

The World Bank

Asia Sustainable and
Alternative Energy Program

EAST ASIA AND PACIFIC CLEAN STOVE INITIATIVE SERIES



Indonesia

Toward Universal Access
to Clean Cooking

June 2013



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Foreword

In accordance with our main policy on diversified energy sources, the Government of Indonesia promotes the utilization of clean stove technology, with the aim of optimizing biomass use and thus creating a better environment and quality of life. We believe that clean stove implementation can also meet other multidimensional challenges, including better health and gender equality. There is no one-size-fits-all solution for energy demand issues, including those in the domestic sector. Rather, complementary clean cooking programs are being implemented across the archipelago, reflecting the country's diverse geography, culture, and cooking practices. The recent government-supported Kerosene-to-LPG Conversion Program has succeeded in replacing kerosene as the country's main household cooking fuel. In addition, nationally and internationally funded biogas programs have installed more than 10,000 biogas units in targeted rural areas with sufficient livestock and agricultural industry waste.

At the same time, 40 percent of Indonesia's households remain dependent on traditional biomass cooking energy. These households are located mainly in rural areas where the LPG conversion program has limited impact and where the biogas option is unlikely to be suitable. Despite limited efforts in the past, a market for clean biomass cookstoves has yet to develop. Indeed, few households use, or are even aware of, clean biomass cookstoves. We need to focus our efforts on helping this 40 percent of the country's households access clean cooking solutions. Technologies and techniques for sustainable production and efficient use of biomass energy

are available. Since biomass energy is a renewable resource if used in an efficient and clean way, biomass cookstoves could contribute significantly to our country's green growth agenda.

The Indonesia Clean Stove Initiative (CSI), a collaborative effort of the Indonesian government and the World Bank, takes an integrated approach to creating the enabling conditions for developing a thriving clean cookstove market. Initiated in 2012, the CSI program consists of four phases: (i) initial stocktaking and development of the implementation strategy; (ii) institutional strengthening, capacity building, and piloting of the strategy; (iii) scaled-up program implementation; and (iv) evaluation and dissemination of lessons learned. This report synthesizes the knowledge to date; emphasizes a market-based approach to sustainability; and proposes a path toward achieving universal access to clean cooking solutions, based on the activities undertaken in phase I of the CSI program. It is our hope that this report will serve as a knowledge base and roadmap for encouraging and engaging all interested parties to work together on this important agenda. We look forward to working with our partners to implement the key policy recommendations offered in the report during the next phase of the CSI program to accelerate Indonesia's journey toward universal access to clean cooking solutions.

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Director General
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Preface

About 2.8 billion people, more than a third of the world's population, rely on open fires or inefficient stoves to cook and heat their homes. They use solid fuels, such as charcoal, wood, and other biomass; animal dung; and coal—all of which produce toxic smoke that pollutes the air inside and outside their homes. The Global Burden of Disease Study 2010, published in 2012, estimates that household air pollution from the use of solid fuels for cooking and heating contributes to 4 million premature deaths each year (2010 figure). Unlike malaria, tuberculosis and HIV/AIDS, for which the death toll is declining every year, the number of premature deaths due to household air pollution is on the rise. How can we reverse this?

As a follow-up to the regional energy flagship report, *One Goal, Two Paths: Achieving Universal Access to Modern Energy in East Asia and the Pacific*, the East Asia and Pacific (EAP) Clean Stove Initiative (CSI) was launched in early 2012 with the aim of scaling up access to clean cooking and heating solutions in the region, particularly for rural households likely to continue relying on solid fuels to meet most of their cooking and heating needs beyond 2030. This multi-country, multi-phase initiative comprises four country-specific programs (China, Indonesia, Lao PDR, and Mongolia) and a regional forum to promote collaboration, learning, and knowledge sharing on access to modern energy at the household level. This report summarizes the findings from phase I of the Indonesia CSI, based on a comprehensive stocktaking review, two national consultation workshops, and a first ever national-scale biomass cookstove supply-side survey.

Indonesia has made great strides in moving its citizens toward clean cooking solutions. Thanks to the government's Kerosene-to-LPG Conversion Program—the world's largest LPG conversion program—the landscape of household cooking fuel choices has shifted dramatically. Today a majority of Indonesian households use LPG instead of kerosene to meet most of their daily cooking

needs. However, some 24.5 million households or two-fifths of Indonesia's population, mainly in rural areas, continue to depend on traditional biomass as their primary cooking energy. In many rural and peri-urban areas, biomass can be freely collected from the local environment or cheaply purchased. Thus, without sufficient economic development or effective policy interventions, the use of traditional biomass for cooking will remain high or may even rise in certain areas. The resulting negative health impacts are significant: an estimated 165,000 premature deaths each year are attributed to household air pollution linked to traditional biomass cooking. Those disproportionately affected are the poor, who depend heavily on biomass for cooking, and women and their young children, who spend many hours each day in the household cooking environment.

Now there is a window of opportunity to promote clean biomass cookstoves in Indonesia, building on the momentum from the country's recent success in promoting clean cooking solutions. The policy recommendations offered in this report reflect the World Bank's shared commitment with the Indonesian government to ensure that all of Indonesia's citizens have access to clean cooking solutions by 2030. On a global scale, this goal is echoed by the United Nations Sustainable Energy for All initiative, to which Indonesia is committed. The scaled-up access to clean biomass cookstoves, complemented by an expanded and sustainable LPG conversion program and greater adoption of other clean cooking fuels, such as biogas systems in suitable areas, can move the country far along the road to achieving this ambitious goal. The benefits are many, including better health, reduced poverty, improved gender equality, and less pressure on the global environment.

Stefan G. Koeberle
Country Director for Indonesia
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Acknowledgments

This report summarizes the findings from phase I of the Indonesia Clean Stove Initiative (CSI), implemented in collaboration with Indonesia's Directorate of Bioenergy, Ministry of Energy and Mineral Resources (MEMR). The World Bank team is particularly grateful to Maritje Hutapea, former Director of Bioenergy, and Dadan Kusdiana, current Director of Bioenergy, for their leadership and commitment to the Indonesia CSI. The team extends special thanks to the CSI Technical Committee, chaired by the Director of Bioenergy, for its open and constructive exchange of ideas and information, which contributed to the preparation of the report.

The Indonesia CSI is led by Yabei Zhang, with a core team including Laurent Durix, Dejan Ostojic, Voravate Tuntivate, Olivia Tanujaya, and Yun Wu. The World Bank team is grateful for the support and inputs from the local NGO team of Yayasan Dian Desa (YDD), led by Christina Aristanti and Prianti Utami.

The report is authored by Yabei Zhang, Voravate Tuntivate, Christina Aristanti, and Yun Wu and benefited from the preparation of three background case studies, which are summarized in the annexes: Indonesia Kerosene-to-LPG

Conversion Program, by Edi Susanto under the guidance of Yusep Kartika Cahyana of the Directorate General of Oil and Gas (MIGAS), MEMR (Annex A); Indonesia Domestic Biogas Programme, by Robert de Groot of the Humanist Institute for Development Cooperation (HIVOS) (Annex B); and Biomass Cookstoves in Indonesia, by the YDD team led by Christina Aristanti and Prianti Utami (Annex C). The report was edited by Norma Adams and typeset by Michael Alwan.

The team wishes to thank peer reviewers Koffi Ekouevi and Venkata Ramana Putti, as well as colleagues Bert Hofman, Douglas Barnes, Andrew Shepherd, and David Hawes, who provided useful comments. The team is also appreciative of the valuable overall guidance provided by World Bank management throughout the process, particularly John Roome, Stefan G. Koeberle, Franz R. Drees-Gross, Vijay Jagannathan, Charles Feinstein, and George Soraya. Finally, the team gratefully acknowledges the generous funding support provided by the Australian Agency for International Development (AusAID), as well as the World Bank's Asia Sustainable and Alternative Energy Program (ASTAE).

Abbreviations and Acronyms

ARI	Acute Respiratory Infection	HAP	Household Air Pollution
AusAID	Australian Agency for International Development	HIVOS	Humanist Institute for Development Cooperation
BIRU	Biogas Rumah program (IDBP)	IDBP	Indonesia Domestic Biogas Programme (BIRU)
BPS	Bandan Pusat Statistik (Indonesian National Statistics Office)	IDR	Indonesian Rupiah (currency)
CAREI	China Association of Rural Energy Industry	LPG	Liquefied Petroleum Gas
CPO	Construction Partner Organization	M&E	Monitoring and Evaluation
CSI	Clean Stove Initiative	M&V	Monitoring and Verification
DJLPE	Directorate General for Electricity and Energy Utilization	MIS	Management Information System
EAP	East Asia and Pacific	NGO	Nongovernmental Organization
EBTKE	Directorate-General of New and Renewable Energy and Energy Conservation	R&D	Research and Development
GACC	Global Alliance for Clean Cookstoves	RBF	Results-Based Financing
GERES	Renewable Energy, Environment, and Solidarity Group	SNV	Netherlands Development Organisation (Stichting Nederlandse Vrijwilligers)
		YDD	Yayasan Dian Desa

Units of Measure

kg	kilogram	m ²	square meter
kl	kiloliter	m ³	cubic meter
km	kilometer	MT	metric ton

Currency Equivalents

Currency Unit = Indonesian Rupiah

IDR 9,152 = US\$1

Main Messages

Rural households in Indonesia are likely to rely on biomass cooking energy for years to come. Today, approximately 40 percent of Indonesia's households—about 24.5 million households, located mainly in rural areas—still rely on traditional biomass energy (mainly fuelwood) as their primary cooking fuel. The Indonesian government's highly successful Kerosene-to-LPG Conversion Program (2007–12) has resulted in a fivefold increase in the number of LPG users, located mainly in urban areas. But among biomass-using rural households located far from the LPG distribution network, the program's impact has been limited, with only a 9 percent decline in fuelwood use over a three-year period (2007–10). Rural households are unlikely to switch to modern fuels on a large scale if they are unaffordable and will likely continue to rely on biomass cooking energy for the foreseeable future.

Scaled-up access to clean cooking solutions can mitigate the risks of cooking with traditional biomass. Household burning of traditional biomass is a major health-risk factor in Indonesia. Household air pollution resulting from the inefficient use of traditional biomass is linked to an estimated 165,000 premature deaths annually, affecting primarily women and their young children. But under conditions of sustainable production and more efficient fuel use, biomass energy is renewable; with better fuels and more efficient cookstoves, such emissions could be reduced. Implementing clean biomass cooking solutions can lead to better health, reduced poverty, greater gender equality, and less pressure on the local and global environment.

