

CHAPTER 2

ACCESS TO CLEAN FUELS AND TECHNOLOGIES FOR COOKING



MAIN MESSAGES

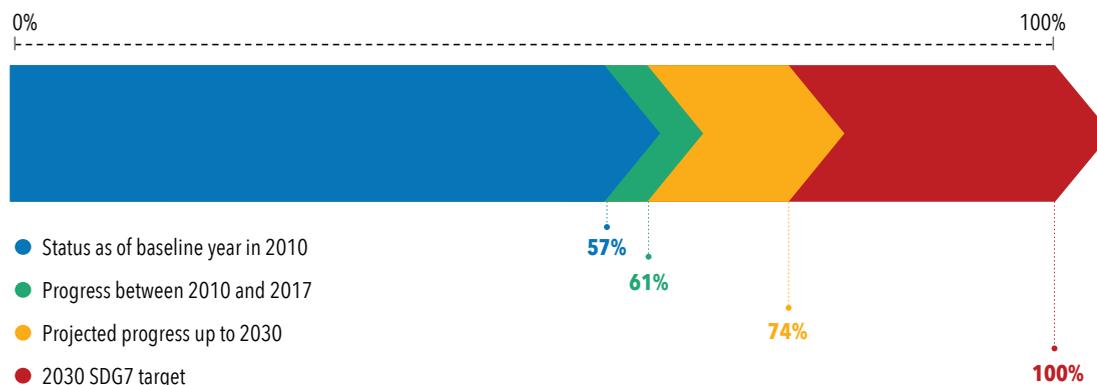
- **Global trend:** The share of the population with access to clean²¹ fuels and technologies for cooking increased from 57% [51, 62]²² in 2010 to 61% [54, 67] in 2017, an average annual increase of 0.5 percentage points [1.6, -0.5]. However, because population growth is outpacing annual access gains, the global access deficit has remained stagnant since 2016, at around 3 billion, having decreased between 2000 and 2017 by 3%. Unless rapid action is taken, household air pollution will remain the cause of millions of deaths from noncommunicable diseases (including heart disease, stroke, and cancer), as well as pneumonia (WHO 2018a).
- **2030 target:** While the global access rate appears to have increased by approximately 0.5 percentage points [1.6, -0.5] annually from 2010 to 2017, annual progress slowed down after 2008. The majority of gains was driven by Central and Southern Asia and Eastern and Southeastern Asia, where the average annual increase in the access was 1.2 percentage points and 0.9 percentage points, respectively, in 2010-2017. To reach universal clean cooking targets by 2030 and outpace population growth, especially in the Sub-Saharan Africa region, the annual rate of access expansion needs to increase to around 3.0 percentage points from the rate of 0.5 percentage points observed between 2010 and 2017. Based on the current trajectory and population projections, around 2.2 billion people will be without access to clean cooking solutions by 2030 (IEA 2018). Each year without a substantial increase in access expansion adds tens of millions to the global access deficit.
- **Regional highlights:** Central and Southern Asia, Eastern and Southeastern Asia, and Sub-Saharan Africa account for the majority of the access-deficit population. Population growth between 2010 and 2017 in Sub-Saharan Africa was 2.5% annually, while the annual change in the share of the region's population with access to clean cooking solutions was less than 0.3 percentage points annually. For this reason, the access-deficit population in this region increased from less than 750 million in 2010 to around 900 million in 2017. In Latin America, access remained stable (around 88% [85, 90]) between 2016 and 2017, with an average annual increase of 0.4 percentage points between 2010 and 2017. The only part of the world that saw substantial progress relative to population growth was Asia, with Central and Southern Asia showing an average annual increase of 1.2 percentage points between 2010 and 2017, and Eastern and Southeastern Asia an annual increase of 0.9 percentage points.
- **Urban-rural distribution:** The rate of access to clean cooking solutions remains much higher in urban areas, where 83% [79, 85] have access, than in rural areas, where only 34% [29, 40] have access.
- **Top 20 access-deficit countries:** The population-weighted average national access rate among the top 20 countries²³ was 44% [54, 33] in 2017, while the average non-population-weighted access rate among these countries was 26% [23, 29]. The country with the largest access deficit in 2017 was India, where an estimated 700 million did not have access to clean cooking solutions. Six of the 20 countries had access rates below 5% and in only 5 of the 20 countries did the expansion of access outpace population growth between 2010 and 2017.

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- **Fuel trends:** Based on the results of national surveys, in most access-deficit regions, the use of wood is declining steadily. However, this trend is largely offset by an increase in charcoal usage, primarily in Sub-Saharan Africa.²⁴ Across the board, use of kerosene as a primary source of cooking energy is gradually declining. Meanwhile, the use of cleaner cooking fuels and technologies such as liquefied petroleum gas, natural gas, and biogas is increasing in both Asia and Sub-Saharan Africa. This increase can be observed in both urban and rural settings in Asia, but is primarily seen among urban households in Africa. Anecdotal evidence suggests that more efficient and cleaner processed biomass fuels are on the rise in some countries, particularly in rural areas, illustrating their important role in the transition to cleaner household energy.
 - **Outlook:** Even though overall progress in access to clean fuels and technologies is slowing down, putting Sustainable Development Goal 7 further out of reach, there is evidence to show that faster progress may be possible in the near future. Overall, 4 of the top 20 access-deficit countries (Vietnam, Indonesia, Sudan, and Afghanistan) expanded access to clean cooking solutions by more than 2 percentage points annually between 2010 and 2017, or at least four times faster than the rest of the world. Achieving universal access to clean and sustainable cooking solutions holds substantial benefits for the health and well-being of women and children. Millions of deaths and years of disability can be attributed to exposure to the inefficient use of cooking energy. Empirical evidence shows women and children in developing countries can spend up to 10 hours a week gathering fuels, and this time-poverty has detrimental impacts on access to education and income-generating opportunities.²⁵

ARE WE ON TRACK?

