A Vision for Clean Cooking Access for All

International Energy Agency

In collaboration with

AFRICAN DEVELOPMENT BANK GROUP
GROUPE DE LA BANQUE AFRICAINE DE DÉVELOPPEMENT

World Energy Outlook Special Report

iea

A Vision for Clean Cooking Access for All

International Energy Agency

World Energy Outlook Special Report

INTERNATIONAL ENERGY AGENCY

The IEA examines the full spectrum of energy issues including oil, gas and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand side management and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability and sustainability of energy in its 31 member countries, 13 association countries and beyond.

IEA member countries:

Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Japan
Korea
Lithuania
Luxembourg
Mexico
Netherlands
Norway
Poland
Portugal
Slovak Republic
Spain
Sweden
Switzerland
Republic of Türkiye
United Kingdom
United States

The European Commission also participates in the work of the IEA

IEA association countries:

Argentina
Brazil
China
Egypt
India
Indonesia
Kenya
Morocco
Senegal
Singapore
South Africa
Thailand
Ukraine

AFRICAN DEVELOPMENT BANK GROUP

The overarching objective of the African Development Bank (AfDB) Group is to spur sustainable economic development and social progress in its regional member countries (RMCs), thus contributing to poverty reduction. The Bank Group achieves this objective by mobilizing and allocating resources for investment in RMCs and by providing policy advice and technical assistance to support development efforts.

Source: IEA.
International Energy Agency
Website: www.iea.org

Foreword by the Executive Director, International Energy Agency

Today, nearly one third of people around the world cook their meals with rudimentary methods. They burn coal, firewood, and even animal dung as fuel, breathing in hazardous fumes daily. It is a silent killer, contributing to millions of premature deaths each year, with women its likeliest victims.

Many in advanced economies take for granted access to modern cooking appliance and the energy that is reliably delivered to our homes to run them. Yet, these appliances are unaffordable or unattainable for many households in developing economies. Bringing clean cooking to the 2.3 billion people who live without it today can transform their lives. It is central not only to the transition to modern, secure and sustainable energy, but to many other facets of the development agenda such as poverty reduction, health and gender equality.

By almost every metric, women suffer the most due to a lack of access to clean cooking solutions. Without these amenities, cooking becomes a full-time job for many women. They spend, on average, five hours each day collecting fuel and cooking, which deprive them of their health as well as opportunities like accessing basic education, taking up employment or starting a business that could deliver financial independence. Many inspiring women leaders are at the forefront of advances in clean cooking today, but troubling disparities in female empowerment in government, business, and the home means clean cooking remains an afterthought in many parts of the world.

Nearly 20 years ago, as IEA's Chief Economist, I first called upon policy makers to make modern cooking solutions for every household around the world a priority issue in "Energy Economics: A Place for Energy Poverty in the Agenda?". In 2015, universal access to clean cooking by 2030 was rightly included among the United Nations' Sustainable Development Goals, and this year marks the midway point toward that goal. Unfortunately, the world has not committed nearly enough resources to reaching it, most notably in sub-Saharan Africa where the number of people without clean cooking continues to rise.

The barriers to delivering on the promise of clean cooking for all are not technical. What is encouraging and disturbing, in equal measure, is that this huge environmental, economic and human challenge could be solved with relatively modest investment. While addressing the issue is complex, there are success stories in India, China, and Indonesia, where those without access were halved last decade.

In 2005 I wrote "Rich industrialised countries have an important role to play in this process. In addition to moral issues involved, we have obvious long-term economic, political and energy-security interests in helping developing countries along the path to energy development. For as long as poverty, hunger and disease persist, the poorest regions will remain vulnerable to humanitarian disasters, to social injustice and to political instability. Lack of resources is not an excuse. The cost of providing assistance to poor countries may

turn out to be far less than that of dealing with the instability and insecurity that poverty creates."

This report, in partnership with our colleagues at the African Development Bank Group, indeed finds that the costs of achieving full access are minimal - and the benefits huge. In 2023, it is inexcusable that people still lack these fundamental services. Between now and COP28, we have an opportunity to make vital progress on clean cooking by rapidly scaling up implementation and mobilising the necessary financial resources that will help reach our shared target.

Dr Fatih Birol
Executive Director
International Energy Agency

Foreword by the President of the African Development Bank Group

It is my pleasure to write a foreword for this new report "A Vision for Clean Cooking Access for All". This is a pioneering knowledge piece from the International Energy Agency (IEA), in collaboration with the African Development Bank Group. The report presents the most recent data and insights on clean cooking, with particular emphasis on Africa, where four out of five individuals lack access to clean cooking solutions. Achieving a Just Energy Transition must therefore be secured in tandem with bridging the clean cooking gap.

The report offers invaluable insights, analysis, and recommendations regarding the current situation and the consequences of inaction in the sector. As such, the report spotlights clean cooking within the context of the current policy landscape, painting a grim picture of the access gap in 2030. The report also outlines country-specific assessments, in addition to providing a roadmap for achieving universal clean cooking access. Finally, it provides an overview of the required policies, technologies, investments, and implementation efforts necessary to attain this ambitious target.

The report presents a comprehensive view of a Stated Policies Scenario underscoring the limited advancements made towards achieving universal access to clean cooking. It examines the rate of progress on a country-by-country basis, the fuel and technology combinations employed to meet access requirements and evaluates the necessary investments and environmental implications. Regrettably, based on existing policies, the world – and especially Africa – will fall short of universal access to clean cooking by 2030.

To address this gap, the report explores an Access for All Scenario. This scenario examines practical regional strategies required to guarantee universal access to clean cooking, thereby aligning with the objectives of SDG7. These pathways consider best practices, cultural considerations, cost factors, technical limitations, and national objectives. Moreover, this scenario delivers a clearer understanding of the actions and measures needed for global progress in this direction.

The report evidences that transforming the clean cooking landscape is a complex endeavour with no straight-forward solutions, but one that requires the establishment of clear policies and robust regulatory frameworks as foundational elements for attracting and driving investment in clean cooking projects.

Meanwhile, financial incentives are a vital policy tool for facilitating the accelerated deployment of clean cooking technologies. In this regard, approximately USD 8 billion of equipment and infrastructure is required annually from now to 2030 to underpin universal access to clean cooking solutions. But, this must be complemented by steadfast leadership from policymakers, given that governments are best-placed to influence the future.

The African Development Bank Group is actively engaged in accelerating efforts to reach universal access to clean cooking through various instruments and initiatives. This includes investing through financial intermediaries such as the Spark+ Africa Fund which has raised

USD 64 million to deliver clean cooking technologies and reduce carbon emissions by around 15 Mt of CO_2 equivalent by cutting emissions from the use of inefficient stoves and open fires and forest degradation for wood fuel. Other interventions include the incorporation of clean cooking into countries' electrification programs, and the provision of technical assistance to ministries of energy and industry bodies.

I hope you will enjoy reading this incredibly insightful report. May it inform, empower, and inspire you to join us in our noble pursuit for global universal access to clean cooking – and especially in Africa.

Dr. Akinwumi Adesina
President
African Development Bank Group

This study was prepared by the Energy Modelling Office-Energy Demand Outlooks (EMO-EDO) team in the Directorate of Sustainability, Technology and Outlooks (STO) in co-operation with other directorates and offices of the International Energy Agency (IEA).

The report was carried out in collaboration with the African Development Bank (AfDB) Group.

The study was designed and directed by **Laura Cozzi**, Director of Sustainability, Technology and Outlooks (IEA). **Daniel Wetzel** co-ordinated the drafting and analysis.

The modelling and analytical work for this study were led by **Gianluca Tonolo**, Energy Access Analyst (IEA) and **Oliver Joy** served as lead writer**.** Other principal IEA authors include: **Ethan Clarke-Hampton Harrison** (data science and research), **Daniel Crow** (emissions), **Nouhoun Diarra** (energy access), and **Gabriel Saive** (lead data science and research).

Other valuable contributions were made by Alexandre Bizeuil, Poeli Bojorquez, Stéphanie Bouckaert, Olivia Chen, Davide D'Ambrosio, Darlain Edeme, Syrine El Abed, Rebecca Gaghen, Emma Gordon, Domenico Lattanzio, Luca Lo Re, Rita Madeira, Arnaud Rouget, Thomas Spencer, Carlo Starace, Sanne van der Milj, David Wilkinson, and Wonjiik Yang.

Contributions from the African Development Bank Group were coordinated by **Kevin Kariuki**, Vice President, Power, Energy, Climate and Green Growth, and key contributors include Dr. Daniel Schroth, Monojeet Pal and Adele Boadzo from the Renewable Energy and Energy Efficiency Department, and Molka Majdoub from the Office of the President.

This report benefited greatly from contributions, data, analysis, and guidance from key international experts. They include:

Rashid Ali Abdallah	African Energy Commission (AFREC)
Heather Adair-Rohani	World Health Organisation (WHO)
Donee Alexander	Clean Cooking Alliance (CCA)
Robert Bailis	Stockholm Environment Institute
Simon Batchelor	Modern Energy Cooking Services (MECS)
Jillene Belopolsky	Clean Cooking Alliance (CCA)
Kimbal Chen	Global LPG Partnership (GLPGP)
Nicklas Forsell	International Institute for Applied System Analysis (IIASA)
Francesco Fuso-Nerini	Swedish Royal Institute of Technology (KTH)
Camilo Ramirez Gomez	Swedish Royal Institute of Technology (KTH)
Babak Kavari	Swedish Royal Institute of Technology (KTH)
Matthew Leach	Modern Energy Cooking Services (MECS)
Jon Leary	Modern Energy Cooking Services (MECS)
Mikael Melin	Sustainable Energy for All (SE4ALL)

Nishant Narayan	Sustainable Energy for All (SE4ALL)
Caroline Ochieng	Sustainable Energy for All (SE4ALL)
Shonali Pachauri	International Institute for Applied System Analysis (IIASA)
Cédric Philibert	International expert
Jem Porcaro	Sustainable Energy for All (SE4ALL)
Elisa Puzzolo	University of Liverpool
David Tyler	World LPG Association (WLPGA)
Kendra Williams	World Health Organisation (WHO)

Thanks go to the IEA's Communications and Digital Office for their help in producing the report and website materials, particularly to Poeli Bojorquez, Curtis Brainard, Astrid Dumond, Merve Erdil, Grace Gordon, Jethro Mullen, Isabelle Nonain-Semelin, Robert Stone, Julie Puech, Gregory Viscusi, Lucile Wall, and Wonjik Yang.

Ivo Letra and Ben McCulloch provided essential support to the production process. IEA's Office of the Legal Counsel, Office of Management and Administration and Energy Data Centre provided assistance throughout the preparation of the report.

The work could not have been achieved without the support provided by the IEA's Clean Energy Transition Programme and the Agency for Development and Cooperation, Switzerland. Additional support was provided by other government bodies, organisations and companies worldwide, notably: European Commission, Directorate-General for International Partnership; European Commission, Directorate-General for Climate; Government of Japan; Netherlands, Ministry of Economic Affairs and Climate Policy; The Norwegian Development Agency (NORAD); and United States Agency for International Development Power Africa.

Peer reviewers

Many other international experts provided input and reviewed preliminary drafts of the report, in addition to the external contributors above. Their comments and suggestions were of great value. They include:

Esther Altorfer	Sistema Bio
Aayushi Awasthy	KAPSARC and Tyndall Centre for Climate Change Research
Papa Samba Ba	Ministère du Pétrole et des Energies - Sénégal
Bipasha Barua	University of Western Ontario
Tim Bauer	Envirofit
David Bleasedale	CITAC
Molly Brown	Burn
Ute Collier	International Renewable Energy Agency (IRENA)

Emmanuela Colombo	Politecnico di Milano
Hannah Daly	University College Cork
Gbaty Tiadja Gbandey	African Energy Commission (AFREC)
Mark Howells	University of Loughborough
Anthony Kamara	International Expert
Isaac Kiva	Ministry of Energy and Petroleum - Kenya
Anibor Kragha	African Refiners and Distributors Association (ARDA)
Hanaan Marwah	KOKO
James McCullagh	CITAC
Ted Miller	Burn
Jan Petter Nore	Norwegian Agency for Development and Cooperation (NORAD)
Abdoulaye Oueddo	African Energy Commission (AFREC)
Gary Still	CITAC
Robert Stoner	Massachusetts Institute of Technology (MIT)
Yagouba Traore	African Energy Commission (AFREC)
Karin Troncoso Torrez	World Health Organisation (WHO)
Ruben Walker	Africa Clean Energy (ACE)
Molly Walton	We Mean Business Coalition

The individuals and organisations that contributed to this study are not responsible for any opinions or judgements it contains. All errors and omissions are solely the responsibility of the IEA.

Comments and questions are welcome and should be addressed to:

Laura Cozzi and Daniel Wetzel

Directorate of Sustainability, Technology and Outlooks
International Energy Agency
9, rue de la Fédération
75739 Paris Cedex 15
France

E-mail: weo@iea.org

Web: www.iea.org

A Vision for Clean Cooking Access for All

Nearly one third of the world still relies on rudimentary cooking means with grave consequences

Today, 2.3 billion people worldwide – nearly one third of the global population - still cook their meals over open fires or on basic stoves, breathing in harmful smoke released from burning coal, charcoal, firewood, agricultural wastes, and animal dung. These practices can still be found in 128 countries today—where households do not have the tools or means to reliably cook meals using clean burning fuels. Even the simplest, widely available cooking devices could improve this situation, including devices like camp stoves using liquefied petroleum gases (LPG) and electric hotplates.

A lack of clean cooking contributes to 3.7 million premature deaths annually, with women and children most at risk. Poor indoor air quality is a leading cause of premature death worldwide. In Africa alone, women and children account for 60% of early deaths related to smoke inhalation and indoor air pollution. This is primarily the result of basic cooking practices that lead to respiratory complications and cardiovascular diseases.

Women disproportionately endure the negative consequences of rudimentary cooking, while afforded limited ways to change to cleaner solutions. In addition to health risks, a lack of clean cooking prevents many women and girls from accessing education, earning a wage, or starting a business that would deliver financial autonomy. In many parts of the world, they typically have little say over household spending, with other purchases prioritised over clean cooking devices. Under-representation of women within executive institutions means that clean cooking also remains low on the political agenda.

Lost time and productivity results in a huge economic cost due to hours spent collecting firewood and other fuel sources. Households without clean cooking spend an average of 5 hours per day collecting fuel and cooking. Daily trips to gather firewood expose women to the risk of violence and assault as they leave their communities to search further afield.

Basic cooking methods using wood and charcoal often contribute to deforestation. The demand for firewood and charcoal results in the loss of forests the size of Ireland each year, with the worst effects concentrated in places like East and Southern Africa where large populations increasingly rely on dwindling forests. This has also led to food stress in some regions where fruiting trees are cut for firewood.

Progress has been swift in Asia, but remains slow in sub-Saharan Africa

Thanks to progress in Asia and Latin America, the number of people without access to clean cooking has been declining, but in sub-Saharan Africa, that number has never stopped growing. The number of people globally without clean cooking fell from 3 billion in 2010 to 2.3 billion in 2022. China, India and Indonesia all halved their populations without clean cooking access. These efforts relied largely on providing free stoves and subsidised canisters

of liquefied petroleum gas (LPG). During the same period, the number of people without clean cooking access continued to grow in sub-Saharan Africa, where clean cooking campaigns did not to keep pace with population growth. Today, 1 billion people on the continent—roughly four in every five—rely on highly polluting cooking fuels used in open fires or basic stoves.

Asia is set to continue providing greater clean cooking access, while most African countries are not expected to reach full clean cooking access even in the 2050s. Under today's policies, the number of people without access to clean cooking is set to decline from 2.3 billion today to 1.8 billion in 2030. Progress continues at a strong pace in Asia, but Africa would end the decade with the same number of people without clean cooking access as today.

Reaching universal access to clean cooking is not a question of technology, and the policy solutions are known, but implementation capacity and funding is lacking. Today, less than a third of people without access to clean cooking live in countries with adequate policies and funding needed to reach universal access by 2030. The gap is widest in Africa where clean cooking plans often lack resources. At present, less than a third of clean cooking plans in Africa are funded, while a confluence of the Covid-19 pandemic and high fuel prices, driven by the global energy crisis, led to a scale back of incentives and financial support to households.

Universal access to clean cooking by 2030 can only be achieved by replicating historic bests

Reaching universal access to clean cooking requires delivering best practices to countries that have made little progress to date, with a special focus on rural areas. Nearly 300 million people need to gain access to cleaner cooking means each year to ensure universal access by 2030, with sub-Saharan Africa accounting for half of the total. Delivering on this annual target would require matching the record years set in China, India and Indonesia combined over the last decade. It also requires stronger efforts in rural areas, where three quarters of those without access live today.

The IEA's analysis identifies a least-cost, realistic scenario to reach universal clean cooking, requiring solutions which are all commercially available today. LPG remains the primary solution to deliver clean cooking access, representing nearly half of the households gaining access to 2030. In the last decade, 70% of those who gained access did so through LPG. Electric cooking becomes the main option for one in eight homes gaining access by 2030, while many more homes adopt appliances like rice makers as part of their cooking routines. Electric cooking benefits from reduced imports, but faces challenges due to low electricity access rates and unreliable grids in some regions to scale. In rural areas, where fuel and electricity infrastructure are lacking, improved cookstoves (ICS) serve as an interim solution to deliver health benefits and time savings in the near term. If minimum performance standards are enforced, ICS reduce fuel needs by 20-75% and drastically cut dangerous smoke and fumes. Continued efforts to provide modern cooking solutions help replace ICS as the primary cooking means for homes by 2040.

Universal access by 2030 comes at a small cost and brings huge benefits

Investment in clean cooking stoves, equipment, and infrastructure over this decade would need to reach about USD 8 billion annually. This is less than 1% of what governments spent in 2022 globally on measures to keep energy affordable for their citizens amidst the global energy crisis. It is also less than 1% of what governments spent last year to keep energy prices affordable for their citizens. Investment would need to grow from levels around USD 2.5 billion today, with most of the growth in sub-Saharan Africa, which would make up to USD 4 billion of the total investment need this decade.

According to the IEA's analysis, increased demand for modern cooking fuels can be met readily by today's energy system, however it will require some additional infrastructure, especially in Africa. Achieving clean access for all by 2030 adds less than 3% to modern energy demand today, while the use of fuel wood and charcoal falls by 70% in emerging and developing economies. Existing infrastructure handles the scale up in most regions, but sub-Saharan Africa requires new supporting infrastructure. In sub-Saharan Africa, LPG demand grows by three-fold, requiring an expansion of distribution services, canisters, and fuelling depots. Electric cooking would increase demand by 10% by 2030, which could place strains on electricity networks at the distribution level if not paired with effective electricity planning.

The gender equality, health and time-savings benefits of universal clean cooking are immense. Our analysis shows that there are 2.5 million less premature deaths caused by the fall in air pollution toward 2030, and the average household saves on nearly 1.5 hours a day from the switch, which can instead be spent pursuing education or work. The time-savings from universal access to clean cooking are roughly equal to the working hours put in by the entire Japanese labour force in 2022.

The shift toward clean cooking creates jobs, but also reduces the need for charcoal, a major part of Africa's informal economy today. The push to reach universal access to clean cooking could employ nearly 1.5 million people in stove production and sales, fuel delivery, and supporting clean cooking campaigns. Making this transition, however, impacts the millions of people working in the charcoal and firewood trade today. These jobs, while still needed in 2030, could decline substantially, emphasising the need for a just, people-centred transition, including efforts to formalise these industries and upskill workers.

Reaching universal access to clean cooking is a net-gain for the environment too. The switch to clean cooking solutions, such as LPG, drives up emissions by 0.1 Gt in 2030. However, the reduction of fuelwood and charcoal consumed also reduces methane and other greenhouse gas emissions emitted by incomplete combustion in basic stoves by 0.9 Gt of CO_2-eq. Deforestation is also reduced, saving 0.7 Gt in 2030. Overall, following the IEA vision for clean cooking for all results in a net reduction of 1.5 gigatons of CO_2 equivalent by 2030, similar to the amount of CO_2 emitted by planes and ships last year.

Realising universal access requires national leadership, with strong involvement from women, and increased international and climate finance

Less than 10% of people without access to clean cooking live in countries with adequate policies and funding needed for a successful clean cooking programme. Reaching universal access to clean cooking will depend on strong national leadership and programmes that are reinforced by international financial support. Key enablers include regulatory authority for implementing agencies, public engagement campaigns, and financial support for consumers to manage upfront stove costs and ongoing fuel costs.

Switching to clean cooking depends on rapid, widespread changes in social norms, where grassroots efforts have proven essential. Successful clean cooking campaigns have been accompanied by user engagement and education programmes. These initiatives engage users on matters such as stove use and maintenance, recipes adjusted for their new stoves, and education on the benefits of clean cooking. Peer-to-peer advocacy, especially women-led, can be the difference between lasting adoption and stoves falling into disuse.

Affordability remains a major challenge, with financial support needed for most households to cover upfront stove costs and, in some cases, ongoing fuel costs. Over half of households lacking clean cooking are unable to afford it on an ongoing basis. The upfront cost of a stove for a low-income household can range from one-third of monthly income to three-quarters, depending on the technology. Yet, if annualised, switching to a modern cookstove eventually pays for itself, and more, due to higher efficiencies and reduced expenditure for charcoal and firewood. Still, for a handful of households, ongoing price support will likely be needed. Governments must balance affordability support with risks of ballooning imports and intractable subsidies. Better targeting of incentives and cross-subsidisation between customers can help.

Around half of the USD 8 billion needed each year in clean cooking investments would need to be concessional finance. International financial flows have and will play a key role in advancing clean cooking, especially in regions without the fiscal space to drive the required investment through public funds. Early efforts funded through development efforts has cultivated a maturing private sector, able to attract more private finance and to take on corporate equity and debt. Still, highly concessional financing will still be needed to support projects in the poorest regions. Around three quarters of concessional finance would need to flow to sub-Saharan Africa.

