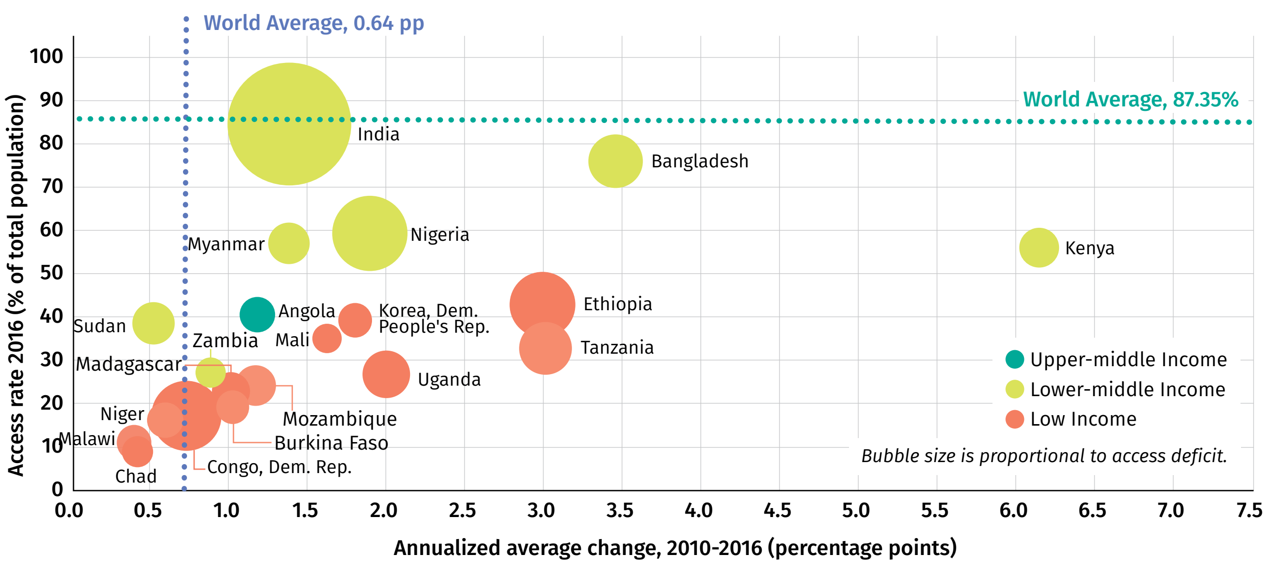
FIGURE 2.10 • Share of population without access and total population, 2016



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

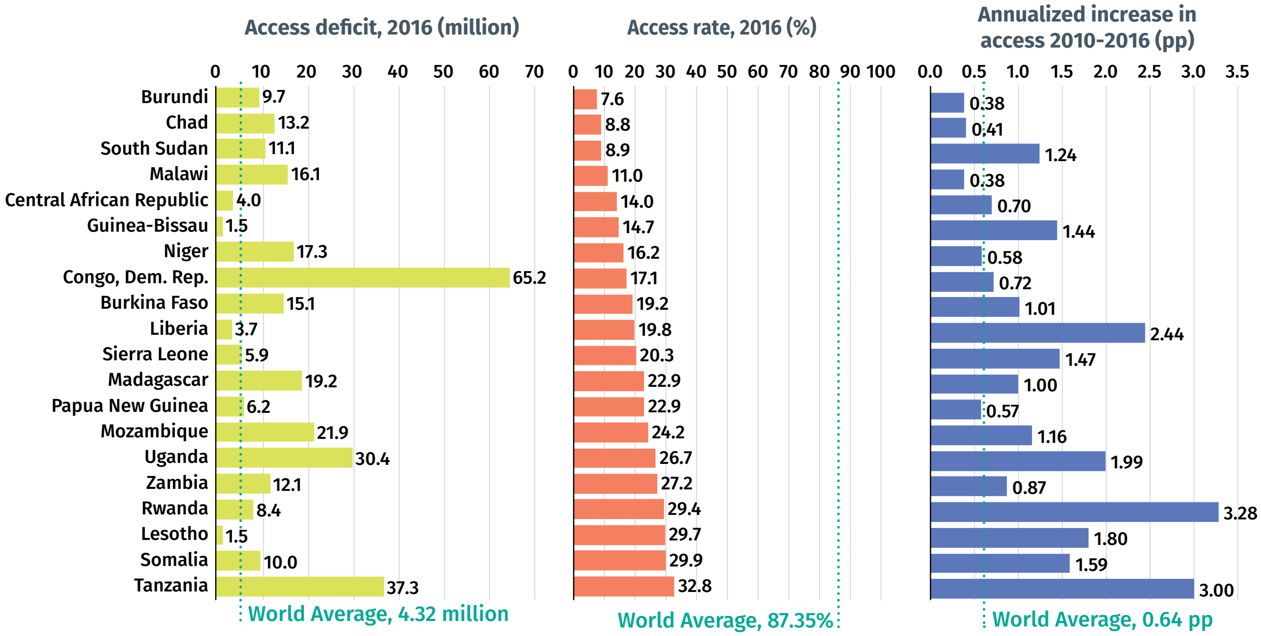
FIGURE 2.11 • The 20 countries with the largest access-deficit over the 2010-2016 period



