AN OPEC FUND KNOWLEDGE SERIES REPORT

OVERCOMING BARRIERS TO CLEAN COOKING GOALS FOR THE FUTURE

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OPEC FUND
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EXECUTIVE SUMMARY

More than two billion people around the world rely on traditional fuels such as kerosene, wood and charcoal for their daily cooking. The continued use of these fuels poses serious health risks through household air pollution, with women and children being the worst affected. Traditional cooking methods contribute to approximately 3.7 million premature deaths annually and significant environmental degradation and climate change.

Clean cooking involves using fuels and technologies that produce little to no household air pollution such as electric stoves, liquefied petroleum gas (LPG), biogas and improved biomass cookstoves.

THE GLOBAL CLEAN COOKING AGENDA

Clean cooking has emerged as a critical component of the global development agenda. It was incorporated into the 2015 UN Sustainable Development Goals (SDG 7) and has been a prominent theme at international climate conferences. Clean cooking is crucial for public health, environmental protection and socio-economic development. It has grown in scale and complexity, encompassing a wide range of technologies, fuels, business models and innovative funding instruments.

Despite the recognized importance, the transition to clean cooking remains slow and challenging. Between 2010 and 2021 global access to clean cooking increased by only 1.4 percentage points annually, with most progress concentrated in a few populous developing countries. Today, roughly three-quarters (74 percent) of those without access to clean cooking are located in just 20 countries, primarily in sub-Saharan Africa and Asia. Investment levels are significantly below the required US$8 billion annually to achieve universal access by 2030.

People who rely on traditional fuels worldwide:

2 BILLION

CHALLENGES IN THE TRANSITION TO CLEAN COOKING

The transition to clean cooking faces several barriers:

Affordability: The cost of new cooking appliances and fuels remains a significant constraint for low-income households. Improved cookstoves cost around US$15-30, LPG stoves US$50-100 and biogas systems require a substantial upfront investment (2024 prices).

Sociocultural Factors: Traditional cooking practices and gender roles influence the adoption of clean cooking solutions. Cultural attachments to traditional cooking methods and gender norms that limit women's decision-making power are significant barriers.

Fuel Stacking: Many households retain traditional methods alongside newer clean cooking solutions, reducing the overall benefits. This practice, known as fuel stacking, reflects both cultural preferences and economic constraints.

SOLUTIONS AND PATHWAYS TO SCALE

A range of clean cooking solutions are available, each with its own set of benefits and trade-offs:

Liquefied Petroleum Gas (LPG): LPG is clean at the point of use, reduces time spent collecting fuel and has lower emissions than biomass. However, its large-scale adoption often requires subsidies.

Electric Cooking: E-cooking is efficient and clean but depends on reliable electricity access. Advances in electrification and falling appliance costs make it an increasingly viable option. However, in sub-Saharan Africa, 43 percent of households lack electricity.

Biogas and Bioethanol: These renewable fuels offer co-benefits such as improved waste management and reduced emissions. Nevertheless, biogas production requires significant infrastructure investment, while bioethanol depends on sustainable agricultural supply chains.

Improved Biomass Cookstoves: These stoves are more efficient and produce fewer emissions than traditional stoves. They are a transitional solution, especially in rural areas, but their health benefits are sometimes questioned due to lower-than-expected emission reductions in real-world conditions.

THE ROLE OF KEY STAKEHOLDERS

Achieving universal access to clean cooking requires concerted efforts from multiple stakeholders:

Governments: Governments play a crucial role in setting policies, providing subsidies, developing infrastructure and promoting public education. Integrated energy plans and national strategies are essential for coordinating efforts.

Private Sector: The private sector is vital for producing and distributing clean cooking technologies at scale. Firms need to invest in understanding local markets and driving technical innovation. The growth in private investment, though encouraging, is concentrated among a few large players.

Development Partners: Development partners will be instrumental in providing the funding, technical assistance and support for accessing carbon finance.

THE OPEC FUND'S APPROACH TO CLEAN COOKING

The OPEC Fund has been a contributor to clean cooking initiatives since the early 2000s, building knowledge and experience in promoting innovative clean cooking solutions. This expertise has shaped the OPEC Fund's approach to financing and implementing clean cooking initiatives, positioning the OPEC Fund to help advance global climate and development goals.

Clean cooking fits well with the OPEC Fund's strategic objectives and focus areas as defined in its updated Strategic Framework 2030. It also aligns with the Climate Action Plan, adopted in 2022, which commits the OPEC Fund to increase climate finance to at least 25 percent of all new financing by 2025 and 40 percent by 2030.

In the coming years, the OPEC Fund will concentrate on several key strategies to enhance the impact of its clean cooking investments. A primary focus will be on scaling up innovation by prioritizing new technologies and business models that can be adapted and scaled across various national contexts. This approach aims to accelerate the deployment of clean cooking solutions, ensuring they are both effective and adaptable to diverse environments. Additionally, the OPEC Fund will expand its partnerships, working closely with regional and international stakeholders to foster knowledge exchange and mobilize additional resources, thereby increasing the reach and effectiveness of its initiatives.

Another critical strategy involves leveraging digital tools to improve the monitoring, evaluation and scaling of clean cooking solutions. By incorporating advanced digital technologies, the OPEC Fund will seek to refine its strategies, enhance the efficiency of its operations and maximize the impact of its investments. These digital advancements will play a crucial role in optimizing resource allocation and ensuring that the OPEC Fund's initiatives are as effective as possible in promoting clean cooking.

The OPEC Fund's approach to clean cooking is grounded in several guiding principles. These include empowering partner countries to lead their initiatives, ensuring that clean cooking projects align with broader objectives (poverty reduction, climate action and maintaining fuel and technology neutrality) to offer a range of solutions tailored to the specific needs of different countries. The OPEC Fund also emphasizes inclusive development, ensuring that clean cooking solutions are accessible to marginalized communities, particularly women, low-income households and rural populations.

To support these efforts, the OPEC Fund will explore sustainable financing models, including blended finance, results-based finance and public-private partnerships, to attract and mobilize additional resources for clean cooking initiatives. Furthermore, the OPEC Fund is committed to capacity building and knowledge sharing, investing in the skills and expertise of partner countries and stakeholders to strengthen the implementation and impact of clean cooking projects. Through these strategic directions, the OPEC Fund aims to significantly scale up its support for clean cooking, contributing to universal access and advancing global efforts in climate resilience and sustainable development.

In alignment with the United Nations Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy), the OPEC Fund is committed to supporting the global target of achieving universal access to clean cooking by 2030.

CONCLUSION

This report provides an overview of the OPEC Fund's clean cooking agenda, the progress made, the challenges faced and the most promising options for scaling up investment. It aims to spark dialogue with partner countries as they plan their clean cooking transitions, in addition to contributing to the global body of knowledge on clean cooking.

OPEC Fund climate finance target as percentage of all new financing by 2030:

40%

INTRODUCTION

More than two billion people around the world rely on kerosene, wood, charcoal and other biomass for daily cooking.[1] Often burned in open fires or basic cookstoves these fuels pose serious health risks through household air pollution, with women and children the worst affected. They also contribute to environmental degradation and climate change.

In recent years, as awareness of these harmful effects has grown, clean cooking has become an increasingly prominent part of the international development agenda. From its origins in small-scale pilot projects in the 1990s and 2000s, clean cooking has grown in scale and complexity to encompass a wide range of technologies, fuels, initiatives, business models and funding instruments. Universal access to clean cooking was included as a target in the UN's Sustainable Development Goals (SDGs), and was a prominent theme at the UN climate change conference COP28 in Dubai in December 2023.

Clean cooking promises to deliver a range of benefits – for public health, the environment, emissions reduction and greater economic and gender equality. However, the transition to clean cooking is complex and needs careful planning. There are many possible clean cooking options and it is widely accepted that there is no one-size-fits-all solution for all countries or households. Each solution offers different benefits and drawbacks in terms of ease and cost of deployment, outcomes delivered and local suitability. Achieving universal access will require concerted action from governments, the private sector and international financiers.

To date, progress has been slow. Completing SDG 7's target of "affordable, reliable, sustainable and modern energy for all" by 2030 is well off-track. Despite stakeholder commitments and many promising initiatives the level of investment remains well short of what is required. Yet with a growing number of organizations and initiatives helping put the conditions for investment at scale in place there are grounds for optimism that this may be about to change.

The OPEC Fund for International Development has two decades of experience of working with partner countries in realizing their clean cooking ambitions. With growing interest among its member countries in supporting the clean cooking agenda, the OPEC Fund is working to scale up its investments as part of ambitious commitments on climate action and clean energy access.

[1] IEA, IRENA, UNSD, World Bank, WHO (2024) Tracking SDG 7: The Energy Progress Report, https://www.iea.org/reports/tracking-sdg7-the-energy-progress-report-2024

This report underpins the further development of the OPEC Fund's clean cooking portfolio, provide a platform for dialogue with partners and contribute to the global body of knowledge on this important topic. It presents an overview of the clean cooking agenda – how far it has come, lessons learned and what are the most promising avenues for scaling up investment. It also outlines the OPEC Fund's own approach to supporting its partner countries in their efforts towards universal access to clean cooking as part of their broader national strategies on energy access, food security and climate action, and highlights opportunities for further OPEC Fund engagement.

Universal access to clean cooking was included as a target in the UN's Sustainable Development Goals (SDGs), and was a prominent theme at the UN climate change conference COP28 in Dubai in December 2023.

1 THE CLEAN COOKING AGENDA

WHAT IS CLEAN COOKING AND WHY DOES IT MATTER?

Premature deaths per year caused by household air pollution:

3 MILLION

Globally, approximately 2.1 billion people depend on firewood and other solid biomass, coal or kerosene as their primary cooking fuel.[2] The continued use of these fuels generates a set of adverse public health, environmental and socio-economic consequences that have been extensively studied.

A transition to clean cooking reduces these damages by moving towards cooking fuels and technologies that meet the World Health Organization's (WHO) global air quality guidelines. Accomplishing this transition encompasses a wide range of options, including high efficiency biomass cookstoves, biogas, alcohol fuels such as ethanol, natural gas, liquefied petroleum gas (LPG) and on- and off-grid electricity (e-cooking).

PUBLIC HEALTH

The harm caused by traditional cooking methods can be divided into a number of categories. Exposure to household air pollution is a leading risk factor for a broad range of health conditions, including childhood pneumonia, chronic obstructive pulmonary disorder, ischemic heart disease, stroke and lung cancer.[3] Through these conditions, household air pollution is estimated to cause more than three million premature deaths per year, including nearly a quarter of a million deaths of children under five.[4] In many parts of the world cooking tasks fall disproportionately on women and girls, making them particularly vulnerable to inhaling harmful fumes. Household smoke is also linked to maternal health challenges, including an increased risk of stillbirth and low birth weight. Household cooking is also the leading cause of childhood poisoning through the accidental ingestion of kerosene and of severe burn injuries. Altogether, an estimated 86 million healthy life years were lost because of household air pollution in 2019, with the greatest burden falling on women in low-income settings.[5] That exceeds the 79 million healthy life years lost to road traffic accidents in the same year.[6]

[2] IEA (2024), SDG 7: Data and Projections, https://www.iea.org/reports/sdg7-data-and-projections

[3] Smith, K, and Pillarisetti, A (2017), Household Air Pollution from Solid Cookfuels and Its Effects on Health, 3rd ed., https://pubmed.ncbi.nlm.nih.gov/30212117/; Clean Cooking Alliance (2022), Air Pollution, Health and Clean Cooking, Health Fact Sheet, https://cleancooking.org/wp-content/uploads/2022/05/CCA-Health-Factsheet-ENGLISH.pdf

[4] IEA (2023), A Vision for Clean Cooking Access for All, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all

[5] WHO, Household aid pollution, December 2023, https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health

[6] WHO Global Health Observatory: DALYs estimates 2000-2019, https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/global-health-estimates-leading-causes-of-dalys

TIME POVERTY, ESPECIALLY FOR WOMEN

Women and children in low-income countries spend an average of 10 hours per week gathering cooking fuel and tending fires.[7] The socio-economic consequences are significant. This time poverty from the use of traditional fuels undermines women's empowerment by taking up time that could otherwise be spent on livelihood activities, education and participation in community life. The annual economic cost is estimated at US$800 billion globally.[8] Research has found the time saved from using clean cooking methods could result in a 3-4 percent increase in daily income per household.[9] Women and girls are also exposed to an increased risk of injury and violence while gathering fuel, particularly in conflict settings. An assessment by the United Nations High Commissioner for Refugees (UNHCR) in Chad found that 42 percent of women in refugee households experienced incidents of sexual or gender-based violence during firewood collection over a six-month period.[10]

ENVIRONMENTAL DEGRADATION AND CLIMATE CHANGE

The use of biomass for cooking is a significant driver of deforestation and environmental harm. Fuelwood for household cooking and heating makes up 55 percent of all wood harvested globally.[11] Unsustainable biomass harvesting for cooking can increase habitat losses and reduce biodiversity, exacerbate soil erosion and disrupt local water cycles. Many of the earliest clean cooking initiatives were driven by a desire to protect the environment, before the additional detriments to health, livelihoods and climate were fully studied and understood.

Traditional cooking fuels are also a driver of climate change. Land use change, principally from deforestation and forest degradation, accounts for an estimated 12-20 percent of global greenhouse gas (GHG) emissions.[12] Roughly 30 percent of this comes from fuelwood harvesting.[13] In addition, many traditional fuels emit long-lived greenhouse gases, such as carbon dioxide and methane, as well as short-lived climate pollutants (SLCPs), including black carbon (soot).[14] Roughly 2 percent of global CO_2-equivalent emissions are attributed to unsustainable harvesting and incomplete biomass combustion for household fuel consumption – roughly equivalent to emissions from the aviation sector.[15] However, SLCPs have an even larger impact on global temperatures and the climate system in the short run than CO_2. With household energy one of the most controllable sources of black carbon, clean cooking was identified at COP27 as a "breakthrough" area for halving emissions by 2030.[16]

[7] Clean Cooking Alliance, Gender and Clean Cooking, undated, https://cleancooking.org/wp-content/uploads/2021/07/CCA-gender-sheet-ENGLISH.pdf

[8] UN (2022), SDG 7 TAG Policy Briefs: Addressing Energy's Interlinkages with other SDGs, https://sdgs.un.org/sites/default/files/2022-06/Policy%20Briefs%20-2022%20Energy%27s%20Interlinkages%20With%20Other%20SDGs.pdf

[9] Simkovich SM, Williams KN, Pollard S, Dowdy D, Sinharoy S, Clasen TF, Puzzolo E, Checkley W. (2019) "A Systematic Review to Evaluate the Association between Clean Cooking Technologies and Time Use in Low- and Middle-Income Countries". International Journal of Environmental Research and Public Health, 27:16(13), https://pubmed.ncbi.nlm.nih.gov/31252636/

[10] Clean Cooking Alliance (2014) Statistical Snapshot: Access to Improved Cookstoves and Fuels and its Impact on Women's Safety in Crises, https://cleancooking.org/binary-data/ATTACHMENT/file/000/000/331-1.pdf

[11] Clean Cooking Alliance, Nature and Clean Cooking, 2024, https://cleancooking.org/wp-content/uploads/2024/05/Nature-and-Clean-Cooking-Factsheet.pdf

[12] Charlene Watson and Liane Schalatek (2020) Climate Finance Thematic Briefing: REDD+ Finance, ODI, https://climatefundsupdate.org/wp-content/uploads/2022/03/CFF5-REDD-Finance_ENG-2021.pdf

[13] Clean Cooking Alliance (2022) Accelerating clean cooking as a nature-based climate solution, https://cleancooking.org/wp-content/uploads/2022/08/Accelerating-Clean-Cooking-as-a-Nature-Based-Climate-Solution.pdf

[14] Black carbon is a major contributor to global climate change, possibly second only to CO_2. Per unit of mass, black carbon has a warming impact on climate that is 460–1,500 times stronger than CO_2. Black carbon is produced both naturally and by human activities and is a result of the incomplete combustion of fossil fuels, biofuels and biomass.

[15] Clean Cooking Alliance (2023) Clean Cooking as a Catalyst for Sustainable Food Systems, https://cleancooking.org/reports-and-tools/clean-cooking-as-a-catalyst-for-sustainable-food-systems/

[16] Climate Champions (2022) Clean cooking named as a critical "Breakthrough" to halve emissions by 2030', UNFCCC, https://climatechampions.unfccc.int/clean-cooking-named-as-a-critical-breakthrough-to-halve-emissions-by-2030/#:~:text=At%20COP27%2C%20the%20UN%20Climate,2.4%20billion%20people%20through%20at

Rural households with access to clean cooking in Africa:

7%

WHAT PROGRESS IS BEING MADE ON CLEAN COOKING?

Progress on the transition to clean cooking is tracked through two main measures: i) the access rate (the share of the population with access); ii) and the access deficit (the total number of people without access).