Any strategy to scale up the use of clean biomass stoves requires an enabling environment. This stocktaking exercise recommends implementing a comprehensive strategy that institutionalizes issues of cooking technologies and biomass fuels into the national policy framework, requiring centralized leadership and cross-sector cooperation. To create a sustainable market, both supply- and demand-side issues must be tackled in an integrated manner, supported by both technical assistance and financing. A results-based financing approach, which offers incentives and flexibility, is recommended to motivate private suppliers to deliver clean cooking solutions to households.

The Indonesia Clean Stove Initiative reflects the World Bank's shared commitment with the Indonesian government to bring clean cooking solutions to all of the country's citizens by 2030.

The World Bank is committed to supporting the Indonesian government's efforts to achieve universal access to clean cooking solutions by 2030. Working with the Directorate of Bioenergy, Ministry of Energy and Mineral Resources, the World Bank has launched the Indonesia Clean Stove Initiative and is completing the first phase of stocktaking and stakeholder consultations. Having characterized the country's biomass use and stove practices, the next phase will focus on establishing stove standards/testing system, strengthening institutions and building stakeholder capacity, and implementing pilot programs in preparation for national-scale program rollout.

Executive Summary

Most households in Indonesia are shifting to modern cooking energy thanks to the government's recent interfuel substitution program, yet 40 percent of households still rely on traditional biomass cooking. The Indonesian government's Kerosene-to-LPG Conversion Program, a five-year effort initiated in 2007, has made significant progress in incentivizing households to switch from kerosene, an increasingly expensive fuel choice, to liquefied petroleum gas (LPG). As a result, the fiscal pressure linked to continued kerosene subsidies has been reduced. Today, LPG is the country's dominant cooking fuel, yet rural and poorer households located far from the distribution network continue to depend on fuelwood collected from the local environment to meet most of their cooking needs. Without designing and implementing targeted policies, the percentage of households cooking with biomass energy will remain high—and may even increase in certain areas—for years to come.

Indonesia ranks second among East Asia and Pacific countries in mortality attributed to household air pollution (HAP) from solid fuel combustion. Household air pollution linked to smoke emitted from the incomplete combustion of solid cooking fuels accounts for about 165,000 premature deaths each year. The use of fuelwood for cooking is associated with increased risk for asthma, lung tuberculosis, and acute respiratory infections (ARIs) among children under age 5. A number of studies show that the use of solid fuels, especially among households in rural areas, is closely linked to a high incidence of respiratory disease. Switching to such modern fuels as LPG or electricity—the most effective way to reduce HAP—would require more costly stoves and delivery infrastructure, which most rural households cannot afford. Such emissions could still be reduced with more efficient use of biomass fuel and cookstoves. **Thus, in areas where biomass cooking persists, the most effective remedy to mitigate HAP exposure is to promote improved or advanced stoves that burn biomass energy in a cleaner, more efficient way.**

The Indonesia Clean Stove Initiative (CSI) aims to scale up access to clean cooking solutions for poorer, primarily rural households who are likely to continue relying on solid fuels beyond 2030. The World Bank, in collaboration with the Directorate of Bioenergy, Ministry of Energy and Mineral Resources, launched the Indonesia CSI in early 2012. This initiative, one of four country-specific programs under the AusAID-funded East Asia and Pacific CSI, focuses on

capacity building, policy development, and support for selected government action plans. The program consists of four phases: (i) initial stocktaking and development of the implementation strategy; (ii) institutional strengthening, capacity building, and piloting of the strategy; (iii) scaled-up program implementation; and (iv) evaluation and dissemination of lessons learned. This study reflects the findings of the initial stocktaking review, including a field survey and stakeholder consultations.

LPG is well on its way to replacing kerosene as Indonesia's primary cooking fuel in the areas targeted by the Kerosene-to-LPG Conversion Program. The LPG conversion program has been especially effective in East, West, and Central Java; all of these areas have exhibited more than a five-fold increase in household use of LPG for cooking since 2007. It was estimated that nearly 30 million households would be using LPG as their main cooking fuel by late 2012, when the program was scheduled to end. At the same time, another 11.7 million households on the island of Java and 12.8 million scattered throughout the country's other provinces, located mainly in less economically advanced areas, will continue to rely on firewood for cooking.

Household selection of cooking fuels is generally determined by a fuel's affordability, availability, accessibility, and cultural acceptability. In the case of Indonesia, the 2006 reduction in the availability of kerosene supply resulted in many households—particularly those in rural areas for whom LPG was too expensive or inaccessible—switching to firewood. In addition, many rural households have been unwilling to pay for LPG, even at the subsidized price, given that they can freely collect fuelwood from the local environment at little or no cost, except for the time spent collecting it. Furthermore, many households rely on a mix of cooking fuels, especially when alternative fuels are available at an affordable price. For example, rural households that cannot access LPG regularly may use kerosene to supplement their firewood use.

The CSI stocktaking survey shows that the commercial market for biomass stoves is quite limited. Indeed, in many rural and more remote areas, there are no existing markets for biomass cookstoves. Annual stove production is far less than the number of households using biomass stoves, suggesting that a significant number of households do not buy stoves available in the market. Many make their

own rudimentary stoves (e.g., three-stone) and have more than one. Primary stoves, commonly made of mud, cement, or stone, are quite energy-inefficient and emit significant amounts of toxic smoke.

The stove supply chain is characterized by longstanding business relationships between traditional producers, wholesalers, and retailers. Members of the traditional stove supply chain at each of these levels usually have worked together for many years and operate according to informal business agreements based on mutual trust. Their business practices in terms of who sells stoves to whom, how stoves are transported, and price margins taken at each level are deeply embedded in these relationships and traditional business practices.

Indonesia's geographic and cultural diversity is reflected in the strong regional variations in business and stove purchasing practices. Key contributing factors include stove costs at each point of sale, final stove cost to users (i.e., what users are accustomed to paying), and the types of stoves primarily sold (including the types of materials used). The rate of stove production and business size varies by province, and production patterns and business relationships differ by area, as do supply-and-demand relationships, which affect the supply chain's readiness to produce and distribute new models and households' willingness to use them.

The traditional cookstove supply chain generally lacks knowledge about better stove models, and a new model's acceptability depends on its potential to be sold. Knowledge about stove performance is limited throughout the entire supply chain. With the primary target of selling as many stoves as possible, producers, wholesalers, and retailers are more concerned with profit than which stoves might be more fuel-efficient or clean-burning. Price plays an important role in the decision to sell a stove since consumers are used to paying low prices. Introducing new stove models would need to be linked to a higher profit margin and would require training supply chain members in how to maximize their benefits from participating in selling the new stove models so they would be incentivized to continue with the trade into the future.

To date, Indonesia's policies and programs have failed to address household biomass cooking energy and health issues in an integrated manner. Without specifics on biomass and clean cooking solutions and recognition of the reality that nearly half of the country's population uses biomass, the problem—involving a wide range of cross-cutting issues—will continue to be overlooked. While various improved stove programs have been implemented in Indonesia over the past 25 years, these decentralized

efforts have tended to be fragmented and sporadic, focusing only on small areas. Most have been donor-funded programs implemented by nongovernmental organizations (NGOs); in virtually all cases, the programs ended when funding ceased.

Key principles underlying the success of the Kerosene-to-LPG Conversion Program and the Indonesia Domestic Biogas Programme can be adapted to a program designed to promote clean biomass cooking. The LPG conversion program has demonstrated the importance of strong government commitment and a firm policy objective, effective marketing and public-awareness campaigns, assured availability of an uninterrupted fuel supply, and effective monitoring and evaluation. In addition, the biogas program has underscored the value of adopting a market-based approach, in combination with targeted financial support to help households overcome high upfront costs. That program also has emphasized the need for quality control and adherence to standards, verification of results and procedures, and local management to ensure program sustainability after international donor funding ends.

The proposed CSI strategy requires an enabling environment within which to scale up the use of clean biomass stoves. The CSI strategy builds on and is consistent with the sector transformation strategy developed by the Global Alliance for Clean Cookstoves and the World Bank's "one goal, two paths" approach to achieving universal access to modern energy in the East Asia and Pacific region. Institutionalization, which lies at the heart of the CSI strategy, is essential to developing this enabling environment. Also vital are the mutually reinforcing pillars of stimulating user demand for clean stoves and supporting the market and supply-side business development. In addition, support is required for establishing and strengthening stove standards, testing, and certification; conducting research and development on improved and advanced stoves and fuel processing technologies; and developing a master plan for a national clean biomass cookstoves program.

Stimulating user demand for clean biomass stoves requires a large-scale public health campaign that must be far-reaching and comprehensive, involving multiple sectors. Without consumer demand coming to permanently influence the clean stove market supply, any market intervention is unlikely to be sustainable. But educating the public about the characteristics and benefits of using modern, high-quality stoves instead of inefficient traditional technologies can result in changes in user preferences, which, in turn, can change the direction of market development. This effort will require cooperation across various ministries, women's groups, local and international NGOs, academia, and the private sector.

Government support of the market and supply-side business development must fit Indonesian conditions and target long-term sustainability.

Where stove supply chains already exist (e.g., Java, Sumatra, and parts of Kalimantan and Sulawesi), the CSI strategy recommends building awareness and capacity. However, in areas without stove supply chains (e.g., East Nusa Tenggara, Papua, and Maluku), significant time and resources will need to be invested in building local supply chains and educating both producers and households in the use and benefits of the new stoves. Additional recommendations are to provide training within the cookstove supply chain, ensure quality control over clean cookstoves, develop and provide training on new business models and entrepreneurship, provide financial incentives for delivering clean cooking solutions to households, and support market research.

The CSI strategy recommends using a Results-Based Financing (RBF) approach to promote clean stoves.

International experience has shown that more innovative subsidy schemes are required to develop a sustainable market and thus make government funding support more effective and efficient. One such scheme is RBF, which disburses public resources against demonstrated, independently verified outputs or outcomes instead of project inputs. This distinguishing feature can mean more effective and efficient use of public funds and improved support of market interventions. The conceptual framework for using RBF in programs to promote clean stoves could include three key building blocks—defined clean stoves, results-based incentives, and a monitoring and verification (M&V) system—supported by the pillars of institutional strengthening/capacity building and awareness-raising campaigns.

