



CHAPTER 1

ACCESS TO ELECTRICITY

MAIN MESSAGES

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

5 Access to electricity (also referred to as “electrification” or “electrification rate” in the report) refers to the share of the population with access to electricity out of the total population in the specified time period or geographic area. It is defined as the ability of the end user to consume electricity for desired services. Where surveys based on the Multi-Tier Framework have been conducted (about 20 countries), access to electricity service at the equivalent of Tier 1 and above (Tier 1+) is considered (ESMAP 2015). Otherwise, electricity access is calculated through binary measurements in existing household surveys, such as the DHS and LSMS (World Bank and IEA 2017). The number of people who gained access between 2010 and 2018 is 1.037 billion.

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

7 United Nations classifications are used for the names and composition of the country groupings used in this report (<https://unstats.un.org/unsd/methodology/m49/>); in chapter 5, the report uses IEA’s World Energy Outlook classifications.

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

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

ARE WE ON TRACK?

As of 2018, 90 percent of the world's population had access to electricity (Figure 1.1). From 2010 to 2018, the global population without access to electricity shrank from almost 1.2 billion to 789 million. Between 2016 and 2018, an average of 136 million people gained access to electricity each year, substantially more than the average annual population growth of 84 million for the same period. The progress between 2016 and 2018 also represented an acceleration from the annual increase in electrification of 127 million people seen between 2010 and 2016. Yet global progress hides glaring disparities among countries and regions. For instance, the least-developed countries fall well behind the global average.⁹ By 2030 (before accounting for covid-19 effects), about 93 percent of the global population are projected to have access to electricity; this means that close to 620 million people would lack it (IEA 2019b). The shortfall in meeting the target reflects the complexities involved in bringing electricity to unserved populations—complexities that extend to affordability, reliability, and the cost of deploying last-mile solutions, especially in low-income, remote, or conflict-affected countries. As of 2018, 57 percent of those without access lived in low-income countries, 30 percent in fragile and conflict-affected areas.¹⁰

FIGURE 1.1 • Percentage of population with access to electricity



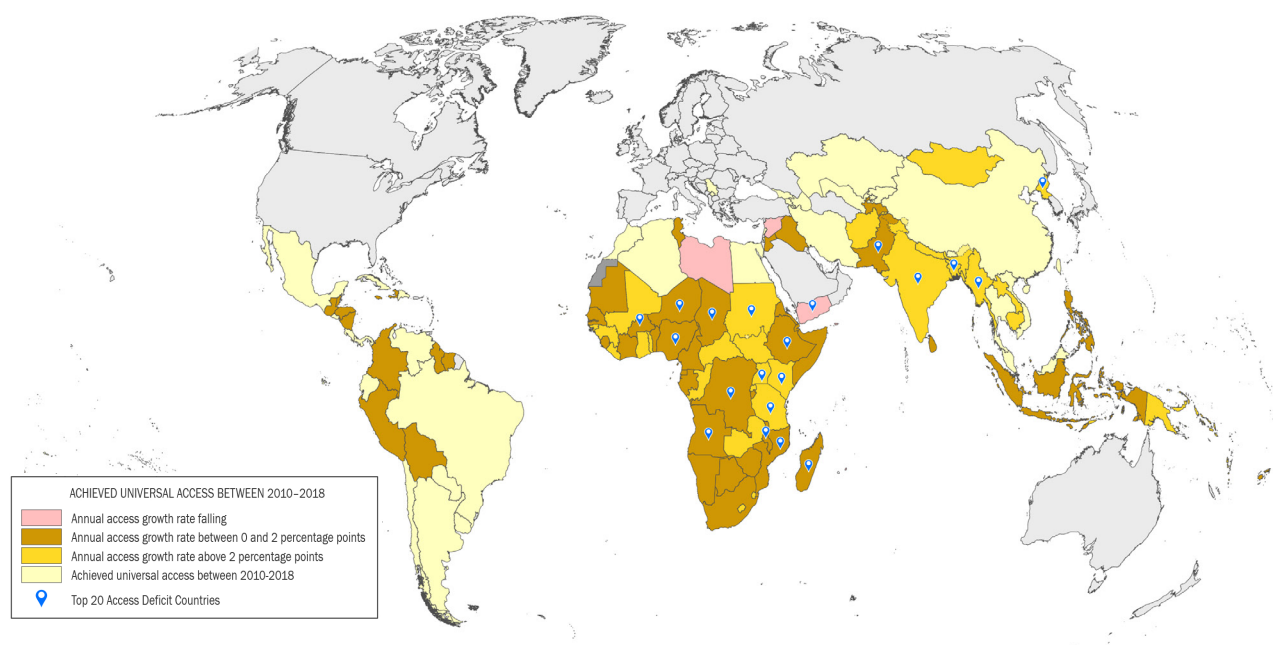
Source: World Bank, IEA.

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

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

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

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



Source: World Bank.

LOOKING BEYOND THE MAIN INDICATORS

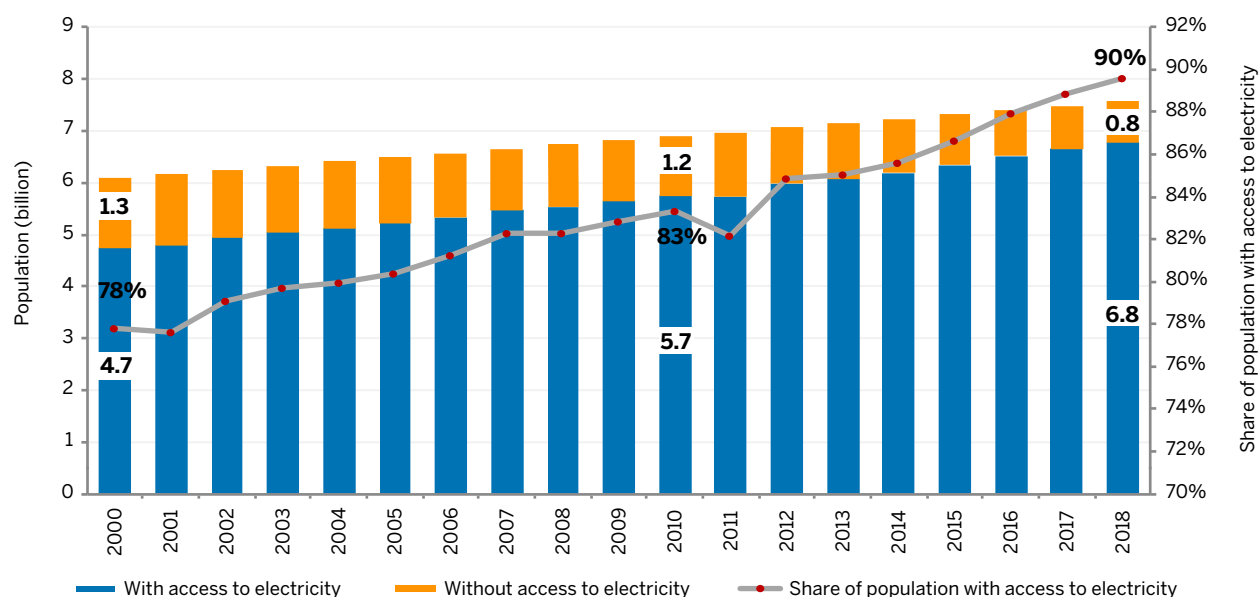
This chapter explores changes in access to electricity between 2000 and 2018, comparing progress across socioeconomic and geographical contexts in response to electrification efforts. The aim of the analysis is to inform efforts to achieve the 2030 target and to sustain gains in access.