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

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

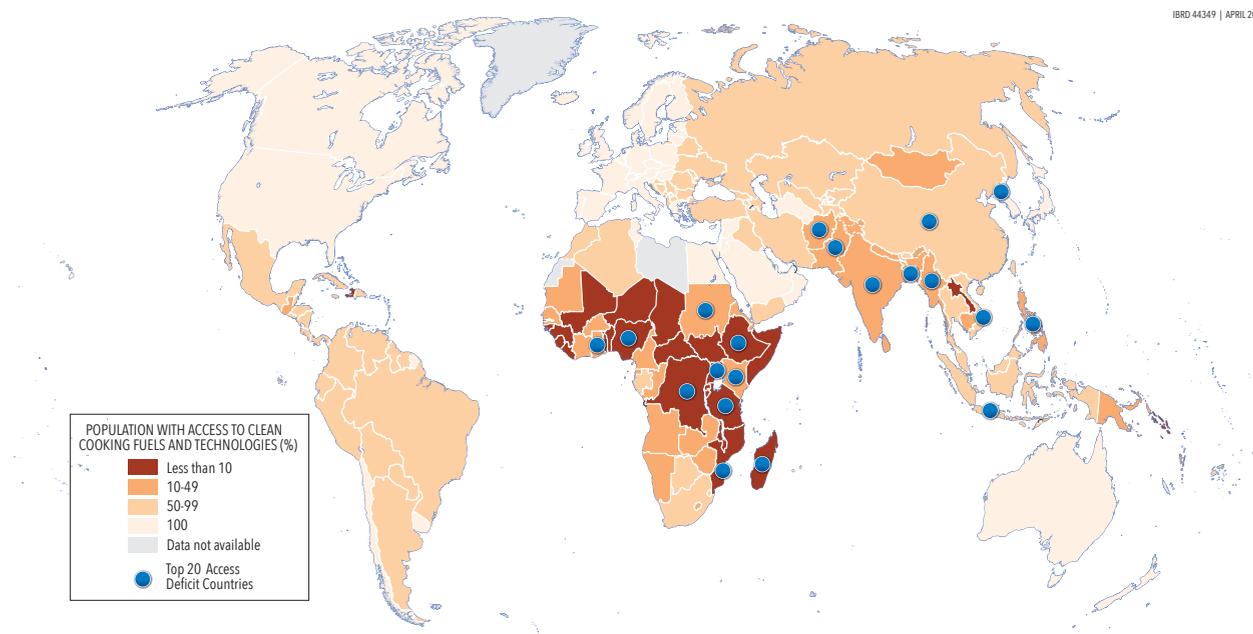


Source: WHO 2019.

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

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

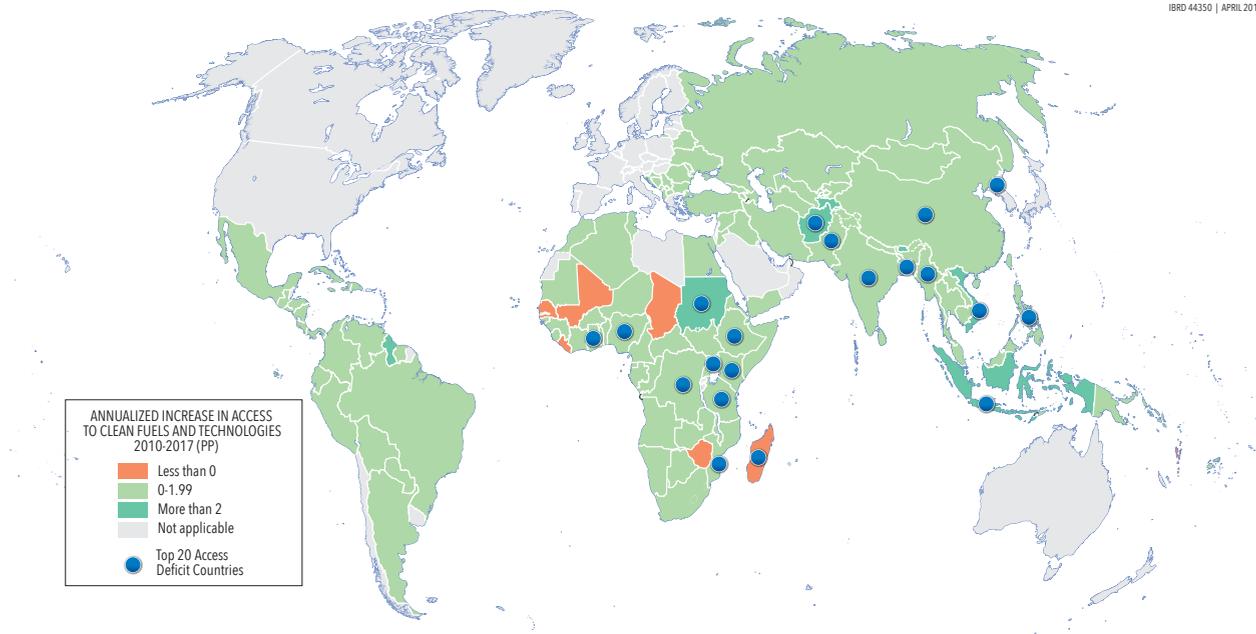
FIGURE 2.2 • REGIONAL POPULATIONS, BY RATE OF ACCESS TO CLEAN COOKING FUELS AND TECHNOLOGIES, 2017



Source: WHO 2019.

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

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



Source: WHO 2019.