ACCESS RATES

Global progress on clean cooking access has been slow, increasing by just 1.4 percentage points annually between 2010 and 2021.[17] This progress has been heavily concentrated in a small number of the most populous developing countries.[18] Since 2010, roughly 80 percent of the progress in the global access rate comes from just three countries (see Figure 1). By contrast, in the 20 countries with the lowest access rates, progress has been far slower at below 0.4 percentage points between 2017 and 2021.[19]

Today, roughly three quarters (74 percent) of those without access to clean cooking are located in 20 countries. In eight of these countries (all located in Africa), less than 10 percent of the population has access to clean fuels and technologies.

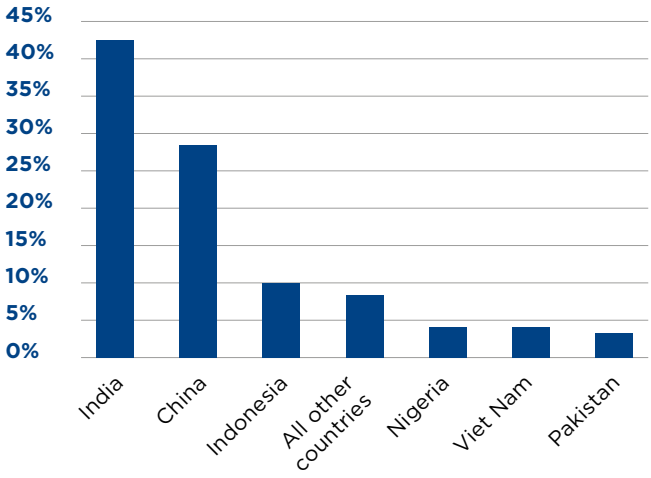
Historically, there have been major discrepancies between urban and rural areas in access to clean cooking fuels and technologies. Urban households often have more reliable access to the infrastructure required for clean cooking solutions such as the electricity grid and LPG fueling stations. Globally, roughly 88 percent of urban households have access to clean cooking, compared to only 54 percent of rural households.[20] This urban-rural access disparity has been gradually narrowing across every region except for sub-Saharan Africa, where only 7 percent of rural households have access to clean cooking (see Box 1).[21]

BOX 1: **URBAN VS RURAL ACCESS TO CLEAN COOKING**

Historically, there have been major discrepancies and between 2000 and 2010 the difference in access to clean cooking technologies between urban and rural areas stood at around 50 percentage points.[22] However, the gap has been narrowing. In urban areas clean cooking access rates rose only slightly over the past decade — from 82 percent in 2010 to 86 percent in 2021.[23] Over the same period rural access rates rose from 31 percent to 51 percent, narrowing the gap to 35 percentage points. By 2030 it will narrow further to 23 percentage points, if current trends continue.[24] Yet it remains likely that the greatest "last mile" clean cooking challenge will be encountered in rural areas, where household incomes are lower and biomass can be collected from the environment without direct cost to the consumer.[25]

Footnotes on next page

FIGURE 1: **Breakdown of global progress towards universal access to clean cooking since 2010**



Source: WHO 2024a.
LMICs = low- and middle-income countries

People in sub-Saharan Africa who lack access to clean cooking:

900 MILLION

"There are only five and a half years until the 2030 goal of universal access to clean cooking – and we are far away from this. BURN is now Africa's leading clean cooking company and one of the only carbon project developers to cover the full carbon value chain, from project design and in-house monitoring to credit issuance and we've distributed over five million stoves. Over 900 million people in sub-Saharan Africa lack access to clean cooking. The reliance on inefficient stoves and open fires bankrupts families, destroys forests and increases indoor air pollution, leading to the death of 600,000 people, mostly women and children, every year. If there are five people in the household and 200 million households there are about 196 million more households to go. It is not a small problem."

– BURN Manufacturing

[17] WHO (n.d.) Air Pollution Data Portal, https://www.who.int/data/gho/data/themes/air-pollution

[18] IEA, IRENA, UNSD, World Bank, WHO (2024) Tracking SDG 7: The Energy Progress Report, IEA (2024), Tracking SDG 7: The Energy Progress Report, https://www.iea.org/reports/tracking-sdg7-the-energy-progress-report-2024

[19] Ibid.

[20] IEA, IRENA, UNSD, World Bank, WHO (2023) Tracking SDG 7: The Energy Progress Report, https://trackingsdg7.esmap.org/data/files/download-documents/sdg7-report2023-ch2._access_to_clean_cooking.pdf

[21] Ibid.

[22] Ibid.

[23] Ibid.

[24] Ibid.

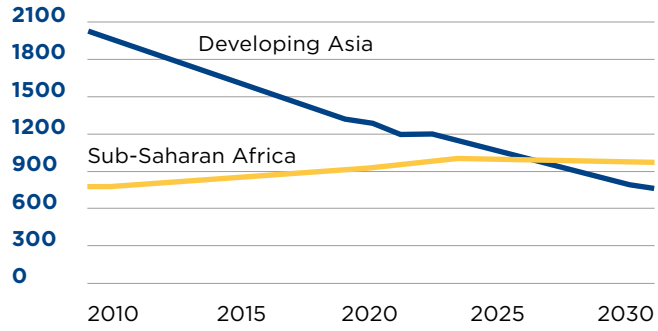
[25] International Energy Agency and the African Development Bank (2023) A Vision for Clean Cooking Access for All, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all

ACCESS DEFICITS

Most of the global population without access to clean cooking is located in Asia and sub-Saharan Africa. While access rates in Asia are much higher (e.g., 68 percent in India and 87 percent in China), Asia still accounts for 55 percent of the global population without access to clean cooking due to its larger population size. India represents the largest share of the global access deficit with 360 million people lacking access, followed by China with 175 million. However, the access deficit has decreased consistently in East and Southeast Asia since 2000 and in Central Asia and Southern Asia since 2010. Access deficits in sub-Saharan Africa have shown a clear upward trend, as the clean cooking transition has failed to keep pace with the region's growing populations. Across sub-Saharan Africa, the population increased by an average of 26 million per year between 2010 and 2019, outstripping access gains of eight million per year. The total number of people without access in Africa therefore continues to grow at a rate of nearly 20 million people per year. If the trends continue, by 2030 three out of five people without access to clean cooking will live in sub-Saharan Africa.[26]

Overall, the SDG target 7.1.2 of universal access to clean cooking is well off-track. The are many reasons for this, including the affordability of clean cooking solutions, consumer choice and value perception, the underfunding of the sector and a lack of awareness alternatives to traditional cooking practices. Many countries are unlikely to reach universal access even by the 2050s unless there is a substantial increase in both the rate of investment and government prioritization. If current trends continue, an estimated 21 percent of the global population, more than a fifth of all people, will still lack access to clean cooking, leaving nearly 1.8 billion people exposed to the adverse health, environmental and economic effects of polluting cooking fuels and technologies.[27]

FIGURE 2: **Population (in millions) without access to clean cooking in sub-Saharan Africa and developing Asia stated policies scenario.**



Source: IEA

People exposed to polluting cooking fuels and technologies by 2030:

1.8 BILLION

[26] IEA, IRENA, UNSD, World Bank, WHO (2024) Tracking SDG 7: The Energy Progress Report, https://trackingsdg7.esmap.org/data/files/download-documents/sdg7-report2023-ch2._access_to_clean_cooking.pdf

[27] IEA, IRENA, UNSD, World Bank, WHO (2024) Tracking SDG 7: The Energy Progress Report, https://www.iea.org/reports/tracking-sdg7-the-energy-progress-report-2024

CLEAN COOKING AND THE GLOBAL DEVELOPMENT AGENDA

Clean cooking became part of the international development agenda during the 1980s and 1990s through initiatives piloting the introduction of improved cookstoves to address concerns about fuel scarcity and help to reduce deforestation and indoor air pollution. These improved stoves burned biomass (firewood or charcoal) more efficiently than the traditional units they replaced, which it was hoped would reduce pressure on the environment.[28]

Over time, as evidence grew on the health risks of household air pollution, there was increased interest in using clean cooking innovations to drive improvements in health, especially for women and children. The World Health Organization (WHO) led the way by promoting global monitoring and reporting of air pollution and its health impacts and by defining emission standards for clean cooking appliances. The focus on health drove an interest in the cleanest solutions, especially LPG and electrification, in view of doubts that improved cookstoves could deliver enough emission reductions for meaningful health impacts.

FIGURE 3: **Clean cooking and the SDGs**

[28] World Bank (2011) Household cookstoves, environment, health, and climate change: a new look at an old problem, https://documents1.worldbank.org/curated/en/732691468177236006/pdf/632170WP0House00Box0361508B0PUBLIC0.pdf

More recently, the clean cooking agenda has also taken impetus from global commitments on clean energy. In the 2015 UN Sustainable Development Agenda, a clean cooking target was included in SDG 7 on access to affordable and clean energy. Figure 3 summarizes the many links between clean cooking and other SDGs, including on poverty reduction, hunger, health, gender equality and environmental protection. Clean cooking has been a recognized part of global campaigns for universal access to energy and has been the subject of a range of recent high-profile initiatives, such as the Global Electric Cooking Coalition at COP28. A growing number of countries have included household energy and clean cooking-related targets in their Nationally Determined Contributions (NDCs) under the Paris Agreement on climate change.[29] Multilateral development banks (MDBs) and development finance institutions (DFIs) are beginning to incorporate clean cooking components into household electrification programs. Electricity companies such as utilities, mini-grid developers and solar home system companies are increasingly involved in the promotion of clean cooking in order to drive demand for their electricity supply services. Table 1 highlights a range of recent multi-stakeholder commitments to accelerate progress towards universal clean cooking access.

Overall, interest in clean cooking has blossomed over the past decade. It has been the subject of a number of high-profile commitments and initiatives, summarized in Table 1.

In parallel, several platforms and networks have been established to take forward the agenda such as:

Clean Cooking Alliance (CCA): A global network of partners working to develop an inclusive clean cooking sector.

Sustainable Energy for All (SEforALL): An international organization launched by the UN to accelerate action on SDG 7.

The World Bank's **Energy Sector Management Assistance Program (ESMAP)** and its **Clean Cooking Fund**.

Modern Energy Cooking Services (MECS): A UK-funded research program.

Energising Development (EnDev): A strategic partnership initiative coordinated by the Dutch and German governments that supports access to modern energy.

Modern Cooking Facility for Africa (MCFA): Supports clean cooking companies across African frontier markets.

Through these, and many other initiatives, clean cooking is increasingly diverse and vibrant, stimulating hope that this increased action will accelerate progress and deliver results at scale in developing countries.

[29] The United Nations Framework Convention on Climate Change (2015) 'Paris Agreement', https://unfccc.int/sites/default/files/english_paris_agreement.pdf

TABLE 1: **Recent International Commitments on Clean Cooking**

COMMITMENT, DATE AND SIGNATORIES
International Energy Agency (IEA) Summit on Clean Cooking in Africa – May 2024 • The first ever high-level clean cooking summit focused on providing clean cooking access to the more than one billion people in Africa who currently lack it; close to 60 countries took part, with over 1,000 delegates in attendance. The summit mobilized US$2.2 billion in pledges from governments and the private sector. • Co-chaired by the leaders of the governments of Tanzania and Norway, the African Development Bank and the IEA.
Global Electric Cooking Coalition – November 2023 • Enable mass transition (more than 10 percent of households and institutions) to e-cooking solutions in at least 10 countries by 2030. • An alliance of experts and advocates, anchored by the Global Energy Alliance for People and Planet, Energising Development (EnDev), Sustainable Energy for All (SEforALL) and Modern Energy Cooking Services (MECS).
Council on Ethanol Clean Cooking – November 2022 • A multi-stakeholder platform launched at COP27 aimed at advancing ethanol as a clean cooking fuel by increasing awareness, capacities, ambition, and technology transfer in developing countries, least-developed countries, and Small Island Developing States. • Originally launched by the governments of Côte d'Ivoire, Mali, Madagascar and Kenya, the council now has 21 members.
G20 Initiative on Clean Cooking and Energy Access[30] – September 2022 • A commitment to accelerating access to clean cooking and electrification by: i. Addressing data and finance gaps for off-track countries. ii. Consolidating approaches to clean cooking. iii. Assisting countries to develop national clean cooking and integrated energy plans. iv. Building public and private sector capacity in targeted countries. v. Supporting institutions and enabling frameworks. • Signatories: G20 Energy Ministers.
SDG 7 Multi-Stakeholder Energy Compact[31] – October 2021 • An initiative launched by the Clean Cooking Alliance (CCA) to unlock SDG 7 through clean cooking, inviting signatories to identify their own specific commitments and actions to deliver the SDG 7 targets. • Endorsed by a wide range of clean energy sector stakeholders, including firms and NGOs.
UN Global Roadmap for Accelerated SDG 7 Action[32] – September 2021 • A pledge to accelerate action towards the SDG 7 targets, including on universal access to clean cooking, in recognition that the SDG 7 pledge of energy access for all is off-track. • Signatories: 130 heads of state and government and other stakeholders at the High-Level Dialogue on Energy.

[30] G20 Energy Ministers Meeting Communique, September 2020, https://g20.utoronto.ca/2020/2020-g20-energy-0928.html

[31] Clean Cooking Alliance (nd), Unlock the SDGs and Net-Zero with Clean Cooking: SDG 7 Multi-Stakeholder Energy Compact, UN, https://www.un.org/sites/un2.un.org/files/clean_cooking_energy_compact_final.pdf

[32] Global Roadmap for Accelerated SDG 7 Action in Support of the 2030 Agenda for Sustainable Development and the Paris Agreement on Climate Change (2021), https://www.un.org/sites/un2.un.org/files/2021/11/hlde_outcome_-_sdg7_global_roadmap.pdf

FINANCING CLEAN COOKING

Comparatively small annual investment required in clean cooking access in accordance with SDG 7:

US$ 8 BILLION

Despite the growing dynamism of clean cooking, investment rates remain far short of what is required.[33] In 2023, the IEA estimated that achieving universal access to clean cooking by 2030 in accordance with SDG 7 would require annual investment of US$8 billion. Of this amount, 21 percent would need to be allocated to infrastructure and 79 percent to stoves and other end-use equipment. A large share of this will need to be publicly funded by governments and international development partners in order to ensure that clean cooking solutions are affordable for even the poorest households. A significant proportion of the financing is expected to be raised from private sources (for example by leveraging public finance), including commercial finance and household purchases of stoves and fuels.[34]

While the financing needs are substantial, the publicly funded component represents only a small fraction of current international development assistance and climate finance. It is also well below the estimated US$1.4 trillion in global health costs resulting from lack of access to clean cooking.[35]

FINANCE PROVIDED TO DATE AND FUTURE OPPORTUNITIES

Estimates of the current rates of investment vary significantly. IEA estimates total current clean cooking finance at around US$2.5 billion per year, with the majority being public investment, including from governments, bilateral donors, MDBs and DFIs. This represents around 30 percent of the total investment needed. However, other estimates put the figure much lower. A survey by CCA found that investment in clean cooking companies reached US$215 million in 2023 – a record high, but far short of the billions required.

Total investment flows are dominated by debt (which in 2022 replaced equity as the largest source of funding for clean cooking) at 79 percent, with the remaining in equity (18 percent) and grants (3 percent).[36] Just over half the investment (54 percent) came from private sources, including local and international banks, large corporations and private fund managers. Around 43 percent came from multilateral sources, with the World Bank's private sector arm, the International Finance Corporation, the largest single investor.[37]

[33] Corfee-Merlot, J., et.al., Achieving Clean Energy Access in Sub-Saharan Africa, Financing Climate Futures, OECD, 2019, https://www.researchgate.net/publication/332467415_Achieving_Clean_Energy_Access_in_Sub-Saharan_Africa_-_A_case_study_prepared_for_the_OECD_project_Financing_Climate_Futures

[34] IEA (2023), A Vision for Clean Cooking Access for All, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all

[35] Energy Sector Management Assistance Program. (2020), https://www.esmap.org/

[36] CCA (2023) Clean Cooking Industry Snapshot, 4th ed., 2023, https://cleancooking.org/reports-and-tools/2023-clean-cooking-industry-snapshot/

[37] CCA (2023) Clean Cooking Industry Snapshot, 4th ed., 2023, p. 10, Ibid.