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

ACCESS AND POPULATION

Despite major progress since 2010, the current pace of electrification is still not fast enough to meet the 2030 target. The global electrification rate has progressed steadily, rising from 83 percent of the world's population in 2010 to 90 percent in 2018 (Figure 1.3). During this same period, the population without access to electricity fell from 1.2 billion to 789 million. Compared with previous decades, the pace of electrification has accelerated since 2010. Between 2016 and 2018, however, electrification grew by just 0.82 percentage points per year, lower than the average annual increase believed necessary (before the onset of covid-19) to achieve universal access by 2030 (0.87 percentage points; Figure 1.4). The last mile of the road to universal access will be especially challenging in view of the difficulty of reaching the populations that remain unserved. In addition, affordability and reliability remain salient issues for many countries moving toward the target. According to the 2018 Regulatory Indicators for Sustainable Energy (RISE), the poorest 40 percent of households in half of the access deficit countries spent more than 5 percent of their monthly household expenditure on 30 kilowatt-hours (kWh) of electricity¹² (ESMAP 2018). One-third of the access-deficit countries face more than one disruption per week in electricity supply, with disruptions lasting more than four minutes on average.

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

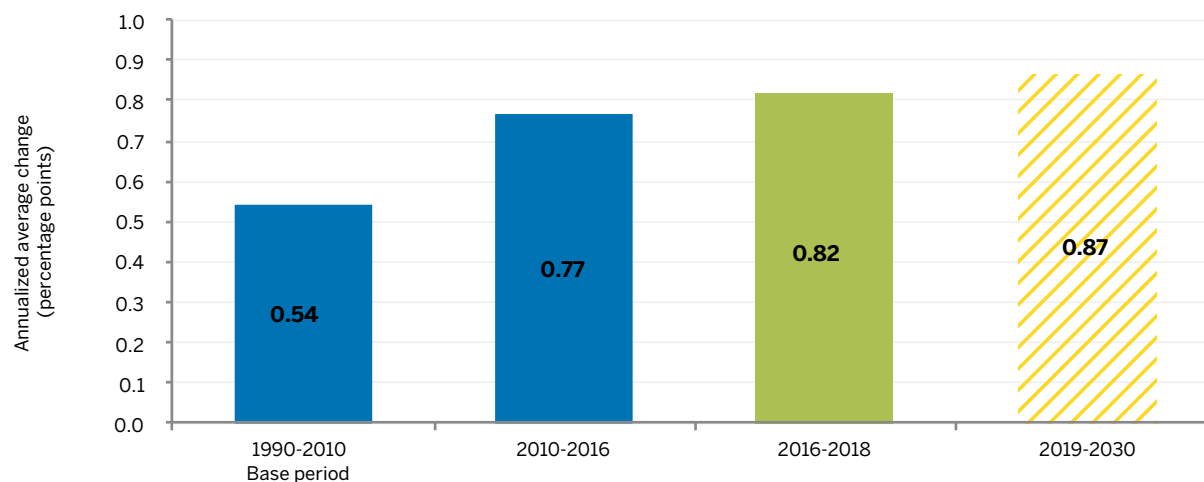


Source: World Bank.

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

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

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

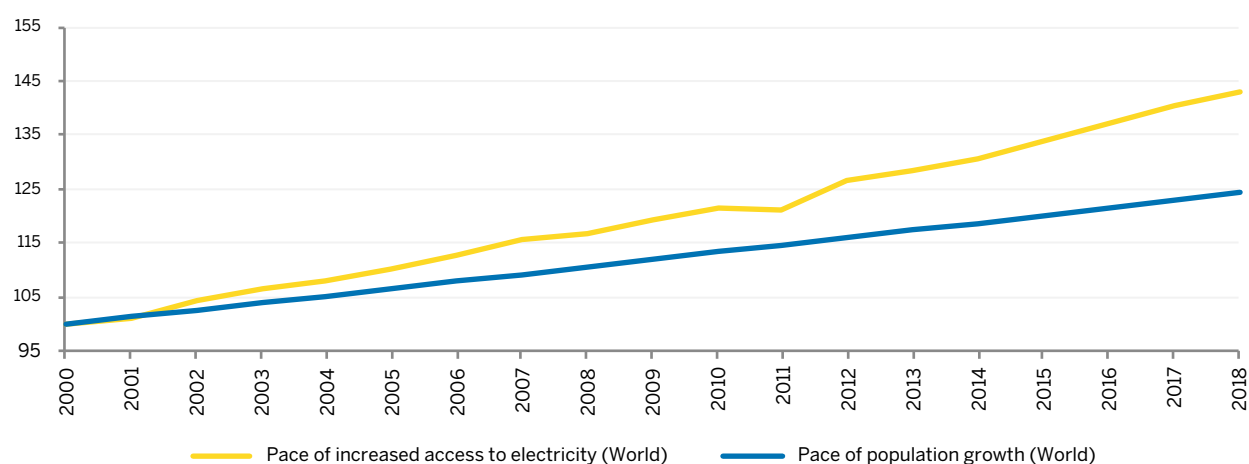


Source: World Bank.

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

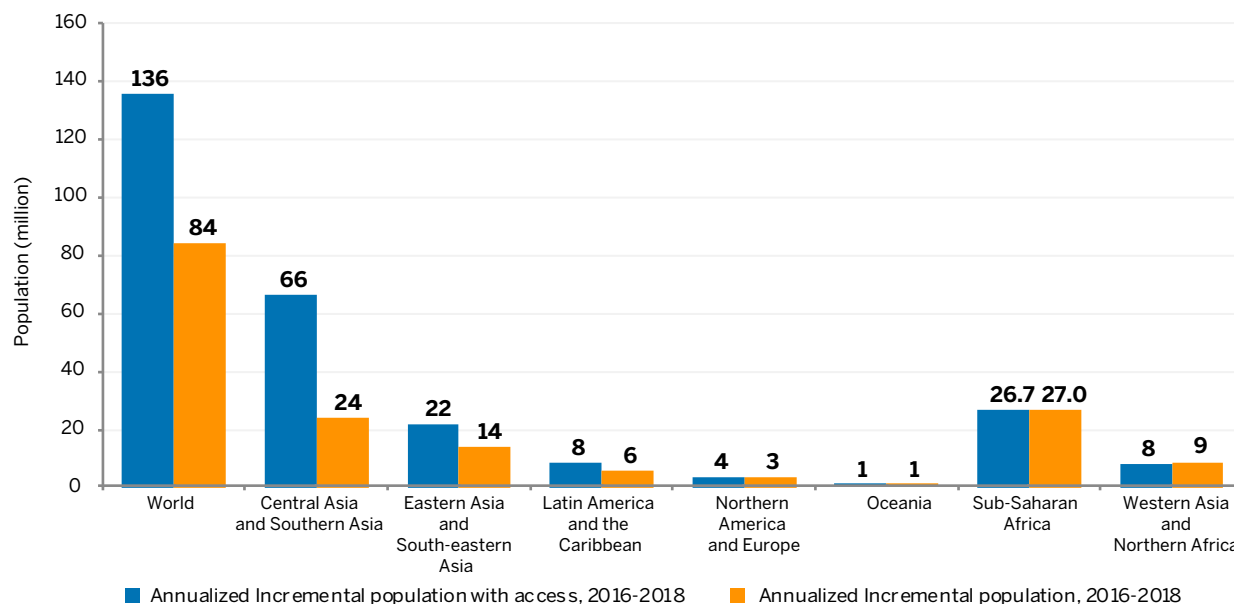
Between 2010 and 2018, electrification accelerated faster than demographic growth worldwide (Figure 1.5). This trend was confirmed between 2016 and 2018, as electricity reached 136 million new people on average annually, while the world population grew by 84 million (Figure 1.6). The increase in population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

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



Source: World Bank.

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



Source: World Bank.