The scenario analysis conducted under this study estimated that at least 10 million clean biomass cookstoves will need to be delivered by 2020 to be on the path to universal clean cooking solutions by 2030. To reach such an ambitious target, it

is recommended that two consecutive national programs be implemented. These will require a high level of government commitment and financial support and adoption of a market-based mechanism to support development of the clean biomass stoves sector, using a phased approach with gradual geographical expansion.

Achieving universal access to clean cooking solutions by 2030 will require action on several key fronts.

These include the continued strengthening and expansion of the LPG retail distribution network, along with ensuring well-targeted subsidies; continued expansion of biogas programs in suitable areas, in line with community resources; and overcoming the institutional and supply- and demand-side barriers to creating a thriving clean biomass cookstove market. As phase I of the Indonesia CSI concludes and the lead-up to the national program accelerates, phase II will focus on establishing stove standards and testing protocols, strengthening institutional capacity, supporting pilot programs, and designing and preparing for the national program rollout, envisioned to begin in 2014.

Over the next 10–20 years, it is expected that national economic development will continue to enrich Indonesian citizens, influencing the increased adoption of LPG, and that those who continue to use biomass fuel will do so with a clean stove.

By 2020, a target has been proposed for achieving 40 percent use of clean biomass stoves (10 million stoves delivered), with momentum leading to 100 percent penetration by 2030. The private sector—including stove designers, producers, wholesalers, and retailers—is in the best position to know its customers; thus, the public sector will provide the private sector sufficient incentives and support so it is enabled to reach its customers. Ultimately, the market should decide which customers and locations to target and which types of technologies and fuels to focus on, with the freedom to innovate over time.

Introduction

Indonesia's household cooking fuels have undergone a dramatic shift in recent years, owing primarily to the government's highly successful Kerosene-to-LPG Conversion Program; yet the impact in poorer rural areas has been limited. Switching to LPG, electricity, and other modern fuels would be the most effective way to achieve clean cooking solutions, but these fuels are expensive, requiring costly stoves and delivery infrastructure that are beyond reach for most rural households. By contrast, many types of biomass can be freely collected from the local environment or purchased for significantly less than other fuels. Thus, large-scale fuel switching in rural areas is unlikely to occur until rural economies become substantially more developed. This means that an estimated 40 percent of households will continue to rely on traditional biomass energy, especially fuelwood, to meet their daily cooking needs for years to come.

Overview of Program Context

As early as the 1980s, a handful of nongovernmental organizations (NGOs) began implementing improved stove programs in Indonesia. While some achievements have been made, most programs are still in their pilot phases, the total number of stoves disseminated remains limited, and a market for improved biomass cookstoves has not yet developed. At the same time, the Kerosene-to-LPG Conversion Program, a five-year effort initiated in 2007, has made significant progress in incentivizing households to switch from kerosene to LPG. While the program has helped to reduce the budgetary cost related to kerosene subsidies, the targeted beneficiaries are mainly kerosene users. The use of biomass fuel for cooking is expected to remain high over the next decade; without significant shifts in policy, it may even increase in certain areas.

Indonesia needs to build on its earlier experiences with stove programs and develop more effective policies and programs that simultaneously address energy conservation, health, gender equality, poverty, and environmental concerns. Families usually burn biomass fuel using traditional, inefficient cookstoves that waste potential fuel energy and emit many health-damaging pollutants into the household environment. Each year about 165,000 premature deaths in Indonesia are attributed to household air pollution (HAP) linked to traditional biomass cooking (Lim et al. 2012) (box 1.1). The groups disproportionately affected are the poor, who rely heavily on biomass for cooking, and women and young children, who spend many hours each day indoors in the household cooking environment.

Achieving universal access to modern energy services by 2030 is the goal set by the United Nations, which declared 2012 as the Year of Sustainable Energy for All. With its large population lacking access to modern energy services, Indonesia will have an important role to play in achieving this global goal.

Clean Stove Initiative

Against this backdrop, the World Bank, in collaboration with the Directorate of Bioenergy, Ministry of Energy and Mineral Resources (MEMR), launched the Indonesia Clean Stove Initiative (CSI) in early 2012. As part of the East Asia and Pacific (EAP) Clean Stove Initiative (box 1.2), the Indonesia CSI aims to scale up access to clean and efficient cooking solutions in Indonesia through capacity building, policy development, and support for selected government action plans.

BOX 1.1 HEALTH IMPACT OF INDOOR POLLUTION IN INDONESIA

Indonesia ranks second among East Asia and Pacific countries in mortality attributed to household air pollution (HAP) from solid fuel combustion. The Global Burden of Disease Study 2010 estimates that each year about 165,000 premature deaths in Indonesia can be attributed to HAP linked to smoke emitted from solid cooking fuels (Lim et al. 2012). The use of fuelwood for cooking is linked to an increased risk of asthma, lung tuberculosis, and acute respiratory infections among children under age 5. Various studies show that the use of solid fuels, especially by households in rural areas, is closely linked to a high incidence of respiratory disease.

Switching to clean fuels—electricity, natural gas, liquefied petroleum gas (LPG), and biogas—is the most effective way to reduce HAP, but most rural households in Indonesia cannot afford modern fuels, which require more costly stoves and difficult-to-access delivery infrastructure. A wide array of technological, housing, and behavioral interventions (e.g., house design and ventilation, stove-use behavior, and amount of time spent near the stove) can be used to reduce HAP exposure in areas where the use of solid fuels persists. But the most effective remedy is the promotion of improved or advanced stoves that use solid fuels in a cleaner, more efficient way.

Sources: Zhang and Wu 2012; Lim et al. 2012.

BOX 1.2 PROMOTING CLEAN STOVES IN EAST ASIA AND THE PACIFIC

The East Asia and Pacific (EAP) Clean Stove Initiative (CSI) is a follow-up regional program to the energy flagship report, *One Goal, Two Paths: Achieving Universal Access to Modern Energy in East Asia and the Pacific*. It focuses on achieving access to modern cooking and heating solutions in the EAP region, particularly scaled-up access to advanced cooking and heating stoves for poor, primarily rural households that are likely to continue relying on solid fuels to meet most of their cooking and heating needs beyond 2030.

With funding support from the Australian Agency for International Development (AusAID), the EAP CSI comprises four country-specific programs (China, Indonesia, Lao PDR, and Mongolia) and a regional forum to promote regional collaboration, learning, and knowledge-sharing on access to modern energy at the household level. The initiative takes a three-pronged approach, focusing on: (i) strengthening institutional capacity and creating an enabling policy and regulatory environment for scaling up access to advanced stoves, (ii) supporting supply-side market and business development, and (iii) stimulating demand for clean and efficient stoves.

Sources: World Bank 2011a, 2011b.

The Indonesia CSI comprises four program phases. Phase I centers on initial stocktaking, which is critical for developing the implementation strategy, designing subsequent program phases, and establishing policy dialogue with the country's institutional focal point. Phase II focuses on required institutional strengthening, capacity building, and piloting of programs. Phase III scales up program implementation, while phase IV centers on program evaluation and dissemination of lessons learned.

that cook with biomass fuels to achieve clean biomass cooking solutions by 2030. Specific objectives are to gain a better understanding of the challenges facing Indonesia's household cooking fuel technologies and cookstove market, review the existing policy and institutional framework for cooking fuels, and identify lessons from successful programs that can be applied to future intervention programs promoting clean biomass cooking solutions (box 1.3).

Study Purpose and Objectives

This study is the key activity under phase I of the Indonesia CSI. Its broad aim is to contribute to developing a roadmap for helping the 40 percent of households

Methodology

This study relied on both primary and secondary data sources. Primary data was gathered through a field survey of the biomass stove supply chain (i.e., producers,

BOX 1.3 TERMINOLOGY CLARIFICATION

In this report, unless otherwise noted, the following definitions apply:

- *Traditional biomass cookstove* refers to a rudimentary biomass stove (either open fire or constructed by artisans or household members) that is energy inefficient with poor combustion features.
- *Clean biomass cookstove* refers to a biomass stove that is either mass-produced or built in situ that, with the benefit of laboratory research, performs better in fuel efficiency, emissions, durability, and safety than open fires or rudimentary traditional cookstoves.

(In this report, the term is broadly used; it is recommended that an Indonesia stove standards/testing/certification system be established to more clearly define the term.)

- *Improved biomass cookstove* refers to the lower segment of clean biomass cookstoves installed in legacy programs.
- *Advanced biomass cookstove* refers to the higher segment of clean biomass cookstoves with superior performance and often using processed biomass fuels.
- *Traditional cooking fuels* refer to coal, charcoal, wood-based biomass fuels, agricultural residues, and dung.
- *Solid fuels* are synonymous with traditional cooking fuels.
- *Transitional fuel* refers to kerosene.
- *Modern energy* refers to electricity, natural gas, liquefied petroleum gas (LPG), and biogas.
- *Modern or clean cooking solution* refers to cooking with modern energy or solid fuels used with clean biomass cookstoves.

Source: Authors.

wholesalers, and retailers) conducted in 17 representative provinces, including West Nusa Tenggara (Nusa Tenggara Barat [NTB]) and East Nusa Tenggara (Nusa Tenggara Timur [NTT]). The information was collected through subsequent guided interviews with producers, wholesalers, retailers, and other relevant parties in the biomass cookstove supply chain.

Data was also gathered from two national stakeholder consultation workshops, which brought together key representatives of the Indonesian government, NGOs, academia, and the private sector; and meetings of the CSI technical committee, established to ensure that the study would be completed in cooperation with the various stakeholders and in accordance with existing policies. The first national stakeholder consultation workshop, held in May 2012, discussed initial field findings and gathered comments and input for improving them. The second workshop, held in July 2012, discussed the final stocktaking results and generated additional ideas for phase II of the CSI. The technical committee, chaired by the MEMR's Director of Bioenergy, includes representatives of relevant ministries and national experts. The committee conducted two meetings to discuss progress

of the CSI and generate new ideas on the initiative's proposed strategy and program direction.

In addition, background case studies were prepared on two successful programs promoting clean cooking solutions in Indonesia—the Kerosene-to-LPG Conversion Program (Annex A) and the Indonesia Domestic Biogas Programme (Annex B)—as well as biomass cookstove use in Yogyakarta and Central Java (Annex C). Finally, the study was supported by a range of published information, including census data and national socioeconomic surveys conducted by the BPS (*Badan Pusat Statistik*), Indonesia's national statistics office.