Access to Clean Cooking

A blindspot in the global energy transition

SUMMARY

- Today, 2.3 billion people—nearly one in three people—still cook their meals over open fires and traditional stoves, using wood, charcoal, kerosene, coal, and even animal waste. Basic cooking devices found in every modern kitchen are unaffordable for most of these households— this extends to simple devices like pressure cookers, propane camp stoves, or electric hotplates. Providing every home with a modern cooking device and access to affordable, secure fuel is at the core of the clean cooking agenda. In 2015, the United Nations set a target to provide every person access to clean cooking by 2030 in the Sustainable Development Goals. Progress to date has been insufficient to reach this target, and a lack of clean cooking remains a challenge in 128 countries today.
- Transitioning to clean cooking delivers immense benefits, by saving lives, time, money, and the environment. Poor air quality from traditional cooking indoors is a major contributor to premature deaths, which if ranked on its own, would be third among premature deaths globally, and second in Africa. Women disproportionately bear the consequences of a lack of clean cooking, forgoing opportunities to pursue schooling, employment, and economic freedom, as they spend five hours a day on average gathering fuel and tending to cooking fires. A lack of clean cooking also contributes to deforestation, environment degradation, and greenhouse gases.
- The number of people without access to clean cooking has fallen by 0.7 billion since 2010. Success stories in China, India and Indonesia demonstrate how focused national efforts backed by public funding can have an impact, with each country providing 2-4% of its population with clean cooking each year. Some sub-Saharan African countries have provided access to 1-1.5% of their population, but still saw a rise in those without access, as population growth outpaced progress. Today, more than four out of five sub-Saharan Africans do not have access to clean cooking.
- The Covid-19 pandemic and high energy prices has brought clean cooking progress to a standstill, pushing 100 million households back to traditional modes of cooking. Rising debt burdens, particularly in Africa, are leading some countries to roll back clean cooking programmes and affordability support.
- Reaching universal access must navigate cultural sensitivities and adoption challenges, but the technical and policy solutions are well-known. The bulk of the people gaining access since 2010 have done so using liquified petroleum gasses (LPG), typically via large government programmes. Electric cooking is poised to play a growing role in households that have, or gain access to, reliable, affordable electricity. A number of other solutions, many using bioenergy, helped provide access in rural areas where a lack of infrastructure and affordability pose major barriers.

1.1 Introduction

One in three people in the poorest regions of the world still cook over traditional stoves and open fires, inhaling hazardous smoke every day that causes millions of premature deaths each year. Women and children are disproportionately affected, in many regions spending hours a day collecting and foraging for firewood to burn, with some resorting to burning animal dung and other wastes for cooking. In some areas, demand for wood and charcoal has led to deforestation, habitat destruction, and even some resorting to chopping down fruiting trees, putting strain on food systems. The hours spent each day gathering fuel and tending to fires contributes to significant time poverty, restrict women and children's opportunity to pursue basic education and formal employment. The stoves needed to address these issues are available at prices as low as USD 20 and the switch to cleaner fuels can cost less per meal than purchased wood and charcoal. However, these remain out of reach for many, especially those who do not earn wages nor have access to remunerated employment.

The clock on achieving universal access to clean cooking worldwide by 2030 is quickly ticking down, as 2023 marks the halfway point for reaching the United Nation's Sustainable Development Goal 7 (SDG7), which targets universal access to affordable, reliable, sustainable, and modern energy for all. However, countries like China, India, and Indonesia have seen remarkable progress and are reaping the benefits of wider access to clean cooking through increased productivity, reduced healthcare costs, and greater convenience, with implementation initiatives enjoying widespread political support. But the number of people without access to clean cooking is still rising in sub-Saharan Africa where population growth is outpacing progress.

Efforts to accelerate energy development and transition must find a central place for access to clean cooking, especially in Africa. Much of the global development agenda depends on it. This year's international meetings on energy, development and climate present a prime opportunity to advance clean cooking up the global agenda. Momentum from France and Barbados' Summit for a New Global Financial Pact could spur important outcomes at the forthcoming SDG Summit in New York, Kenya's African Climate Action Summit and COP28.

The IEA's new report *A Vision for Clean Cooking Access for All 2023* aims to inform these important dialogues by bringing together the latest analysis and data on clean cooking, with a special focus on Africa, where efforts are most urgently needed to fulfil the Sustainable Development Agenda. As one of the official co-custodians of SDG7, the IEA builds on more than two decades of work on energy access issues and is partnering with the African Development Bank Group to shed light on the challenges and successes in sub-Saharan Africa. The report also aims to leverage the rich body of work from other international partners deeply involved in shaping the global clean cooking agenda. The short report covers:

- The state of play today and the costs of inaction.
- The outlook for clean cooking under today's policies including country-by-country assessments, and the roadmap to universal access to clean cooking.

- An overview of the policies, technologies, investments, and implementation efforts needed to reach universal access.

The report aims to shine a light on one of the most overlooked aspects of global energy systems in emerging and developing economies, in the hope that the world may arrive at a meaningful outcome on clean cooking before this year's COP28 hosted in the United Arab Emirates.

1.2 What is clean cooking?

For the purposes of this report, clean cooking access is defined as a household that has reliable access to and uses as their primary cooking means, fuels and equipment that significantly limit or avoid the release of pollutants harmful to human health. The International Organization for Standardization (ISO) published in 2018 the international standards for laboratory testing of cookstoves, which describes tiers of stoves, and which types of stoves meet these standards, and specifies testing and reporting protocols to measure emissions, thermal efficiency, safety and durability. The World Bank used similar metrics, with the addition of affordability, to develop the Multi-Tier Framework for Clean Cooking. As stoves vary greatly on these performance metrics it is important to ensure deployed stoves are providing the expected results and can be classified as clean cooking. In this report, clean cookstoves is defined as tier 4 and above. There are several different clean cooking technologies that meet this definition, including stoves using natural gas, liquefied petroleum gas (LPG), electricity, bioethanol, and biogas. Improved biomass cookstoves (ICS) of ISO tier 3 can act as a transitional technology from traditional biomass cookstoves and three-stone fires to the clean-cooking technologies listed above, and play an important role in providing immediate, meaningful health benefits to areas where needed infrastructure is unlikely to reach in the coming years. When considering the different technologies used to reach universal access, the IEA examines a range of criteria including affordability, reliability, safety, convenience, and sustainability (Table 1.1).

There are also technical constraints which could limit some solutions from being deployed in certain regions, for instance LPG needs delivery infrastructure, while natural gas and electricity require household connection to distribution networks. Different countries also have varying policy preferences reflecting the resources in that region and sensitivities regarding energy security. The analysis aims to consider these factors in exploring viable pathways to reaching universal access to clean cooking, while also recognising that a mixture of cooking technologies will be used and rarely is the switch from one technology to another clear cut. For instance, electric cooking devices, such as pressure cookers and hot plates, often complement other devices, like high-heat gas stoves and barbeques, reflecting the diverse cuisines and customs of different regions. Households may also continue using traditional cooking stoves in parallel with modern cooking solutions to manage affordability. The use of different cooking means is known as "fuel stacking". In this report, a household is considered to have access to clean cooking when they consistently use one or more of the clean cooking technologies as their primary cooking mode for most meals.

Figure 1.1 ▷ Definition of cooking technologies

Traditional solid fuel stoves

A pot perched on three rocks or a simple structure with a fire underneath that is not sufficiently enclosed or vented to reduce smoke from burning solid fuels.

Kerosene stoves

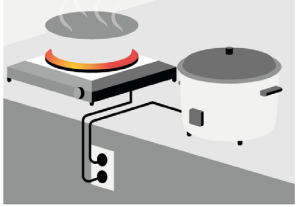
A liquid fuel derived from oil sold in small canisters that attach to a simple burner, and when burned emits hazardous fumes.

Improved biomass stoves

An enclosed stove that burns solid fuel, but keeps heat from escaping and improves combustion, thereby reducing smoke. There are many types of ICS, each with different performance standards.

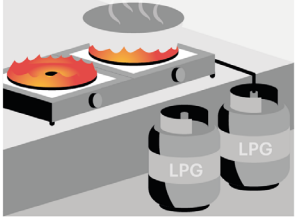
E-cooking or electric stoves/cooking

Primarily hot plates, induction stovetops, rice cookers or electric pressure cookers for those gaining clean cooking access, but technically includes all electric cooking appliances.



LPG stoves

A burner that uses a stable mixture of propane and butane distributed in large pressurised cylinders.



Biodigesters

A large vessel where organic matter (animal manure, agriculture residues, food waste) is decomposed into biogas. This biogas is then used in a burner-type stove.

Ethanol

A simple burner that attaches to a small canister containing alcohol fuel made from crops, such as corn or sugar, that has been fermented and distilled.

Natural gas

A burner that uses natural gas (largely methane) typically delivered to customers via distribution pipelines.

Table 1.1 ▷ Cooking stoves assessment of performance against key metrics

	Type of stove	Health	Gender	Environment	Upfront cost	Fuel cost	Disruption risk	Scalability	Efficiency and cooking time
Basic	Gathered biomass	Low	Low	Low	High	High	Medium	Not applicable	Low
	Charcoal and fuelwood	Low	Low	Low	High	Medium	Medium	Not applicable	Low
	Coal	Low	Low	Low	Medium	Medium	Medium	Not applicable	Low
	Kerosene	Low	Low	Low	Medium	Medium	Medium	Not applicable	Medium
Traditional	Improved biomass cookstoves	Medium	Medium	Medium	Medium	Medium	Medium	High	Medium
Modern	LPG	High	High	Medium	Medium	Medium	Medium	High	High
	Natural gas	High	High	Medium	Medium	Medium	Medium	Low	High
	Electric cooking	High	High	Medium	Medium	Medium	Medium	Medium	High
	Biogas	High	High	High	Low	High	Medium	Low	High
	Ethanol	High	High	High	Medium	Medium	Medium	High	High

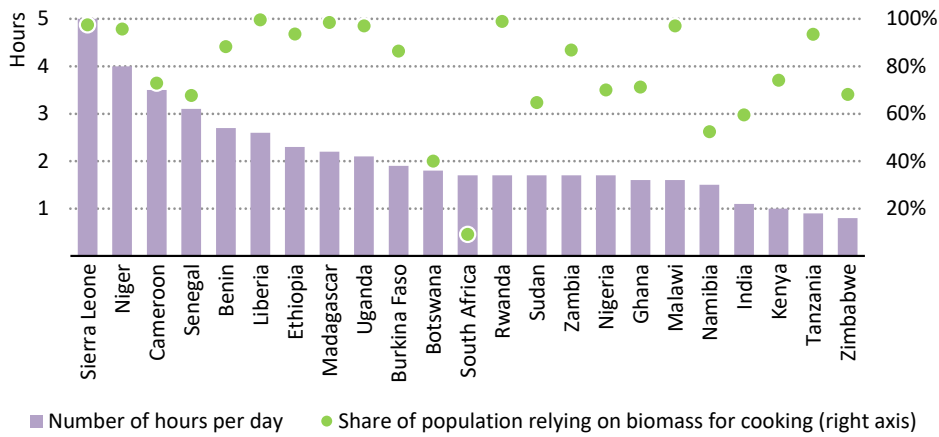
High performance | Medium performance | Low performance | Not applicable

Notes: Health refers to the impacts of inhalation of harmful criterion pollutants, such as carbon monoxide and $PM_{2.5}$ caused by the incomplete combustion of fuels. Gender refers to the ways certain cooking means negatively impact women, primarily considering health, safety (e.g., exposing them to gender-based violence), and social (e.g. time for gathering biomass). Environment refers to impacts to climate through the emissions of GHG in combustion and to deforestation caused by the unsustainable harvesting of biomass. Upfront cost refers to the price of cooking and fuel delivery equipment. Fuel and operation cost refers to the cost incurred in the utilisation of the stoves for cooking, which includes purchases of fuels and maintenance of stoves. This does not factor in minimum volumes for retail fuels that could present upfront cost hurdles. Disruption risk refers to the risk of losing the physical availability or the affordability caused by high price spikes of the energy source used for cooking. Scalability refers to the techno-economic feasibility of deploying the technology in new regions. Efficiency and cooking time refers to the energy efficiency of stoves, which is the key contributor to the time required to cook a meal, plus stove preparation time.

1.3 The cost of not having access to clean cooking: on women, health, productivity and the environment

Households without clean cooking access spend hours each day gathering biomass, preparing fires, and cooking, with these burdens typically falling on women. Across sub-Saharan Africa, households without clean cooking access typically spend an average of 2 hours per day collecting fuel and an additional 3 hours for cooking and food preparation, including tending to the fire. The time spent varies from region-by-region, often depending on a settlement's proximity to woodlands or other areas where foraged fuel is available. In countries such as Sierra Leone, Niger and Cameroon, the average time spent collecting fuel is on the upper end, ranging from 3-5 hours per day, while in Kenya, Tanzania and Zimbabwe, collection times can be below one hour daily (Figure 1.2). However, in regions facing deforestation and increased urbanisation, collection times are increasing.

Figure 1.2 ▷ Average number of hours spent collecting fuel per day per household



A high reliance on biomass for cooking in many countries means that households without clean cooking access spend an average of 2 hours per day collecting fuel

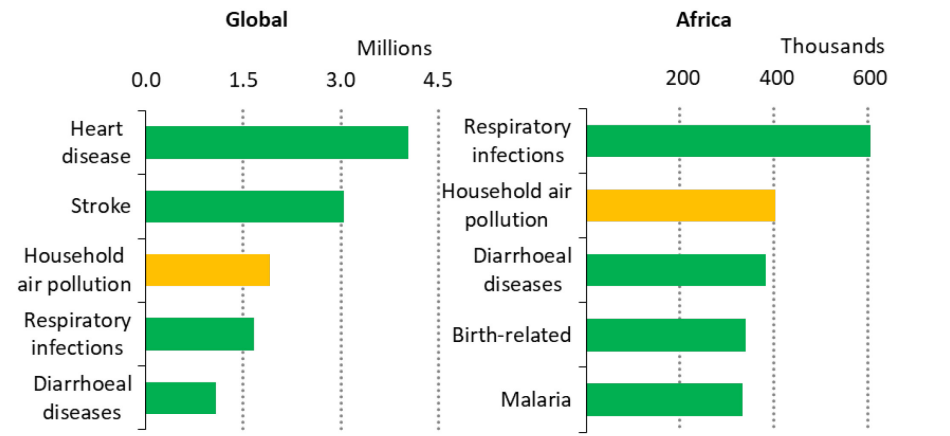
Source: IEA Analysis, UNEP (2017), Practical Action (2014).

The time spent collecting fuel and cooking limits opportunities for women, often preventing them from seeking out formal employment, earning a wage or starting a business that would provide them with a degree of financial autonomy. The time spent on these activities is estimated to have an opportunity cost of USD 0.8 trillion per year globally, according to World Bank estimates. Attaining this increased productivity would require parallel actions to cultivate employment opportunities, and points to the critical importance of energising productive uses in remote areas as well.

The need to search for biomass for cooking fuel, can put women at higher risk of gender-based violence. Often, women must wander outside community boundaries to collect firewood leaving women in many cases more exposed to violent attack and other forms of abuse. For example, in Chad, 42% of households reported incidents of gender-based violence during firewood collection over a six-month period. Providing access to clean cooking does not eliminate these risks nor does it address the underlying causes and other forms of prevention. However, it offers one step to reduce exposure to risks.

The health impacts of cooking over traditional stoves and open fires are immense. Household air pollution due to a lack of clean cooking access contribute to around 3.7 million fatalities per year globally. Household air pollution would be the third-largest cause of premature death among women and children globally and the second in sub-Saharan Africa (Figure 1.3), where women and children represent 60% of those deaths. Many of these premature deaths are associated with respiratory and cardiovascular disease, which is often accelerated by breathing in significant particulate matter produced by the incomplete combustion of solid biomass in a three-stone fire.

Figure 1.3 ▷ Annual deaths by cause amongst women and children globally, 2019



Household air pollution is the third leading cause of premature globally among women and children, concentrated in countries with a high reliance on biomass and coal for cooking

Source: Global Health Observatory, World Health Organization.

Women and children remain more exposed to poor household air pollution and its consequences. While women have fewer of the pre-existing health risks that household air pollution can exacerbate, their increased exposure means they make up the largest share of lost years of life caused by household air pollution, falling mostly upon women living in low- and middle-income countries. The daily physical exertion required to collect and carry heavy

loads of firewood also takes its toll, with traditional stove use requiring up to 10 kg or more of firewood per day, depending on local contexts. By comparison, using an ICS requires between 1 and 5 kg thanks to improved efficiency. Exposure to household air pollution is particularly damaging to the development of young children, contributing to lasting respiratory complications into adulthood. Exposure to household air pollution nearly doubles the risk for childhood lower respiratory infections and is responsible for over 40% of all pneumonia deaths in children less than 5 years old.

Unprocessed coal, charcoal, kerosene are also common cooking fuels in some regions of the world. All fuel sources generate high levels of pollution in the home, with poor air quality and a lack of proper ventilation resulting in toxic smoke inhalation in enclosed spaces. Kerosene, a liquid oil product, is also highly flammable and can be ingested accidentally by children if left unattended, and is the leading cause of childhood poisoning. In aggregated, health impacts of a lack of clean cooking add considerable costs to the health sector, with estimates of global costs reaching nearly USD 1.4 trillion a year.

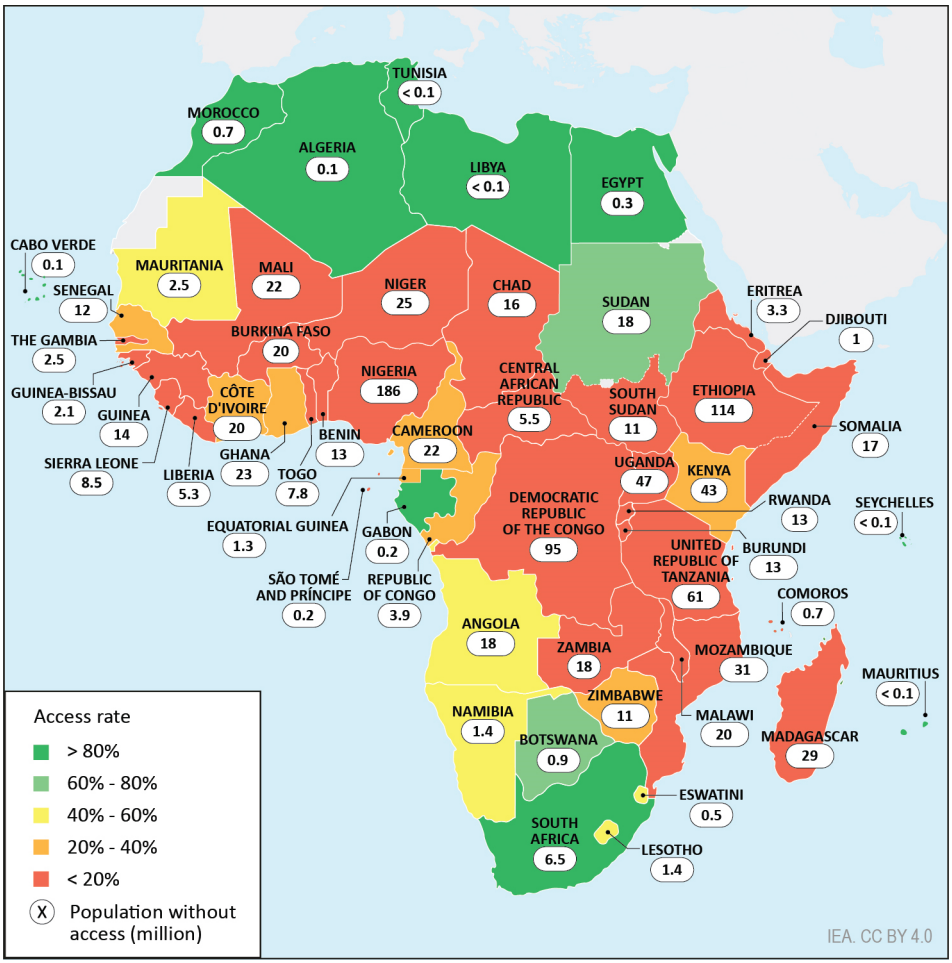
Basic cooking methods also contribute to increase greenhouse gases emissions, both through their combustion and as trees cut for fuelwood or charcoal production contribute to environmental degradation and deforestation. The incomplete combustion of charcoal and fuelwood in traditional stoves releases methane, a potent greenhouse gas, in addition to other particles that effect climate changes, like black carbon (more in Chapter 2). The inefficient combustion of these fuels in traditional stoves means more of these greenhouse gasses are emitted than from ICS. Cutting trees for fuelwood and charcoal production, often for sale in urban areas, also contributes to deforestation.

Informal operators offering firewood and charcoal are increasingly common in underserved urban and peri-urban areas, often selling them at well-above market rates. This contributes to a perpetual poverty cycle for families, many of whom already live in urban slums, make-shift dwellings, or refugee camps. Charcoal and fuelwood enterprises are often unregulated, with no price controls and environmental standards, or where they do exist are under-enforced.

1.4 Progress to date and status today

Today, 2.3 billion people live without access to clean cooking, largely in sub-Saharan Africa and developing Asia (Figure 1.4 and Figure 1.5). In sub-Saharan Africa, 29 countries have access rates below 20%, with half of the almost 1 billion people without clean cooking access concentrated in five countries (Nigeria, Ethiopia, DRC, Tanzania, Uganda). In Asia, access rates are higher with only seven countries, of which five small island countries, having access rates below 20%. However, large countries like China, India, and Indonesia, who have higher access rates, are still home to many people without access. Countries in Latin America also do not have universal access to clean cooking, but most countries have over 80% access rates, and the population without access is less than 75 million across the region.

Figure 1.4 ▷ Population without access to clean cooking in Africa, 2022

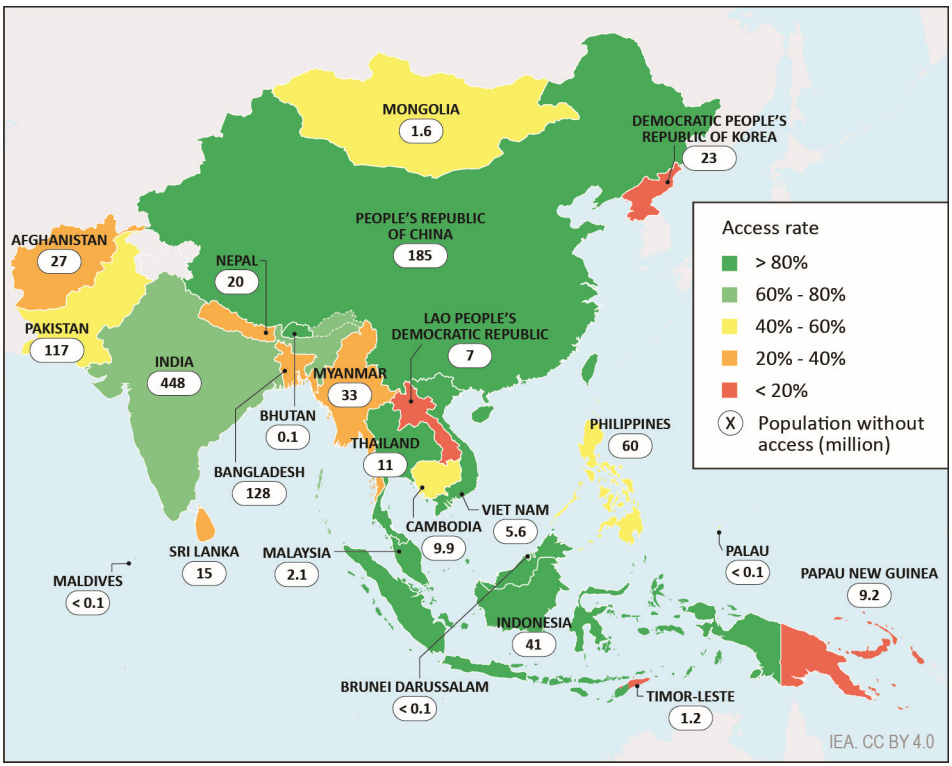


Almost a billion people are without access to clean cooking in Africa, half of those are concentrated in 5 countries (Nigeria, Ethiopia, DRC, Tanzania, Uganda).

