



REPORT

UNLOCKING CLEAN COOKING PATHWAYS

A Practitioner's Keys to Progress

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Preface

Provision of clean cooking for all is recognized as a critical cross-sectoral development issue. The potential societal benefits are enormous, particularly for public health, women's productivity and empowerment, and the environment. Along with electrification, clean cooking is an essential component to achieving Sustainable Development Goal (SDG) Target 7.1—ensuring universal access to affordable, reliable, and modern energy services. However, the stark reality is that progress on clean cooking access has been stymied by past perceptions of the sector as orphaned, invisible, and expensive. As of 2020, 2.4 billion people were still living in cooking poverty, compared to 733 million without access to electricity. Increasingly, policy makers recognize the urgent need to integrate clean cooking into the energy planning process and development policies. Tackling the issue will require high-level political commitment; large-scale public investment to crowd in private investment; and knowledge and innovation to lower the costs of interventions.

Recent developments have opened a window of opportunity for driving scale. Clean cooking is being elevated to a higher priority on the policy agenda; better definitions and in-depth data and research tools are making it possible to understand households' cooking energy needs and sector dynamics; and technological advances, aided by new payment and financing approaches, are putting modern-energy cooking solutions within reach of many more low-income households. At the same time, impact-driven forms of finance are gaining ground as a way to pay for the expected public-goods benefits from clean cooking interventions. The World Bank's Clean Cooking Fund—the largest dedicated fund for galvanizing political commitment, scaling up public and private investment, and catalyzing innovation—is using innovative Results-Based Financing (RBF) designs and applications to promote long-term market development and advance access for all.

Lessons and success stories from the World Bank's recent operational experience in the sector show how making access to clean cooking a political priority, using people-centered approaches, can drive large development impacts for society. To unlock a country's clean cooking pathways, stakeholders must carefully consider its overall enabling environment, including its institutional capacity to implement transformative solutions. In countries with a high access deficit, addressing the cooking poverty issue will initially require modernizing the biomass fuel sector and promoting integrated, cost-effective approaches. The Clean Cooking Fund's first IDA co-financed project in Rwanda offers a promising example of how a pro-poor approach can be used to fill the affordability gap and incentivize local stove design and technology innovation.

How does one make the case for clean cooking in countries with a high access deficit? What are the guiding principles for developing a clean cooking strategy? What building blocks are necessary to promote market development for long-term sustainability? This report attempts to answer these and other key questions. We hope it provides practitioners—from project task teams, development partners, and policy makers to implementing agency staff, including champions in government—a useful resource for moving the needle forward on clean cooking access for all.

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Acknowledgments

This report aims to equip task teams, development partners, policy makers, implementing agency staff, and practitioners more generally with the knowledge and tools required to drive country progress on clean cooking adoption, drawing mainly on the experience and lessons learned from the World Bank's operational projects in the sector.

The report was prepared by a team of the World Bank's Energy Sector Management Assistance Program (ESMAP) led by Yabei Zhang (Senior Energy Specialist) and comprised Norma Adams, Crispin Pemberton-Pigott, Alisha Pinto, Jingyi Wu, Douglas Barnes, Voravate Tig Tuntivate, and Laurent Durix. The team appreciates the overall guidance provided by Demetrios Papathanasiou (Global Director for Energy and Extractives Global Practice) and Gabriela Elizondo Azuela (ESMAP Practice Manager) and the constructive feedback from peer reviewers Dana Rysankova (Lead Energy Specialist), Patrick Thaddayos Balla (Senior Energy Specialist), and Tanuja Bhattacharjee (Energy Specialist). Editing by Norma Adams, cover design and typesetting by Duina Reyes, and communications support led by Lucie Cecile Blyth are gratefully acknowledged.

Acronyms and Abbreviations

CCF	Clean Cooking Fund
CCPT	Clean Cooking Planning Tool
CDD	community-driven development
Ci-Dev	Carbon Initiative for Development
CSI	Clean Stove Initiative
ECCH	Efficient, Clean Cooking and Heating (program)
EPC	electric pressure cooker
HAP	household air pollution
HELE	high-efficiency, low-emissions (stove technologies)
ICS	improved cookstoves
KPT	Kitchen Performance Test
LMIC	low- and middle-income countries
LPG	liquefied petroleum gas
MECS	Modern Energy Cooking Services
MFI	microfinance institution
MTF	Multi-Tier Framework
MV&E	monitoring, verification, and evaluation
NDC	Nationally Determined Contribution
PAYGo	pay-as-you-go
PM	particulate matter
RBF	Results-Based Financing
RISE	Regulatory Indicators for Sustainable Energy
SDG	Sustainable Development Goal
SEforALL	Sustainable Energy for All
SHS	solar home system
VPT	Voluntary Performance Target
WBT	Water Boiling Test
WTP	willingness to pay

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Key Findings

Uplifting the world’s poor from cooking poverty is an urgent development issue with huge potential benefits for public health, advancement of gender equality, and the global climate. Today, some 2.4 billion people—about one-third of the global population—are living in cooking poverty, meaning they rely on polluting, traditional fuels and technologies to cook their meals. Without accelerated action, 2.1 billion people will remain in cooking poverty in 2030. The cost to human health, women’s productivity, and the environment is staggering, conservatively estimated at US\$2.4 trillion per year. Furthermore, some 4 billion people are yet to reach cooking decency, meaning they lack access to Modern Energy Cooking Services—that is, cooking solutions that are clean, efficient, convenient, safe, reliable, and affordable.

Progress on improving access to clean cooking has been stymied because the sector has been perceived as

- **Orphaned.** Access to clean cooking cuts across multiple sectors—from health, gender, social protection, and environment/climate to finance, rural and urban development, and private-sector development. Even so, it is not prioritized by any for large-scale public investment.
- **Invisible.** Women and young children, particularly those from poor households, are the most affected groups, but have the least voice and means of making change. Intra-household decision-making norms or affordability constraints often prevent families from prioritizing the adoption of clean cooking solutions.
- **Expensive.** End-user households that can freely collect fuelwood, particularly those in rural areas, do not prioritize the public-goods benefits of clean cooking in their decision-making. Also, the contextual nature of clean cooking solutions makes it difficult to scale up solutions that are affordable. The sector’s lack of profitability, in turn, makes it less attractive to private investors.

Since access to clean cooking is critical to achieving Sustainable Development Goal 7 (SDG 7), it must be integrated into the energy planning process and development policies. The energy sector is expected to lead in providing solutions and coordinate with relevant sectors, leveraging their networks and expertise. This requires a strong institutional champion that can coordinate with other relevant sectors. High-level political commitment is needed to spotlight the importance and urgency of accelerating access to clean cooking. Raising the sector’s visibility requires strategy, targets, budget, and a monitoring and evaluation mechanism. Public investment that takes global public goods into account is essential for crowding in private investment, while knowledge and innovation are key to bringing down the costs of interventions.

Increasingly, policy makers and practitioners recognize that scaling up access requires a paradigm shift, supported by large-scale public- and private-sector investments. It means opening to the many performance-based solutions available and taking advantage of rapidly developing technologies. More effective operational strategies call for prioritizing clean cooking in the policy agenda; using a multi-tiered classification of cooking service levels; and taking a whole-system, contextualized approach to interventions rather than the piecemeal approaches of the past. They emphasize the need to utilize innovative business and financing models; identify and support the development of transformative technical solutions; apply new methods to measure the social benefits of interventions; and build partnerships for cross-sector collaboration, knowledge exchange, and co-financing.

Lessons synthesized from the World Bank’s sector experience suggest the need for mutually reinforcing principles to guide the development of successful operational strategies. The adverse impacts resulting from not having access to clean cooking solutions are mainly experienced by the world’s poor and other vulnerable populations, particularly women and girls, who usually bear major responsibility for household cooking. This means that interventions must ensure inclusiveness by addressing the needs and aspirations of the end users themselves. Developing national strategies and roadmaps ensures the full and formal integration of clean cooking into national policies and sector planning. With sufficient public and private investments, results-oriented implementation can create the enabling environment for catalyzing innovations that deliver affordable solutions at scale to spur sustainable market development.

The extent to which a country has put these principles into practice helps determine how one shapes an intervention to overcome barriers to developing sustainable markets. The key operations models of successful interventions include technical assistance, business incubation, credit support instruments for clean cooking suppliers and consumers, and community-driven development (CDD) approaches that promote better technological solutions through demand aggregation for product choice and awareness raising. Based on its operational experience in some 13 countries, the World Bank’s Energy Sector Management Assistance Program (ESMAP) has identified Results-Based Financing (RBF) as an effective instrument for unifying and aligning these operations models toward performance-based targets and results.

Regardless of the operations models adopted, clean cooking projects must have certain building blocks in place to ensure product access and uptake. Interventions that aim to promote market development for long-term sustainability require six building blocks: (1) Market Assessment; (2) Design of the Intervention Strategy; (3) Technology Evaluation; (4) Supply Development Support; (5) Market Testing, Evaluation, and Adjustment; and (6) Demand Stimulation. Learning feedback loops among these building blocks ensure customer satisfaction with the new clean cooking solutions. The building blocks can be put in place as part of a project’s identification and preparation phases or integrated into its implementation design.

Scaling up access to clean cooking solutions for all requires systematic approaches to ensure that the long-term impacts of projects are beneficial. ESMAP is playing an increasingly stronger leadership role in mobilizing financing to the clean cooking sector, developing markets for clean stoves and fuels, and convening development partners to work together. The ESMAP-hosted Clean Cooking Fund (CCF), with a US\$500 million target, aims to galvanize political commitment and investment to achieve universal access to clean cooking by 2030. This report aims to equip stakeholders at all levels—task teams, development partners, government officials and implementing agency staff, and practitioners more generally—with critical “keys” for unlocking the clean cooking pathways of access-deficit countries. With our accumulated sector knowledge and experience, evidence, and new tools for better decision making, combined with a higher prioritization of clean cooking on the policy agenda, we are well-equipped to start driving scale to achieve cooking decency for all.

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Executive Summary

Clean Cooking for All: The Current Access Status

The world is far off track to meet the 2030 target of clean cooking for all, a key component of achieving UN Sustainable Development Goal 7 (SDG 7). Today, some 2.4 billion people—about one-third of the global population—are living in cooking poverty, meaning they rely on polluting, traditional fuels and technologies to cook their meals. Without taking accelerated action, one can expect that about 2 billion people will remain in cooking poverty in 2030. The estimated cost of inaction for human health, progress toward gender equality, and the environment is staggering, at US\$2.4 trillion per year. Furthermore, about 4 billion people are yet to reach cooking decency, with access to Modern Energy Cooking Services (MECS)—that is, cooking solutions that are clean, efficient, convenient, safe, reliable, and affordable.

Progress in global access has been uneven, particularly in Sub-Saharan Africa, where the access rate has not kept pace with population growth. As of 2020, 69 percent of the global population had access to clean cooking solutions. Since 2000, the five most populous low- and middle-income countries (Brazil, China, India, Indonesia, and Pakistan) have witnessed substantial progress. Over the past decade, a steady rise in the global access rate (averaging 1 percentage point per year) was driven mainly by increases in Central and South Asia and East and Southeast Asia. Over that period, the access rate in Latin America and the Caribbean remained stable, at about 88 percent. However, in Sub-Saharan Africa, the annual rate of population growth, which averaged 26 million between 2010 and 2019, outpaced access gains of just 8 million per year. By 2020, its access deficit had reached 923 million people, the highest among all world regions.

Breaking the Impasse to Lagging Progress

Past perceptions of the cooking sector as orphaned, invisible, and expensive have stymied progress in improving access. Even though access to clean cooking is increasingly recognized as an important development issue that cuts across multiple sectors—from health, gender, social protection, and environment/climate to finance, rural and urban development, and private-sector development—none prioritize it for large-scale public investment. Women and children, particularly those in poor households, are the most affected groups, yet have the least voice and means of making change. Also, intra-household decision-making norms or affordability constraints often prevent families from prioritizing the adoption of clean cooking solutions. In addition, end-user households located in areas where fuelwood can be freely collected do not prioritize the public-goods benefits of clean cooking. Furthermore, the contextual nature of clean cooking solutions makes it difficult to scale up affordable solutions; this lack of profitability, in turn, makes the sector less attractive to private investors.

Overcoming such perceptions requires transformative solutions—both market-based and investment-driven—that improve the overall cooking ecosystem, with end users' needs and priorities at the center. Breakthroughs are especially needed in three inter-linked areas: (1) political commitment, (2) investment, and (3) knowledge and innovation. The World Bank's Clean Cooking Fund, housed under the Energy Sector Management Assistance Program (ESMAP), is the largest dedicated fund for galvanizing political commitment, scaling up public and private investment, and catalyzing innovation. With a funding target of US\$500 million, the fund's ambition is to catalyze another US\$2 billion in public and private investments to help 200 million people gain access to clean cooking.

Driving Scale: Why Now Is the Time

Prioritizing clean cooking at global and national levels and designing more effective strategies for project interventions are gaining momentum. Clean cooking is being elevated to a higher priority on the policy agenda. Key sector milestones over the past few years include launching of the Health and Energy Platform of Action (2019); endorsement of the G20 Initiative on Clean Cooking and Energy Access (2020); and outlining of a global roadmap by the High-level Dialogue on Energy, which calls for 1 billion more people to have gained access by 2025 and the achievement of universal access by 2030. Through their Energy Compacts, some 70 countries have already included clean cooking-related goals and activities in their Nationally Determined Contributions (NDCs).

The understanding of households' cooking energy needs and sector dynamics is growing thanks to the availability of more comprehensive definitions and in-depth data and research tools. Introduction of the terms *Modern Energy Cooking Services (MECS)* and *Improved Cooking Services*—both of which build on the Multi-Tier Framework (MTF) for cooking and account for the multiplicity of contextual, as well as technical, factors that shape a household's unique cooking context—is an important step in this direction. Using the MTF approach for measuring household access makes it possible to understand households' current energy cooking services and how to design their movement along a continuum of improvement or access tiers.

Technological advances, aided by new payment and financing approaches, are putting MECS within reach of many more low-income households. Promising technologies for overcoming the affordability challenges include pellet-fed gasifier stoves, electric pressure cookers and eCooking, and itemized ethanol. Equally important are the digital pay-as-you-go (PAYGo) business models and bundling of cooking with other modern-energy products and services.

Impact-driven forms of finance are gaining ground as a way to pay for the expected public-goods benefits from clean cooking interventions. The Results-Based Financing (RBF) framework and instruments make it possible for donors to invest in the broader development objectives of interventions (e.g., improved health, better air quality, greater gender equality, and reduced black carbon emissions). Carbon finance has traditionally been an attractive source of financing for clean cooking projects, and, with the recent surge in carbon prices, more carbon finance is finding its way to the clean cooking sector. Building on the carbon market infrastructure, it is possible to monetize the additional verified social impacts of interventions using recently developed methods that quantify and measure the public co-benefits.

Making the Case for Clean Cooking

Supporting a country's clean cooking transition requires stocktaking of its cooking poverty status, commitment to achieving access for all, and steps being taken to tackle the issue. ESMAP's website for tracking SDG 7 provides a downloadable spreadsheet for indicator SDG 7.1.2, including the latest datasets for countries and regions. If clean cooking is not yet on the front burner of a country's energy policy agenda, then practitioners must make the case for it, explaining the adverse development impacts and costs of inaction and the huge societal benefits that clean cooking can deliver. ESMAP's scenario-based Clean Cooking Planning Tool, which integrates a consolidated 71-country database and the Regulatory Indicators for Sustainable Energy (RISE), is designed to help a country's energy planners and decision makers benchmark its sector policy and regulatory framework against those of regional and global peers and visualize potential transition pathways (including fuel-mix options) for achieving universal access to clean cooking by 2030.

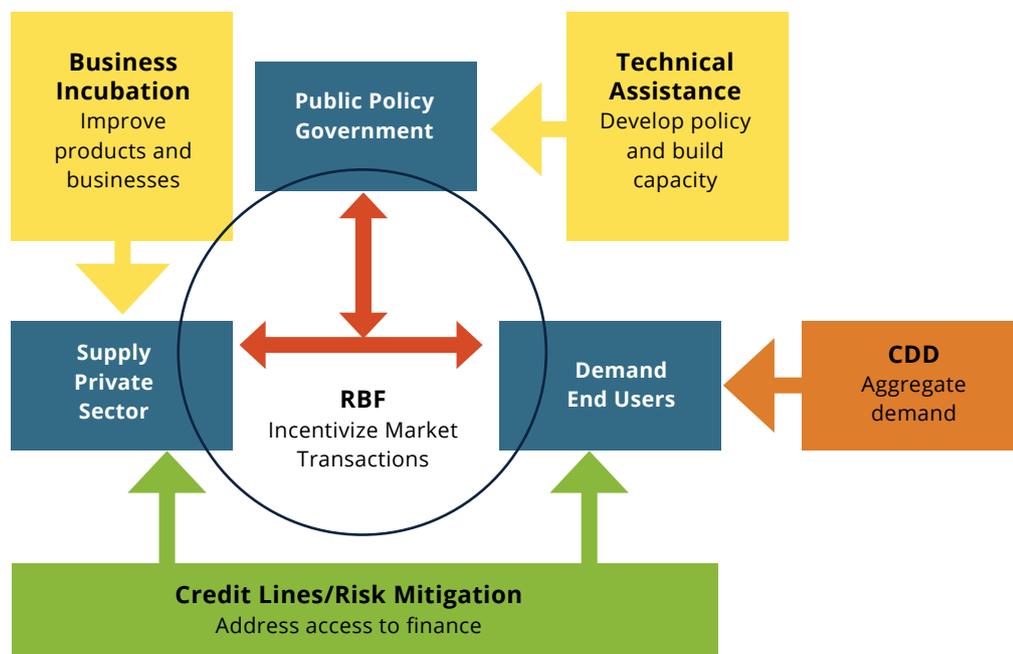
Building on lessons from past sector experience is also critical. The World Bank's recent operational experience shows how making access to clean cooking a political priority, using people-centered approaches, can drive large development impacts for society. Selecting transition pathways depends, in large part, on the country's level of economic development and national-level political, technical, and financial support. In high-deficit countries, large-scale fuel switching is unlikely to occur until rural economies become substantially more developed or ongoing public funding is provided for fuel switching. In countries where biomass use is likely to persist, it is important to modernize the biomass fuel sector and promote integrated, cost-effective approaches. Since cooking is a contextualized system with no one-size-fits-all solution, the long-term sustainability of interventions requires a systems approach that promotes localized solutions and innovation. Scaling up requires high-level national support, including effective subsidy allocation mechanisms to mobilize and sustain private-sector participation and target households with an affordability gap. RBF is as an effective approach for using public resources to incentivize the market and can be designed to fit the country context and market conditions.

The mutually reinforcing principles of impacts, inclusiveness, integration, investments, and innovation can guide the development of successful operational strategies. By adopting these five principles, informed by a heart-head-and-hands approach, all stakeholders can work together to strengthen the ecosystem for developing a clean cooking market. Achieving development impacts requires adopting people-centered approaches aligned with stove users' diverse needs, as well as broader development objectives. These approaches must ensure inclusiveness by addressing the needs of poor, vulnerable, fragile, and displaced populations, as well as engaging the empowering women across the clean-cooking value chains. Developing national strategies and roadmaps requires the full and formal integration of clean cooking into national policies and planning for energy, climate, and COVID-19 recovery. Achieving better on-the-ground results requires sufficient investments; hands-on practices and learning by doing; and ongoing monitoring, evaluation, and adjustment; as well as ongoing innovation for accelerating access.

Key Operations Models

World Bank-supported projects have employed various operations models to tackle the challenges faced by players across the cooking ecosystem. Key among these models are (1) technical assistance to governments to develop policy and build capacity; (2) business incubation to improve stove suppliers' products and businesses; (3) community-driven development to aggregate customer demand; and (4) credit lines, as well as risk mitigation instruments, for stove and fuel suppliers and end-user households to address their need to access finance (figure ES.1).

FIGURE ES.1
Key Operations Models Used to Promote Clean Cooking



Source: World Bank 2022.

Note: Gendered considerations, including proactive actions, should be included in all interventions.

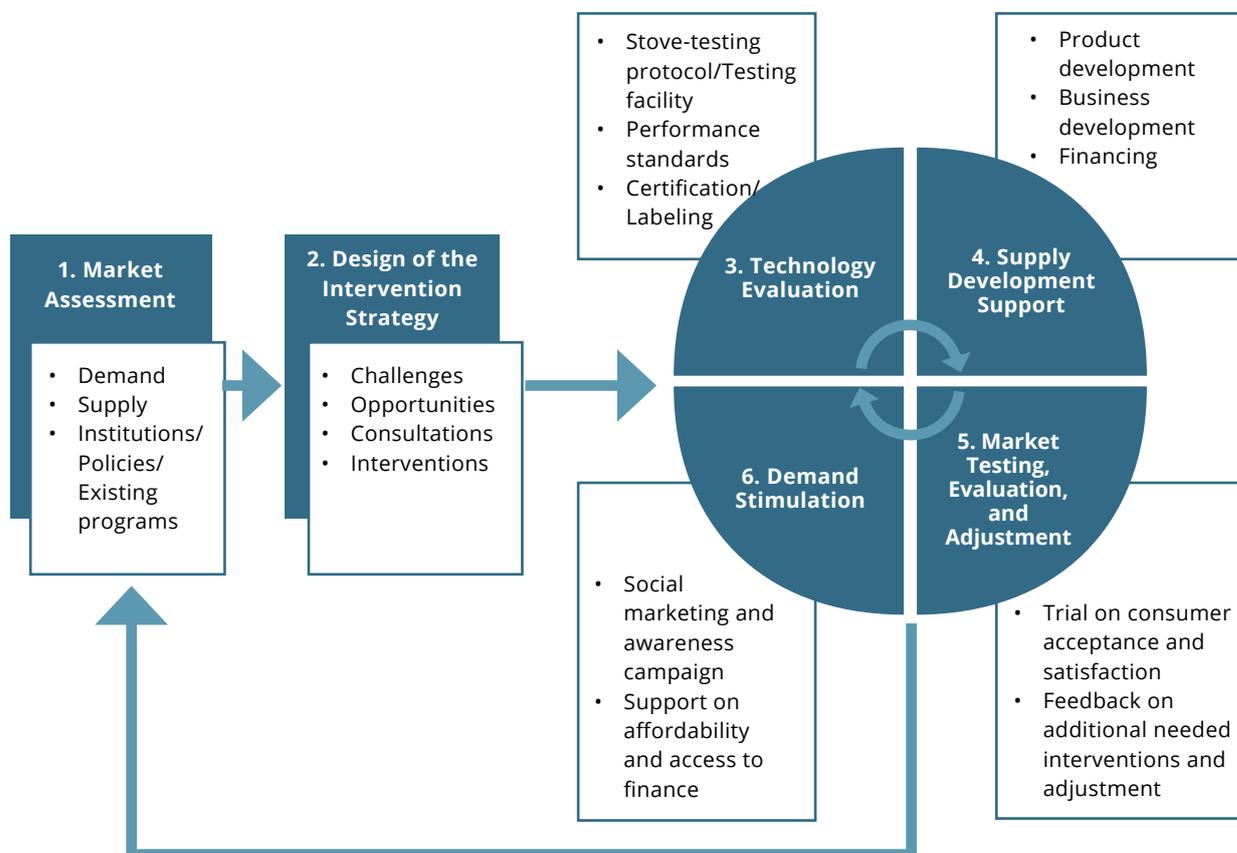
RBF has been demonstrated as an effective instrument for incentivizing market transactions. It avoids the fragmented approaches of past stoves programs by unifying and aligning interventions toward performance-based targets and results that reward market transactions and adoption (figure ES.1). World Bank–supported projects have successfully used such approaches to incentivize the private sector to deliver clean cooking solutions, drive sector development, and invest in broader development objectives. The Clean Cooking Fund currently uses RBF as its main instrument and continues to innovate RBF designs and applications for more targeted incentives to promote sustainable market development and advance access for all. To succeed, interventions that utilize RBF mechanisms require a strong enabling environment, including an institutional champion, technical assistance and capacity building tailored to the needs of enterprises, and effective marketing and awareness-raising campaigns. Without having a favorable regulatory environment in place to support market development, risk-averse private-sector players are unlikely to invest in the clean stoves-and-fuels market.

Building Blocks for Developing Sustainable Markets

All projects promoting the development of clean cooking markets require putting certain building blocks in place to ensure access to the new products and stimulate uptake. Those that promote market development for long-term sustainability require six key building blocks: (1) Market Assessment; (2) Design of the Intervention Strategy; (3) Technology Evaluation; (4) Supply Development Support; (5) Market Testing, Evaluation, and Adjustment; and (6) Demand Stimulation (figure ES.2). These building blocks can be put in place as part of a project’s identification and preparation phases or integrated into its implementation design. Learning feedback loops among Building Blocks 3–6 and between them and Building Block 1 ensure that candidate products meet the established eligibility requirements, meet end-users’ needs, and reach target customers effectively. Across the building blocks, the project team needs to conscientiously assess, design, monitor, and evaluate interventions that help to promote gender equality.

FIGURE ES.2

Key Building Blocks for Clean Cooking Interventions



Source: World Bank 2022.

The first step in planning and implementing a clean cooking project is carrying out a market assessment. Household demand-side surveys are needed to better understand the range of contextual factors that influence the target population’s demand for cooking technologies and fuels. MTF household surveys capture multidimensional data on users’ cooking behavior and practices and may be integrated into existing national household surveys and the methodology for tracking SDG 7.1 indicators. Supply-side surveys are needed to (1) identify the main stove suppliers, (2) better understand suppliers’ potential and constraints, (3) learn how the supply chain works (especially the distribution channel), (4) understand existing business models, and (5) identify key challenges and opportunities to reach project objectives. Market research is also needed to understand consumer behavior, preferences, and willingness to pay for the clean stove technologies and fuels. In addition, institutional mapping of policies, programs, and players is required to learn from past and ongoing program experience, and identify the institution best positioned to take the lead in promoting and implementing clean cooking solutions.

After assessing the market, the next step is to conduct a gap analysis and design the overall intervention strategy, which informs the design of the country investment project. The gap analysis should identify (1) a competent and committed institutional champion to lead project implementation; (2) the project's overall strategy, key interventions, and targets; (3) ways to mobilize and prioritize resources; and (4) mechanisms for collaboration and leveraging of partnerships. The shape of the strategy depends on what building blocks the country's government has already put in place and can be designed to close gaps in existing programs. During this phase, the project team should present the findings from the market assessment and consult with key stakeholders on the proposed strategy and approach to get their feedback and inputs in order to align support for implementation.

Selecting the technical performance criteria is a critical building block in project preparation. Technology evaluation, together with institutionalization of the clean cooking issue and addressing demand- and supply-side barriers, is key to creating the enabling environment. Specifically, the project team must select (1) a validated stove testing method; (2) a test sequence reflecting known behaviors and fuels in the community of interest; (3) the performance targets for metrics based on project, national, or international targets (or some combination thereof); and (4) an acceptable product certification process. Like any other product, a stove must be tested in the context of its conditions and anticipated use. A robust, contextual stove testing protocol is key to ensuring that the results of controlled laboratory testing reflect the variables that depend on the local context. It is also vital to set specific stove performance standards in order to affirm product quality for stove makers, assure consumers they are making a worthwhile investment, and drive industry innovation. Setting up an open, fair, and transparent stove certification system and process for accrediting qualified testing centers to conduct the certification is essential to ensuring stove quality; this is especially important when certification is linked with government incentives.