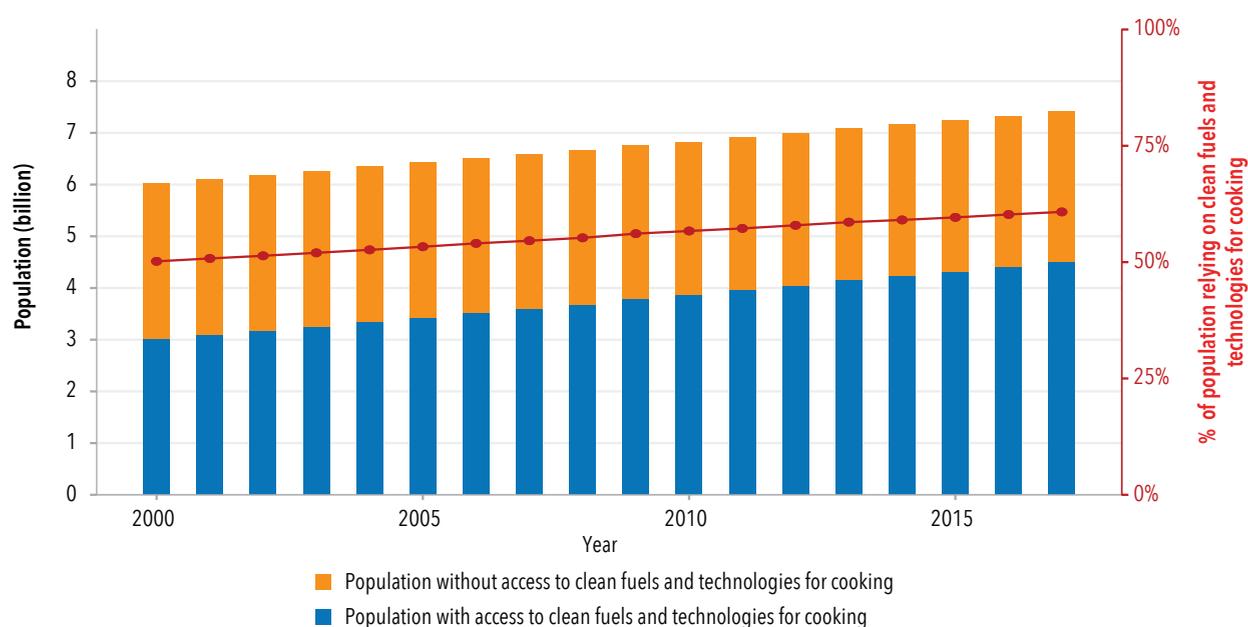
Unfortunately, most countries have made only incremental progress in recent years: figure 2.3 shows the average annual increase between 2010 and 2017, by country. Access did not improve substantially in Sub-Saharan Africa, remained stable in Latin America, and showed only slow progress in Developing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

LOOKING BEYOND THE MAIN INDICATORS

ACCESS AND POPULATION

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

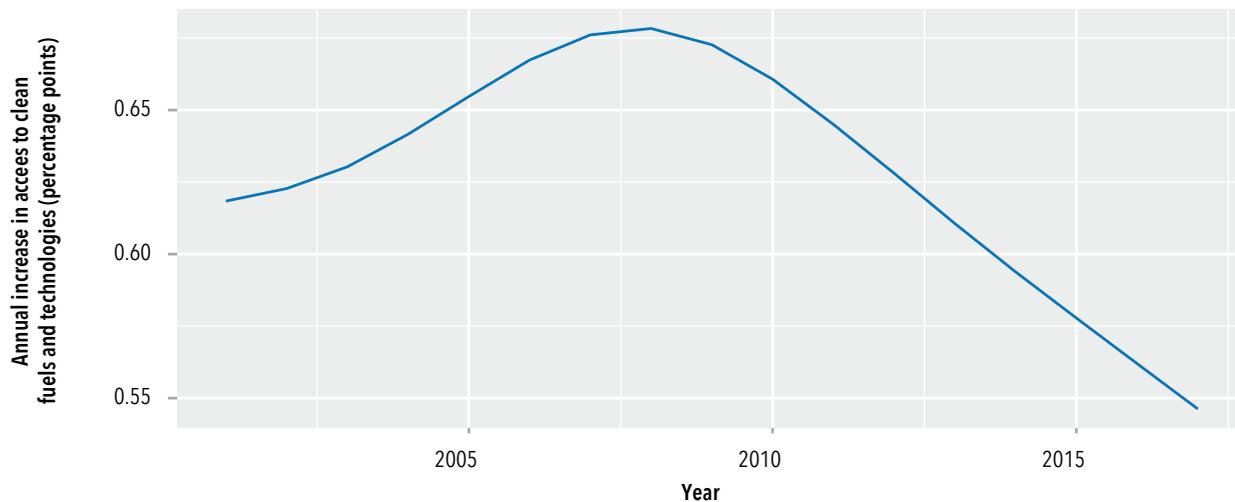
FIGURE 2.4 • CHANGE OVER TIME IN THE ABSOLUTE NUMBER OF PEOPLE (LEFT AXIS) AND PERCENTAGE OF THE GLOBAL POPULATION (RIGHT AXIS) WITH AND WITHOUT ACCESS TO CLEAN COOKING SOLUTIONS, 2000-2017



Source: WHO 2019.

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

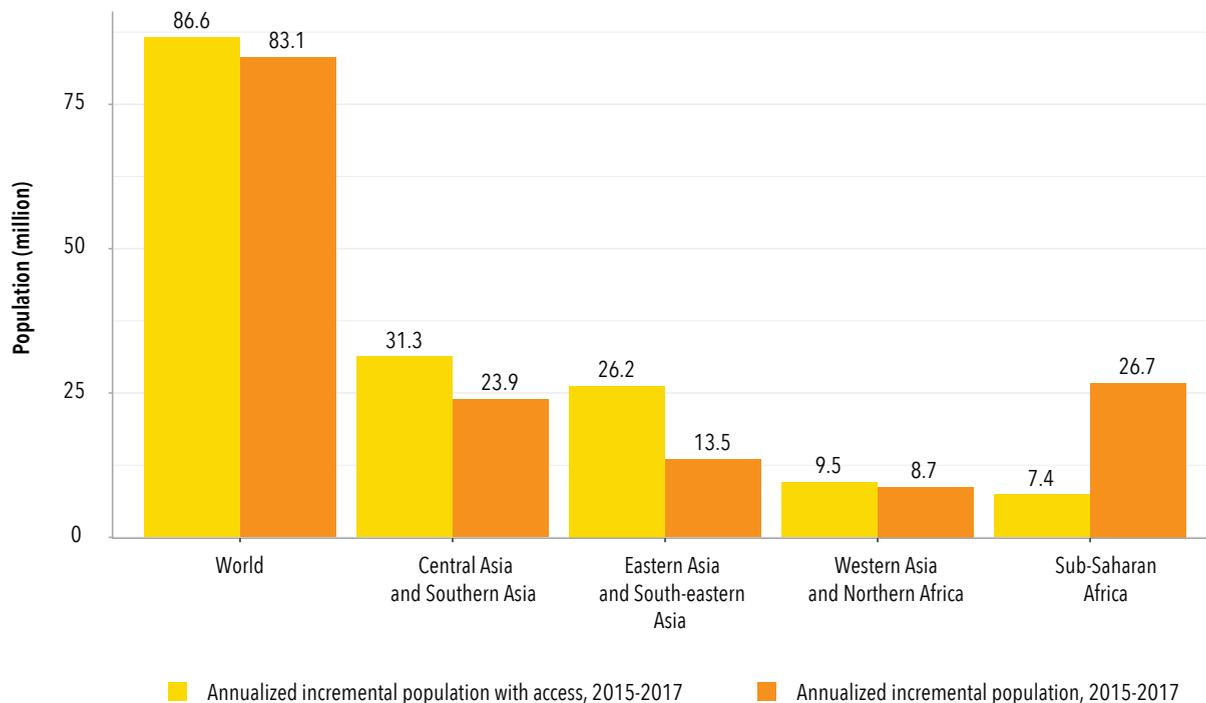
FIGURE 2.5 • AVERAGE ANNUAL INCREASE (PERCENTAGE POINTS) IN THE GLOBAL CLEAN COOKING ACCESS RATE (THE PERCENTAGE OF PEOPLE WITH ACCESS)



Source: WHO 2019.