Note: This document, as well as any data and map included herein, are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Sources: IEA analysis based on the World Health Organisation (WHO) household energy database and other national sources.

Figure 1.5 ▷ Population without access to clean cooking in developing Asia, 2022



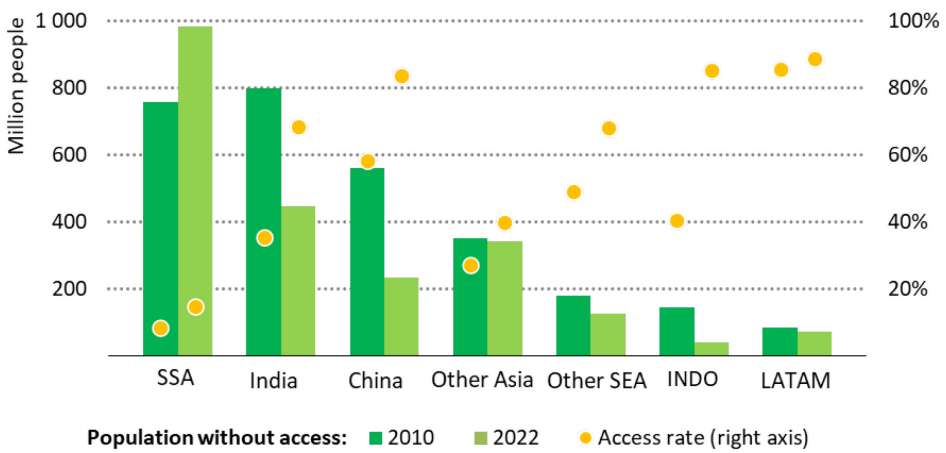
Around 1.2 billion people are without access to clean cooking in developing Asia

Note: This document, as well as any data and map included herein, are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Sources: IEA analysis based on the World Health Organisation (WHO) household energy database and other national sources.

Progress on providing clean cooking access has been mixed across the 128 countries that currently do not have universal access, with some regions making great strides. The number of people without access to clean cooking has fallen from approximately 3 billion in 2010 to an estimated 2.3 billion in 2022. In developing Asia, the number of people without clean cooking access has declined by 840 million, with China, India and Indonesia leading the way. These three countries account for most of the progress made since 2010, with each country at least halving the number of people without clean cooking access (Figure 1.6).

Figure 1.6 ▷ Access rate and population without access to clean cooking by region, 2010-2022



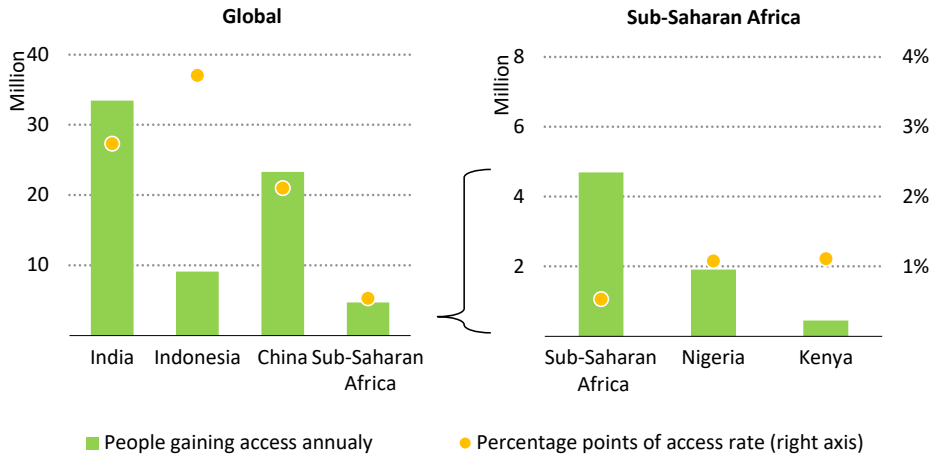
Steady progress has been made in Asia, while population growth outpaced improvements in sub-Saharan Africa, where more than four in five people lack clean cooking today

Note: SSA = Sub-Saharan Africa, Other SEA = other Southeast Asia, INDO = Indonesia, LATAM = Latin America including Mexico and Central and South American countries.

In sub-Saharan Africa, population growth has outpaced progress. Despite access rates climbing from 8% to above 15% from 2010 to 2022, the number of people without clean cooking solutions in sub-Saharan Africa increased by 220 million. Over this period, sub-Saharan Africa provided clean cooking access to about 0.5% of its population each year. This lags behind the pace seen in leading countries in Asia, such as Indonesia (4%), India (3%), and China (2%) (Figure 1.7). Some notable success stories can be found in Africa, including South Africa, and recently Nigeria and Kenya, who both implemented new clean cooking strategies in 2015-2021, and since 2010 have brought clean cooking to around 1% of their population each year accelerating to 1.5% since 2015.

Major progress in providing clean cooking has largely been driven by LPG. In India the number of people primarily cooking with LPG increased by nearly 300 million from 2015 to 2022, thanks to strong measures and schemes as the Pratyaksh Hanstantrit Labh (PAHAL), which has been subsidising LPG refills since 2015 and the Pradhan Mantri Ujjwala Yojana (PMUY), which has provided more than 80 million deposit-free LPG connections to women in poor households since 2016. Similarly in Indonesia, the government's LPG subsidy programme helped increase in population primarily cooking with LPG by 60 million in the same period – more than 20% of the population. In sub-Saharan Africa, a series of efforts in different countries has helped make LPG the most pervasive clean cooking technology today.

Figure 1.7 ▷ Annual improvement in clean cooking access by country, 2010-2022



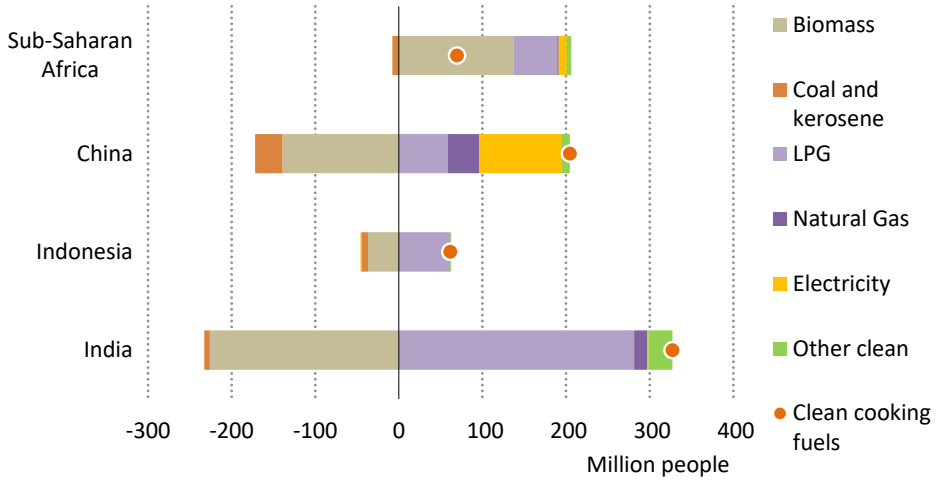
Indonesia provided access to nearly 4% of its population each year since 2010. The fastest countries in sub-Saharan Africa have progressed at 1% yearly.

Policy efforts are also increasingly focusing on other clean cooking options. Electric cooking has also witnessed widespread uptake in emerging market and developing economies, where since 2010 the number of people primarily cooking with electricity more than tripled to just below 300 million people. In China, where over 70% of people already had clean cooking access in 2015, saw an accelerated shift to electric cooking (Figure 1.8). This evolution has been witnessed elsewhere, aided by increasing popularity of electric appliances like rice cookers and water kettles, and government efforts to reduce LPG imports. Indonesia's government has a policy objective to reduce the use of LPG in favour of electric cooking to reduce the economic burden of subsidies on imported LPG. Countries like South Africa have for a long time advanced electric cooking as their primary solution, with more than 80% of people cooking with electricity today. However, due to recent power supply shortages, there have been efforts to diversify cooking fuels.

Other clean cooking options have also seen widespread support, including bioethanol, notably in East Africa, and biogas, largely around farming communities with livestock and other agricultural wastes to fuel biodigesters. Households also adopted improved cookstoves, as a quick-to-deploy, transitional solution for rural areas with minimal access to fuel distribution and electricity.

Urbanisation has also aided adoption of clean cooking options over the same period. For instance, 130 million people in China migrated into urban centres where clean cooking devices are more commonplace. Similar trends are delivering improved access in India and Indonesia as well, although targeted LPG campaigns in rural areas contributed more than urbanisation.

Figure 1.8 ▷ Change in population primarily cooking by fuel, 2015-2022



Since 2015, India and Indonesia clean cooking improvements mostly relied on LPG. In sub-Saharan Africa households mostly relying on traditional biomass increased.

Note: Other clean includes mainly biogas and bio-ethanol.

Despite consistent progress, the rate of clean cooking improvements has slowed in recent years due to the Covid-19 pandemic and the global energy crisis triggered by Russia's invasion of Ukraine. Public health measures taken during the Covid-19 pandemic, particularly lockdowns and restrictions on movement, slowed the deployment of new clean cooking stoves and prevented many workers from earning wages needed to pay for modern cooking fuels. Governments stepped in to ensure reliable delivery of LPG and other clean cooking fuels, with targeted measures concentrated in Asia, particularly in India and Indonesia. Utilities in many emerging market and developing economies also stepped in to keep the lights on even as customers struggled to pay bills, helping lessen the impact on household expenditures.

Following the Covid-19 pandemic, energy prices climbed rapidly as geopolitical instability took centre stage, driving significant price inflation for many basic commodities. Price increases for LPG were particularly steep. Since the beginning of the energy crisis, the IEA estimates that nearly 100 million people globally reverted to traditional uses of biomass for cooking. Prices have since then returned to pre-pandemic levels, but the spikes left intensified concerns of energy security exposure to depending on imported fuel.

While some challenges from Covid-19 and the global energy crisis have abated, the lasting impacts, such as high levels of debt, are dampening the outlook for clean cooking. Many countries already lacked the programmes, targets, plans, fiscal incentives, and subsidies needed to make progress. Yet, proven models of advancing clean cooking access exist, and if

replicated, could improve the global outlook. The next chapter explores the outlook under today's policies, and what the pathway to universal access could look like, with a particular focus on sub-Saharan Africa. The final chapter will examine the key measures needed to ensure that stakeholders at all levels place clean cooking at the forefront of the global development agenda.

Outlook for clean cooking

Finding the recipe for universal access

SUMMARY

- Current policies are insufficient to reach universal access to clean cooking. Under the Stated Policies Scenario, the number of people without access to clean cooking declines from 2.3 billion today to 1.8 billion in 2030. Progress is rapid in Asia, but Africa ends the decade with the same number of people without access as today. Under current policy and investment environments, many African countries are not expected to reach full clean cooking access even into the 2050s.
- Reaching universal access to clean cooking requires providing over 300 million people with access each year through the end of the decade, with about half of them in sub-Saharan Africa. The required effort in sub-Saharan Africa is equivalent to repeating the best single year advances in the rest of the world every year from now to 2030. While African countries are putting clean cooking plans in place, they lack the resources to support them. Today, less than 20% of clean cooking plans are backed by clear financing schemes.
- In the Access for All scenario, universal access is reached by 2030. In that scenario, liquefied petroleum gasses (LPG) remain the leading fuel for providing clean cooking—reaching 45% of those gaining access by 2030. Electricity represents 12% of those gaining access and other sources like bioethanol and biogas around 10%. Up to 2030, high-quality improved cookstoves (ICS) provide a first transitional step to cleaner cooking for one third of households, providing meaningful benefits as a fast and feasible solution for rural households that infrastructure will be slow to reach.
- In the Access for All scenario, modern energy demand grows minimally to 2030, while the use of fuel wood and charcoal falls 50%. In some regions, new infrastructure would be needed. For instance, in sub-Saharan Africa LPG demand grows three-fold to 2030, requiring an expansion of distribution services, cylinders, and refilling stations. By 2030, electric cooking in sub-Saharan Africa drives electricity demand up by 16% from today, which could strain distribution systems if not managed well.
- The benefits of reaching universal clean cooking access are immense. In the Access for All scenario, premature deaths from poor household air quality are reduced by 2.5 million. The average household would save 1.5 hours a day, freeing up working hours equivalent to those of the entire Japanese workforce. Greenhouse gas emissions from incomplete biomass combustion and deforestation would see a net reduction of 1.5 Gt CO_2-eq by 2030, equal to emissions from aviation and shipping today.
- Investment in clean cooking stoves, equipment, and infrastructure by 2030 would need to reach USD 8 billion annually. This represents a substantial increase on the USD 2.5 billion currently invested each year. Sub-Saharan Africa accounts for about half of the total investment requirement this decade.

2.1 Introduction

The pace at which access to clean cooking evolves depends on a variety of factors, including domestic policies, energy prices and investment flows. This chapter first explores how access to clean cooking is set to evolve toward 2030 under today's policies, called our Stated Policies Scenario (STEPS). It analyses and assesses the pace of progress by country, the fuel and technology mix used to meet access, investment needs and environmental implications.

Based on current policies, the world will fall short of reaching universal access to clean cooking for all by 2030. Therefore, this report explores a scenario called Access for All, which looks at practical regional pathways to provide universal access to clean cooking in line with SDG7[1]. The clean cooking solutions deployed in the Access for All scenario consider existing best practices, scaling them to other regions, while considering cultural factors, costs, technical constraints, and national objectives. Access for All also assumes parallel efforts to reach universal access to electricity by 2030. The Access for All scenario does not take place in a vacuum and assumes evolutions in the rest of global energy systems are consistent with national energy development and climate-related goals, in full and on-time.

The mix of clean cooking solutions in the Access for All scenario all carry important considerations policymakers must weigh in pursuing these options. These are discussed in more depth at the end of this chapter, in the key technologies section.

2.2 Outlook under today's policies

Under today's policies, progress toward universal access to clean cooking remains modest. In the STEPS, the number of people without access to clean cooking declines from 2.3 billion today to 1.8 billion in 2030, owing largely to policy efforts in developing Asia (Figure 2.1). These policies are set to deliver access to clean cooking for about 55 million people a year across developing Asia, roughly consistent with the pace over the last decade. This reduces the number of people without clean cooking in the region by around 35%.

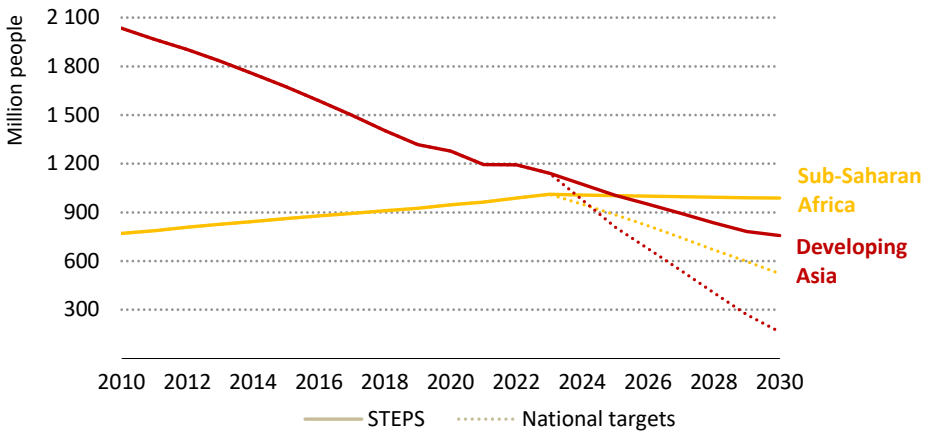
In sub-Saharan Africa, efforts on clean cooking accelerate from historic levels, providing access to around 30 million people per year, thanks to robust plans and policies in Kenya, Rwanda, Ethiopia, Uganda, Ghana, and Nigeria, among others. However, this acceleration barely manages to keep pace with population growth at the regional level. As a result, the number of people without access to clean cooking in Africa in 2030 remains roughly around the current level of 980 million.

Many countries today do not even have targets to reach universal access to clean cooking, and many that do, do not have the policies on the books to deliver on those targets. Around 20% of the population without access live in countries without official clean cooking targets and of those that do, only 40% live in countries targeting universal access by 2030 in line with SDG7. Most of the countries without nationally established access to clean cooking targets

[1] This includes by 2030 a share of the population relying on transitional improved biomass cookstoves of ISO tier 3.

are in sub-Saharan Africa. Even if all countries met their national targets on-time and in full, there would still be 730 million people without access to clean cooking by 2030 globally.

Figure 2.1 ▷ Population without access to clean cooking in sub-Saharan Africa and Developing Asia under different scenarios



Under today's policies, the number of Africans without access does not improve and even if all national targets are achieved, over half a billion remain without access by 2030

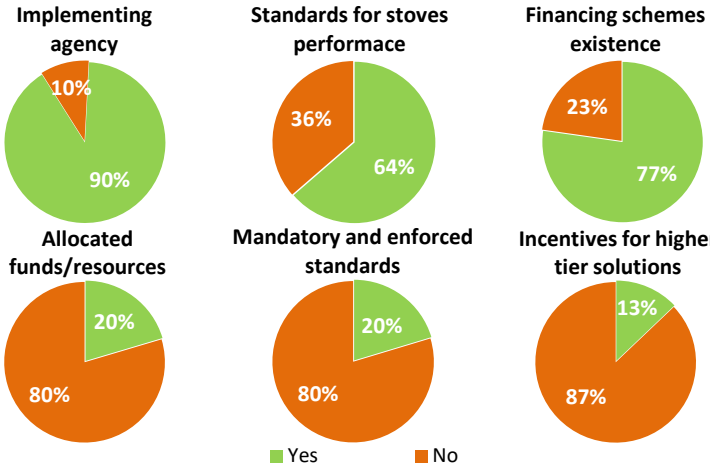
Note: National targets here refer to officially established national targets that include a clear level of access and target year. For instance, a target aligned with SDG7 goals would state that country aims at reaching 100% access rate by 2030.

The key policy gaps that perpetuate slow progress in the STEPS is a lack of financial support and resources for clean cooking programmes to support implementing agencies work. As of 2022, 90% of the population without access lives in countries with regulatory institutions charged with implementing clean cooking plans, but only 20% live where these agencies have funds and resources for the implementation of those plans. Historically, programmes that provide cookstoves for free or at discounted rates have made the fastest progress, often paired with financial support to provide stable, affordable fuel and energy prices for consumers. Almost 80% of those without clean cooking access live in countries that have financial incentives in place for upfront stove costs and ongoing price support for cooking fuel (Figure 2.2). However, just above 10% live in countries where targeted incentives exist for higher tier cooking technologies, and only 8% live where targeted funding exists for last-mile solutions in rural areas.

Most of these incentives are typically available to all consumers and are not targeted to those most in need of financial support. This creates a substantial fiscal burden on public finances. During the energy crisis, many countries, such as Sri Lanka, India, Kenya, Sudan and Nigeria changed their support schemes, balancing growing debt burdens with the public need for support. Sudden changes in these schemes can negatively impact households and enterprises providing clean cooking solutions. Timely adjustments to fiscal policy must be

balanced against enduring policy support to ensure clean cooking support does not interfere with prevailing fuel and capital market trends. See chapter 3 for more discussion on managing affordability.

Figure 2.2 ▷ Share of people without access who live in a country with key clean cooking policies, 2022



90% of people without access live in a country with clean cooking implementing agencies, but only 20% live where resources are available for implementation of plans.

Notes: Implementing agency refers to the existence of an authority or agency in charge of coordinating and implementing clean cooking strategies or action plans; Allocated funds/resources refers to the existence of resources and funds for the implementation of clean cooking plans; Standards for stove performance refers to the existent of quality standards for stoves thermal efficiency, emissions, safety and durability; Mandatory and enforced standards refers to the fact that stoves standards are mandatory and are enforced by law; Financing schemes refer to the existence of financing facilities to support consumers or suppliers to purchase or develop clean cooking solutions, or specific financing or subsidy programs to support low income consumers; Incentives for higher tier solutions refers to the existence of targeted incentives for the promotion of higher tiers cooking solutions.

Source: RISE Indicators, ESMAP IEA analysis.

Development finance plays an important role in today's clean cooking ecosystem, especially where public spending from national sources is limited. However, levels of international support remain far too low and fail to attract sufficient private sector participation. In the STEPS, international support remains rather flat, with some growth from offsetting instruments and climate finance that have helped tip many clean cooking projects toward profitability, such as those from the Green Climate Fund or the Global Environment Facility.

Collectively, international and national measures are reflected in our STEPS scenario, and are used to develop a country-by-country assessment of clean cooking progress from now to 2030 (Figure 2.3), which for the first time the IEA is releasing for select countries.