On the supply side, support is required to develop clean stove products and businesses, as well as financing to create and sustain end-user demand and spur market development. An open-call process is used to identify and select enterprises that can produce a certain quantity of clean stove technologies that meet minimum, project-defined performance standards. Early on, the project team should identify, engage, and provide technical support to promising suppliers to avoid implementation delays. The eligible technologies and suppliers may be (1) imported stoves, with locally produced or imported fuels; (2) local products, which may include imported parts; or (3) internationally designed stoves with local assembly. Support for businesses (e.g., technology training and market development) can build the capacity of key market players, motivate private-sector investment, and promote grassroots innovation in business models. Common forms of financing include access to lines of credit through microfinance and commercial banks, risk mitigation instruments (e.g., guarantee and collateral support), and impact-driven models (e.g., social impact investing, innovation grants, and RBF).

Market testing, evaluation, and adjustment are needed to gain an in-depth understanding of what customers expect and need from the new stove products introduced by the project. Before implementation, the project team should conduct pilot trials to gauge customers' level of acceptance and satisfaction with the new stoves and fine-tune designs based on this feedback. A post-sales market survey should be conducted to determine which design features meet (or do not meet) customers' needs and expectations, their reasons for using (or not using) the clean stoves, frequency of usage, and the effectiveness of the marketing strategy. If the project introduces more than one clean stove model or technology, it is important to discover which one(s) customers consider more acceptable and why. This information is part of the feedback loop to designers for further product development, as well as designing more relevant education and promotion campaigns. For projects that have already identified the types and models of clean stoves they will promote, the main objectives of market testing are to evaluate (1) field performance of the newly designed clean stoves with real household cooks, (2) whether and how users of the new stoves adjust their cooking behavior and habits, and (3) users' acceptance of the new stoves.

Stimulating stove demand requires effective social marketing and awareness-raising campaigns. The project team must carefully consider how to allocate social marketing and promotional resources. If it decides to share this responsibility with the stove manufacturers or distributors, it should closely monitor such activities to assess whether additional community-level support (e.g., cooking demonstrations) may be needed to boost sales. Knowing potential customers' level of awareness is key to developing strategic messages that link the value of clean cooking products to the co-benefits of adoption (e.g., a cleaner and thus healthier cooking environment). In countries where clean-fuel transition programs have already been advanced but stacking persists, messaging around the clean cooking devices that can meet customers' stacking needs (e.g., multiple burners to allow for simultaneous cooking), can keep households that stack on the modern-energy transition pathway.

Accessing finance to meet the affordability challenge is also essential to stimulating demand. Using the MTF affordability criteria as a reference, along with such factors as awareness and availability of cooking options, the project team can collect the household income/expenditure data during the demand assessment, compare the costs of various clean cooking solutions, and assess whether and how much end-user subsidies or other forms of financing are needed to fill the affordability gap. Using household expenditure results from the initial market survey, the project team can assess the target consumers' ability to pay for the stoves and associated fuels, and, in turn, the types of financing to increase accessibility (e.g., through PAYGo, microfinance, or leasing) and affordability (e.g., through end-user subsidies).

Recommendations

Charting a course to meet the aspirations of SDG 7.1 will be challenging, but targeted and concerted actions building on past experience and the leveraging of new opportunities can guide the sector forward. Key recommendations are summarized as follows:

- **Engage sector stakeholders in prioritizing clean cooking.** Since access to clean cooking is critical to achieving SDG 7, it must be integrated into the energy planning process and development policies. The energy sector is expected to lead in providing solutions and coordinate with relevant sectors, leveraging their networks and expertise. This requires a strong institutional champion that can coordinate with other relevant sectors. High-level political commitment is needed to spotlight the importance and urgency of accelerating access to clean cooking. Raising the sector's visibility requires strategy, targets, budget, and a monitoring and evaluation mechanism. Public investment that takes global public goods into account is essential for crowding in private investment, while knowledge and innovation are key to lowering the costs of interventions. If clean cooking is not yet on a country's energy policy agenda, practitioners, including champions in government, must make the case for it. The new measurement and planning tools to visualize transition pathways can reduce the transaction costs of identification and engagement.
- **Take a whole-system approach focused on customer service and user satisfaction.** To succeed, clean cooking interventions must consider the whole system of food preparation (who cooks, what is cooked, how it is cooked, with what fuel at which time, in which vessel, for how long, and how frequently). During the initial market assessment (Building Block 1), task teams can use household surveys and/or MTF surveys and social-science investigation to collect this contextual information, which can be used as a baseline for monitoring and evaluating the project's progress and to inform social marketing strategies (Building Block 6). During the technology evaluation phase (Building Block 3), information on the real context of stove usage is critical to selecting an appropriate test sequence to ensure that the results of controlled laboratory stove testing reflect the variables that depend on the local context (Building Block 3).
- **Develop a strategy that fits the country context.** The whole-system approach must be adapted to the country context since enabling environments can vary widely. Many projects require upstream stakeholder support, including technical assistance and capacity building for stove manufacturers, distributors, and research laboratories. They may need help in setting up a stove testing laboratory, reaching out to a development bank to take the lead in financing, and working with the private sector to promote technical innovation and create an incentive framework for the sale and marketing of clean cooking technologies. While all projects should promote the highest tiers of access or MECS (i.e., cooking decency), the immediate goal for countries with a high access deficit is to eliminate cooking poverty and include transitional solutions (i.e., Improved Cooking Services) as part of their strategy. During the transitional period, a new baseline and building blocks for promoting higher-performance solutions can be put in place.

- **Encourage cross-sector collaboration to maximize benefits.** To accelerate the transition to cooking decency for all, practitioners should look for opportunities to encourage dialogue and build synergies between clean cooking and closely-related sectors and disciplines. To ensure that clean cooking solutions reach the poor and most vulnerable populations, project teams can collaborate with cash transfer and social safety net programs. Clean cooking, public-health, and gender practitioners should seek ways to combine their efforts and resources to raise awareness about the disproportionately adverse impacts of cooking poverty on women and girls and promote clean stove technologies and fuels (e.g., by monitoring and reporting on the positive health impacts women and girls experience after switching to clean cooking solutions). For delivery models, practitioners can look into leveraging the networks and innovative approaches of adjacent sector models serving the same consumer base (e.g., microfinance institutions [MFIs], solar home system [SHS] companies, and other last-mile distributors).
- **Mitigate the downside risks of carbon finance.** With more funding from carbon finance flowing into the sector, governments need to carefully weight its pros and cons for meeting their clean cooking targets, energy access goals, and NDCs. The carbon market's current regulatory ambiguity and higher carbon prices have encouraged some companies to adopt a free-stove distribution business model that relies fully on carbon revenue. However, both economic theory and evidence confirm that free stove distribution distorts the market by removing consumer choice, squeezing out local producers, and limiting product innovation. Governments, certification agencies, development partners, and private companies all have a role to play in mitigating the risks.

Moving forward, governments should (1) set up technical performance standards for clean cooking technologies (with a process for periodic review and updating) and require all projects, including those using carbon finance, to comply; (2) strengthen the country's capacity in designing, authorizing, registering, and coordinating carbon-financed projects; (3) offer a framework to ensure carbon financing is aligned with its policy efforts to develop clean cooking solutions; and (4) develop eligibility guidelines to determine which customer groups receive what levels of discounts. Carbon finance can be channeled to cover those discounts as support for climate benefits (as global public goods). Carbon-credit certification agencies should (1) strengthen transparency and traceability of carbon credits and (2) provide guidance and procedures related to local market impact and long-term sustainability. Development partners should (1) support governments to build capacity in accessing and managing carbon finance and (2) coordinate incentive programs and interactions with carbon finance to level the playing field for all companies. Finally, international carbon-market companies should align interventions and price discounts with government policies and programs, including those supported by development partners.

What's on the Horizon?

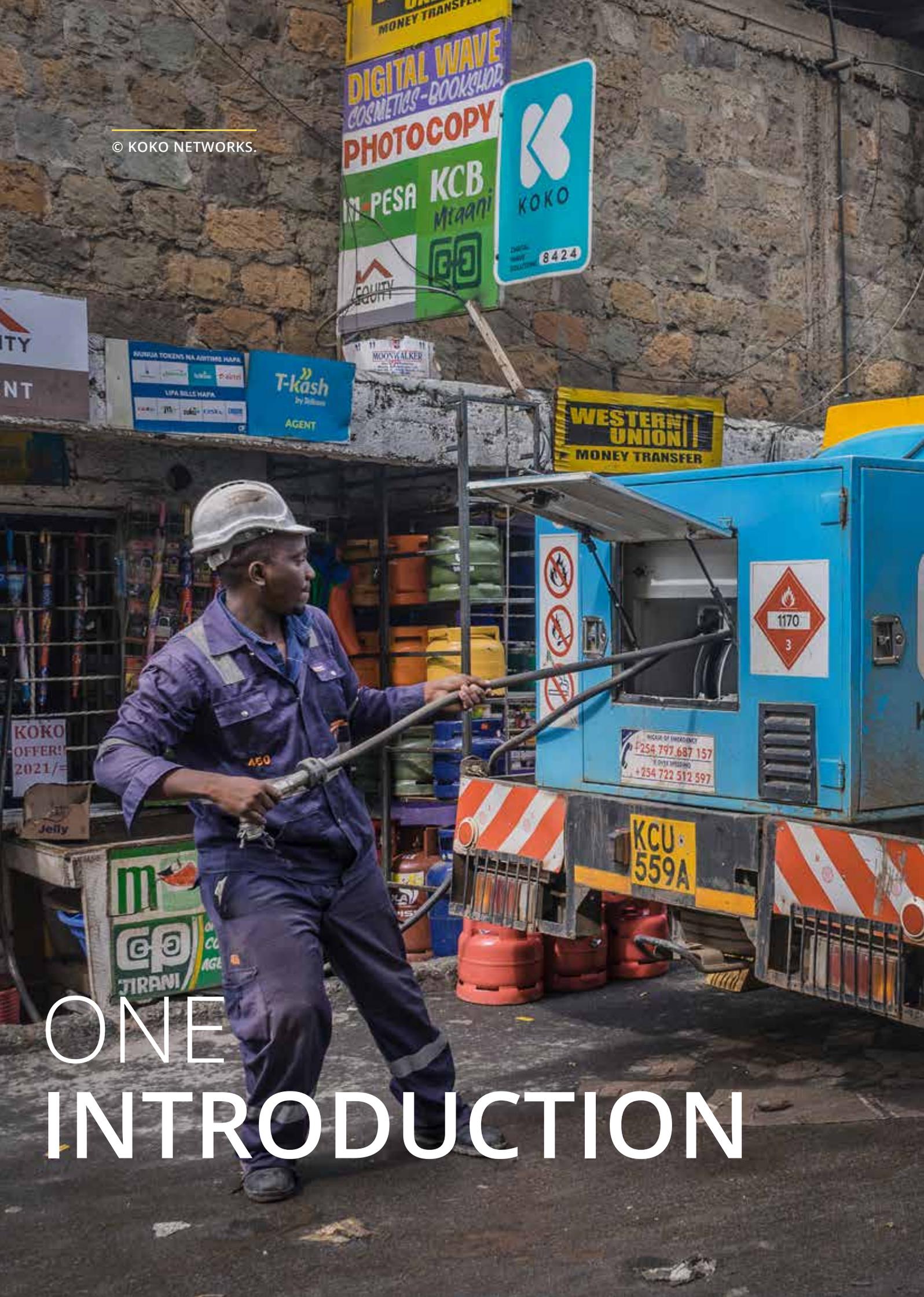
Increasingly, clean cooking programs are taking an integrated approach with institutional champions in place to coordinate development of the necessary building blocks to promote market development for long-term sustainability. For its part, the World Bank is increasing its commitment and efforts to accelerate universal access, particularly through the Clean Cooking Fund. With our accumulated sector knowledge and experience and principles to guide the development of operational strategies; better definitions, measurement and planning tools, and technological innovations; and a growing prioritization of clean cooking on the policy agenda; we are well-equipped to accelerate the transition to universal access. Solving the cooking poverty issue is not only possible; it is imperative, with enormous benefits for public health, women's productivity, and the environment. Clearly, now is the time to drive scale.

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ONE INTRODUCTION





The world is far off track to meet the 2030 target of clean cooking for all, a key component of achieving the UN Sustainable Development Goal 7 (SDG 7). Even though clean cooking is increasingly recognized as an important cross-cutting development issue, about a third of the global population still relies on polluting, traditional stove technologies and fuels for cooking meals. The latest access data shows that, in 2020, some 2.4 billion people were living in cooking poverty (IEA et al. 2022). Moreover, some 4 billion people are yet to reach cooking decency, meaning they lack access to Modern Energy Cooking Services (MECS)—that is, cooking solutions that are clean, efficient, convenient, safe, reliable, and affordable (ESMAP 2020a). Without taking accelerated action, one can expect that about 2 billion people will remain in cooking poverty in 2030 (IEA et al. 2022).

Not progressing beyond the status quo adversely impacts human health, progress toward gender equality, and the environment, at a staggering annual cost of US\$2.4 trillion (ESMAP 2020a).¹ The annual health cost alone, resulting from household air pollution (HAP) linked to cooking with inefficient stove-and-fuel combinations, is estimated at US\$1.4 trillion. Cooking-related HAP is associated with nearly 4 million premature deaths each year, mainly women and young children (ESMAP 2020a).² The gender cost, calculated in terms of women's lost productivity, is US\$0.8 trillion per year. This conservative figure accounts for women's time spent on cooking-fuel collection, a significant contributor to women's time poverty (Barnes, Kumar, and Openshaw 2012; Barnes and Sen 2004; Das et al. 2017); food preparation and cooking; and stove cleaning. The climate impact—greenhouse gas (GHG) emissions from woodfuels collected unsustainably for cooking and the contribution of residential solid fuels to black carbon (BC) emissions—is estimated at US\$0.2 trillion per year.

What Is the Current Access Status?

As of 2020, 69 percent of the world's population had access to clean cooking fuels and technologies. Over the past two decades, substantial progress was made in the five most populous low- and middle-income countries (LMIC)—Brazil, China, India, Indonesia, and Pakistan—while the access rate for all other LMIC rose by 3 percentage points (figure 1.1) (IEA et al. 2022). Between 2010 and 2020, the global access rate rose steadily (an average of 1 percentage point per year); however, progress was uneven, driven mainly by increases in Central and South Asia and East and Southeast Asia. In Latin America and the Caribbean, the access rate remained stable, at about 88 percent. However, in Sub-Saharan Africa, where action is urgently needed, the access rate did not keep pace with population growth.

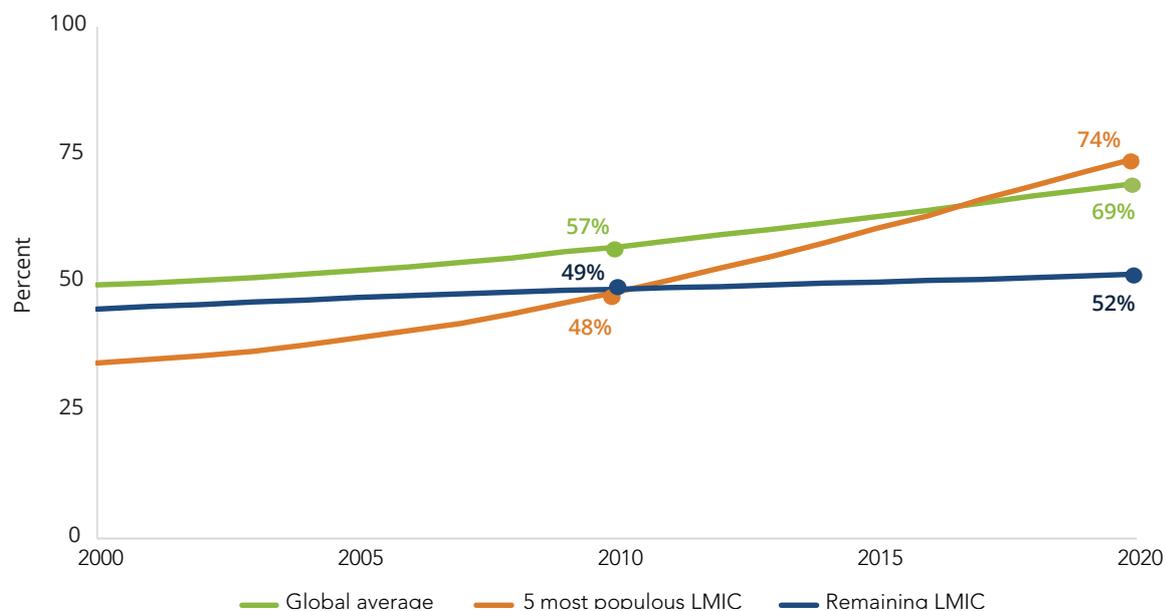
¹ The World Bank's Clean Cooking Fund Planning Tool (CCPT), launched at the Sustainable Energy for All (SEforALL) Forum in Kigali, Rwanda in May 2022, makes country-level data available on the cost of inaction to help energy planners, decision makers, program developers, and researchers visualize potential transition pathways to universal access by 2030.

² New estimates from the World Health Organization estimate this figure at 3.2 million (IEA et al. 2022).

Between 2010 and 2019, that region’s annual rate of population growth averaged 26 million, compared to access gains of just 8 million per year. By 2020, Sub-Saharan Africa’s access deficit had reached 923 million people, the highest among all world regions (IEA et al. 2022) (figure 1.2).

FIGURE 1.1

Population with Access to Clean Cooking Fuels and Technologies, 2000–20

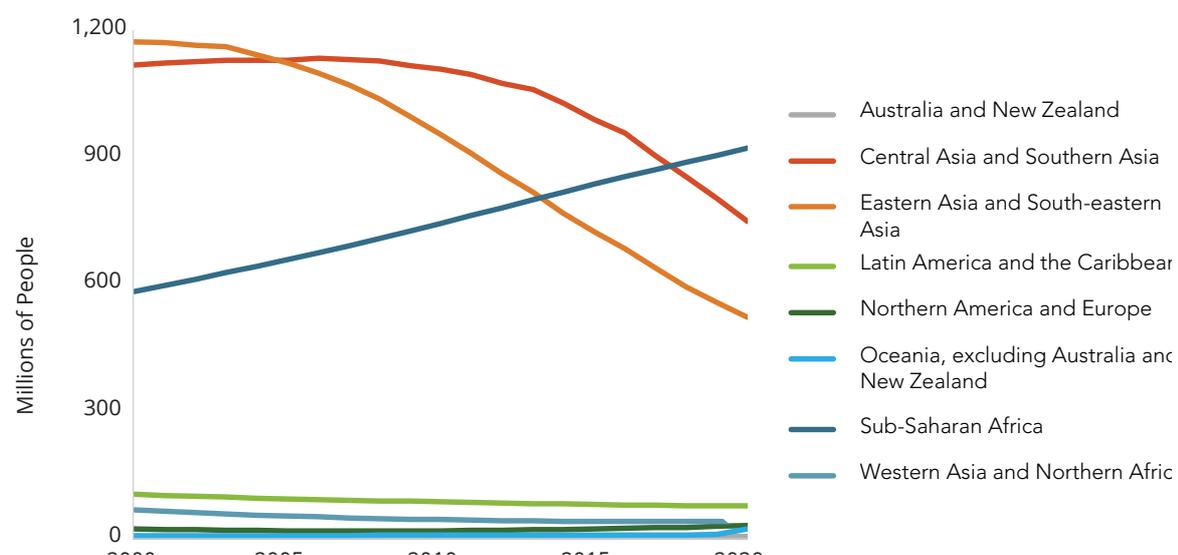


Source: IEA et al. 2022.

Note: LMIC = low- and middle-income countries.

FIGURE 1.2

Population without Access to Clean Cooking Fuels and Technologies by Region, 2000–20



Source: IEA et al. 2022.

Access to electricity and clean cooking solutions are complementary components to achieving the SDG 7.1 target of ensuring universal access to affordable, reliable, and modern energy services; however, progress on the clean cooking front has been especially slow (Bellur, Mathew, and Besnard 2022). As of 2020, the global population without electricity access had declined to 733 million, compared to 2.4 billion people still living without access to clean cooking solutions (IEA et al. 2022). Today, public and private finance for clean cooking remains well below what is needed to achieve the SDG 7.1 target by 2030. Between 2015 and 2019, annual tracked commitments were only about US\$130 million (SEforALL 2021), a mere fraction of the estimated US\$6 billion needed for access to clean cookstoves only (IEA 2021), and less than 0.1 percent of the investment required to achieve the highest tiers of MECS (ESMAP 2020a).

What Is the Response to Lagging Progress?

Progress on improving access to clean cooking has been stymied by a perception of the sector as

- **Orphaned.** Access to clean cooking cuts across multiple sectors—from health, gender, social protection, and environment/climate to finance, rural and urban development, and private-sector development. Even so, it is not prioritized by any for large-scale public investment.
- **Invisible.** Women and young children, particularly those from poor households, are the most affected groups, but have the least voice and means of making change. Intra-household decision-making norms or affordability constraints often prevent families from prioritizing the adoption of clean cooking solutions.
- **Expensive.** In their decision-making, end-user households, particularly those in rural areas where fuelwood can be freely collected (Hosier et al. 2017), do not prioritize the public-goods benefits of clean cooking (e.g., health, gender equality, and climate). Also, the contextual nature of clean cooking solutions makes it difficult to scale up solutions that are affordable. The sector's lack of profitability, in turn, makes it less attractive to private investors.

Since access to clean cooking is critical to achieving SDG 7, it must be integrated into the energy planning process and development policies. The energy sector is expected to lead in providing solutions and coordinate with relevant sectors, leveraging their networks and expertise. This requires a strong institutional champion that can coordinate with other relevant sectors. High-level political commitment is needed to spotlight the importance and urgency of accelerating access to clean cooking. Raising the sector's visibility requires strategy, targets, budget, and a monitoring and evaluation mechanism. Public investment that takes global public goods into account is essential for crowding in private investment, while knowledge and innovation are key to bringing down the costs of interventions.

Breaking the Impasse

Overcoming past perceptions of the sector requires transformative solutions—both market-based and investment-driven—that improve the overall cooking ecosystem with end users’ needs and priorities at the center (Zhang 2022). Breakthroughs are especially needed in three key, interlinked areas: (1) political commitment, (2) investment, and (3) knowledge and innovation. The World Bank’s Clean Cooking Fund (CCF) is the largest dedicated fund for galvanizing political commitment, scaling up public and private investment, and catalyzing innovation (box 1.1).

BOX 1.1

CLEAN COOKING FUND: SPURRING CLEAN COOKING DELIVERY AND MARKET DEVELOPMENT

The World Bank’s Clean Cooking Fund (CCF), housed under the Energy Sector Management Assistance Program (ESMAP), was launched at the 2019 UN Climate Summit to galvanize political commitment and investment to achieve universal access to Modern Energy Cooking Services (MECS) by 2030. With a funding target of US\$500 million, the fund’s ambition is to catalyze another US\$2 billion in public and private investments to help 200 million people gain access to clean cooking. The CCF’s main objectives are to

- co-finance and leverage concessional finance from the World Bank and attract private-sector investments to the sector;
- catalyze technology and business innovations by providing incentives to players across the clean cooking value chains; and
- link incentive payments with verified results at the output, outcome, and impact levels, thereby contributing to better health, gains in gender equality, environmental sustainability, and inclusive development.

Source: World Bank.

Driving Scale: Why Now Is the Time

Prioritizing clean cooking at global and national levels and designing more effective strategies for project interventions are gaining momentum. Clean cooking is being elevated to a higher priority on the policy agenda, and more in-depth analytical tools have opened the door for understanding the state of access and the large-scale investments and user-centered approaches required to move the needle forward.

A Higher Priority on the Policy Agenda

Establishment of the Sustainable Development Goals (SDGs) has helped to catalyze increased policy prioritization of clean cooking at both the global and country levels. Key sector milestones over the past few years have included launching of the Health and Energy Platform of Action (2019) and endorsement of the G20 Initiative on Clean Cooking and Energy Access (2020). At the national level, more countries have started to formalize cooking energy demand in their energy planning and strategies with specific targets. In September 2021, the High-level Dialogue on Energy, convened by the Secretary-General of the United Nations under the auspices of the UN General Assembly, outlined a global roadmap for achieving SDG 7 and the objectives of the Paris Agreement. The roadmap calls for 1 billion more people to have gained access to clean cooking solutions by 2025 and the achievement of universal access by 2030. Energy Compacts, whereby countries include clean cooking-related goals and activities in their Nationally Determined Contributions (NDCs) to reductions in emissions, are key to translating these global targets into concrete actions.³

New Definitions and Tools for Measuring the State of Access

Thanks to the availability of more comprehensive definitions and in-depth data and research tools, the understanding of households' cooking energy needs and sector dynamics is growing. Introduction of the terms *Modern Energy Cooking Services (MECS)* and *Improved Cooking Services*—both of which build on the Multi-Tier Framework (MTF) for cooking and account for the multiplicity of factors that shape a household's unique cooking context—is an important step in this direction. MECS and Improved Cooking Services cover not only the technical metrics that have long defined access to clean cooking solutions (exposure and efficiency), but also the valuable contextual attributes on how and why a technology may be used (convenience, affordability, safety, and [fuel] availability) (box 1.2).

³ As of this writing, some 70 countries had included household energy or clean cooking-related goals in their NDCs.

BOX 1.2

CLARIFICATION OF KEY TERMS

Multi-Tier Framework (MTF) for cooking—Multidimensional, tiered approach to measuring household access to cooking solutions across six technical and contextual attributes with detailed indicators and six thresholds of access, ranging from Tier 0 (no access) to Tier 5 (full access). The aggregate MTF tier is the lowest tier rating across the six attributes.

Modern Energy Cooking Services (MECS)—Refers to a household context that has met the standards of Tier 4 or higher across all six measurement attributes of the Multi-Tier Framework: convenience, (fuel) availability (a proxy for reliability), safety, affordability, efficiency, and exposure (a proxy for health related to exposure to pollutants from cooking activities).

Improved Cooking Services—Refers to a household context in Transition, meaning it has met the standards of Tier 2 or Tier 3 across all six measurement attributes of the Multi-Tier Framework, but not all of those for Tier 4 or higher.

Clean Cooking—Refers to a household context that has moved out of Cooking Poverty (MTF Tier 0 or 1) into Cooking Decency, with access to Modern Energy Cooking Services (MTF Tier 4 or 5), or that is in Transition, with access to Improved Cooking Services (MTF Tier 2 or 3).

Cooking Decency—See “Modern Energy Cooking Services (MECS).”

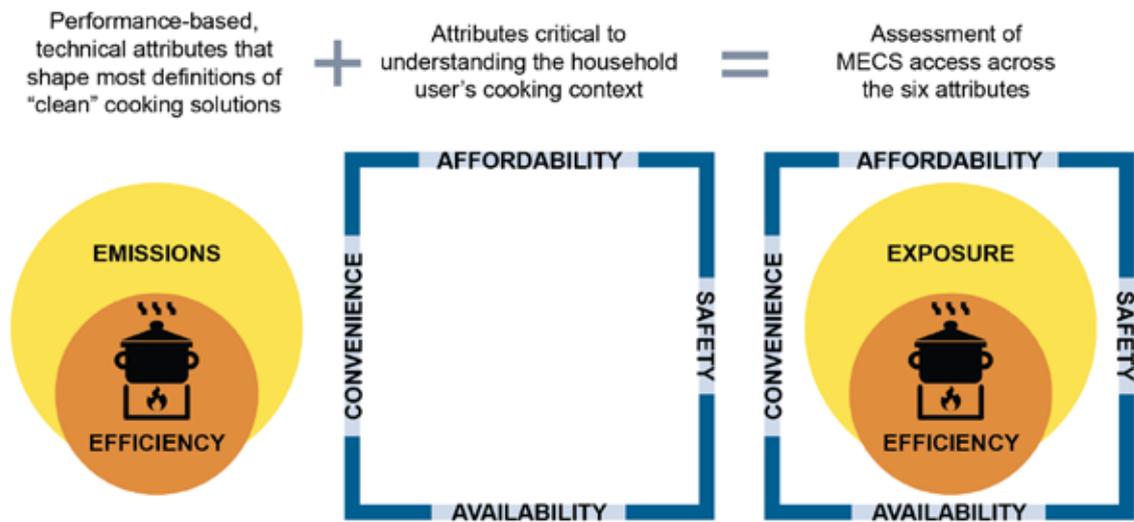
Cooking Poverty—A household context reliant on traditional, polluting cooking fuels and technologies, synonymous with “lack of access to clean cooking fuels and technologies” in Sustainable Development Goal (SDG) 7 tracking.