TABLE 2: **Comparing Investment Need in Lower-Middle-Income Countries across SDGs**

SECTOR	2030 SDG GOALS	ANNUAL INVESTMENT NEEDED (ESTIMATE)
Clean cooking	**Universal clean cooking (SDG target 7.1.2)**	**US$8 billion per year**
Water, sanitation and hygiene (WASH)	Universal access to clean water and sanitation (SDG 6)	US$28.4 billion per year
Food systems	Zero hunger (SDG 2)	US$265 billion per year
Health	Global health targets (SDG 3)	US$371 billion per year
Education	Quality education for all (SDG 4)	US$461 billion per year

Sources: For clean cooking, IEA (2023), A Vision for Clean Cooking Access for All, https://iea.blob.core.windows.net/assets/180b8bee-3d30-4436-abe0-9e93ca56b0bd/AVisionforCleanCookingAccessforAll.pdf
For other SDG targets: UNCTAD website: The costs of achieving the SDGs: Resource, https://unctad.org/sdg-costing/resources

The growth in private investment is encouraging, signaling a maturing market and the growing commercial viability of clean cooking enterprises. However, the investment is concentrated on a few large players with the seven leading clean cooking firms receiving 90 percent of all investment. As of 2020, there were an estimated 450-500 firms fully dedicated to the manufacturing and distribution of cookstoves.[38] However, few of them have yet been able to reach the volumes and economies of scale that investors are looking for. Potential investors face a range of barriers, including a lack of proven business models, lack of investible pipeline, concerns about investee profitability, and lack of operational history.[39] These barriers are compounded by the need for investors to understand and evaluate a complex set of solutions in markets with low consumer affordability and with limited reliable data on supply and demand trends for clean cooking across markets.

While these challenges are significant, they are progressively being overcome as the sector develops new technologies and business models that increase the affordability of clean cooking. There are a growing number of international financiers interested in supporting clean cooking, deploying a range of financial instruments from technical assistance grants to results-based financing, and a range of debt and equity offers. As the barriers to scaling up clean cooking are resolved, more financiers will likely be attracted.

[38] Energy Sector Management Assistance Program. (2020), https://documents1.worldbank.org/curated/en/937141600195758792/pdf/The-State-of-Access-to-Modern-Energy-Cooking-Services.pdf

[39] Cowdrey, O., Lant, P., and Ashworth, P., (2023) Elucidating Finance Gaps through Clean Cooking Value Chain, Sustainability, 14(4), https://www.mdpi.com/2071-1050/15/4/3577

TABLE 3: **A Growing Landscape of Clean Cooking Financiers**

TYPE OF CAPITAL PROVIDER	EXAMPLES OF PROVIDERS	TYPICAL FINANCIAL INSTRUMENTS
Bilateral development agencies	Foreign, Commonwealth and Development Office (UK), Swedish International Development Cooperation Agency, International Development Cooperation (Netherlands), U.S. Agency for International Development	• Energy access programs which include clean cooking research & development and corporate grant programs • Results-based financing • Blended finance
Multilateral development banks (MDBs) and development finance institutions (DFIs)	OPEC Fund for International Development, World Bank Group, Asian Development Bank, African Development Bank, Inter-American Development Bank, Dutch Entrepreneurial Development Bank (FMO), British International Investment, Nordic Development Fund	• Sovereign and non-sovereign loans • Indirect financing via debt or equity funds • Technical assistance • Results-based grants, e.g. World Bank Clean Cooking Fund
Private foundations	Osprey Foundation, Shell Foundation	• Grants, e.g. for institution building and policy-making or risk-tolerant equity • Early-stage debt to high-risk companies • First loss and other subordinated debt
Impact investors/private investment funds	**Equity funds:** e.g. Acumen, Energy Access Ventures, Novastar Ventures, ENGIE Rassembleurs, IIX Growth Fund **Debt investors and funds:** e.g. SIMA, Oikocredit, AlphaMundi, Triodos	• Equity and debt generating both financial return and socio-economic impact
Crowdfunding	**Peer-to-peer lending platforms:** Lendahand, Trine Bettervest, Crowd Credit (Japan)	• Loans for small and medium-sized enterprises at different stages of development • Loans for micro enterprises
N/A	**Venture debt platforms:** Kiva	• Donations and rewards

One of the most promising avenues for scaling up investment is carbon finance – the buying and selling of carbon credits to help offset greenhouse gas emissions. Many in the sector view it as a game changer despite recent doubts over the value of some carbon credits schemes.

The global voluntary carbon market surpassed US$2 billion in 2021.[40] Clean cooking is an attractive investment for carbon financiers, given its potential to not just tackle climate change, but also to deliver co-benefits for public health and gender equality, amongst others.

Carbon credits for clean cooking have doubled in price over the past decade, while company revenues from carbon credits have increased 45-fold since 2017, accounting for 22 percent of clean cooking firms' revenues in 2022.[41] Carbon credits offer a promising route to scale, enabling participating companies to offer lower prices to consumers and thereby build a market. They also help to mobilize private finance by offsetting risk.

Global voluntary carbon market surpassed in 2021:

US$ 2 BILLION

[40] Voluntary carbon market value tops US$2B, Climate Trade, 4 August 2022, https://climatetrade.com/voluntary-carbon-market-value-tops-us2b/

[41] CCA, 2023 Clean Cooking Industry Snapshot, 4th ed., 2023, https://cleancooking.org/wp-content/uploads/2023/12/CCA-2023-Clean-Cooking-Industry-Snapshot.pdf

2 CHALLENGES IN THE CLEAN COOKING TRANSITION

Encouraging the adoption of clean cooking practices is a complex undertaking. It is often described as a two-step challenge: the initial uptake of a new cooking method, followed by its sustained use over time. To succeed, there are two major challenges that any clean cooking initiative must overcome. First, it needs to be affordable for consumers in low-income settings. Second, participating households need to change cooking practices that are often deeply ingrained. This section considers what has been learned about these challenges and how they can be addressed.

Average price of simplest improved cookstoves:

US$ 15-30

AFFORDABILITY

Across all countries the uptake of clean cooking is concentrated among higher-income groups with the poorest lagging behind. This pattern holds even in countries where substantial public subsidies are in place to improve affordability. This makes it clear that cost, unsurprisingly, is a key factor in clean cooking access.

While the cost of transitioning to clean cooking varies by technology and context, in most cases it requires upfront investment in a new cooking appliance and generates fuel costs. The simplest improved cookstoves are priced at US$15-30, representing around a third of monthly income in low-income households in sub-Saharan Africa. Liquefied petroleum gas (LPG)-powered and electric stoves average US$50-100, or between one half and three-quarters of monthly income, while biogas stoves and digesters can be several times more expensive.[42] So far, few consumers in developing countries have spent more than US$30 on their primary cookstoves.[43]

In terms of recurrent costs, many households without clean cooking already purchase solid fuels such as charcoal and firewood, which represents a significant outlay for them each month. In these cases, improved biomass cookstoves can quickly repay the investment. However, for the many households that collect their own biomass, fuel costs may be unaffordable. The affordability challenge also rises sharply in rural areas, where lack of infrastructure and weaker markets lead to higher distribution and fuel costs.

There is a range of potential solutions to the affordability challenge. Public subsidies may be necessary in order to lower the costs for the poorest households. However, experience shows that subsidy programs need to be well-designed and targeted. If not, they can create major fiscal burdens for governments and disproportionately

[42] IEA (2023) A Vision for Clean Cooking Access for All, World Energy outlook Special Report, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all

[43] ESMAP (2015) The State of the Global Clean and Improved Cooking Sector, https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_State_of_Globa_Clean_Improved_Cooking_sector_Optimized.pdf

> "When I recall our first meetings with ministers – they thought clean cooking is only about very poor people with no money, and the immediate thought is only on subsidies for technology. But let's be more sophisticated, divide areas into target groups and utilise smart subsidies. In some locations, you have a growing middle class in rural areas that can finance a US$10-50 clean cookstove, yet are held back by lack of knowledge and awareness."
> – SNV Netherlands Development Organisation

benefit wealthier households. Tackling market distortions, waste, bureaucracy and financial misallocation are also other potential solutions. On the private sector side, clean cooking firms are developing business models that maximize affordability, such as pay-as-you-go models and making use of carbon credits to lower prices. These options are considered further in Chapter 5. It should be noted, however, that studies have shown that providing highly subsidized cookstoves, even to the point where they are given away at no cost, does not necessarily lead to changes in cooking practices.[44] This is because cooking behaviors are strongly influenced by individual perceptions, value judgements, traditions, and practices. Moreover, weak supply chains for delivering LPG highlights that a free cookstove is of little worth without the fuel to use it. A further issue to note is the inappropriate use of cookstoves, poor maintenance, and unhelpful instructions as additional reasons why cookstoves may not be used regularly over time.

Indeed, studies have shown that expenditure on cleaner fuels such as LPG is generally lower than daily household costs for charcoal and purchased firewood. This is true even in rural settings.[45] This suggests that high perceived costs can be a significant barrier to adoption.

In addition, studies show that, among target communities for clean cooking, there is often high uptake of technologies such as televisions and mobile phones, despite their high initial cost.[46] This suggests that the challenge is not simply one of affordability, but of convincing households of the value of the outlay. This is made more difficult by the fact that women are the primary beneficiaries of clean cooking, but often have limited control over household expenditure and decision-making. Gender inequity is therefore a barrier to the roll-out of clean cooking, determining in particular the pace at which households make the transition.

[44] R. Hanna, E. Duflo & M. Greenstone, "Up in Smoke: The Influence of Household Behaviour on the Long-Run Impact of Improved Cooking Stoves", American Economic Journal: Economic Policy, Vol. 8(1), February 2016, pp. 80-114, https://scholar.harvard.edu/files/remahanna/files/1_stoves.pdf

[45] Gill-Wiehl, A., Sivers, S., Katakura, R. et al., (2023) Evaluation of the preference for and viability of clean cookstove adoption in rural Tanzania, Energy, Sustainability and Society, https://energsustainsoc.biomedcentral.com/articles/10.1186/s13705-023-00422-3

[46] Rousseau, N., et al., (2021) Overcoming the "Affordability Challenge" associated with the transition to electric cooking, MECS, https://mecs.org.uk/wp-content/uploads/2021/01/MECS-report-affordability-challenge-Final-2.pdf

SOCIOCULTURAL FACTORS

Affordability and other challenges are compounded by social and cultural factors that affect households' willingness to make the transition to clean cooking.

Communities are often highly attached to their traditional cooking methods, which are often tied to particular dishes, occasions or ceremonies, and which may vary considerably by locality. For instance, in Nepal particular ceremonial dishes are prepared in temporary, separate stoves. In Kenya, communal cooking rituals are integral to certain social gatherings. Meanwhile, in parts of Latin America the tradition of *asado* is a community event involving a range of open-fire grilling techniques.

The local dishes characteristic of a given country or region may also dictate the types of stoves and technologies that appeal to households, highlighting the challenge of identifying a universal stove design. In some cases, a preference in preparing traditional dishes using older cooking methods, rather than a new stove or fuel, acts as a barrier to change.

Traditional cooking methods also produce bioproducts that are seen as valuable for other uses. For example, ash is used in fertilizer and traditional medicines, while smoke can be used to repel mosquitos and preserve food. In some contexts, traditional stoves also serve to heat houses, a function that is not provided by most modern cooking appliances. While the cookstove cost is partly holding back adoption of cleaner cooking, there are several other compelling reasons why price may not be the sole reason.

Gender norms around household decision-making further complicate the uptake of clean cooking. While women typically do most of the cooking, domestic resources are often controlled by male household heads with low awareness of the inconveniences and risks associated with biomass cooking.[47] Even in contexts where women have more financial autonomy (e.g., when they earn an income outside the home), they may still lack influence over a decision of this significance.

[47] Das, I. et al. (2020) A virtuous cycle. Reviewing the Evidence on Women's Empowerment and Energy Access, Frameworks, Metrics and Methods, Duke University, https://energyaccess.duke.edu/publication/a-virtuous-cycle-reviewing-the-evidence-on-womens-empowerment-and-energy-access-frameworks-metrics-and-methods/

FUEL STACKING

Various social and cultural factors can determine the rate of transition to clean cooking, leading it to take place incrementally over an extended period. Research shows that clean cooking is often seen by households (at least initially) as an addition to traditional cooking methods rather than a replacement. Extensive survey evidence shows that improved cookstoves and clean cooking options are often used in combination with solid fuels, a practice known as fuel stacking (see Box 2). It is a phenomenon that reflects the durability of established cooking practices and preferences as well as challenges around the affordability of cleaner fuels.

The extent of fuel stacking is not well captured in the statistics, which are based on each household's primary cooking fuel (see Box 3). This can lead policy-makers to overestimate both the extent of the transition to clean cooking and its long-term sustainability. This has raised doubts among some investors, particularly those focused on health outcomes. Many of the intended health benefits of clean cooking initiatives are contingent on the near-complete replacement of traditional fuels and the reduction of household air pollution to very low levels. That said, many argue that a shift towards cleaner cooking, involving a fuel stack that includes some clean or cleaner stoves and fuels, is nonetheless progress and a necessary step in the eventual full transition to clean cooking.

BOX 2: **MEASURING CLEAN COOKING ACCESS AND FUEL STACKING**

Most household demographic and energy surveys have historically asked respondents about the primary fuel used for cooking. However, this gives a limited view of the full fuel profile and cooking behaviors of a household, given the widely documented practice of fuel stacking – that is, using a mix of fuels and stoves. Various initiatives are underway to generate better data on uptake. In 2015, the World Bank's Energy Sector Management Assistance Program (ESMAP) launched its multi-tier framework, which "collects and analyses data on multiple dimensions of access such as user behavior, cooking conditions, the use of multiple cooking solutions, convenience, and safety aspects to account for the multiplicity of contextual and technical factors that shape a household's unique cooking context."[48] The recognition of a more nuanced picture that goes beyond the "clean vs non-clean" dichotomy has been welcomed by many, allowing for more fine-tuned clean cooking policies.

[48] ESMAP (2023) Unlocking Clean Cooking Pathways : A Practitioner's Keys to Progress, World Bank Group: Washington, D.C, https://www.esmap.org/Unlocking-Clean-Cooking-Pathways

Many studies have been undertaken to build a better understanding of how socio-cultural and awareness factors affect the uptake of clean cooking. Most of the evidence suggests that the priorities of the development sector such as reduced long-term health risks are generally not strong motivators for households. While there is no single driver of clean cooking uptake, the most commonly cited reasons offered by clean households include convenience (both ease of lighting and faster cooking), cleanliness (reduced smoke and soot), reduction in physical discomfort such as itchy eyes and a desire to be more modern. [49] Higher levels of education are also associated with a greater uptake of clean cooking.[50]

There is a clear consensus that a thorough understanding of cooking behaviors in each context is essential to the design and execution of clean cooking interventions. [51] Because there is no one-size-fits-all approach, successful programs are likely to involve some level of public education and awareness raising, while taking into account cultural factors in target communities. However, these behavioral interventions need to be carefully sequenced with other activities. Behavior change efforts are generally effective only when offered in support of clean cooking options that are affordable and offer a solid value proposition. Moreover, community-based approaches that seek to shift group rather than individual behavior are another aspect to consider.

[49] Gould CF., and Urpelainen J. (2018) LPG as a Clean Cooking Fuel: Adoption, Use, and Impact in rural India. Energy Policy, volume 122, https://www.sciencedirect.com/science/article/abs/pii/S0301421518304877; Coony, J. et al. (2021) Behavioral science serves up new ways to boost clean cooking, World Bank Group, https://blogs.worldbank.org/en/climatechange/behavioral-science-serves-new-ways-boost-clean-cooking

[50] Gould, C., and Urpelainen J. (2020) The Role of Education and Attitudes in Cooking Fuel Choice: Evidence from two states in India, Energy Sustain Dev, https://www.sciencedirect.com/science/article/abs/pii/S0973082619300584

[51] Galimberti, A (2021) Behavioural change promotion toward cleaner cooking solutions. Energising Development, https://endev.info/wp-content/uploads/2021/10/EnDev_Learning-and-Innovation-Agenda_Clean-Cooking_Behavioural-change-promotion-toward-cleaner-cooking-solutions.pdf

3 CLEAN COOKING SOLUTIONS

People who gained access to clean cooking driven by large-scale uptake of LPG:

70%

The clean cooking agenda encompasses a range of potential routes to clean – or cleaner – cooking. Each offers a different combination of benefits, with regard to health risks, environmental impact and emissions reductions, and over different timeframes. Each also offers trade-offs when it comes to overcoming barriers to the uptake of clean cooking, including upfront and long-term costs.

This section introduces the main options to deliver clean cooking outcomes and discusses lessons learned about their advantages and disadvantages. It is widely accepted that there is no one-size-fits-all solution to clean cooking. Most countries will need to invest in multiple clean cooking solutions. The optimal combination of solutions needs to be carefully considered, based on an understanding of local conditions and the relative importance attached by policy-makers to different outcomes and risks.