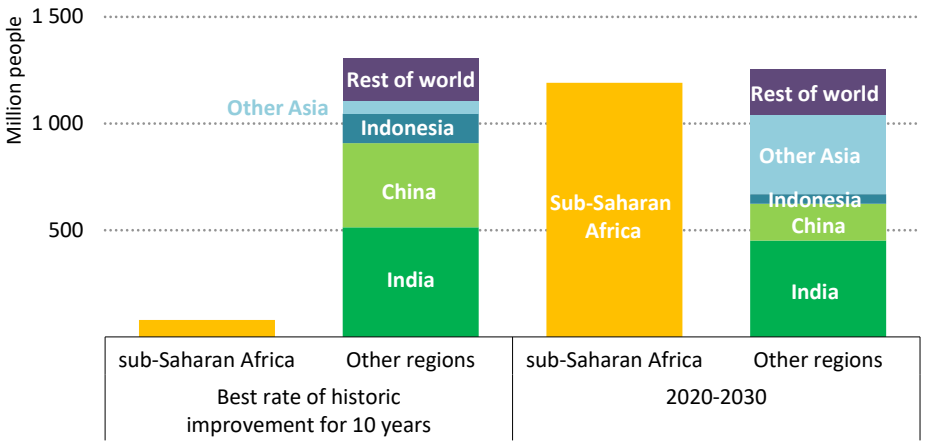
Figure 2.3 ▷ **Clean cooking access rate evolution by selected country in the Stated Policies Scenario, 2015-2030**

Many countries in Asia see continued progress like last decade, while few African countries accelerate beyond historic trends in the STEPS

2.3 Reaching clean cooking access for all

Achieving universal access to clean cooking by 2030 requires scaling success stories to every country facing a gap today. To achieve universal clean cooking by 2030 and meet the SDG7 target, clean cooking access would need to be provided to 1.2 billion people in sub-Saharan Africa by 2030, and roughly the same number other countries without universal clean cooking access. This means around 300 million people each year will need to gain access to clean cooking. To reach this pace, sub-Saharan Africa and developing Asia would both need to replicate the best single year progress seen in each country last decade. This rate would need to be repeated each year until 2030 (Figure 2.4). Improvement rates will need to be much higher in rural areas, where 75% of those without clean cooking access reside today.

Figure 2.4 ▷ Number of people gaining access to clean cooking by region, best historic rates and the Access for All scenario



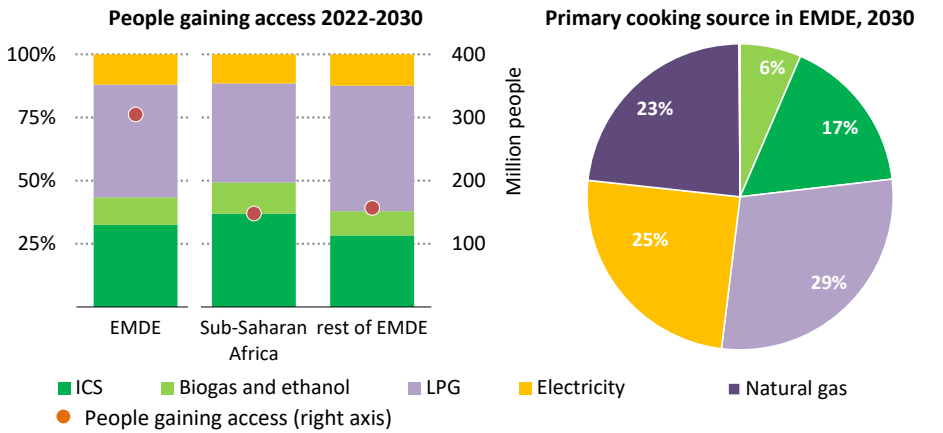
By 2030, 1.2 billion Africans gain access to clean cooking in the Access for All scenario, comparable to the people who gained access outside of Africa in the last decade

Note: Rest of world excludes sub-Saharan Africa. The category "best rate of historic improvements for 10 years" reflects the single best historic year of providing clean cooking access for each country and assumes this is repeated for 10 years as a representative point of comparison for the level of effort required to reach SDG7.

In the Access for All scenario, LPG remains the leading fuel for providing clean cooking – reaching 45% of those gaining access by 2030 (Figure 2.5). Electricity represents 12% of those gaining access with around 10% from other sources like bioethanol and biogas. Up to 2030, improved cookstoves (ICS) provide a first transitional step to clean cooking for one third of households, providing meaningful benefits as a fast and feasible solution for rural households where infrastructure will be slow to reach.

In the Access for All scenario, urban households gain clean cooking access primarily through LPG and electricity, together accounting for over 95% of the viable options in most households and communities. Bioethanol plays a role in African cities where distributors are already set up, such as in Nairobi, and nearby regions where they are expected to expand. ICS deployment in urban areas is very limited as firewood and charcoal vendors in urban areas often sell at prices that, on a per meal basis, are commensurate or higher to LPG or electric cooking.

Figure 2.5 ▷ Share of population gaining access and population by primary cooking by technology in the Access for All scenario, 2022-2030.

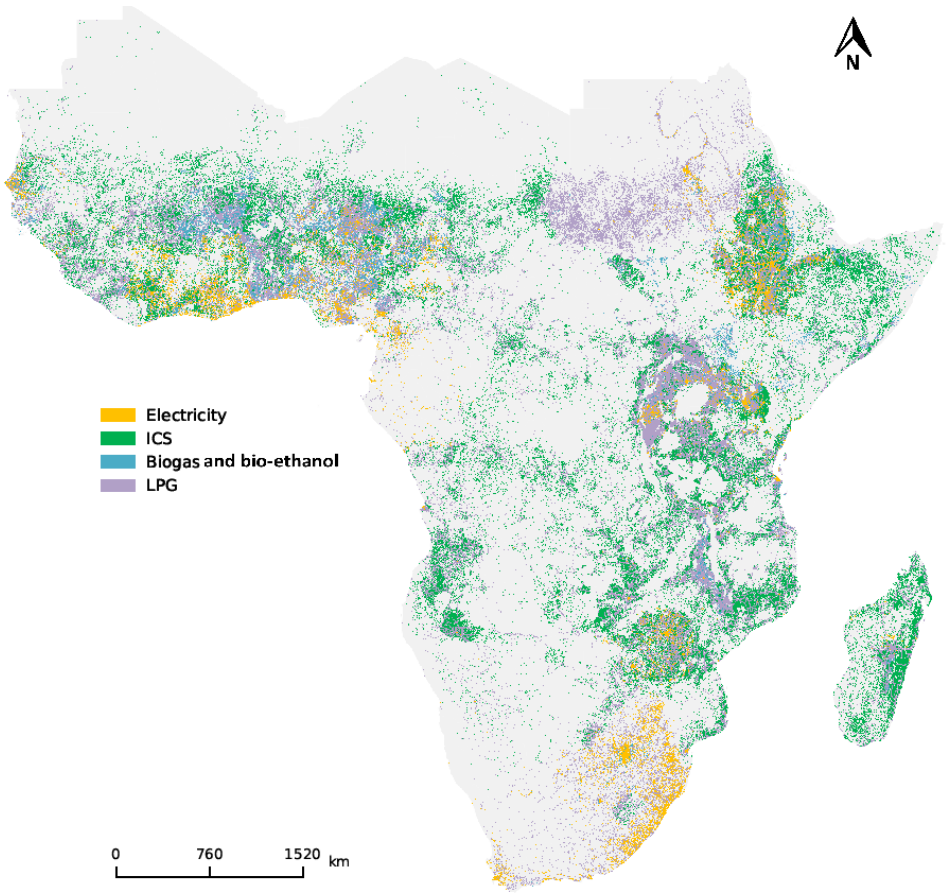


Displacing the traditional use of biomass for cooking involves a scale up of LPG, electricity and modern bioenergy.

Note: ICS = Improved Biomass Cookstoves (ISO Tier ≥ 3). EMDE = Emerging market and developing economies.

In rural areas, LPG continues to play a substantial role, providing access to around a third, especially households near roads that allow easy delivery and access to fuelling stations. Electric clean cooking provides access to 5% of rural households in the Access for All scenario, often following along with parallel efforts to extend electricity access in rural areas. Biogas digesters also present an important clean cooking option for rural households where available animal waste enables the production of enough biogas. However, due to a mixture of infrastructure and affordability challenges, ICS play a role in a significant portion of rural households as a transitional solution, especially in sub-Saharan Africa. These stoves are more efficient, burn less wood, and emit less harmful smoke than a traditional cook stove or "three-stone" fire. By the end of the decade, around 45% of rural households without access today switch to ICS in the Access for All scenario, most prominently in sub-Saharan Africa. After 2030, consumers gradually shift to modern cooking services, as they become more accessible and affordable for rural households.

Figure 2.6 ▷ People gaining access to clean cooking in the Access for All scenario by 2030 in sub-Saharan Africa



Settlements closer to urban areas gain access mainly with LPG and electricity, while in rural areas modern bioenergy solutions still play an important role to 2030

Note: The map shows the spatial distribution of stoves across the region and does not necessarily give a fair representation of the population shares as population densities vary vastly across the region.

Source: IEA and KTH analysis based on the OnStove tool.

Natural gas is a major fuel for cooking in many parts of the world today but is likely to play a small role in providing first access to people switching from traditional and basic cooking means by the end of the decade. A lack of natural gas storage and distribution systems in many urban areas in Africa and developing Asia make LPG a lower cost solution than building new pipelines. In regions without heating demand, the economic case for natural gas pipeline expansion remains limited. Even in sub-Saharan African countries developing new natural gas production, gas is often prioritised for power generation and industrial production in the

Access for All scenario. Where natural gas is already a prominent cooking fuel, it continues to play a prominent role in cooking in 2030.

Each country has different circumstances based on its geography, natural resources, and energy policies. As such, governments can shape which cooking solutions are best based on policy objectives and natural capital. Geospatial analysis highlights which regions are most likely to select which set of cooking solutions across Africa based on consumer benefits, costs, and access to key infrastructure, which are reflected in the mix seen in the Access for All scenario (Figure 2.5 and Figure 2.6). Geospatial data and tools, which became a best practice for electrification planning, has recently been explored for clean cooking planning to identify target markets and help support national governments in improving access, as well nurturing a growing number of clean cooking companies in Africa. An in-depth discussion on key clean cooking solutions can be found in section 2.4 of this chapter.

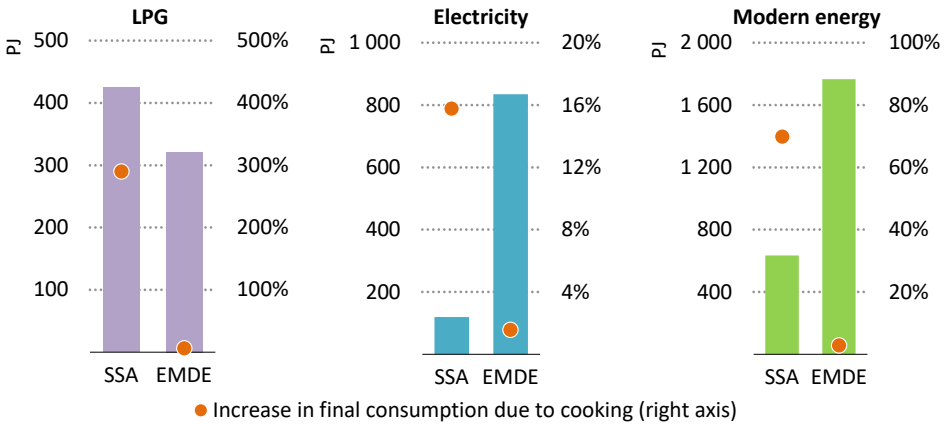
2.3.1 Energy implications

The Access for All scenario minimally increases the total demand for modern energy, while greatly reducing fuelwood and charcoal consumption. In emerging market and developing economies, the universal access of clean cooking results in a 3% increase in total energy supply for modern fuels, while demand for solid biomass falls 50%. This is significant for a number of least developed countries, where 90% of their total energy supply today comes from biomass, mostly for clean cooking. This is because cooking over an open fire or traditional stoves is very inefficient, generating a significant amount of waste heat during combustion – with much of it failing to reach the cooking vessel.

The increase in modern cooking fuel demand can be handled by existing infrastructure in many places but can be significant in certain regions. This is notably true in sub-Saharan Africa (Figure 2.7). By 2030 in sub-Saharan Africa, LPG demand for cooking in the Access for All scenario is expected to grow three-fold from today's levels while the increase in electricity demand for cooking to drive total electricity final consumption up by 16%. Demand for bioethanol and biogas also grows substantially in sub-Saharan, but has fewer implications for energy infrastructure.

Meeting expanding demand requires investment in upstream capacity across the African continent. For LPG, this is largely in the form of cylinders, bottling plants, distribution infrastructure, transport, terminals, and storage. Countries refining crude oil or producing wet gas – natural gas with high shares of liquids such as ethane, propane and butane – may produce LPG, including Uganda, Nigeria and Mozambique. In other countries, import and storage facilities have already been developed or reached investment decisions, such as in Kenya and South Africa. LPG refilling and distribution infrastructure requirements depend highly on whether companies adopt a cylinder exchange model or operate customer-owned cylinder models. Regulations and consumer preferences will shape this on a country-by-country basis.

Figure 2.7▷ **Growth in cooking energy demand by fuel in the Access for All scenario, 2022-2030**



Reaching universal access to clean cooking contributes little to rising energy demand but does imply a 3-fold increase in LPG supply in sub-Saharan Africa.

Notes: SSA = sub-Saharan Africa; EMDE = emerging market and developing economies; Modern energy includes LPG, electricity, biogas and ethanol. Growth is over the period 2022 to 2030 as compared to 2022 levels.

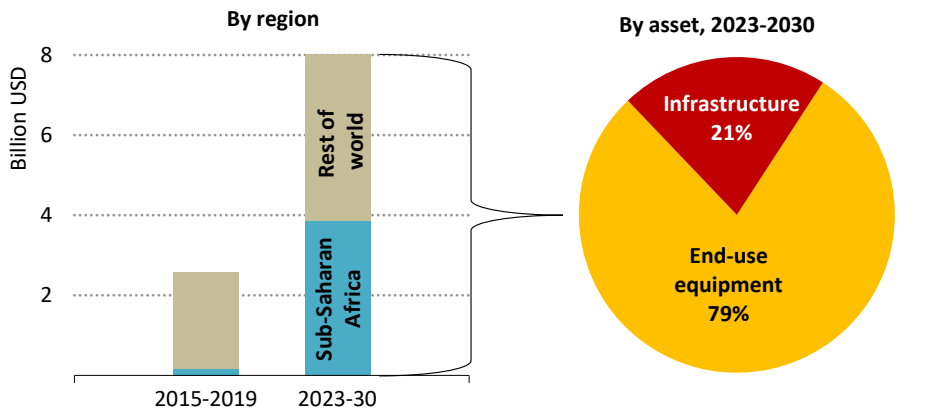
Increased electricity demand from cooking in the Access for All scenario does not, by itself, necessitate additional generating capacity to cope with rising demand. However, local distribution grid upgrades and increasing the reliability of household connections will be an important enabler for widespread electric cooking. Investments are also needed to improve grid reliability more broadly, which remains very low in many countries in sub-Saharan Africa today and presents a major barrier to consumer uptake of electric cooking (as discussed in section 2.4).

Bioethanol production facilities would also need to grow, as well as the deployment of biogas. Bioethanol facilities are currently operating in Ghana, Malawi, Mozambique, Ethiopia, Zimbabwe, Kenya, and Uganda, with some of these already contracted to provide bioethanol to clean cooking firms. Nigeria and South Africa have committed publicly to develop new bioethanol facilities to come online in the next few years. The opportunity in the region to exploit existing and potential sugar and starch resources is high. Centralised biogas production blended into natural gas systems are on the rise globally, however, to provide clean cooking access, these require distributed biodigesters installed on premises in farming communities. Building up biodigester supply chains will be key and could leverage the momentum of emergent companies proposing pre-fabricated digesters.

2.3.2 Investment

Total investment in clean cooking access is substantially lower than what is required to deliver on broader climate and energy objectives. Today, clean cooking investments are around USD 2.5 billion annually. In the Access for All scenario, this would need to rise to USD 8 billion annually between now and 2030 – requiring a cumulative investment of around USD 60 billion (Figure 2.8). Africa makes up around half of these investment needs, standing at almost USD 4 billion annually. Despite having the largest clean cooking budget shortfall, only 7% of the historic investments in clean cooking have flowed to Africa in the last 5 years.

Figure 2.8 ▷ Annual investments required in the Access for All scenario by 2030



Annual investments need to reach USD 8 billion per year until 2030 to achieve access for all, half of which would be in Africa. Most of the investment need is for stoves.

Note: End-use equipment includes stoves, gas cylinders, and biodigesters. Infrastructure includes that for LPG (e.g., importing storage units, refilling stations, bottling facilities, etc.) and the consumer connection cost for electricity (e.g., connection to the grid or an off-grid system). Investment figures include upfront costs only and exclude fuel, energy and operation costs. LPG infrastructure represent the bulk of infrastructure investments as electricity infrastructure is often being expanded to support other end-uses than cooking.

The required investments in clean cooking through the rest of this decade will need to be split between stoves, accompanying equipment and supporting infrastructure to ensure continued delivery. Roughly 80% of the total investment goes into providing stoves and equipment. The remainder is designated for infrastructure, largely to serve LPG delivery with a smaller share for electricity. This does not account for the investments needed to build up clean cook stove supply chains. In some regions, repurposing closed refineries and ports can help alleviate this cost, as was the case in Kenya's retired Mombasa refining facility. Grid reliability upgrades and capacity development to support electric cooking should happen alongside efforts for reaching universal access to electricity.

Many consumers without access today may be unable to afford the upfront costs for the stoves and associated equipment, even is many payback within a few years when compared to using purchased charcoal. For Africans in extreme poverty, the upfront cost for these stoves can be 1-2 months of income depending on technology, and much higher for the installation of a biodigester. While not considered in the investment cost presented above, additional end-use financial mechanisms would likely be needed to help consumers afford LPG or electricity for cooking. Ongoing fuel costs would be far higher than the upfront cost of stoves. In the Access for All scenario, those gaining access would spend around USD 100 billion annually by 2030 on fuel if they were not subsidised in some way. LPG subsidies and electric cooking tariffs would be essential for many households to manage costs and prevent backsliding amidst fluctuating fuel prices (see Chapter 3).

2.3.3 Environment

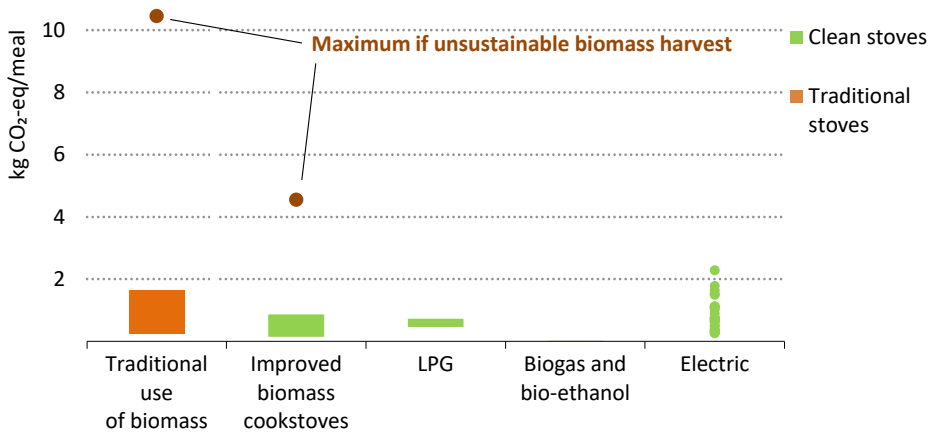
The switch to clean cooking fuels and technologies by 2030 is a no-regrets option when considered through a climate lens. Inefficient combustion of wood, charcoal, dung and crop residues releases methane and nitrogen oxide, greenhouse gases more potent than CO_2, and other polluting agents. Moreover, traditional use of biomass is also a major source of black carbon, which is a short-lived aerosol with a very high global warming potential, that could be avoided by delivering universal clean cooking access.

In Africa, the switch to clean cooking delivers reductions in net greenhouse gas emissions in virtually every context—even before the emission impacts of unsustainable harvesting or black carbon emissions are factored in (Figure 2.9). Using LPG stoves also directly emits half the GHG than the traditional use of biomass in average. LPG also offers a cleaner alternative to other hydrocarbon liquid fuels such as kerosene, with GHG emissions estimated to be between 15-18% lower. Improved biomass cookstoves reduce GHG emissions by reducing the amount of fuel burned to cook the same meal. Deploying improved stoves today could reduce fuel use by 20-75%, but even tier 2 commercial stoves present significantly higher efficiencies than the lower end of the range. The switch to biogas can bring additional climate benefits by capturing methane released from decomposition of biomass.

The switch to electric cooking reduces emissions in countries with low-emitting generation, but in countries with coal-intensive power sectors, like India, Indonesia, and China, a move toward electric cooking could today increase emissions. Prioritising efficient electric cooking reduces the risk of increasing emissions, and electrification in the long-run leads to emission reductions as the power mix shifts to greater shares of renewables. The number of countries in Africa where switching to electric cooking could increase emissions is limited. Based on current energy mix and load profiles, the switch from traditional use of biomass to electric hot plates in South Africa, Botswana, and Niger would increase direct greenhouse gas emissions, while the switch to induction stoves would increase in emissions only in Botswana.

The climate impact of the traditional use of biomass is not solely the result of combustion in the cooking process. The methods of collecting fuel feedstock place heavy strains on natural assets and also contribute substantially to the overall intensity of the fuel source. For example, traditional use of biomass where wood is unsustainably gathered from chopping down trees in forest areas is over 7 times more GHG intensive than if the biomass were sustainably harvested alongside conservation and replanting programmes. Researchers estimate around one third of wood fuel harvesting is unsustainable, and more than 275 million people live in locations where such practices are widespread. The share of firewood collection that is unsustainable varies greatly from region to region, due to differing forest stock, climate and volumes gathered, with regions like East Africa and the Sahel prone to higher levels of deforestation due to firewood gathering. These hotspot regions are among the fastest growing in the world, leading to the share of biomass that is unsustainably harvested growing into the future. Removing traditional use of biomass from the cooking equation would also mitigate threats to local biodiversity, with a number of species now considered endangered, largely due to the destruction of natural habitats.

Figure 2.9 ▷ LCA GHG emissions from cooking a meal by fuel in Africa, 2022



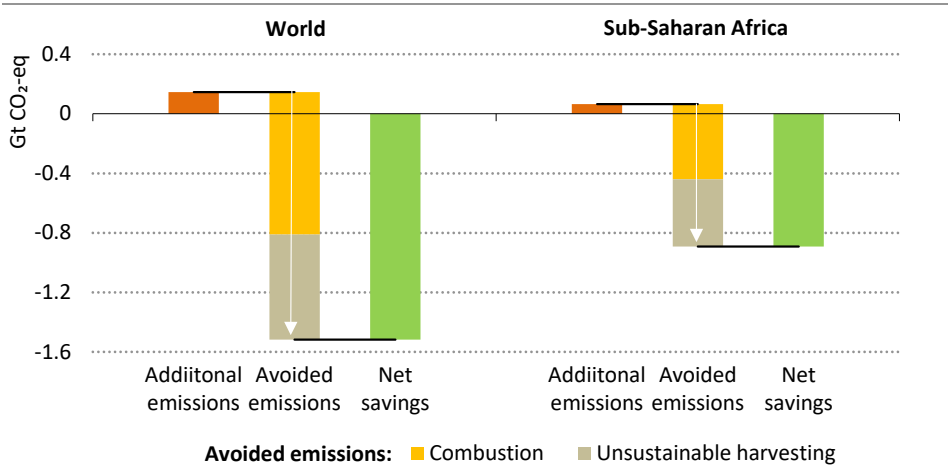
Traditional use of biomass is on average more than two times as intensive as LPG, but can be more than fifteen-times if the biomass is harvested unsustainably

Notes: "Maximum if unsustainable biomass harvest" includes the CO2 emissions from the combustion of biomass, as no regrowth occurs to allow for reabsorption. Dots showing GHG emissions from electric cooking represent selected African countries at 2022 grid LCA emission factors.