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

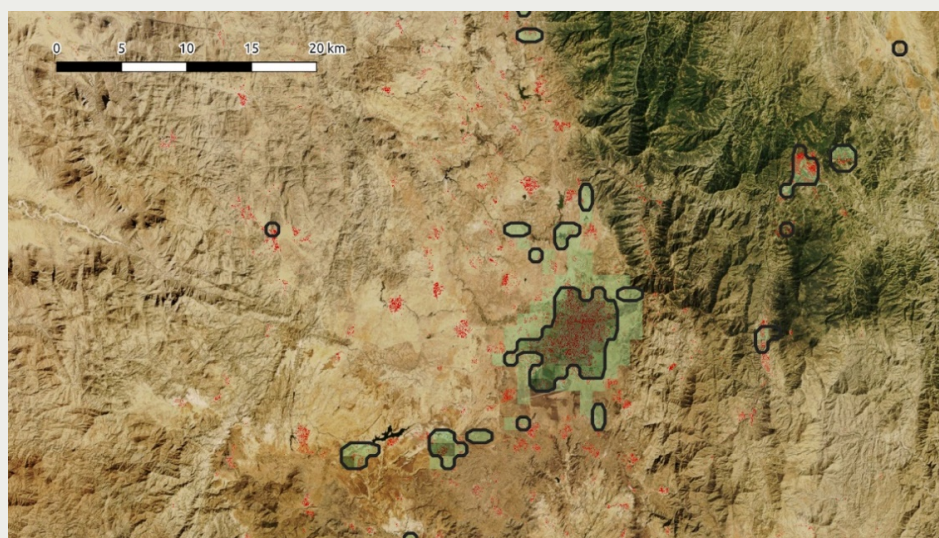
BOX 1.1 • MEASURING ACCESS TO ELECTRICITY FROM THE NIGHT SKY

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

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

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

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



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

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

THE ACCESS DEFICIT

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

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

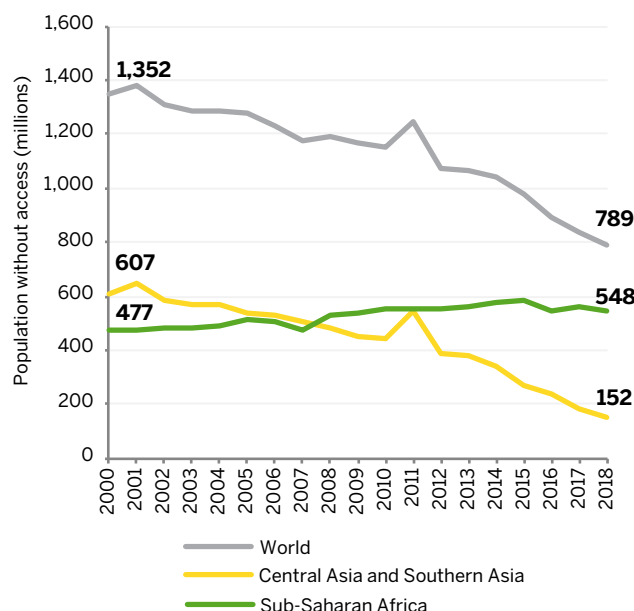
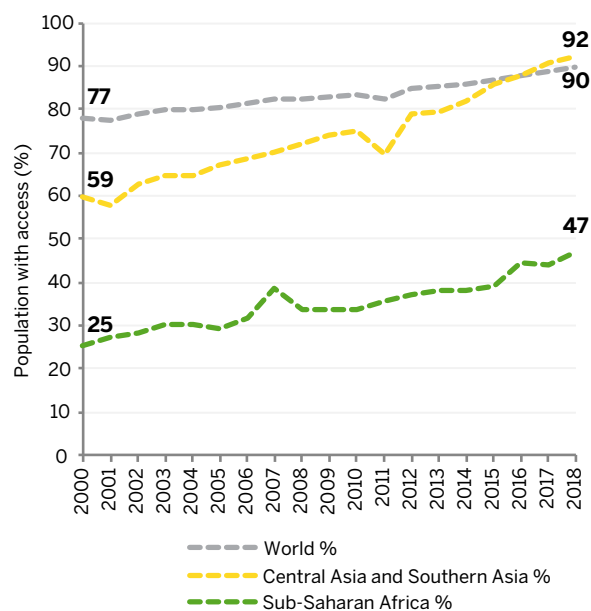


FIGURE 1.8 • Evolution of electricity access (percentage of population with access), 2000–18



Source: World Bank.

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

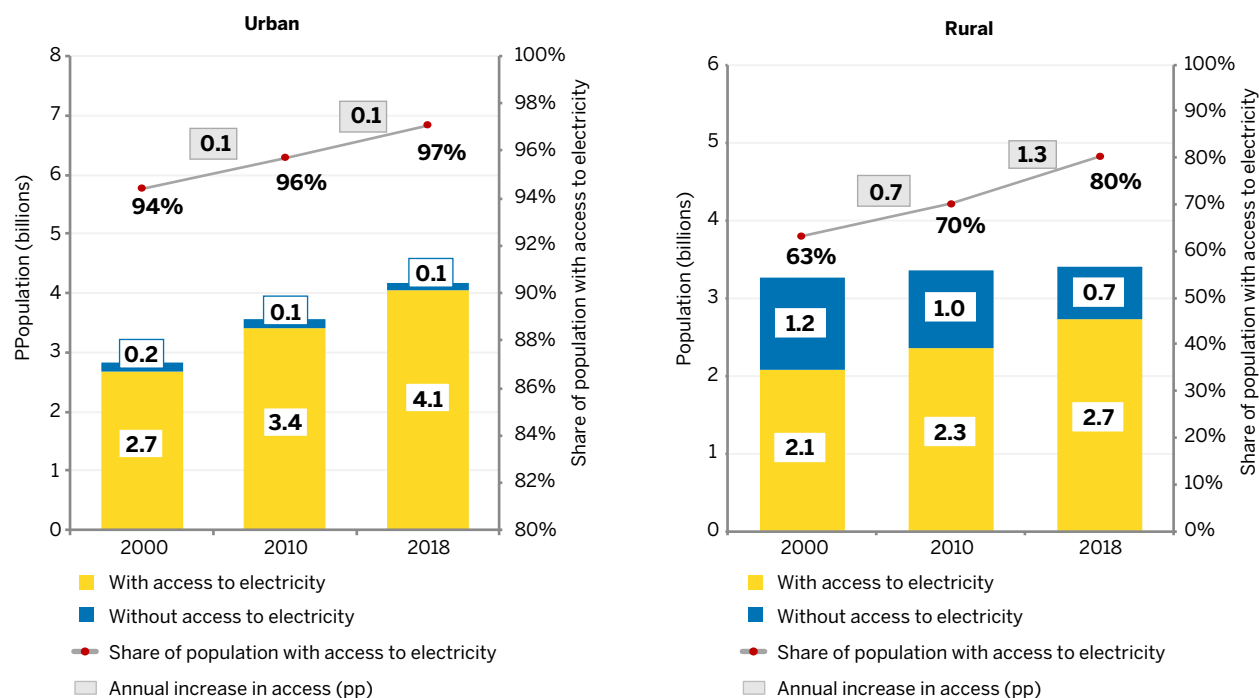
THE URBAN-RURAL DIVIDE

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

Globally, despite slower growth in access, urban electrification brought access to more than 83 million urban residents on average each year between 2016 and 2018 (compared with population growth of 80 million). In Sub-Saharan Africa, electrification in urban areas dipped below population growth. As a result, in 2018, most of the world's unelectrified urban population lived in Sub-Saharan Africa (76 percent in 2018) (Figure 1.11). A vast majority of this unserved urban