Structure of This Report

This report is structured according to the directional organization of the study. Chapter 2 presents an overview of household cooking fuels in Indonesia, including policy changes and other factors that influence fuel choices. Chapter 3 examines an array of stove supply-side issues, including market and production capacity, popular stove models, limitations of business models,

key features of the supply chain, and attitudes toward new stoves. Chapter 4 identifies gaps in policies and institutional strengthening that future intervention programs will need to fill and reviews lessons from successful programs promoting clean cooking solutions that can be applied to those focused on clean biomass

cooking. Finally, chapter 5 presents the recommended implementation strategy, including an innovative financing approach, and the proposed next steps in helping Indonesia move toward universal access to clean cooking solutions by 2030.

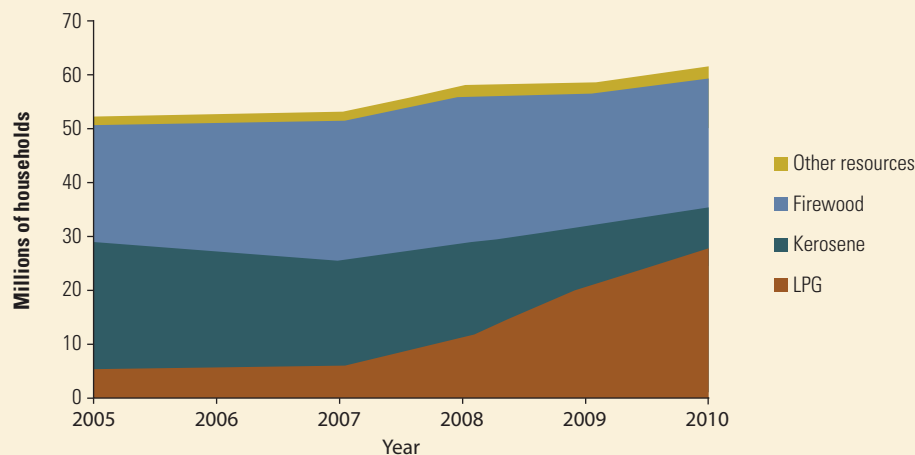
Overview of Household Cooking Fuels

The types of cooking fuels used by Indonesia's more than 60 million households reflect diverse factors, ranging from geographical differences throughout the archipelago's many islands to level of socioeconomic development, household income level, and cultural preferences. In addition, government intervention can significantly alter patterns of cooking fuel use on a large scale (YDD 2012). This chapter explores recent national trends in household cooking energy, focusing on the impact of the government's Kerosene-to-LPG Conversion Program, as well as the implications for the large portion of households that will continue to rely on firewood and other alternative energy sources to meet their cooking needs.

What Cooking Fuels Do Households Use?

Today Indonesian households mainly use liquefied petroleum gas (LPG) and firewood to meet most of their cooking needs. The 2010 national socioeconomic survey, conducted by the BPS (*Badan Pusat Statistik*), shows that about 46 percent of all households (27.6 million households) now rely on LPG as their main cooking fuel. Some 40 percent (24.5 million households) continue to depend primarily on firewood, while about 12 percent (7.2 million households) rely on kerosene. The remaining 2 percent use other resources, including electricity, charcoal, other biomass, and biogas (figure 2.1).

FIGURE 2.1 NATIONAL TREND IN HOUSEHOLD COOKING FUEL USE, 2005–10



Source: BPS: year 2005 (Intercensal Population Survey [SUPAS]), years 2007–09 (National Socioeconomic Survey [SUSENAS]), year 2006 (estimated from 2005 SUPAS and 2007 SUSENAS), year 2010 (Laporan Bulanan Data Sosial Ekonomi 2012).

Note: Other resources include electricity, charcoal, other biomass, and biogas.

BOX 2.1 WHAT IS THE NICHE MARKET POTENTIAL FOR BIOGAS?

Currently, biogas comprises a small segment of Indonesia's market for household cooking fuels. Fewer than 12,500 household systems have been installed to date. Some 40 percent (5,056 units) were installed under the Indonesia Domestic Biogas Programme (IDBP)—the national program under bilateral cooperation between the Government of Indonesia and the Kingdom of the Netherlands—while the remaining 60 percent (7,370 units) were installed under various programs, including the World Bank-supported National Program for Community Empowerment and other programs supported by local government and nongovernmental organizations. A case study on the IDBP prepared for this study estimates the total market potential at about 1 million units, most of which would be located on the island of Java (Annex B). The main barriers to household adoption are insufficient supply of feedstock (a daily supply of 25 kg of dung is needed), limited outdoor space around the house, and high upfront system costs. To reach more farming households, ongoing efforts will be required to overcome these technical constraints, along with raising households' awareness of the environmental, health, and economic benefits of biogas cooking.

Source: Authors, based on de Groot 2012.

In terms of total energy consumption, firewood remains the main primary energy source for households in Indonesia. In 2007, biomass represented 72 percent of the household sector's energy demand. The household sector accounted for more than 84 percent of the 119 million tons of officially recorded biomass energy use across all sectors, while industry represented about 15 percent (GERES 2009).

From 2005 to 2010, the percentage of households who used kerosene as their primary cooking fuel fell from 45 percent to 12 percent, while the number of households using LPG rose from about 10 percent to 46 percent (from 5.6 million to 27.6 million households). Over the same period, the percentage of households who relied on firewood remained at or above 40 percent, peaking at 49 percent in 2007. The use of other fuel sources for household cooking remained limited; for example, by 2010, just 300,000 households (less than half of a percent) used charcoal as their main cooking fuel, and fewer than 12,500 household biogas systems had been installed (box 2.1).

The next section examines the policy changes behind this recent shift in household cooking fuels, the areas covered, and the implications for households outside the targeted areas.

Mapping Recent Developments

Before 2006, kerosene had been the preferred household cooking fuel among Indonesia's urban and peri-urban households and, to a certain extent, rural families. Historically, the price to consumers had been kept low owing to heavy government subsidies. But rising oil

prices over the past decade, particularly the 2005–06 price jump, put fiscal pressure on the government to significantly reduce the volume of subsidized kerosene in the market.¹ As a result, households reduced their kerosene use by 8 percent (from 45 to 37 percent) over the subsequent two years. Many wealthier urban households increased their LPG use, while lower-income rural households stepped up use of locally available firewood. Indeed, by 2007, firewood use had risen to 49 percent, highlighting that affordability and availability are key drivers of household cooking fuel decision-making and the importance of interfuel substitution for households faced with higher fuel prices and limited availability.

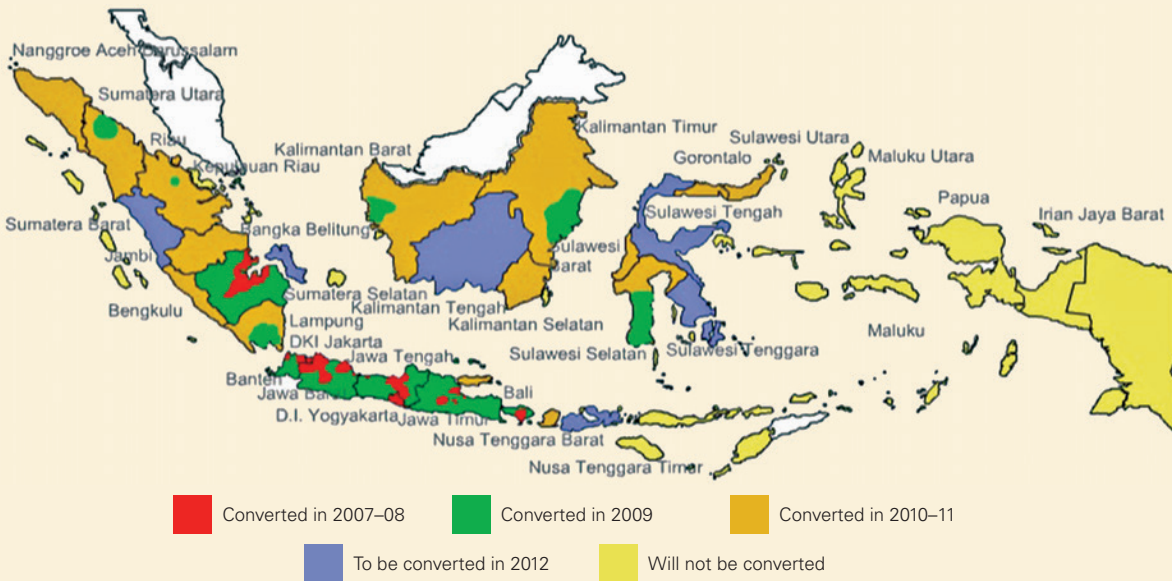
Kerosene-to-LPG Conversion Program

The Indonesian government's Kerosene-to-LPG Conversion Program, launched in 2007, has succeeded in replacing kerosene with LPG as the nation's dominant cooking fuel, substantially changing the landscape of fuel choices for households and small business enterprises (map 2.1).

During the first four years of the conversion program (2007–11), more than one-third of households (from 11 percent to 46 percent) switched to LPG as their main cooking fuel, while one-quarter (from 37 percent to 12 percent) shifted away from kerosene, underscoring the program's success. Households in western areas of Indonesia have been specifically targeted. More than three-quarters of the households that use LPG as their main cooking fuel—an estimated 21 million households—live on the island of Java (map 2.2). The eastern part of the

1. Over a three-year period (2005–08), the Indonesian government reduced the market volume of subsidized kerosene by one-third (from 11.4 to 7.8 million kl).

MAP 2.1 AREA COVERAGE OF THE KEROSENE-TO-LPG CONVERSION PROGRAM



Source: PT Pertamina and WLPGA 2012.