Source: ESMAP 2020a.

Using the MTF approach for measuring household access makes it possible to understand households' current energy cooking services and how to design their movement along a continuum of improvement or access tiers (MTF Tiers 0–5). Households are considered to have achieved access to MECS when their cooking practices meet MTF Tier 4 or above, while those whose cooking practices meet MTF Tier 2 or 3 are considered “in Transition,” with access to Improved Cooking Services (box 1.2 and figure 1.3).

FIGURE 1.3

MTF Attributes Used to Measure the State of Access to MECS



Source: ESMAP 2020a.

BOX 1.3

UPDATING SECTOR UNDERSTANDING ON THE STATE OF ACCESS AND INVESTMENT NEEDS

The State of Access to Modern Energy Cooking Services, a 2020 global review report, is a product of the research efforts implemented under the Modern Energy Cooking Services Program, a five-year initiative funded by UK Aid of the Foreign, Commonwealth and Development Office (FCDO) and led by Loughborough University and the World Bank's Energy Sector Management Assistance Program (ESMAP). Following on the 2015 report, *The State of the Global Clean and Improved Cooking Sector*, led by ESMAP and the Clean Cooking Alliance (CCA), the 2020 global report, also led by ESMAP in collaboration with Loughborough University and the CCA, presents newly compiled evidence and insights to inform better decision-making to guide progress toward meeting Sustainable Development Goal (SDG) Target 7.1.

Analysis of new, more granular datasets from a 71-country sample comprising 5.3 billion people reveals that some 4 billion of them lack access to Modern Energy Cooking Services (MECS). Achieving universal access to MECS by 2030 will require increasing investments from tens of millions to tens of billions. The total cost of transitioning to universal access to MECS is approximately US\$1.5 trillion, or US\$148–156 billion annually over the next 10 years. A more pragmatic, though less ambitious, scenario considers universal access to Improved Cooking Services by 2030, at an estimated total cost of approximately US\$100 billion.

The report was launched in September 2020 during UN Climate Week. Supplementary products based on the report's findings include the Players and Initiatives Database; a first interactive geo-map from a systematic literature review on factors that drive the transition to MECS; the Clean Cooking Planning Tool (CCPT); and online, e-learning course modules.

Source: ESMAP 2020a; Putti et al. 2015

Utilizing the MTF measurement approach and household surveys from 71 countries reveals that, out of 5.3 billion people, 4 billion lack access to MECS or cooking decency (box 1.3). Of these, 1.25 billion are living in Transition (Tiers 2–3), with access to Improved Cooking Services, while the other 2.75 billion are living in cooking poverty, with no access (Tiers 0–1). A geographic breakdown shows that Sub-Saharan Africa lags behind all other regions, with only 10 percent of its population able to access MECS. Access in Latin America and the

Caribbean and East Asia stands at 56 percent and 36 percent, respectively (ESMAP 2020a). Without evolving beyond the status quo, the goal of universal access to MECS will remain out of reach for 4.5 billion people by 2030. Based exclusively on expected population growth and urbanization over the next decade, a majority of the populations in Sub-Saharan Africa, South Asia, and Southeast Asia would be expected to remain in cooking poverty in 2030.

Emerging Technologies, Business Models, and Financing

Technological advances, aided by new payment and financing approaches, are putting MECS within reach of many more low-income households. Promising technologies for overcoming the affordability challenges include pellet-fed gasifier stoves, electric pressure cookers (EPCs) and eCooking, and itemized ethanol (box 1.4). Equally important are the digital pay-as-you-go (PAYGo) business models and bundling of cooking with other modern-energy products and services, which are poised to transform the ways in which consumers access MECS (box 1.5).



BOX 1.4

PROMISING TECHNOLOGIES TO ACCELERATE ACCESS AND AFFORDABILITY

Pellet-fed gasifier stoves, electric pressure cookers (EPCs) and eCooking, and itemized ethanol are among the innovative technologies that are increasing MECS accessibility and affordability for many more households. Gasifier stoves, which use pellets instead of raw biomass, can lower emissions and, by reducing moisture content, allow for highly efficient combustion. The economics of pellet production are also encouraging. New-generation, EPC eCooking appliances are especially promising because, by reducing the amount of electricity required for cooking, they can dramatically lower its cost. In Asia, grid-powered EPCs have already taken root in many markets. Within the next few years, one can expect that the cost of battery-powered eCooking in weak-grid and off-grid contexts will be on par with charcoal and kerosene cooking. Itemized ethanol offers another attractive solution as it can reduce company costs and user prices, achieve scale, and realize safety and environmental benefits.

The promise of these technologies is strong, but key challenges remain. For gasifier stoves, research and development (R&D) is an ongoing priority, and in-depth research is needed on the pellet emissions profile and personal exposure of stove users. In the case of EPC eCooking, innovative delivery and financing models are required to support the rollout, particularly in Sub-Saharan Africa, where localized supply chains are not yet in place and consumer awareness is low.

Source: ESMAP 2020a (Deep-Dive Case Studies, pp. 80–82).

Results-Based Financing Incentives

As more financial resources move in the direction of access to clean cooking, Results-Based Financing (RBF) and other forms of impact-driven finance are gaining ground as a way to pay for the expected public-goods benefits from clean cooking interventions. RBF spurs product-sector companies to manufacture and deliver stoves to a pre-agreed target population, usually lower-income households and marginalized populations. Once customers purchase the clean cooking technologies and the transactions are verified by an independent, third-party team, the payment is transferred to the company. The World Bank's CCF currently uses RBF as its main instrument and continues to innovate RBF designs and applications for more targeted incentives to promote sustainable market development and advance access for all (box 1.1).⁴

⁴ Currently, the World Bank's Clean Cooking Fund (CCF) and Carbon Initiative for Development (Ci-Dev) are field-testing methods and tools for quantifying and measuring the health, gender, and climate co-benefits from clean cooking interventions (ESMAP 2020b). The goal is to monetize these co-benefits, using RBF mechanisms, to attract potential impact donors and thus incentivize private-sector investment and co-benefit delivery.

BOX 1.5

INTEGRATED BUSINESS AND FINANCING MODELS

New business and financing models are transforming the ways in which consumers can access Modern Energy Cooking Services (MECS). The pay-as-you-go (PAYGo) model, which typically builds on the penetration of mobile money and cell phones, allows customers to pay for cooking solutions in small amounts, as needed. In Kenya, several companies have integrated PAYGo technology for extending solar home systems (SHSs) and liquefied petroleum gas (LPG). Envirofit started its own PAYGo LPG solution in Nairobi using gas cylinders enabled with smart meters. In Tanzania, KopaGas offers PAYGo LPG, which is enabled by money services and smart meters.

Bundling stoves with other modern-energy products and services makes it possible for cooking enterprises to capitalize on existing distribution networks in adjacent sectors (e.g., off-grid solar companies and last-mile, multi-product distributors), which can potentially increase revenues and spread risk. Various off-grid solar companies (e.g., M-KOPA and Bboxx) cross-sell cookstoves and other home-related products using PAYGo consumer financing. Biolite, a U.S.-based stove producer with operations in Africa, integrates bundling into its own off-grid solar products (e.g., including a motion-detector light and radio/mp3 player) and partners with a company specialized in PAYGo to facilitate distribution and sales.

Source: ESMAP 2020a (Deep-Dive Case Studies, pp. 82–85).

Harnessing Carbon Finance

With higher carbon prices for clean cooking projects—from less than US\$10 per ton of carbon dioxide equivalent (tCO₂e) in 2019 to the current price range (often seen at US\$15–25 per tCO₂e)—more funding is finding its way to the clean cooking sector, attracting a growing number of project developers and impact financiers. Carbon finance can boost the financial viability of clean cooking projects. Using an RBF approach that pays for the verified emissions reductions at the impact level, carbon finance has several advantages for developing the cooking energy sector. Project developers are motivated to generate more carbon credits by focusing on user adoption and the promotion of higher-efficiency stoves. Also, the monitoring and verification process enables them to better understand users' needs for further adjustment. The challenge for projects' host-country governments and development partners is how to harness this opportunity while managing its downside risks (chapter 5).

COVID-19 Recovery: A Policy Opportunity

Governments can transform the COVID-19 challenge into an opportunity by recognizing clean cooking as a basic service and critical part of inclusive response-and-recovery efforts. Demand for cooking energy should be integrated into national energy planning, with a target of ensuring cooking decency (MECS) for all (box 1.2). Without stepped-up public support, the pandemic will have pushed many lower-income households further down the energy ladder, exacerbating the already severe impacts on families' health, women's productivity, and the environment/climate. Poorer households—those most affected by, but least equipped to recover from, the pandemic's effects—should receive the greatest budgetary support. This could take the form of conditional or unconditional cash transfers or results-based grants that provide cash incentives to eligible households (Zhang and Li 2021).

Report Purpose and Organization

Based on lessons synthesized from the World Bank's operational experience in the sector, this report aims to equip task teams, development partners, policy makers, implementing agency staff, and practitioners more generally with the tools required to drive country progress on clean cooking adoption.⁵ A key objective is to help stakeholders reduce the transaction costs of identification and engagement in the preparation of clean cooking operations. Complementary to the report, the CCF provides informal, interactive resources (both internal and external), which offer more specific guidance with detailed operational examples. The report is organized into five chapters. Chapter 2 highlights opportunities governments now have to drive the clean cooking transition and principles for developing an operational strategy. Chapter 3 examines the key operations models of successful interventions, while chapter 4 turns to the building blocks for promoting market development. Finally, chapter 5 summarizes lessons learned and recommendations for moving forward.

⁵ Although the report's primary focus is access to clean cooking, experience and lessons learned are also drawn from projects that promote efficient and clean heating for poor households in cold-climate regions beyond district heating networks. Thus, the approaches and design principles are also applicable to access to decentralized heating solutions.

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A woman wearing a red headscarf and a grey shirt is cooking over a large, black, cylindrical pot. The pot is placed on a traditional brick stove. Steam is rising from the pot, indicating that the food is being cooked. The woman is using a long wooden stick to stir the contents of the pot. The background shows an outdoor setting with various items and structures, suggesting a rural or semi-rural environment.

TWO MAKING THE CASE FOR CLEAN COOKING

Supporting a country's transition to universal access to clean cooking begins by taking stock of its cooking poverty status, level of awareness and commitment to making the transition, and steps being taken to integrate clean cooking into national policy and planning. This chapter offers tools and resources for identification and engagement, highlighting lessons from recent World Bank project experience, and principles to guide the development of clean cooking strategies.

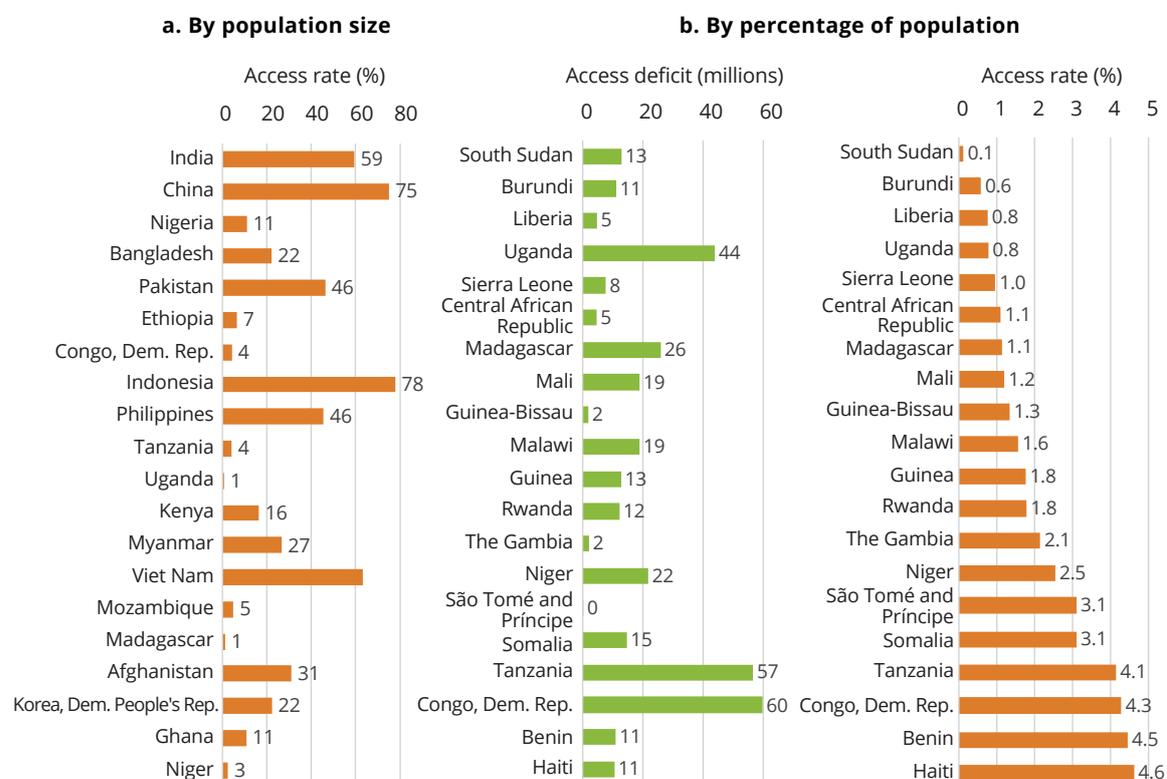
Identification

The starting point for determining a country's cooking poverty status is understanding the extent to which it lacks access to clean cooking fuels and technologies. The Energy Sector Management Assistance Program's website for tracking Sustainable Development Goal 7 (SDG 7) provides a downloadable spreadsheet for SDG 7.1.2—the official indicator used to track the “proportion of the population with primary reliance on clean fuels and technologies”—including the latest SDG 7.1.2 datasets for countries and regions.

› Does the country have a high access deficit for clean cooking?

FIGURE 2.1

Top 20 Access-Deficit Countries for Clean Cooking Fuels and Technologies



Source: IEA et al. 2022.

Note: Figures are averages for 2016–20.

Figure 2.1 shows that, in terms of numbers of people without access to clean cooking fuels and technologies, 20 countries account for 82 percent of the global total (IEA et al. 2022). India and China, whose access rates are 59 percent and 75 percent, respectively, together account for about 38 percent of the access deficit; the other countries, with the exception of Indonesia and Vietnam, have access rates below 50 percent (figure 2.1a). Among the 20 highest-deficit countries by percentage of population without access, 4 have access rates below 1 percent (figure 2.1b). The Democratic Republic of Congo, Madagascar, Niger, Tanzania, and Uganda are among the top 20 access-deficit countries in terms of both population size and percentage, highlighting the severe cooking poverty issues these countries face.

Engagement

How does one know whether a country is already trying to tackle its cooking poverty issue? A variety of tools and resources can provide a useful starting point for determining the country's current level of awareness.

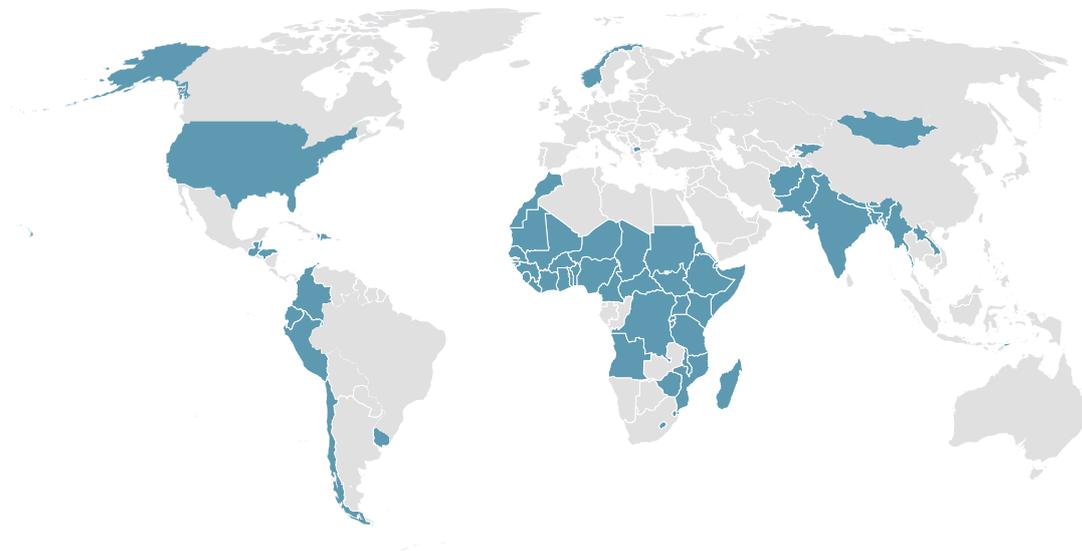
› *Does the country have a high access deficit for clean cooking?*

A review conducted by the Climate and Clean Air Coalition (CCAC) and the Clean Cooking Alliance (CCA) shows that, as of October 2021, 67 countries had included household energy or clean cooking-related goals in their Nationally Determined Contributions (NDCs) (figure 2.2).

Following the UN High Level Dialogue on Energy in September 2021, the Energy Compacts of an increasing number of developing countries (e.g., Ethiopia, Honduras, Kenya, Malawi, Nigeria, Rwanda, Sierra Leone, United Arab Emirates [UAE], and Zambia) now include specific clean-cooking targets (box 2.1). Also, such organizations as the World Bank, SEforALL, UN Energy, and the CCA; governments (e.g., the Netherlands and Denmark); and other development partners have made commitments to supporting access to clean cooking in their Energy Compacts.

FIGURE 2.2

Countries with Household Energy or Clean Cooking–Related Goals in Their Nationally Determined Contributions



Countries Included:^a

- | | | | |
|------------------------------|------------------------|----------------------|-------------------|
| 1. Afghanistan | 19. Djibouti | 38. Madagascar | 57. Somalia |
| 2. Angola | 20. Dominican Republic | 39. Malawi | 58. South Sudan |
| 3. Azerbaijan | 21. Ecuador | 40. Mali | 59. Sudan |
| 4. Bangladesh | 22. Eritrea | 41. Marshall Islands | 60. Tanzania |
| 5. Barbados | 23. Eswatini | 42. Mauritania | 61. Timor-Leste |
| 6. Belize | 24. Ethiopia | 43. Mongolia | 62. Togo |
| 7. Benin | 25. The Gambia | 44. Morocco | 63. Uganda |
| 8. Bhutan | 26. Ghana | 45. Mozambique | 64. United States |
| 9. Burkina Faso | 27. Guatemala | 46. Myanmar | 65. Uruguay |
| 10. Burundi | 28. Guinea | 47. Nepal | 66. Vanuatu |
| 11. Cameroon | 29. Guinea-Bissau | 48. Niger | 67. Zimbabwe |
| 12. Central African Republic | 30. Haiti | 49. Nigeria | |
| 13. Chad | 31. Honduras | 50. North Macedonia | |
| 14. Chile | 32. India | 51. Norway | |
| 15. Colombia | 33. Kenya | 52. Pakistan | |
| 16. Comoros | 34. Kyrgyz Republic | 53. Peru | |
| 17. Congo, Dem. Rep. | 35. Lao PDR | 54. Rwanda | |
| 18. Côte d'Ivoire | 36. Lesotho | 55. Senegal | |
| | 37. Liberia | 56. Sierra Leone | |

Source: Adapted from CCAC and CCA 2021.

Note: This map was produced by the World Bank's Cartography Unit.

a. As of October 25, 2021.

BOX 2.1

MALAWI: HIGH-LEVEL COMMITMENT TO TACKLING COOKING POVERTY

Malawi has made clean cooking a top political priority, which is a remarkable achievement for a high access-deficit country. From 2016 to 2020, the country's average rate of access to clean cooking fuels and technologies was just 1.6 percent (IEA et al. 2022). According to the World Bank's Multi-Tier Framework (MTF), 18.54 million people in Malawi lack access to Modern Energy Cooking Services (MECS), 3.43 million of whom are considered in Transition (MTF Tier 2 or Tier 3) and the other 15.11 million reliant on primitive, polluting stoves and fuels (MTF Tier 0 or Tier 1) (ESMAP 2020a). By 2030, it is projected that biomass supply will not be enough to sustainably meet the demand for firewood and charcoal. The government recognizes the high cost of not taking action, which totals US\$8.6 billion per year from the negative externalities for health (US\$3.2 billion), gender (US\$4.5 billion), and climate (US\$0.9 billion) (ESMAP 2020a).

Since 2017, when Malawi's national plan for achieving clean cooking access for all was officially adopted, clean cooking initiatives have been gaining momentum. Last-mile distribution networks, an awareness-raising program, and a financial incentive structure have been put in place. By 2019, the country's Regulatory Indicators for Sustainable Energy (RISE) score had reached 62/100—higher than the regional average for Sub-Saharan Africa (32/100) (ESMAP 2022a).

Under Malawi's Nationally Determined Contributions (NDCs) (updated July 2021), cooking-related, climate-mitigation measures focus on introducing high-efficiency firewood and charcoal cookstoves in rural and urban areas, respectively, with total funding estimated at US\$26 million over 20 years (2020–40). Malawi's Energy Compact, put forward by the Ministry of Energy and National Cookstove Steering Committee (NCSC) in September 2021, set two ambitious clean-cooking targets for 2030 (at a total investment of US\$596 million): (1) ensuring universal access to affordable, reliable, and cleaner energy services (US\$149 million) and (2) substantially increasing the share of renewable energy in the global energy mix (US\$447 million).^a The co-benefits from meeting these transition targets total US\$2.7 billion per year (US\$0.7 billion for health, US\$1.6 billion for gender, and US\$0.5 billion for climate).

BOX 2.1 (Continued)

Malawi's clean cooking market is fledgling. The coordinated efforts of the NCSC have helped to position the clean-cooking issue high on the political agenda, but strengthening the capacity of institutional champions and intersectoral and intergovernmental coordination are needed to attract private-sector investment. Other key challenges include the need to develop and enforce regulations, standards, and testing capacity. Shaping and growing the ecosystem will require an integrated, coordinated approach that puts end users at the center and brings in all key players to scale up investments, spur market innovation, and ensure inclusiveness.

Sources: ESMAP 2020a, 2022a, b; IEA et al. 2022.

a. These targets are comparable to those using the World Bank's Clean Cooking Planning Tool (CCPT), which aims to achieve 100 percent Improved Cooking Services in rural areas and 28 percent MECS and 72 percent Improved Cooking Services in urban areas (ESMAP 2022b). However, the CCPT's targets are more ambitious as they eliminate traditional, polluting cookstoves and assume every household has access to a two-burner (or two single burners) improved cookstove or modern cooking device. Following the CCPT approach, approximately US\$102.8 million is needed each year (US\$31.6 million from the public sector, US\$1.5 million from the private sector, and US\$69.7 million from households).

› How does one develop the narrative to make the case for clean cooking?

If clean cooking is not yet on the front burner of the access-deficit country's energy policy agenda, one must make the case for it, beginning with explaining the adverse development impacts of cooking poverty (table 2.1).

TABLE 2.1
Adverse Impacts of Cooking Poverty, by Externality

EXTERNALITY	MAIN IMPACTS
Health	<ul style="list-style-type: none"> • Broad range of health conditions associated with household air pollution (HAP), including chronic respiratory disease, acute lower respiratory infections (ALRI), lung cancer, stroke, and cardiovascular disease • Burns suffered by household members cooking with traditional fuels and appliances • Chronic and acute physical ailments that can occur during fuel collection
Gender	<ul style="list-style-type: none"> • Disproportionate effects on women and young girls: <ul style="list-style-type: none"> - Health conditions associated with HAP - Burns from cooking with traditional fuels and appliances - Physical ailments, injury, and gender-based violence (GBV) associated with fuelwood collection - Time poverty (from cooking, fuel collection, and drudgery), resulting in less time for leisure and opportunities for market employment, with potential risk of lowered household status
Other social effects	<ul style="list-style-type: none"> • Avoidable spending on fuel due to reliance on inefficient fuel-stove combinations • Lost opportunities for income generation due to time spent cooking • Reduced access to education due to impaired child health and time spent on fuel collection • Poorer nutrition due to partly prepared food or reduced food budgets • Increased poverty due to diversion of scarce resources to pay for fuel • Negative aesthetic effects (e.g., poor lighting and soot-darkened home environment)
Climate	<ul style="list-style-type: none"> • Greenhouse gas (GHG) emissions due to the use of inefficient fuel production and consumption • Catalytic warming effects of black carbon (BC) emissions
Environment	<ul style="list-style-type: none"> • Forest degradation and deforestation due to fuel collection and production • Foregone agricultural productivity due to habitat degradation and combustion of dung as fuel
Employment	<ul style="list-style-type: none"> • Risk of displacement of existing economic activities for poor rural and urban households in the woodfuel value chain

Source: ESMAP 2020a.

a. However, switching to modern energy cooking solutions brings rewards in the form of broader macroeconomic potential, particularly in the creation of local jobs.

The World Bank' Energy Sector Management Assistance Program (ESMAP) has developed a scenario-based Clean Cooking Planning Tool (CCPT), which can help energy planners and decision makers visualize the potential transition pathways (including fuel-mix options) for achieving universal access to clean cooking solutions (ESMAP 2022b). The CCPT integrates the consolidated country database developed for *The State of Access to Modern Energy Cooking Services* report (box 1.3), as well as the Regulatory Indicators for Sustainable Energy (RISE) (ESMAP 2022a), to benchmark the sector policy and regulatory framework against those of regional and global peers. For a selected country or region, users can view (1) the 2020 state of access (baseline), (2) the 2030 business-as-usual (BAU) scenario, (3) the cost of inaction, (4) the current policy/regulatory environment, and (5) the estimated investment cost based on the user's selected transition pathway. Box 2.2 provides an initial assessment for the Democratic Republic of Congo (DRC).

BOX 2.2

DEMOCRATIC REPUBLIC OF CONGO: INITIAL SECTOR ASSESSMENT

The Democratic Republic of Congo (DRC) is committed to transitioning to clean cooking solutions, as reflected in its Nationally Determined Contributions (NDCs) (updated October 2021). However, the country's clean-cooking policy and regulatory framework is nascent (ESMAP 2022a), and no single government document provides a concrete plan for improving the uptake of clean cooking. The clean cooking ecosystem is defined by butane supply chains, which are not sufficiently visible or decentralized. Points of sale are few, even in the capital city of Kinshasa. For most Congolese households, butane is not a viable cooking solution owing to the high fuel price, limited equipment availability, low supply networks, and the ready availability of less expensive woodfuels. Just over 4 percent of the overall population has access to clean cooking fuels and technologies (IEA et al. 2022).