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

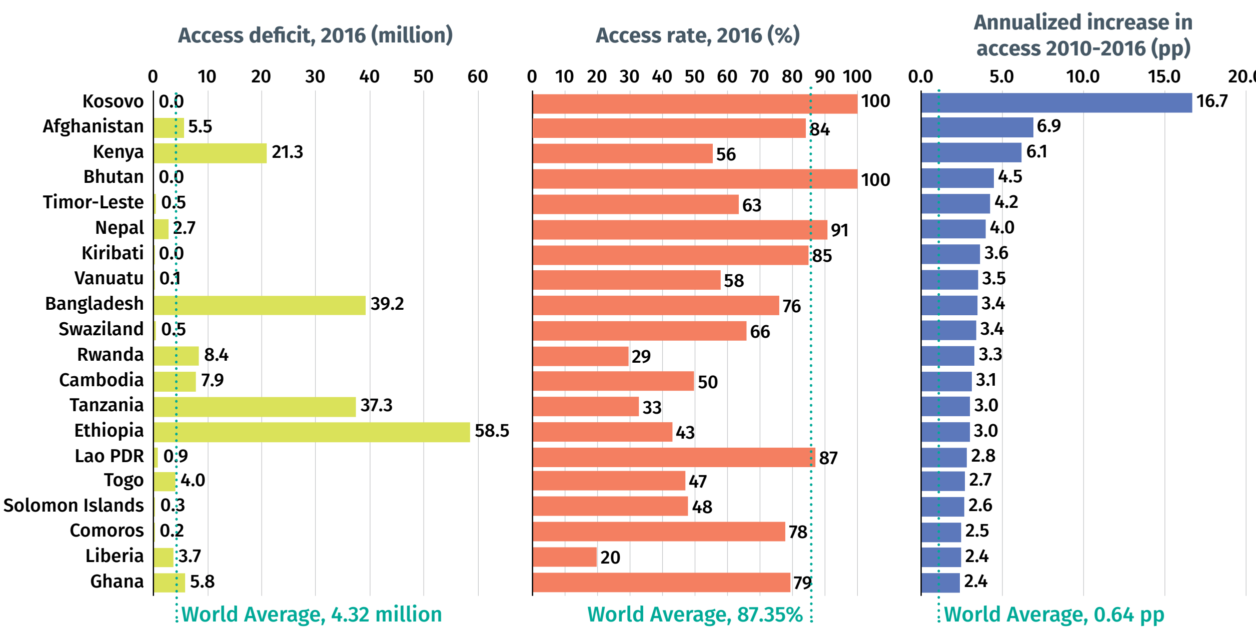
FIGURE 2.12 • The 20 least-electrified countries over the 2010-2016 tracking period