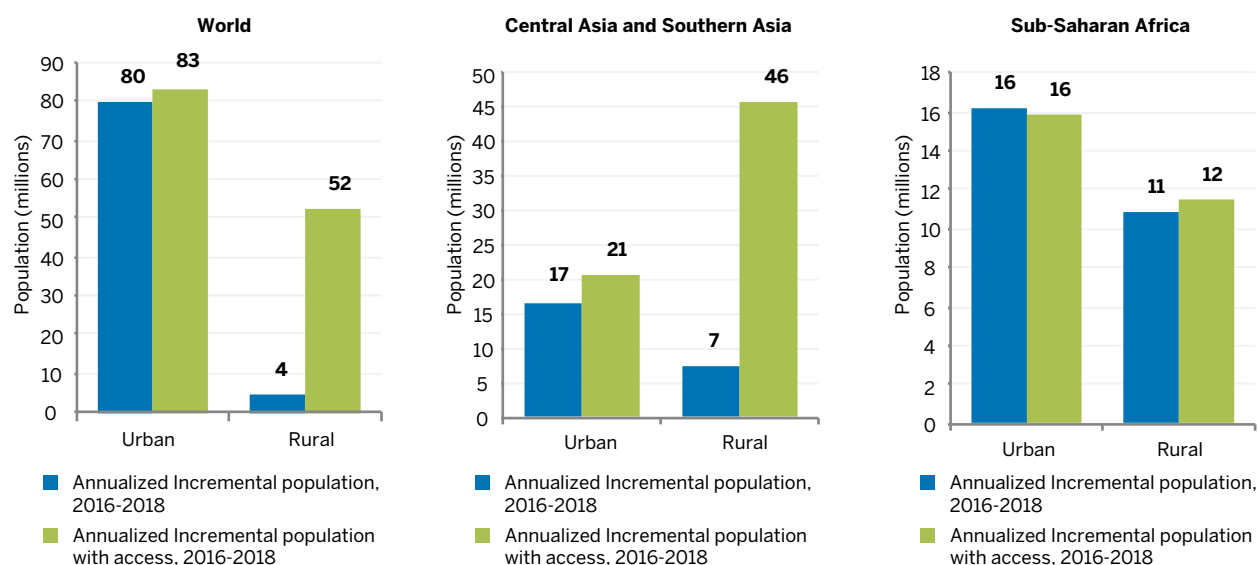
population in Sub-Saharan Africa lived in low-income and fragile and conflict-affected countries (62 percent and 75 percent, respectively). The last-mile issues for large cities are posed by populations residing in vast informal settlements that are unlikely to be attractive customers for utilities, as they present thorny barriers pertaining to legality, ownership, low demand, and housing type. Electrifying new areas is generally more newsworthy than densifying existing areas already connected. Additionally, donors have tended to push for rural electrification.

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



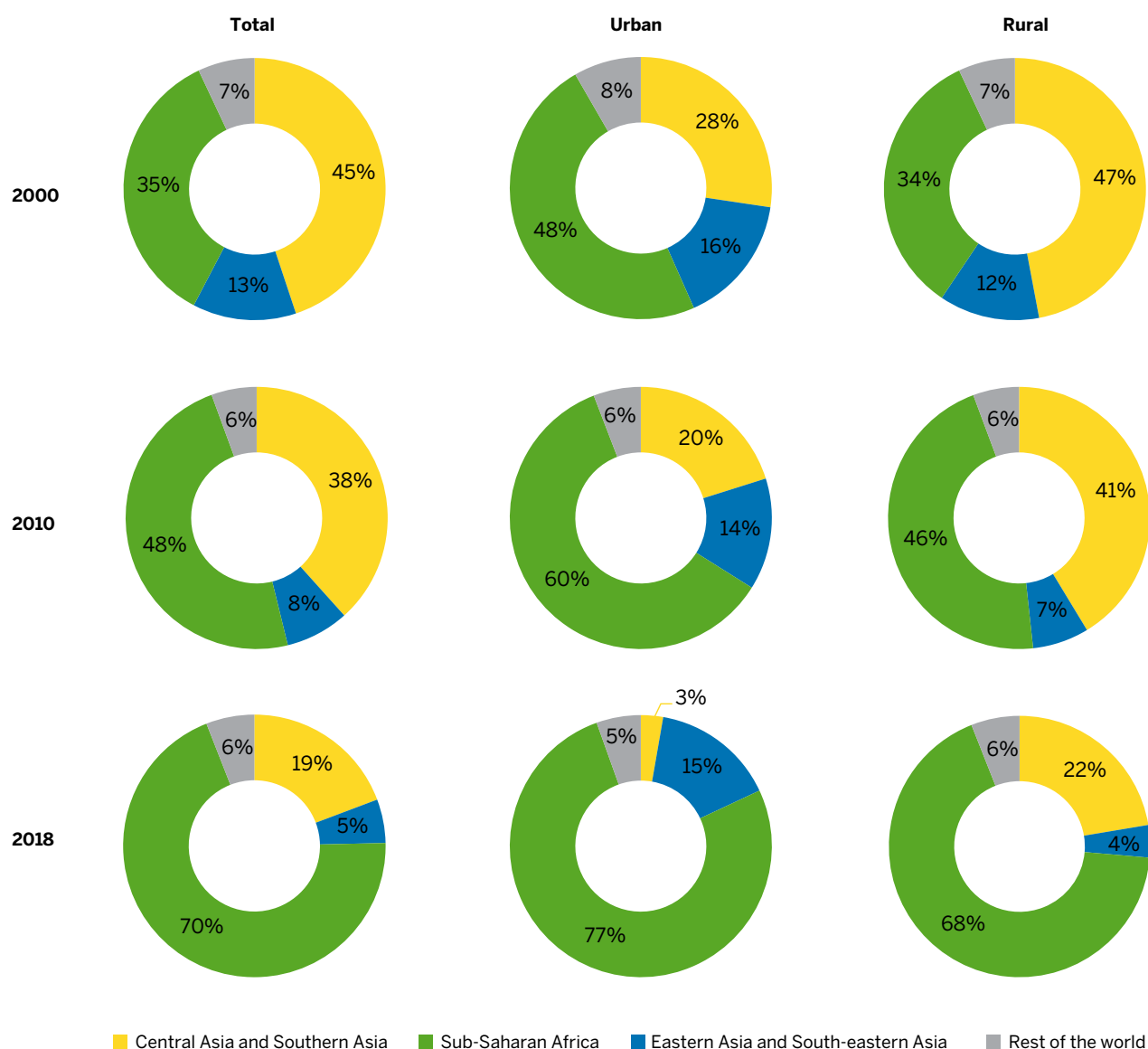
Source: World Bank.

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



Source: World Bank.

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



Source: World Bank.