The DRC also faces a substantial disease burden associated with household air pollution (HAP) linked to cooking with traditional biomass stove and fuels, as well as rapid deforestation. Without meeting the clean cooking target under Sustainable Development Goal 7 (SDG 7.1.2), the cost of not taking action—driven by the negative externalities for health, gender, and climate—would total US\$32.3 billion per year. The health impact alone is estimated at US\$13.6 billion per year. The gender cost is US\$16.1 billion annually, owing to women's lost productivity from extended hours spent on cooking-related tasks;^a and the climate-impact cost is US\$2.6 billion per year.

As of 2020, 84.3 million people in the DRC lacked access to Modern Energy Cooking Services (MECS)—that is, solutions that are clean, efficient, convenient, safe, reliable, and affordable (MTF Tier 4 or above). Of these, 61.0 million were living in cooking poverty (MTF Tier 0 or 1), while 23.3 million were considered in Transition (MTF Tier 2 or 3), with access to Improved Cooking Services (ESMAP 2022b). Meeting the SDG 7.1.2 target, as well as the complementary SDGs on health, gender equality, and climate, requires modernizing the country's biomass fuel sector, upgrading cookstove technologies and industry, and promoting access to MECS.

An integrated and collaborative approach working across sectors is needed to create an enabling environment, tackle supply constraints, and stimulate user demand. The most urgently needed enabling conditions are high-level political commitment that puts users at the center of the development and delivery of clean cooking solutions and dedicated grant resources to leverage public- and private-sector investments. Specifically, the government

BOX 2.2 (Continued)

needs to (1) prioritize access to clean cooking in national policies by building institutional capacity and designating an institutional champion to coordinate with key stakeholder agencies; (2) formalize cooking energy demand in national energy planning and development of a strategy for achieving universal access to clean cooking; and (3) scale up public and private financing by working with development partners and developing incentive mechanisms to attract private investments.

Achieving universal access to MECS by 2030 would require approximately US\$3.24 billion per year. Of this amount, US\$1.75 billion would be needed from the public sector to ensure that the poorest households can afford modern cooking solutions. The private sector would need to provide US\$161 million to install downstream infrastructure for the functioning of modern energy cooking markets; and the remaining US\$1.33 billion would come from households' direct contributions. To reach Improved Cooking Services for all by 2030, approximately US\$226.33 million per year would be required, including US\$53.89 million from the public sector to fill the affordability gap and the rest by households.

Sources: ESMAP 2020a, 2022a, b; IEA et al. 2022.

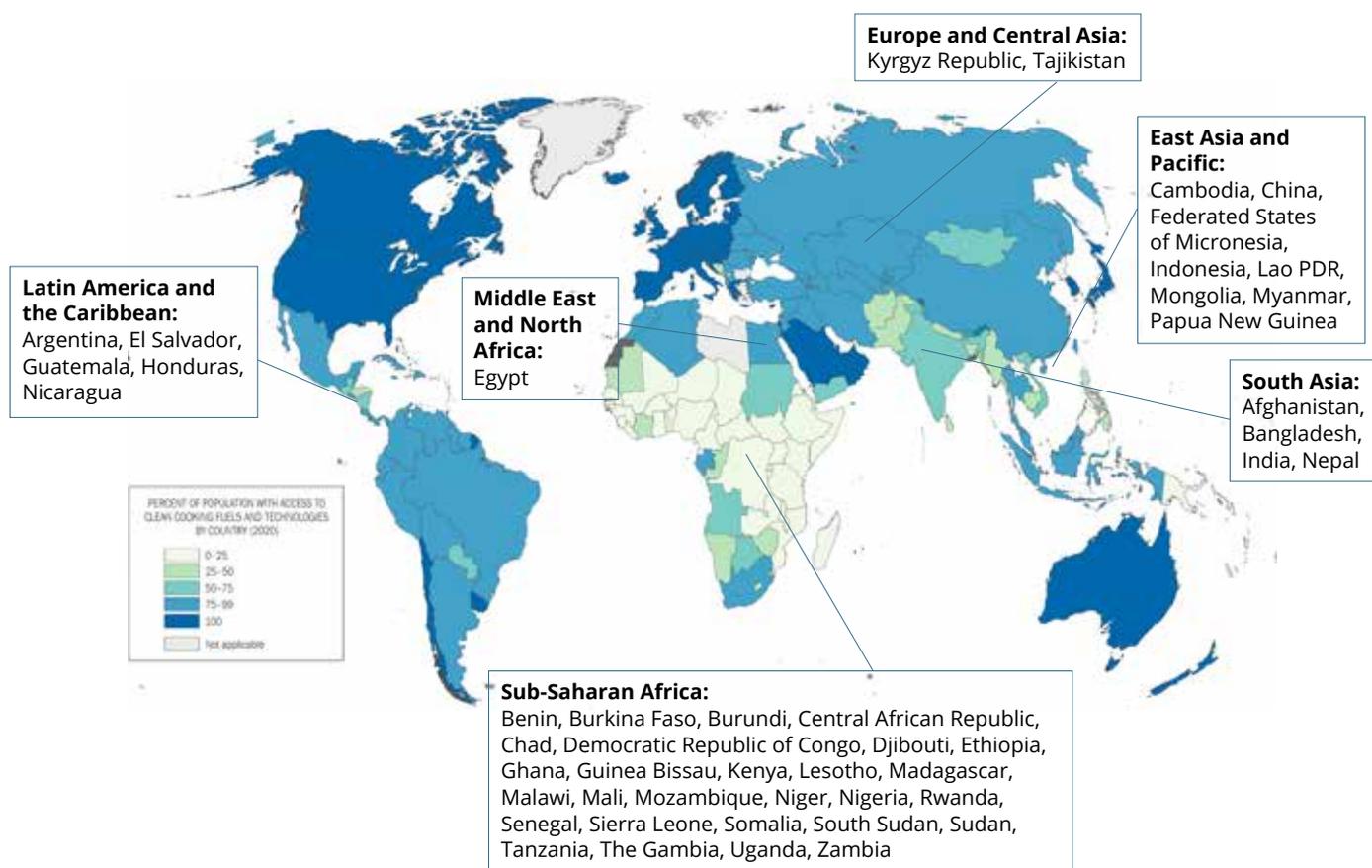
a. Women who live in rural and urban areas of the DRC spend an average of 14 hours and 8 hours per week, respectively, on cooking-related tasks.

› How does one build on past experience and lessons learned?

As part of the engagement process, it is important to share what has already been done and learned from past experience. Figure 2.3 shows that the World Bank's engagement in the sector, either through investment lending projects or technical assistance, extends to most access-deficit countries.

FIGURE 2.3

Map Showing the World Bank's Global Presence in Clean Cooking and Heating, 2022



Source: World Bank 2022.

Note: This map was produced by the Geospatial Operations Support Team (GOST) of the World Bank, and population data on access to clean cooking fuels and technologies was provided by the World Health Organization (WHO 2022).

A review of the World Bank's lending portfolio underscores the cross-sectoral nature of clean cooking, as well as the urgent need for scaled-up, dedicated investments to deliver its large potential benefits for society (Appendix A). Switching to such modern fuels as liquefied petroleum gas (LPG) and electricity to address the harmful impacts of household air pollution (HAP) should be encouraged; however, one must also consider the country's overall enabling environment for promoting clean cooking, including its institutional capacity to implement transformative solutions. In China, for example, the government succeeded in moving 1.2 million rural households in Hebei Province from traditional cooking and heating stoves that burn coal or firewood to modern gas or electric cooking and heating appliances that significantly reduced HAP, owing primarily to its high-level political support and large-scale investments in the delivery infrastructure and stove-and-fuel subsidies (box 2.3).

BOX 2.3

CHINA: HEBEI AIR POLLUTION PREVENTION AND CONTROL PROGRAM

In 2012, China's Jingjinji Region (Beijing, Tianjin, Hebei, and neighboring provinces) was one of the world's most polluted urban areas, with annual ambient concentrations of particulate matter (PM_{2.5}) about three times higher than the specified government standards. A source apportionment study identified residential emissions from stalk and coal burning (mainly from household cooking and heating stoves) as contributing more than 32 percent to ambient pollution, second only to industrial processes, at 54 percent. At the national level, the State Council issued the Air Pollution Prevention and Control Action Plan in 2013, which specified a 10 percent reduction in China's ambient PM_{2.5} concentrations by 2017. At the provincial level, Hebei's action plan specified a 25 percent reduction in ambient PM_{2.5} concentrations over the same period.

To support the implementation of key measures in Hebei's action plan, the World Bank, in 2016, approved US\$500 million in loan funding for the Hebei Air Pollution Prevention and Control Program. Among its large sector interventions, the program included a US\$80 million clean-stove component. An innovative results-based lending instrument, known as Program-for-Results (PforR) financing, linked disbursement of funds with the verified number of eligible clean stoves deployed to replace traditional coal-fired or biomass-burning stoves.

To encourage residents to switch from traditional to clean-burning gas stoves, the government paid for the installation of the pipeline network and household connections and, for the first three years, subsidized the cost of stove and gas in rural areas. By the end of 2019, 1.22 million households had replaced their traditional coal stoves with gas (1.086 million) and electric (0.135 million) cooking and heating appliances, exceeding the set target by 400,000 stoves. The clean-stove program component helped to reduce total PM_{2.5} emissions by 5,000 tons, exceeding the original target by 3,700 tons (Zhao et al. 2019).

For Hebei residents, the program's benefits included time savings and convenience from not having to carry coal to their homes every day or clean coal dust from their kitchens. Also, the stoves are affordable, at a cost of only US\$3 per month. In addition, residents enjoy better health from having eliminated the risk of carbon monoxide (CO) poisoning during winter heating months (World Bank 2019).

Source: World Bank.

In other country contexts with rapidly growing rural economies, tackling access to clean cooking may require a market-driven approach that builds on already successful models within the country. Bangladesh provides an example, whereby a government-owned, development-financial institution—the institutional champion—leveraged the capacities of a well-structured network of partner organizations to strengthen the commercial market for improved cookstoves (box 2.4).

BOX 2.4

BANGLADESH RERED II PROJECT

In 2013, an improved cookstoves (ICS) component was added to the already successful, World Bank-supported Rural Electrification and Renewable Energy Development (RERED) Project. Since 2003, this project had supported off-grid rural electrification and renewable energy development using solar home systems (SHSs). By 2013, the Infrastructure Development Company, Limited (IDCOL), the project's implementing agency, had a proven results-based funding mechanism in place for extending credit lines to partner organizations (POs) responsible for the delivery of SHSs to off-grid rural households. This market-based model became the foundation for promoting ICS (box 4.4).

Design of the ICS component's Results-Based Financing (RBF) framework aligns supplier incentives and sales increases, ensuring that only those stoves that meet customers' preferences are manufactured and distributed (ESMAP 2019a). The program supports the POs in establishing production centers and partnering with local entrepreneurs to improve production capacity, in accordance with IDOL's technical specifications.

IDCOL's research and development (R&D) initiatives under the program have upgraded the stoves' level of thermal efficiency from Tier 1 to Tier 3. In 2017, testing by the Bangladesh University of Engineering Technology (BUET) showed that emissions from particulate matter (PM) and carbon monoxide (CO) were reduced by 20 percent and 90 percent, respectively (ESMAP 2019a).

With support of the World Bank's Energy Sector Management Assistance Program (ESMAP), the project has mobilized US\$20 million in grant funding from the Green Climate Fund and US\$20 million in IDA financing for a scaled-up ICS program that aims to reach 5 million households by December 2023. As of June 2022, the program had reached 2.8 million households and reduced greenhouse gas (GHG) emissions by

BOX 2.4 (Continued)

6.17 million metric tons of CO₂ equivalent (MtCO₂e). ICS adoption has lowered fuel costs and reduced the average amount of time a user spends on firewood collection by about 102 hours per year. Uptake has increased as opportunities for women have opened across the value chain. Women now represent 20 percent of the 3,000 employment opportunities created, and that percentage is expected to double by the end of the project. Over its lifetime, the ICS program is expected to save 23 million tons of biomass and reduce GHG emissions by 13.36 MtCO₂e.

Source: World Bank.

In countries where high percentages of households rely on traditional biomass, addressing access to clean cooking will require modernizing the biomass fuel sector and promoting integrated, cost-effective approaches. A pro-poor approach can be used to fill the affordability gap and incentivize local stove design and technology innovation. The Clean Cooking Fund's first IDA-co-financed project in Rwanda offers a promising example (box 2.5).

BOX 2.5

RWANDA: ENERGY ACCESS AND QUALITY IMPROVEMENT PROJECT

Rwanda depends highly on traditional biomass for cooking energy, with some 80 percent of households reliant on firewood and 17 percent on charcoal. Lack of access to clean cooking has serious health consequences. Each year, nearly 7,400 premature deaths are attributable to household air pollution (HAP), with US\$674 million in annual welfare losses. In response, the Government of Rwanda has developed an ambitious strategy for shifting all of its households and institutions to clean cooking solutions by 2030.

The World Bank-supported Energy Access and Quality Improvement Project (EAQIP), approved in 2020, is contributing to the government's 2030 strategy through its US\$20 million clean cooking subcomponent, co-financed by the Clean Cooking Fund (CCF) and the IDA. This subcomponent is integrated with an off-grid solar

BOX 2.5 (Continued)

subcomponent, both of which use Results-Based Financing (RBF) instruments to incentivize private-sector investment and the delivery of modern energy solutions with pre-defined results levels and triggers for payment.

The project's pro-poor design approach enables a practical transition to improved and modern cooking solutions. Two stove-and-fuel combinations are considered: pellet-fed gasifiers and LPG stoves. Subsidies are adjusted to ensure customer affordability and mobilize and sustain private-sector participation. The RBF window (US\$17 million) initially supports technologies that meet at least the Tier 2 performance level and later the Tier 3 level once enough higher-level cooking technologies and products are available and affordable. Technical assistance (US\$3 million) is provided to local stove producers, as well as the Rwanda Standards Board, which is responsible for certification of cooking products and standards-setting.

By 2024, the project expects to provide 2.15 million people (500,000 households) with access to Modern Energy Cooking Services (MECS) or Improved Cooking Services and mobilize US\$19 million in private investment. A number of development partners have plans to support various aspects of the strategy, such as capacity building; facilitation of knowledge exchange; and development of standards, quality assurance, and testing procedures appropriate to local conditions. Also, additional project finance has been approved to enable the country to benefit from carbon revenue through the purchase of emissions-reduction credits by the Carbon Initiative for Development (Ci-Dev), a World Bank-administered trust fund. The carbon revenue will be used to replenish the RBF fund to make it a revolving fund.

Source: World Bank.

Key lessons from the World Bank's sector experience are summarized as follows:

- **Access to clean cooking services is a development issue.** Access to clean cooking is closely related to the level of economic development and urbanization rate. The most effective way to reduce HAP is by switching to modern clean fuels (e.g., electricity, natural gas, LPG, ethanol, and biogas). Fuel switching should be encouraged, and more efforts are needed to invest in the delivery infrastructure. At the same time, it should be recognized that large-scale fuel switching in rural areas is unlikely to occur until rural economies become substantially more developed or ongoing public funding is provided for fuel switching. To lower HAP in rural households where the use of biomass is likely to persist over the near term, it is important to modernize the biomass fuel sector and promote integrated and cost-effective approaches (e.g., improved/advanced biomass stoves, together with improved ventilation and behavior change).
- **A systems approach is needed to promote access to clean cooking.** In order to make the cooking process clean, the whole system of interactions of cooking technologies (the combination of stove and fuel) with human behavior (e.g., what to cook, how to cook, and how often and long to cook) and housing conditions (e.g., kitchen location, arrangement of rooms and size, construction materials, and quality of ventilation) needs to be considered. It is important to encourage innovation in each element of the system.
- **Local innovation and localized solutions are critical for long-term sustainability.** Cooking is a contextualized system with no one-size-fits-all solution. Although projects share common barriers, the best solutions will vary by location owing to differences in cooking behavior, culture, resources, institutions, and market conditions. Therefore, empowering the development of localized solutions, based on lessons from international experience, including the latest technology innovations, will be key because localized solutions are more likely sustainable. And only when solutions are sustainable can they be truly transformative.
- **A national program with high-level support is essential to scale up access to clean cooking.** While such programs need to involve stakeholders from a wide variety of positions and roles (public sector, civil society, and private sector) at all levels (local, provincial, national, and international), there is no substitute for high-level political, technical, and financial support from national leaders and agencies.
- **Incentives or subsidies will be needed to achieve universal access to clean cooking.** Like universal access to electricity—which no country has achieved without some form of subsidy—subsidies will be needed to achieve universal access to modern-energy cooking solutions. Market forces and mechanisms are powerful tools for ensuring a sustainable supply of modern cooking technologies and should be harnessed in a way that helps the private sector to develop, market, and deliver modern cooking solutions. However, if left to market forces alone, access will be limited by affordability and other constraints that affect mainly poor households, particularly in less developed and more remote areas. Thus, government policies are needed to (1) establish and maintain adequate levels of subsidies and (2) design and implement effective subsidy allocation mechanisms to

mobilize and sustain private-sector participation and target households with an affordability gap.

- ***Results-Based Financing (RBF) has been demonstrated as an effective approach for using public resources to incentivize the market and can be designed to fit the country context and market conditions.*** The World Bank has implemented the RBF framework to support efficient clean-cooking and heating solutions in some 13 client countries, with variations based on country conditions. The results demonstrate that RBF is an effective instrument to incentivize private-sector investment and deliver clean and efficient cooking and heating solutions with pre-defined result levels and triggers for payment.

Guiding Principles

Decades of evidence-based experience underscore the cross-sectoral nature of clean cooking and the urgent need for scaled-up, dedicated investments to deliver its large potential benefits for society. Driving transformative solutions in the sector requires that clean cooking become a political, economic, and environmental priority, supported by policies, investments, and multi-sector partnerships.

› ***What are the guiding principles for developing a clean cooking strategy?***

Five mutually reinforcing principles—impacts, inclusiveness, integration, investments, and innovation—informed by a heart-head-and-hands approach (Appendix B), can guide the development of a clean cooking strategy. Achieving development impacts requires adopting people-centered approaches aligned with stove users' diverse needs, as well as broader development objectives. These approaches must ensure inclusiveness by addressing the needs of poor, vulnerable, fragile, and displaced populations, as well as engaging and empowering women across the clean-cooking value chains.

Developing national strategies and roadmaps requires the full and formal integration of clean cooking into national policies and planning for energy, climate, and COVID-19 recovery. An institutional champion responsible for stakeholder coordination and results accountability should be designated to lead the effort. The strategy development and planning process requires stocktaking of the baseline situation on cooking energy demand, supply, and the policy environment, combined with lessons and insights from the review of relevant programs and consultation with a wide range of stakeholders. The transition pathways of the roadmap should be guided by a least-cost, best-fit approach that reflects diverse users' needs, local market conditions, and national comparative advantages on energy resources. Through the process, governments can raise stakeholder awareness, build coalitions and partnerships, and mobilize the needed public and private investments for implementation.

Achieving better on-the-ground results requires sufficient investments; hands-on practices and learning by doing; and ongoing monitoring, evaluation, and adjustment. Because cooking is a contextualized system with no one-size-fits-all solution, program design and implementation should encourage the development of contextualized solutions and continued innovation for accelerating access. Advancing localized, best-fit approaches, in turn, can lead to realizing the longer-term development co-benefits of adopting clean cooking solutions.

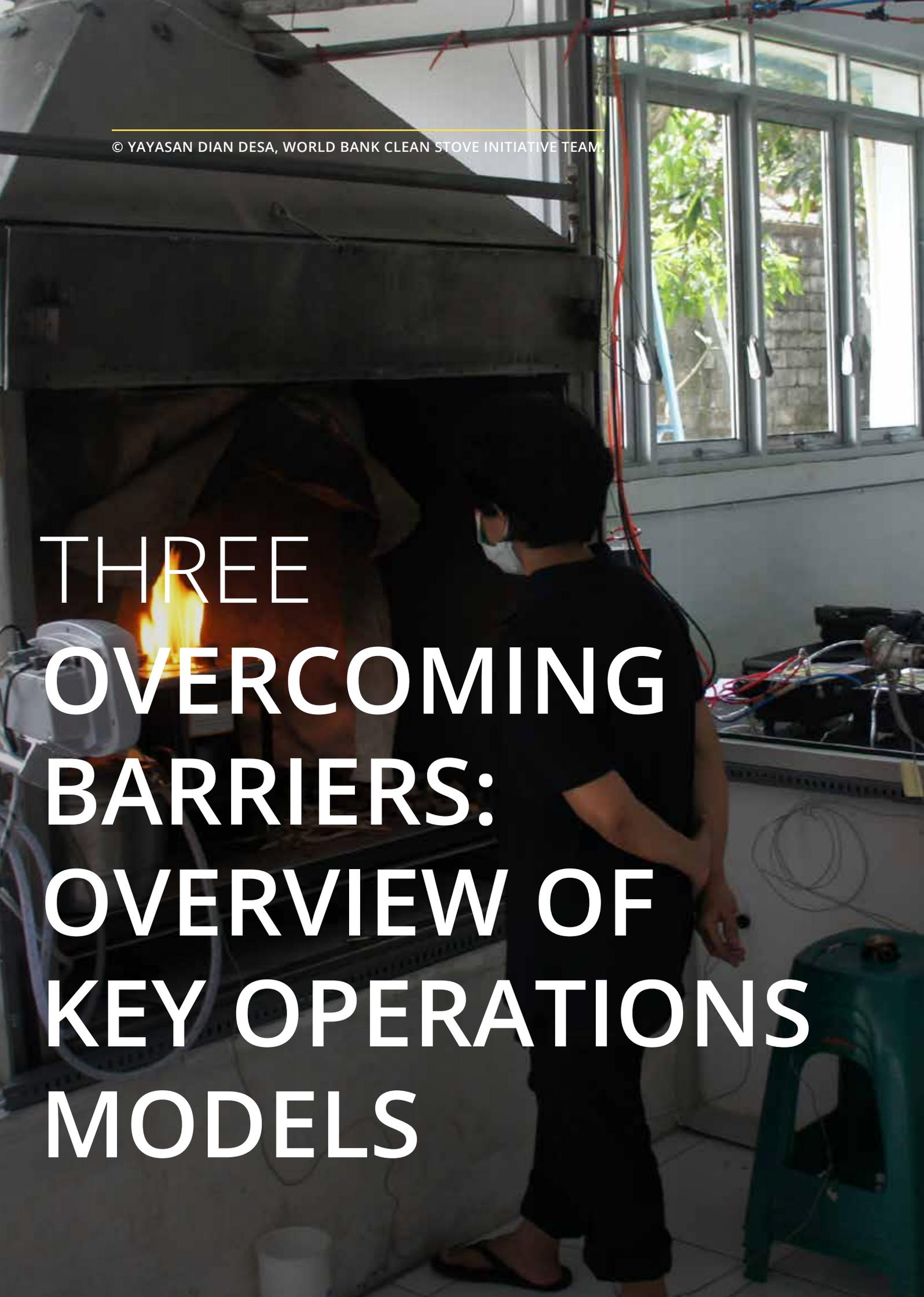
Summary Remarks

This chapter has offered a springboard for initiating national-level policy dialogue on cooking poverty. The starting point is to identify the country's current access-deficit status and commitment to achieving universal access to clean cooking. Engagement requires understanding the extent to which clean cooking has been formally integrated into the country's strategic energy development and planning processes and other relevant policies and strategies. In high-deficit countries that already recognize clean cooking as a top priority on their policy agenda, key challenges are how to support development of the clean cooking market and leverage financing to achieve program targets. In high-deficit countries with low levels of awareness, helping planners and decision makers grasp the adverse impacts and costs of cooking poverty, explore transition pathways for achieving universal access and the benefits of transition, and sharing what has been learned from international experience can help to make the case. The featured projects and lessons from the World Bank's recent sector experience demonstrate how making access to clean cooking a political priority, using people-centered approaches, can drive large development impacts for society. Selecting the transition pathways for scaling up will depend, in large part, on the country's level of economic development and national-level political, technical, and financial support.

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THREE OVERCOMING BARRIERS: OVERVIEW OF KEY OPERATIONS MODELS

Designing interventions to support clean-cooking market development requires understanding the challenges faced by each key player in the ecosystem: households/end users (demand side), clean-cooking product and service providers (supply side), and the government (market shapers to develop policies). This chapter begins by describing the various operations models used by World Bank projects to overcome identified barriers, followed by lessons from the World Bank's experience in using results-based financing (RBF) as the main operations model to unify them to tackle supply, demand, and public policy challenges.

Key Operations Models

Technical Assistance: Develop Policy and Build Capacity

Governments are responsible for making sure the enabling environment is right for the promotion of better technological solutions for fuels and stoves. Most projects require some form of support to governments or designated agencies to strengthen their institutional capacity for implementation. Technical assistance might include public policy, regulation, and strategy development; market assessments; standards for eligible stoves, testing protocols, and labeling; research and technology development; technology transfer; social assessments; and awareness-raising activities. Identifying successful technologies well-suited to transfer into areas where they remain unknown is often less expensive than attempting to develop them locally.

Business Incubation: Improve Products and Businesses

Building stove-supplier capacity comprises various aspects of business incubation, including nurturing local enterprises and providing seed financing, training, and technical assistance. Supply-side barriers typically include a lack of business expertise and initial funding. Channel-filling can be a fiscal no-man's-land, particularly for new products. When accompanied by complementary approaches to promote better stoves, business incubation can be used to provide technical assistance and seed funding to local enterprises that promise to sell and distribute the new stoves. Examples include the Modern Energy Cooking Services (MECS) program (box 3.1) and the Climate Innovation Centers (e.g., Ethiopia and Ghana) supported by the World Bank Group's info/Dev (Information for Development Program), which focus on the development of innovative technologies, business models, and entrepreneurship (infoDev 2019).

BOX 3.1

THE MODERN ENERGY COOKING SERVICES PROGRAM AT A GLANCE

The Modern Energy Cooking Services (MECS) program is a five-year initiative (2019–24) funded by UK Aid of the Foreign, Commonwealth and Development Office (FCDO) that aims to rapidly accelerate the household transition from biomass to clean cooking with electricity and gas. A key driver is the potential for clean, renewable electricity to reach a price point of affordability with associated reliability and sustainability within a few years. The program focuses on essential research and sector-building activities, drawing on a partnership of the UK's world-leading universities and innovators, led by Loughborough University. Through engagement with the World Bank's Energy Sector Management Assistance Program (ESMAP), it also works to understand and generate evidence on the non-technical drivers of the household energy transition (e.g., "clean" fuel stacking, cooking demand and behavior change, and enabling policy environments to support market and enterprise development). The program's intended outcome is a market-ready range of innovations, both technology and business models, that will lead to improved choice of affordable and reliable MECS for consumers.

Source: <https://meecs.org.uk/>.

Strengthening suppliers' production capacity also includes specialized equipment and technical assistance for local artisans to make improved versions of the most popular stove models purchased by households in the target communities. Such support can reduce artisans' production costs and attract those who otherwise could not afford to enter the stove-making business owing to the costs of market development (box 3.2).

BOX 3.2

BUILDING STOVE-PRODUCER CAPACITY IN THE KYRGYZ REPUBLIC

The Kyrgyz Republic ranks among the worst-affected countries in Europe and Central Asia for diseases linked to household air pollution (HAP). Only 17 percent of households have access to district heating, while 83 percent—mainly the rural and peri-urban poor—rely on solid fuel-fired stoves (coal, wood, and dung) for heating.