LIQUEFIED PETROLEUM GAS (LPG)

LPG is one of the most widely-used cooking fuels in the world, both in developed and developing countries. The IEA calculates that most progress in expanding access to clean cooking in recent years has been driven by the large-scale uptake of LPG, accounting for around 70 percent of those who gained access over the last decade. This large uptake has been concentrated in middle-income countries such as India, Indonesia and China.[52]

LPG is a naturally occurring by-product of oil refining and natural gas extraction. It consists of a variable blend of propane and butane that can be stored in pressurized containers. Because of its portability, LPG can be readily distributed, even in rural areas, once supply chains have been established to refill gas canisters.[53] Unlike other clean cooking solutions such as electricity and piped natural gas it does not require major investment in infrastructure – although, unlike electricity, the investment does not support other end uses than cooking.[54]

LPG cookstoves are clean at point of use and simple to cook with. When compared to biomass, LPG significantly reduces the time spent by women and girls in collecting and processing fuel, tending fires, cooking food and cleaning up after cooking. The easy adjustment of the cooking flame enables instant and controllable heat,

[52] International Energy Agency (2023) A Vision for Clean Cooking Access for All, World Energy Outlook Special Report, https://iea.blob.core.windows.net/assets/212dda1e-63ec-4f42-a530-f2ef3da74fdf/AVisionforCleanCookingAccessforAll.pdf

[53] Puzzolo, H., et al (2019) Supply Considerations for Scaling Up Clean Cooking Fuels for Household Energy in Low-and Middle-Income Countries, Volume 3, issue 12, Review Article, Advancing Earth and Space Sciences, https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019GH000208#gh2133-bib-0096.

[54] Floess, E, et al. (2023) 'Scaling up gas and electric cooking in low-and middle-income countries: climate threat or mitigation strategy with co-benefits?' Environmental Research Letters 1 volume 8, issue 3: 034010, https://iopscience.iop.org/article/10.1088/1748-9326/acb501

TABLE 4: **Types of Clean Cooking Solutions**

TECHNOLOGY - FUEL TYPE	OPPORTUNITIES	LIMITATIONS
Liquefied petroleum gas (LPG)	• No household pollution • Lower GHG emissions than biomass or coal • Can be readily distributed once supply chains are established • Widely considered a good transitional fuel	• LPG is a finite, fossil fuel resource • It contributes to climate change • There is reluctance to allocate public funding to non-renewable resources
Electric cooking	• No household pollution • If generated from renewable sources, low GHG emissions • Very efficient with appliances such as electric pressure cookers	• Electric cooking often depends on reliable and accessible grid or off-grid electricity infrastructure • More expensive in remote and rural areas
Biogas	• No household pollution • Generated from renewable sources • Biogas production can contribute to waste management strategies • Produces fertilizer as a by-product	• High upfront investment cost • Biogas systems need additional water to work • Requires a continuous supply of suitable feedstock, seasonal variation in availability
Bioethanol	• No household pollution • Efficient • Affordable in context with appropriate supply ecosystems • Can be produced from a variety of feedstocks • Can be renewable	• Large-scale cultivation of ethanol feedstock can have environmental and social costs • Ethanol requires production and dedicated supply chain infrastructures
Improved biomass cookstoves (ICS)	• Low manufacturing costs • Suitable for rural and remote areas • Widely available in most contexts • More efficient than three-stone fires • Advanced commercial models meet many of the international quality standards • A potential transitional step towards cleaner alternatives	• Many ICS fall below international clean cooking standards • Dependent on biomass fuel sources, many of which are unsustainably collected and cause environmental degradation • As most biomass is non-renewably collected, contributes to climate change

allowing for fast or slow cooking options. Some studies have shown that time savings from solid fuels to LPG translates into increased educational opportunities for children and provided more time for livelihood activities and other pursuits, including family care and leisure.[55]

Compared to other fuels, the cost of cooking with LPG is relatively low, although this varies by context and country. It involves relatively high initial capital costs for LPG equipment, which are often unaffordable for the poorest households. However, it can offer longer-term savings for households that would otherwise be purchasing firewood or charcoal.

To overcome the affordability challenge, national programs to roll out LPG often subsidize the upfront purchase costs or gas refills, or both. For example, the governments of India and Indonesia provided significant price subsidies for household LPG. While subsidies can be an effective way of scaling up household LPG use, once established they are difficult to scale back, can stimulate a black market in subsidized fuel and often impose an unsustainable fiscal burden on governments.[56] Blanket subsidies also tend to disproportionately benefit middle class households, who have the highest LPG consumption, making them a potentially regressive form of expenditure.

The rapid uptake of LPG at subsidized prices also creates energy security risks, particularly for countries that import fuel at variable international prices. For example, Indonesia's national cooking conversion campaign, launched in 2007, replaced kerosene with subsidized LPG. Along the way, Indonesia transitioned from being an LPG-exporter to importing around 6,500 kilotons of LPG a year. When LPG prices doubled in early 2022 following the conflict in Ukraine, the government was forced to withdraw subsidies, pushing people back into the use of traditional cooking fuels.[57] Indonesia is now planning to scale back the use of LPG in favor of electric cooking to reduce the risks associated with dependence on imported LPG.[58]

Although LPG is a fossil fuel, it is one of the least damaging for the climate and used by many developing countries as part of the energy mix in their transition to cleaner fuels. It burns efficiently and has a high ratio of hydrogen to carbon, resulting in more energy output for lower carbon emissions. Unlike wood and charcoal, it does not deplete forest resources or contribute substantially to emissions of black carbon and methane, which are among the most powerful, short-acting climate warmers. Transition to LPG has been shown to have a positive environmental and climate mitigation impact through its potential to limit deforestation and improve carbon capture.[59]

[55] MECS (2020) 'National scaling up of LPG to achieve SDG 7: Implications for Policy, Implementation, Public Health and Environment, https://mecs.org.uk/wp-content/uploads/2020/02/MECS-LPG-Briefing-Paper_Jan-2020.pdf

[56] Quinn, Ashlinn K., et al. (2018) 'An analysis of efforts to scale up clean household energy for cooking around the world.' Energy for Sustainable Development, Volume 46, https://www.sciencedirect.com/science/article/pii/S0973082618302679

[57] International Energy Agency and the African Development Bank (2023) A Vision for Clean Cooking Access for All, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all

[58] International Energy Agency (2023) A Vision for Clean Cooking Access for All, World Energy Outlook Special Report, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all

[59] MECS (2020) 'National scaling up of LPG to achieve SDG 7: Implications for Policy, Implementation, Public Health and Environment, https://mecs.org.uk/wp-content/uploads/2020/02/MECS-LPG-Briefing-Paper_Jan-2020.pdf

Overall, LPG is widely considered to be one of the best available transitional short-term fuels. The IEA projects that LPG will be the leading fuel in achieving universal access to clean cooking, accounting for 45 percent of those gaining access.[60] Some also argue that LPG can eventually (and somewhat seamlessly) be replaced by bioLPG, made from renewables including biomass, biogas or waste from agricultural products and animal fats. BioLPG is chemically and functionally identical to fossil fuel LPG and can be produced, distributed and consumed with existing LPG distribution and storage infrastructure, cylinders and stoves.[61] The technology is, however, still in a nascent stage and requires public funding to support research and development.[62] Just like LPG, bioLPG offers cleaner air with low NOx, SOx and particulate matter but has an even lower carbon footprint (up to 80 percent) than conventional LPG.[63]

BOX 3: **INDIA'S NATIONAL LPG CAMPAIGN**

India's recent national campaigns on clean cooking have been among the most successful in the world. The Pradhan Mantri Ujjwala Yojana (PMUY) scheme, launched by the government in 2016, has distributed over 100 million LPG connections to poor households, substantially supporting LPG access.[64] Under the program, customers receive subsidies to help cover the upfront cost of the stove, the cylinder deposit and a certain number of subsidized refills each year. Consumers can book refills through multiple channels, including mobile applications such as WhatsApp, with the cylinders delivered to their doorstep. The convenience is thought to be a key success factor for the program. PMUY also undertakes public education and awareness campaigns to help overcome behavioral barriers. A novel aspect of the approach is that LPG connections are registered in the names of the adult women of the household, affording them greater decision-making power.

However, survey evidence shows that more than a third of the households who received an LPG stove continue to use traditional cooking methods in parallel (fuel stacking). There are concerns that the continued use of solid fuels negates many of the health benefits that PMUY was intended to provide. The prevalence of fuel stacking suggests continued challenges with affordability and the gradual nature of the transition. Without subsidies, a typical rural household would need to spend around 7 percent of their monthly household expenditures on LPG, which is about 40 percent more than traditional fuel. When the subsidy program was discontinued in 2020, as part of broader subsidy reform, it led to a decline in LPG usage. It was subsequently reinstated for the poorest households. Since 2015, the government has run the "Give It Up" campaign, persuading 10 million wealthier households to voluntarily renounce their access to LPG subsidies.[65]

[60] International Energy Agency (2023) 'A Vision for Clean Cooking Access for All – A Special Report of the World Energy Outlook, https://www.fao.org/wood-energy/search/detail/en/c/1646461/#:~:text=User%20Guide-,A%20Vision%20for%20Clean%20Cooking%20Access%20for%20All%20%E2%80%93%20A%20Special,the%20World%20Energy%20Outlook%20(2023)&text=The%20report%20presents%20country%2Dby,to%20the%20needs%20in%20Africa

[61] GLPGP (2020) 'Assessing Potential for BioLPG Production and Use within the Cooking Energy Sector in Africa', https://mecs.org.uk/wp-content/uploads/2020/09/GLPGP-Potential-for-BioLPG-Production-and-Use-as-Clean-Cooking-Energy-in-Africa-2020.pdf

[62] GLPGP (2020) 'Assessing Potential for BioLPG Production and Use within the Cooking Energy Sector in Africa', https://mecs.org.uk/wp-content/uploads/2020/09/GLPGP-Potential-for-BioLPG-Production-and-Use-as-Clean-Cooking-Energy-in-Africa-2020.pdf

[63] Liquid Gas UK, https://www.liquidgasuk.org/about/biolpg

[64] Pradhan Mantri Ujjwala Yojana, Mani, S., Jain, A., Tripathi, S. et al. (2020) The drivers of sustained use of liquified petroleum gas in India, Nat Energy 5, https://pubmed.ncbi.nlm.nih.gov/32719732/

[65] Liquid Gas Europe, https://www.liquidgaseurope.eu/liquid-gases/

Reduction of carbon emissions through universal adoption of e-cooking by 2030 over 2018 levels:

40%

ELECTRIC COOKING

Most specialists agree that electric cooking ('e-cooking') from renewable energy sources remains the ideal solution over the longer term. Universal adoption of e-cooking by 2030 would reduce carbon emissions from cooking by up to 40 percent over 2018 levels. However, this would require major investments in enhancing electricity access and grid reliability, including by bolstering generation capacity, improving transmission and distribution systems and reducing losses.[66] In large part, enhancing electricity access is the goal of SDG 7, with the benefits to advancing e-cooking coming from a spillover effect from universal electrification. However, the funding required to achieve SDG 7 (see Table 2) highlights the challenge of achieving this double goal of increased cleaner cooking and renewable energy.

Over the last decade, e-cooking provided solutions to 12.5 percent of those who gained access to clean cooking through the uptake of hotplates, induction plates and other e-cooking appliances.[67]

Historically, electricity was not seen as a practical clean cooking solution in low-income settings, due mainly to the widespread lack of reliable electricity access and high cost. However, with advances in electrification, increased access to renewable energy through mini-grids and off-grid solutions and the falling cost of electric appliances e-cooking is now seen as an important part of the clean cooking mix.[68] E-cooking appliances include hot plates, modern cooktops (induction and infrared), electric pressure cookers, rice cookers and others. A MECS study on the energy efficiency of such appliances found that, when compared with traditional resistive element hotplates, modern cooktops (induction and infrared) can save 10 percent, automated devices such as rice cookers can save approximately 25 percent and electric pressure cookers can save approximately 50 percent energy.[69]

Many developing country governments and electric utilities favor electric cooking solutions in order to reduce dependence on imported LPG. There is growing interest internationally in incorporating clean cooking components into household electrification programs. The additional cost of providing an e-cooking device when connecting consumers to the grid is thought to be about 10 percent.[70] In some

[66] IRENA (2023), Renewables-based electric cooking: Climate commitments and finance, https://www.irena.org/Publications/2023/Dec/Renewables-based-electric-cooking-Climate-commitments-and-finance

[67] International Energy Agency (2023) A Vision for Clean Cooking Access for All, World Energy Outlook Special Report, https://iea.blob.core.windows.net/assets/212dda1e-63ec-4f42-a530-f2ef3da74fdf/AVisionforCleanCookingAccessforAll.pdf

[68] Cooksafe Coalition (nd), The future of cooking is electric, https://cooksafecoalition.org/wp-content/uploads/2022/11/23098-GCR-Cooksafe-Report-D10.pdf

[69] MECS (2023) Comparing energy consumption and costs – from cooking across the MECS programme, https://mecs.org.uk/wp-content/uploads/2023/03/Comparing-energy-consumption-and-costs-from-cooking-across-the-MECS-programme.pdf

[70] International Energy Agency (2023) A Vision for Clean Cooking Access for All, World Energy Outlook Special Report, https://iea.blob.core.windows.net/assets/212dda1e-63ec-4f42-a530-f2ef3da74fdf/AVisionforCleanCookingAccessforAll.pdf

countries use of special e-cooking tariffs also helps the uptake of electric cooking by keeping the cost competitive with other fuels.

The major barrier to scaling up e-cooking, however, remains the slow pace of electrification in many developing countries together with the high cost and poor reliability of electricity supplies. In sub-Saharan Africa, 43 percent of households continue to lack electricity, with wide urban-rural gaps in electricity access.[71] Globally, the number of people relying on traditional cooking fuels (around 2.3 billion) far exceeds those without electricity access (around 733 million).[72] This suggests that a high proportion of the target population for clean cooking already has some access to electricity, but is not currently using it for cooking. This also indicates that it may be easier to "close the gap" with the 2.3 billion who have electricity access but use traditional cooking, rather than focus clean cooking efforts on the 733 million with no access.

> "The hot areas in the sector are for e-cooking, and specifically institutional e-cooking. Institutional cooking is a controlled environment. People tend to eat the same things at the same time of day and in the required volume, so you can predict peak times for grid usage. This includes prisons, schools, hospitals and the military – any institution. This is an area for many funders to tick boxes, especially in places like hospitals, where they want to ensure reliable nutrition without the carbon output from providing it."
>
> – Modern Energy Cooking Services

Unreliable electricity supply is a major reason for this. In Cameroon, a MECS-funded research survey found that of over 1,500 households that were connected to the electricity grid but were not cooking with electricity, 58 percent indicated that the power supply was too irregular for everyday cooking.[73] This is a barrier to the uptake of clean cooking and encourages the practice of fuel stacking.

Literature also suggests other barriers, including a lack of understanding of the benefits, high cost and unreliability of e-cooking appliances, perceptions that e-cooking is prohibitively expensive and cultural preferences for cooking with biomass cookstoves.[74]

One important frontier for e-cooking are institutional settings such as schools, hospitals, prisons and military facilities, which typically have a more reliable connection to the grid. Having predictable daily energy needs makes it possible to optimize energy generation, transmission and distribution, especially during peak times, to improve grid predictability.

[71] International Energy Agency (2023) A Vision for Clean Cooking Access for All, World Energy Outlook Special Report, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all

[72] International Energy Agency (2023) A Vision for Clean Cooking Access for All, World Energy Outlook Special Report, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all

[73] Rubinstein, Fernando, et al. (2022) 'Adoption of electricity for clean cooking in Cameroon: A mixed-methods field evaluation of current cooking practices and scale-up potential', Energy for Sustainable Development 71: 118-131, https://www.sciencedirect.com/science/article/pii/S0973082622001624

[74] Leary, J., Meynen, B., Chapungu, V., and Troncoso, K. (2021). "eCooking: Challenges and opportunities from a consumer behaviour perspective". Energies, 14(14), 4345, https://www.mdpi.com/1996-1073/14/14/4345

BIOGAS AND BIOETHANOL

People with access to clean cooking using biogas and bioethanol:

10%

Biogas and bioethanol are clean and renewable energy sources that have provided solutions for 10 percent of those who gained access to clean cooking over the last decade.[75] These options often attract less attention by policy-makers and investors, given their relatively niche application. However, they offer a viable option that should be considered as part of the clean cooking package (see Box 4).