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

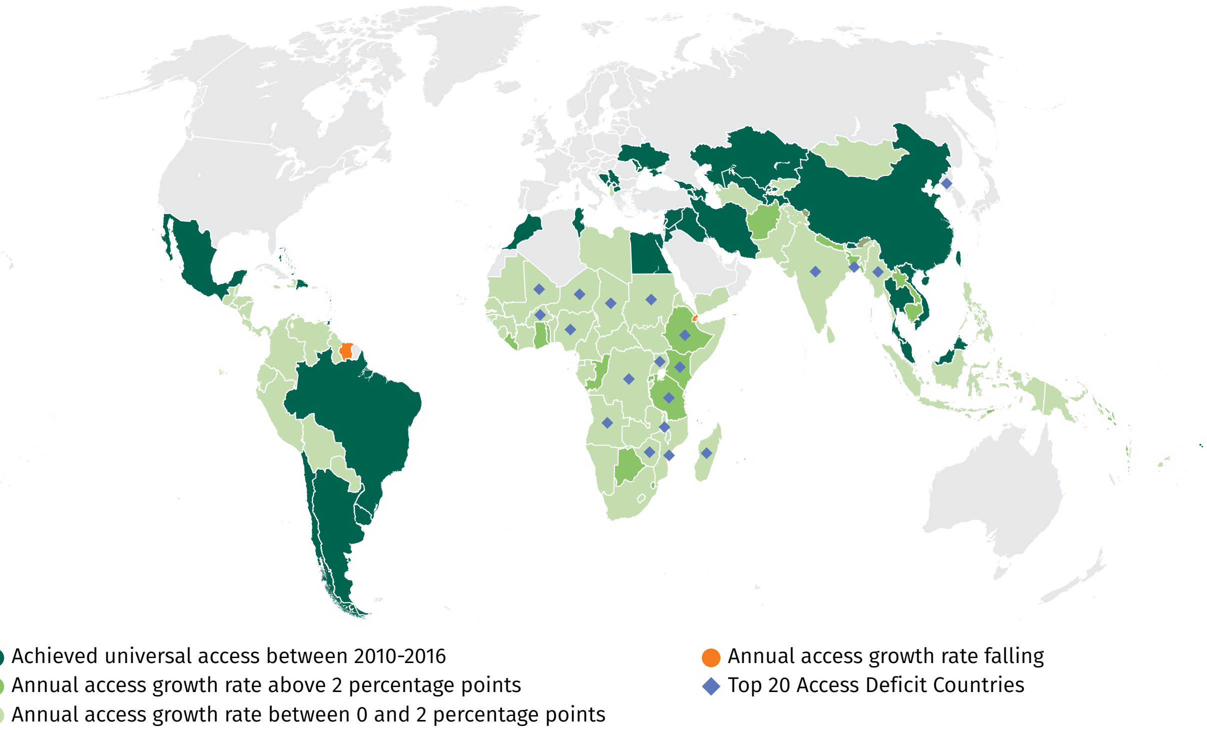
FIGURE 2.13 • The 20 fastest moving countries over the 2010-2016 tracking period



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.

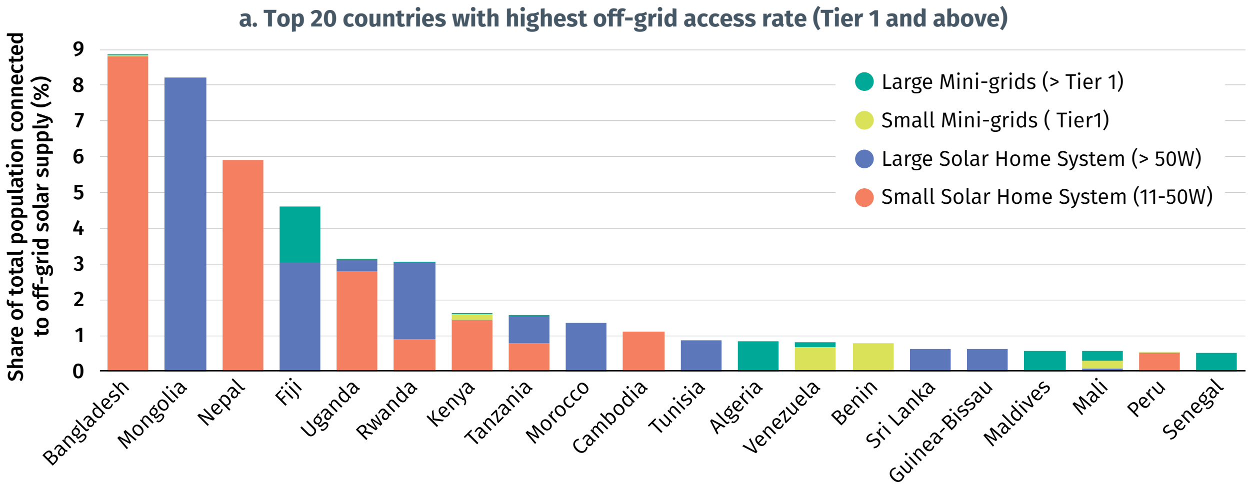
By way of comparison, the IEA estimates that 33 million people currently benefit from electricity access with off-grid renewables and mini-grid solutions (IEA 2017). This is broadly comparable to the number reported by IRENA. The pace of solar electrification has been accelerating: an estimated 5 million 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.