When deforestation is factored in, achieving universal clean cooking globally could save annually around 1.5 Gt CO_2-eq by 2030, roughly equivalent to the CO_2 emitted by all planes and ships today. Sub-Saharan Africa reduces its emissions by around 900 $MtCO_2$-eq (Figure 2.10). Just above half of this is from direct GHG emissions reductions from avoided

combustion of biomass in traditional stoves, with avoided unsustainable harvesting contributing around 47% of these reductions to 2030. The traditional use of biomass is also a major source of black carbon emissions, a short-lived aerosol with high global warming impact – if included the avoided CO_2eq savings would be even larger. By 2030, thanks to the achievement of universal cleaner cooking access and the related limitations of unsustainable harvesting, 225 million hectares of forest is saved in the Access for All scenario– with more than 55% of this in Africa. The clear environmental and climate benefits of switching to clean cooking make all cleaner cooking technologies, including LPG prime candidates for attracting climate finance and carbon offset credits. Leveraging both these tools would provide a channel for international private capital as investors seek returns in environmentally sustainable activities.

Figure 2.10 ▷ Net GHG emissions annual savings from clean cooking access in the Access for All scenario by 2030



Achieving universal clean cooking access reduces GHG emissions by 800 Mt CO_2-eq in 2030, additional 700 Mt CO_2-eq are saved thanks to avoided unsustainable harvesting.

Notes: Additional GHG emissions refers to increase in GHG emissions from population gaining access. Avoided emissions refers to GHG emissions saved from avoided combustion of biomass, coal and kerosene. GHG emissions shown in the graph exclude black carbon, a short-lived but high global warming potential emitted aerosol. Methane emissions from biomass relies on the upper range IPCC emission factor for biomass combustion, reflecting higher levels of incomplete combustion in traditional stoves. These values differ from the Global Methane Tracker, which uses the mid-range IPCC emissions factor per report conventions.

Source: IEA analysis, IIASA modelling.

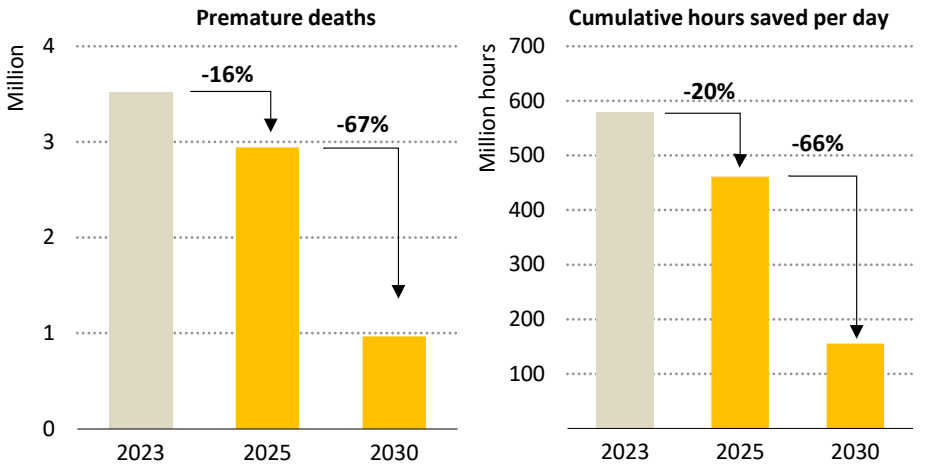
2.3.4 Health and gender

Reaching universal access to clean cooking brings substantial benefits to human health and productivity. By 2030, the reduction in household air pollution due to shifts in clean cooking

reduces premature deaths by about 2.5 million in the Access for All scenario (Figure 2.11). This contributes to reductions in medical costs and lost productivity due to respiratory illnesses, which today are assessed at roughly USD 1.4 trillion annually.

The time savings related to reduced firewood and fuel gathering, tending to fires, and cooking is also considerable, dropping by roughly two thirds. The average household saves around 1.5 hours each day, which by 2030 frees up time equivalent to the hours worked each year by a labour force the size of Japan's. Time freed can lead to meaningful increases in economic productivity but requires parallel efforts to extend remunerated employment opportunities to remote communities in parallel. Women stand to benefit the most from this additional time, pursuing education, employment, civic engagement, or taking other roles to support their families and communities. Many of these women also play a key role in expanding clean cooking access to other households (see Chapter 3 on Managing social impacts of clean cooking).

Figure 2.11 ▷ Time saved in fuel gathering, fire tending, and cooking; and reduction in premature deaths due to household air quality globally in the Access for All scenario, 2022-2030



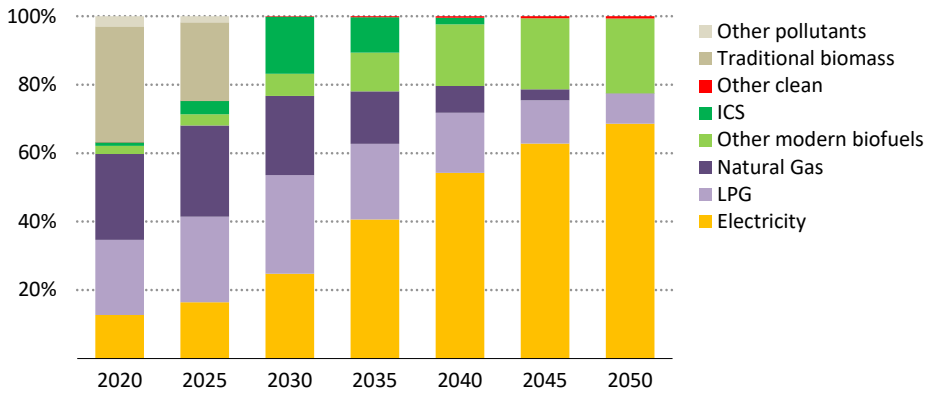
Reaching clean cooking for all brings significant health and social benefits

2.3.5 The pathway post-2030

As governments design their clean cooking strategies, they must consider the future evolution of cooking energy needs: how can they continue to shift people away from charcoal and wood to modern energy? How do supply chains built today continue to support evolving energy needs? And how to ensure choices today consider the need to address climate change?

The pathway after 2030 in the Access for All scenario prioritises the transition away from fuelwood and charcoal, even in improved cookstoves, to modern energy cooking solutions, which is achieved around 2040. Continued urbanisation naturally brings more people onto electric and LPG cooking, but another 80 million people in rural areas would need to switch to modern energy stoves and fuels each year after 2030. Most of them switch to LPG and electricity (Figure 2.12).

Figure 2.12 ▷ Primary cooking fuel by share of population in the Access for All scenario in emerging market and developing economies, 2020-2050



Every household has access to modern cookstoves by 2040. Electric cooking becomes the norm, but gas and liquid cooking fuels persist, albeit increasingly lower emissions

Note: ICS = Improved Biomass cookstove (Tier ≥ 3. Other modern biofuels includes gaseous and liquid modern biofuels (e.g. biogas, bio-methane, ethanol, and bioLPG).

Consumers with proven, reliable access to electricity, will increasingly cook with it. By 2050, electric cooking is expected to meet around three quarters of total cooking needs in emerging market and developing economies in the Access for All scenario. While initially concentrated in urban centres, electric cooking appliances see uptake in rural households, but depending on the region and local cuisines, continue to be used in parallel with other cooking solutions. Global supply chains for stoves are set to increasingly shift toward electric in light of global policy efforts to address climate change, which contributes to falling costs for induction cookstoves and other energy-efficient appliances.

Despite the rising share of electric cooking, the role for liquid and gaseous fuels for cooking remains substantial to 2050, however with increased blending with bio-derived alternatives such as bioethanol, biogas, and bioLPG (Figure 2.12). Accordingly, infrastructure built today will see use well past 2040 in the Access for All scenario, diminishing concerns of stranded assets. Today's existing natural gas infrastructure also sees continued use delivering

commercial scale biogas and biomethane production to be injected in distribution pipelines. Efforts can be accelerated to entirely shift liquid and gas fuels to bioenergy. Such a pathway would be compatible with reaching global net zero energy emissions by 2050.

These evolutions in cooking habits require additional policy efforts to realise. The total investment cost for shifting consumers away from ICS from 2030-40 is roughly USD 1.5 billion per year. Further policy efforts would be required to shift cooking trends toward one compatible with net zero emissions by 2050.

2.4 Key clean cooking technologies

Each clean cooking alternative comes with opportunities and challenges, which countries must weigh when designing their own clean cooking strategies. This section provides a primer on each technology, highlighting the major barriers to scaling up deployment of each.

Liquified petroleum gas

LPG has been the fuel of choice for many countries to rollout clean cooking to large swathes of their population. Portable, a natural by-product of gas production and oil refining, it presents a reliable, low-cost solution that can be scaled quickly. Roughly 70% of those gaining access to clean cooking since 2010 did so through LPG. In the Access for All scenario, around half of those without clean cooking access gain it by 2030 using LPG. However, this rapid uptake, often at subsidised rates, creates energy security risks and import burdens. For instance, Indonesia went from an exporter to a net importer of LPG in 2008. The country now imports around 6 500 kt of LPG a year, which at current market rates is USD 3.5 billion a year.

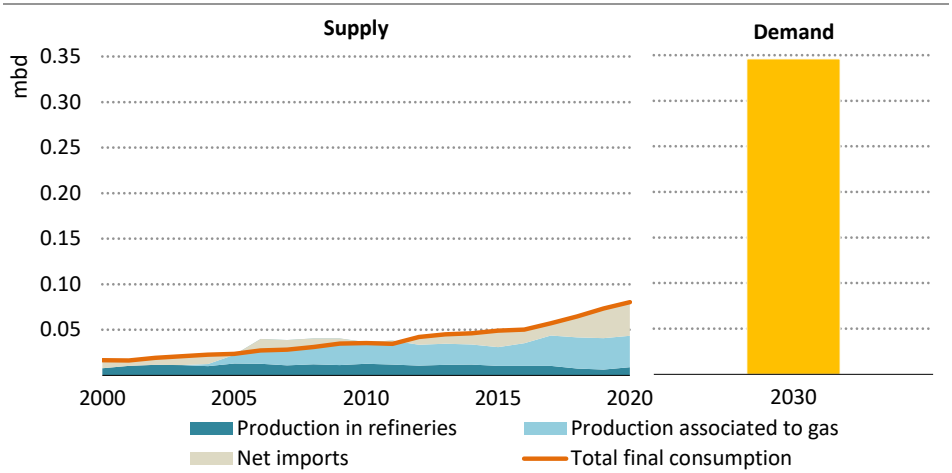
Reducing financial incentives has proven to be unpopular and often obliges household to revert to cooking with traditional biomass stoves, as seen in Kenya, where a value added tax discount for the fuel was removed in 2021 and reinstated in 2023. When international LPG prices doubled in 2022 the knock on effects for food and other basic goods was a catalyst for pushing up to 100 million people back into using traditional fuels for cooking. Prices have since decreased substantially returning to pre-Covid levels, with a stable outlook projected on the horizon.

Still, the recent price shocks have led countries to pursue strategies to reduce their exposure to global LPG markets and shield users from price spikes. Some countries have looked to diversify by pursuing electric cooking programmes in parallel, as is the case in Indonesia, Morocco, and Ecuador. Countries with oil refining and gas production have sought to increase domestic LPG production to supply clean cooking programmes in their country and the surrounding region. Maintaining strategic LPG reserves could theoretically help reduce market volatility, but proves difficult as it requires special storage facilities, which can be costly to maintain for long periods of time.

In the Access for All scenario, global LPG demand increases can readily be met by projected production. While markets are set to remain well supplied, accelerating clean cooking

deployment could create new import liabilities for a number of countries. This risk can be marked in sub-Saharan Africa, which is already a net importer of LPG, after a brief period of being an exporter in the 2000s. In 2020, LPG net imports stood at around 35% of total demand (Figure 2.13). By 2030, in the Access for All scenario, LPG demand for cooking will climb to just under 0.35 million barrels per day annually. If Africa's gas production and oil refineries continue to produce similar shares of LPG by 2030, domestic production would stand at roughly one quarter of this demand. Much of Africa's LPG production is propane, whereas LPG used in Africa requires a higher share of butane to ensure safe storage in hot climates. Accordingly, much of the propane produced in Africa is allocated for export while butane is largely imported for blending.

Figure 2.13 ▷ Sub-Saharan African LPG production and consumption for cooking in the Access for All scenario, historic and 2030



LPG demand increased 5-fold in sub-Saharan Africa since 2000 with net imports covering 35% of demand in 2020. Demand then triples to 2030 in the Access for All scenario.

LPG has also faced scrutiny as a fossil fuel, amid concerns over whether LPG deployment poses an impediment to achieving climate ambitions. The switch to LPG from the traditional use of biomass represents a net reduction in greenhouse gas emissions in virtually all contexts. Despite proven reductions, LPG has remained ineligible for international offsets, eliminating a possible revenue stream to expand clean cooking projects.

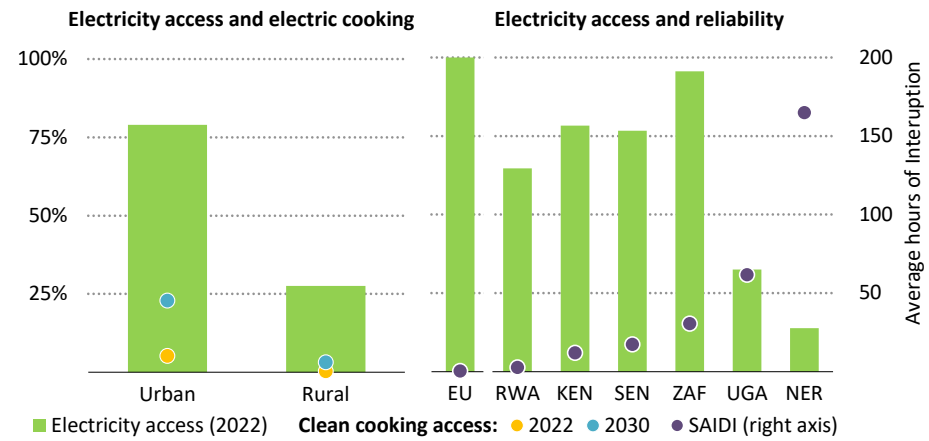
On the path to net-zero emissions, LPG cooking would gradually be reduced and replaced with BioLPG, an alternative source of the same fuel supplied from local municipal solid wastes and agricultural residues, which can make use of the same infrastructure. Major European, American and Canadian LPG companies have provided funding for different types

of bioLPG research and are preparing to commit to first generation plants in advanced economies.

Electric Cooking

In the Access for All scenario, electric cooking provides first-time access to one in eight people gaining clean cooking, largely via hotplates, induction plates and other e-cooking appliances. Many more also supplement their primary cookstove with electric secondary solutions, such as microwaves, kettles, electric pressure cookers. Households with access today increasing adopt these appliances as they offer great convenience, especially for staple grains that require long cook times. By 2030 in the Access for All scenario, one quarter of the population in emerging market and developing economies cook with electricity, with this sharing growing past the 50% mark in the late 2030s.

Figure 2.14 ▷ Electricity access and electric cooking rates in sub-Saharan Africa in the Access for All scenario, and key electric reliability indicator, today and 2030



Electric cooking grows in urban areas where access rates are higher, but even where access rates are high, reliability may be low, creating barriers to electric cooking adoption

Notes: SAIDI = System Average Interruption Duration Index and represents the average number of hours with outage experienced by a customer during a year. KEN = Kenya; NER = Niger; RWA = Rwanda; SEN = Senegal; ZAF = South Africa; UGA = Uganda; EU = European Union average.

Sources: IEA data and analysis, World Bank Doing Business project.

Access to reliable electricity remains the most immediate barrier to electric cooking uptake for those without clean cooking today. Many countries in Asia with clean cooking deficits have high electricity access rates, while in sub-Saharan Africa, 43% of people lack electricity access today. However, in urban areas, access rates are much higher, with 17 countries

including Cameroon, Cote d'Ivoire, Eritrea, Ethiopia, Ghana, Kenya, Nigeria, Senegal and Uganda having urban electricity access rates higher than 90%. Low reliability can make consumers reticent to adopt electric cooking as their primary cooking solution. With a few notable exceptions (e.g. Rwanda, Kenya), major African utilities have reliability levels lower than the EU and other advanced economies (Figure 2.14). Although reliability is increasing in many contexts, consumers' concerns remain a factor preventing them switching to e-cooking.

In regions with high shares of electric cooking, some grid operators have pointed to evening demand peaks as a potential problem for widespread adoption. The contribution of electric cooking to peak demand ranges widely but has contributed to documented grid instability in South Africa. Most of these issues present on distribution systems well before they create system-wide resource adequacy concerns, although not being able to maintain stability on the distribution system can cascade to create system-wide reliability issues. Even beyond distribution systems, many consumer connections are not suited to accommodate the high-power demands of electric cooking, with wiring in houses not rated for the power draws of some electric cooking devices. Household battery-supported e-cooking devices could address reliability and peak demand issues but would add cost.

That said, governments and utilities have been strong advocates for electric cooking programmes, as they reduce import exposure vis-à-vis LPG and cultivates higher residential electricity demand to support utilities in the future. Some e-cooking programmes build on ongoing electricity access efforts, with the incremental cost to include an e-cooking device when connecting consumers to the grid is about 10%. Many governments and utilities also offer special e-cooking tariffs, alongside existing low-income tariffs. These ensure adopting electric cooking does not move customers up to a higher rate class. With these rates, electric cooking is already cheaper than LPG in many parts of the world today (see Chapter 3, Managing affordability section).

In Africa, many consumers have or will be gaining access to electricity via off-grid systems, in the Access for All scenario. Electric cooking in these contexts can present challenges, but technological advances in cheap photovoltaics, and high-efficiency, low-wattage cooking appliances with integrated battery systems have made it possible, albeit expensive. For solar-home systems, enabling electric cooking requires at least a 300 W system, which remain unaffordable for most rural households today without subsidies. In the case of mini-grids, e-cooking helps increase demand, making the economics for mini-grids more appealing.

For some cuisines, electric cooking is perceived to be incompatible with current cooking norms. Education campaigns, recipe books, and other initiatives can help to address this. Consumers are quicker to adopt electric cooking for staple grains and beans, which require long cooking and are more convenient in modern electric cookers, and which have bigger impacts on time savings and reduced fuel consumption.

Box 2.1 ▷ Electric cooking opportunities in Kenya

Kenya has an ambitious target to reach universal access to clean cooking by 2028. Electric cooking (eCooking) represents a strategic opportunity to help achieve this goal. The country has made significant progress in electrification, going from 20% to over 75% electricity access in just 10 years, with over 90% of grid electricity coming from renewable sources. However, over 70% of the population still relies on biomass, charcoal, and kerosene for cooking.

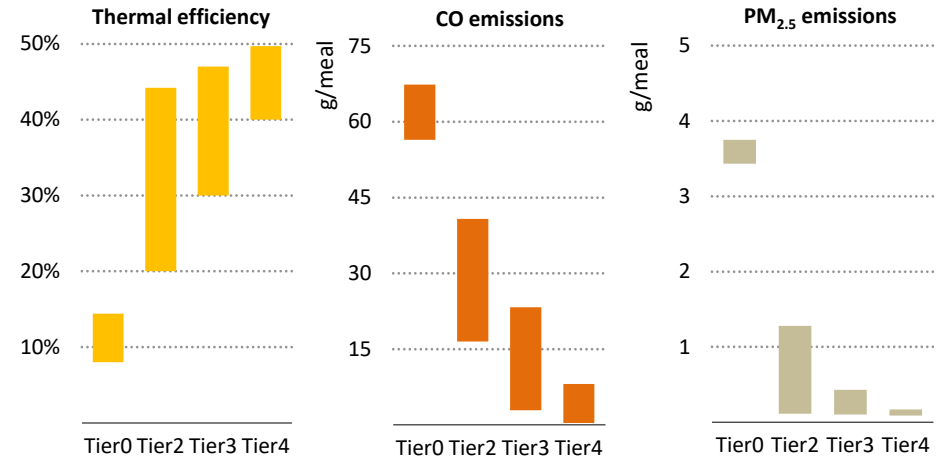
To encourage switching to electric cooking, Kenya is developing a National eCooking Strategy while exploring a market development program targeting customers. Focusing on electric pressure cookers (EPC) in peri-urban and urban areas, the program entails distributing EPCs at a low cost, coupled with awareness campaigns through the successful Pika na Power (Cook with Electricity) platform. EPCs align well with Kenyan cuisine, offering significant energy and time savings for dishes like beans or tripe. Sales of EPCs have grown rapidly, and there is growing interest in other energy-efficient eCooking appliances such as air fryers and induction stoves. By stimulating electricity demand, the program aims to expand national utility's kWh sales and profitability. A review is underway for introducing an electric cooking tariff, which would help avoid consumers adopting electric cooking being bumped up to a more expensive rate class.

Improved biomass cookstoves

Improved biomass cookstoves (ICS) represent a quick-to-deploy option for transitioning to cleaner cooking access in remote and rural areas where other technologies may not be suitable due to a lack of infrastructure or affordability issues. There exist a variety of ICS options depending on the technology used, and while most provide energy and GHG emissions savings, not all of them substantial reduce harmful emissions of CO and $PM_{2.5}$ (Figure 2.15). Cooking the same meal on a more efficient ICS already reduces biomass use compared to a traditional stove by between 20-75% depending on efficiencies, with most commercial ICS presenting efficiencies in the higher end. This alone delivers health and time-saving benefits by burning less biomass, thereby producing less smoke. However, moving to Tier 3 and above stoves is a large decrease in hazardous criteria pollutants. Accordingly the Access for All scenario, in line with World Health Organisation definitions, considers ICS as a transitional solution starting from ISO tier 3 and providing clean cooking access starting from ISO tier 4. Wherever higher tier stoves can be realistically deployed, these are preferred. While this does add cost, the incremental cost of tier 3 cookstoves over tier 2 is between USD 5 and 15. Regulating the performance and safety of these stoves is an important measure for determining which stoves qualify for financial support provided for clean cooking.