Biogas is a renewable energy source produced from the breakdown of organic matter (e.g., animal or human waste or agricultural residue) by anaerobic bacteria in a biodigester. As a clean cooking fuel it offers a number of additional benefits, including improved waste management, mitigated emissions (capturing methane released from the decomposition of biomass) and by-products that can be used for fertilizer or compost.[76]

BOX 4: **DOMESTIC BIOGAS – NEW OPPORTUNITIES IN VOLUNTARY CARBON MARKETS**

Recent advancements in technology for measuring the performance of biodigesters (systems that biologically digest organic material) has opened up new opportunities for biogas programs to gain carbon credits. Worldwide, more than 200 clean cooking activities have been certified by a carbon standard – primarily the Gold Standard. One of the most widely respected carbon standards available on the market, the Gold Standard was established in 2003 by the World Wide Fund for Nature (WWF) and other international NGOs to ensure that projects that reduce carbon emissions meet the highest levels of environmental integrity and also contribute to sustainable development. Today, domestic biogas programs represent over four-fifths of all registered clean cooking projects in the voluntary carbon market, a mechanism that gives companies, governments and individuals the opportunity to buy and sell carbon offset credits. China and India alone are responsible for 80 percent of these projects, with Nepal, Kenya and Tanzania also active in the area. Domestic biogas projects can achieve emission reductions from both fuel switching and improved manure/organic material management. This means that they tend to generate more carbon credits per installation than other clean cooking technologies.[77]

[75] International Energy Agency (2023) A Vision for Clean Cooking Access for All, World Energy Outlook Special Report, https://iea.blob.core.windows.net/assets/f63eebbc-a3df-4542-b2fb-364dd66a2199/AVisionforCleanCookingAccessforAll.pdf

[76] IRENA (2023) Advancing renewables-based clean cooking solutions: key messages and outcomes, https://www.irena.org/Publications/2024/Mar/Advancing-renewables-based-clean-cooking-solutions-Key-messages-and-outcomes

[77] Galt, H., Mikolajczyk, S., Long, I., Della Maggiore, M., Bravo, F., & Tierney, M. (2023). "The Role of Voluntary Carbon Markets in Clean Cooking". Climate Focus and the Modern Energy Cooking Services Programme, https://mecs.org.uk/wp-content/uploads/2023/05/FINAL-The-Role-of-Voluntary-Carbon-Markets-in-Clean-Cooking-17-April-2023-with-photo-accreditation.pdf

Biogas production requires substantial upfront investment in infrastructure, including digesters and pipelines, resulting in relatively high costs for households. The market is more advanced in Asia, where a number of countries, including India, have established codes and standards for biogas plants and are developing national biogas and waste-to-energy programs.[78] Across Africa, the technology is currently most advanced in East Africa, but the potential across throughout the continent is considered high, given the high share of households involved in agriculture.[79] Several African countries have implemented market-oriented biodigester programs and efforts are underway to create an enabling ecosystem for the scale up of household and institutional biodigester solutions.[80] Some countries are creating incentives for livestock farmers to include biodigesters as part of their waste management procedures, particularly in Africa's growing dairy industry.[81]

However, there are several challenges to scaling up biogas. So far, the pipeline of projects is relatively weak. Faced with seasonal variations in the availability of feedstock, projects have struggled to reach the necessary scale. In Indonesia, for instance, the recent outbreak of foot-and-mouth disease in cattle resulted in a decrease in overall feedstock availability.[82]

Bioethanol is a substance produced through the fermentation of sugar-rich or starch-based crops such as sugarcane, corn, wheat and straw. In sub-Saharan Africa the main source of feedstock is molasses, which is a by-product of sugar manufacturing, but there are other options such as cassava. Bioethanol cookstoves are clean-burning and efficient alternatives to traditional biomass stoves. They produce fewer emissions and can be relatively affordable in contexts with appropriate supply ecosystems.

However, there are also limitations on the large-scale use of bioethanol fuel, which can be environmentally and socially damaging. Feedstock production can take up large amounts of land which would otherwise be available for food produc-

Clean cooking provided through bioethanol by 2028:

22%

[78] IRENA (2022), Off-grid renewable energy statistics 2022, https://www.irena.org/Publications/2022/Dec/Off-grid-renewable-energy-statistics-2022

[79] SNV (2019), Technical potential for household biodigesters in Africa, https://a.storyblok.com/f/191310/61a849e3e2/technical_brief_-_technical_potential_for_household_biodigesters_in_africa.pdf

[80] IRENA (2023) Advancing renewables-based clean cooking solutions: key messages and outcomes, https://www.irena.org/Publications/2024/Mar/Advancing-renewables-based-clean-cooking-solutions-Key-messages-and-outcomes

[81] IRENA (2023) Advancing renewables-based clean cooking solutions: key messages and outcomes, https://www.irena.org/Publications/2024/Mar/Advancing-renewables-based-clean-cooking-solutions-Key-messages-and-outcomes

[82] IRENA (2023) Advancing renewables-based clean cooking solutions: key messages and outcomes, https://www.irena.org/Publications/2024/Mar/Advancing-renewables-based-clean-cooking-solutions-Key-messages-and-outcomes

tion and which can impact biodiversity. Bioethanol is, however, considered a viable option in countries with a strong agricultural sector, when accompanied by supportive national policies and market conditions.

In Africa today several private sector entities are working in partnership with governments and farmers to develop production chains to deliver bioethanol for cooking.[83] In Kenya alone, over a million bioethanol cookstoves have been distributed to households (see Box 5). However, in many contexts progress is held back by limited government support, a lack of transport and logistical infrastructure and lack of investment.

The primary challenge to scaling bioethanol lies in underdeveloped local supply chains. This forces many countries to rely on imported bioethanol, which is vulnerable to price and currency fluctuations. There is also some risk of bioethanol competing with the food industry for scarce inputs, which partly explains why E85 ethanol-based cars failed to catch on in the US in the 2000s. Some bioethanol companies are engaging with farmers to address this problem through vertically integrated agricultural supply chains to boost both food and bioethanol supplies. Others have opted to utilize second generation feedstock such as agricultural waste products. For example, Econexus Ventures, a Ghana-based social enterprise commercializing sustainable bioethanol fuel as an alternative clean cooking solution, uses pineapple crowns as feedstock.

Kenyan government target for bioethanol as share of clean cooking:

22%

BOX 5: **KOKO IN KENYA**

In 2021, Kenya's government adopted an Ethanol for Cooking Masterplan, which set a target of 22 percent of clean cooking to be provided through bioethanol by 2028 (bioethanol is a by-product of the sugar industry, which is produced in Kenya by CIST Africa and Giraffe Bioenergy). The government has actively supported the entry of new private sector players into the bioethanol market. For example, KOKO Networks, since its launch in 2019 has distributed over 800,000 bioethanol cookstoves to urban households. Through their network of over 600 fuel distribution points, known as "KOKO points", which are installed inside local shops, customers can buy clean bioethanol fuel in small quantities. The system is managed through KOKO's cloud software, which monitors the distribution points. KOKO's growth is linked to its success in accessing carbon finance (which is based on bioethanol fuel replacing the charcoal normally used for cooking), enabling it to keep prices affordable. There are several other case studies that illustrate instances where governments initiated or stimulated substantial demand for a product through a policy action, which then resulted in a transformation or the emergence of a new market (such as Brazil and its bioethanol blending mandate.[84]

[83] IRENA (2023) Advancing renewables-based clean cooking solutions: key messages and outcomes, https://www.irena.org/Publications/2024/Mar/Advancing-renewables-based-clean-cooking-solutions-Key-messages-and-outcomes

[84] Mingo, S., & Khanna, T. (2014). Industrial policy and the creation of new industries: Evidence from Brazil's bioethanol industry. Industrial and Corporate Change, 23(5), 1229-1260, https://doi.org/10.1093/icc/dtt039

People who gained access to clean cooking over the last decade:

30%

IMPROVED BIOMASS COOKSTOVES

Improved biomass cookstoves use improved design to burn biomass more cleanly and efficiently, resulting in lower smoke and particulate emissions and reduced overall fuel consumption. While not a fully clean solution, it is considered a transitional step towards cleaner cooking in low-income settings. It accounts for around 30 percent of those who gained access to clean cooking over the last decade.[85]

Improved cookstoves use a range of biomass fuels, including firewood, charcoal, agricultural and forestry residues and processed fuels such as pellets and briquettes (see Box 6).

The case for improved cookstoves (see Box 7) lies in their low cost and suitability for rapid deployment in rural or remote areas.[86] While the basic models are readily affordable, the price rises considerably with the more sophisticated designs associated with higher fuel efficiency and emissions standards.[87] Nonetheless, the options continue to evolve rapidly, with international initiatives such as CCA, the Climate and Clean Air Coalition (CCAC) as well as private enterprises investing significant

BOX 6: **VARIETIES OF IMPROVED BIOMASS COOKSTOVES**

The International Organization for Standardization (ISO), an independent, non-governmental body founded in 1947 and based in Switzerland, provides a set of testing and reporting standards for the emissions, efficiency, safety and durability of cookstoves. Tests are done in a lab setting and cookstoves are rated from Tier 0 (lowest) to Tier 5 (highest). Tier 0 aligns with the performance of open fires.

Basic portable cookstoves. These artisan-produced ceramic or clay models offer moderate efficiency improvements in the burning of wood and charcoal. In the past they were often distributed as part of national and donor clean cooking programs and are therefore often called "legacy" models. Under the ISO ratings for emissions they reach only Tier 1, indicating only modest improvement on traditional stoves.

Intermediate cookstoves. There is a wide range of intermediate-level solid fuel cookstoves that offer significant improvements in fuel efficiency, but with limited health and environmental benefits compared to cooking with modern fuels. They may be portable (e.g., the Envirofit charcoal and wood cookstoves), semi-portable (e.g., Ethiopia MIRT cookstoves) or built-in (e.g., Uganda Rocket Lorena cookstove) and may be either unvented or combined with chimneys. They are rated Tier 2 for emissions and are considered a stepping stone towards cleaner solutions.

Advanced biomass cookstoves. These more sophisticated designs use fans or natural draft to convert solid fuel into combustible gases ("gasification"), thereby achieving significant particulate emission reductions – although still not at the level of modern fuel cookstoves. At peak performance and under lab conditions some gasifier stoves can now exceed ISO Tier 3 emissions performance, particularly when combined with chimneys, making them significantly safer to use.[88]

amounts in research and development to find the optimal combination of performance and cost.[89]

Some studies have cast doubts on the health benefits of improved cookstoves. The expected benefits often assume levels of emission reductions that are achieved only in laboratory conditions by expert users. In normal use, the reductions may not be enough to make a significant difference to health outcomes.[90] This has led to some disillusionment among financiers and a shift of focus from stove design towards the fuels they use. However, proponents of improved cookstoves point out that measurement problems make it difficult to draw clear conclusions. In real-world conditions, with high levels of ambient air pollution from road traffic and other people's cookstoves, it is hard to capture the health benefits for individual families of moving to cleaner cookstoves. However, incremental benefits may still be achieved.

Overall, however, it is widely accepted that improved cookstoves offer an interim or transitional step towards clean(er) cooking, delivering meaningful, short-term benefits in areas where fully clean cooking options are still many years away. In particular, improved cookstoves can lead to significant reductions (20-75 percent) in the amount of biomass used for each cooking task, helping to combat deforestation. Advocates also argue that focusing solely on long-term outcomes would leave some of the poorest households without access. In its modelling, the International Renewable Energy Agency (IRENA) calculates that roughly 25 million improved cookstoves will have to be deployed in rural areas every year to reach universal access by 2030.[91]

BOX 7: **THE ROLE OF IMPROVED COOKSTOVES (BURN CASE STUDY)**

Founded in 2011, BURN was created to save forests by revolutionizing the clean cooking sector. While traditional, inefficient cooking appliances can bankrupt families, damage their health and destroy forests, BURN stoves can save families' money on fuel, limit indoor air pollution and protect forests. BURN is a carbon project developer that covers the full carbon value chain from project design and in-house monitoring to credit issuance. Headquartered in Kenya and with direct operations in 10 African countries, BURN employs 3,500 people across Africa, of which 50 percent are female. The company has made and distributed nearly five million clean cooking appliances, transforming the lives of over 25 million people and preventing over 21 million tons of CO_2 from entering the atmosphere.

"We would like to make the case that high-quality biomass stoves make a meaningful difference. Our charcoal stove 'Jikokoa' has been known to be the best charcoal cookstove for families with unique attributes which include durability of over 5+ years and up to 62 percent savings on charcoal. An independent study found that one stove generates US$1,000 in benefits for society. For wood, we are at 51 percent thermal efficiency and we are piloting digital monitoring for biomass stoves. A lot of innovation is happening. There is space for more R&D for a good biomass stove."

- BURN

[85] International Energy Agency (2023) A Vision for Clean Cooking Access for All, World Energy Outlook Special Report, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all

[86] International Energy Agency (2023) A Vision for Clean Cooking Access for All, World Energy Outlook Special Report, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all

[87] ESMAP (2015) The state of the global clean and improved cooking sector, https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_State_of_Globa_Clean_Improved_Cooking_sector_Optimized.pdf

[88] ESMAP (2015) The state of the global clean and improved cooking sector, https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_State_of_Globa_Clean_Improved_Cooking_sector_Optimized.pdf

[89] Clean Cooking Alliance, link; Climate and Clean Air Coalition, https://www.ccacoalition.org/partners/clean-cooking-alliance#:~:text=Established%20in%202010%2C%20the%20Alliance,consumers%20save%20time%20and%20money

[90] Phillip, E et al. (2023) Improved cookstoves to reduce household air pollution exposure in sub-Saharan Africa: A scoping review of intervention studies. PLoS ONE, https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0284908

[91] International Energy Agency (2023) A Vision for Clean Cooking Access for All, World Energy Outlook Special Report, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all

WEIGHING UP THE COSTS, BENEFITS AND TRADE-OFFS

Each of the clean cooking solutions discussed offers a mix of benefits, risks and trade-offs in terms of public health outcomes, environmental impact, emission reductions, costs, affordability (in terms of initial outlay and long-term fuel costs) and other direct benefits for consumers. Many of the advantages are inherently difficult to measure. For governments there are also considerations around the fiscal burden (particularly when subsidies are involved) and long-term energy security.

BOX 8: **WEIGHING THE COSTS AND BENEFITS OF FUEL TYPES**

SEforAll supported the development of the Malawi Integrated Energy Plan to examine the trade-offs of different fuel types. The integrated plan provides real-time assessment of the energy value, emissions, fuel and stove price and household air pollution exposure to help weigh costs and benefits.[92]

FUEL PRICE

FUEL	PRICE ($/unit)	UNIT
Firewood	0.046	kg
Charcoal	0.738	kg
Briquette/Pellet	0.42	kg
Biogas	0.74	kg
Bioethanol	0.905	kg
LPG	0.63	kg
Electric	0.064	kWh

FUEL PARAMETERS

FUEL	ENERGY VALUE (MJ/kg)	PM 2.5 (g/kg_fuel)	EMISSIONS FACTOR (k_CO_2/kg_fuel)
Firewood	18.41	7.1	1.775
Charcoal	31.98	19.7	3.662
Briquette/Pellet	16.75	17.3	2.409
Biogas	22.65	0.1	1.476
Bioethanol	22.80	0.1	1.943
LPG	31.98	0.1	3.242
Electric	N/A	0.0	0.064

[92] SEforALL (2023) Malawi Integrated Energy Plan, https://www.seforall.org/system/files/2023-04/Malawi%20IEP%20-%20Electrification%20Report_FINAL_compressed.pdf

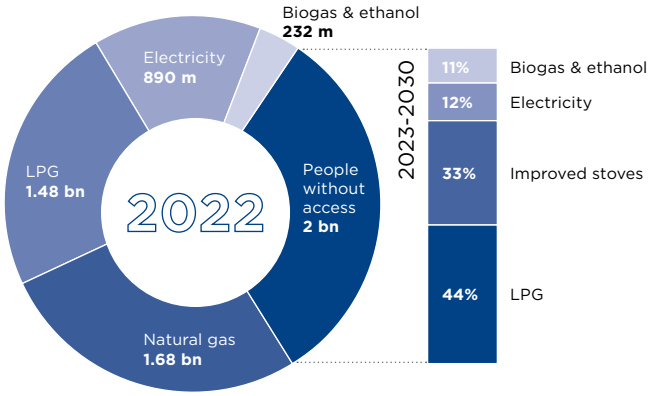
[93] International Energy Agency (2023) A Vision for Clean Cooking Access for All, World Energy Outlook Special Report, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all

Across clean cooking the main consensus is that there is no one-size-fits-all options. The IEA's *Vision for Clean Cooking Access for All* report sketches out a global pathway to universal access involving a diverse portfolio of fuels and technologies (see Figure 4).[93] For most countries, the path towards universal access will involve multiple options to reflect the needs of different geographical areas and market segments.

This puts national policy-makers in the driving seat. They are best placed to determine which investments to prioritize, based on the conditions present in each country. There is a growing number of tools to support their decision-making. SEforAll is developing integrated energy plans based on geospatial data and affordability considerations (see Box 8).[94] The Clean Cooking Alliance has developed the Fuel Analysis, Comparison & Integration Tool (FACIT), which helps policy-makers "to interactively analyze and compare trade-offs of different cooking fuels".[95] The WHO's Benefits of Action to Reduce Household Air Pollution (BAR-HAP) Tool also helps with identifying clean cooking policy interventions to maximize health impacts.[96] In each case, the starting point should be detailed analysis of market conditions across the country and an explicit statement of which benefits policy-makers choose to prioritize.

The range of clean cooking options can make it challenging for financiers to develop harmonized approaches. However, development partners such as the OPEC Fund are increasingly adopting a fuel- and technology-neutral approach, signaling their willingness to support individual national pathways towards universal access. This approach also benefits from the advanced collaboration that the OPEC Fund has developed with key organizations such as SEforALL, the United Nations Industrial Development Organization (UNIDO), the United Nations Development Programme (UNDP) and CCA, which have built up country and solutions knowledge in many years of clean cooking engagements.