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

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



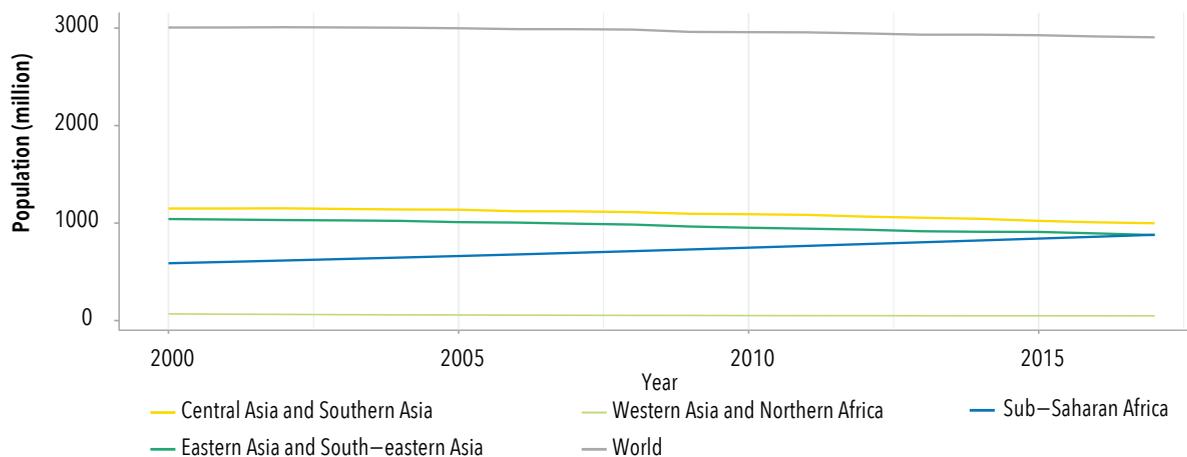
Source: WHO 2019.

Note: UN estimates of population were used.

THE ACCESS DEFICIT

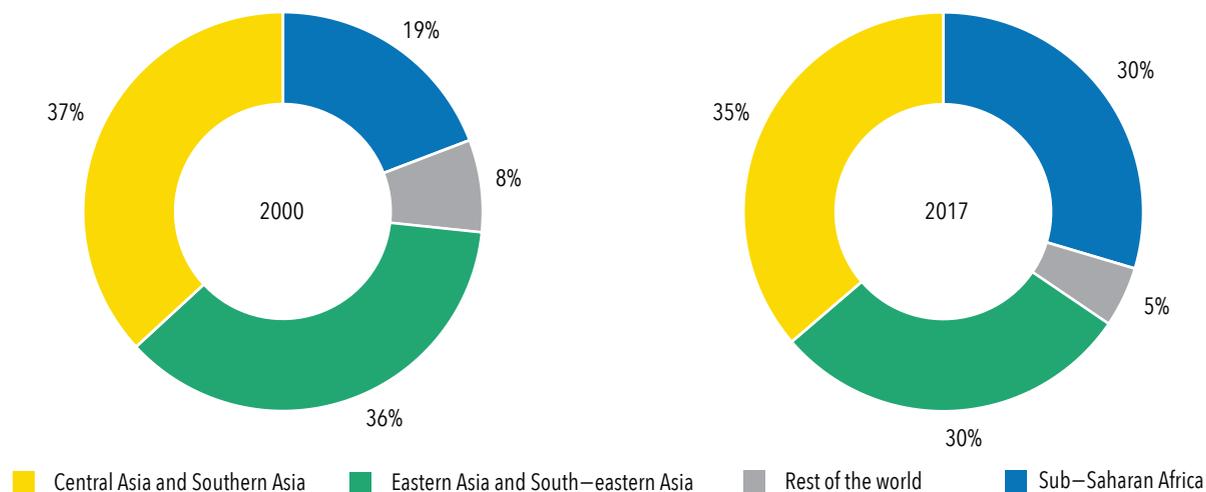
In some parts of the world, the human cost from cooking-related air pollution is increasing. The change over time in the population lacking access to clean cooking solutions, known as the access deficit, is illustrated for each region in figure 2.7. The plot shows that the global population lacking access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

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



Source: WHO 2019.

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



Source: WHO 2019.