OFF-GRID ELECTRIFICATION

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

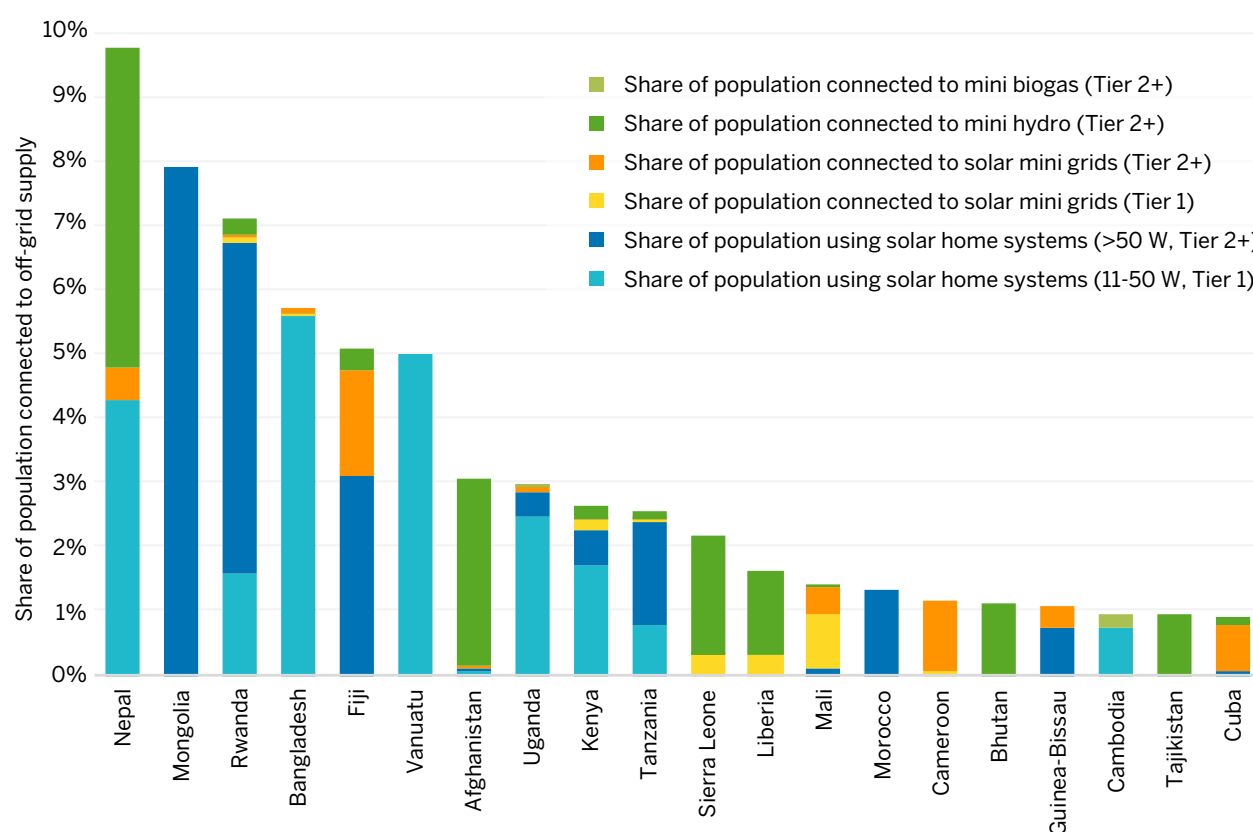
As of 2018, more than 35 million people had Tier 1+ electricity service access through standalone home systems or renewable-based mini grids (IRENA 2019a; GOGLA 2019). The population with access to standalone systems providing Tier 1+ service increased almost four times between 2010 and 2018; although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

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

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

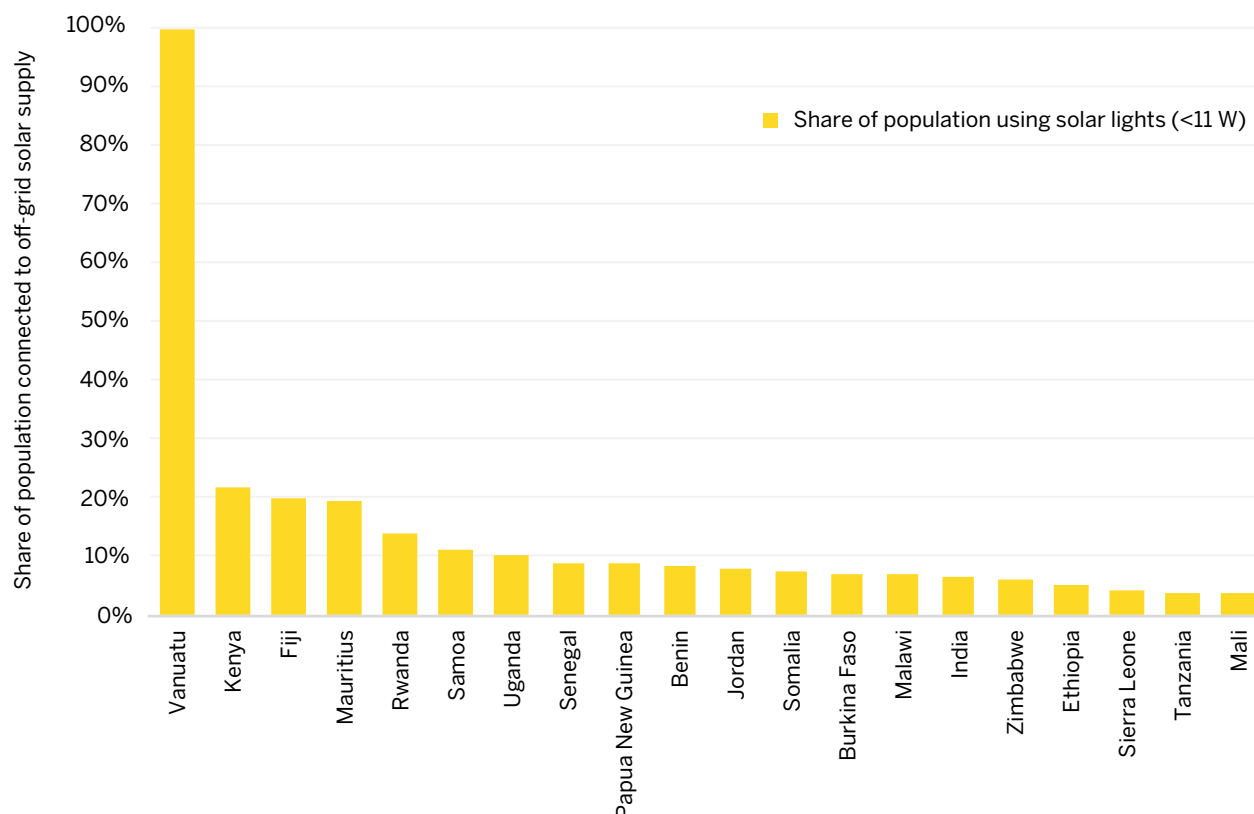
By 2018, below-Tier 1 solutions were providing basic electricity services to 136 million people globally, compared with about 1 million people in 2010. Some of the access-deficit countries that provided more than 10 percent of their population with such access were Kenya, Rwanda, Somalia, Uganda, and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

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



Source: IRENA, GOGA.

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



Source: IRENA, GOGILA.

COUNTRY TRENDS

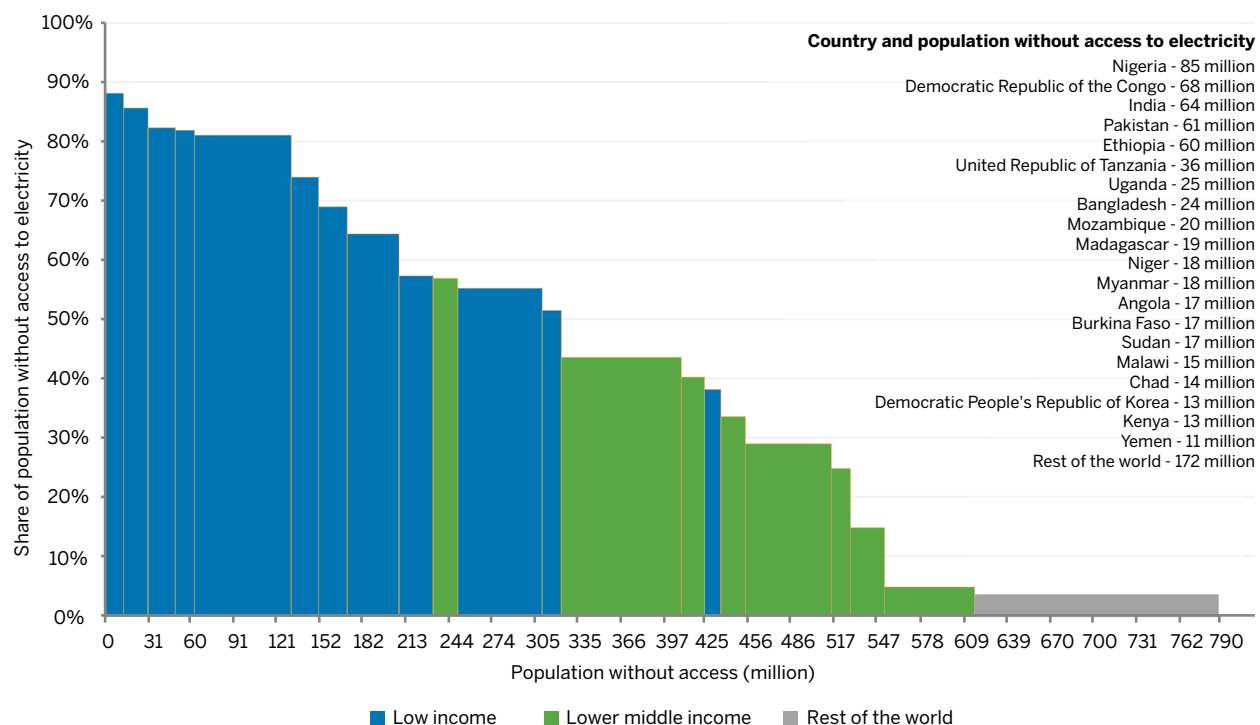
Of the unserved population at the end of 2018, more than 617 million people (78 percent) lived in the 20 largest access-deficit countries (as determined by the number of people lacking access), also called “high-impact countries” (Figure 1.14). For that reason, closing the access deficit globally will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