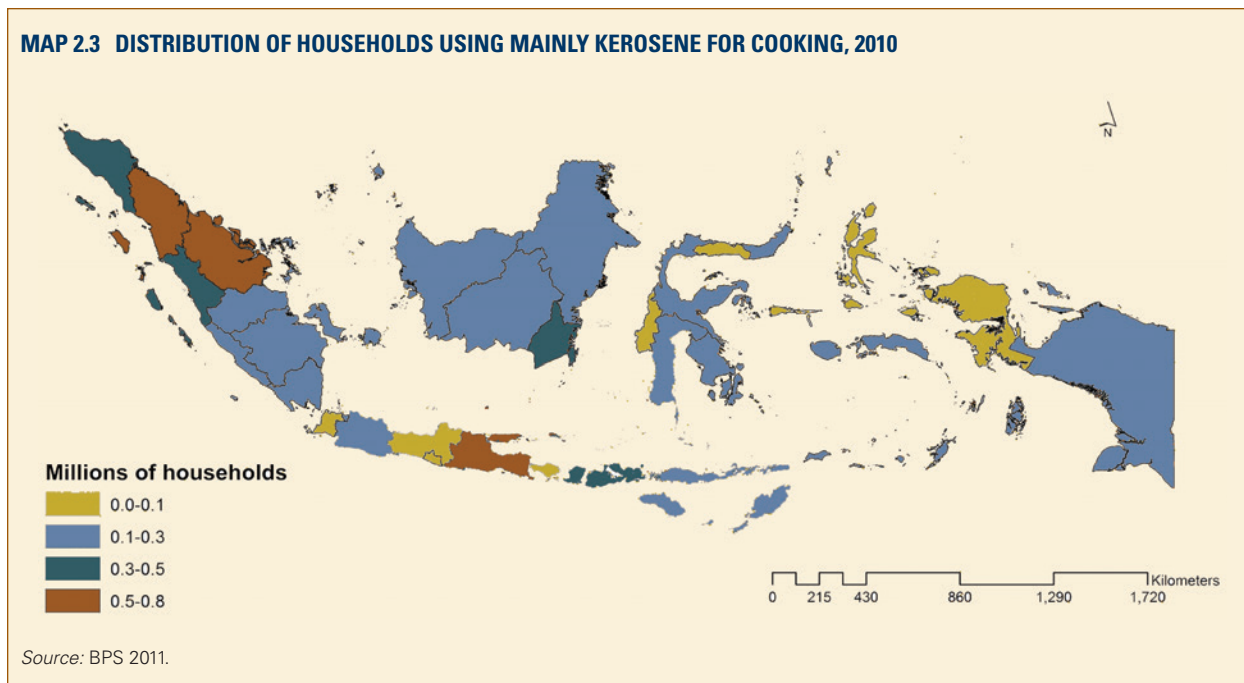
MAP 2.2 DISTRIBUTION OF HOUSEHOLDS USING MAINLY LPG FOR COOKING, 2010



Source: BPS 2011.

country—including Papua, Maluku, North Maluku, and East Nusa Tenggara—and other more remote areas are excluded from the program owing to the potentially high investment cost of developing supply networks in such sparsely populated areas.

By 2010, when the conversion program was in full swing, 48.2 million LPG start-up packages (i.e., a filled 3-kg LPG cylinder, stove, hose, and regulator) had been distributed free of charge to 48.2 million eligible households and small- and medium-sized enterprises (SMEs). That year,

MAP 2.3 DISTRIBUTION OF HOUSEHOLDS USING MAINLY KEROSENE FOR COOKING, 2010

some 27.6 million households—46 percent of all households—were reported to be using LPG as their primary cooking fuel, suggesting that a significant portion of those who had received the start-up packages made the switch from kerosene to LPG (BPS 2011) (map 2.3). In 2011–12, an additional 8.5 million start-up packages were distributed.²

The conversion program has been especially effective in the provinces of East, West, and Central Java, all of which have exhibited more than a fivefold increase in household use of LPG for cooking since 2007. As of 2010, East Java had reported a sixfold increase, while West Java had the largest total number of LPG users, at 8 million households. In that province, where kerosene had been used by nearly half of all households in 2007, LPG surpassed it as the dominant cooking fuel as early as 2009. Such dramatic increases can be attributed to the program’s effectiveness, combined with the advantageous geographic and socioeconomic conditions of these provinces.

Today, LPG is the dominant cooking fuel in some 10 provinces, located mainly in the western part of the country. In all but 7 provinces, both the number and share of LPG users have increased. Clearly, LPG is well on its way to

2. It was estimated that nearly 30 million households would be using LPG as their main cooking fuel by late 2012, when the program was scheduled to end.

replacing kerosene as the primary cooking fuel in the areas targeted by the conversion program (Annex A).

Limited Future for Kerosene

By mid-2012, the Kerosene-to-LPG Conversion Program had been implemented in 23 out of the country’s 33 provinces; however, only 13 provinces had been designated as “closed and dry,” meaning that distribution of the LPG start-up packages had been completed and supply networks were considered secure, with all subsidized kerosene withdrawn. In the remaining 10 provinces covered by the conversion program, the kerosene subsidy is being reduced gradually until all LPG start-up packages are distributed and supply networks are considered secure and sufficient to meet demand. Thus, as program implementation winds down, only non-subsidized kerosene will be available on the market (Susanto 2012).

It is expected that about 10 percent of households will continue to rely on kerosene as their primary cooking fuel beyond the end of the conversion program. These households are located in areas where it has not been economically feasible for the government to implement the conversion program (i.e., such eastern provinces as Papua, Maluku, North Maluku, and East Nusa Tenggara and other sparsely populated regions). In these areas, where the government has no plans to implement the conversion program, subsidized kerosene use will continue.

MAP 2.4 DISTRIBUTION OF HOUSEHOLDS USING MAINLY FIREWOOD FOR COOKING, 2010



Source: BPS 2011.

Sustained Levels of Firewood Use

In 2010, an estimated 40 percent of all households in Indonesia (24.5 million households) used firewood as their main source of cooking energy (map 2.4). Just prior to launching the Kerosene-to-LPG Conversion Program, the government reduced the supply of subsidized kerosene, at which time LPG supply could not yet meet demand. In response, these households either switched to firewood or began using more of it in their fuel mix; as a result, the percentage of firewood users rose to 49 percent in 2007. Once LPG supply was raised sufficiently, firewood use fell to about 40 percent, where it is expected to remain in the coming years.

About half of all households that depend on firewood as their main cooking fuel—approximately 11.7 million

households—are concentrated on Java, the country's most densely populated island. These households comprise about 40 percent of all households in the provinces of East, Central, and West Java (table 2.1). The other 12.8 million households that rely on firewood for cooking are scattered throughout the other 30 provinces (map 2.4).

Those provinces least dependent on firewood for cooking energy tend to be more economically advanced. For example, in DKI Jakarta, only 5,559 households—less than 1 percent of households—depend on firewood as their main cooking fuel, while in Kepulauan Riau, just 40,077 households or 9 percent of households use firewood. By contrast, the 13 provinces considered most reliant on firewood for cooking tend to have higher proportions of lower-income households (table 2.2). These provinces,

TABLE 2.1 PROVINCES WITH LARGEST NUMBER OF HOUSEHOLDS USING WOOD FOR COOKING, 2007–10

Province	Number of households (million)			
	2007	2008	2009	2010
East Java	5.3	5.5	5.1	4.8
Central Java	5.2	5.3	4.4	4.0
West Java	3.6	3.6	3.1	2.9
Countrywide	26.3	27.4	25.3	24.5

Source: BPS 2011.

TABLE 2.2 PROVINCES HEAVILY RELIANT ON FIREWOOD FOR HOUSEHOLD COOKING, 2010

Province	Poverty rate (percent)	Number of households (million)	Households using firewood as main source of cooking energy	
			Number (million)	Percent
Nusa Tenggara Timur	21.23	1.01	0.85	83.4
Sulawesi Barat	13.89	0.26	0.19	74.2
Papua	31.98	0.66	0.47	70.6
Lampung	16.93	1.93	1.33	68.6
Maluku Utara	9.18	0.21	0.15	68.1
Sulawesi Tengah	15.83	0.62	0.41	65.7
Gorontalo	18.75	0.24	0.15	63.3
Sulawesi Tenggara	14.56	0.50	0.31	62.6
Nusa Tenggara Barat	19.73	1.25	0.77	61.1
Bengkulu	17.50	0.43	0.26	59.7
Maluku	23.00	0.32	0.18	57.9
Kalimantan Barat	8.60	1.02	0.56	55.2
Sumatera Barat	9.04	1.15	0.62	53.6

Source: BPS 2011.

which stretch from west to east, are particularly concentrated in Nusa Tenggara, Papua, and Sulawesi—lands that exhibit the country's highest poverty rates. Nearly two-thirds of these 13 provinces' 9.6 million households use firewood as their main cooking fuel.

Factors Influencing Cooking Fuel Choices

Indonesia's 2006 reduction in kerosene supply resulted in a significant number of households switching to firewood, particularly those in rural areas for whom LPG

was too expensive or inaccessible. Currently, LPG use is subsidized, with about 40 percent of it imported. However, international price fluctuations could impinge on the government's fiscal ability to maintain today's level of price subsidy. If subsidies were reduced and retail prices raised, many households would likely shift to firewood as an alternate fuel, underscoring the importance of affordability in households' cooking fuel decision-making (box 2.2).

Although LPG is now the preferred cooking fuel among urban households, rural households continue to prefer firewood for several key reasons. First, firewood is

BOX 2.2 WHAT DRIVES HOUSEHOLDS TO SWITCH COOKING FUELS?

In 2009, the Renewable Energy, Environment, and Solidarity Group (GERES) conducted a household energy survey in selected districts of Central Java and DI Yogyakarta, Indonesia to examine the factors that influence household fuel choice and reasons for switching fuels. The results identified fuel cost as the main reason for changing fuels. Nearly one-third of respondents reported switching fuels because of changes in fuel subsidies, while more than one-quarter said they were looking for cheaper fuels. Fifteen percent said they were seeking fuels that were easier to obtain. Others reported a desire for better-tasting food, a cleaner cooking environment, and ease of use (Annex C).

Source: YDD 2012.

readily available in the local environment at little or no cost, except for the time spent collecting it; also, a recent study showed that most firewood used by households is renewably harvested (GERES 2009). Second, LPG distribution networks tend to be limited to urban and peri-urban areas. Finally, many rural households either cannot afford LPG, as suggested in table 2.2, or are unwilling to pay for it, even at the subsidized price, given that they can freely collect firewood. Based on these factors, combined with the analysis presented earlier, it is expected that most rural households will continue using firewood for the foreseeable future, with demand remaining at levels prior to the 2007 launching of the conversion program.

Moreover, empirical evidence suggests that many households rely on a mix of cooking fuels rather than a single one, especially when alternative fuels are available at an affordable price. For example, in urban areas where firewood is not readily available, households that use LPG as their main cooking fuel may use electricity as a supplemental or substitute fuel. But in peri-urban areas where firewood can be collected at no cost or purchased cheaply, households that use LPG may supplement it with firewood or use firewood for specific purposes. Since national-level data indicate only one main cooking fuel that households use, the estimated portion of households that use a mix of LPG and firewood is unknown. But it is important to take these households into account since they will continue to rely significantly on firewood,

albeit at a level of lesser intensity than households that use firewood as their main cooking fuel.