FIGURE 4: **Share of Population Gaining Access by Technology (IEA's Access for All Scenario, 2022-2030)**



Source: IEA. Licence: CC by 4.0

[94] SEforALL (n.d) Universal Integrated Energy Plans, https://www.seforall.org/programmes/universal-integrated-energy-plans - :~:text=An%20IEP%20is%20a%20'power,help%20them%20reach%20these%20goals.; examples of tool application for Nigeria and Malawi: SEforALL (n.d) Universal Integrated Energy Planning, https://sdg7energyplanning.org/

[95] Clean Cooking Alliance, Fuel Analysis, Comparison & Integration Tool (FACIT), Research Report, https://cleancooking.org/reports-and-tools/fuel-analysis-comparison-integration-tool-facit/

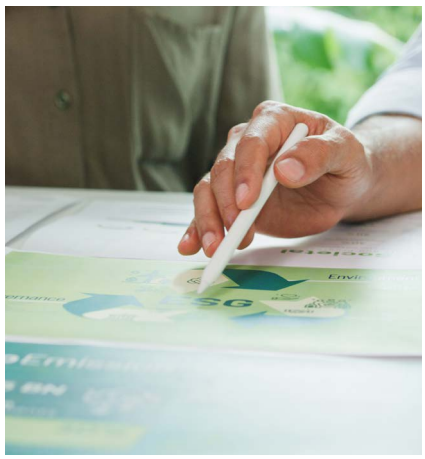
[96] Benefits of Action to Reduce Household Air Pollution (BAR-HAP) Tool (Version 2, July 2021), https://www.who.int/publications/m/item/benefits-of-action-to-reduce-household-air-pollution-(bar-hap)-tool-(version-2-july-2021)

4 OPTIONS FOR SCALING UP CLEAN COOKING

It is widely acknowledged that a dramatic scaling up of investment is needed in order to achieve universal access to clean cooking. However, no single organization can make this happen. It requires concerted efforts by governments, international development partners, clean cooking firms, financial institutions, consumer groups and research and development organizations. Moreover, compared to most development investment, clean cooking has been increasingly market-based – market-led solutions are seen as more scalable and sustainable. Yet market-based solutions continue to encounter significant affordability barriers and have struggled to reach the poorest households. It is therefore important to recognize that governments play an essential part in creating the conditions for market growth – increasingly as regulators rather than suppliers. This section sets out some of the key actions that are needed from different stakeholders.

GOVERNMENTS

Governments play an indispensable role in scaling up clean cooking solutions and achieving universal access. Each country should determine its own priorities and preferences in the transition to clean cooking, based on its own unique circumstances. Past experience suggests that political leadership at high levels is needed in order to drive the process, ensure coordination among all stakeholders, mobilize donor funding and ensure the sustainability of interventions. National governments are also central in creating the conditions for private investment at scale and work with campaigners and consumer groups to demonstrate to the public the benefits of clean cooking.



Data and Analysis: The factors holding back full access to clean cooking are highly contextual.[97] They also vary significantly within countries, affected by issues such as geography, market conditions and household (behavioral) characteristics. Developing national clean cooking policies and strategies calls for targeted data research and data collection, including learning from pilot programs. Governments can also play a key role in generating information on supply and demand to help inform private investment decisions.[98] For example, the government of Nigeria has developed an online data visualization that enables private firms to estimate the demand for clean cooking across different geographical areas.

[97] Bharadwaj, B (2022) Context matters: Unpacking decision-making, external influences and spatial factors on clean cooking transitions in Nepal, Energy Research & Social Science, https://www.sciencedirect.com/science/article/abs/pii/S2214629621004953

[98] Shupler, M., et al., (2021) Modelling of supply and demand-side determinants of liquefied petroleum gas consumption in peri-urban Cameroon, Ghana and Kenya, Nature Energy, 6, https://www.nature.com/articles/s41560-021-00933-3

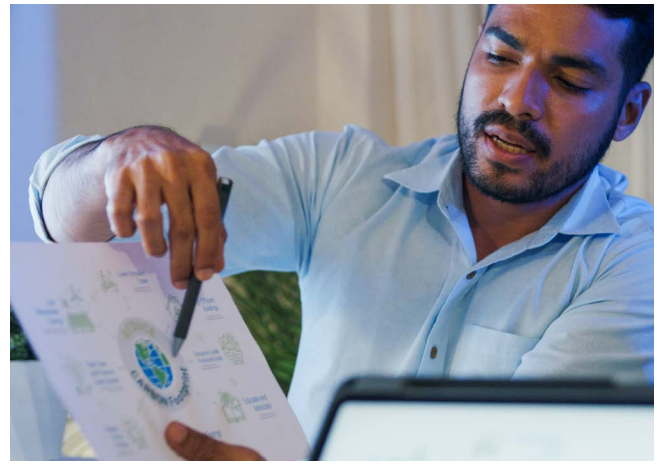
Policies and Strategies: So far, only a minority of developing countries have enacted comprehensive national policies and strategies to support clean cooking and many countries are yet to formally adopt the SDG 7 target of universal access by 2030.[99] The challenge often lies in the lack of a clear lead agency within an administration, capacity constraints and/or poor coordination across ministries involved.[100] A well-formulated strategy setting out institutional roles and responsibilities can help resolve these challenges.[101] Based on data and analysis, the strategy should identify a set of priority clean cooking solutions with associated target populations. It should provide a clear signal to private investors on the government's intentions (such as introducing price subsidies and the distortions they can create – as highlighted above) to help inform investment decisions. Many countries are opting to do this in the form of integrated energy plans, which analyze energy consumption needs across different economic sectors and the mix of energy sources best suited to meeting them. Clean cooking commitments can also be incorporated into Nationally Determined Contributions under the Paris Agreement. Many countries are also incorporating clean cooking objectives into other national programs such as electricity, water, education, nutrition and health.

BOX 9: **CLEAN COOKING DELIVERY UNITS SUPPORT TO GOVERNMENT**

The Clean Cooking Alliance (CCA), a global network of partners, has established the Clean Cooking Delivery Units Network to provide tailored support to national governments seeking to achieve ambitious clean cooking transitions. The initiative is partnering with governments in Africa and around the world to launch dedicated teams of clean cooking experts reporting to national leaders at presidential or ministerial level, with CCA providing funding and technical support. The Delivery Units coordinate clean cooking activities, policies and programming, to accelerate access at a national level.

"Our focus now is on translating global advocacy for clean cooking into concrete actions within national planning. It is easy to state objectives and set targets, but the real challenge lies in implementing these actions. Integrated energy plans not only define a country's path (or trajectories) to electrification but also provide clear plans for achieving access to clean cooking."

- Sustainable Energy for All



[99] International Energy Agency (2023) A Vision for Clean Cooking Access for All, World Energy Outlook Special Report, https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all

[100] Global Alliance for Clean Cookstoves (2011) Igniting Change: A Strategy for Universal Adoption of Clean Cookstoves and Fuels, https://cleancooking.org/reports-and-tools/igniting-change-a-strategy-for-universal-adoption-of-clean-cookstoves-and-fuels/

[101] SEforALL (2023) 'Ghana energy transition plan gains momentum as consultations held with President Akufo-Addo, ministers, local stakeholders', https://www.seforall.org/news/ghana-energy-transition-plan-gains-momentum-as-consultations-held-with-president-akufo-addo

[102] Global Alliance for Clean Cookstoves (2017) Comparative Analysis of Fuels for Cooking: Life Cycle Environmental Impacts and Economic and Social Considerations, https://cleancooking.org/wp-content/facit/assets-facit/Comparative-Analysis-for-Fuels-FullReport.pdf

[103] MECS (2021) Global Market Assessment for electric cooking, https://pure.strath.ac.uk/ws/portalfiles/portal/123386173/Coley_etal_MECS2021_Global_market_assessment_electric_cooking.pdf

[104] Vigolo et al., (2018) Drivers and Barriers to Clean Cooking: A Systematic Literature Review from a Consumer Behaviour Perspective, Sustainability 2018, 10(11), 4322, https://www.mdpi.com/2071-1050/10/11/4322

Infrastructure Development: The IEA estimates that 20 percent of investment in clean cooking will need to be in the form of infrastructure. Governments play a critical role in putting in place the infrastructure needed to support clean cooking. For example, investment in LPG fuel stations are helping to bring down transportation costs for clean cooking enterprises and expand their customer base.[102] Investments to improve access, reliability and strength of the national grid, mini-grid and off-grid electrical infrastructure are also needed to scale up the uptake of electric clean cooking solutions.[103]

Public Education: Promoting universal access to clean cooking means changing ingrained cooking practices and traditions. Governments can support this through public education and awareness-raising programs designed to communicate the advantages of clean cooking.[104] Some international development partners are working with governments to develop national campaigns. For example, the World Food Programme (WFP) collaborates with governments to introduce advocacy for clean cooking into school curricula, teaching and encouraging cooks to adopt efficient practices while also preserving food's nutritional value.[105] Lesson learned from public education initiatives include the importance of reaching women, who are primarily responsible for cooking and disproportionately affected by the drawbacks of traditional methods, but with complementary messaging for men, who often hold greater economic power and the decision-making authority.[106]

Smart Subsidies and Tax Incentives: Given affordability barriers some element of public subsidy may need to be incorporated in national clean cooking programs. However, subsidies need to be designed with care to avoid sustainability problems and market distortions (see Box 10). Most commentators suggest that "smart subsidies", targeted towards specific market segments for limited periods, offer the best option. Selling clean cookstoves at highly subsidized prices does not necessarily lead to increased utilization. Indirect subsidies and tax incentives to manufacturers appear to offer better results.[107] Some countries are also introducing tax incentives to encourage market development such as by making clean cooking products exempt from value-added tax and import duties.

Promoting Entrepreneurship and Innovation: Governments can also ensure that policies and instruments are in place to

BOX 10: **KENYA'S CHALLENGES WITH INCENTIVIZING CLEAN COOKING**

In 2016, Kenya eliminated the 16 percent value added tax (VAT) on liquefied petroleum gas (LPG) and reduced the import duty on energy-efficient cookstoves. At the same time, the government increased the cost of kerosene by 7.20 Kenyan schillings (US$0.07) per liter, to discourage its use. While initially successful, later studies showed that, when 16 percent VAT on LPG was restored in 2021, more than half of consumers decreased their use of LPG in favor of charcoal and wood.[108] Kenya's recent draft National Green Fiscal Incentives Policy Framework from 2023 proposes a range of tax exemptions and waivers to companies that produce clean cooking technologies, demonstrating the variety of fiscal incentives that can be used to incentivize market development.[109]

[105] Birnbaum, J (n.d) Clean Cookstoves, Regeneration, https://regeneration.org/nexus/clean-cookstoves

[106] Vigolo et al., (2018) Drivers and Barriers to Clean Cooking: A Systematic Literature Review from a Consumer Behaviour Perspective, Sustainability 2018, 10(11), 4322, https://www.mdpi.com/2071-1050/10/11/4322

[107] Akbar Sameer, Douglas Barnes, Andrew Eil, and Anastasia Gnezditskaia. Household Cookstoves, Environment, Health, and Climate Change: A New Look at an Old Problem. Working Paper. World Bank, 2011, https://documents1.worldbank.org/curated/ar/732691468177236006/pdf/632170WP0House00Box0361508B0PUBLIC0.pdf

[108] Shupler, M., et al., (2022), COP26 and SDG 7 goals under threat: 16 percent VAT on LPG reverses progress made in clean cooking adoption in Kenya, https://www.researchgate.net/publication/360109458_COP26_and_SDG7_goals_under_threat_16_VAT_on_LPG_reverses_progress_made_in_clean_cooking_adoption_in_Kenya

[109] The Republic of Kenya (2022) Draft National Green Fiscal Incentives Policy Framework, The National Treasury and Economic Planning, https://www.treasury.go.ke/wp-content/uploads/2023/01/Draft-Green-Fiscal-Incentives-Policy-Framework.pdf

promote entrepreneurship and innovation. The government of India worked with the MECS program to identify and fund emerging clean cooking initiatives. The program trained and mentored entrepreneurs, helping them create a business plan and providing cash grants to the most promising submissions. In 2021, Nepal's National Planning Commission worked with CCA to develop an action plan for transforming the national cookstoves and fuels market. It sets out measures to drive innovation in distribution models, including by coordinating with agricultural cooperatives to leverage existing seed and fertilizer networks, employing local women as sales agents for clean cookstoves and using customer management software to streamline the costs of last-mile distribution businesses.[110]

TABLE 5: **Options for Regulating Clean Cooking**

TECHNOLOGIES	POTENTIAL REGULATORY NEEDS
Liquefied petroleum gas (LPG)	• Safety rules for LPG storage, transportation and handling • Rules requiring LPG cylinders to be owned, inspected and maintained by LPG marketers (the "branded cylinder recirculation model"), rather than customers • Licensing of distributors, transporters and selling agents • Penalties for unsafe filling practices
Electric cooking	• National safety standards for e-cooking devices such as hotplates and pressure cookers
Biogas and Bioethanol	• Policy frameworks to incentivize the installation of biodigesters by the private sector[111] • Definitions and standards for ethanol fuel • Licensing of stoves
Improved biomass stoves	• Establish public or trade bodies to set voluntary standards for biomass stoves, drawing on ISO standards • Regulations or industry standards for pellet production

[110] Clean Cooking Alliance (2022) Country Action Plan (CAP) for Transforming the Cookstoves and Fuels Market in Nepal, https://cleancooking.org/reports-and-tools/country-action-plan-for-transforming-the-cookstoves-and-fuels-market-in-nepal/

[111] Puzzolo, H., et al (2019) Supply Considerations for Scaling Up Clean Cooking Fuels for Household Energy in Low-and Middle-Income Countries, Volume 3, issue 12, Review Article, Advancing Earth And Space Sciences, https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019GH000208

Decline in investment in research and development since 2019:

1/3

PRIVATE SECTOR

The private sector has a key role to play in efforts to achieve universal access to clean cooking. Only the private sector can produce and distribute cooking equipment and fuels at the scale required, while adapting to the needs and preferences of different localities and market segments. This section sets out some key steps that are helping clean cooking enterprises take their businesses to scale.

Understanding Local Markets: Given the highly contextualized nature of the clean cooking challenge a deep understanding of local markets is critical. Firms need an understanding of cooking practices and traditions, the dynamics of household decision-making, the needs and preferences that drive consumer choices, the size and characteristics of different customer segments and their ability and willingness to pay for clean cooking, as well as the strategic direction set by governments, among many other considerations. Successful companies undertake their own market entry and feasibility studies to inform the design of products and business models. Clean cooking advocates such as CCA also put the results of their market research into the public domain to facilitate new entrants.

Driving Technical Innovation: Continual technical innovation is needed to develop clean cooking products that are high performing (through lower emissions and improved efficiency), affordable and attractive to consumers – a challenging set of improvements to regularly deliver. The most successful companies are continually adapting their products in response to customer feedback. Many advances in technology, design and business models have been achieved in recent years, but the industry remains constrained by a lack of investment in research and development, which CCA estimates has declined by a third from 2019 levels.[112]

Firms and investors need to recognize that the future of the industry lies in successful innovation. Industry stakeholders interviewed for this report reflected that the clean cooking space is wide open with relatively little direct competition among firms. This suggests that there is scope for more coordination of innovation across the sector to reduce duplication and accelerate progress. Financiers can do their part by recognizing the need to build research and development capacity within firms and to provide concessional finance on terms and timelines that align with the needs of the innovation process.

Developing Innovative Business Models: As well as technical innovation firms need to innovate with business models that will enable them to reach consumers with products and services that they can afford in the long term (see Box 11). Many of these innovations involve extending finance to low-income customers without collateral or documented credit histories, which is inherently risky.

[112] Clean Cooking Alliance (2022) Clean Cooking Industry Snapshot, https://cleancooking.org/reports-and-tools/2022-clean-cooking-industry-snapshot/

BOX 11: **INNOVATIVE BUSINESS MODELS IN CLEAN COOKING**

Metering technologies: The use of metering technologies for various fuel types (e.g. electric, LPG, biogas) has increased hugely within clean cooking in recent years. Meters allow for detailed tracking of stove and fuel usage and generate valuable data on usage volumes and patterns. This data is key to making use of carbon finance and other results-based finance, because it provides a reliable and efficient way of verifying usage.[113]

Pay-As-You-Go (PAYG): Metering also facilitates incremental payment for fuel purchases using pay-as-you-go approaches. Smaller payments increase affordability for low-income households, copying the expenditure patterns common for traditional fuels such as buying charcoal every few days. Payments can often be made with mobile money, which maximizes convenience for customers. Companies using pay-as-you-go business models typically provide warranties to ensure the long-term functioning of their equipment and often deliver fuel replenishments directly to households, reducing motivation and access barriers. Pay-as-you-go adds to the cost of doing business and is generally best suited to firms operating at scale or those that can make use of carbon finance to offset their costs.