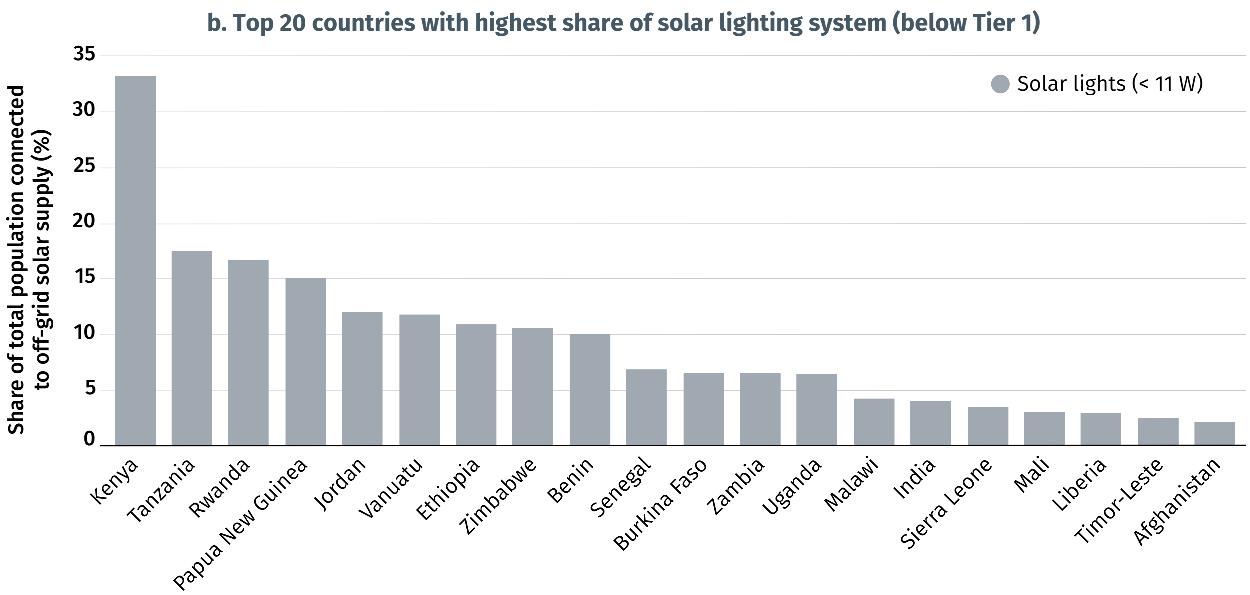
off-grid solar grew from 0.1% in 2005 to 40% in 2014. Because of civil conflicts, the Republic of Yemen's latest 2017 household survey reported 55% of households relied on solar PV as the primary source of lighting, whereas only 0.5% of households relied on electricity through the grid.[7] In addition, 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

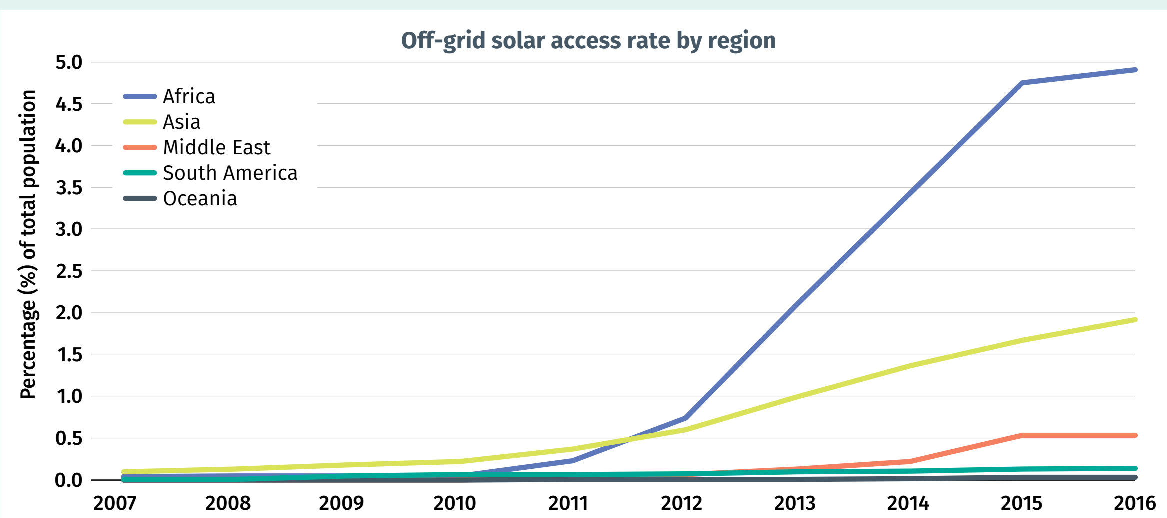
One part of the energy sector that has grown rapidly in recent years is the use of solar panels by households and enterprises to meet their own needs for electricity. These uses are often missing from official supply side energy statistics, but the growth in off-grid solar electricity production can 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