Summary Remarks

As a result of the government's Kerosene-to-LPG Conversion Program, LPG has replaced the kerosene market, but its availability is limited mainly to urban and peri-urban areas.³ Rural households that can afford LPG may be located too far from the distribution network to be able to regularly access the fuel. Other rural households may choose to use kerosene along with firewood in their fuel mix. It is imperative that such households, along with those who cannot afford or access transitional or modern fuels, have access to clean-burning, fuel-efficient biomass stoves. In addition to mitigating the health risks associated with household air pollution, clean biomass stoves can alleviate the fiscal pressure on LPG subsidies by providing alternative clean cooking solutions. As a renewable resource in Indonesia, biomass is abundant and affordable to the poor. Used with fuel-efficient, clean-burning cookstoves, it could contribute significantly to the country's green growth agenda.

3. Although this report relies on 2010 data and the conversion program was ongoing through 2012, it was expected that about 40 percent of households would continue to rely on firewood as their main cooking fuel, the same level prior to implementing the conversion program. The vast majority of these households reside in rural areas, where gaining access to LPG is quite difficult or not possible.

Stove Supply Issues

As discussed in chapter 2, 40 percent of Indonesia's households (24.5 million households)—nearly half located on the densely populated island of Java and the other half scattered throughout lower-income provinces—are expected to continue relying on firewood as their main source of cooking energy for years to come, suggesting a total technical potential of at least 24 million clean-burning, fuel-efficient cookstoves. This chapter examines key supply-side issues, including the current market and production capacity, the most popular stove types, business model limitations, production costs and profits, and attitudes toward new stoves.

Cookstove Market and Production Capacity

Currently, the commercial market for biomass stoves is quite limited. Households in Indonesia either purchase or construct their own stoves, and usually own more than one. Many rural households make rudimentary three-stone stoves. Primary stoves are commonly made of

mud, cement, or such materials as stone, scrap metal, and recycled oil drums. These stoves are quite energy-inefficient and emit significant amounts of toxic smoke. The stove types selected by households are closely tied to income. Purchased stoves are relatively inexpensive. Most households buy from the local market, others purchase directly from producers, and still others buy from local shops or mobile traders. The usable lifetime of household stoves varies from about six months up to four years, given that many owner-built stoves are repaired on an ongoing basis (YDD 2012) (Annex C).

The field survey conducted for this study reveals that annual stove production is far less than the number of households using biomass stoves, suggesting that many households do not buy stoves available in the market. In many rural and more remote areas, there are no markets for biomass cookstoves. By contrast, in the more developed regions of Java, Sumatra, and Sulawesi, markets are fairly well-established. Five of the 17 provinces that participated in the survey were found to produce nearly 850,000 cookstoves each year (table 3.1).

TABLE 3.1 ESTIMATED ANNUAL COOKSTOVE PRODUCTION IN FIVE SELECTED PROVINCES

Province	Stove fuel type		Number of stoves produced
	Firewood	Charcoal	
East Java	429,240	32,820	462,060
West Java	172,800	101,160	273,960
Central Java	50,880	26,460	77,340
Lampung	14,400	—	14,400
North Sumatra	120	21,600	21,720
Total	667,440	182,040	849,480

Source: Indonesia CSI field survey.

Stove production capacity varies widely among producers. Among the 580 producers interviewed for this study's field survey, the average monthly production is about 275 stoves. The monthly output range among the smallest producers is 5–10 stoves. About one-fifth of producers have a capacity of up to 20 stoves per month, while another one-fifth can produce 21–50 per month. Less than one-fifth have a capacity of 500–5,000 stoves. Ten large producers make more than 1,000 stoves per month, while the three largest ones have a total monthly production capacity of some 10,000 stoves. Many producers make terra-cotta (clay-based) stoves. Those with a smaller production capacity may construct stone stoves, while others may make stoves from brick and cement. Production is concentrated mainly on the island of Java and in South Sulawesi.

Business Models and Limitations

The survey results confirm that all commercially sold biomass cookstoves are based on the Artisan Production Model, meaning that local producers build stoves individually by hand. Most of these artisans run small family-owned businesses, which are passed down from one generation to the next, with few new business start-

operated by women, 26 percent by men, and the remaining 34 percent by women and men jointly. About half of producers diversify their stove product lines by also making ceramic roof tile, clay pottery, or other items.

Limited working space is one of several key determinants of the scale of stove production. A typical stove-making facility consists of a small shed without walls and a kiln used for firing stoves. On the island of Java, where the population density is quite high, a facility's working space averages only about 50 m². A kiln typically consists of a simple square with a short wall and firing holes at the side. Smaller producers (i.e., those constructing fewer than 50–100 stoves a month) usually do not own a kiln but rent one from nearby producers, adding to their production cost and reducing their profit margin. A case study conducted in Central Java for this project revealed that only 47 percent of the 117 producers interviewed owned kilns with a firing capacity of at least 100 stoves (YDD 2012) (Annex C).

Most artisan producers make terra-cotta stoves using clay, while stoves made of stone are quite common on the island of Java. The energy inputs for kiln-firing include firewood, scrap wood, biomass residue, and rice husk. Clay must be mixed with ash or rice husk. The major-



Women producers making fired-clay (pottery) stoves



ups. Both owners and workers have been trained by their parents or other artisans or are self-taught. In addition to lacking formal training in stove-making techniques, most artisan producers lack skills in business management and marketing.

The survey results also suggest that women dominate the stove-making trade. Among the producers interviewed, about 40 percent of businesses are owned and

ity of producers mix the clay manually (using their feet), while a small minority (less than 10 percent) use electric motors. Stoves that are made of stone involve the labor-intensive steps of removing the stone from the mountain, cutting it into pieces, and carving it into the stove shape. Slow production processes incur high labor costs; and quality control, which is based on visual inspection, is weak. An analysis of production costs, based on interviews with producers and data on wholesale and retail



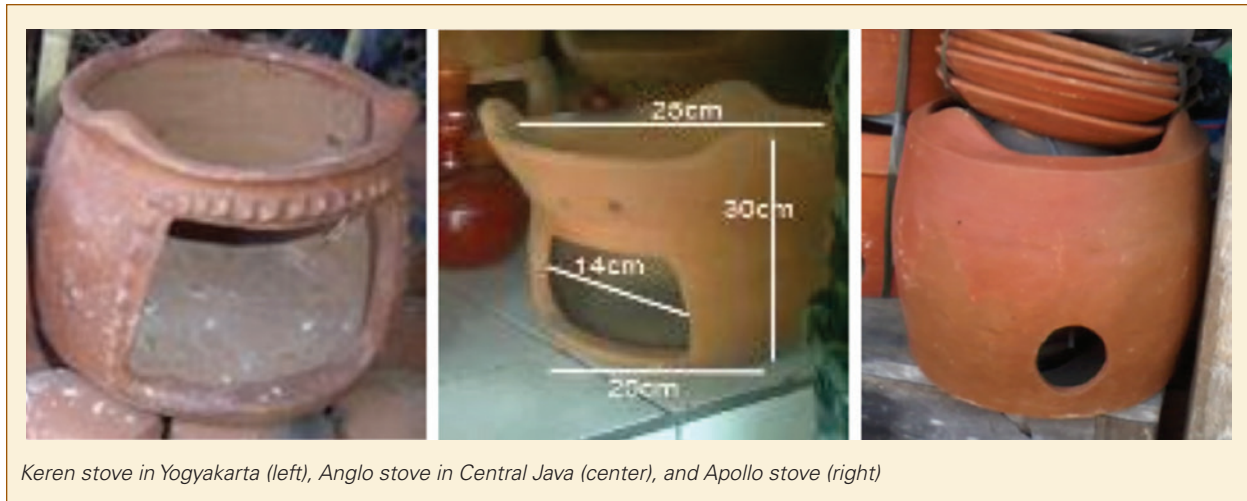
stove prices, indicates that producers have a relatively thin profit margin.

Business arrangements among producers, retailers, and wholesalers are mostly informal, based on mutual trust, with no legally binding conditions of sale and purchase. Most local artisans are passive producers, meaning that they do not actively market their stoves. Among those interviewed for this study, only 15 percent reported actively promoting their stoves to wholesalers and retailers. In most cases, wholesalers, retailers, and even users buy directly from the producers. About 87 percent of the producers surveyed reported using cash payment only for their financial transactions, while the remaining 13 percent use credit, consignment, and cash combined with other payment arrangements.

More than 90 percent of the wholesalers surveyed have been in operation for more than a decade (more than half have been in business for more than 20 years), while more than one-third of retailers have been in business for more than 20 years. Nearly half of wholesalers conduct business from their homes, while the other half include those who operate in the market (12 percent), established shops (*toko*) (12 percent), and less formal, smaller shops (*warung*) or stalls (10 percent); the remainder work

as mobile vendors. As expected, most retailing occurs in the market; thus, sales are limited in *toko* and *warung*, located mainly in residential areas. On the other hand, in the market, stoves are typically sold at *warung* that sell basic household appliances. Outside the market, stoves are sold at grocery stores or small convenience shops in residential areas. Stoves may also be sold at retailers' homes or by mobile vendors who use carts and bicycles. In addition, some retailers use more than one distribution method (e.g., at the market and door-to-door sales).





Traditional stove supply chains and improved stove producers and distributors provide no after-sales service, except for large fixed stoves used for commercial purposes. Spare parts are limited mainly to the grate for the Anglo Supra (Thai Bucket) improved charcoal stove; however, stovemakers often produce adjustable pot rings, allowing users to fit the stove to the pots they want to use, which are sold as part of the stoves by wholesalers and retailers.

Common Stove Types

The CSI field survey results show that wood-burning cookstoves are the most popular stove types produced and sold in the 17 provinces covered. Three biomass cookstove models commonly used in Indonesia are the Keren, Anglo, and Apollo, which are distinguished by the types of fuels used. The Keren is a firewood-burning stove, usually made of terra cotta or other materials. The Anglo, typically made of clay pottery, uses charcoal; while the Apollo uses sawdust and rice husk for fuel. Many local names, which vary by region, are used to refer to fuelwood and charcoal stoves. In Central Java and Yogyakarta, for example, the Pawon refers to the large fixed stove that burns firewood.