The Access for All scenario sees roughly 25 million ICS deployed in rural areas every year through the end of this decade. After 2030 in the Access for All scenario, ICS below tier 4 are supplanted by modern cookstoves over the course of the decade.

Figure 2.15 ▷ Range of thermal efficiencies and harmful emissions from different biomass stoves by Tier.



Most improved biomass cook stoves reduce energy demand, however many tier 2 stoves do not sufficiently reduce emissions of harmful criteria pollutants

Notes: Tiers refers to the ISO 19867:2018 Tiers for clean cook stoves and clean cooking solutions. Stoves are categorised here by the minimum Tier in any of the 5 categories. Tier 0 stoves are mostly traditional stoves as three stone fires. The IEA consider stoves providing transitional access starting from Tier 3. $PM_{2.5}$ = fine particulate matter. CO = carbon monoxide.

As with other cooking technologies, ICS also face consumer adoption challenges. Some designs are perceived to be difficult to use and require users to change their cooking and fire-tending habits. Proper education and identifying more popular stove varieties can help improve consumer acceptance. Many programmes have reported that as with clean cooking stoves, some ICS supplied to households often remain unused, especially if their deployment did not come with effective consumer education efforts.

Other clean cooking options

A number of other clean cooking technologies are available on the market today. Bio-ethanol stoves and fuel are seeing widespread distribution in convenience stores and other small businesses across Kenya, where around 675 000 households already use it today. Similar success could expand where bio-ethanol feedstocks are widely available and government support for production is available, either as clean cooking fuel, biofuels, or other applications. Bio-ethanol fuel can also be transported easily in small bottles, which are appealing to price-sensitive customers. It also has a better safety profile compared to other gaseous and liquid cooking fuels.

Biodigesters are another solution, which are commonly deployed in farms or rural households where enough agricultural or farming waste (typically a minimum of two cows)

is available to feed a digester to produce biogas for cooking and fertilisers. While these systems have relatively high-upfront capital requirements, operating costs are negligible beyond the labour to ensure the facilities run effectively and monitor output. Challenges include maintenance to ensure facilities do not degrade or fall into disuse. Commercial-scale biodigesters could play a prominent role in the future, and gradually contribute to existing natural gas distribution pipelines.

Solar cookers are also a clean cooking solution, using solar radiation to concentrate heat on a cooking vessel. While a slow method, it can act as an oven or slow cooker. Solar heating is already commonly used for other food processes such as driers and heating water.

Recommendations for achieving access for all

Taking clean cooking off the back burner

SUMMARY

- Reaching universal access to clean cooking will depend on strong national leadership and programmes reinforced by international financial support. Today, less than 10% of people who lack access to clean cooking live in countries with adequate policies and funding to reach near universal access by 2030. Key enablers include regulatory authority for implementing agencies, public engagement campaigns, and financial backing for consumers to manage upfront stove costs and ongoing fuel costs.
- Without additional support, 50% of households in sub-Saharan Africa could not afford clean cooking at today's prices. Today, modern cookstoves typically cost from one-third of a low-income household's monthly budget for a transitional ICS to around three-quarters for an electric cookstove. Yet, if annualised, switching to modern cookstoves can pay back up to four-times the upfront investment within a year for those previously buying firewood or charcoal. Still, ongoing fuel affordability support will be needed for some households using modern fuels.
- Switching to clean cooking relies on widespread changes to social and cultural norms. Grassroots efforts, often woman-led, have proven essential to lasting adoption of clean cooking solutions. Programmes that amplify peer-to-peer advocacy, including training salespeople and safety technicians, can make the difference between lasting adoption, or stoves going unused.
- The push to reach universal access to clean cooking could employ nearly 1.5 million people in sub-Saharan Africa by 2030. The transition, however, impacts the millions of people working in charcoal and firewood trade in Africa today. These jobs could decline substantially by 2030, emphasising the need for a just, people-centred transition, including efforts to formalise these industries and up/re-skill workers.
- International financial flows have and will play a role in advancing clean cooking, especially in regions without the fiscal latitude to use their own public funds to attract clean cooking investments. Development finance institutions have helped pull in more private capital over the years, and maturing enterprises are shifting from project-by-project financing to models where they fund projects using corporate equity and debt. New business models are emerging, such as Pay-go and on-bill financing which can make a difference. Carbon and climate finance is expected to play a growing role as the number of clean-cooking projects funded via carbon markets has increased significantly in recent years.
- Even as more private capital comes into the market, highly concessional lending will still be needed to support projects in the poorest regions. Around USD 4 billion in concessional finance would be needed annually for access to clean cooking, with around three quarters of that flowing to sub-Saharan Africa.

3.1 Introduction

A major obstacle to achieving universal access to clean cooking is investment and finance, from both public and private sector institutions. Clean cooking is a topic that often struggles to draw attention on the international stage and therefore money allocated to support development often flows elsewhere, remaining far below what is required to hit the SDG7 target by 2030.

The progress made in China, India, Indonesia, Viet Nam, South Africa and other countries demonstrate models for successful programmes. Lessons learned in these countries can be transferred and adapted to spur efforts in other countries. While not all solutions may be suitable and country contexts must be accounted for, some core principles are universally applicable. Leveraging grassroots initiatives, empowering women by offering choice and opportunity, while also cultivating a vibrant domestic private sector, all lay at the heart of bottom-up success stories. So too does finding the right enduring policy settings to attract sufficient investment, from both international and domestic sources, public and private. This chapter explores some of these best practices and highlights the role of the international community to achieve clean cooking for all.

3.2 Domestic efforts

The most successful case studies, led by countries like China, India, and Indonesia, were reinforced by a high-level political vision, clear targets, a determined implementation plan, and effective distribution of subsidies and international funds. This section explores the elements needed to deliver successful clean cooking campaigns with a special focus on affordability. Lastly, the section explores the importance of gender and people-centred considerations in the transition to clean cooking solutions.

3.2.1 Managing social impacts of a clean cooking transition

Cooking is central to cultural and community identity and efforts to shift to clean cooking must affirm this. This requires adopting strategies that account for local traditions while also addressing barriers to adoption rooted in traditional cooking practices.

Examples of successful programmes include providing sufficient training for stove use, education on safety, cooking classes and recipe books that help people adapt to new ways of cooking. In the absence of these training programmes and educational resources, there is a high risk that new cook stoves will be installed and go unused as households may prefer to stick to tried and tested methods. Education is particularly important for technologies such as biogas digestors which require regular maintenance. The African Biodigester Component (ABC) programme in Kenya equipped farmers with the skills to act as peer-to-peer trainers, and of the 21 000 biodigesters installed more than 80% of them are still functional in 2022.

Training and education can be amplified by the launch of traditional and social media campaigns to raise awareness of the social benefits of clean cooking which may not be

immediately apparent. Public information campaigns can also target youth groups to ensure the next generation of citizens are well-informed on the dangers of traditional forms of cooking. Cultivating strong local champions, as done in India and Kenya, has proven to be particularly effective, as people tend to trust local voices which are reinforced when the tangible benefits become evident in day-to-day life. Peer-to-peer advocacy has often been more successful than centralised campaigns spearheaded by governments.

Women often play a major role in driving clean cooking initiatives. One study found that women sell three times as many stoves as men. The same study found that women who received dedicated mentorship and entrepreneurial training were significantly more effective in scaling clean cooking, hence the importance of programmes like the Clean Cooking Alliance's Mentorship Program and Women's Empowerment Fund (WEF). There are a growing a number of clean cooking businesses with women in leadership roles.

In the Access for All scenario, the switch toward clean cooking is expected to reduce the use of firewood and charcoal by 50% globally and 70% in sub-Saharan Africa to 2030. The most precipitous declines are in urban areas where most of the charcoal market is today. This shift must be managed responsibly to avoid widespread loss of livelihoods as charcoal and firewood value-chains are a major source of informal employment throughout much of sub-Saharan Africa. While there is no certainty around how many workers are supported by the informal charcoal and firewood industry today, some estimates range up to 7 million people.

The transition to clean cooking could lead to charcoal jobs falling substantially to 2030. Managing the impact of job losses on communities dependent on the charcoal trade will be key to a successful shift to clean cooking. Creating a just transition for these workers requires strategic guidance from policymakers and could include support for reskilling these individuals to access long-term employment opportunities (including redeployment in the clean cooking industry). This can dovetail with larger government efforts to raise the level of unskilled workers across the economy. These programmes could prioritise women to help realise the full benefits of time-savings from clean cooking and increase female participation in the workforce.

The IEA estimates that over 1.5 million people could be employed globally between now and 2030 to support clean cooking campaigns[1]. The majority of these jobs are in developing and providing cookstove solutions to households, as well as administering clean cooking campaigns. Expanding LPG value chains in Africa is expected to create 350 000 jobs, with the bulk of them in retailing and distribution. As the group most affected by a lack of access to clean cooking, women would have a vital role to play here to ensure that strategies and education properly reflect the needs and concerns of people and communities.

[1] Jobs normalised to full-time equivalent, assuming 40-48 workweek hours and three weeks paid leave each year (ILO).

If refining, cylinder, and appliance manufacturing operations are brought onshore, the number of jobs in the clean cooking sector could grow substantially. Operators of terminals, storage, refilling and delivery infrastructure, including drivers of LPG tank trucks and local installers, must be well trained in safety procedures. Biogas digester production, installation and maintenance can also be a major boon to employment but require training to ensure performance standards. In parallel, extending electricity access also creates jobs in the Access for All scenario, and providers may also play a role in selling bundles that include electric cooking solutions. Worker training is key to building up successful clean cooking programmes. Many of these jobs do not require extensive training (defined as less than 4 weeks, including on-the-job training), but cultivating a skilled workforce is necessary for domestic firms to compete in the growing clean cooking market.

3.2.2 Developing clean cooking policy and plans

When it comes to policies and plans, clean cooking can be considered as an orphan sector. Although most countries without universal access to clean cooking have implementing agencies, the development and carrying out of plans can be hindered by fragmented objectives between ministries and agencies. For instance, some countries may have a biomass master plan, a charcoal strategy, and an electric cooking strategy, each designed by different government bodies. The first step for any clean cooking programme is a statement of ambition, ideally with cross-ministry support, an authority in change of implementation and an implementation plan backed by funding.

An increasing number of governments have clean cooking targets and policies, but many still lack adequate resourcing or authority to drive implementation. Many countries have laid out plans to tackle clean cooking and about 90% of the population without access today live in countries that have set up implementation agencies to implement clean cooking plans. However, only around 20% of those people lives in countries that have also allocated funds and resources to the implementation of those plans. Today, by the IEA's assessment, less than 10% of people without access to clean cooking live in countries with adequate policies and funding to reach near universal access by 2030 (see Chapter 2 for more details on current policy settings).

Establishing clear regulatory oversight through agencies can help track the domestic stove market, ensure minimum standard requirements and provide support only to those that are approved. Providing stable, long-term incentives to deploy clean cookstoves and supporting technology is important to create a competitive ecosystem for private sector actors. Allocating predictable, long-term funding for these measures, as well as minimising revisions to the programme, can help build confidence for market entry, fostering a network of original equipment manufacturers and distributors for LPG, biogas, electricity and ICS in rural areas. Reducing or scrapping tariffs and duties on imported cookstove components and providing access to cheaper finance for firms willing to invest under government-led programmes can also encourage further market participation.

Policy efforts should also consider how to cultivate domestic capital market participation in clean cooking enterprises and initiatives. The success of clean cooking efforts in India and Indonesia can be attributed to the existence of local companies and domestic capital markets which provides both loans to customers but also capital for domestic companies that are directly involved in the clean cooking sector. The availability of domestic financing is particularly important for small- and medium-sized enterprises and can increase the number of commercial firms that operate in the sector. Equally, local capital may provide loans to individual customers to buy clean cookstoves, and pilot new models to extend financing. Some markets have considered securing additional finance by extending credit to the most reliable clean cooking customers, an approach which relies on local counterparts to provide data and assess risks.

Tracking progress on clean cooking deployment and evolving technology costs, and making this publicly available, supports a more dynamic and successful private sector. Routine surveys by implementing agencies should include questions on cooking technologies, cooking safety, clean cookstove sales and fuel sales to build a year-on-year picture of clean cooking progress.

Clean cooking should not be viewed in isolation from other energy, development and climate objectives. Countries should integrate clean cooking with electricity access efforts, and make sure these programmes define outcomes for gender equality, health standards, forestry/agricultural practices, including metrics to track progress against these outcomes. In order to be successful, these approaches must be tailored to local contexts, as technologies and methods often interact with the cultural roots of a country or region. For instance, the suitability of technologies in East Africa may differ significantly from those in West African nations due to cooking preferences such as slow cooking versus high-heat frying. Cultural norms on cleanliness have made biogas from waste an unpopular option for a number of consumers. Programmes must also consider societal perceptions of gender, customs, land rights and wildlife protection, as well as different ethnic communities within the same country. Clean cooking campaigns can adapt best practice and share these experiences to help other countries better plan their efforts.

3.2.3 Managing affordability

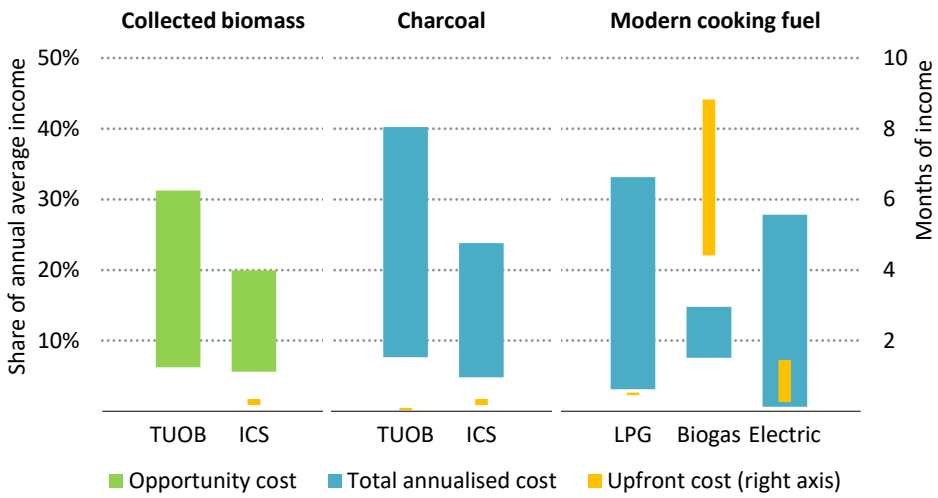
Well-designed policies and programmes are needed to overcome the upfront and operation cost barriers facing consumers adopting clean cooking technologies. Incentives and appropriate business models will be required to encourage uptake as many vulnerable households lack the financial means to cover the upfront costs of a cookstove, and most consumers yet to gain access will need ongoing support, at least initially, to afford fuel.

Based on current technology costs, improved charcoal cooking stoves represent on average around one-third of monthly income for a low-income household in SSA. For LPG stoves, that share rises to half, three-quarters for electricity cookstoves and to around six-times the monthly income for biogas stoves and digesters (Figure 3.1). Yet, if the cost of the stove is

annualised, switching to improved biomass cook stoves can pay back up to four-times the upfront investment within a year due to their higher energy efficiency when households are buying firewood or charcoal. The switch to any modern cookstoves would pay back over its lifetime in almost all urban contexts. More efficient appliances such as electric pressure cookers have higher upfront costs, but the improved efficiency can bring additional savings in the long term. This suggests that the availability of cheap end-user credit, including novel approaches like on-bill financing for efficient appliances or PayGo models, could help further scale clean cooking uptake.

In rural areas, the cost-saving case for switching to modern fuels are more nuanced. For those who gather solid biomass fuels, the switch to paid fuels is always perceived as an increased cost, especially for households with little access to cash. However, daily fuel gathering and traditional cooking carries important hidden costs in forgone time and risk exposure. When accounting for these opportunity costs, even assuming low-paid work available near rural communities, the effective cost of traditional use of biomass can be higher than other modern energy cooking options.

Figure 3.1 ▷ Annualised total cost of cooking and up-front cost as a share of income for low-income household in sub-Saharan Africa, 2022

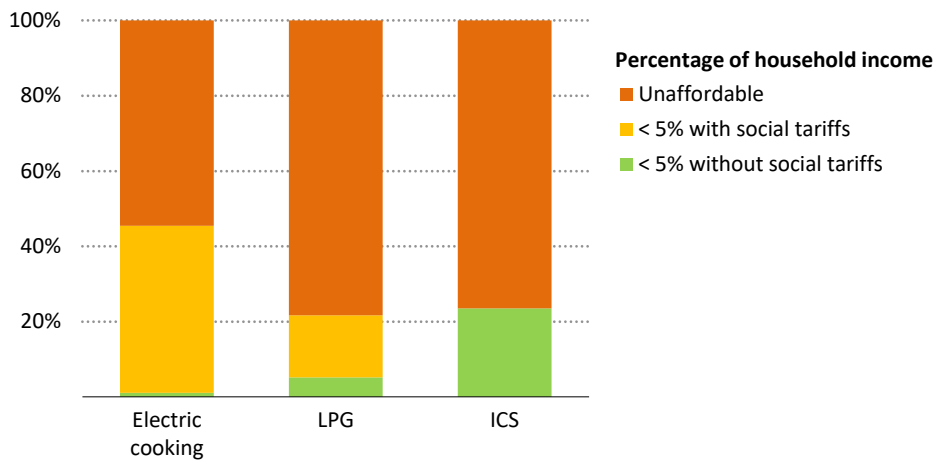


Clean cooking solutions have higher upfront cost than using traditional biomass, but in most cases the differential is paid back within their lifetime due to their higher efficiency

Notes: TUOB = Traditional use of biomass; ICS = the use of solid biomass in intermediate and advanced improved biomass cook stoves (ISO tier ≥ 3). Total cost includes upfront and fuel costs annualised over ten years and is shown in the left axis. Electric cooking includes both traditional hot plates and induction. Biogas cost includes a basic standalone household digester but excludes the production of bio-slurry that can boost agricultural production and/or avoid the need to buy commercial fertiliser. Cost showed for collected biomass users include the opportunity cost of the time used for biomass gathering/harvesting (collection) and the stove cost for ICS. The analysis assumes two cooked meals a day.

The share of income consumers in emerging market and developing economies spend on cooking remains much higher than elsewhere in the world. In advanced economies, the average consumer spends between USD 100 and 250 a year on energy for cooking – on average less than 0.5% of their income. In emerging and developing economies, this share is roughly double on average. However, averages fail to represent the cost burden on the poorest, especially in sub-Saharan Africa. More than half of households yet to gain access in the region would spend more than 5% of their income[2] on cooking devices and fuels, regardless of the clean cooking option used (Figure 3.2). This is true even after accounting for incentives allocated to devices and fuels.

Figure 3.2 ▷ Share of households yet to gain access in sub-Saharan Africa where clean cooking is less than 5% of their income by technology, 2022



Improved and advanced cookstoves could provide access to a substantial share of households, but most of them will need financial support

Notes: ICS = Improved Biomass Cookstoves (ISO TIER ≥ 3). Electric cooking includes electric hot plates and induction stoves, while the use of efficient appliances as electric pressure cookers could improve affordability over the product life-time. In the analysis it is assumed that upfront costs are spread over the infrastructure or product lifetime. Upfront cost incentives are excluded and only end-use fuel price incentives are included. The analysis is based on household income data by percentile [source World Bank PIP] and a solution is considered affordable if its cost is lower or equal to 5% of the household income. A social tariff represents any discounted rate for low-income households which is paid for through charging higher prices to other households. This is not considered a subsidy if the average price across all consumers remains above the true cost of supply.

[2] 5% of income is commonly used as a threshold for affordability as for example used by the World Bank Multi Tier Framework for clean cooking.

As such, ongoing affordability support combined with end-user financing schemes may be needed for many of these households. All households switching to modern fuels between now and 2030, would, in aggregate, spend USD 65 billion annually by 2030 on LPG and electricity in the Access for All scenario. This does not consider the sizable spending on purchased fuelwood, charcoal and ethanol by urban households, which can be significant. Bringing down the cost for cooking to levels consistent with 5% of income for all households gaining clean cooking access would require USD 40-55 billion per year. Some of this can be managed through cross-subsidisation between low-income and high-income consumers, but targeted direct consumer support would likely be needed.

Managing affordability of stoves for consumers without placing too much strain on public finances is a delicate balancing act. India and Indonesia both relied heavily on fiscal incentives for LPG stoves and cylinders. However, sustaining these subsidies over the long-term can become a fiscal burden for governments, particularly if they are poorly targeted. Moreover, once subsidies have been put in place, removing them without unwinding progress can become challenging and unpopular. This is why targeted measures to support the most vulnerable households and communities is important. There are many examples whereby the removal of subsidies provided a catalyst for consumers to revert to traditional use of biomass, such as in Senegal in 2010-13.

A number of countries have intentions to diversify their cooking energy mix, increasingly looking to electricity to reduce LPG imports and subsidy burdens. Several countries are currently looking to remove or reduce financial support for LPG. For instance, India implemented a voluntary scheme for wealthier households to forgo LPG subsidies in 2015, then made efforts to remove subsides during Covid-19 when prices were low. However, the global price spikes compelled India in 2023 to extend the subsidies by one year to avoid disruption to the poorest households. In Indonesia, nearly 35% of cooking energy demand comes from LPG, driving the government to implement programmes aimed at increasing electric cooking, which is less exposed to price shocks. While electricity subsidies also present difficulties, targeting consumers through electric rate design is easier than with retail LPG. Additionally, electricity tariffs are composed to cover a higher share of fixed costs, leaving them less exposed to fuel prices, especially in regions with higher shares of renewables.

There may be scope in some cases to move from broad-based, fuel-specific subsidies for LPG to more targeted support that reduces fiscal burdens without sacrificing affordability. Yet, tailoring support remains a challenge in regions where administrative systems are under-resourced. Digital payment schemes (such as Pay-as-you-cook or Pay-as-you-go) and partial refills business models can provide a useful window into the ability of end users to afford clean cooking solutions. Data from these transactions could be used to offer the most vulnerable consumers an appropriate level of support. Lessons learned from payment schemes in Ghana, Kenya, Nigeria and South Africa could be leveraged to provide a template for other countries across the region.

Consumer awareness and education for households to ensure they fully understand the opportunity dividend of switching to modern, cleaner stoves is crucially important. Often this

transition is only thought of in terms of upfront financial support costs, rather than the economic benefits that it will deliver by freeing up those in the home to work and engage in other activities.