Under a World Bank-supported efficient-heating pilot program, technical assistance support in open-source product design and development was provided to local stove producers. Prototypes of high-efficiency, low-emissions (HELE) stoves and low-pressure boilers (LPBs) were adapted to locally available materials, tools, and producer skills. The adapted prototypes were piloted in remote rural areas over two heating seasons, and gained broad acceptance among participating households. At least 27 producers were trained in the production of one or more models. The results of independent health monitoring were quite encouraging, showing significant reductions in respiratory symptoms and infections among most adults and children. Keys to enabling producers to continue improving their skills and services included design assistance; bidirectional knowledge transfer; and initial investments in prototypes, testing, casting patterns, and field installations. An authoritative set of documents covering production, installation, and inspection was produced and used during implementation.

Sources: van Gemert et al. 2019; World Bank 2022; Zhang, Adams, and Pemberton-Pigott 2019.

Community-Driven Development: Aggregate Demand

One operations model that has proven successful in raising public awareness about the benefits of clean cooking solutions and making products affordable to households is community-driven development (CDD). Generally, CDD interventions involve government-assisted community choices (e.g., paving a local road or making improvements to a school or other public facility). Typically, the government holds a community meeting, where members decide on desired and eligible investments. During the meeting, they discuss the range of possible investments, after which they agree on the type of project that best fits their local needs and desires.

BOX 3.3

PROMOTING BETTER STOVES THROUGH PRODUCT CHOICE IN BANGLADESH

The Nuton Jibon Livelihood Improvement Project (NJLIP) in Bangladesh introduced poor communities in the country's worst-off subdistricts (*upazilas*) to improved cooking solutions and other development alternatives, using a community-driven development (CDD) approach. In selected communities, the project team introduced the Bondhu Chula improved cookstove as one of various product choices, utilizing several ministries to promote it.

The Bondhu Chula Company Private, Ltd., which was already active in the project area, agreed to sell its stove to members of the Nuton Jibon Community Society below market costs; subsequently, the Bondhu Chula was selected for the project. The company provided project beneficiaries orientation, leaflets, and technical services at no cost. To overcome the higher upfront costs of the Bondhu Chula improved cookstove, the beneficiaries were allowed to pay in installments.

Among the keys to the success of this CDD activity was giving communities a menu of development options from which to choose. Those that selected the improved cooking option showed that they understood the benefits of using better stoves for their communities.

Sources: Rosenbaum et al. 2013; Tuntivate 2018.

To be eligible, the proposed investments must benefit the entire community and meet certain quality standards. If the community decides on improved stoves, they must be made available to everyone in the community using either full or partial subsidies. In this way, demand can be aggregated to reduce the transaction costs of stoves delivery and achieve economies of scale. The operational strategy of the Nuton Jibon Livelihood Improvement Project (NJLIP) in Bangladesh offers a good example of how a CDD project can stimulate aspirations for improved cooking among communities that depend on biomass for household cooking (box 3.3).

Credit Lines and Risk Mitigation Instruments: Address Access to Finance

Access to finance for clean cooking solutions includes credit lines (including microfinance) for stove and fuel suppliers and end-user households, as well as risk mitigation instruments (e.g., guarantee and collateral support) to enhance their ability to access upfront investment. Credit facilities and microfinance institutions (MFIs) play key roles in promoting the adoption of clean cooking solutions. The former provides clean-stove manufacturing and distribution companies working capital and collateral, while MFIs make such stoves affordable by allowing households to make installment payments. Having the ability to spread out costs over time can help consumers decide on purchasing the clean stoves (box 3.4).

BOX 3.4

CREATING A THRIVING, DEMAND-DRIVEN MARKET FOR BETTER STOVES IN ETHIOPIA

The Ethiopia Clean Cooking Energy Program is a carbon finance project aimed at providing carbon revenues for household biodigesters. The program is complementary to the parent project, Electricity Network Reinforcement and Expansion Project (ENREP): Additional Financing. The credit line component of the parent project establishes a facility for private-sector enterprises and households to develop a market for an array of off-grid, renewable-energy products and services, including better stoves. The Development Bank of Ethiopia, the program's implementing agency, promotes two lines of credit: one to support the working capital requirements of project developers (e.g., private-sector enterprises and small- and medium-sized enterprises) and the other to provide on-lending support to microfinance institutions (MFIs) to make the off-grid renewable-energy technologies, including clean cooking, affordable to household consumers.

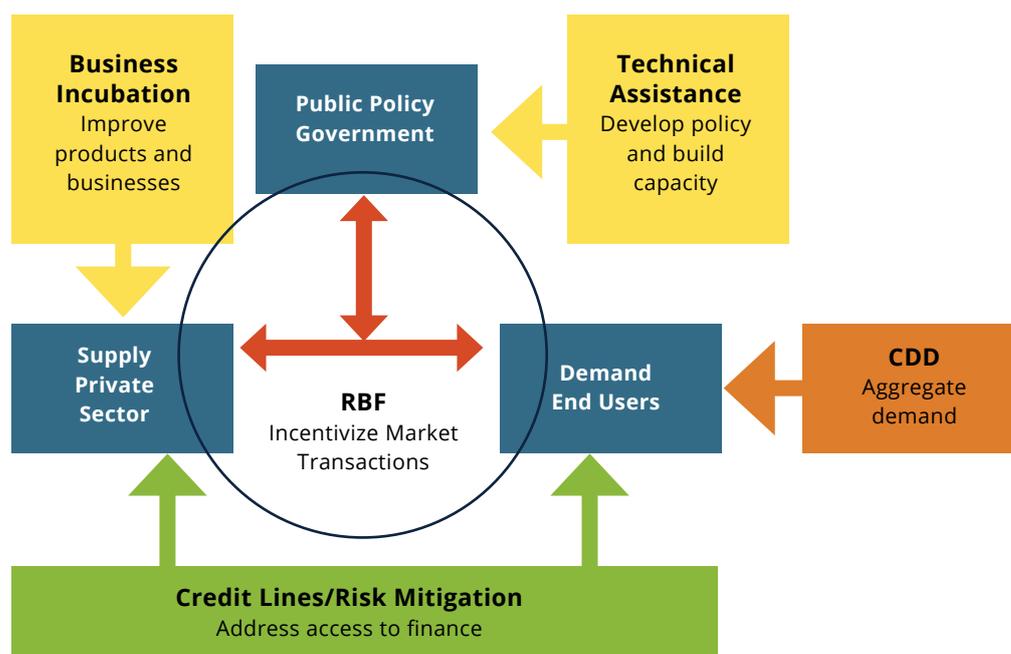
Source: World Bank 2016a.

Results-Based Financing: Incentivize Market Transactions

Results-Based Financing (RBF) is a useful instrument for unifying the key interventions to achieve results that center on market transactions (e.g., clean cooking product sales and adoption) to advance development of the clean cooking market (figure 3.1).

FIGURE 3.1

Key Operations Models Used to Promote Clean Cooking



Source: World Bank 2022.

Note: Gendered considerations, including proactive actions, should be included in all interventions.

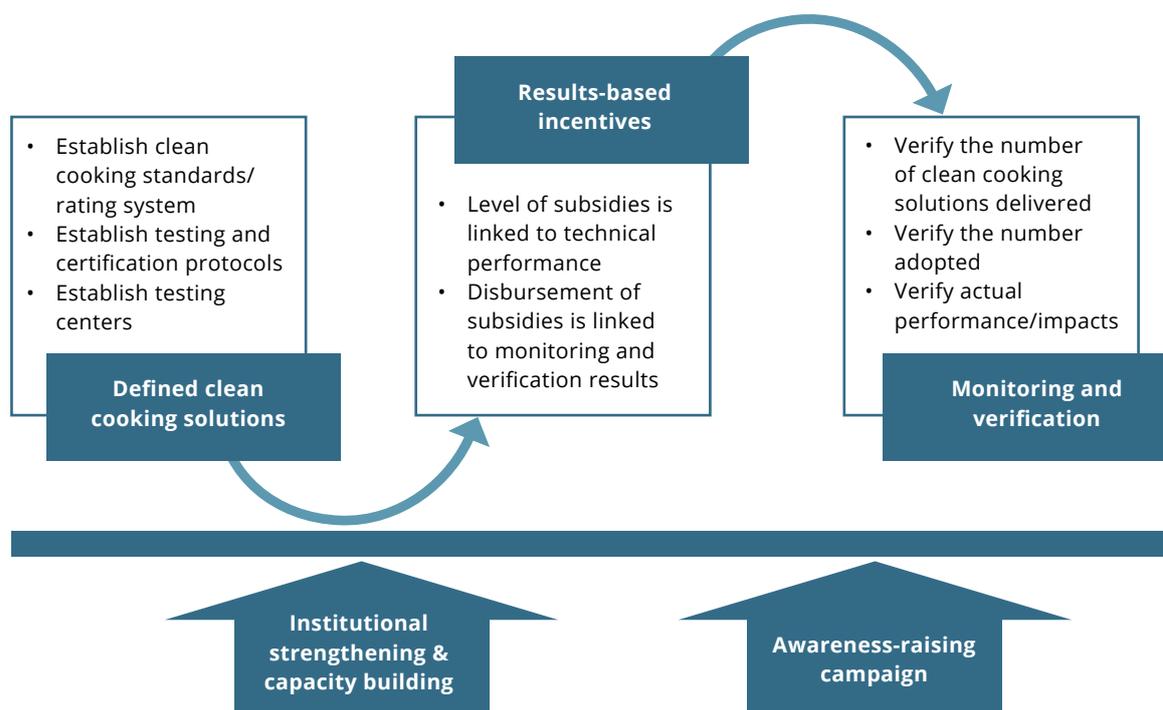
The RBF concept comprises a range of public-policy instruments, whereby financial incentives, rewards, or subsidies are set up that link to performance and delivery of pre-defined, verified results.⁶ Applied to the clean cooking sector, public-sector entities specify the results and subsidies and pay private-sector suppliers against the verified delivery of stoves and their performance (figure 3.2). This approach gives suppliers the flexibility to design, produce, and sell eligible clean cooking solutions that fit the local context (Zhang and Knight 2012).⁷ The instrument's flexibility allows for adjusting the pre-defined results and associated incentives based on the country context, market conditions, and feedback from program implementation.

⁶ The health, infrastructure, and education sectors have demonstrated the effectiveness of RBF in using public resources to incentivize the private sector to deliver third-party verified results. Appendix C provides guidance on how to design RBF tools in the clean cooking sector.

⁷ Private-sector suppliers' access to credit lines might involve setting criteria for eligible technologies and evaluating the eligibility of businesses. Subsidies for higher-efficiency or lower-emissions stove models might be larger than for those with lower levels of efficiency or pollution reduction. Groups that play a major role in selling stoves to consumers (e.g., private firms, community groups, and NGOs), must meet qualifying criteria to be included.

FIGURE 3.2

Conceptual Framework for Applying the RBF Instrument



Source: World Bank 2022.

The World Bank's Experience in Results-Based Financing

The World Bank has implemented the RBF framework to support clean cooking solutions in some 13 client countries (Bangladesh, Burundi, China, Ethiopia, Indonesia, Kenya, Lao PDR, Madagascar, Mongolia, Mozambique, Nepal, Rwanda, and Uganda), with variations based on country conditions. This section highlights the RBF models used and lessons learned.

Driving Sector Development

The RBF pilot implemented under the Indonesia Clean Stove Initiative—one of the pioneering projects that helped mainstream RBF in energy-access operations—provided a framework for unifying all of the key elements needed for developing the clean-stove sector (i.e., policy, institution, technology, standards and testing, private-sector support, demand stimulation, and closing of the affordability gap) and sending the private sector clear signals on expected performance and results (box 3.5).

BOX 3.5

RESULTS-BASED INCENTIVES FOR MARKET DEVELOPMENT IN INDONESIA

Indonesia has made great strides in getting its citizens to adopt clean cooking solutions. Thanks to the government's highly successful Kerosene-to-Liquefied Petroleum Gas (LPG) Conversion Program (2007–12), more than 54 million LPG packages and cylinders were distributed to households and small businesses across the country. Despite these efforts, about two-fifths of the population—some 110 million people—still used fuel-inefficient, polluting stoves. Some 70 percent of households cooking with LPG used biomass energy to heat water on traditional stoves, there being no dedicated high-performance, wood-fueled water-heating appliance on the market. In response, the Government of Indonesia agreed to implement the Indonesia Clean Stove Initiative (CSI) to promote cleaner biomass cooking and water-heating stoves. Lessons from the CSI Results-Based Financing (RBF) pilot program can be found in the report *Incentivizing a Sustainable Clean Cooking Market: Lessons from a Results-Based Financing Pilot in Indonesia* (World Bank 2018).

One of the pilot program's goals was to test a new operations model to create a thriving market for clean cookstoves—something that previous programs implemented by nongovernmental organizations (NGOs) and donors had failed to do because they lacked scale and did little to involve the private sector. The key changes included the following innovations:

- **Pioneered contextual stove testing method incorporating local cooking practices.** Known as the Indonesia Clean Stove Initiative Water Heating Test,^a this new, conceptually sound testing methodology incorporated key variables that depended highly on local context. By developing a holistic, contextual technical test, common and newly devised metrics could not only provide pertinent information regarding fuel efficiency and emissions; these lab tests also reasonably predicted in-home performance.
- **Stimulated local stove design and technology innovation.** Among 15 stove types that qualified for the pilot, 7 were locally designed and produced—in large measure the result of strong technical assistance from the project. Compared with the baseline stoves, the eligible clean stoves reduced particulate emissions (PM_{2.5}) by 90 percent and fuel consumption by half. Overall, pellet-fed stoves were more efficient and less polluting, confirming that processed fuels, combined with modern hardware, delivered better performance.

BOX 3.5 (Continued)

- **Promoted grassroots innovation in business models.** Diverse business experiences and sizes enabled the participating entities to create their own business models, which were often dictated by whether they could negotiate terms of payment for stove procurement from the producers, terms of payment they expected from stove buyers, and the level of risk they were willing to accept. Innovations included extending manufacturer credit to consumers through installment payments, partnering with microfinance institutions (MFIs) to offer consumer credit, offering bundling discounts for stoves/fuels, and partnering with cooperatives as fuel (pellet) distributors.

Sources: World Bank 2016b, 2018; Zhang 2018.

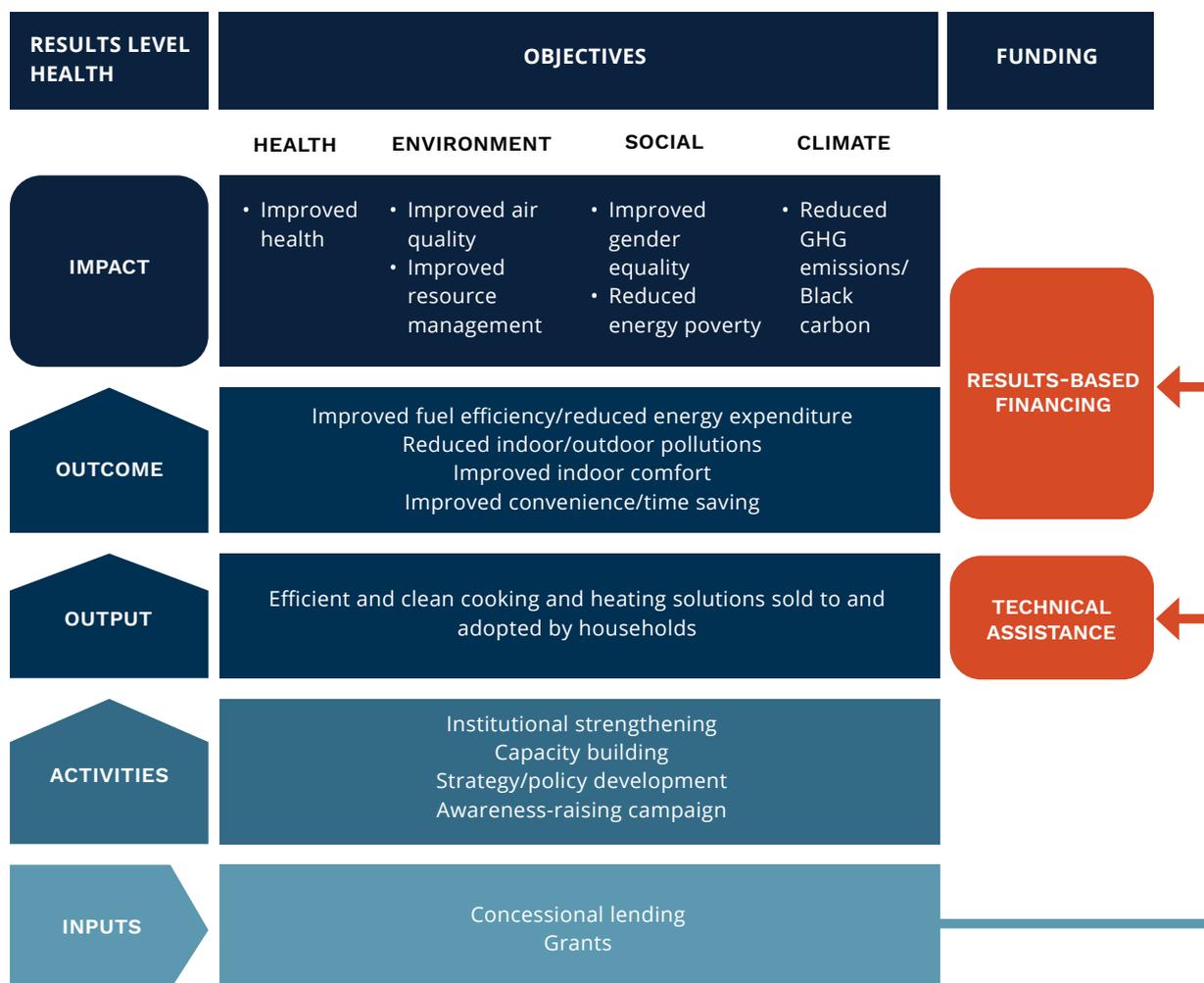
a. Also abbreviated as the CSI test method; see Clean Cooking Alliance Protocols.

Importantly, due to the absence of appropriate national legislation, the pilot project produced its own performance targets and testing standard, which were subsequently adopted in the national standard. These same principles and metrics were later applied to the Program for Results (P4R) financing instrument under the China Hebei Air Pollution Prevention and Control Program (box 2.3).

Impact Investing

The RBF framework and instruments make it possible for donors to invest in the interventions' broader development objectives (e.g., reduced GHG emissions, better health, or advancement of gender equality) (Ahmed et al. 2005; Wang et al. 2013). Carbon finance, essentially an RBF mechanism, has traditionally been an attractive source of financing for clean cooking projects. Building on the carbon market infrastructure, it is possible to monetize the additional verified social impacts, using recently developed methods that quantify and measure health, gender, and black carbon impacts (Gold Standard 2017 a–c; WOCAN 2014). Achieving these impacts would require linking the results-based incentive to certified clean stoves sold to and used by households and technical assistance support (figure 3.3).

FIGURE 3.3
Sample Results Chain for Clean Cooking Interventions



Source: World Bank 2022.

The RBF model used under the Lao PDR Clean Cookstove Initiative (2019–25) links public support to the achievement of demonstrable co-benefits, which, in turn, mobilizes private-sector investments (box 3.6).⁸ In June 2018, a carbon finance grant of US\$5.2 million was approved by the Carbon Initiative for Development (Ci-Dev); and in February 2019, a base-of-the-pyramid investor officially onboarded the project as part of the investment pipeline.

⁸ By 2019, the Dutch NGO SNV had rolled out an inexpensive charcoal stove lighting technology in Lao PDR that had been developed as part of the Indonesia CSI project’s technical assistance and transferred to SNV through Cambodia by GERES, a CSI partner organization. The technology, which reduced total PM emissions by more than half, was adopted throughout Lao PDR.

BOX 3.6

TRANSFORMING THE STOVE AND FUEL MARKET IN LAO PDR

The Lao PDR Clean Cookstove Initiative (2019–25) plans to distribute 50,000 forced-draft gasifier cookstoves to decrease charcoal consumption across 8–11 districts in three provinces of the country. The project will generate economic, environmental, health and gender co-benefits for target households through a switch to energy-efficient, forced-draft gasifier cookstoves that use biomass pellets. The Results-Based Financing (RBF) model helps to lower the stove price and promote the establishment of a market where sales can flourish in the long term, thereby improving energy efficiency in the cooking sector, as well as lowering greenhouse gas (GHG) emissions. The forced-draft gasifier cookstove meets the World Health Organization’s guidelines on household air pollution (HAP), as well as the voluntary performance targets (VPTs) for thermal efficiency, safety, and durability set by the International Organization for Standardization (ISO).

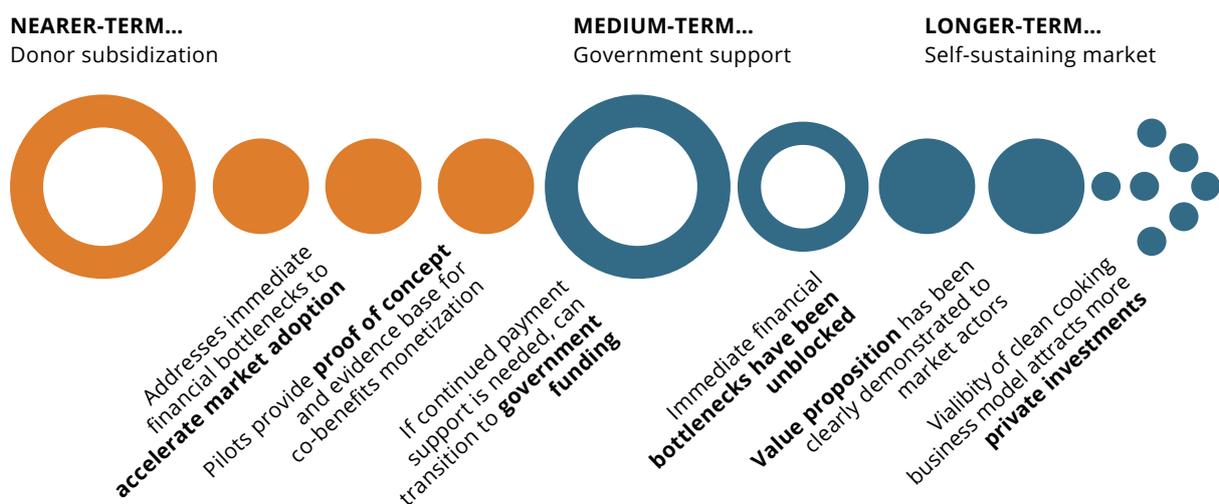
While similar technology has been implemented elsewhere with some success, this is the first time a project has aimed to distribute the technology at such a large scale with the goal of transforming the local cookstove and fuel-source market. Results of a 2017 pilot implemented in collaboration with the World Food Programme and the Poverty Reduction Fund showed positive stove uptake and revealed strong links to health benefits (e.g., decreased coughing and headaches), shifts in women’s time and labor burden, household savings, and lowered emissions.

Source: World Bank.

Incentivizing the Private Sector

The World Bank's Clean Cooking Fund (CCF) mainly uses RBF approaches to help countries incentivize the private sector to deliver clean cooking solutions and spur market development (box 1.1). Donor subsidies are used to address the immediate financing bottlenecks faced by both suppliers and consumers, as well as the public impacts not internalized by market players. Over the medium term, as the approaches become more established with the evidence base for monetizing the co-benefits (e.g., health, gender, and climate), it is expected that the need for continued payments for market development and equal access to clean cooking will transition to government support. Over the longer term, as the market further develops with economies of scale, financial bottlenecks will be unblocked and the viability of clean cooking businesses will be able to attract more private investment. The market could then move into a self-sustaining state, and the affordability concern for the poor could be fully integrated into the country's social safety net programs (figure 3.4).

FIGURE 3.4
RBF's Role in the Context of the Clean Cooking Fund



Source: World Bank 2022.

The CCF's first IDA co-financed project in Rwanda, which has adopted a pro-poor RBF design, is expected to help more than 2 million people access clean cooking solutions (box 2.5). In Uganda, another CCF co-financed project, which combines RBF with a debt facility, will support the strengthening of supply chains for high-efficiency biomass stoves and the transition to clean cooking fuels (box 3.7).

BOX 3.7

STRENGTHENING STOVE SUPPLY CHAINS IN UGANDA

Uganda is heavily dependent on traditional, polluting biomass stoves and fuels. In 2019, it ranked among the world's top 20 access-deficit countries for clean-cooking fuels and technologies by both population size and percentage of the population (figure 2.1). The country's high access deficit can be explained, in part, by households' inability to access improved and efficient stoves, owing to missing links in the supply chain, as well as their limited awareness of or inability to afford products already on the market.

The US\$2.2 million Uganda Clean Cooking Supply Chain Expansion Project (2017–20), a pilot project funded by the World Bank's Energy Sector Management Assistance Program (ESMAP), was designed to address gaps in the country's supply chain for quality-assured, efficient biomass stoves and enhance companies' efforts to raise consumer awareness and engagement. A grant facility set up by the pilot's implementing body, Private Sector Foundation Uganda (PSFU), extended credit lines to incentivize new sector players; provided upfront matching grants and ongoing Results-Based Financing (RBF) to scale up distribution networks for select products; and enabled flexible consumer-payment methods. Pre-project activities included consumer trials to assess product compatibility and willingness to pay and lab- and field-based product testing to meet thermal efficiency and other eligibility criteria. The pilot also commissioned a behavioral diagnostic study to better understand the drivers of customer decision-making.

By the project close in September 2020, 72,535 stoves had been sold, exceeding the target by more than 27,500 units. Women reported that the stoves freed up 30–90 minutes per day. Households enjoyed a 36 percent reduction in monthly fuel consumption and an equivalent amount in financial savings, while emissions were reduced by 30 percent.

Lessons from the pilot project have informed the design of a scaled-up US\$20 million clean cooking component under the US\$638 million Uganda Electricity Access Scale-up Project, approved in 2022. Co-financed by the Clean Cooking Fund (CCF) and the IDA, at US\$10 million each, the clean cooking component is expected to leverage another US\$10 million in private-sector financing. The component will establish a debt facility for supplier and consumer financing of off-grid solar and clean cooking solutions, and an RBF mechanism for clean cooking solutions (including liquefied petroleum gas [LPG], ethanol, biogas, and electricity).

Source: ESMAP 2021.

Complementary Measures

The World Bank's RBF experience, like that of Energising Development (EnDev) and other global initiatives, confirms that successful interventions require a strong enabling environment, which reduces the amount of incentives needed to direct the market (EnDev 2021). Key elements include an institutional champion, technical assistance and capacity building tailored to the needs of enterprises, and effective marketing and awareness-raising campaigns (ESMAP 2020a; World Bank 2018). Without a favorable regulatory environment in place to support market development (e.g., tax and tariff policies), risk-averse private-sector players are unlikely to invest in the clean stoves-and-fuels market. Appendix C summarizes lessons in how to design effective RBF tools.

Summary Remarks

How one shapes the design of a clean cooking intervention depends, to a certain extent, on a country's readiness for promoting clean cooking technologies. For example, if an extensive stove testing laboratory is already well-integrated into a country's enabling environment, the technical assistance provided by the intervention has no need to duplicate this feature save to ensure that national evaluation metrics match those of the project. However, technology transfer and capacity-building activities may be needed to support and encourage local innovation. In some countries, private-sector sellers of appliances can easily fit stoves into their businesses. In others, nongovernmental organizations (NGOs) may be ready to take up stoves programs. To ensure a successful project outcome, these various elements need to be adapted to fit the local context.