More than three-fifths of the stove producers and retailers who participated in the CSI field survey reported making or selling the Keren and traditional Anglo stoves. Pawon stoves are made and sold mainly in West and Central Java, where the required stone material is available. The survey showed that, in North Sumatera, some of the cookstoves produced and sold are made of concrete and metal. Among all of the 17 provinces surveyed, none of the identified producers make technically advanced biomass stoves.

Supply Chain Features

The CSI field survey reveals that stove producers rely on two main channels to market their products (figure 3.1). The first channel, which is used by about 30 percent of producers, is direct delivery to customers. This choice requires producers to own or rent a truck or other means of transport; in return, they receive a better price for their stoves. A producer may deliver stoves to either or both wholesalers and retailers or retail buyers. Smaller-scale producers tend to deliver more to retailers than wholesalers owing to the smaller quantity of their products. Thirteen percent of mainly small-scale producers sell their products (including heavier, bulkier stoves) directly to retail buyers (i.e., stove users) at the market.

The second, and by far the most common, channel for stove producers to market their stoves is to rely on wholesalers and/or retailers to purchase their stoves in bulk and transport them to retail shops, where they are sold (figure 3.2). This channel, used by nearly 70 percent

FIGURE 3.1 DIRECT DELIVERY ROUTES USED BY STOVE PRODUCERS



Source: Indonesia CSI field survey.

FIGURE 3.2 PRODUCER RELIANCE ON WHOLESALERS, RETAILERS, AND RETAIL BUYERS

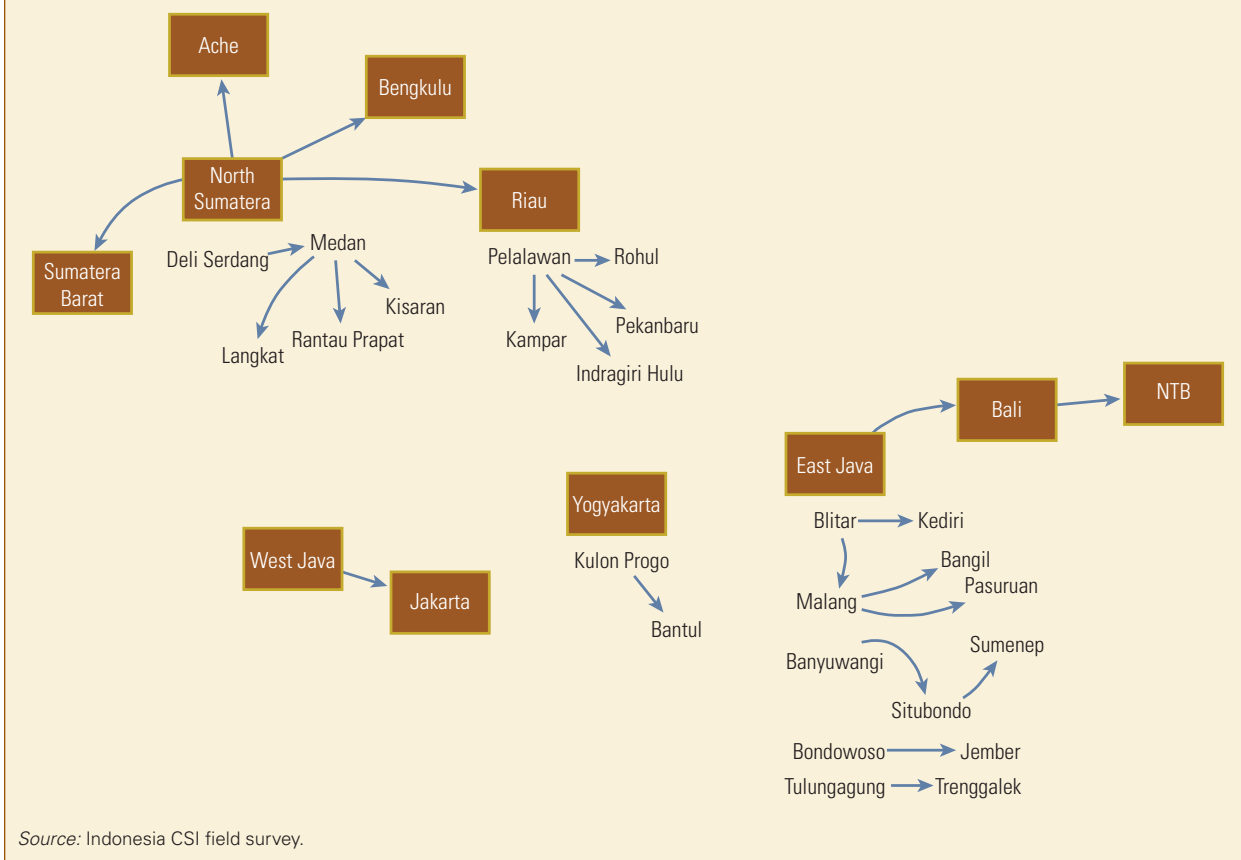


The selling of stoves by producers, wholesalers, and retailers to respective downstream suppliers commonly occurs at the city, district, or subdistrict level within provinces. The survey results show that it is commonplace for producers and wholesalers to serve local needs, with few working to meet demand beyond their provinces. Approximately one-third of producer sales is at the city or district level, with just 14 percent occurring outside their respective provinces. Similarly, most wholesalers limit their sales to within their own provinces, owing mainly to their small delivery capacity, which averages 10 or fewer stoves per delivery. However, one-third of wholesalers have a delivery capacity greater than 40 stoves—they use larger transport vehicles, such as pick-up trucks—reflected in the 8 percent who sell between provinces (figure 3.3) (box 3.1).

of the producers surveyed, requires that wholesalers or retailers provide the means of transport. Typically a producer is visited by wholesalers exclusively, both wholesalers and retailers, or wholesalers and retail buyers (i.e., stove users); stove users who buy directly from the producer usually purchase heavier, bulkier stoves, such as those made of stone or mud.

The survey results indicate that the majority of wholesalers are facing certain obstacles that limit their capacity to expand their businesses. The main issues cited by survey respondents include lack of sufficient capital, too limited space for storing stove inventory, lack of transportation, and the quality level of the cookstoves.

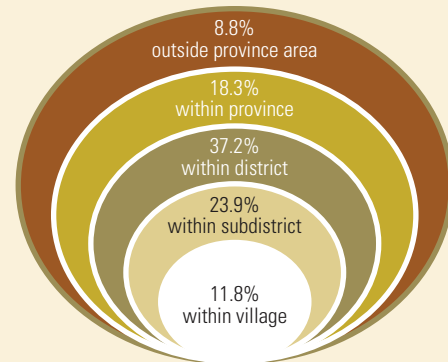
FIGURE 3.3 WHOLESALER DISTRIBUTION NETWORK, SHOWING INTER- AND INTRA-PROVINCE COVERAGE



BOX 3.1 COVERAGE AREA OF STOVE PRODUCERS IN CENTRAL JAVA

In Central Java, most cookstove production and supply chains focus on meeting local demand. More than 37 percent of producers cover the market within their district, about 24 percent cover their subdistrict, and nearly 12 percent sell their products within their own villages. Only about 18 percent sell their stoves outside their district area, while just 9 percent sell outside their province or between provinces. Producers that do sell cookstoves outside their province usually target West and East Java, including Jakarta and even parts of Yogyakarta province. However, no producers in Yogyakarta sell stove products outside their province.

Source: YDD 2012.

COVERAGE AREA OF STOVE PRODUCT SALES FROM THE PRODUCERS**Production Costs and Supplier Profits**

Analysis of stove production costs and supplier prices collected from the CSI field survey indicate that profit margins at each level of the supply chain are relatively low. Thus, the prices of biomass cookstoves are affordable for the vast majority of Indonesia's households. Based on the survey data, wholesalers charge retailers an average price of about IDR 14,921 per stove, while the average price retailers charge households is about IDR 30,000, with a combined margin—difference between the wholesale and retail price—of about IDR 15,000, from which costs for marketing, labor, and other expenses (averaging IDR 7,000–8,000 per stove), must be deducted.⁴ Similarly, producers must cover stove-making materials, fuel for firing the kiln, and other costs. Most producers do not record their own time and labor spent on the stove business as part of their production costs (Case Story 3.1).

The survey reveals that producers usually make stoves of various types and sizes targeted to different clientele. As a result, the margin, including the profit, received by producers varies according to the client group, as well as stove type and size. For example, producers can make more profit by selling to retailers and end-user consumers. The average selling price to retailers is 1.5 times higher than that to wholesalers and 4 times higher when selling directly to consumers. At the same time, producers must bear added costs to ensure that their stoves reach the customers. In terms of stove type and size, producers can command a higher price and profit from the Anglo Supra charcoal stove, especially the larger-sized version (Case Story 3.2). By contrast, the lowest profit margin is on the popular Keren wood stove, which costs less to make and has a low retail price, making it the preferred stove among poorer households. To

compensate for the low profit margin, producers rely on a fast turnover; indeed, the durability of the Keren stove is usually less than six months.

Wholesaler transport and delivery of stoves from producers to retailers is estimated as high as IDR 10,000 per stove. Typically, wholesalers rely on a motorcycle owing to the vehicle's relatively low operating costs compared to a truck or van and the small scale of the business. However, wholesalers with a larger operation must have a truck or van, which allows them to cover more than one retailer; typically, they have three or more retailers as their customers.

Retailers' price margins, including profits and operating costs, depend largely on the size, type, and location of the retail shop. For example, the price margin for the Keren stove, which has the lowest retail price range, is IDR 500–3,000. For medium- and larger-sized stoves in the low-to-mid retail price range, the price margin rises to IDR 3,000–6,000. For higher-priced stoves, it increases to IDR 8,000–16,000 (e.g., 5,000–10,000 for the large-sized Anglo Supra).

Knowledge and Attitudes Toward Clean Stoves

Most stove suppliers in Indonesia are unaware of clean stove designs and programs. Among the producers interviewed as part of the CSI field survey, only 21 percent had ever heard of new or improved stoves; of those, 12 percent were mistakenly referring to traditional stove designs from other areas. Similarly, more than 80 percent of the wholesalers interviewed were unaware of improved stove designs, while the other 20 percent mistakenly regarded traditional stove designs (e.g., Apollo, Keren, and SBY) as improved ones.