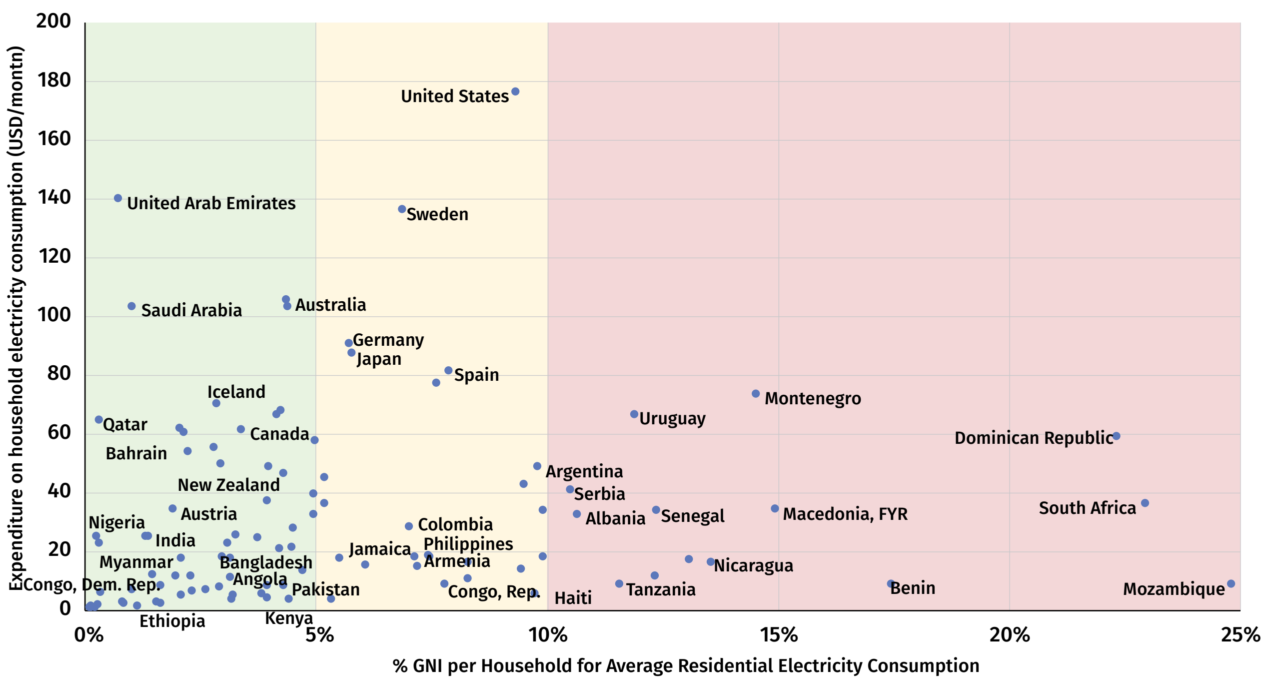
TRACKING AFFORDABILITY AND RELIABILITY

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%

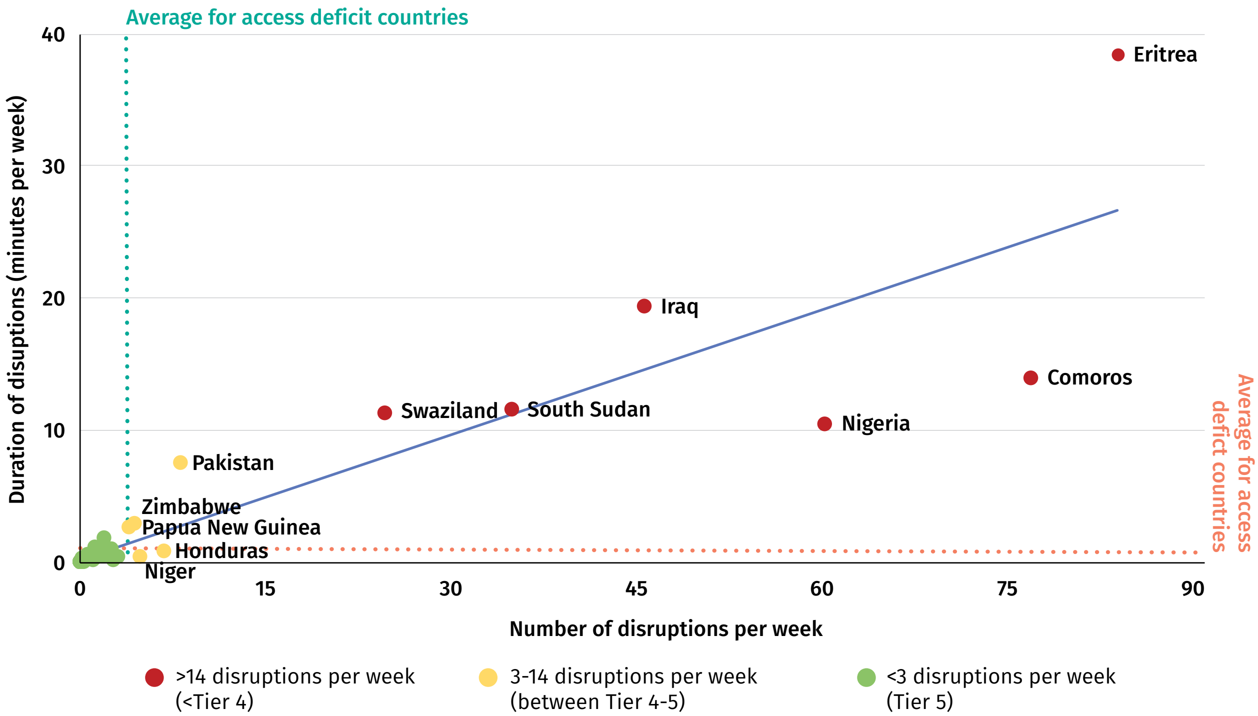


Source: World Bank RISE, WDI, IEA, UN Statistics

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