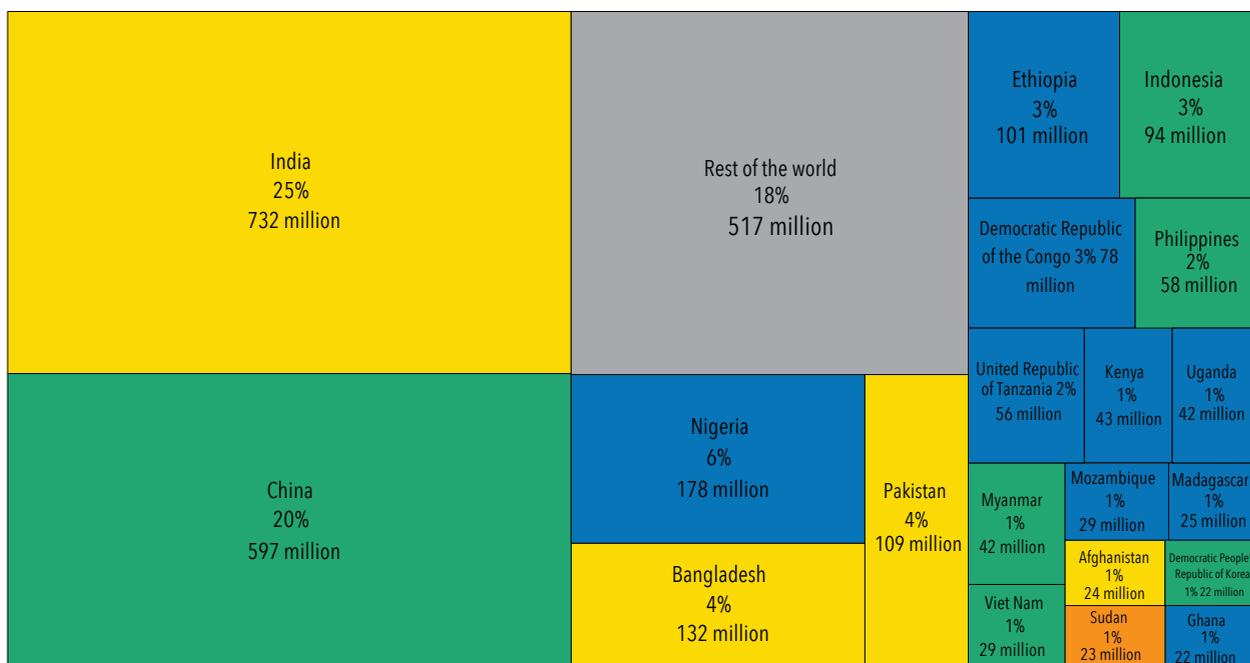
From 2000 to 2017, the percentage of the global access-deficit population who resides in Central and Southern Asia changed only a little, being still slightly more than one-third. Meanwhile, the proportion in Sub-Saharan Africa increased from approximately one-fifth to almost one-third of the total;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

COUNTRY TRENDS

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

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

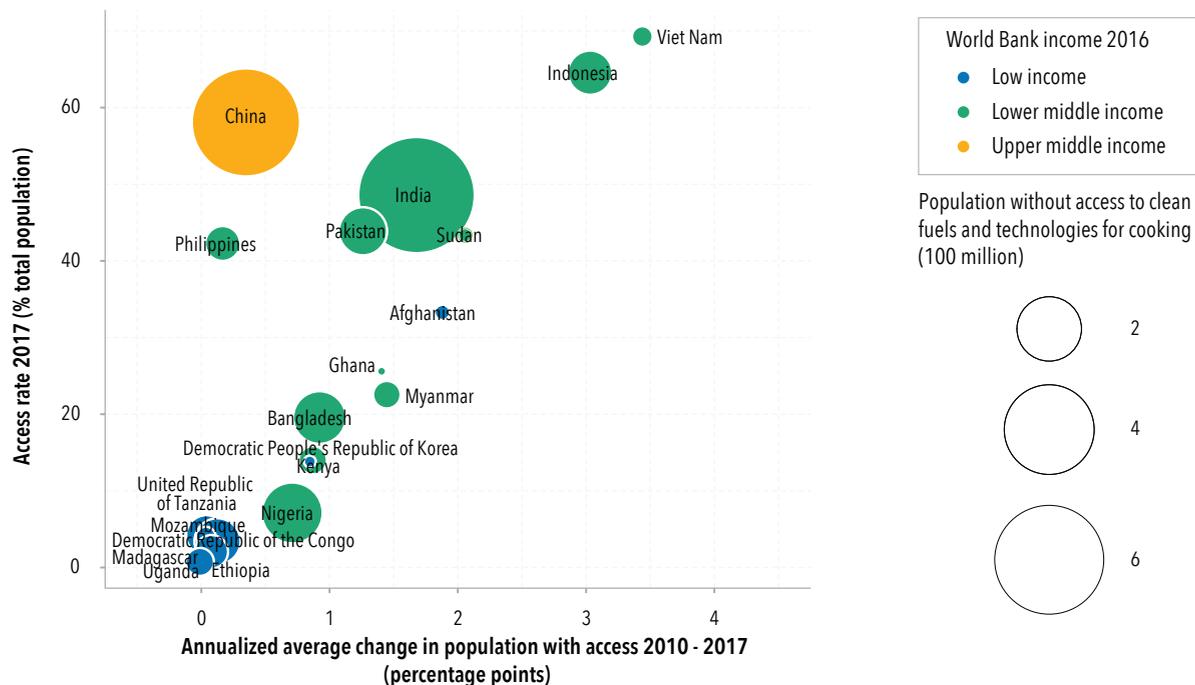
FIGURE 2.9 • THE 20 LARGEST ACCESS-DEFICIT COUNTRIES, BY SHARE OF TOTAL ACCESS DEFICIT AND NUMBERS OF PEOPLE WITHOUT ACCESS, 2017



- Central Asia (M49) and Southern Asia (MDG=M49)
- Eastern Asia (M49) and South-eastern Asia (MDG=M49)
- Sub-Saharan Africa (M49)
- Western Asia (M49) and Northern Africa (M49)
- World