"Tool and Fuel": Another business model that has gained traction in recent years is the "tool and fuel" approach, which is similar to the "razor and blade" model where a company sells the base product at a low margin and then sells the consumable goods at a higher margin. In clean cooking this often involves bundling the cost of upfront equipment with ongoing fuel costs through fuel purchase contracts. This enables consumers to reduce the high upfront cost by spreading the burden over time. This model typically involves taking a very small margin on the "tool" and then recovering the revenues through margins on the sale of the cooking fuel over several years.

Integration with non-cooking offerings: A number of firms are bundling clean cooking products with other services, such as household solar power systems, allowing lower upfront costs. For example, BBOXX, a longstanding player in the off-grid solar sector, has added pay-as-you-go LPG to their portfolio. This allows them to leverage their existing last-mile distribution networks, partnerships with telecom companies and experience with mobile money payments and the ability to invest in product research and development.

Diversification of product offerings: Another approach taken by many clean cooking companies is to expand their product offerings to serve multiple customer segments and fuel types. This allows them to increase their customer base and enter new markets, while leveraging existing resources such as manufacturing infrastructure, distribution networks or pay-as-you-go intellectual property. It can help firms to diversify by offering low margins on new products, offset by higher margins on more established ones. For example, BURN Manufacturing – traditionally a charcoal stove manufacturer – has recently launched electric pressure cookers for grid-connected customers in Kenya. ATEC, originally a biodigester company operating in Cambodia and Bangladesh, has added magnetic induction cookers as an offering.

Broader consumer finance offerings: Companies have been exploring other solutions to affordability barriers through non-PAYG consumer finance, including instalment and payment plans managed in-house or partnering with financial institutions to implement payment plans. For example, the Indian cookstove manufacturer Greenway has partnered with its last mile micro-entrepreneurs and agents – who are mostly women – to share a portion of carbon revenues with them, creating healthy economics through the value chain.

[113] Clean Cooking Alliance (2022) Accelerating clean cooking as a nature-based climate solution, https://cleancooking.org/reports-and-tools/accelerating-clean-cooking-as-a-nature-based-climate-solution/

DEVELOPMENT PARTNERS

The landscape of international development partners prepared to support clean cooking is diverse and growing all the time. It includes bilateral development agencies, working individually or through cooperative platforms such as CCA, MECS, multilateral development banks, development finance institutions, foundations and private impact investors. At this stage of development, clean cooking needs a diverse range of support. This section sets out some of the most important ways in which development partners can help to take clean cooking to scale.

Grants and Technical Assistance (TA): Grant funding plays an essential role in many countries (particularly low-income countries) embarking on the clean cooking transition. TA grants can be used to support governments or their designated public sector agencies to build capacity and put in place enablers for private investment. Key activities include developing national policies, strategies, regulations and standards, conducting social and market analysis, establishing national research and development programs and public education and awareness-raising programs. There is also an important role for grant funding in supporting promising clean cooking enterprises. CCA's analysis suggests that grants accounted for 3 percent of all funds raised by clean cooking enterprises in 2022, although this has been as high as 15 percent in the past. Grant funding can be used to establish business incubators that nurture local clean cooking enterprises with seed funding, training and technical support and to support research, innovation and piloting. Program examples include the World Bank's Clean Cooking Fund (CCF) and the Modern Cooking Facility for Africa (MCFA, see Box 12).

Integrating Clean Cooking into Other Programs: In a 2022 review of the clean cooking funding landscape, MECS recommended that MDBs and DFIs integrate clean cooking components into their sector operations. Examples include introducing home biogas technology as part of climate-smart agriculture (see Box 13), incorporating e-cooking into household electrification programs and integrate clean cooking into programs that support infrastructure development in the health and education sectors. The OPEC Fund actively does this as demonstrated by a recently approved project in Tanzania (Climate Smart Dairy Transformation) that has a clean cooking component which involves using biogas as a fuel for clean cooking stoves.

BOX 12: **GRANT-BASED CLEAN COOKING PROGRAMS**

The World Bank launched the Clean Cooking Fund (CCF) at the UN Climate Action Summit in September 2019. The US$500 million fund seeks to scale up public and private investment and accelerate progress toward universal access to clean cooking by 2030. It provides financial and technical support, primarily through technical assistance and results-based grants to help countries incentivize the private sector to deliver modern energy cooking services. Operational since early 2020, the CCF is expected to leverage US$2 billion in investments to support businesses delivering clean cooking solutions, with a view to transforming the market.

The **Modern Cooking Facility for Africa (MCFA)** is a multi-donor facility, established and managed by the Nordic Environment Finance Corporation, an international finance institution established by Denmark, Finland, Iceland, Norway and Sweden funding green initiatives. It offers a combination of results-based financing, non-reimbursable catalytic grant financing and technical assistance to companies active in clean cooking to grow and scale up their businesses. As a result of the first funding round, launched in 2022, MCFA is financially incentivizing cooking service providers to deliver their services to almost four million people in Africa by the end of 2027.[114]

Result-based Financing: Results-based financing (RBF) is increasingly the instrument of choice for publicly funded interventions in clean cooking. RBF is an umbrella term for a range of financing mechanisms linked to the delivery of pre-agreed and independently verified results. This contrasts with the traditional input-based finance in which the financing is provided upfront before any results have been achieved.[115] RBF thereby shifts the delivery risk from the financier to the project implementer. RBF programs allow implementers greater flexibility to select the mix of interventions most likely to deliver the agreed results. The positive feedback loops created through robust monitoring arrangements add to the likelihood of successful outcomes.[116]

Some key design considerations around RBF programs include:

• **Eligibility:** Most RBF programs define upfront which clean cooking technologies they are willing to support. While most programs are technology-neutral, some contain provisions pushing suppliers towards higher-tier and more climate-friendly options.[117]

• **Program Management:** Financiers may elect to support a public body as the primary implementing partner, a social enterprise or a mix of the two. Public-body engagement ensures a level of political buy-in and better integration with national priorities. However, it also involves more complex set-up arrangements and can increase the risk of delay.

• **Monitoring, Reporting and Verification (MRV):** RBFs release funding only following demonstrated results and therefore need strong MRV processes. These can be costly and resource intensive, so their design is a key issue. Most clean cooking RBFs rely on manual verification – that is, user surveys via telephone or SMS. Experience has shown that surveys tend not to capture the extent of utilization. As a result, there is increasing interest in the potential of remote monitoring systems to improve accuracy. Smart monitoring systems can be integrated with pay-as-you-go systems and mobile money payments. They also generate useful customer data for clean cooking companies beyond the RBF requirements.[118]

• **Operating in Low-Income or Fragile Settings:** So far, RBF has principally been used in relatively mature clean cooking

[114] Modern Cooking Facility for Africa (n.d) Increasing access to high-technology cooking solutions, https://www.moderncooking.africa/

[115] MECS (2021) 'Clean cooking: results-based financing as a potential scale-up tool for the sector', https://mecs.org.uk/wp-content/uploads/2021/10/Clean-cooking-results-based-financing-as-a-potential-scale-up-tool-for-the-sector.pdf

[116] Stritzke, S., et al (2021) 'Results-Based Financing (RBF) for Modern Energy Cooking Solutions: An Effective Driver for Innovation and Scale?', https://www.mdpi.com/1996-1073/14/15/4559

[117] MECS (2021) 'Clean cooking: results-based financing as a potential scale-up tool for the sector', https://mecs.org.uk/wp-content/uploads/2021/10/Clean-cooking-results-based-financing-as-a-potential-scale-up-tool-for-the-sector.pdf

markets such as Kenya. For low-income or fragile settings the design needs to be adjusted to enable smaller companies to participate and to give them space to grow their businesses. This might include providing them with a portion of the resources in advance to support bulk purchasing of equipment and providing them with the resources and time to develop their products or set up distribution networks. The inclusion of an upfront grant component to support pre-financing and cash flow can help diversify the spectrum of participants.[119]

• **Managing Currency Risk:** Program participants often pay for imported equipment with hard currency, but receive their revenues in local currency, leaving them exposed to exchange rate changes. Financiers may wish to build mitigation against currency risks into their RBF programs.[120] However, trying to hedge against potential exchange rate losses comes with a cost and is typically only a short-term solution.

Concessional Capital: Development partners can also support clean cooking enterprises and crowd in private finance through "concessional capital". This refers to financing on more favorable terms than commercial capital such as debt at below-market rates or equity with asymmetrical returns. This type of financing helps cover risks that return-seeking investors are not willing to bear, giving companies more time and space for testing new technologies and business models. One example is the Spark+ Africa Fund, a US$64 million fund supported by both public (including bilateral DFIs) and private partners, which invests in early-stage companies. Another is Acumen, an impact investor that has invested over US$6 million in "patient capital" since 2015 in five clean cooking companies. Through its philanthropic approach to investment it is able to take on more risk and come in at an earlier stage of its investee companies' development, when equity is hard to find.[121]

Challenge Funds and Innovation: There is a major shortfall in funding for clean cooking companies at the initial stages of the business innovation cycle, when risks are at their highest and most return-seeking investors are unlikely to invest. Development partners can help bridge the gap with research and challenge funds, using grants to accelerate innovation, including through technology development, business model development, piloting and proof of concept.

Supporting NGOs and Community-based Initiatives: NGOs also play a critical role in facilitating the transition to clean cooking. Their knowledge of, and connections with, local communities can help build a better understanding of social and cultural norms and other contextual factors that influence the uptake of clean cooking. NGOs can also serve as local champions and channels for awareness raising and public education campaigns as well as distributors of products and services.

BOX 13: **CLEAN COOKING AS CATALYST FOR SUSTAINABLE FOOD SYSTEMS**

In 2023, a UNDP project introduced home biogas technology to 500 Rwandan farmers as part of a wider project on climate-smart agriculture. Over its 10-year lifespan the project is introducing home-based equipment to convert animal manure into cooking gas and biofertilizer. This is projected to save over 14,000 tonnes of firewood, produce 194,000 cubic meters of digestate, which can be used for fertilizer and to save 1.7 million working hours for women.

[118] Ibid.

[119] Ibid.

[120] MECS (2021) 'Clean cooking: results-based financing as a potential scale-up tool for the sector', https://mecs.org.uk/wp-content/uploads/2021/10/Clean-cooking-results-based-financing-as-a-potential-scale-up-tool-for-the-sector.pdf

[121] MECS and ENERGY 4 IMPACT (2022) Modern Energy Cooking: Review of The Funding Landscape, Report 5 of the Financing Clean Cooking Series, https://mecs.org.uk/wp-content/uploads/2022/02/Modern-Energy-Cooking-Review-of-the-Funding-Landscape.pdf

BOX 14: **KENYA CLEAN COOKSTOVE MARKET ACCELERATION PROJECT**

EnDev, a multi-donor initiative coordinated by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the Netherlands Enterprise Agency (RVO), promotes sustainable access to modern energy services for households. In Kenya, in EnDev's second phase, it has supplemented its support for solar home systems with a results-based clean cooking component – one of the first clean cooking RBF programs in Africa. The program supported a range of stoves, including charcoal, wood, ethanol and gasifier models, provided they achieved ISO performance rating at Tier 2 or above and a 40 percent fuel efficiency gain. This was tested at the Kenya Institute of Research and Development.

EnDev's eligibility criteria included a range of partners, including local financial institutions, cookstove manufacturers, retailers and distributors, civil society organizations and community-based organizations. This resulted in 29 program participants, nine of which were financial institutions. In practice, however, the financial institutions found it difficult to deliver the desired results as clean cooking firms generally fell outside their risk appetite, while their consumer credit offerings were unable to compete with nimbler, pay-as-you-go models.

As is common for RBF programs, payments were dependent upon pre-agreed and independently verified results – namely, sales of cookstoves above an agreed baseline based on historical sales to ensure business growth. The payments were capped at €100,000 (around US$90,000) bi-annually and limited to a total of €500,000 (around US$450,000) per beneficiary. An independent verification agent was contracted by GIZ to provide independent validation of claimed results, including through telephone interviews, field visits and document review. Overall, the program was judged to be highly successful, outperforming its target of 80,000 cookstoves by 20 percent. In addition, 20 participating cookstove distributors were able to extend their operations into new geographical areas, thereby extending coverage to all 47 Kenyan counties.

Despite these successes, an independent evaluation of the program highlighted a number of challenges to be addressed in future programs, including:

• Delays in the verification processes and the disbursal of funds to the distributors were a key concern for participants.

• The uptake in remote and marginalized areas was low, due to high logistics and distribution costs caused by poor infrastructure connections, security issues and a lack of skilled staff.

• The nature of the RBF, which requires participants to provide their own upfront investment and working capital, is challenging in low-income and fragile settings.[122]

• A lack of working capital was a challenge as driving sales and credit provision requires adequate means.

[122] MECS and ENERGY 4 IMPACT (2022) Modern Energy Cooking: Review of The Funding Landscape, Report 5 of the Financing Clean Cooking Series, https://mecs.org.uk/wp-content/uploads/2022/02/Modern-Energy-Cooking-Review-of-the-Funding-Landscape.pdf
and Stritzke, S., et al (2021) 'Results-Based Financing (RBF) for Modern Energy Cooking Solutions: An Effective Driver for Innovation and Scale?', https://www.mdpi.com/1996-1073/14/15/4559

MAKING CARBON FINANCE WORK FOR CLEAN COOKING

Carbon finance has been an important driver of clean cooking in recent years and is seen by many stakeholders as the most promising route for scaling up investment. Carbon finance is essentially a results-based financing mechanism, financed through the global market in carbon credits. Payment is linked to verified emission reductions, achieved by replacing inefficient cooking devices with clean ones. Clean cooking is an attractive investment for carbon financiers, given its ability to combine emissions reductions with other benefits such as improvements in health and gender equality. Clean cooking companies can use carbon finance to lower their prices and scale up their businesses. It also facilitates their access to commercial finance.

While the potential is large, there are issues that need to be resolved to unlock carbon finance at the scale needed. One challenge is reaching international agreement on a common methodology for calculating and verifying the value of credits. This is made challenging by the wide range of possible clean cooking solutions, each with different emissions characteristics. Investors are cautious, given that some previously negotiated carbon offsets proved to be overestimated.[123]

The Clean Cooking and Climate Consortium (4C) is a partnership formed to address this challenge. It is leading a sector-wide effort to develop a new methodology for crediting emission reductions from cookstove projects. In July 2024, 4C released the draft of a new methodology for crediting emission reductions from cooking projects under the name "Comprehensive Lowered Emission Assessment and Reporting (CLEAR) Methodology for Cooking Energy Transitions." It is open for public comments.[124] It is the first methodology to be applicable to all cooking transition scenarios, including metered and non-metered fuels. 4C intends this new methodology to become the standard for cookstove projects under the Paris Agreement (Articles 6.2 and 6.4) and the voluntary carbon market. It is accompanied by efforts to build trust in clean cooking credits such as through the development of a code of conduct among project developers to ensure that clean cooking credits are high quality.

A second challenge is finding cost-effective means of verifying emission reductions. The verification requirement is pushing companies to adapt their business models, take on new costs such as sensors for measuring use and emissions and additional staffing to ensure accurate recording and verification of customers. While there is value to the companies in these investments, they may not be sustainable without continuing carbon finance. Companies therefore face difficult choices as to whether to assume long-term access to carbon finance or to develop strategies for transitioning out of business models driven by the demands of carbon finance.

[123] The Economist (Dec 2023) Can the carbon-offset market be saved?, https://www.economist.com/finance-and-economics/2023/12/20/can-the-carbon-offset-market-be-saved

[124] Clean Cooking Alliance, CCA-led 4C Releases Draft Comprehensive Clean Cooking Carbon Methodology, published July 1, 2024, https://cleancooking.org/news/cca-led-4c-releases-draft-comprehensive-clean-cooking-carbon-methodology

5 GOALS FOR THE FUTURE

The OPEC Fund has been investing in clean cooking projects since the early 2000s. Over the years, the OPEC Fund has built substantial knowledge and experience in promoting innovative cooking solutions. This expertise has not only shaped its approach to financing and implementing clean cooking initiatives but also positioned the OPEC Fund as a key player in advancing climate and development goals.

The OPEC Fund's commitment to clean cooking is a critical component of its broader strategy to drive climate action, promote sustainable development and support human capital growth across its partner countries. As the OPEC Fund aligns its investments with its Climate Action Plan and the strategic priorities outlined in the Strategic Framework 2030, the approach to clean cooking is designed to deliver impactful and scalable solutions that address pressing global challenges.

ALIGNMENT WITH OPEC FUND'S STRATEGIC FOCUS AREAS

The transition to clean cooking is deeply intertwined with the commitment to achieving the Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy), SDG 3 (Good Health and Well-being), and SDG 13 (Climate Action). By focusing on clean cooking the OPEC Fund is addressing the nexus of health, energy and climate, contributing to the reduction of carbon emissions, the mitigation of health risks associated with household air pollution and the enhancement of energy access for marginalized communities.

Driving Climate Action: Clean cooking initiatives are pivotal for the OPEC Fund's climate strategy. The institution aims to increase its climate finance to at least 25 percent by 2025 and 40 percent of all new financing. Clean cooking solutions are integral to reducing GHG emissions and achieving the climate resilience goals.