The main advantage of RBF is that it avoids the fragmented approaches of past stoves programs by unifying and aligning the key operations models toward performance-based targets and results that reward market transactions and adoption. It corrects a temporary market failure by monetizing the full co-benefits of clean cooking interventions not currently priced in by the market and subsidizing market actors' costs to build customer awareness and market adoption. By developing the evidence base and track record, it can crowd in new RBF buyers and future commercial financiers and eventually act as a revenue source to attract upfront private investment funding for project developers.

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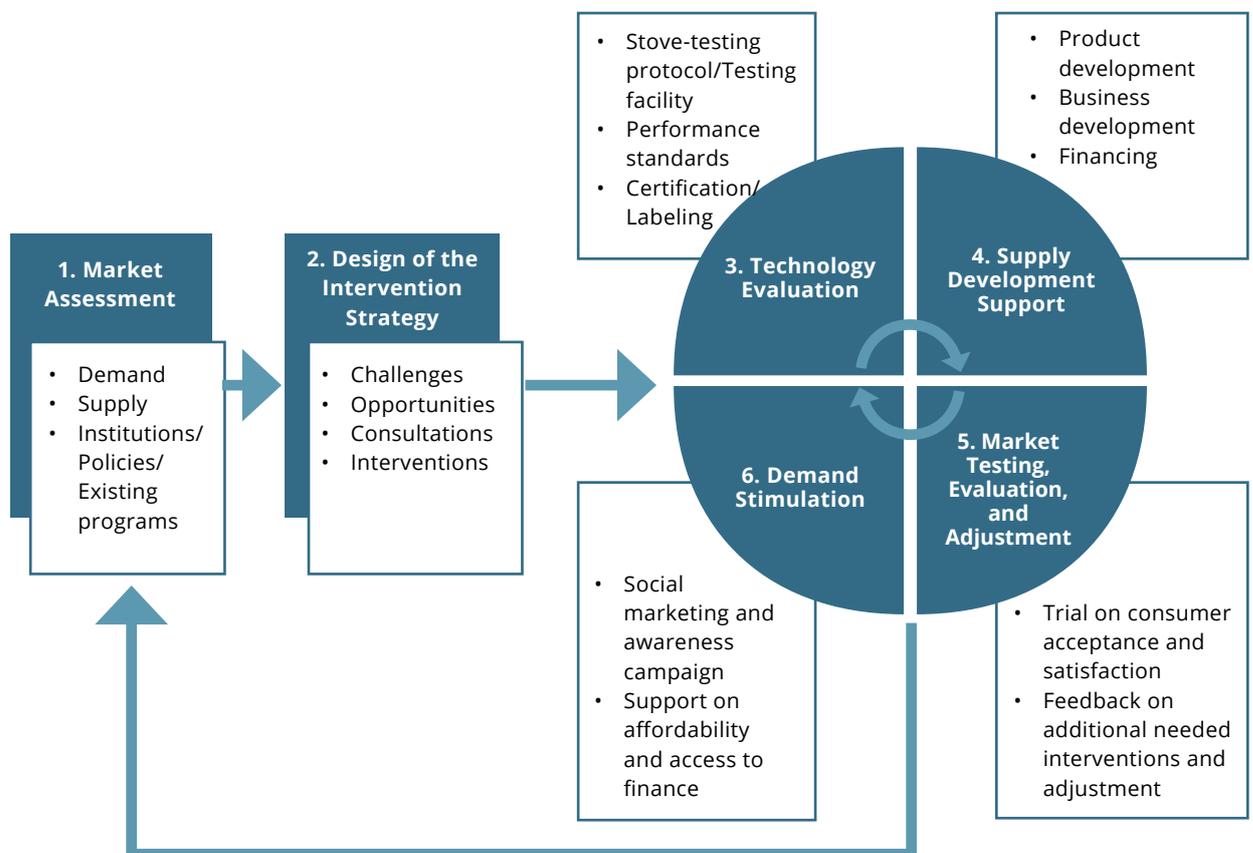


A photograph of four young people standing in a brick-making area. They are surrounded by large, rectangular bricks and wooden structures. The background shows a rural landscape with trees and hills. The text 'FOUR BUILDING BLOCKS TO PROMOTE MARKET DEVELOPMENT' is overlaid on the image in large, white, bold letters.

FOUR
BUILDING
BLOCKS TO
PROMOTE MARKET
DEVELOPMENT

All projects that promote the development of clean cooking markets, regardless of their operations models, require putting certain building blocks in place to ensure access to the clean stove products and stimulate uptake. For interventions that aim to promote market development for long-term sustainability, the key building blocks are (1) Market Assessment; (2) Design of the Intervention Strategy; (3) Technology Evaluation; (4) Supply Development Support; (5) Market Testing, Evaluation, and Adjustment; and (6) Demand Stimulation (figure 4.1). These six building blocks can be put in place as part of a project’s identification and preparation phases or integrated into its implementation design.

FIGURE 4.1
Key Building Blocks for Clean Cooking Interventions



Source: World Bank 2022.

Figure 4.1 highlights the project’s learning feedback loop among Building Blocks 3–6 and between them and Building Block 1. For example, stove developers and designers may discover they need to make technical adjustments to their candidate products to meet the eligibility requirements established during the technology evaluation. Based on iterative consumer feedback before or after pilot trials, they may also need to modify or redesign their products to better meet users’ needs and gain consumer acceptance. Feedback from

consumer surveys may positively reinforce the appropriateness of the project's social marketing strategy or reveal the need for refinements to reach target customers more effectively. After project completion, a market assessment may be conducted again to evaluate the effectiveness of its implementation and inform the next round of interventions to promote market development.

1. Market Assessment

The first step in planning and implementing a clean cooking project is to carry out a market assessment of demand; supply; and institutions, policies, and existing programs (box 4.1). Market surveys are needed to assess both household demand for stoves and fuels and the cookstove supply and market. In addition, institutional mapping of policies, programs, and players is needed to identify who has done what and learn from past and ongoing program experience.

BOX 4.1

ASSESSING MARKET READINESS

Designing effective clean-cooking interventions depends, in part, on the state of a country's enabling conditions, particularly its institutional capacity, supply-side development, and demand-side stimulation. In countries where stove programs have been conducted for decades and the necessary infrastructure is already in place, the required technical assistance for a successful intervention may be limited. However, in countries where commercial markets and supply chains are undeveloped and both producers and consumers have low awareness levels, considerable time and resources are required for building the capacity to implement scaled-up, transformative solutions.

Source: World Bank.

Household Demand for Stoves and Fuels

A critical initial step is gaining a better understanding of the range of contextual factors that influence the target population's demand for cookstove technologies and fuels. Household surveys, the most common approach for assessing this demand, seek to identify the following:

- **Stove usage.** Determined by the types and number of cookstoves commonly used by the household, frequency of use, and frequency of non-cooking use (e.g., for heating or income generation).
- **Ability to pay.** Determined by the types and quantity of fuels used, seasonal variation, and total household spending on cooking.
- **Expectations about durability and safety.** Determined by the cost of stoves, number in use, and frequency of replacement.
- **Willingness to pay.** Determined by the typical decision tree for making purchases and taking on family debt and the cost threshold requiring spousal consultation.
- **Heating power and burn and cooking cycles.** Determined by the cooking habits of the household's main cook(s) (frequency of stove use; length of time spent cooking each meal; types of food usually cooked; and, if the stove is also used to generate income, the cooking fuels, vessels, and duration).
- **Adequacy of ventilation.** Determined by the physical characteristics of the kitchen or cooking area.
- **Awareness of health impacts.** Determined by knowledge about and attitude toward household air pollution (HAP), clean cookstoves, and a clean cooking environment.
- **User preferences on performance.** Determined by the key functions of cooking stoves.

In addition to providing useful information for designing and implementing interventions, household demand-side surveys can be used as baseline information for monitoring and evaluating progress as projects move forward. They can also clarify the focus of education, promotion, and social marketing campaigns and materials (World Bank 2018).

For countries where Multi-Tier Framework (MTF) data is available, household demand-side surveys may not be needed. New datasets from the MTF household surveys and analysis of household demand have allowed stakeholders to delve into the “hows” and “whys” of adopting modern cooking services (box 4.2).⁹

⁹ One should note that the geographic coverage of MTF surveys is national, including urban and rural localities; thus, if a project's geographical scope is regional, the MTF survey would be inappropriate, in which case a more region-specific and specialized survey would be necessary to assess markets for cleaner and better stoves.

BOX 4.2

INFORMING PROJECT DESIGN: THE MULTI-TIER FRAMEWORK

The Multi-Tier Framework (MTF) for cooking, developed in 2015, is part of a global initiative to measure energy access for household cooking and electrification and track progress toward achieving Sustainable Development Goal (SDG) Target 7.1. The MTF household surveys capture multidimensional data on users' cooking behavior and practices, including fuels and appliances used, frequency of use, convenience, safety of stoves and fuels, cooking arrangements and kitchen ventilation, and cooking expenditures and affordability. The surveys allow for disaggregate and aggregate data analysis to yield detailed information on various parameters, including geographic distribution, locality, and gendered aspects of cooking, fuel-collection time, and incidence of health issues.

A first round of nationally representative household surveys has been completed in 16 countries: Bangladesh, Cambodia, Democratic Republic of Congo, Ethiopia, Honduras, Kenya, Liberia, Madagascar, Myanmar, Nepal, Niger, Nigeria, Rwanda, São Tomé and Príncipe, Uganda, and Zambia. A second round of data collection is under way in another 9 countries: Burkina Faso, Burundi, Cameroon, Eswatini, Malawi, Pakistan, Papua New Guinea, Sierra Leone, and Zimbabwe.

In 2021, the World Health Organization and the World Bank's Energy Sector Management Assistance Program (ESMAP) published *Measuring Energy Access: A Guide to Collecting Data Using 'The Core Questions on Household Energy Use'*. This guidebook provides survey practitioners and policy makers the tools and technical support required for integrating the MTF attributes into existing national household surveys and the methodology for tracking SDG 7.1.1 and 7.1.2 indicators and effectively measuring progress. A questionnaire module and steps for calculating indicators are provided, and follow-on, capacity-building activities are planned.

Sources: Bhatia and Angelou 2015; UN 2019; World Bank and WHO 2021.

The MTF survey results show that ensuring demand requires services, products, and interventions adapted to the household's needs. The number of households with access to clean, as well as less clean, fuels has increased in absolute terms. Stacking is prevalent, even among urban households and those with higher incomes (box 4.3). In countries where clean-fuel penetration is relatively strong, affordability and availability factors (seasonal variation in fuel availability and supply chain volatility) may drive stove users, particularly those in lower-income and rural households, toward less clean, secondary cooking solutions. While convenience factors (e.g., time spent collecting fuel and preparing the stove for cooking) are consistent across countries, their relative importance as a driver of cooking solutions varies dramatically by fuel.

BOX 4.3

INTEGRATING STACKING INTO THE CLEAN COOKING TRANSITION

Stacking—the use of multiple stove-and-fuel combinations within the same household—is a pervasive practice in many developing countries. A recent systematic review shows that stacking was reported in nearly all of the literature covered (ESMAP 2020d). Even in countries with decades-long, clean-fuel penetration, stacking can persist. In rural Nepal, for example, 58 percent of households that use liquefied petroleum gas (LPG) as their primary cooking fuel supplement it with traditional stoves. In Ecuador, 44 percent of LPG-using households use secondary wood for cooking (ESMAP 2020a). These examples underscore the importance of contextual and behavior-change factors that influence users' cooking choices and preferences.

The reasons for stacking—ranging from affordability and convenience issues to seasonal fuel availability and supply-chain volatility—depend highly on the local cooking context. A recent qualitative study in urban and rural Kenya, for example, finds that time savings from parallel cooking is the most prevalent reason for stove stacking, followed by the need to accommodate large-sized pots for cooking traditional dishes and warming water (Ochieng et al. 2020).

Having a better contextual understanding of what drives households' stacking behavior is an essential element in designing programs to advance the transition process to clean cooking solutions. Such tools as the World Bank's Multi-Tier Framework (MTF) for cooking, whose national surveys capture stacking data, can

BOX 4.3 (Continued)

help to explain the reasoning behind households' choices of secondary cookstove technologies and fuels. The MTF surveys can be utilized to inform program and policy design, track incremental progress toward achieving Sustainable Development Goal (SDG) Target 7.1, and measure impacts (ESMAP 2020a).

Equipped with a deeper understanding and appreciation of households' energy use and priorities, program designers can develop practical solutions that address the technical deficiencies that drive households' need for stacking. For example, two-burner stoves can eliminate users' need for a parallel traditional cookstove; adjustable pot rests can be added to stoves to accommodate large-sized pots; and electric pressure cookers (EPCs) can address the need for fast or energy-saving bulk cooking (Zhang and Ochieng 2020). Such user-centered solutions and innovations, along with existing stoves, can be offered as a suite of "clean" stacking options. In this way, households can sample and aspire to modern cooking solutions, while maintaining a fallback option when faced with bottlenecks associated with the newly adopted technologies and fuels.

Sources: ESMAP 2020a, d; Ochieng et al. 2020; World Bank and WHO 2021; Zhang and Ochieng 2020.

Using behavioral diagnostics to assess the barriers to consumers' uptake and sustained use of clean or improved cooking fuels and technologies can provide project teams important insights that can be translated into more customized approaches to stimulate household demand. Examples of behavioral barriers include low consumer exposure to the new technologies, low awareness levels, and biases, among others. In Uganda, for example, a behavior change study found that the roles and preferences of men and women affected consumer choices (ESMAP 2019b). As a result, the Uganda Clean Cooking Supply Chain Project made changes in its awareness-raising strategy to include brand activation events in strategic hotspots, radio advertisements, digital marketing, and social media outreach (ESMAP 2021) (box 3.7). A behavioral study under the Rwanda Energy Access and Quality Improvement Project found that the length of time households spent cooking beans and other staple foods resulted in stove stacking. The study recommended demonstrations explaining how one can save cooking time by soaking beans beforehand (De Martino, Lourenço, and Coony 2021).

Stoves and Fuels Supply and Market

Before developing new mechanisms to promote better stoves, designers of clean cooking interventions also need to gain a better understanding of the project area's existing stove/fuel production and supply chain. Stoves markets can vary widely within countries. In Indonesia, for example, markets for purchased biomass stoves are unlikely in remote rural areas and islands, where most households make their own stoves; however, more developed regions may have better-established markets for regionally produced and even manufactured stoves. To assess the stoves market and supply chain, it is necessary for the project team to conduct a supply-side survey, complemented by market research.

The supply-side survey and market research objectives are to identify the following:

- Types of cookstoves being locally produced.
- Methods and techniques commonly used to produce stoves (e.g., artisanal, manufacturing, or a combination thereof).
- The stove producers and their production capacity and capability.
- How these stoves reach the market.
- Production costs and durability of the stoves being produced.
- Key barriers to improving product performance and reaching scale.

Supply-side market surveys help the project team identify the main stove suppliers and better understand suppliers' potential and constraints, how the supply chain works (especially the distribution channel), existing business models, and key challenges and opportunities to reach project objectives. The team may also reach out to potential suppliers attracted to the sector to get their views on market potential; these suppliers might include international companies active in the cooking sector or local household energy or appliance businesses (e.g., off-grid solar home systems [SHSs]).

In addition, market research may be needed to gain a better understanding of consumer behavior, preferences, and willingness to pay (WTP) for the clean stove technologies and fuels so that suppliers may improve their products and business models. In Uganda, for example, a comprehensive 2015 study on consumer acceptance and WTP for clean cookstoves served as a guide for product designers and suppliers (e.g., consortia of stove manufacturers and distributors) who participated in selling qualified cookstoves through grant support provided by the Distribution Challenge Fund (ESMAP 2021). Under the Indonesia Clean Stove Initiative (CSI), data collected by the social and gender team using participant observation methods, interviews, and surveys allowed the project team to better understand how women interacted with the stoves. The data was shared with stove designers and developers so they could adapt their product designs to users' needs. At least one stove manufacturer used this data, along with laboratory-testing results, to directly involve women in the redesign and development of a much improved version of the baseline Keren clay stove, known as the Keren Super 2 (World Bank 2018).

Institutional Mapping

Clean cooking solutions involve a variety of cross-cutting, energy-related issues (e.g., modern energy access, promotion of energy efficiency and renewable energy, business development and renewable energy investment, and biomass utilization), as well as issues related to health, gender equality, and climate/environment. Thus, the project should examine the country's current laws and policies related to clean stove technologies and fuels and review applicable lessons from past and ongoing programs promoting clean cooking. This process should be followed by identifying key institutions—government, development partners, nongovernmental organizations (NGOs), and private-sector players—and deciding which one might be best positioned to take the lead in promoting and implementing clean cooking solutions.

2. Design of the Intervention Strategy

After completing the market assessment, the next step is to conduct a gap analysis and design the overall intervention strategy, which will then inform the design of the country investment project. The gap analysis should identify the key supply- and demand-side and institutional barriers faced by the project and opportunities for overcoming them. For example, without demonstrated consumer demand, small producers, who have limited working capital, may be hesitant about producing clean cooking solutions. Household customers accustomed to inexpensive stove prices who are unaware of the harmful health effects of traditional stoves may be unwilling to pay for cleaner stove products, which are usually more expensive. Institutional challenges may include neglect of the biomass cooking issue owing to low awareness; failure to prioritize the health, gender, and climate impacts of traditional biomass cooking; or lack of a counterpart agency. The gap analysis should identify a competent and committed government-supported institution (i.e., an institutional champion) to lead project implementation (box 4.4). In addition, it should identify the overall strategy; key interventions; and targets (near-, medium-, and longer-term). Furthermore, it should identify ways to mobilize and prioritize resources, as well as mechanisms for collaboration and leveraging of partnerships.

BOX 4.4

IDCOL'S KEY ROLE AS INSTITUTIONAL CHAMPION

In Bangladesh, the Infrastructure Development Company Limited (IDCOL)—the implementing agency for the Rural Electrification and Renewable Energy Development (RERED) II Project—well illustrates an institutional champion's vital role in the success of a Results-Based Financing (RBF) cookstoves program (box 2.4). IDCOL is responsible for fund management, including approval of proposals submitted by the participating organizations and subsequent dispersal of credit or subsidies, developing a testing-and-approval system for stoves promoted by those organizations, and managing business incubation grants. It may also approve the development of stoves included in community-driven development (CDD) activities and other government programs.

The strong monitoring and quality assurance process that IDCOL has put in place keeps track of each improved cookstove sold and installed under the project, utilizing an inspection team, call center, and web-based software. To enhance accountability for service delivery, mobile text messaging and other information technology (IT)-based options are used to monitor customer feedback. IDCOL also keeps track of program impacts (e.g., improved levels of indoor air quality and reduced levels of carbon emissions).

Source: World Bank.

The shape of the intervention strategy depends on what building blocks the country's government has already put in place and can be designed to close gaps in existing programs (box 4.1). In cases where little government action has occurred, most or all of the building blocks need to be developed to facilitate program implementation. For example, at the time the World Bank-supported Clean Stove Initiative (CSI) was initiated in Indonesia, that country's highly successful Kerosene-to-LPG Conversion Program had substantially increased the number of urban households using liquefied petroleum gas (LPG) and development of its biogas sector was under way; however, few elements were in place to support a clean cooking program for the remaining two-fifths of the population dependent on traditional biomass cooking energy. Further research indicated that about 70 percent of those who cooked with biomass also used some LPG, if available; and 70 percent of those who primarily used LPG still used biomass (mainly for heating water and cooking dishes for special occasions). Thus, it was necessary for the project to focus efforts on developing all six building blocks (figure 4.1).

During development of the intervention strategy, the project team should present the findings from the market assessment and consult with key stakeholders on the proposed strategy and approach to get their feedback and inputs. This is an important step to align support for implementation. Box 4.5 illustrates the structural components of a country investment project using RBF as the main approach, which may be included as a component under a much larger-scale, energy-access project.

BOX 4.5

ILLUSTRATIVE STRUCTURE OF A COUNTRY INVESTMENT PROJECT

To scale up investment in clean cooking, a country investment project might focus on several interlinked intervention components, as follows:

- **Support for the enabling environment.** This component includes (1) policy development and improvement (e.g., better fuel/stove regulations, quality standards, and tax/tariff policies to support development of the clean cooking market); (2) technical assistance to market players (e.g., market intelligence studies and entrepreneurship technical support, including product development and targeted training for women entrepreneurs); (3) innovation grants to co-finance research and development (R&D) or early piloting of technological, business, and data-collection innovations and knowledge transfer; (4) consumer awareness campaigns (e.g., working with health practitioners, women's groups, and educators on household air pollution [HAP] and clean cooking options); and (5) coordination with relevant sectors (e.g., the social protection sector to improve affordability for low-income households and access for vulnerable populations).
- **Improved access to finance for clean cooking businesses and end users.** This component provides lines of credit, partial credit guarantees, and collateral support to eligible clean cooking businesses and end users (institutions, businesses, and households). It is likely operated together with an access-to-finance facility also accessible to providers of off-grid and mini-grid products and services through a financial intermediary.

BOX 4.5 (Continued)

- **Results-Based Financing (RBF) incentives for verified output, outcome, or impact results and innovation grants.** This component provides (1) upstream RBF incentives supporting the development of clean cooking businesses by targeting high-performance technological solutions, innovative business models, or particularly challenging market segments with verified outputs; (2) RBF incentives for verified outcomes (e.g., continued use of clean cooking solutions), which may be channeled directly to end users; (3) RBF incentives for verified impact-level co-benefits (for climate, health, and gender) following the established methodologies and monitoring and verification (M&V) protocols; and (4) fund management and verification costs.

Source: World Bank.

3. Technology Evaluation

Selecting the technical performance criteria is a critical building block in project preparation. Promoted stoves must do, in the field, what is claimed about them. Specifically, the project team must select (1) a validated stove testing method; (2) a test sequence reflecting known behaviors and fuels in the community of interest; (3) the performance targets for metrics based on project, national, or international targets (or some combination thereof); and (4) an acceptable product certification process. These elements, together with the institutionalization of the clean cooking issue and addressing demand- and supply-side barriers, are key to creating the enabling environment.

Stove Testing Protocols and Facilities

Using laboratory-based testing of performance with an arbitrary fuel, pot, and test sequence (e.g., WBT and IWA) for rating and selecting a stove is widely recognized as obsolete. Arbitrary tests in a lab cannot predict field performance, even relatively. Rather, like any other product, a stove must be rated in the context of its conditions of anticipated use. Extensive work on how to test stoves “in context” has been done by the World Bank’s CSI projects in Indonesia and China, as well as others elsewhere.

The ISO stove testing method includes a default test sequence that can be adjusted to better fit the project context. Contextual evaluation of performance is essential for selecting stove models and fuel technologies that can benefit the target population, as well as to estimate or demonstrate the project's outcome targets and potential co-benefits (e.g., for health or climate/environment) (box 4.6). Contextual test sequences are based on social surveys, field observations, and laboratory-based testing that reflects intended patterns of use. Field testing measures various indicators—dependent on local cooks, foods, practices, and fuels—while the stove is in use. Field testing is not normally used for rating performance. However, it does provide useful input when designing the contextual test sequence for the laboratory. Contextual lab testing evaluates stove performance and quality within a controlled setting, using repeat tests, which allow for differentiation between stoves replicating a set of known behaviors.

The 2003 Kitchen Performance Test (KPT) is the most common field-testing protocol used for projects under the Clean Development Mechanism (CDM) of the Kyoto Protocol,¹⁰ even though it is not reviewed or published by them.¹¹ The KPT aims to (1) assess the qualitative aspects of stove performance through household surveys and (2) compare the impact of the clean cookstoves on fuel consumption in working household kitchens. To meet these aims, the test includes quantitative surveys on fuel consumed and qualitative surveys on stove performance and acceptability.¹² Increasing use of new technological devices to monitor and record emissions (e.g., stove-use monitors and indoor air pollution [IAP] meters for measuring carbon monoxide [CO] and particulate matter [PM]) have provided reliable insights into cooking system performance when adopted in real-life contexts.

The KPT is a test of the family and is not useful for rating stove performance. It observes total family fuel consumption and indoor air quality, not stove performance based on ISO metrics; thus, it cannot validate ISO performance ratings. It cannot separate the influence of the physical environment (inside and outside the home) and user behavior from the stove performance itself, and its measurements bear little relationship to other protocols.¹³ However, it can be useful in assessing a project's impact on the community. One drawback is that it is costly and time-consuming to implement (i.e., to ensure acceptable statistical power, a relatively large sample size is required, but the test intrudes on households' daily activities).

¹⁰ It is unclear what will be used under Article 6 of the Paris Agreement, which requires the re-assessment of all existing carbon projects.

¹¹ The KPT has not been published in a peer-reviewed journal and has no custodian; some version of the ISO Field Test could be considered as a replacement.

¹² Acceptability is not an ISO metric, however it could be a useful clean-cooking project metric.

¹³ The KPT field observations bear little relationship to lab ratings primarily because the WBT, which has been used to select products for promotion, does not consider how the stove will be used.

BOX 4.6

CONTEXTUAL STOVE TESTING

Increasingly, scientists recognize that contextual stove testing protocols that combine field-based observations and contextual laboratory tests are critical for developing a clean stoves market and mitigating the risk that arbitrary testing or performance modeling results may overestimate a project's outcomes, benefits, and potential co-benefits for society. The first step is to collect data on the actual cooking and fuel practices of households in the project setting through social-science investigation (i.e., characterizing the customers, their behaviors, expectations, and fuels). This understanding is used to develop a suitable testing sequence (technical test) for that market. This technical test is used to rate the performance tiers of candidate products, which are assessed through an iterative feedback process.

The robust, contextual stove testing protocol developed under the World Bank's Indonesia Clean Stove Initiative (CSI) was key to ensuring that results of controlled laboratory testing reflected the variables that depend on the local context (e.g., fuel-moisture content, user expectations, operating sequences, and types of cooking vessels). Known as the CSI-Water Heating Test, the outcome metrics could reasonably predict in-home performance. Utilizing the feedback, local stove suppliers could adapt their models for a given geographic market, and manufacturers in other countries could test their stoves remotely for the Indonesian market. The Indonesian government subsequently adopted the CSI project's performance targets and testing protocol as its national standard.

Sources: Abdelnour and Pemberton-Pigott 2018; World Bank 2018.

Laboratory-testing protocols take less time and are easier to implement; however, their results are criticized as being irrelevant to the context of use. In past years, seven laboratory-based tests have been used by cookstove projects:¹⁴ (1) WBT in 7 versions, (2) Emissions and Performance Test Protocol (USA), (3) Adapted WBT (Cambodia), (4) Heterogeneous Testing Procedure (RSA), (5) Indian Standard on Solid Biomass Chulha-Specification, (6) Chinese Biomass Stove Standard, and (7) Controlled Cooking Test (CCT, 2003), ISO 19867-1 (emissions targets are based on stoves with a firepower < 10 kW).

¹⁴ The Clean Cooking Alliance (CCA) provides detailed information on clean cooking protocols.

To select an appropriate test sequence, the project team should carefully examine the real context of stove usage, including the following:

- Local culture and tradition related to cooking tasks.
- Types of food cooked and vessels used by households in the project area.
- Types and moisture content of fuels used for various tasks.
- How foods are prepared.
- How cooks interact with the stove while cooking.
- The cooking sequence and its associated burning sequence (fire management).

By understanding how each of these criteria is integrated into the laboratory-based replication, the project team can choose the sequences that are likely to represent stove use.