3.3 International support

International support, particularly financing, will be essential to reach universal access to clean cooking this decade. The success of India, China, and Indonesia's clean cooking progress comes from strong policy commitment and dedicated public funding. In turn, this attracted substantial private and state-backed capital to clean cooking. However, this model is not replicable in many countries, particularly in sub-Saharan Africa. High debt burdens, constrained fiscal leeway for increasing public spending, and shallow domestic capital markets all signal the need for international participation to spur an increase in clean cooking investments. In the Access for All scenario, investments in cookstoves, consumer equipment, and infrastructure totals USD 8 billion annually through to 2030.

Achieving universal access to clean cooking will depend heavily on the availability of sufficient concessional financing, a form of financing that offers far more generous terms than private investors or commercial capital markets. This type of financing comes in many forms but typically these are grants that do not need to be repaid, loans with very favourable rates of interest, or guarantees whereby a third party agrees to cover losses in case repayments cannot be made.

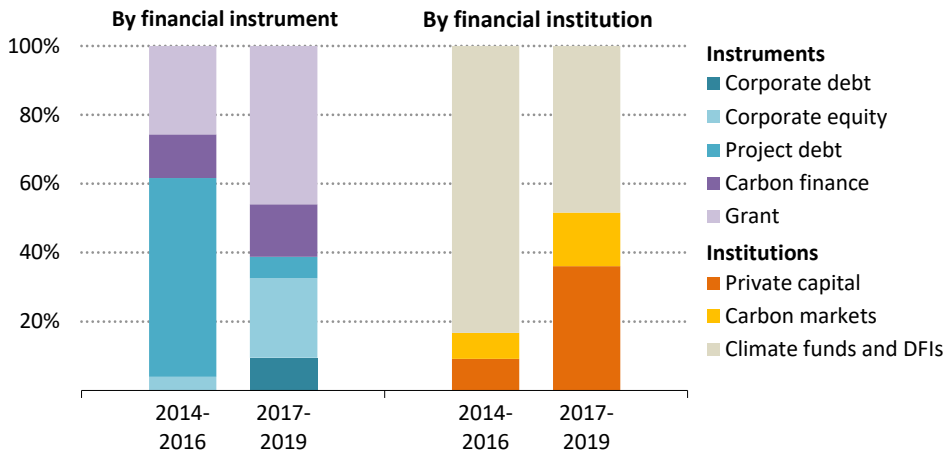
Development finance institutions (DFIs) and multi-lateral development banks (MDBs) are the main providers of concessional capital for clean cooking projects today. The best practice is to provide enough concessional financing support to start projects that would otherwise struggle to attract investment, appealing to private and commercial actors (e.g. pensions, banks, private equity) to then commit additional funds.

Concessional finance is essential to attract the private sector to make stoves and equipment available to the poorest households and the most vulnerable communities. In this sense, the projects may be considered too risky or fail to demonstrate a clear pathway to financial returns for a private investor alone. However, infrastructure projects related to clean cooking could offer a more compelling investment case to the private sector. For instance, infrastructure for LPG delivery, as well as grid reinforcement and expansion, could rely more on private finance over time with concessional support focused on consumers, which helps ensure the demand will be there to support these investments. The IEA estimates around USD 4 billion of concessional finance would be needed annually for access to clean cooking, with around three quarters flowing to sub-Saharan Africa.

As companies providing clean cooking solutions develop and mature, the degree of concessional support needed for these projects declines. This evolution can be seen in the sources of international financial flows to clean cooking projects tracked over the last decade, where the share of private capital in clean cooking projects has risen (Figure 3.3). By

the end of the 2010s, this share grew from less than 10% to around 35% in the most recent years tracked. Further increases would be necessary to reach the level of investment required by the end of this decade. Rising private participation does not lessen the need for concessional financing for clean cooking from DFIs, which must continue to work in regions and with households that the private sector would not serve to without their intervention.

Figure 3.3 ▷ International finance flows for clean cooking to select countries, 2014-2019



Clean cooking is shifting from highly concessional financing to more private capital and moving from project-by-project financing to investing in clean cooking companies.

Source: Energizing Finance: Understanding the Landscape 2021, Sustainable Energy for All.

The types of financing instruments used have also changed in recent years. Early on, **project debt** was common, with projects financed individually and under very specific terms based on their risk profile and likely returns. Over time and with proven track records, clean cooking developers were able to attract investors to take **equity** stakes in their companies and fund projects using **corporate debt**. In the early 2010s, project debt represented over half of all international financing flows to clean cooking and has largely been supplanted by corporate debt and equity. Still, concessional finance can help crowd in more institutional investors, as is the case in the Spark+ Africa Fund, which attracted institutional investors by including a first-loss tranche provided by the African Development Bank Group.

Access to this variety of financing instruments gives developers the flexibility to scale and explore new approaches. For instance, they can procure a larger order of stoves for several projects at a time, which can help bring down the cost per stove. Similar models exist, such as demand aggregation, in which authorities can help clear a larger transaction for numerous small-to-medium enterprises, bringing down costs but also simplifying financing by having a single large contract with a government entity, instead of numerous small deals with

different companies. Firms relying on PayGo models have also had success securitising revenue streams from their most reliable customers, allowing them to further leverage their capital to extend to new customers.

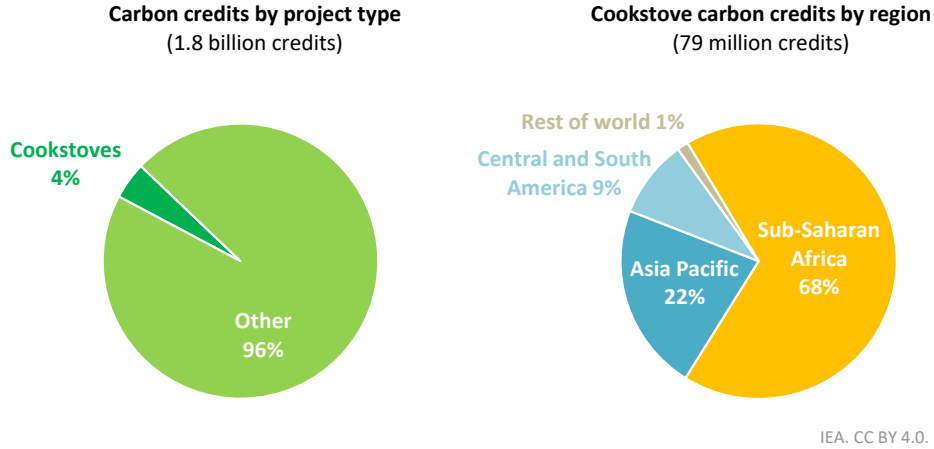
Grant funding continues to play an important role for clean cooking in contexts that do not guarantee immediate returns. The need for this highly concessional pot of money, including philanthropy, is essential to reach universal access quickly, as private capital's role is likely to remain limited this decade. Novel approaches such as Results-Based Financing (RBF) can play a role too. Grants are also useful to set up financial and legal frameworks necessary for receiving carbon financing or RBF, and can be used to carry out pilot projects, including local RD&D efforts which can pave the way for future projects that are more attractive to private capital.

The role of **carbon markets and finance** is also increasing and is poised to play an important role in the future, albeit providing small amounts to clean cooking today. International carbon credits have been available for clean cooking projects for the past two decades. These credits are purchased by companies and governments in industrialised countries to help them meet their climate targets by financing projects in non-industrialised countries. These revenue streams can be substantial enough to move projects into the realm of bankability, especially as they are frequently backed by a country or company with a stronger credit rating than local entities.

Clean cookstove projects in rural areas are considered highly additional, as the projects would not occur without these credits. Additionality is important for companies looking to make sustainability claims with these credits, making them attractive instruments. Clean cooking credits often fetch a higher price than other credits on offer, due to the multiple benefits of improving health, gender equality, poverty alleviation, and reducing deforestation. In the last 5 years, international carbon credits from clean cooking projects often traded three- to six- times higher than the average credit, and typically fetched prices of around USD 10-25 per stove. Clean cookstoves represent a fraction of voluntary carbon markets by volume of issuances (5%), with about 79 million credits issued up to 2023. Of these, almost 70% were focused on sub-Saharan Africa. In the Access for All scenario, the full mitigation potential for sub-Saharan Africa could be reach below USD 30 per tonne of CO_2, making it one of the cheapest options for project investments with robust additionality.

Several challenges exist in Measurement, Reporting and Verification (MRV) to meet requirements for high-quality carbon credits, as does the legal system to access these funds. Grant funding can help set up these systems. One challenge is that today international carbon credit markets lack depth. Scaling up the use of these revenues in parallel requires bringing more buyers to the market. Schemes must balance emissions reduction accountability for companies' scope 1 and 2 (operations and indirect) emissions, while also not prohibiting greater use of international offsets that can be key to rising levels of investment in EMDEs.

Figure 3.4 ▷ Carbon credits issued for cookstove-related projects, 2004-2023



Clean cooking represents 5% of carbon credits issued since 2004, despite 1.5 Gt of potential reductions. 70% of cookstove credits sold support projects in sub-Saharan Africa.

Note: The data covers carbon credits' issuances listed by American Carbon Registry (ACR), Climate Action Reserve (CAR), Gold Standard (GS), and Verra (VCS).

Source: Voluntary Registry Offsets Database, Berkeley Carbon Trading Project (May 2023), (Berkeley, 2023)

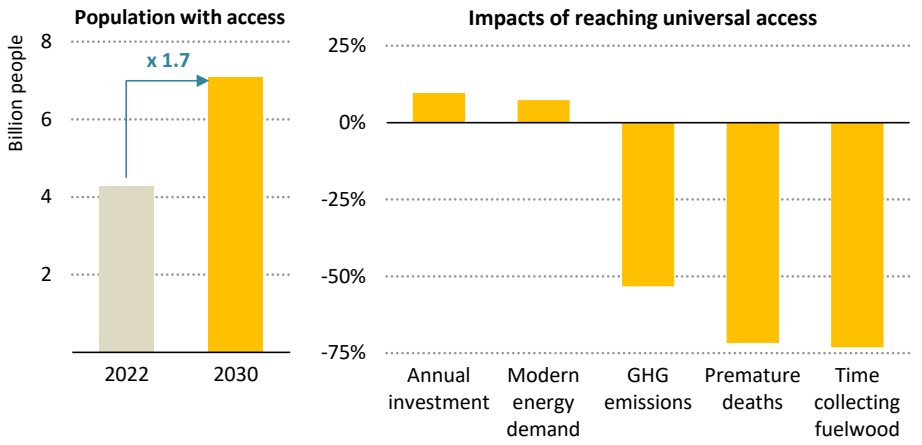
Rules and market structures have been evolving lately to account for these challenges. The Article 6 of the Paris Agreement, setting the new rules for carbon credit mechanisms, incorporates corresponding adjustments mechanisms, and shall provide an increased focus on the quality and integrity of those credits. Regional initiatives, like the Africa Carbon Markets Initiative (ACMI), should also help in enabling carbon markets to grow in developing economies, with the development of a regulatory environment.

New models of financing clean cooking projects continue to emerge that can increasingly pull more private capital into clean cooking. For instance, carbon credits have been used to discount clean fuel costs instead of stoves, as has been the case for bioethanol sales in Kenya. However, this should not serve as signal for international finance institutions to take a backseat role, but instead they can help find opportunities for commercial lenders to take their position in mature projects, freeing up capital to reallocate to more nascent projects.

3.4 Conclusions/Summary

The economic, social and environmental benefits of universal access to clean cooking for those across sub-Saharan Africa and beyond are undeniable. Delivering on this goal means fewer emissions, fewer premature deaths, fewer women and children out of work and education, and fewer ecosystems lost to deforestation and destruction of natural habitats. Crucially, the technical solutions are available, while the policies required to stimulate investment and incentivise uptake of these are also well known.

Figure 3.5 ▷ Impacts of the Access for All scenario in Emerging Market and Developing Economies relative to 2022



The benefits of achieving universal access to clean cooking by 2030 far outweigh the costs

Note: Impacts over annual investments, energy demand and GHG emissions only encompasses the buildings sector.

The Covid-19 pandemic and the global energy crisis have seen the world backslide on clean cooking progress, with 100 million households reverting to traditional cooking practices due to issues over affordability and security of supply. It is now incumbent on governments, development institutions, and other key stakeholders to act to address this long-standing yet entirely solvable problem. The most vulnerable consumers, in both rural and urban areas, need support to overcome the upfront costs of investing in these technologies whether it be e-cooking, LPG stoves or ICS. Some consumers will also need support on fuel costs, which must be managed prudently to ensure that it is sustainable and fiscal discipline maintained.

The world is off-track on the reach universal access to clean cooking by 2030 under the UN's SDG 7 goals. A full scale up of international capital and concessional financing can correct this in very short time with a relatively modest level of funds required on an annual basis. This also means making the clean cooking sector a more attractive and vibrant investment opportunity through innovative financing solutions and mechanisms that would give would-be investors assurance to inject funds into these critical development projects. It is now time to bring all these important elements together to enable clean cooking for all.

ANNEXES

Definitions

This annex provides general information on terminology used throughout this report including units and general conversion factors; definitions of fuels, processes and sectors; regional and country groupings; and abbreviations and acronyms.

Units

Area	ha	hectare
Coal	Mtce	million tonnes of coal equivalent (equals 0.7 Mtoe)
Emissions	ppm	parts per million (by volume)
	t CO_2	tonnes of carbon dioxide
	kg CO_2-eq	kilogrammes of carbon-dioxide equivalent
	Mt CO_2-eq	million tonnes of carbon-dioxide equivalent
	Gt CO_2-eq	gigatonnes of carbon-dioxide equivalent (using 100-year global warming potentials for different greenhouse gases)
Energy	EJ	exajoule (1 joule x 10^{18})
	PJ	petajoule (1 joule x 10^{15})
	TJ	terajoule (1 joule x 10^{12})
	GJ	gigajoule (1 joule x 10^{9})
	MJ	megajoule (1 joule x 10^{6})
	boe	barrel of oil equivalent
	toe	tonne of oil equivalent
	ktoe	thousand tonnes of oil equivalent
	Mtoe	million tonnes of oil equivalent
	bcme	billion cubic metres of natural gas equivalent
	kWh	kilowatt-hour
	MWh	megawatt-hour
	GWh	gigawatt-hour
	TWh	terawatt-hour
Gas	bcm	billion cubic metres
	tcm	trillion cubic metres
Mass	kg	kilogramme
	t	tonne (1 tonne = 1 000 kg)
	kt	kilotonnes (1 tonne x 10^{3})
	Mt	million tonnes (1 tonne x 10^{6})
	Gt	gigatonnes (1 tonne x 10^{9})
Monetary	USD million	1 US dollar x 10^{6}
	USD billion	1 US dollar x 10^{9}
	USD trillion	1 US dollar x 10^{12}
	USD/t CO_2	US dollars per tonne of carbon dioxide
Oil	kb/d	thousand barrels per day
	mb/d	million barrels per day
	mboe/d	million barrels of oil equivalent per day

Power	W	watt (1 joule per second)
	kW	kilowatt (1 watt x 10^3)
	MW	megawatt (1 watt x 10^6)
	GW	gigawatt (1 watt x 10^9)
	TW	terawatt (1 watt x 10^{12})

General conversion factors for energy

		Multiplier to convert to:					
		EJ	**Gcal**	**Mtoe**	**MBtu**	**bcme**	**GWh**
Convert from:	**EJ**	1	2.388×10^8	23.88	9.478×10^8	27.78	2.778×10^5
	Gcal	4.1868×10^{-9}	1	10^{-7}	3.968	1.163×10^{-7}	1.163×10^{-3}
	Mtoe	4.1868×10^{-2}	10^7	1	3.968×10^7	1.163	11 630
	MBtu	1.0551×10^{-9}	0.252	2.52×10^{-8}	1	2.932×10^{-8}	2.931×10^{-4}
	bcme	0.036	8.60×10^6	0.86	3.41×10^7	1	9 999
	GWh	3.6×10^{-6}	860	8.6×10^{-5}	3 412	1×10^{-4}	1

Note: There is no generally accepted definition of boe; typically, the conversion factors used vary from 7.15 to 7.40 boe per toe. Natural gas is attributed a low heating value of 1 MJ per 44.1 kg. Conversions to and from billion cubic metres of natural gas equivalent (bcme) are given as representative multipliers but may differ from the average values obtained by converting natural gas volumes between IEA balances due to the use of country-specific energy densities. Lower heating values (LHV) are used throughout.

Currency conversions

Exchange rates *(2022 annual average)*	**1 US Dollar (USD) equals:**
British Pound	0.81
Chinese Yuan Renminbi	6.74
Euro	0.95
Indian Rupee	78.60
Indonesian Rupiah	14 850
Japanese Yen	131.50
Russian Ruble	78.48
South African Rand	16.35

Source: OECD National Accounts Statistics (database): purchasing power parities and exchange rates dataset (period-average), https://stats.oecd.org/Index.aspx?DataSetCode=SNA_TABLE6A, accessed July 2023.

Definitions

Access for All Scenario: It is a scenario in which key energy-related United Nations Sustainable Development Goals (SDGs), in particular achieving universal energy access by 2030 are met.

Biodigester: A biodigester breaks down organic material (such as animal manure, agriculture residues, food waste) to produce biogas (see definition below). This can be a source of energy for clean-cooking solutions.

Bioenergy: Energy content in solid, liquid and gaseous products derived from biomass feedstocks and biogas. It includes solid bioenergy, liquid biofuels and biogases.

Biogas: A mixture of methane, CO_2 and small quantities of other gases produced by anaerobic digestion of organic matter in an oxygen-free environment.

Biogases: Include both biogas and biomethane.

Biogasoline: Includes all liquid biofuels (advanced and conventional) used to replace gasoline.

Biomethane: Biomethane is a near-pure source of methane produced either by "upgrading" biogas (a process that removes any carbon dioxide and other contaminants present in the biogas) or through the gasification of solid biomass followed by methanation. It is also known as renewable natural gas.

Carbon capture, utilisation and storage (CCUS)**:** The process of capturing carbon dioxide emissions from fuel combustion, industrial processes or directly from the atmosphere. Captured CO_2 emissions can be stored in underground geological formations, onshore or offshore, or used as an input or feedstock in manufacturing.

Carbon credits: A carbon credit or offset is a transferable financial instrument (e.g. can be traded or sold) that certifies an emissions reduction.

Carbon dioxide (CO_2)**:** Is a gas consisting of one part carbon and two parts oxygen. It is an important greenhouse (heat-trapping) gas.

Clean cooking systems: Cooking solutions that release less harmful pollutants, are more efficient and environmentally sustainable than traditional cooking options that make use of solid biomass (such as a three-stone fire), coal or kerosene. This refers to improved cook stoves, biogas/biodigester systems, electric stoves, liquefied petroleum gas, natural gas or ethanol stoves.

Coal: Includes both primary coal, i.e. lignite, coking and steam coal, and derived fuels, e.g. patent fuel, brown-coal briquettes, coke-oven coke, gas coke, gas works gas, coke-oven gas, blast furnace gas and oxygen steel furnace gas. Peat is also included.

Electric cooking or e-cooking: Cooking technologies that use electricity for heat such as induction plates, hot plates or electric pressure cookers. Electricity used for cooking is considered a clean-cooking solution

Ethanol: Refers to bioethanol only. Ethanol is produced from fermenting any biomass high in carbohydrates. Currently, ethanol is made from starches and sugars, but second-generation technologies will allow it to be made from cellulose and hemicellulose, the fibrous material that makes up the bulk of most plant matter. Bioethanol cookstoves are considered a clean-cooking solution.

Fossil fuels: Include coal, natural gas and oil.

Gaseous fuels: Include natural gas, biogases, synthetic methane and hydrogen.

Improved cook stoves: Intermediate and advanced improved biomass cook stoves (ISO tier ≥ 3). It excludes basic improved stoves (ISO tier 0-2).

Investment: Investment is the capital expenditure in energy supply, infrastructure, end-use and efficiency. Fuel supply investment includes the production, transformation and transport of oil, gas, coal and low-emissions fuels. *Power sector* investment includes new construction and refurbishment of generation, electricity networks (transmission, distribution and public electric vehicle chargers), and battery storage. *Energy efficiency* investment includes efficiency improvements in buildings, industry and transport. *Other end-use* investment includes the purchase of equipment for the direct use of renewables, electric vehicles, electrification in buildings, industry and international marine transport, equipment for the use of low-emissions fuels, and CCUS in industry and direct air capture. Data and projections reflect spending over the lifetime of projects and are presented in real terms in year-2021 US dollars unless otherwise stated. Total investment reported for a year reflects the amount spent in that year.

Kerosene: Liquid mix of hydrocarbons that is used to produce jet fuel as well as being used for heating, cooking, and lighting. Kerosene used for cooking is not considered a clean-cooking solution.

Levelised cost of electricity (LCOE)**:** The LCOE combines all the cost elements directly associated with a given power technology into a single metric, including construction, financing, fuel, maintenance and costs associated with a carbon price. It does not include network integration or other indirect costs. The LCOE provides a first indicator of competitiveness.

Liquefied petroleum gas (LPG)**:** A stable, clean burning gas consisting of propane, butane, or a mixture of the two. LPG used for cooking is considered a clean-cooking solution.

Liquid biofuels: Liquid fuels derived from biomass or waste feedstock, e.g. bioethanol, biodiesel and biojet fuels. They can be classified as conventional and advanced biofuels according to the combination of feedstock and technologies used to produce them and their respective maturity. Unless otherwise stated, biofuels are expressed in energy-equivalent volumes of gasoline, diesel and kerosene.

Low-emissions fuels: Include modern bioenergy, low-emissions hydrogen and low-emissions hydrogen-based fuels.

Low-emissions gases: Includes biogas, biomethane, low-emissions hydrogen and low-emissions synthetic methane.

Modern energy: Modern energy includes LPG, electricity, biogas and ethanol.

Modern gaseous bioenergy: See biogases.

Modern liquid bioenergy: Includes biogasoline, biodiesel, biojet kerosene and other liquid biofuels.

Modern renewables: Include all uses of renewable energy with the exception of traditional use of solid biomass.

Modern solid bioenergy: Includes all solid bioenergy products (see solid bioenergy definition) except the traditional use of biomass. It also includes the use of solid bioenergy in intermediate and advanced improved biomass cook stoves (ISO tier > 1), requiring fuel to be cut in small pieces or often using processed biomass such as pellets.

National targets:
take account of all the climate commitments made by governments around the world inclu ding Nationally Determined Contributions as well as longer term net zero emissions targets and assumes that they will be met in full and on time.