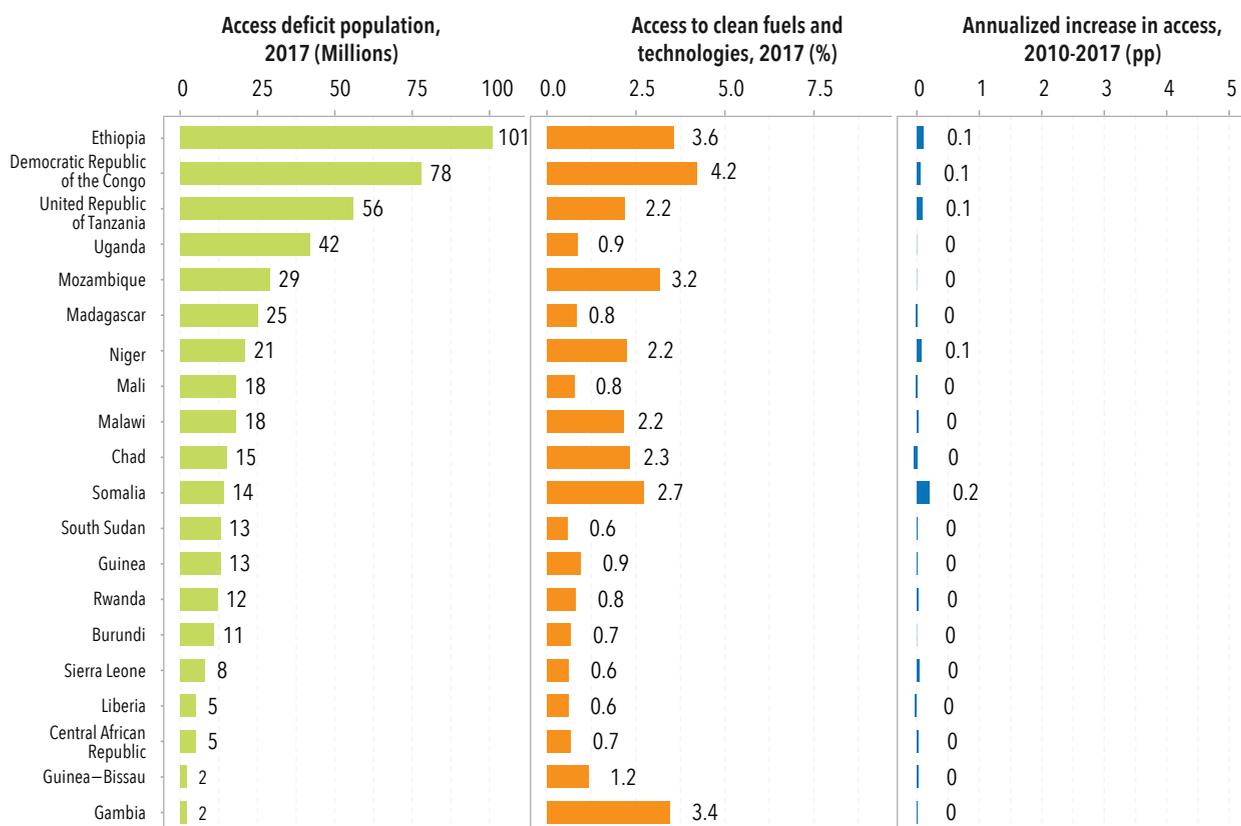
Source: WHO 2019.

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



Source: WHO 2019.

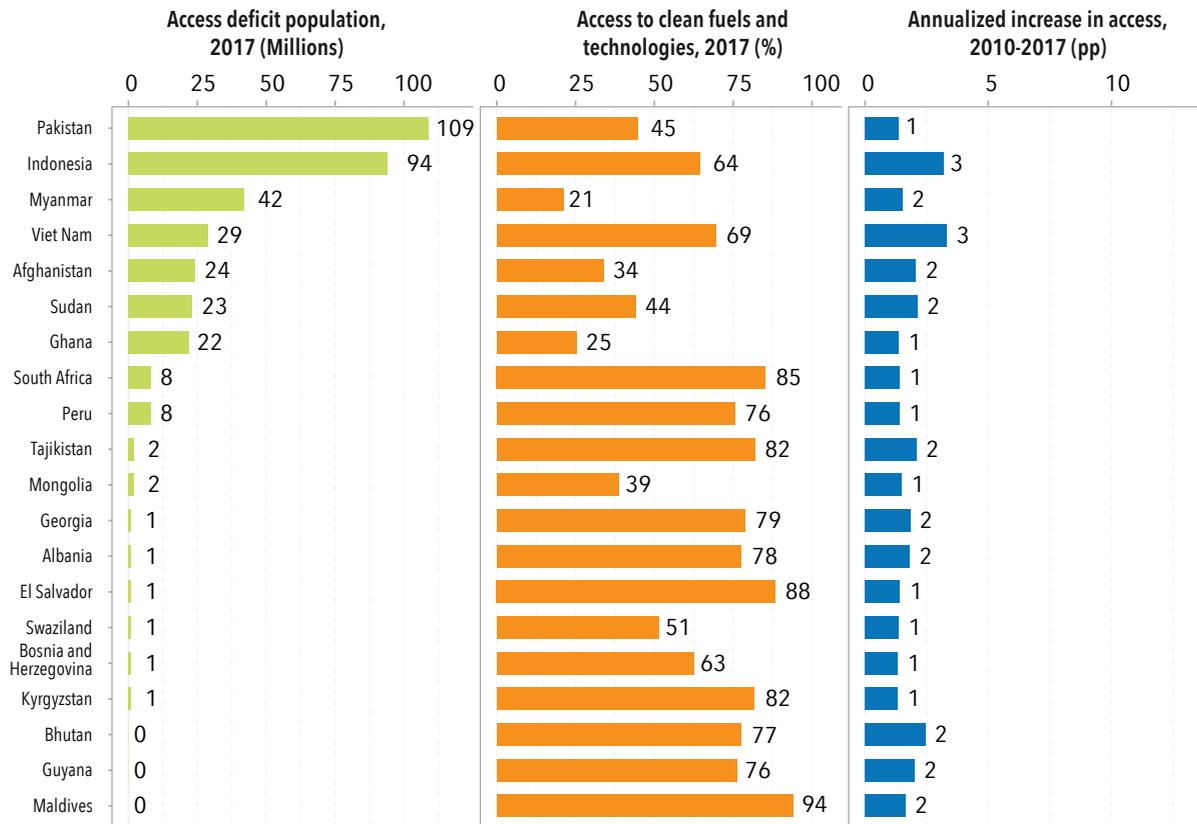
FIGURE 2.11 • ANALYSIS OF THE 20 COUNTRIES WITH THE LARGEST DEFICIT IN ACCESS TO CLEAN COOKING FUELS



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

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

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



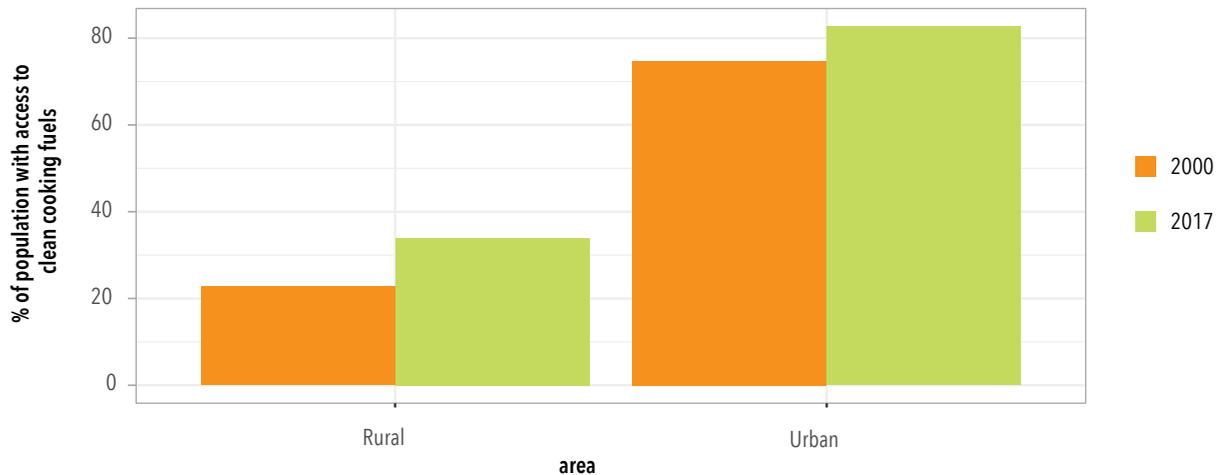
Source: WHO 2019.
Note: pp = percentage points.