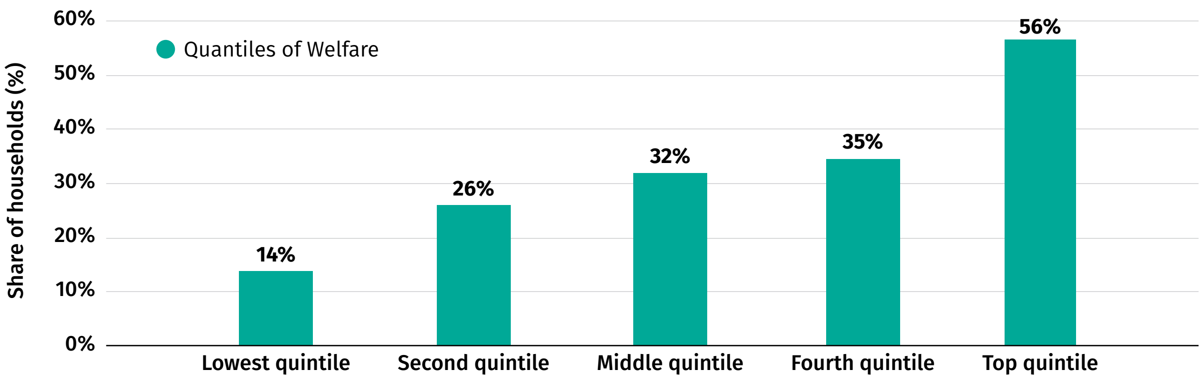
[8] GPWG-DB is an World Bank internal database that enables access to most recent household survey data across World Bank Global Practices.

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).