Natural gas: Includes gas occurring in deposits, whether liquefied or gaseous, consisting mainly of methane. It includes both non-associated gas originating from fields producing hydrocarbons only in gaseous form, and associated gas produced in association with crude oil production as well as methane recovered from coal mines (colliery gas). Natural gas liquids, manufactured gas (produced from municipal or industrial waste, or sewage) and quantities vented or flared are not included. Gas data in cubic metres are expressed on a gross calorific value basis and are measured at 15 °C and at 760 mm Hg (Standard Conditions). Gas data expressed in tonnes of oil equivalent, mainly for comparison reasons with other fuels, are on a net calorific basis. The difference between the net and the gross calorific value is the latent heat of vapourisation of the water vapour produced during combustion of the fuel (for gas the net calorific value is 10% lower than the gross calorific value). Natural gas used for cooking is considered a clean cooking solution.

Oil: Includes both conventional and unconventional oil production. Petroleum products include refinery gas, ethane, liquid petroleum gas, aviation gasoline, motor gasoline, jet fuels, kerosene, gas/diesel oil, heavy fuel oil, naphtha, white spirits, lubricants, bitumen, paraffin, waxes and petroleum coke.

Residential: Energy used by households including space heating and cooling, water heating, lighting, appliances, electronic devices and cooking.

Services: Energy used in commercial facilities, e.g., offices, shops, hotels, restaurants, and in institutional buildings, e.g., schools, hospitals, public offices. Energy use in services includes space heating and cooling, water heating, lighting, appliances, cooking and desalination.

Solid bioenergy: Includes charcoal, fuelwood, dung, agricultural residues, wood waste and other solid biogenic wastes.

Solid fuels: Include coal, modern solid bioenergy, traditional use of biomass and industrial and municipal wastes.

Stated Policies Scenario (STEPS)**:** does not take for granted that governments will reach all announced goals. Instead, it explores where the energy system might go without additional policy implementation.

Total final consumption (TFC)**:** Is the sum of consumption by the various end-use sectors. TFC is broken down into energy demand in the following sectors: industry (including manufacturing, mining, chemicals production, blast furnaces and coke ovens), transport, buildings (including residential and services) and other (including agriculture and other non-energy use). It excludes international marine and aviation bunkers, except at world level where it is included in the transport sector.

Total final energy consumption (TFEC)**:** Is a variable defined primarily for tracking progress towards target 7.2 of the United Nations Sustainable Development Goals (SDG). It incorporates total final consumption by end-use sectors, but excludes non-energy use. It excludes international marine and aviation bunkers, except at world level. Typically this is used in the context of calculating the renewable energy share in total final energy consumption (indicator SDG 7.2.1), where TFEC is the denominator.

Traditional use of biomass (TUOB)**:** Refers to the use of solid biomass with basic technologies, such as a three-stone fire or basic improved cook stoves (ISO tier 0-1), often with no or poorly operating chimneys. Forms of biomass used include wood, wood waste, charcoal, agricultural residues and other bio-sourced fuels such as animal dung.

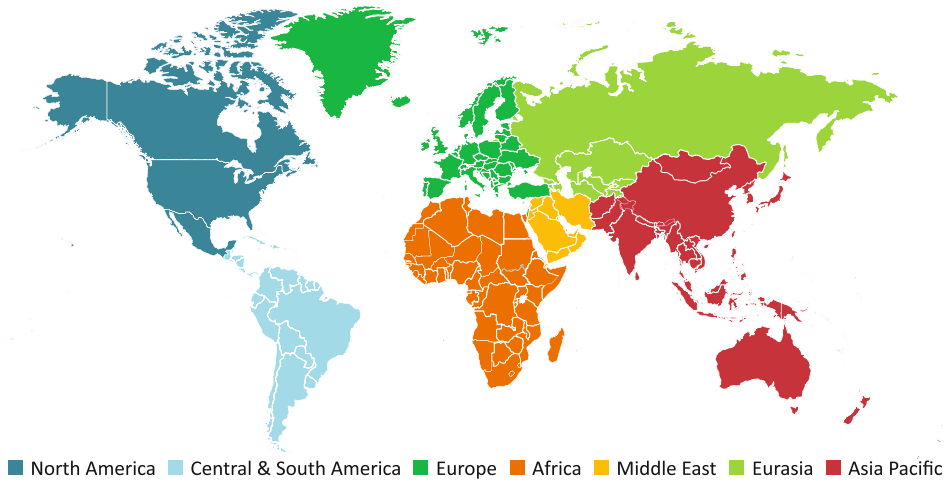
Three-stone fire: Traditional cooking set-up where the cooking vessel is placed near open flame to limit heat loss.

Useful energy: Refers to the energy that is available to end-users to satisfy their needs. This is also referred to as energy services demand. As result of transformation losses at the point of use, the amount of useful energy is lower than the corresponding final energy demand for most technologies. Equipment using electricity often has higher conversion efficiency than equipment using other fuels, meaning that for a unit of energy consumed, electricity can provide more energy services.

Unsustainable harvesting: Unsustainable harvesting/gathering/collection of firewood refers to the use of forestry resources for cooking needs that leads to a decrease in forest areas. This happens when the harvesting is faster than the natural growth (or replanting) of the forest resources.

Regional and country groupings

Figure C.1 ▷ Main country groupings



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

Advanced economies: OECD regional grouping and Bulgaria, Croatia, Cyprus[1,2], Malta and Romania.

Africa: North Africa and sub-Saharan Africa regional groupings.

Asia Pacific: Southeast Asia regional grouping and Australia, Bangladesh, Democratic People's Republic of Korea (North Korea), India, Japan, Korea, Mongolia, Nepal, New Zealand, Pakistan, People's Republic of China (China), Sri Lanka, Chinese Taipei, and other Asia Pacific countries and territories.[3]

Caspian: Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

Central and South America: Argentina, Plurinational State of Bolivia (Bolivia), Brazil, Chile, Colombia, Costa Rica, Cuba, Curaçao, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad and Tobago, Uruguay, Bolivarian Republic of Venezuela (Venezuela), and other Central and South American countries and territories.[4]

China: Includes the People's Republic of China and Hong Kong.

Developing Asia: Asia Pacific regional grouping excluding Australia, Japan, Korea and New Zealand.

Emerging market and developing economies (EMDEs)**:** All other countries not included in the advanced economies regional grouping.

Eurasia: Caspian regional grouping and the Russian Federation (Russia).

Europe: European Union regional grouping and Albania, Belarus, Bosnia and Herzegovina, North Macedonia, Gibraltar, Iceland, Israel[5], Kosovo, Montenegro, Norway, Serbia, Switzerland, Republic of Moldova, Türkiye, Ukraine and United Kingdom.

European Union: Austria, Belgium, Bulgaria, Croatia, Cyprus[1,2], Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain and Sweden.

IEA (International Energy Agency)**:** OECD regional grouping excluding Chile, Colombia, Costa Rica, Iceland, Israel, Latvia and Slovenia.

Latin America: Central and South America regional grouping and Mexico.

Middle East: Bahrain, Islamic Republic of Iran (Iran), Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic (Syria), United Arab Emirates and Yemen.

Non-OECD: All other countries not included in the OECD regional grouping.

Non-OPEC: All other countries not included in the OPEC regional grouping.

North Africa: Algeria, Egypt, Libya, Morocco and Tunisia.

North America: Canada, Mexico and United States.

OECD (Organisation for Economic Co-operation and Development)**:** Australia, Austria, Belgium, Canada, Chile, Czech Republic, Colombia, Costa Rica, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Türkiye, United Kingdom and United States.

OPEC (Organisation of the Petroleum Exporting Countries)**:** Algeria, Angola, Republic of the Congo (Congo), Equatorial Guinea, Gabon, the Islamic Republic of Iran (Iran), Iraq, Kuwait, Libya, Nigeria, Saudi Arabia, United Arab Emirates and Bolivarian Republic of Venezuela (Venezuela).

Southeast Asia: Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam. These countries are all members of the Association of Southeast Asian Nations (ASEAN).

Sub-Saharan Africa (excludes South Africa)**:** Angola, Benin, Botswana, Cameroon, Republic of the Congo (Congo), Côte d'Ivoire, Democratic Republic of the Congo, Eritrea, Ethiopia, Gabon, Ghana, Kenya, Mauritius, Mozambique, Namibia, Niger, Nigeria, Senegal, South Sudan, Sudan, United Republic of Tanzania (Tanzania), Togo, Zambia, Zimbabwe and other African countries and territories.[6]

Country notes

[1] Note by Republic of Türkiye: The information in this document with reference to "Cyprus" relates to the southern part of the island. There is no single authority representing both Turkish and Greek Cypriot people on the island. Türkiye recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Türkiye shall preserve its position concerning the "Cyprus issue".

[2] Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Türkiye. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

[3] Individual data are not available and are estimated in aggregate for: Afghanistan, Bhutan, Cook Islands, Fiji, French Polynesia, Kiribati, Macau (China), Maldives, New Caledonia, Palau, Papua New Guinea, Samoa, Solomon Islands, Timor-Leste and Tonga and Vanuatu.

[4] Individual data are not available and are estimated in aggregate for: Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Bermuda, Bonaire, British Virgin Islands, Cayman Islands, Dominica, Falkland Islands (Malvinas), French Guiana, Grenada, Guadeloupe, Guyana, Martinique, Montserrat, Saba, Saint Eustatius, Saint Kitts and Nevis, Saint Lucia, Saint Pierre and Miquelon, Saint Vincent and Grenadines, Saint Maarten, Turks and Caicos Islands.

[5] The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD and/or the IEA is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

[6] Individual data are not available and are estimated in aggregate for: Burkina Faso, Burundi, Cabo Verde, Central African Republic, Chad, Comoros, Djibouti, Kingdom of Eswatini, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Réunion, Rwanda, Sao Tome and Principe, Seychelles, Sierra Leone, Somalia and Uganda.

Abbreviations and acronyms

AfDB	African Development Bank Group
ASEAN	Association of Southeast Asian Nations
ABC	African Biodigester Component
BECCS	bioenergy equipped with CCUS
CCA	Clean Cooking Alliance
CCUS	carbon capture, utilisation and storage
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2-eq	carbon-dioxide equivalent
COP	Conference of Parties (UNFCCC)
DFI	Development finance Institutions
DRC	Democratic Republic of Congo
EMDE	Emerging Market and Developing Economies
EPC	Electric pressure cooker
EU	European Union
FDI	foreign direct investment
GEC	global energy and climate (IEA model)
GDP	gross domestic product
GHG	greenhouse gases

IEA	International Energy Agency
IIASA	International Institute for Applied Systems Analysis
IPCC	Intergovernmental Panel on Climate Change
ICS	Improved Cook stoves
KPLC	Kenya Power and Lighting Company
KTH	Kungliga Tekniska Hogskolan (Sweden University)
LCA	Life Cycle Assessment
LCOE	levelized cost of electricity
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MDBs	Multi-lateral Development Bank
MRV	Measurement, reporting and verification
NDCs	Nationally Determined Contributions
NGLs	natural gas liquids
NOC	national oil company
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PPA	power purchase agreement
PPP	purchasing power parity
R&D	research and development
SDG	Sustainable Development Goals (United Nations)
SAIDI	System Average Interruption Duration Index
SEA	Southeast Asia
SSA	Sub-Saharan Africa
STEPS	Stated Policies Scenario
TFC	total final consumption
TFEC	total final energy consumption
TUOB	Traditional use of biomass
UAE	United Arab Emirates
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USD	United States Dollar
WEF	Women's Empowerment Fund
WEO	World Energy Outlook
WHO	World Health Organization

References

Chapter 1: Access to clean cooking

BPS (Badan Pusat Statistik/Statistics Indonesia) (2019), The State of the Workforce in Indonesia August 2019, https://www.bps.go.id/publication/2019/11/29/96138ece33ccc220007acbdd/labor-force-situation-in-indonesia-august-2019.html [in Bahasa].

Cai, B., Q. Lin and J. Ma (2020), China Status of CO_2 Capture, Utilization and Storage 2019, https://www.researchgate.net/publication/343628620_China_Status_of_CO2_Capture_Utilization_and_Storage_CCUS

China, National Bureau of Statistics (2021), Statistical Communiqué of the People's Republic of China on National Economic and Social Development in 2020, http://www.stats.gov.cn/tjsj/zxfb/202102/t20210227_1814154.html [in Chinese].

China, National Development and Reform Commission (2021), In 2020, the national coal mining and washing industry realized a profit of 222.27 billion yuan, a decrease of 21.1%, https://www.ndrc.gov.cn/xwdt/ztzl/nybzgzzl/gnjnybz/202101/t20210129_1266371.html?code=&state=123 [in Chinese].

China, Inner Mongolia Autonomous Region Statistics Bureau (2021a), Statistical Bulletin of Inner Mongolia Autonomous Region's National Economic and Social Development, http://tj.nmg.gov.cn/tjyw/tjgb/202202/t20220228_2010485.html [in Chinese].

China, Inner Mongolia Autonomous Region Statistics Bureau (2021b), Inner Mongolia Statistical Yearbook 2021, http://tj.nmg.gov.cn/files_pub/content/PAGEPACK/83e5521da4e94d50ab45483b58e5fa7e/zk/indexch.html [in Chinese].

DANE (Departamento Administrativo Nacional de Estadística/National Administrative Department of Statistics) (2021), Boletín Técnico. Gran Encuesta Integrada de Hogares. Mercado laboral por departamentos Año 2021 [Technical Bulletin. Large integrated household survey. Labour market by departments Year 2021], https://img.lalr.co/cms/2021/11/30163259/bol_empleo_oct_21.pdf [in Spanish].

Energy Foundation China (2021), Coal Information Updates, https://www.efchina.org/News-en/Program-Updates-en/programupdate-coaltf-20211223-en

EURACOAL (European Association for Coal and Lignite) (2020), Coal industry across Europe, https://euracoal2.org/download/Public-Archive/Library/Coal-industry-across-Europe/EURACOAL-Coal-industry-across-Europe-7th.pdf

European Commission (2020), Silesia, Poland - Regional profile, https://ec.europa.eu/energy/sites/ener/files/documents/silesia_regional_profile_-_start_technical_assistance.pdf

Global Energy Monitor (2022), Global Coal Mine Tracker (database), https://globalenergymonitor.org/projects/global-coal-mine-tracker/ (accessed 20 July 2022).

IEA (International Energy Agency) (2022a), Africa Energy Outlook, https://www.iea.org/reports/africa-energy-outlook-2022

IEA (2022b), World Energy Outlook 2022, https://www.iea.org/reports/world-energy-outlook-2022

IEA (2021a), World Energy Outlook 2021, https://www.iea.org/reports/world-energy-outlook-2021

IEA (2021b), The Role of Low-Carbon Fuels in the Clean Energy Transitions of the Power Sector, https://www.iea.org/reports/the-role-of-low-carbon-fuels-in-the-clean-energy-transitions-of-the-power-sector

ILO (International Labour Organisation) (2021), ILOStat (database), https://ilostat.ilo.org/ (accessed 10 September 2022).

India, Ministry of Coal (2022), Total Coal Production in the Country & Efforts to Enhance Quantity, https://pib.gov.in/PressReleasePage.aspx?PRID=1794791

India, Ministry of Statistics and Programme Implementation (2021), Periodic Labour Force Survey 2020-2021, https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1833855

IPCC (Intergovernmental Panel on Climate Chance) (2021), Sixth Assessment Report, https://www.ipcc.ch/assessment-report/ar6/

Kholod N. et al. (2020), Global methane emissions from coal mining to continue growing even with declining coal production, Journal of Cleaner Production, Vol. 256, 120489, https://doi.org/10.1016/j.jclepro.2020.120489

Renshetong (2021), In 2021, the average annual salary of employees in urban non-private units in Shanxi Province is 82,413 yuan, https://si12333.cn/policy/kmaa.html [in Chinese].

SEI (Stockholm Environment Institute) (2019), The end of coal?, https://www.sei.org/wp-content/uploads/2019/02/planning-a-just-transition-in-south-africa.pdf

Shanxi Provincial Bureau of Statistics (2021), Shanxi Province Statistical Bulletin of National Economic and Social Development, http://www.tjcn.org/tjgb/04sx/36982.html [in Chinese].

Statistics Bureau of Inner Mongolia Autonomous Region (2021), In 2021, the average annual salary of employees in urban private units in Inner Mongolia is 51,270 yuan, http://tj.nmg.gov.cn/zfxxgk/fdzdgknr/fbyjd/202206/t20220607_2067959.html [in Chinese].

Statistics Poland (2021), Employed persons by economic sectors and sex (database), https://bdl.stat.gov.pl/bdl/dane/podgrup/tablica (accessed 30 June 2022).

Statistics South Africa (2019), Quarterly Labour Force Survey, https://www.datafirst.uct.ac.za/dataportal/index.php/catalog/846

UPME (Unidad de Planeación Minero Energética: Carbón/Energy Mining Planning Unit: Coal) (database), https://www1.upme.gov.co/simco/Cifras-Sectoriales/Paginas/carbon.aspx (accessed July 2022).

World Bank (2020), Coal rents (database), https://data.worldbank.org/indicator/NY.GDP.COAL.RT.ZS?end=2018&start=1970 (accessed 30 June 2022).

Chapter 2: Outlook for clean cooking

China Electricity Council (2022), Analysis and Forecast of China Power Demand-Supply Situation 2021-2022, https://www.cec.org.cn/detail/index.html?3-306171

Global Energy Monitor (2022), Global Coal Plant Tracker (database), https://globalenergymonitor.org/projects/global-coal-plant-tracker/ (accessed July 2022).

IEA (International Energy Agency) (2022a), Nuclear Power and Secure Energy Transitions, https://www.iea.org/reports/nuclear-power-and-secure-energy-transitions

IEA (2022b), Solar PV Global Supply Chains, https://www.iea.org/reports/solar-pv-global-supply-chains

IEA (2021a), Net Zero by 2050: A Roadmap of the Global Energy Sector, https://www.iea.org/reports/net-zero-by-2050

IEA (2021b), Financing Clean Energy Transitions in Emerging and Developing Economies, https://www.iea.org/reports/financing-clean-energy-transitions-in-emerging-and-developing-economies

IEAGHG (IEA Greenhouse Gas R&D Programme) (2019), Towards Zero Emissions CCS in Power Plants Using Higher Capture Rates or Biomass, https://ieaghg.org/publications/technical-reports/reports-list/9-technical-reports/951-2019-02-towards-zero-emissions

International CCS Knowledge Centre (2018), The Shand CCS Feasibility Study: Public Report, https://ccsknowledge.com/pub/documents/publications/Shand%20CCS%20Feasibility%20Study%20Public%20_Full%20Report_NOV2018.pdf

IRENA (International Renewable Energy Agency) (2022), Renewable Power Generation Costs in 2021, https://www.irena.org/publications/2022/Jul/Renewable-Power-Generation-Costs-in-2021

REN21 (2022), Renewables 2022 Global Status Report, https://www.ren21.net/reports/global-status-report

S&P Global (2021), World Electric Power Plants (database), S&P Market Intelligence Platform, www.spglobal.com/marketintelligence (accessed March 2022).

Chapter 3: Achieving access for all

G7 (2022), G7 Climate, Energy and Environment Ministers' Communiqué, https://www.g7fsoi.org/wp-content/uploads/2022/06/2022-05-27-1-climate-ministers-communique-data.pdf

Global Cement (2022), Global Cement Directory, https://www.globalcement.com/directory

Global Cement and Concrete Association (2022), GNR 2.0 – GCCA in Numbers, https://gccassociation.org/sustainability-innovation/gnr-gcca-in-numbers/

Global Energy Monitor (2022), Global Steel Plant Tracker (database), https://globalenergymonitor.org/projects/global-steel-plant-tracker/ (accessed September 2022).

IEA (International Energy Agency) (2022a), Achieving Net Zero Heavy Industry Sectors in G7 Members, https://www.iea.org/reports/achieving-net-zero-heavy-industry-sectors-in-g7-members

IEA (2022b), World Energy Balances, https://www.iea.org/data-and-statistics/data-product/world-energy-balances

IEA (2022c), Energy Technology Perspectives: Clean Energy Technology Guide, https://www.iea.org/data-and-statistics/data-tools/etp-clean-energy-technology-guide

IEA (2022d), Global Hydrogen Review 2022, https://www.iea.org/reports/global-hydrogen-review-2022

IEA (2021), Net Zero by 2050: A Roadmap for the Global Energy Sector, https://www.iea.org/reports/net-zero-by-2050

IIASA (International Institute for Applied Systems Analysis) (2022), PFU Database (database) https://tntcat.iiasa.ac.at/PFUDB/dsd?Action=htmlpage&page=about (accessed 10 September 2022).

Pauliuk, S., T. Wang and D. Müller (2013), Steel All Over the World: Estimating in-use stocks of iron for 200 countries, Resources, Conservation and Recycling, pp. 22-30, https://doi.org/10.1016/j.resconrec.2012.11.008

World Steel (2022), Steel Statistical Yearbook, https://worldsteel.org/steel-topics/statistics/steel-statistical-yearbook/

International Energy Agency (IEA)

IEA Publications
International Energy Agency
Website: www.iea.org
Contact information: www.iea.org/contact

Typeset in France by IEA - July 2023
Cover design: IEA
Photo credits: © Shutterstock

A Vision for Clean Cooking Access for All

World Energy Outlook Special Report

Nearly one in three people, the vast majority of them in the poorest regions of the world, still lack access to clean cooking facilities, with major ramifications for public health, local environments and socio-economic development. Inhaling hazardous smoke from traditional stoves and open fires causes millions of premature deaths annually, disproportionately affecting women and children. The arduous task of collecting firewood also hinders educational and employment opportunities and strains natural resources – compounding costs for vulnerable populations.

The International Energy Agency (IEA) and the African Development Bank Group have joined forces to address this critical issue in a special report, *A Vision for Clean Cooking Access for All*. While covering global trends, the report pays special attention to the needs in Africa, where they are most pressing. It sheds light on the current state of clean cooking, the costs of inaction, and the benefits of boosting access in line with United Nations Sustainable Development Goal 7.

Countries like China, India and Indonesia have made commendable strides in disseminating clean cooking technologies. Yet in sub-Saharan Africa, there are a rising number of people without access to cleaner stoves and fuels, largely because population growth is outpacing gains. This could hinder broader development efforts, making it imperative to elevate clean cooking as a policy priority.

The report presents country-by-country assessments and an outlook for clean cooking under existing policies, offering a roadmap towards universal access. By identifying the required policies, technologies, investments and implementation efforts, the report seeks to galvanise international support for clean cooking initiatives, informing conversations ahead of the UN Sustainable Development Goal Summit, the African Climate Action Summit, and the COP28 Climate Change Conference taking place later in 2023.