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

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

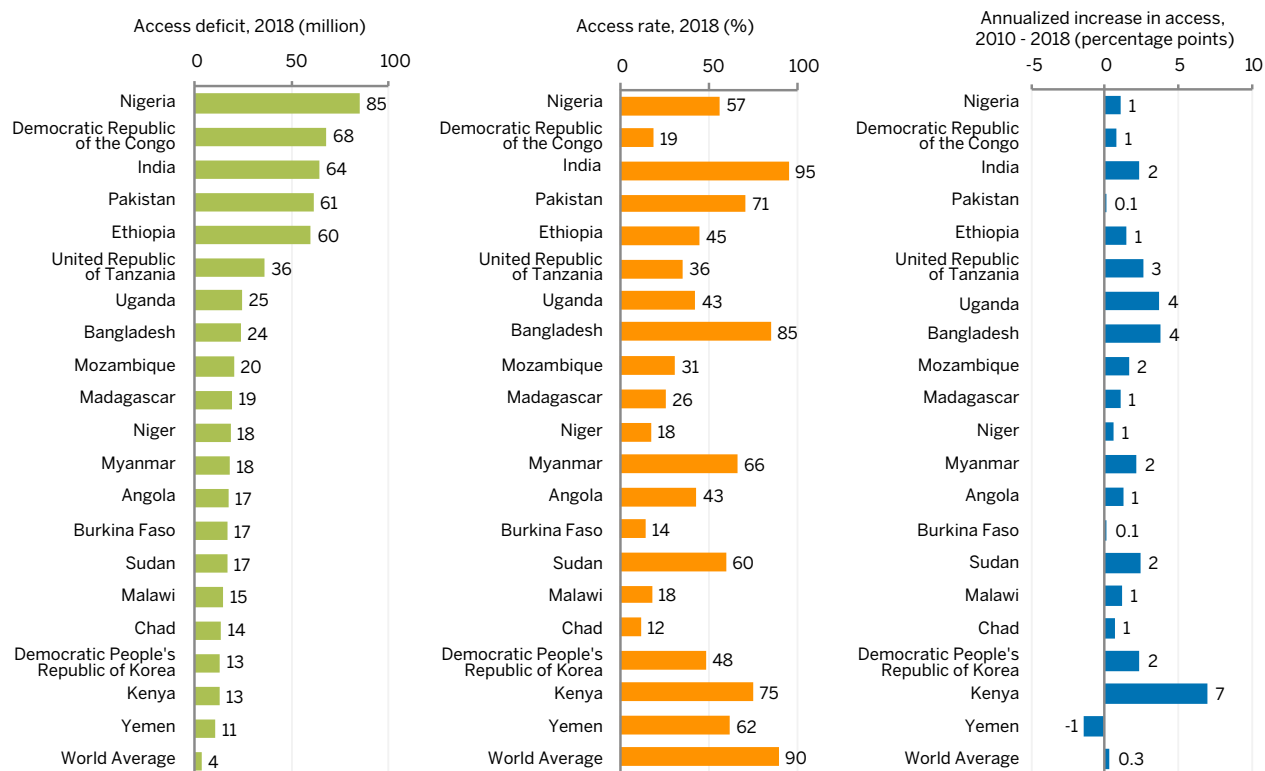
Some larger countries with unserved populations of more than 50 million in 2018—such as Pakistan—have electrified at rates of less than one percentage point per year since 2010, resulting in increased access deficits (Figure 1.15). As a result of conflict, Yemen has seen its access rate shrink since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

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



Source: World Bank.

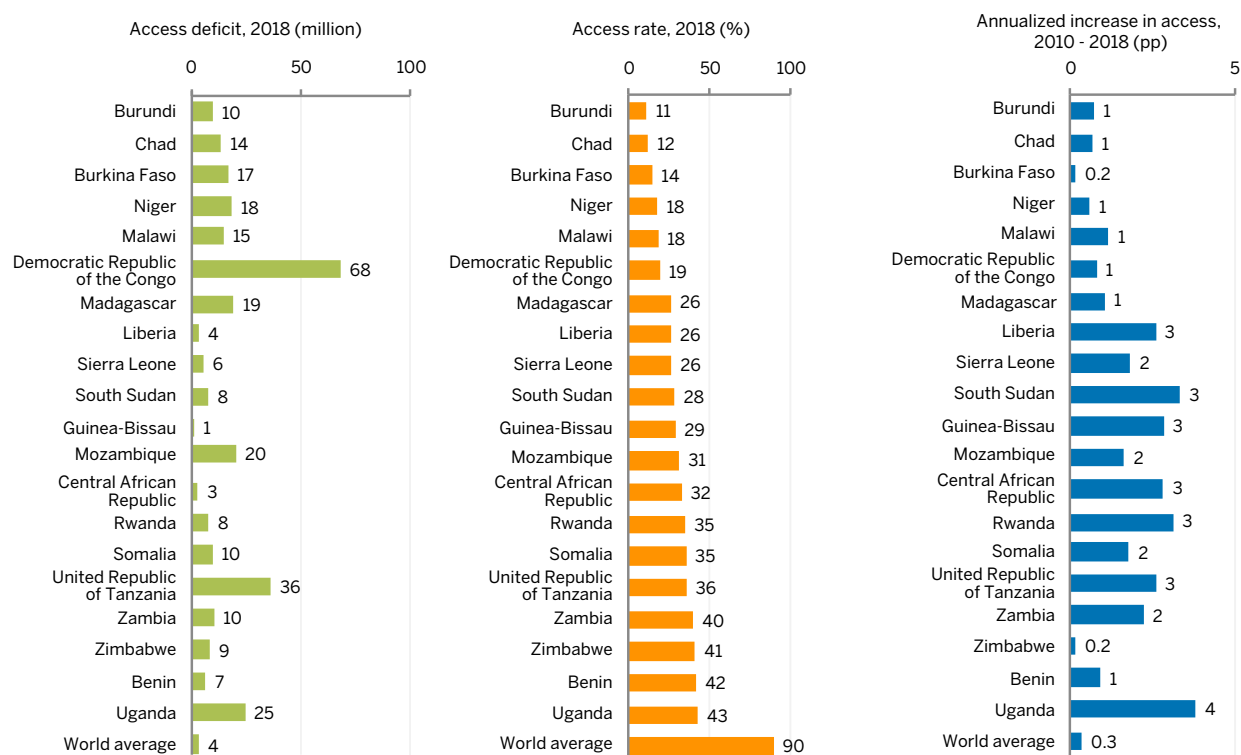
FIGURE 1.15 • Electricity access in the top 20 access-deficit countries by population, 2010–18



Source: World Bank.