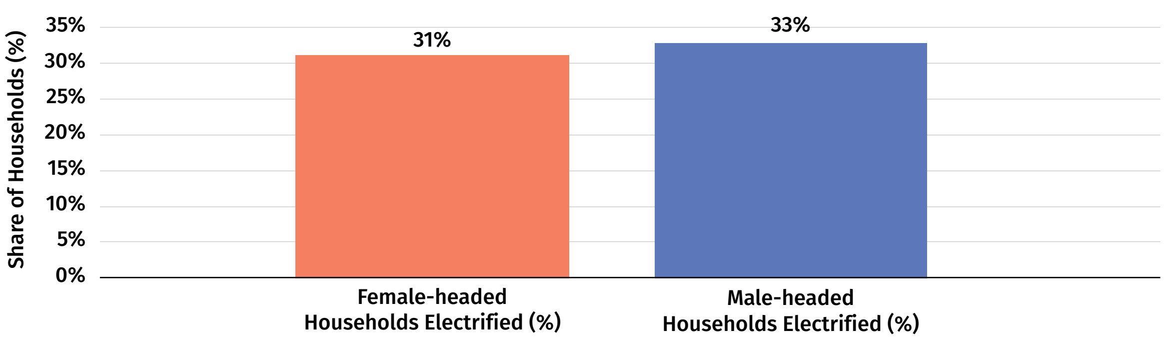
On the other hand, gender-disaggregated data show that electricity access for male- and female headed-households differs only slightly (1.6 percentage points) overall (figure 2.19). Moreover, controlling for poverty level, the disparity in access between male and female households largely disappears, 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.

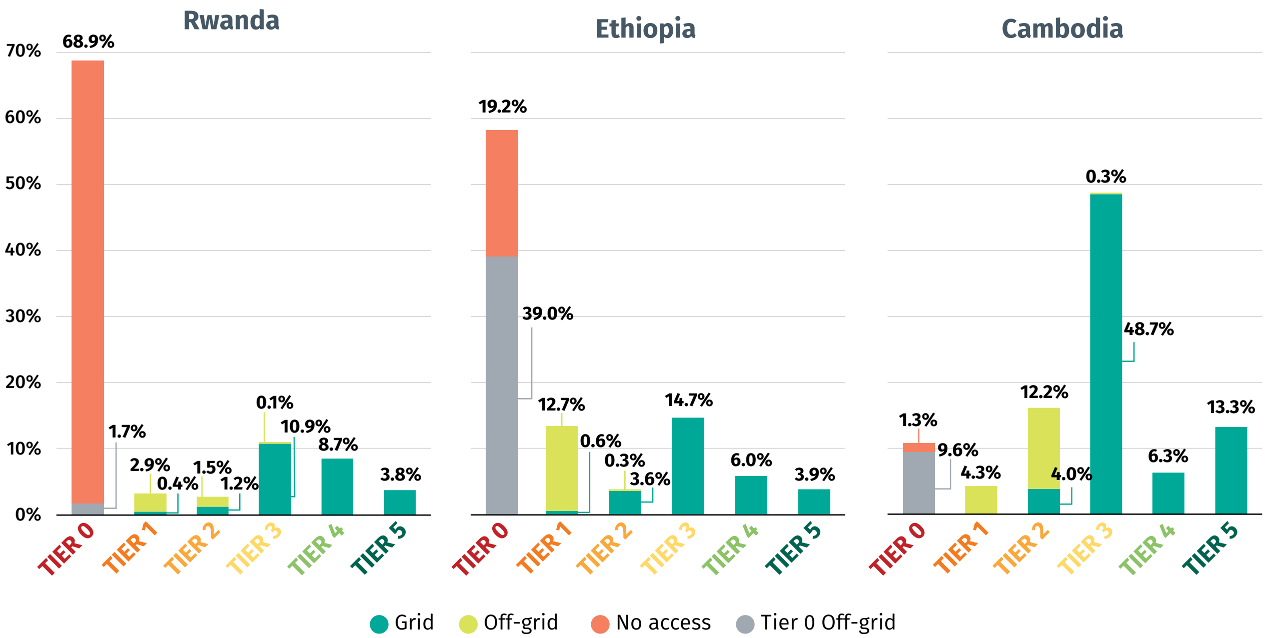
The Multi-Tier Framework has been developed over some time by a broad community of practitioners (Bhatia and Angelou 2015) and is currently being rolled out in 17 access-deficit countries around the world, with a full set of results anticipated early in 2019.