Stove testing capacity varies significantly by country. Large countries, such as India and China, have their own stove testing laboratories, protocols, and test sequences. Having an available in-country lab allows for immediate and frequent communication on test results with local stove developers, as well as international stove suppliers if projects include local/international collaboration. Smaller countries often have no capacity to test stoves for efficiency, emissions, safety, and durability. A project could identify a test sequence and the required metrics but find no testers. In such cases, stoves will have to be sent to an external testing agency.¹⁵ Alternatively, the project can include local capacity building in stove testing as a component of technical assistance.¹⁶ If packing and shipping stoves in bulk to an outside lab are cost prohibitive, the project team may prefer to establish an in-country lab. If so, the first step is to assess the in-country technical capacity, know-how, and willingness to adapt and evaluate the equipment needed for conducting the required protocol. The team should always consider ways to enhance the capacity of the in-country testing laboratory.

Performance Standards

Setting stove performance standards is critical because better stoves, by definition, have higher efficiency, lower emissions, improved safety, and increased durability. A set of performance-based standards was published in 2018 by the International Organization for Standardization Technical Committee 285 (ISO/TR 19867-3 2018). While allowing for the development of project-specific performance tiers, the default voluntary performance targets (VPTs) cover five indicators against which a project's baseline stove may be rated (box 4.7).¹⁷

¹⁵ The CCA maintains a list of international stove laboratories. However, any certifications are national, and, in most countries, are rarely conducted by a nationally registered ISO 17065–certified inspector.

¹⁶ Examples of projects with components for establishing stove testing laboratories include the Indonesia Clean Stove Initiative and the Mongolia Ulaanbaatar Clean Air Project.

¹⁷ The ISO Technical Committee 285 initially comprised experts nominated by 45 countries and 8 liaison organizations.

BOX 4.7

PERFORMANCE BENCHMARKS FOR RATING STOVES

The Technical Report (ISO/TR 19867-3) voluntary performance guidelines established by the International Organization for Standardization provides default benchmarks for the rating of stoves tested in a laboratory setting. The benchmarks permit adaptation of the performance goals to suit a project and/or the cooking tasks so as to accommodate a contextual testing sequence. Test results for each of the five indicators are rated on six performance tiers, from lowest to highest (table B4.7.1).

TABLE B4.7.1

Default Values for ISO Voluntary Performance Targets

TIER ^a	THERMAL EFFICIENCY (%)	CO EMISSIONS (g/MJd)	PM _{2.5} EMISSIONS (mg/MJd)	SAFETY (score)	DURABILITY (score)
5	≥ 50	≤ 3.0	≤ 5	≥ 95	< 10
4	≥ 40	≤ 4.4	≤ 62	≥ 86	< 15
3	≥ 30	≤ 7.2	≤ 218	≥ 77	< 20
2	≥ 20	≤ 11.5	≤ 481	≥ 68	< 25
1	≥ 10	≤ 18.3	≤ 1031	≥ 60	< 35
0	< 10	> 18.3	> 1031	< 60	> 35

Note: CO = carbon monoxide; PM = particulate matter; g/MJd = grams per megajoule delivered; mg/MJd = milligrams per megajoule delivered.

a. Tier 0 indicates a stove with one or more low-performance indicators (e.g., an open fire or simple cook-stove). Tier 5 indicates a stove with the highest level of performance across all five indicators. It is possible that a stove could be rated “3, 4, 4, 2, 5” for the various metrics. CO and PM_{2.5} have been grouped into “emissions” without differentiation. Many stoves casually said to be “Tier 4” are so only for PM_{2.5} or PM_{2.5} + CO.

The voluntary performance targets (VPTs) are intended for use with laboratory test results provided by ISO 19867-1 covering stoves up to 150 kW. Results from other protocols should not be mapped to this framework without validation. The tiers are not designed to be combined because each indicator is relevant only for a certain impact. There are no fractional tiers (i.e., Tier 3.5). The emissions rates that define Tier 5 for CO and PM_{2.5} are based on modeled exposure and attributed health

BOX 4.7 (Continued)

risks based on the World Health Organization’s guidelines for indoor air quality (WHO 2014); these are calculated for a standard kitchen, occupancy, air turnover rate, and cooking energy and emissions rate and apply to stoves under 10 kW. If region- or country-specific data are available, new tier target values for these indicators should be established. In sum, the guidance provided by the VPTs may not fully predict a stove’s environmental or health impacts since multiple local factors influence emissions and exposure.

Source: Clean Cooking Alliance.

Once the cutoff values for the baseline stove are defined across these five indicators, the clean stoves with the associated cooking fuel promoted by the project use the same protocol to generate respective values for the indicators, which are then used to define a minimum performance standard or a set of tier ratings. The cutoff values that define Tiers 0–5 generally fall within the range of the default values. Based on the tier ratings and the baseline stove assessment, project teams should further define their goals. It is generally recommended that they promote clean cooking solutions that meet the standards of Tier 3 and above, informed by the VPTs, or at least two tiers above the established baseline with a clear roadmap for moving to even higher performance solutions (box 4.8).

BOX 4.8

USING THE VPTS TO EVALUATE STOVE ELIGIBILITY IN RWANDA

The clean cooking program under the Energy Access and Quality Improvement Project (EAQIP) in Rwanda has adopted the ISO voluntary performance targets (VPTs) under its Results-Based Financing (RBF) window (box 2.5). For thermal efficiency and emissions (CO and PM_{2.5}), biomass-burning stoves must meet the testing/evaluation requirements for Tier 2 (no additional processing of fuels required)^a or Tier 3 (additional processing of fuels required),^b while stoves using modern fuels/energy^c must meet those for Tier 4 or Tier 5. For all cooking technologies, safety and durability are evaluated separately following a warranty requirement and the local consumer protection policy.^d

Source: EDCL 2020.

a. Tier 2 cooking technologies are considered transitional, and may only be qualified for support and promotion during the program's initial two years.

b. Includes wood and charcoal pellets and briquettes

c. Modern fuels include most liquid and gaseous energy carriers, as well as electricity.

d. Biomass-burning stoves fitted with a chimney will be assessed for fugitive CO and PM_{2.5} emissions (leakage into the home) during typical patterns of use, as well as efficiency.

When defining performance criteria, it is important to take all five indicators into account since they provide a credible benchmark for comparison as the project progresses toward a cleaner and safer cooking environment for stove users.¹⁸ Setting specific performance standards affirms product quality for stove makers, assures consumers they are making a worthwhile investment, and drives industry innovation. Equally important, project teams should consider implementing quality assurance and performance monitoring activities to ensure that manufacturers and distributors do not cut corners as the project moves forward.

¹⁸ Before the ISO VPTs were available, many projects, especially carbon finance projects, only used the energy-efficiency indicator based on the WBT (2003, 2007, or 2012). Good examples using all five indicators to establish stove performance standards include the Ulaanbaatar Clean Air Project in Mongolia, the Hebei Air Pollution Prevention and Control Program in China (box 2.3), and the Indonesia CSI (box 3.5).

Certification and Labeling

Setting up an open, fair, and transparent stove certification system and process for accrediting qualified testing centers to conduct the certification is essential to ensuring stove quality; this is especially important when certification is linked with government incentives. Brand recognition is a key social marketing strategy to ensure customers can easily identify clean stove technologies in the marketplace, as well as raise public awareness on the stoves' health and energy-saving benefits. The Uganda Clean Cooking Supply Chain Expansion Project (box 3.7) and the Indonesia Clean Stove Initiative (CSI) (box 3.5) are good examples of projects that created effective clean stove logos and related outreach materials (figure 4.2) (ESMAP 2021; World Bank 2018).

FIGURE 4.2

Examples of Clean Stove Logos for Marketplace Identification



Sources: © Supa Sigiri (left); © Prime Indonesia (right).

4. Supply Development Support

Product Development

An open-call process is used to identify and select enterprises that can produce a certain quantity of clean stove technologies that meet minimum performance standards, as defined by the project. Early on, the project team should identify, engage, and provide technical support to promising suppliers to avoid implementation delays.¹⁹ The eligible technologies and suppliers may be (1) imported stoves with locally produced or imported fuels; (2) local products, which may include imported parts; or (3) internationally designed stoves with local assembly (table 4.1).

¹⁹ The baseline for most high-deficit countries is characterized by low- or no-cost traditional artisan or self-built stoves with a limited or no clean-cooking supply chain for products or fuels.

TABLE 4.1

Advantages and Drawbacks of Eligible Technologies and Suppliers, by Category

CATEGORY	PROS	CONS	POTENTIAL SUPPORT
Imported stoves with locally produced or imported fuels	<ul style="list-style-type: none"> • High performance • High quality • Strong management team 	<ul style="list-style-type: none"> • High cost, particularly with import tariff and value-added tax (VAT) • Potential issue with after-sales service • Lack of local distribution channel • Possible need to modify products to fit the local cooking practice • Potential failure of sustained use after incentives are removed 	<ul style="list-style-type: none"> • Review and proposal of more favorable tax policies • Facilitation of partnership with local distributors • Provision of demand information and support for market testing
Local products	<ul style="list-style-type: none"> • Low cost • Fit the local cooking practice • Have established supply chain • Likelihood of sustained use after incentives are removed 	<ul style="list-style-type: none"> • Low performance • Need to upgrade product design to meet the technical criteria • Low capacity and quality control 	<ul style="list-style-type: none"> • Technical support/knowledge transfer to improve product design • Technical assistance on business development
Internationally designed stoves with local assembly	<ul style="list-style-type: none"> • Reduced cost compared to imported final products • Local presence to establish a supply chain • Likelihood of sustained use after incentives are removed 	<ul style="list-style-type: none"> • High investment costs to set up an assembly facility • Possibly a complex business decision with higher risks involved • Need for convincing on market potential 	<ul style="list-style-type: none"> • Provision of demand information and support for market testing • Facilitation of access to finance

Source: World Bank.

World Bank-supported projects have taken various approaches to supply-side support.²⁰ In Bangladesh, the Rural Electrification and Renewable Energy Development (RERED) II Project started out with relatively low, technical-performance criteria (mainly on thermal efficiency), which attracted local suppliers due to cost competitiveness. Concurrently, it was supporting capacity building and technical improvement for locally produced technologies. As the project has begun to achieve scale with established supply chains and the availability of better products, it is moving toward higher performance criteria (box 2.4).

In Mongolia, the Ulaanbaatar Clean Air Project's technical performance criteria could be met by only one local producer with limited capacity. The project relied on expensive, imported stoves from Turkey until Chinese contractors were engaged to produce a sufficient quantity of lower-priced stoves; at the same time, a product development center supporting local

²⁰ Projects involving fuel switching may require additional support related to sustainable fuel supply. For example, the Madagascar Ethanol Clean Cooking Climate Finance Program, financed by the World Bank's Carbon Initiative for Development (Ci-Dev), also supports policies related to the import of ethanol fuel, as well as local ethanol production through demonstration.

design improvements was established, which resulted in very high-performance stove products that could be made locally. Under the Uganda Clean Cooking Supply Chain Expansion Project (box 3.7), eligible stoves supported by the Distribution Challenge Fund included both imported and locally produced stoves, and manufacturers were required to form a consortium with distributors to ensure better market development.

The RBF pilot under the Indonesia Clean Stove Initiative (CSI) attracted both internationally designed stoves and local products (box 3.5). However, participating local distributors were unwilling to carry the high-performance, internationally designed stoves (even though their RBF incentives were higher), owing to high tariff and transport costs and concern about after-sales service. Moreover, none of the international stove companies were ready to set up their own distribution channel or assembly facility owing to the small size of the pilot. As a result, the pilot partnered with GERES (*Groupe Energie Renouvelables, Environnement et Solidarités*), a CSI partner NGO, to provide technical support for improving the design and production of locally produced artisan stoves (the Keren Super 2 [wood] and the Anglo Supra Nova [charcoal]), which eventually met the technical performance criteria.

Business Development

Support for business development can build the capacity of key market players, motivate private-sector investment, and promote grassroots innovation in business models. Such support typically includes technology and business training, market development, and access to finance (e.g., credit line, RBF, or guarantee/collateral). The Cooking Industry Catalyst, launched by the Clean Cooking Alliance (CCA) in 2020, develops and implements a range of interventions focused on business ventures, markets, and consumer demand. The GET.invest Finance Catalyst links small- and medium-scale clean cooking businesses in Sub-Saharan Africa and the Caribbean with finance opportunities and provides advisory support on household-level business models. Women-targeted support includes the CCA's Women's Empowerment Fund, which provides women-led clean cooking enterprises working capital, networking, and training to scale their business models (ESMAP 2022c).

Financing

Innovative supply-side financing models are needed to create and sustain end-user demand for clean stove products and spur market development. Common forms include access to lines of credit through microfinance and commercial banks; risk mitigation instruments, such as guarantee and collateral support; and impact-driven models, such as social impact investing, innovation grants, and Results-Based Financing (RBF). Under a clean cooking, carbon-finance program in Ethiopia, for example, the Development Bank of Ethiopia, as the program's implementing agency, extends lines of credit to private-sector enterprises to support their working capital requirements, as well as on-lending support to microfinance institutions (MFIs) (box 3.4). Among the impact-driven models, RBF has gained increasing donor interest over the past decade. This instrument affords private-sector suppliers the

opportunity to innovate how they design, produce, and sell stoves, based on their familiarity with local conditions. The incentive (subsidy) is linked to the performance level of the project-certified stove; and triggers for payment disbursement are linked to the verified number of stoves delivered, used, and their actual performance (figure 3.3). A key challenge is setting the right level of incentive to attract suppliers without distorting the market (Appendix C).

5. Market Testing, Evaluation, and Adjustment

Creating a sustainable market for the clean stoves introduced by the project requires an in-depth understanding of what customers expect and need from these new products. Before implementation, the project team should pilot the new technological solutions to (1) gauge customers' level of acceptance and satisfaction and, based on this feedback, (2) fine-tune the stove designs to better meet customers' needs and expectations.

After the pilot trial, follow-up market research is needed to determine whether and why consumers accept or reject the clean cookstove(s). A post-sales market survey should be designed to identify (1) customers' needs and expectations, including specific design features that meet or do not meet them; (2) customers' reasons for using (or not using) the clean stove(s) and frequency of usage; and (3) the profile of customers. The survey results should determine whether education and promotion campaigns can be used to reach the target customers and the effectiveness of the marketing strategy. If the project introduces more than one clean stove model or technology, it is important to discover which one(s) customers consider more acceptable and why. This information is part of the feedback loop to designers for further product development and can also be used to design more relevant education and promotion campaigns (figure 4.1).

Results of the post-sales market survey should be compared to the market research data collected during the initial demand assessment. This comparison data is used to (1) confirm whether potential customers—those who bought the clean stoves in the market trial—have the same socioeconomic and demographic characteristics as those earlier identified and (2) evaluate whether messages used for the education and promotion campaign need to be modified or updated.

The most common approach to follow-up market research is to compare survey results from household consumers that purchased the clean stoves promoted by the project with those that did not to better understand the underlying reasons for household decisions. The follow-up market research carried out by the Uganda Distribution Challenge Grant Facility is a good example of a project activity designed to help participating stove manufacturers and distributors better understand consumer behavior. Unlike the project's initial

behavioral diagnostic study, the second one, conducted during the pilot rollout, focused on consumer responses related to specific clean stove types and models promoted by the project and purchased by the households in the market trial.

Another follow-up approach tests consumer feedback on new stove prototypes prior to rollout. Most projects that take this approach have already identified the types and models of clean stoves they will promote. In this context, the main objectives of market testing are to evaluate (1) field performance of the newly designed clean stoves with real household cooks, (2) whether and how users of the new stoves adjust their cooking behavior and habits, and (3) users' acceptance of the new stoves. The Kyrgyz Republic Heat Supply Improvement Project provides a good example of this approach to market testing. Under the project's pilot study, 51 households were recruited and agreed to have their traditional heating stoves removed and replaced by new ones designed by project-hired experts. Follow-up surveys of household adopters were conducted for a period of two heating seasons. The survey results were used to fine-tune the design of the high-efficiency, low-emissions (HELE) stoves and provide training to more than 25 local manufacturers (box 3.3).

6. Demand Stimulation

Virtually all clean cooking interventions designate a portion of their resources for social marketing and awareness-raising campaigns to stimulate demand for the clean stoves. The project team must carefully consider how to allocate these resources and which parties should implement the activities.

Social Marketing and Awareness Campaigns

Projects that rely on RBF may consider sharing this responsibility with stove manufacturers or distributors. In the Indonesia CSI and Bangladesh RERED II cases, the RBF subsidies provided to stove manufacturers and distributors are inclusive of marketing and promotion of their own stove products, and both projects feature comprehensive awareness-raising and promotion campaigns targeted at the regional or national level. To avoid picking winners, the activities are designed to increase awareness and promote a clean cooking environment and technology without focusing on specific brands.

If the project team decides to share marketing and promotional responsibility with the manufacturers or distributors, it should closely monitor such activities to assess whether additional support may be needed. For example, the Indonesia CSI provided additional community-level support through household-targeted education and information campaigns and cooking demonstrations, which helped to boost stove sales (World Bank 2018) (box 4.9).

BOX 4.9

STIMULATING DEMAND FOR CLEAN COOKING SOLUTIONS

Live cooking demonstrations and other awareness-building techniques can help women and their families overcome the reluctance to purchase modern cooking solutions. Field demonstrations, which can be broadcast through the mass media, can reach a wide audience; and door-to-door marketing can reinforce the messages from such shows, reaching households with lower literacy levels (ESMAP 2022c). Trust in the information source and positive feedback from peers (e.g., on stove performance and after-sales support services) are critical to household uptake (ESMAP 2020d). Home trial periods can help women manage the perceived risks (both financial and nonfinancial) of adopting clean stove solutions and assure family members of the proposed products' benefits and value (ESMAP 2022c). Women-to-women marketing has proven successful in increasing women's consistent use of the stoves (World Bank 2018), while mixed gender teams at the point of sales can help resolve gendered misperceptions about clean cooking solutions (ESMAP 2022c).

Sources: ESMAP 2020d, 2022c; World Bank 2018.

Knowing the profile of potential customers in the target population allows the team to develop appropriate messaging for education, promotion, and social marketing materials and recognize where to focus efforts. The level of consumer awareness is key to developing strategic messages that link the value of clean cooking products to the co-benefits of adoption (e.g., a cleaner and thus healthier cooking environment). In countries where clean-fuel transition programs have already been advanced but stacking with traditional cooking fuels and technologies persists, messaging around the clean cooking devices that can meet customers' stacking needs (e.g., multiple burners to allow for simultaneous cooking and adjustable pot rests to accommodate large pot sizes) can keep households that stack on the modern-energy transition pathway (Ochieng et al. 2020). Recommendations of a behavioral diagnostic study commissioned under the Uganda Clean Cooking Supply Chain Expansion Project (box 3.7) informed the development of brand activation events in strategic hotspots, which proved critical in helping customers choose products to meet their cooking requirements (ESMAP 2019b, 2021).



Affordability and Access to Finance

Income remains a fundamental driver of fuel and stove demand, with poorer households historically dependent primarily on wood and charcoal as the more affordable fuels. Following the MTF affordability criteria, a levelized cost-of-cooking solution as a share of household expenditures should not exceed 10 percent for Tier 3 and 5 percent for Tier 4 and Tier 5. Using these criteria as a reference, along with such factors as awareness and availability of cooking options, the project team can collect the household income/expenditure data during the demand assessment, compare the costs of various clean cooking solutions, and assess whether and how much end-user subsidies or other forms of financing are needed to fill the affordability gap. The affordability challenge can be especially acute where the high up-front costs of appliances and fuels severely limit the potential for the bottom half of the market. Using household expenditure results from the initial market survey, the project team can assess the target consumers' ability to pay for the stoves and associated fuels, and, in turn, the types of financing to increase accessibility (e.g., through pay-as-you-go [PAYGo], microfinance, or leasing) and affordability (e.g., through end-user subsidies that link to socioeconomic classifications and are possibly integrated as part of social protection or poverty alleviation programs). The pro-poor design of the World Bank-supported Energy Access and Quality Improvement Project (EAQIP) in Rwanda shows how RBF instruments can be channeled to end-user consumers through stove suppliers and subsidy levels can be linked to a country's established anti-poverty categorization to increase household affordability and incentivize market development (box 2.5).

Addressing the Gendered Aspects of Interventions

Across the building blocks, the project team needs to conscientiously assess, design, monitor, and evaluate interventions that help to promote gender equality. Clean cooking interventions can open opportunities for engaging and empowering women across the clean-cooking value chains. In addition to being direct project beneficiaries as users and managers of clean cooking solutions, women can leverage these existing skills to become stove co-designers or sales agents, as well as benefit from employment in nontraditional areas (e.g., as stove metalworkers, installers, and inspectors) (ESMAP 2022c). The World Bank's Clean Cooking Fund (CCF) requires that all of its supported projects take proactive actions to promote female employment/entrepreneurship and gender co-benefits (ESMAP 2022c) (box 1.1). Interventions must appropriately document the gender outcomes realized to ensure that unintended negative consequences are avoided. At project preparation, a results framework can be developed, along with sex-disaggregated indicators (both qualitative and quantitative), monitoring methodology, and management information systems that reflect gender issues arising from the project (ESMAP 2022c).

Summary Remarks

Designing successful project interventions does not end with developing the building blocks outlined in this chapter. Beyond these needed assessments and technical assistance to get clean cooking solutions into the field, the project team must put in place an effective mechanism for monitoring consumers' satisfaction with the new stoves, verifying the number of stoves delivered and actually used for most daily household cooking tasks, and eventually measuring climate, health, and gender impacts. A key advantage of using the RBF framework design is its embedded monitoring and verification (M&V) system, which can be used during project implementation to evaluate the overall market performance (e.g., how many eligible clean cooking products are available on the market, how many suppliers are actively selling what eligible products, and how many household consumers are purchasing what type of stoves at what price) and make adjustments, as needed, to enhance success.

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FIVE TACKLING THE CHALLENGE



Because cooking poverty is a development issue that mainly affects the world's poor, incentives are needed to develop and deliver cooking decency for all. For long-term sustainability, interventions must be guided by principles that put stove users' needs and aspirations at the center and formally and fully integrate the universal access goal into national strategies and roadmaps, with high-level political support and investments. These are critical for building the enabling environment for implementing innovative solutions, which, in turn, spur market development (Appendix B).

Practitioners increasingly recognize that the transition pathways to universal access to clean cooking have no one-size-fits-all solution. Localized solutions that put stove users' total access picture at the center—including how stove technologies and fuels interact with user behavior and other household factors and energy services—are more likely to be sustainable; and, as the synthesis of lessons from the World Bank's sector experience confirms, only sustainable solutions can be truly transformative. Practitioners also recognize the need for strategic subsidy policies to promote the use of clean technologies and fuels across higher-performance tiers of access. Poorer households with an affordability gap require greater financial support, while effective incentive mechanisms are needed to mobilize and sustain private-sector participation. In addition, it is generally understood that fuel substitution and cleaner cookstoves should be considered as complementary, rather than competing, solutions.

Recommendations

Engage Sector Stakeholders in Prioritizing Clean Cooking

The energy sector is expected to lead in providing solutions and coordinate with relevant sectors, leveraging their networks and expertise. Raising the clean cooking sector's visibility requires strategy, targets, budget, and a monitoring and evaluation mechanism. Public investment that takes global public goods into account is essential for crowding in private investment, while knowledge and innovation are key to lowering the costs of interventions. If clean cooking is not yet on a country's energy policy agenda, practitioners, including champions in government, must make the case for it, explaining the adverse impacts (for public health, women's productivity, and the environment) and the enormous potential co-benefits of taking action. The new definitions and tools for measuring progress, as well as scenario-based tools for visualizing potential transition pathways (e.g., the Clean Cooking Planning Tool [CCPT]) can reduce the transaction costs of identification and engagement. The lessons and principles gleaned from the World Bank's sector experience and that of other development partners can help energy planners avoid the pitfalls of past stoves programs and guide the development of successful operational strategies.

Take a Whole-System Approach Focused on Customer Service and User Satisfaction

Clean cooking interventions need to acknowledge that the new stoves promoted by the project are only one element in the context of the daily services performed by the household's cooking technologies. Since the purpose of cooking is to transform food items into meals, interventions must consider the whole system of food preparation in order to succeed; this includes who cooks, what is cooked, how it is cooked, with what fuel at which time, in which vessel, for how long, and how frequently. During a project's initial market assessment (Building Block 1), task teams can use household surveys and/or national Multi-Tier Framework (MTF) surveys and social-science investigation to collect this contextual information, which can be used as a baseline for monitoring and evaluating the project's progress and to inform social marketing strategies (Building Block 6). During the technology evaluation phase (Building Block 3), information on the real context of stove usage is critical to selecting an appropriate test sequence to ensure that the results of controlled laboratory stove testing reflect the variables that depend on the local context (e.g., fuel-moisture content, user expectations, operating sequences, and types of cooking vessels) (Building Block 3).

Prioritizing the cooking needs and behaviors of the ultimate customers—the stove users themselves—is at the heart of successful projects promoting new cooking technologies. Interventions must be inclusive of women and girls—those who bear major responsibility for meeting the household's cooking-energy needs and are the most adversely impacted by cooking poverty. The project team can conduct consumer surveys before or after pilot trials to determine whether design adjustments are needed to gain consumer acceptance (Building Block 4).

Develop a Strategy That Fits the Country Context

The whole-system approach needs to be adapted to the country context since enabling environments can vary widely. Before designing the intervention strategy (Building Block 2), a gap analysis should be conducted to identify the key supply- and demand-side and institutional barriers faced by the project and opportunities for overcoming them. A competent and committed institutional champion should be identified to lead project implementation. The shape of the intervention strategy depends on what building blocks are already in place and can be designed to close gaps in existing programs. Many projects require upstream stakeholder support, including technical assistance and capacity building for stove manufacturers, distributors, and research laboratories. They may need help in setting up a stove testing laboratory, reaching out to a development bank to take the lead in financing, and working with the private sector to promote technical innovation and create an incentive framework for the sale and marketing of clean cooking technologies. While all projects should promote cooking decency (i.e., Tiers 4 and 5), the immediate goal for countries with a high access deficit is to eliminate cooking poverty (Tiers 0 and 1) and include transitional

solutions (Tiers 2 and 3) as part of their strategy. During the transitional period, a new baseline and building blocks for promoting higher-performance solutions can be put in place.

Encourage Cross-Sector Collaboration to Maximize Benefits

To accelerate the transition to cooking decency for all, practitioners should look for opportunities to encourage dialogue and build synergies between clean cooking and closely related sectors and disciplines. To ensure that clean cooking solutions reach the poor and most vulnerable populations, project teams can collaborate with cash transfer and social safety net programs. Clean cooking, public-health, and gender practitioners should seek ways to combine their efforts and resources to raise awareness about the disproportionately adverse impacts of cooking poverty on women and girls and promote clean stove technologies and fuels (e.g., by monitoring and reporting on the positive health impacts women and girls experience after switching to clean cooking solutions). For delivery models, practitioners can look into leveraging the networks and innovative approaches of adjacent sector models serving the same consumer base (e.g., microfinance institutions [MFIs], solar home system [SHS] companies, and other last-mile distributors).

Mitigate the Downside Risks of Carbon Finance

With more funding from carbon finance flowing into the sector, governments need to carefully weigh its pros and cons for meeting their clean cooking targets, energy access goals, and NDCs. The carbon market's current regulatory ambiguity and higher carbon prices have encouraged some companies to adopt a free-stove distribution business model that relies fully on carbon revenue. However, both economic theory and evidence confirm that free stove distribution distorts the market by removing consumer choice, squeezing out local producers, and limiting product innovation. Governments, certification agencies, development partners, and private companies all have a role to play in mitigating the risks.