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

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



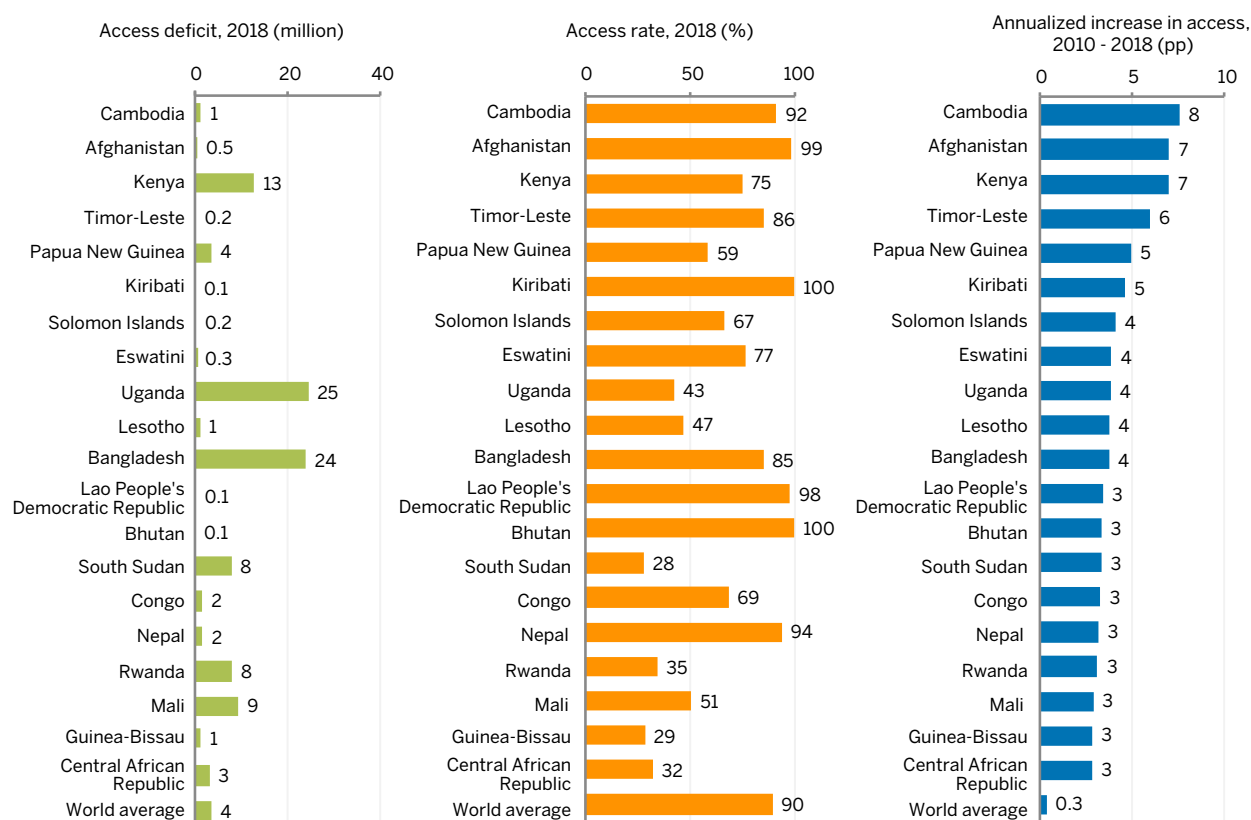
Source: World Bank.

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

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

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

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



Source: World Bank.

POLICY INSIGHTS

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

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

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

The most successful national strategies integrate grid improvements, mini grids, and off-grid technologies—presenting credible paths to universal access. As in Myanmar and Togo, the strategy must span the power sector value chain and all population segments to support economic and social development goals. National ownership, coherence, inclusivity, capacity, robustness, and data transparency/accessibility are key principles in developing effective initiatives to be undertaken by local authorities and their development partners.¹⁴ Comprehensive data from the Multi-Tier Framework and new electricity-access planning techniques (e.g., geospatial least-cost algorithms based on satellite imaging) and tools such as the Global Electrification Platform¹⁵ are critical for informed decision-making. Better quality and fewer gaps in data will make these tools more practical. These tools also need to capture more information about how electricity is actually used so that communities can realize its full benefits.

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

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

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

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

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

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

LEVERAGED PUBLIC AND PRIVATE FINANCING TO FUND ELECTRIFICATION AT SCALE

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

LEAVING NO ONE BEHIND

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

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

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

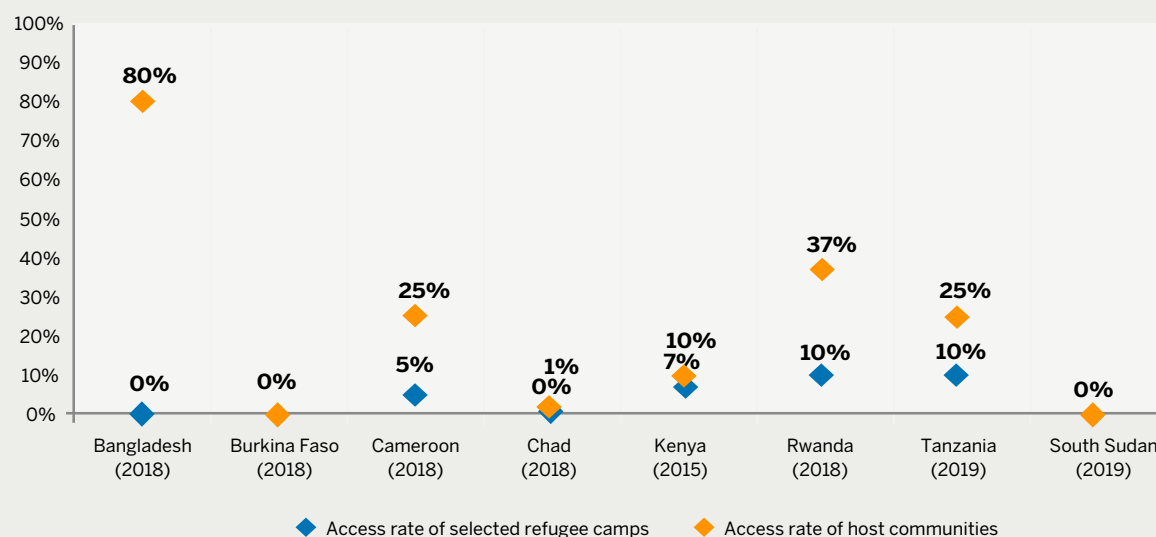
Today, forcible displacement affects a record number of 75 million people around the world, including almost 24 million refugees and asylum seekers. Of the 75 million forcibly displaced people at the end of 2018, about 20 million were refugees and over 3.5 million were asylum seekers (UNHCR 2019).

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

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

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

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



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

Limited data suggest that refugees do have somewhat better access to off-grid electricity. A study conducted among 600 sample households in three refugee camps (Gihembe, Kigeme, Nyabiheke) in Rwanda in 2018 found that 41–51 percent of the refugees had access to electricity for lighting from an off-grid power source (Sandwell

and others 2019).^b Another study conducted among 500 sample households in Nyarugusu in Tanzania in 2017 found a similar situation, with 43 percent of refugees having access through off-grid electricity (Rivoal and Haselip 2017). This indicates the potential for market-based approaches to off-grid electricity solutions in refugee settings. One estimate has refugees and internally displaced people spending USD 223 million on off-grid lighting technologies alone, of which USD 121 million is attributed to refugees living in camps (Moving Energy Initiative 2018).