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.

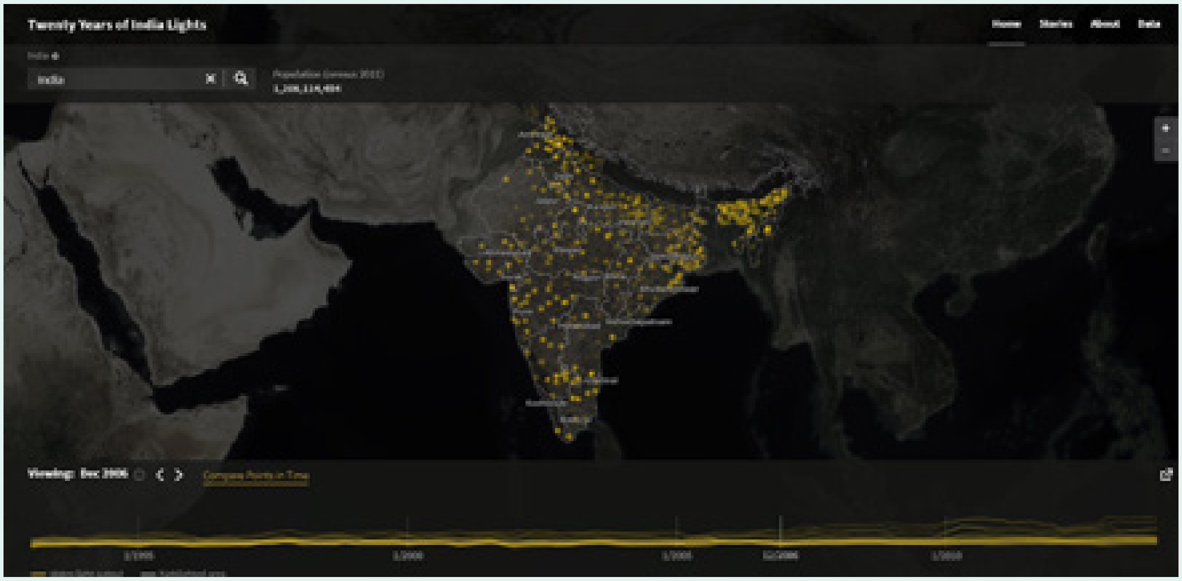
Finally—and looking a little further ahead—the arrival of a multiplicity of big data sources makes it possible to contemplate entirely different methods of tracking electrification in future. Satellite imagery, in particular, offers nightly high-resolution images of the entire world, and algorithms are 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?

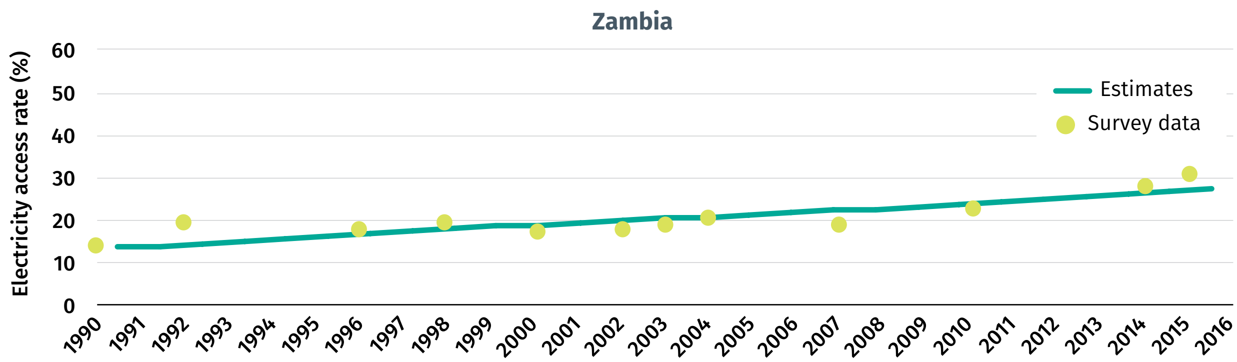
Name	Statistical agency	Number of countries	Number of surveys	Question on electrification when standardized across countries
Demographic and Health Survey	Funded by USAID funded; implemented by ICF International	87	269 (28%)	Does your household have electricity?
Living Standards Measurement Survey	National 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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