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

URBAN-RURAL DIVIDE

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

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



Source: WHO 2019.

UNDERSTANDING THE HOUSEHOLD ENERGY MIX: FUEL TYPES

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

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

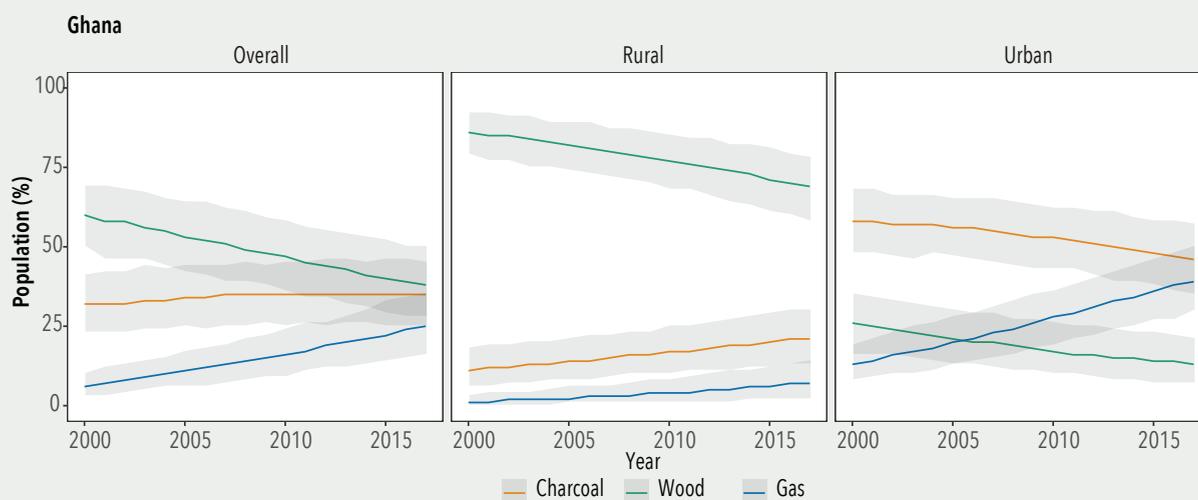
It is worth noting that between 1990 and 2017, an inverse relationship between the use of kerosene and gaseous fuels was observed in low- and middle-income countries around the world. As kerosene use decreased, use of gaseous fuel increased in many areas. Policy makers should set up incentives to pursue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

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

BOX 2.1 • ANALYSIS OF FUEL USE IN GHANA

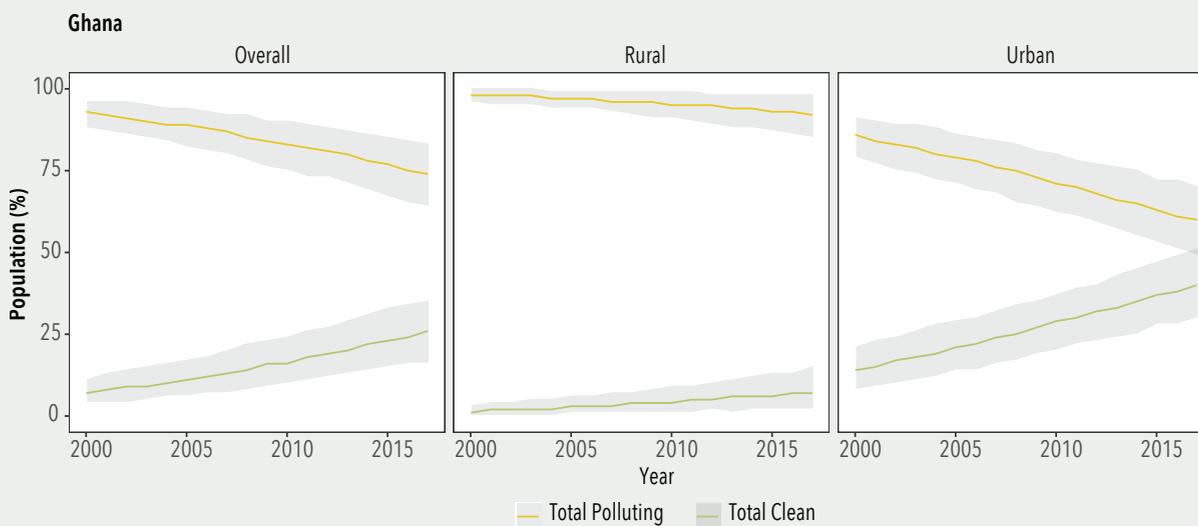
In Ghana, overall use of charcoal was around 35% [25, 45] in 2017 and its use decreased in urban settings, from 58% [48, 68] in 2000 to 46% [35, 57] in 2017. About 69% [58, 78] of the rural population relied on wood as a cooking fuel in 2017, compared with 13% of the urban population [7, -21]. Wood use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

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



Source: Stoner et al. 2019.

Note: Associated confidence intervals are 95%.



Source: Stoner et al. 2019.

Note: Associated confidence intervals are 95%.

POLICY INSIGHTS

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

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

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

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

The key challenges are:

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

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

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

Priority policy actions include:

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

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

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

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

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

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

GEOGRAPHIC VARIATIONS

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

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

None of the top 20 access-deficit countries in Sub-Saharan Africa saw a significant increase in access, with the exception of Ghana, which increased access from 24% in 2015 to 25% in 2017 and expanded access of 1.4 percentage points annually between 2010 and 2017. In terms of policy, Ghana has put many of the building blocks in place for a

successful clean cooking transition, including the development of national standards for cookstoves and a national rural LPG program, which has already distributed some 70,000 LPG cylinders to households since 2014, and efforts to expand the use of biogas and alcohol fuels at the household level. However, misperceptions regarding the safety of LPG use, unaffordable supply, user preferences, and the penetration of inefficient charcoal use in both urban and rural areas are some of the critical barriers toward the sustained adoption of clean household energy in Ghana.