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

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

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

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

ENERGIZING WOMEN

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

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

GOING BEYOND CONNECTIONS: IMPROVING LIVELIHOODS AND HUMAN CAPITAL

Electrification programs must be grounded in a broader agenda of social transformation. Countries with universal electricity access built their programs as part of a transformative agenda of social and economic development (e.g., China, Tunisia, United States of America, Viet Nam). Electricity access programs should be designed to support countries' sustainable development initiatives. There is growing evidence that demand-side factors are impeding the scale-up of electrification, particularly in Sub-Saharan Africa, where electrified households often remain at minimum consumption levels, not making full use of electricity's socioeconomic benefits. Persistent lack of household demand, inability to pay, or unwillingness to pay makes service providers reluctant to serve low-income users and threatens

the sustainability of efforts across all technologies—grid, mini grid, and off-grid. That so many rural schools and health facilities remain without reliable access to electricity (box 1.3) likewise limits the impact of electrification because the objectives of human capital development remain unrealized.

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

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

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

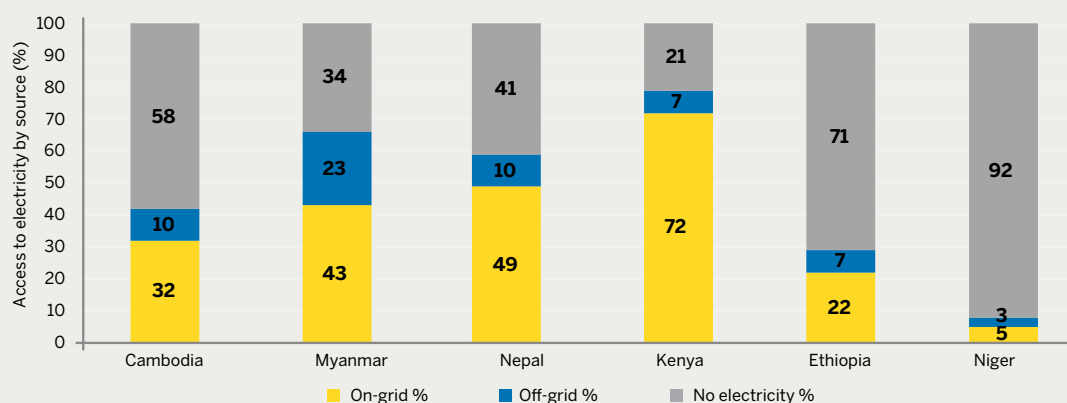
Education facilities^b

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

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

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

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



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

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

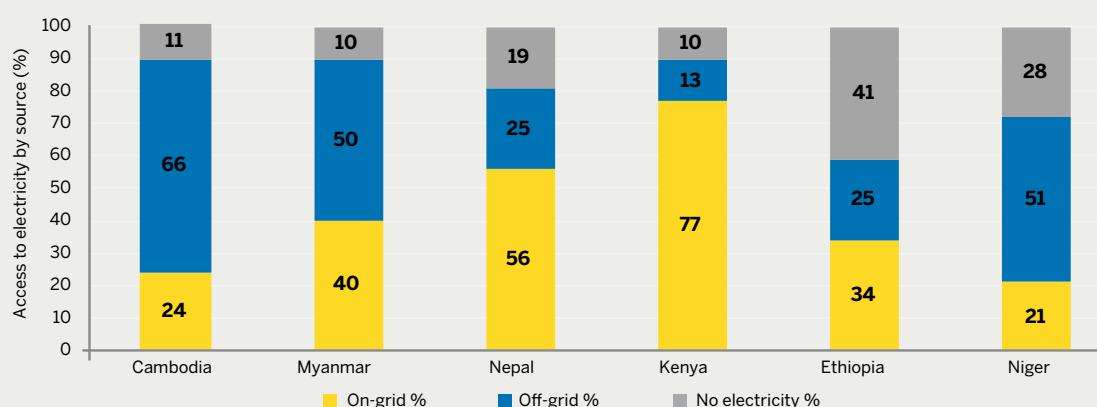
Beyond access, the poor quality of electricity service affects the functioning of educational facilities. At the aggregate level, only 16 percent of schools report enjoying 24 hours of electricity each day. Unscheduled interruptions hinder the functioning of more than 25 percent of educational centers.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

Health centers^c

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

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

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



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

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

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

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

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

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

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

METHODOLOGY

DATABASE

The World Bank's Global Electrification Database (<https://databank.worldbank.org/source/world-development-indicators>) compiles nationally representative household survey data as well as census data from 1990 to 2018. It also incorporates data from the Socio-Economic Database for Latin America and the Caribbean, the Middle East and North Africa Poverty Database, and the Europe and Central Asia Poverty Database, all of which are based on similar surveys. At the time of this analysis, the Global Electrification Database contained 1,133 surveys from 144 countries, excluding surveys from high-income countries as classified by the United Nations. In general, about 25 percent of the countries publish or update their electricity data each year, thus permitting global data collection since 2010. Greater investment in data collection and capacity building is needed in order to gain a more comprehensive and accurate understanding of the electricity access picture (chapter 6).

ESTIMATING MISSING VALUES

Surveys are typically published every two to three years, but they can be irregular and infrequent in many regions. To estimate values, a multilevel, nonparametric modeling approach developed by the World Health Organization to estimate clean fuel usage was adapted to predict electricity access and used to fill in the missing data points for the time period between 1990 and 2018. Where data are available, access estimates are weighted by population. Multilevel nonparametric modeling takes into account the hierarchical structure of data (country and regional levels), using the regional classification of the United Nations.

The model is applied for all countries with at least one data point. In order to use as much real data as possible, results based on real survey data are reported in their original form for all years available. The statistical model is used to fill in data only for years where they are missing and to conduct global and regional analyses. In the absence of survey data for a given year, information from regional trends was borrowed. The difference between real data points and estimated values is clearly identified in the database.

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

In the present report, to avoid having electrification trends from 1990 to 2010 overshadow efforts since 2010, the model was run twice:

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

MEASURING ACCESS TO ELECTRICITY THROUGH OFF-GRID SOURCES

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

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

The tier-wise data are presented by technology as:

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

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

CALCULATING THE ANNUAL CHANGE IN ACCESS

The annual change in access is calculated as the difference between the access rate in year 2 and the rate in year 1, divided by the number of years to annualize the value:

$$(\text{Access Rate Year 2} - \text{Access Rate Year 1}) / (\text{Year 2} - \text{Year 1})$$

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

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

The World Bank and IEA maintain separate databases of global electricity access rates. The World Bank's Global Electrification Database derives estimates from a suite of standardized household surveys and censuses that are conducted in most countries every two to three years, in conjunction with a multilevel nonparametric model used to extrapolate data for the missing years. This ensures that demand-side data are being collected. The IEA Energy Access Database sources data, where possible, from government-reported values for household electrification (usually based on utility connections), which focuses more on supply-side electrification data. IEA considers a household to have access if it receives enough electricity to power a basic bundle of energy services (IEA 2019a, 2019c). The World Bank utilizes a similar access structure to determine energy access called the Multi-Tier Framework, ranging in a tiered spectrum, from Tier 0 (no access) to Tier 5 (highest level of access).

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

A comparison of the two datasets in the previous edition of this report (and updated in this edition) highlights their different strengths. Household surveys, typically conducted by national statistical agencies, offer two distinct advantages for measures of electrification. First, with longstanding efforts internationally to harmonize questionnaire designs, electrification questions are mostly standardized across country surveys. Although not all surveys reveal detailed information on the forms of access, survey questionnaire designs can now capture emerging phenomena such as off-grid solar access. Second, data from surveys convey user-centric perspectives on electrification. Survey data capture all forms of electricity access, painting a more complete picture of access than may be possible from service provider data.

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

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