Moving forward, governments should (1) set up technical performance standards for clean cooking technologies (with a process for periodic review and updating) and require all projects, including those using carbon finance, to comply; (2) strengthen the country's capacity in designing, authorizing, registering, and coordinating carbon-financed projects; (3) offer a framework to ensure carbon financing is aligned with its policy efforts to develop clean cooking solutions; and (4) develop eligibility guidelines to determine which customer groups receive what levels of discounts. Carbon finance can be channeled to cover those discounts as support for climate benefits (as global public goods). Carbon-credit certification agencies should (1) strengthen transparency and traceability of carbon credits and (2) provide guidance and procedures related to local market impact and long-term sustainability. Development partners should (1) support governments to build capacity in accessing and managing carbon finance and (2) coordinate incentive programs and interactions with

carbon finance to level the playing field for all companies. Finally, international carbon-market companies should align interventions and price discounts with government policies and programs, including those supported by development partners.

Conclusion

Charting a course to meet the aspirations of SDG 7.1 will be challenging, but targeted and concerted actions building on the past experience and leveraging the new opportunities can guide the sector forward. More clean cooking programs are taking an integrated approach with institutional champions in place to coordinate development of the necessary building blocks to promote market development for long-term sustainability. The World Bank is increasing its commitment and efforts to accelerate universal access, particularly through the ESMAP-hosted Clean Cooking Fund. With our accumulated sector knowledge and experience and principles for developing operational strategies; better definitions, measurement and planning tools, and technological innovations; and a growing prioritization of clean cooking on the policy agenda; we are well-equipped to accelerate the transition to universal access. Solving the cooking poverty issue is not only possible, it is imperative; the benefits are enormous for public health, women's productivity, and the environment. Clearly, now is the time to drive scale.

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APPENDIX A.

The World Bank's Sector Experience

The World Bank has maintained a continuous presence in the field of clean household energy for cooking over the past half-century. The Energy Sector Management Assistance Program (ESMAP) was among the first in the world to identify woodfuels as a major form of energy use in developing countries. During the 1980s, the issue of cooking with traditional biomass cookstoves was viewed mainly from the perspective of forestry management. At that time, much research centered on the efficiency of biomass energy and fuel substitution, based on concerns about deforestation and fuel scarcity (World Bank 1996). In the 1990s, the research focus shifted toward the inefficient use of fuelwood and other cooking fuels, as well as the burden of fuelwood collection on women's time use. Over the past two decades, the research focus has broadened to include the effects of household air pollution (HAP) on health, particularly that of women and children, and the contributing effect of emissions from the incomplete combustion of solid fuels for domestic cooking and heating on climate change (Akbar et al. 2011).

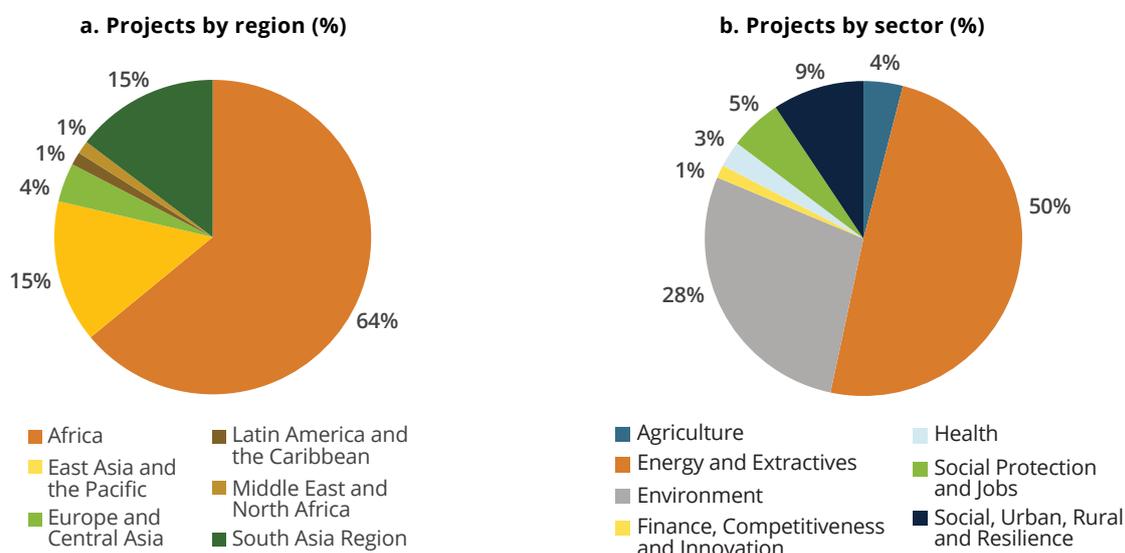
Lending Portfolio

The World Bank's Clean Cooking Fund (CCF), which was operationalized in 2020 to scale up commitments and public- and private-sector investments in the clean cooking sector, builds on the achievements of the Efficient, Clean Cooking and Heating (ECCH) Program. Between 2015 and 2020, the ECCH was the driving force for advancing the World Bank's clean cooking agenda through technical advice and country/regional grants to its operational teams. Over that period, nearly 20 million people in Bangladesh, China, Egypt, Indonesia, Mongolia, Senegal, and Uganda gained access to more efficient and cleaner cooking and heating solutions. The World Bank's active lending portfolio in the sector totals over US\$590 million across 33 countries (figure A.1).²¹

²¹ A global database of cookstove initiatives and players is available at energydata.info (ESMAP 2020c).

FIGURE A.1

Distribution of the World Bank’s Lending Portfolio in Efficient, Clean Cooking and Heating



Source: World Bank 2022.

Note: The Efficient, Clean Cooking and Heating (ECCH) portfolio includes non-district heating solutions.

Project Subcomponents across Sectors

ECCH interventions have usually been embedded within projects across multiple, diverse sectors. Projects in the energy-access sector have had the most significant clean cooking and heating subcomponents; these projects aim to reduce HAP and ambient air pollution near households, reduce fuel collection time, and lower solid-fuel expenditures—all directly contributing to improved energy conditions in developing countries. Various projects in the environment and natural resources sector (e.g., improvement of forestry and land management, conversion of agricultural waste into biogas, and control of ambient air pollution) have included cleaner cooking and heating subcomponents, as have social resilience and carbon finance projects.

Energy Access

Energy access projects have promoted clean cooking solutions with and without fuel switching. In China, the Hebei Rural Renewable Energy Development Project (2015–21) focused on converting agricultural waste into biogas; the goal was to install and operate biogas facilities as investment subprojects in six project counties to assure rural residents of a stable and clean energy supply. Under the Increased Access to Modern Energy Project in Benin (2009–18), private-sector programs promoted LPG fuel substitution, whereby 24,670 new households gained access to gas cooking equipment. In Egypt, the Household Natural Gas

Connection Project, launched in 2015, expected to have switched 2.3 million households from LPG to natural gas by project closure in mid-2022. In Bangladesh, the Rural Electrification and Renewable Energy Development (RERED) II Project focuses on creating the enabling conditions to stimulate consumer demand for improved cookstoves (ICS) and advanced combustion stoves without fuel switching (box 2.4). The Kenya Off-Grid Solar Access Project (KOSAP) promotes cleaner cooking fuels and appliances in five underserved counties with and without fuel switching, as well as performance-based criteria.

Environment and Natural Resources

Environmental health and management of natural resources have been overarching concerns of ECCH interventions. These issues have often involved upstream forestry management, including reduction in deforestation and land degradation and control of downstream ambient air pollution resulting from heating or cooking with solid fuel-fired stoves. These issues are also tied to agriculture, including biogas production management and the use of biochar, a by-product of stove combustion, for soil enrichment.

FORESTRY AND LAND MANAGEMENT

Some forestry and land management projects with ECCH subcomponents have focused on the prevention of forest degradation in at-risk areas resulting from illegal commercial harvesting of fuelwood and heavy fuelwood demand. These projects have sought to preserve the forest environment through conserving carbon stocks and ensuring sustainable forest management and livelihoods for forest-dependent people. The projects have been located in rural areas, as well as densely populated peri-urban areas, where increasing pressure is being put on the local environment and biomass resources. By region, most projects have focused on Sub-Saharan Africa. The development objectives of the Forested Landscape Management Project (Democratic Republic of Congo) (2014–22), the Forest Investment Project (Mozambique) (2017–22), and the Oromia National Regional State Forested Landscape Program (Ethiopia) (2017–22) have been to reduce emissions from deforestation and forest degradation, conserve forest carbon stocks by improving forest management or forested landscape management, and improve the environment in areas where forests are an important part of land management. In Senegal, the Second Sustainable and Participatory Energy Management Project (PROGEDE II) (2010–18) aimed to sustainably increase the availability of diversified household fuels and increase community incomes while preserving forest ecosystems.

AGRICULTURE

Projects with an agriculture focus are diverse, covering such issues as watershed management, water conservation and use, agricultural waste conversion, and improved livelihoods for farmers. In Madagascar, the development objective of the Sustainable Landscape Management Project (2017–23) is to increase access to improved irrigation services and agricultural inputs, along with strengthening the integrated management of natural

resources in the selected landscapes. In Kenya, the Climate Smart Agriculture Project (2017–23) promotes appropriate, low-cost biodigesters and efficient technologies for converting agricultural waste into useful forms of energy. The goal of the Nuton Jibon Livelihood Improvement Project in Bangladesh (2015–21) was to encourage appropriate cow-dung management among livestock farmers and biogas use in rural villages (box 3.4).

AIR POLLUTION CONTROL

Controlling downstream ambient air pollution linked to cooking and heating with solid fuel-fired stoves has been the focus of two projects in East Asia and the Pacific. In China, the Hebei Air Pollution Prevention and Control Program (2016–19) sought to eliminate inefficient coal- and biomass-burning stoves, which in 2012 contributed to more than 32 percent of PM_{2.5} emissions in the region. The project helped 1.22 million households to replace coal stoves with gas (1.086 million) and electric (0.135 million) cooking and heating appliances, with a 5,000 t reduction in PM_{2.5} emissions (box 2.3). In Mongolia, the Ulaanbaatar Clean Air Project (2012–23) aims to reduce air pollution from the burning of poor-quality coal in traditional heating stoves. Specific objectives are to (1) connect some 1.2 million consumers in the capital city area—especially households who live in *gers* and detached houses—to less polluting heating services, (2) facilitate the development of particulate abatement measures over the medium term in coordination with development partners, and (3) raise public awareness about air pollution reduction. The idea is to transform the stove market toward the supply and servicing of cleaner technologies. The project features capital subsidies for households, technical design support for suppliers, and third-party verification for stove installation and use.

Social Resilience

The Development Response to Displacement Impacts Project (DRDIP), approved in 2019, aims to improve energy access for refugee host countries in Djibouti, Ethiopia, Kenya, and Uganda. Refugees into these countries tend to be settled in camps. People previously spread out in mostly rural areas are now concentrated in areas without sufficient resources to serve their energy needs. The DRDIP introduces host-country communities to cleaner, more efficient cookstoves, using a community-driven development (CDD) strategy. Better energy access leads to improved local livelihoods and also reduces the impact of refugee concentrations on the local environment.

Carbon Finance

The Carbon Initiative for Development (Ci-Dev), a World Bank trust fund, has supported the ECCH subcomponents of various carbon finance projects in low-income countries that are vulnerable to climate change, including Burkina Faso, Ethiopia, Kenya, Lao PDR, Madagascar, and Rwanda. Many of these interventions have promoted switching rural households'

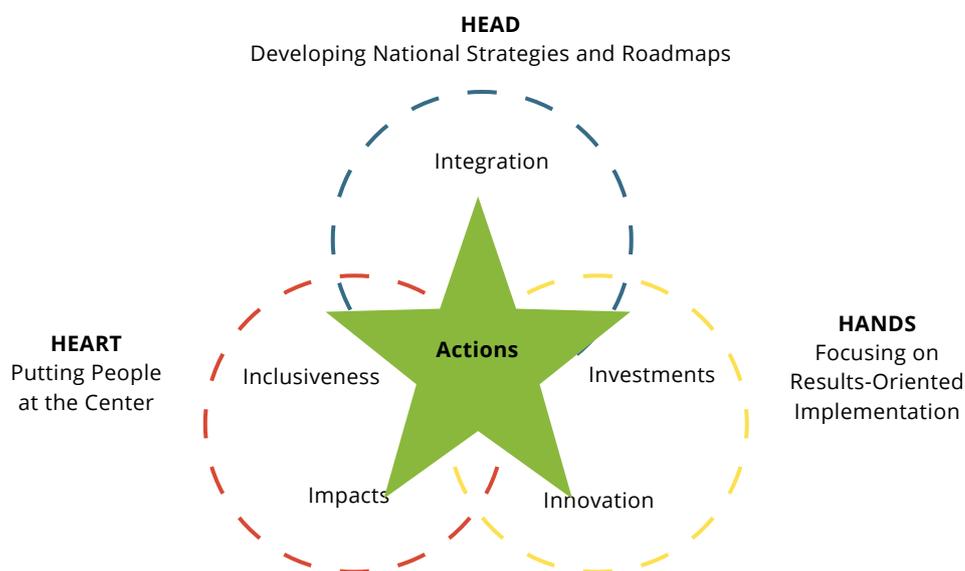
cooking energy from traditional biomass to cleaner fuels (e.g., processed biomass, biogas, and ethanol). In Rwanda, innovative business approaches have been used to sell clean stoves in the marketplace and certified emission reductions (CERs) to Ci-Dev. One private-sector company, Inyenyeri (operations ceased in April 2020), leased pellet-fed gasifier stoves to consumers at no cost, conditional on their agreeing to purchase a minimum quantity of pellets from the company each month. The Madagascar Ethanol Clean Cooking Climate Finance Program (2016–25) includes both fuel-switching for household cooking and the use of performance-based criteria for clean household stoves.

APPENDIX B.

An Approach and Principles for Strategy Development

By adopting a “heart-head-and-hands” approach, all stakeholders can work together to strengthen the ecosystem for developing a clean cooking market, thereby accelerating the transition from cooking poverty to cooking decency. Putting people at the center is the “heart” of development and delivery of clean cooking solutions. With empathy and compassion for those whose lives are adversely impacted by not having access to clean cooking, decision makers can make access to clean cooking a political priority and drive attention to the large socioeconomic returns that can result from improving access, especially for women, youth, and other often marginalized groups.²² Developing national strategies and roadmaps is the “head” that guides the transition to universal access to clean cooking; while the “hands” focus on results-oriented implementation of the roadmap’s strategies and action plans (figure B.1).

FIGURE B.1
Overview of the Heart-Head-and-Hands Approach



Source: World Bank 2022.

²² For households that cannot afford the cost, the delivery of clean cooking solutions should be part and parcel of social safety net programs.

The mutually reinforcing principles or “I’s” aligned with the heart-head-and-hands transition approach—impacts, inclusiveness, integration, investments, and innovation—can guide the development of intervention strategies that lead to self-sustaining, clean cooking markets.

Impacts

Achieving development impacts requires aligning the adoption of inclusive, people-centered interventions with broader and better-integrated development objectives (e.g., health, gender, environment/climate, and sustainable livelihoods). A Results-Based Financing (RBF) framework can unify the key elements of successful interventions to achieve results that advance the development of the clean cooking sector.

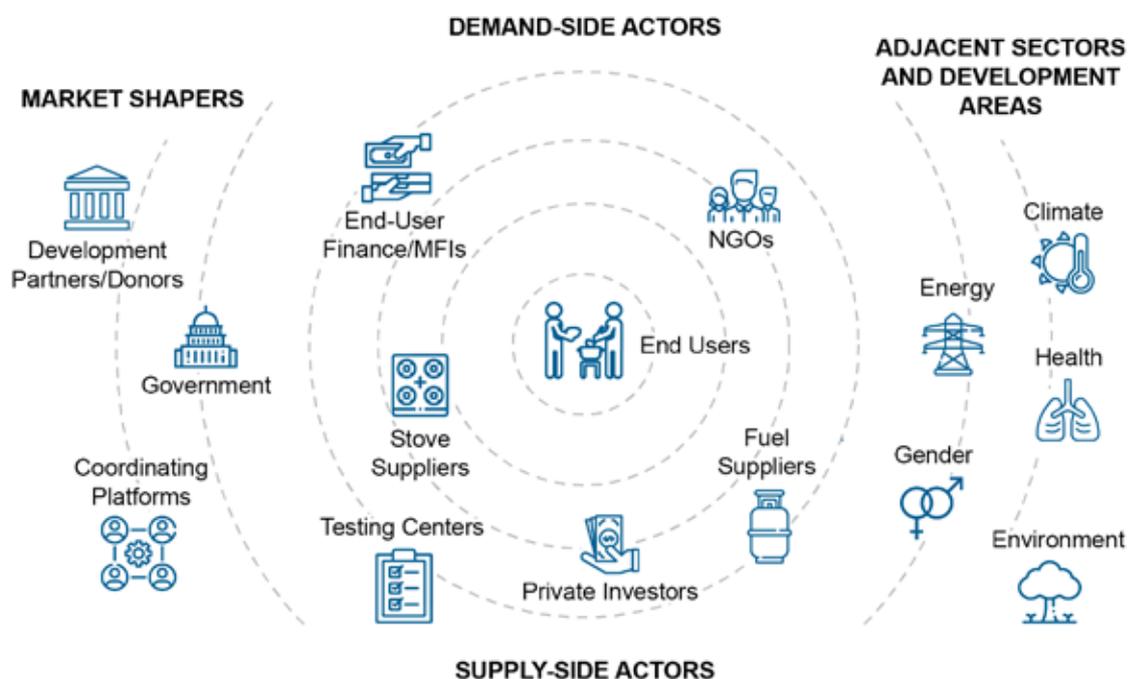
Inclusiveness

The economic and social opportunities afforded by clean cooking interventions are particularly important for addressing the needs of poor, vulnerable, fragile, and displaced populations. For those who cannot afford it, the delivery of clean cooking solutions should be part and parcel of social safety net programs. A pro-poor design using Results-Based Financing (RBF), such as the approach taken by the Energy Access and Quality Improvement Project (EAQIP) in Rwanda (box 2.5), provides poorer households greater financial support to fill the affordability gap, enabling their practical transition to modern cooking solutions.

Integration

Clean cooking for all must be integrated into national policies and planning for energy, climate, and COVID-19 recovery. Accelerating the transition requires strengthening the overall clean cooking ecosystem with a prioritization of end users’ needs and preferences at the center. Progress necessitates integrated approaches that bring together the interests of all key players—from market shapers and demand- and supply-side actors to adjacent sectors and development areas (e.g., energy, health, gender, environment/climate)—with a more consistent focus on outcomes (figure B.2).

FIGURE B.2
Main Players across the Cooking Ecosystem



Source: ESMAP 2020a.

Note: Fuel suppliers include designers, manufacturers, distributors, and retailers.

Market shapers include development partners/donors and government agencies. Development partners/donors are best placed to invest in data, tools, open-source technologies, and platforms that can spur innovation, knowledge sharing on best global practices, and learning. Government agencies can put into play national policies and strategies that prioritize cooking and embed political priorities for the sector within broader energy decision-making. They can develop and enforce regulations and standards that promote market development and play a role in localizing international standards through close coordination with international standards-setters. In addition, they can deploy infrastructure and programming investments that reflect the country's comparative advantages for energy supply and greatest requirements for energy demand. International platforms specific to a fuel, technology, or one or more sectors can strengthen coordination and cooperation among diverse actors in joint advocacy and resource mobilization and aggregate and disseminate technical knowledge and standards. National-level platforms can promote networking, communication, and knowledge sharing among public and private sectors, NGOs, and academia, as well as international partners.

Demand- and supply-side actors and government institutions are critical to creating the enabling environment for developing a self-sustaining clean cooking market. Key demand-side players include NGOs, which support commercialization and market dissemination through program design and implementation, and end-user finance providers (e.g., microfinance institutions [MFIs]), savings and credit cooperative organizations, and commercial banks).

On the supply-side, key players include private investors, research and testing centers, and fuel and stove suppliers. Private investors (e.g., carbon finance firms, commercial banks, social-impact investors, and private-equity firms) can drive targeted seed and growth capital toward supply-side innovators and first-movers; seek blended finance commitments from donors and development institutions to help maximize the leverage available for investing in emerging and best-in-class business models; and push for user-centered innovation and focus on long-term business sustainability. Research and testing centers innovate new designs, test stoves in the lab and field, conduct market studies, and undertake monitoring and evaluation (M&E) programs. Fuel and stove suppliers develop new stove designs, produce and distribute fuels and stoves, and provide after-sales service. By diversifying their range of products and services, they create opportunities for partnerships with adjacent off- and on-grid energy-services players.

Investments

To expand the clean cooking market and ensure clean cooking for all, partial subsidies and performance-based incentives are required to support affordability and pay for public benefits. Financing for fuel and stove suppliers can include credit lines and relevant credit enhancement instruments, such as guarantee and collateral support. For end-user households, microfinance can be used to support upfront investment needs. Credit facilities and MFIs play key roles in promoting the adoption of clean cooking solutions. The former provides clean-stove manufacturing and distribution companies working capital and collateral, while MFIs make such stoves affordable by allowing households to make installment payments. Having the ability to spread costs out over time can help consumers decide on purchasing the clean stoves.

Innovation

Catalysts are needed to spur market innovations that can deliver affordable clean-cooking solutions at scale. These include, but are not limited to, technical assistance support to governments and producers and business incubation for eligible stove suppliers and local artisans.

APPENDIX C.

Lessons in Designing Results-Based Financing Tools

A literature review of more than 50 publications on Results-Based Financing (RBF) experience in the cooking and broader energy sectors, as well as other sector contexts (e.g., health, water, sanitation, and hygiene), provides project teams useful guidance on how to design RBF tools (EnDev 2018; World Bank 2018).

Overall Design

- *Have a clear objective and theory of change aligned with the results framework of the P-code.* Whether it be market initiation, development, expansion, or design innovation, the specific objective should then drive the RBF tool used (e.g., auctions, innovation prizes, or traditional market incentives). The results could include the output level (number of stoves or stove-fuel combination sold), outcome level (number of households with sustained use of technology), or impact level (for health, gender, and climate).
- *Take a segmented view.* Relevant RBF tools differ, depending on market maturity, targeted impact, and entry point in the value chain.
- *Embrace simple RBF designs that are flexible and responsive to evolving market conditions that can engage the private sector over the long term.*
- *Keep the quality bar sufficiently high.* It is beneficial to remain technology and business-model neutral at the chosen level of stove-and-fuel quality; in the near term, however, there is a need to accept the creation of private benefit for short-listed firms (i.e., it is okay to pick “winners”).
- *Incorporate the private sector’s risk-taking capacity (e.g., higher risk appetite for urban versus rural) and consider its business value proposition to engage with RBF.*
- *Ensure pro-poor targeting.* If pro-poor impact is an explicit part of RBF objectives, then upfront design thinking, including rural targeting and demand-side incentives (e.g., direct benefit transfer) is required.
- *Think of ways to combine (or facilitate) upfront financing alongside outcome-linked RBF incentives since the RBF payment stream will not be sufficient to unlock market development where significant capital expenditure is needed for market entry.*
- *Consider partnering with the host government from the outset of RBF design and pilot phases (even if funds flow to private entities) to build capacity and plan for future sustainability (e.g., to pave the way for models where the government budget provides all or part of future RBF payments).*

- *Package complementary inputs for energy market access; that is, think of RBF payments within the broader ecosystem of working capital financing, technical assistance, consumer-awareness programs, and even conditional benefit-transfer schemes.*
- *Think about the exit strategy (e.g., declining payments over time) when defining the existing structure to minimize market distortion.*
- *Consider additionality upfront.* Market innovation additionality is clearer in markets with some antecedents already in place. Market creation additionality is clearer in markets where there is less activity and fewer competing initiatives.
- *Take the time to find the fund manager/implementation intermediary as this is a major failure risk in RBF designs.*

Payments Sizing, Sequencing, and Entry Points

- *Consider targeting incentive payments to more than one part of the supply chain (e.g., manufacturers, importers, distributors, and consumers), given the complexity of market bottlenecks in many clean-cooking markets, but focus on market aggregators as the main anchor.*
- *Ensure that the payment type reflects the market's characteristics and needs and complements its other financial tools.*
- *Set up a flexible structure that allows for adjustment of payment levels over time.* Getting the right payment level upfront is difficult, even when market-based mechanisms are used to set payments (e.g., auctions); since markets are dynamic, adjustments will be needed.
- *Consider the RBF exit strategy from a payments perspective.* In some cases, a phased strategy with gradually reduced incentives over time may be appropriate for catalyzing markets without creating ongoing market distortions.
- *Consider whether auctions should be part of design.* The auction experience is mixed. The benefit of auctions in which market mechanisms determine the incentive may be outweighed by high administrative and management costs or undermined by low market capacity. On the other hand, in cases where a market signal for RBF pricing is absent, they are at least worth considering.
- *Have clear and simple payments-incentive structures, with straightforward criteria showing what results the project expects and how incentives will be disbursed.* The incentives should also align with the companies' financial cycles, whenever possible.
- *Consider combining sales/use incentives with those that target other barriers (e.g., importation inventory, bonuses for local sales agents, or customer service), depending on which ones have been identified ex-ante.* Other incentives can encourage women's employment across the values chain (e.g., hiring marketing and sales agents of ethnicity relevant for the target group).
- *Ensure payment triggers are tied to outcome levels.* Payment triggers tied to results above the output level (e.g., for research and development, innovation, or capital-expenditure

investments in market development) can be a hazardous strategy without triggers tied to the outcome level and may not lead to the desired impacts.

- *Recognize that insufficient payments/incentives are a far bigger risk than payments that create windfall profits.* In the clean cooking context, market development costs are high, and market participants are chronically starved off funding.
- *Address the challenge of pre-financing RBF payments.* This is key to successfully implementing and scaling up RBF programs. In the absence of interested local or global financing partners, parallel innovations like reimbursable grant facilities are worth considering.

Monitoring, Verification, and Evaluation (MV&E)

- *Budget for MV&E.* When trying to implement multiple and new methodologies, the costs of MV&E are often higher than expected. Teams can budget about 10–15 percent of the RBF allocation to cover the MV&E costs.
- *Standardize MV&E tools while maintaining flexibility in the implementation process owing to the diversity of geographic contexts.*
- *Complete the verification process quickly in line with business practices to maintain private-sector confidence.*
- *Leverage existing MV&E mechanisms, maximally utilizing current carbon-financing infrastructure as a foundation for RBF monitoring to reduce the costs and risks of creating and supporting new mechanisms.*
- *Use technology to reduce MV&E costs for validating use, stacking, and emissions (e.g., learn from RBFs in the pay-as-you-go [PAYGo] solar context).*

Systems Approach

- *Take a holistic systems approach to designing clean and efficient cooking solutions.*
- *Develop local and (where relevant) regional production and distribution capacity while simultaneously working with government entities to reduce policy-related cost barriers (e.g., taxes and tariffs).* This is critical for transforming the clean stoves market.

Institutional Strengthening

- *Take care that, in attempting to introduce new technologies and stimulate demand, the RBF mechanism does not distort the market.*
- *Identify an institutional champion from the project outset to boost credibility and allow for effective branding (box 4.4).*
- *Coordinate across sectors to prevent duplication, meet broader needs (e.g., pre-financing), and increase learning and cooperation.*

Awareness Raising and Quality

- *Implement awareness-raising campaigns targeting users and government.* User-targeted communication modes include short films, video clips, logos, and posters; while government can be reached through workshops, community meetings, public media, and training of health practitioners.
- *Use RBF certification labels on eligible stoves to align and maintain market-quality standards.*

Energy Sector Management Assistance Program

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