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

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

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

GENDER AND HEALTH IMPLICATIONS

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

Women, who are the ones most impacted by the effects of inefficient cooking, remain an untapped resource to scale adoption. A 2015 study²⁶ showed that empowerment training in Kenya led the sale of cookstoves to more than double. Women sales representatives who received empowerment training outsold men by a margin of three to one. Women can better reach female consumers, which can increase overall sales and peer-to-peer communication to enhance demand, adoption, and ultimately, willingness-to-pay.

LOOKING AHEAD

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

Women entrepreneurs can be a valuable vector for scaling up clean cooking programs, if they are supported to use, market, and sell cookstoves (IRENA 2019). There is a huge global market opportunity for the private sector in access to cooking energy. Developing women's enterprises in the clean energy sector can play a key role along

every step of the value chain. New approaches and business models include a comprehensive entrepreneurship development process that entails a careful identification of the barriers that women face in starting a business and then systematically addresses them through technical, managerial, leadership, and empowerment training; customized support from mentors; the strengthening of product supply chains using the private sector; and the building of partnerships with the private sector and financing institutions, in an ecosystem approach to women's enterprise development. Access to capital is important, but must be complemented by a raft of other measures. These approaches have been demonstrated to be able to overcome market barriers and tap into last-mile markets, for example, the ENERGIA Women's Economic Empowerment Program, which has enabled 4,000 women entrepreneurs in seven countries (Dutta 2018).

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

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

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

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

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

METHODOLOGY

DATA SOURCES

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

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

MODEL

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

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

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

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

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

CONFIDENCE INTERVALS

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

GLOBAL AND REGIONAL AGGREGATED AND ANNUAL GROWTH RATE

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

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

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

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

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

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

REFERENCES

- Bonjour, S., H. Adair-Rohani, J. Wolf, N. G. Bruce, S. Mehta, A. Prüss-Ustün, M. Lahiff, E. A. Rehfuss, V. Mishra, and K. R. Smith. 2013. "Solid Fuel Use for Household Cooking: Country and Regional Estimates for 1980–2010." *Environmental Health Perspectives* 121 (7): 784–90.
- Clean Cooking Alliance. 2019. "Gender and Clean Cooking." Gender Factsheet, February 14. <https://www.cleancookingalliance.org/resources/352.html>.
- Durix, L., C. Rex, H. Monika, M. Joffre, and J. V. Guillermi. 2016. "Contextual Design and Promotion of Clean Biomass Stoves: The Case of the Indonesia Clean Stove Initiative." Live wire knowledge note series no. 2016/64, World Bank Group, Washington, DC. <http://documents.worldbank.org/curated/en/316761475585884934/pdf/108734-REVISED-LW64-fin-logo-OKR.pdf>.
- Dutta, S. 2018. *Supporting Last-Mile Women Energy Entrepreneurs: What Works and What Does Not*. The Hague, Netherlands: International Network on Gender and Sustainable Energy (ENERGIA). <https://www.energia.org/cm2/wp-content/uploads/2019/01/Supporting-Last-Mile-Women-Entrepreneurs.pdf>.
- IEA (International Energy Agency). 2018. *World Energy Outlook 2018*. Paris: IEA.
- IRENA (International Renewable Energy Agency). 2019. *Renewable Energy: A Gender Perspective*. Abu Dhabi: IRENA. <https://www.irena.org/publications/2019/Jan/Renewable-Energy-A-Gender-Perspective>.
- Shankar, A.V, M. Onyura, and J. Alderman. 2015. "Agency-Based Empowerment Training Enhances Sales Capacity of Female Energy Entrepreneurs in Kenya." *Journal of Health Communication* 20 (Suppl 1): 67–75. <https://www.ncbi.nlm.nih.gov/pubmed/25839204>.
- Stoner, O., G. Shaddick, T. Economou, S. Gummy, J. Lewis, I. Lucio, and H. Adair-Rohani. 2019. "Estimating Global Household Air Pollution: A Multivariate Hierarchical Model for Cooking Fuel Prevalence." Cornell University, New York. <https://arxiv.org/abs/1901.02791>.
- SEforALL (Sustainable Energy for All) and CPI (Climate Policy Initiative). 2018. *Energizing Finance: Understanding the Landscape 2018*. Washington, DC: SEforALL and CPI. <https://www.seforall.org/EnergizingFinance2018>.
- UN (United Nations). n.d. "SDG Indicators Regional Groupings Used in 2017 Report and Statistical Annex." <https://unstats.un.org/sdgs/indicators/regional-groups/>.
- WHO (World Health Organization). 2018a. "Burden of Disease from Household Air Pollution for 2016." April. https://www.who.int/airpollution/data/HAP_BoD_results_May2018_final.pdf.
- . 2018b. "Air Pollution: WHO Household Energy Database." WHO, Geneva. <https://www.who.int/airpollution/data/household-energy-database/en/>.
- . n.d. "Health Statistics and Information Systems: Definition of Regional Groupings." WHO, Geneva. https://www.who.int/healthinfo/global_burden_disease/definition_regions/en/.

ENDNOTES

- 21 Electricity, liquid petroleum gas, natural gas, biogas, solar, and alcohol fuels.
- 22 Bracketed percentages represent a 95% confidence interval (for more details, refer to the methodology section at the end of this chapter).
- 23 The 20 countries with the largest access-deficit population. These are Afghanistan, Bangladesh, China, the Democratic People's Republic of Korea, the Democratic Republic of Congo, Ethiopia, Ghana, India, Indonesia, Kenya, Madagascar, Mozambique, Myanmar, Nigeria, Pakistan, the Philippines, Sudan, Uganda, Tanzania, and Vietnam.
- 24 See WHO Household Energy Database (WHO 2018b) and Stoner et al. (2019).
- 25 For additional information, see the Clean Cooking Alliance (2019).
- 26 Agency-based empowerment training has been seen to enhance sales capacity of female energy entrepreneurs in Kenya (Shankar, Onyura, and Alderman 2015):\Users\fayre\Documents\Clients\SBK\bmed\25839204.