Building Infrastructure: Infrastructure development is a cornerstone of the clean cooking strategy. The OPEC Fund will focus on supporting the expansion of energy infrastructure such as LPG distribution networks, electrification projects and biofuel supply chains. These investments are essential for making clean cooking accessible and affordable, particularly in rural and underserved areas. By integrating clean cooking into broader energy infrastructure projects the OPEC Fund will ensure that these solutions contribute to long-term energy security and sustainability.

Enhancing Institutional Capacity: The success of clean cooking initiatives depends on the strength of institutional frameworks in partner countries. The OPEC Fund will work closely with governments to develop and implement national clean cooking strategies, providing technical assistance and capacity-building support. Efforts will focus on empowering local institutions to lead their clean cooking transitions, ensuring that these initiatives are aligned with national development priorities and sustainable over the long term.

Promoting Private Sector & Trade: The OPEC Fund recognizes that achieving universal access to clean cooking requires significant private sector involvement. It is committed to fostering a conducive environment for private investments by leveraging public-private partnerships (PPPs) and providing targeted financial support to scalable business models. The approach will emphasize market-based solutions that are sustainable and adaptable to local contexts, driving innovation and expanding access to clean cooking technologies.

Human Capital Development: Clean cooking has far-reaching implications for human capital, particularly in terms of health and gender equality. By reducing household air pollution, clean cooking can significantly lower the incidence of respiratory diseases, improving overall public health. Additionally, by alleviating the time pressure on women and girls caused by many hours spent collecting fuel, this time could otherwise be spent participating in education and economic activities. The OPEC Fund's investments in clean cooking will prioritize solutions that deliver these socio-economic benefits, contributing to the broader goal of human capital development.

Bolstering Food Security: Clean cooking is also integral to bolstering food security, especially in rural communities where traditional cooking methods are closely linked to food production and preservation practices. By promoting efficient and clean cooking methods the OPEC Fund aims to reduce food spoilage, enhance nutritional outcomes and support sustainable agricultural practices. This aligns with the broader objectives of promoting food security and sustainable development across partner countries.

In the coming years, the OPEC Fund will focus on several forward-looking strategies to maximize the impact of its clean cooking investments:

- **Scaling Up Innovations:** Embracing new technologies and business models to accelerate the deployment of clean cooking solutions. The OPEC Fund will prioritize innovative approaches that offer scalable and adaptable solutions to diverse national contexts.

- **Expanding Regional Partnerships:** Strengthening collaborations with regional and international stakeholders to foster knowledge exchange and leverage additional resources. By reinforcing strategic alliances, the OPEC Fund aims to enhance the effectiveness and reach of its clean cooking initiatives.

- **Leveraging Digital Tools:** Incorporating digital technologies for monitoring, evaluation and scaling clean cooking solutions. Data-driven insights will help refine strategies and improve the efficiency and impact of investments.

- **Capacity Building and Knowledge Sharing:** The OPEC Fund will invest in capacity building and knowledge sharing to enhance the capabilities of partner countries and stakeholders. By facilitating the exchange of best practices and lessons learned, the OPEC Fund aims to strengthen the implementation and impact of clean cooking projects. It will actively aim to identify and share knowledge of successful initiatives between its partner and member countries.

Households that are able to afford LPG, e-cooking and biogas solutions, respectively:

70% 56% 92%

GUIDING PRINCIPLES AND FUTURE DIRECTIONS

The OPEC Fund's approach to clean cooking is anchored in several guiding principles, which will continue to drive future efforts:

1. Country Ownership: Empowering partner countries to lead their clean cooking initiatives is fundamental. This principle is consistent with the OPEC Fund's mission as a South-South MDB, emphasizing locally-driven strategies within integrated energy access plans. The OPEC Fund will support countries in developing and executing their clean cooking strategies, ensuring they are tailored to local needs and conditions.

2. Integration with Broader Objectives: Clean cooking initiatives will remain closely integrated with the OPEC Fund's broader objectives of poverty reduction and climate action. By addressing clean cooking as part of a holistic approach to energy access and development, the OPEC Fund will reinforce the interconnectedness of energy, health and economic growth.

3. Fuel and Technology Neutrality: Maintaining a flexible approach to fuels and technologies is essential. The OPEC Fund continues to support a variety of clean cooking solutions from LPG and biogas to electric cooking technologies, ensuring that each solution is suited to the specific needs and context of partner countries. This approach will enable the deployment of the most appropriate and effective solutions for different environments.

4. Inclusive Development: The OPEC Fund prioritizes inclusive development by addressing the needs of marginalized and underserved communities. Special attention will be given to ensuring that clean cooking solutions are accessible to women, low-income households and rural populations.

5. Sustainable Financing Models: Developing and supporting innovative financing mechanisms will be crucial for scaling clean cooking solutions. The OPEC Fund continues to explore new avenues for financing, including blended finance, results-based finance and public-private partnerships to attract and mobilize additional resources for clean cooking initiatives.

BOX 15: **NIGERIA'S INTEGRATED ENERGY PLANNING TOOL**

In 2019, Nigeria's Rural Electrification Agency developed a geospatial model to determine the least-cost solution to achieving 100 percent electrification by 2030. The Nigeria Integrated Energy Planning Tool is an online, interactive data visualization platform to advance energy access in the country. In collaboration with SEforALL the agency updated the analysis with recent data sets in 2022 and expanded analysis to incorporate clean cooking, developing an online, interactive data visualisation platform that is accessible to any interested party. The tool draws together a range of data and analysis, including:

- Settlements with limited access to clean cooking,
- Household cooking energy consumption, and the
- Affordability of each cooking technology.

A combination of filters can be applied by users to help determine geographic demand for clean cooking technologies. For example, analysis of affordability includes the total cost of ownership over 20 years at household level and potential expenditure on clean cooking for each consumer class. It found that 70 percent, 56 percent and 92 percent of households are able to afford LPG, e-cooking and biogas solutions, respectively. Additional filters can be applied to determine the likelihood of adoption (e.g. female education level, access to sufficient agricultural residue from farming activities for biogas).

PARTNERSHIPS ARE KEY

Effective partnerships are central to the OPEC Fund's approach to clean cooking. The OPEC Fund works with other development partners and financial institutions to draw on their knowledge and capabilities.

Acting as a collaboration hub, the OPEC Fund leverages the strengths of its partners and its unique position as a South-South-focused institution. This approach is exemplified by its close work across all operations with peer MDBs and other prominent development agencies, including fellow members of the Arab Coordination Group (ACG).

The OPEC Fund Climate Finance and Energy Innovation Hub (see Box 16) is one example of a partnership launched to leverage financial and technical knowhow in support of access to clean energy, including modern cooking.

The OPEC Fund uses a range of financing instruments to support the scaling up of clean cooking. It offers grants to support partner countries with research and analysis, the development of integrated energy access plans and the adoption of supporting policies and regulations. It offers a combination of grant and debt finance to help clean cooking enterprises develop their supply chains. It can also deploy instruments such as results-based finance, blended finance, repayable grants (zero-interest loans) and first-loss credit guarantees to unlock access to carbon finance and private investment.

CLOSE COLLABORATION WITH PARTNER COUNTRIES

In line with its principle to develop projects that reflect the characteristics of each partner country, the OPEC Fund works closely with governments to support country-led projects that maximize development impact.

The OPEC Fund is currently working with the government of **Madagascar** and UNIDO on an integrated approach to clean cooking. Madagascar is one of the most important frontier markets for clean cooking. It is home to 5 percent of the world's biodiversity with an extraordinary array of plants and animals that are unique to the island.[125] This rich biodiversity is at critical risk from deforestation, and one of the key drivers of deforestation is the charcoal industry that supplies traditional cookstoves. Furthermore, the southern part of the island is currently experiencing what many interested parties are calling the world's first climate change-induced famine.[126] Currently, just 1.6 percent of the population has access to modern cooking fuels,[127] and household air pollution accounts for around 17,000 deaths annually. Clean cooking is a

BOX 16: THE CLIMATE FINANCE AND ENERGY INNOVATION HUB

The Climate Finance and Energy Innovation Hub is a partnership launched in June 2022 by the OPEC Fund for International Development, the United Nations Capital Development Fund (UNCDF) and SEforALL to accelerate access to clean and affordable energy in development countries. The International Renewable Energy Agency (IRENA) and the Arab Bank for Economic Development in Africa (BADEA) have joined as partners. The hub is a policy and finance global platform with a focus on using innovative finance solutions to mobilize additional capital into sustainable energy investments. It also helps to promote innovative business models and to foster new financing partnerships and blended financing mechanisms. With ongoing projects in DR Congo, Madagascar, Tanzania, Malawi and Rwanda, the hub is helping countries to advance clean cooking within their integrated energy plans.

[125] World Resources Institute, Madagascar, http://www.thaglerfoundation.org/madagascar.html

[126] United Nations, "Madagascar: Severe drought could spur world's first climate change famine", UN News, October 2021, https://news.un.org/en/story/2021/10/1103712

[127] World Bank, Access to clean fuels and technologies for cooking (percent of population) – Madagascar https://data.worldbank.org/indicator/eg.cft.accs.zs/?locations=MG

key frontier for reducing emissions and protecting Madagascar's extraordinary natural heritage.

Working with UNIDO as the technical specialist agency, the OPEC Fund has to date (November 2024) provided US$1.5 million in grants to Madagascar for studies and pilot projects to help identify the most promising clean cooking technologies and business models. The grants have prepared the way for finalizing the design of a US$35 million investment (the loan agreement was signed in September 2024) that is aimed at supporting clean cooking through a number of interlocking components:

• **Finance for the rollout of clean cooking technologies,** including LPG, e-cooking (linked to ongoing investments in solar mini-grids) and improved cookstoves. This will involve a combination of financial instruments, including grants, debt and equity, with a focus on helping local clean cooking firms to access carbon finance.

• **Agro-forestry initiatives** to promote ecotourism and sustainable forestry management and livelihoods.

• **Community empowerment initiatives** to help women make productive use of the time saved through the introduction of clean cooking and to promote alternative livelihoods for those involved in charcoal production. This may involve a combination of training and capacity building with microfinance solutions.

• **Building partnerships** across a range of national stakeholders in government, civil society and at community level to raise awareness of the advantages of clean cooking and building coalitions in support of the transition.

The OPEC Fund has also recently approved a grant as part of a financing package to accelerate access to clean cooking in **Somalia** and provided technical assistance to establish a Climate Finance and Energy Innovation Hub in **Sierra Leone**. With the hub the OPEC Fund will support the operationalization of Sierra Leone's Energy Transition Plan and National Clean Cooking Strategy and support pipeline development and resource mobilization for clean cooking projects, while ensuring coordination among key domestic and international stakeholders.

Furthermore, the OPEC Fund is also in conversation with the governments of **Kenya**, **Tanzania**, **Uganda**, **Zambia**, **Mozambique** and **Rwanda** and others about similar programs and aims to work with more partner countries over the coming years.

OPEC Fund clean cooking loan
to Madagascar:

US$ 35 MILLION

In alignment with the SDGs, particularly SDG 7, the OPEC Fund is committed to supporting the global target of achieving universal access to clean cooking by 2030. Recognizing that access to clean cooking is essential for improving public health, reducing environmental degradation and addressing climate change, the OPEC Fund is focused on driving scalable and impactful solutions. Central to its strategy is the commitment to work closely with all partner countries, ensuring that our efforts are tailored to the specific needs and contexts of each nation. By prioritizing innovative technologies, fostering strong partnerships and mobilizing sustainable financing, the OPEC Fund aims to accelerate the transition to clean cooking in collaboration with governments, development partners and the private sector. Through these concerted efforts the OPEC Fund is dedicated to ensuring that every household, particularly in underserved regions, has access to affordable, reliable and modern cooking solutions by 2030, thereby contributing to a healthier and more sustainable future for all.

People who use clean primary cooking methods in Uganda:

1%

BOX 17: **A NATIONAL INTEGRATED CLEAN COOKING STRATEGY FOR UGANDA**

Recent analysis suggests that 94 percent of households in Uganda depend primarily on biomass for cooking, with only 1 percent using a clean primary cooking method. Uganda's Ministry of Energy and Mineral Development and Ministry of Water and Environment are working with research partners to develop a National Integrated Clean Cooking Strategy. Uganda's third National Development Plan (2020/21 – 2024/25) defines the national clean cooking objectives as:

1) increase the share of clean energy used for cooking from 15 percent to 50 percent;

2) reduce the share of biomass for cooking from 88 percent to 50 percent; and

3) increase LPG from 1 percent to 8 percent of energy use (all by 2025).

The next step is to synthesise and consolidate existing policies (Uganda already has separate programs on biogas, LPG, e-cooking and ethanol) and work with stakeholders to co-develop a National Clean Cooking Roadmap. A monitoring system will be put in place to track progress towards the strategy targets.

6 LESSONS LEARNED AND CONCLUSION

Clean cooking is an increasing priority in the international development arena and a key frontier in tackling global climate challenges. There is extensive evidence on the importance of clean cooking for health, the environment, gender equality and poverty reduction. New technologies and business models are emerging rapidly and there is growing interest from a diverse range of financiers. Yet there are also many practical challenges that need to be tackled before investment in clean cooking can reach the scale required to accelerate progress towards universal access.

This survey of clean cooking has highlighted a number of key lessons for the OPEC Fund and its partner countries:

• **The transition to clean cooking** is complex, without simple or one-size-fits-all solutions. Each country will need to plan its own clean cooking transition, deploying a range of fuels and technologies.

• **Governments need to be in the driver's seat,** developing national clean cooking strategies that are tailored to each unique context and which clearly signal national priorities to stakeholders. These strategies should be supported by policies, regulations and standards that encourage innovation and investment.

• **Private sector firms** will lead on the development of new cooking technologies and business models. Careful market research is needed to understand the needs and preferences of different market segments.

• **Affordability remains a key constraint** on universal access. National strategies may need to involve elements of public subsidies, but these should be carefully targeted and temporary. Firms also have a key role to play in developing business models that are suited to low-income settings. Models such as pay-as-you-go can help reduce upfront costs and mirror household expenditure patterns on traditional fuels.

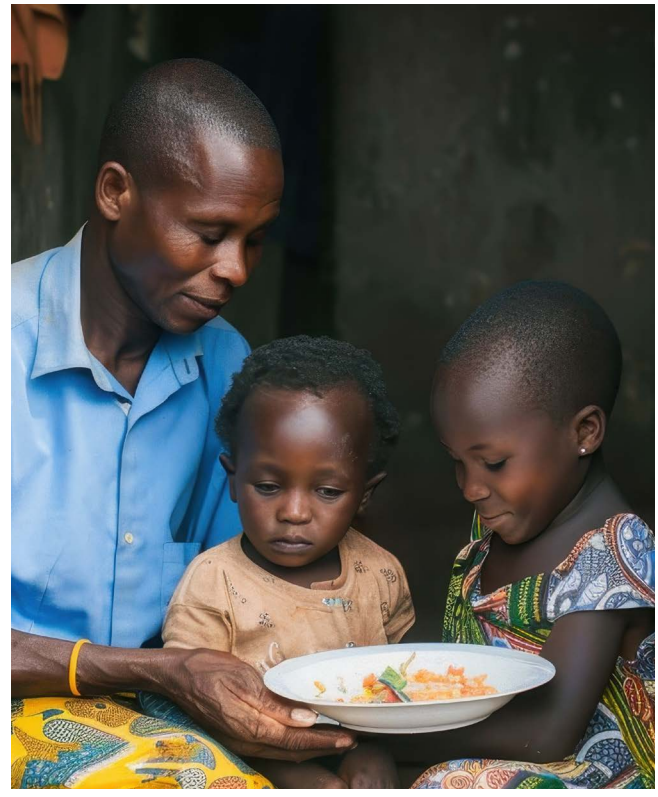
• **However, affordability is only one part of the challenge.** Socio-cultural factors, including gender norms and household perceptions about affordability also play an important role and need to be carefully considered. Maintenance and repair are also factors affecting long-term adoption by consumers.

• **For investors,** there is a growing range of innovative options for financing clean cooking. Results-based financing options, including those funded through carbon credits, are a promising route for unlocking new sources of investment, but need careful project design in each national context.

• **For development partners** such as the OPEC Fund retaining an element of grant finance is important to help capacitate governments to lead the clean cooking transition and to support research and innovation.

• **Multi-stakeholder partnerships** such as the OPEC Fund Climate Finance and Energy Innovation Hub have a pivotal role in bringing together expertise on different aspects of the clean cooking challenges with sources of innovative finance in support of national efforts.

For its part the OPEC Fund views clean cooking as a key priority and an area of increased focus in order to support the development aspirations of its partner countries. The OPEC Fund is committed to working with a growing number of partner countries to support their national strategies in order to help make clean cooking a reality. The institution will deploy the knowledge and experience it has gained to date, as reflected in this report, and the know-how from its ongoing clean cooking operations to help its partner countries seize new opportunities emerging in this dynamic field.



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