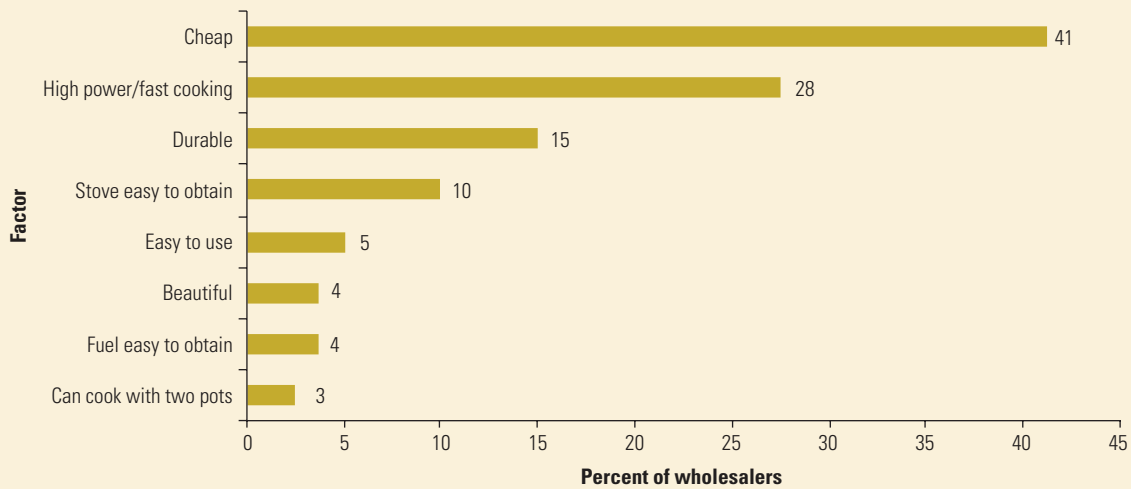
4. Based on an exchange rate of IDR 9,152 = US\$1.

At the same time, the survey results confirm that the entire supply chain—stove producers, wholesalers, and retailers—is enthusiastic about learning about clean cookstove models. About 79 percent of the producers interviewed are open to new ideas and clean stove products and believe they should have access to new stove technology; 9 percent are interested because they believe clean stoves are saleable, and 7 percent foresee a potential market (Case Story 3.1).

The wholesalers and retailers interviewed identified a stove’s price as the most critical factor for sales and thus the supply sector’s acceptability of new stoves (figures

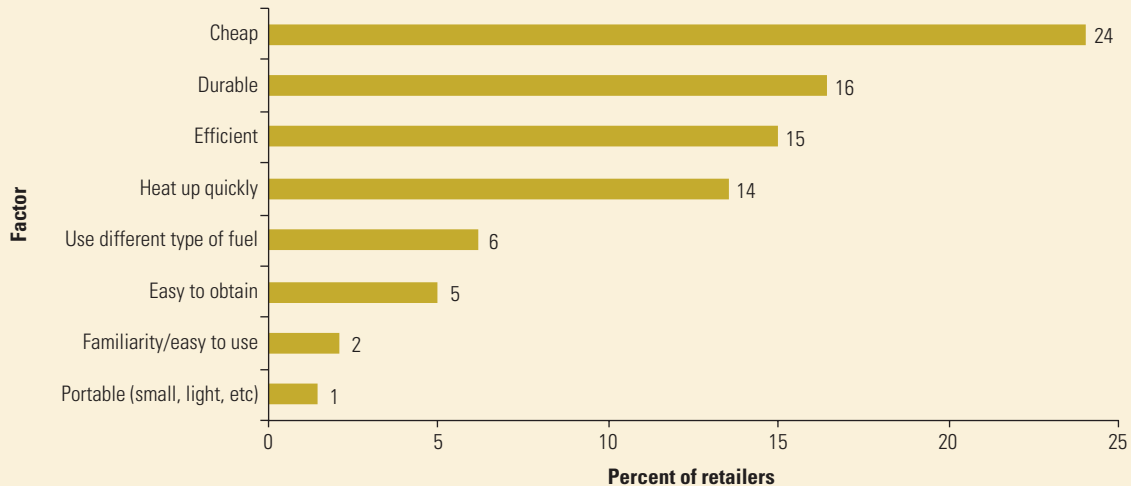
3.4 and 3.5). Both generally agreed that users consider price as the most important feature of a stove and believe that cheap stoves sell well and fast. Some retailers expressed concern that the price of the new clean cookstoves would be beyond reach for their customers, which would ultimately hurt sales. Many stressed the need to test the stoves before selling them to ensure that they would meet the stated claims. Many others said they were satisfied with the current stove models, believing that the new ones would not sell. This finding underscores the importance of extending knowledge and information on advanced (clean and efficient) biomass stoves to all levels of the supply chain.

FIGURE 3.4 WHOLESALERS’ OPINION ON FACTORS THAT MAKE STOVES BEST SELLERS



Source: Indonesia CSI field survey.

FIGURE 3.5 RETAILERS’ OPINION ON FACTORS THAT MAKE STOVES BEST SELLERS



Source: Indonesia CSI field survey.

CASE STORY 3.1 TRADITIONAL STOVE PRODUCER FORESEES CONTINUED GROWTH

Pak Buang, who lives on the island of Java, Indonesia, is a producer of traditional biomass stoves. He runs his stove production business out of his home in Panjangrejo, a village in Pundong, a subdistrict of Bantul District. Buang, his wife, and two sons manage the business, which Buang inherited from his parents. The family produces three sizes of a one-pothole woodfuel stove, locally known as the “Keren.”



Unlike most producers who passively wait for buyers, Buang and his family proactively market and deliver their stove products to areas located up to 60 km from their village, including Gunung Kidul District. Like most traditional stove producers, Buang does not keep records on the cost of his input materials, but he does calculate cash expenses, which allows him to organize production batches.

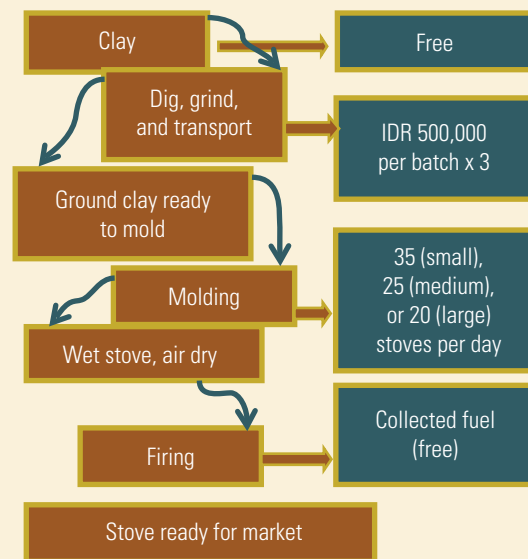
Buang obtains the clay material for free, but must pay to rent a truck for its transport, at IDR 500,000 per trip. He estimates that one truckload of clay lasts about three months; at this rate, one person can produce 35 small-, 25 medium-, or 20 large-sized Keren stoves per

day. When asked about his monthly production levels, he can only provide information based on his kiln capacity, which holds about 500 stoves per firing. Since the family usually does three firings, monthly production averages about 1,500 stoves of mixed sizes.

When Buang and his family do not have enough of their own stoves for a batch, they purchase raw (not fired) stoves from neighbors to make up the difference. The price of one raw stove, including materials and labor, is IDR 1,000 (small), IDR 1,400 (medium), and IDR 1,750 (large).

Buang spends about IDR 800,000 each month to fire about 1,500 stoves of mixed sizes, so the cost of firing one stove averages about IDR 533. Based on this information, we can attempt to analyze Buang’s production costs and profit margin from selling to the wholesaler, as follows:

MONTHLY PRODUCTION PROCESS



Keren stove size	Production cost, IDR*	Selling price, IDR	Profit, IDR
Small	1,533	3,000	1,467
Medium	1,933	5,000	3,067
Large	2,283	7,000	4,717

*Production costs exclude labor, working space, and depreciation; selling price is roughly calculated, based on proven business sustainability and profitability.

(Continued next page)

CASE STORY 3.1 (CONTINUED)

For the same stoves, the wholesaler's selling price and profit margin from the retailer are as follows:

Keren stove size	Purchase price, IDR	Selling price, IDR	Profit, IDR
Small	3,000	4,000	1,000
Medium	5,000	7,000	2,000
Large	7,000	10,000	3,000

The wholesaler's profit from a medium-sized stove is double what s/he receives from a small-sized one, while a large-sized stove is three times more profitable than a small-sized one. By contrast, the retailer receives less profit from selling the medium-sized stove than s/he does from the small-sized one, as shown here:

Keren stove size	Purchase price, IDR	Selling price, IDR	Profit, IDR
Small	4,000	7,500	3,500
Medium	7,000	9,000	2,000
Large	10,000	14,000	4,000

According to Buang, the stove business is good, offering his family a promising future. Moreover, stove demand has not been affected by the recent Kerosene-to-LPG Conversion Program, in part, because the family's target market includes rural areas in Gunung Kidul, where people are less likely to use LPG for cooking. In fact, demand for the Keren wood stoves is increasing, and Buang has sought out more people to supply raw stoves to his production center.



Though Buang runs a traditional business, he is open to new ideas. When asked whether he would be interested in producing new (improved) stove designs, he confirmed his interest. He had previously seen the improved two-hole stove design (that is, the TSHE) introduced by Yayasan Dian Desa (YDD), a local NGO, and had tried to produce a similar looking stove on his own. However, since Buang had not been trained in making the improved stove, his look-alike version, indeed a two-hole pottery stove, had no baffle and thus failed to realize similar benefits in fuel savings and emissions reduction.

CASE STORY 3.2 IMPROVED STOVE TRAINING OPENS OPPORTUNITIES

Today Mr. and Mrs. Sutrars are the prosperous owners of an improved stove business in Metroyudan, a town near Magelang city in Central Java, Indonesia. It all started eight years ago when the couple, then makers of brick roof tile, participated in improved stove training facilitated by Yayasan Dian Desa (YDD), an NGO based in Yogyakarta. Among the various producers who completed the YDD training, only Mr. and Mrs. Sutrars persevered in learning how to make the Anglo Supra, an improved pottery stove that burns charcoal, more commonly known as the Thai Bucket stove.

At first Mr. and Mrs. Sutrars produced the Anglo Supra only if they received orders for it, and continued their roof tile business for income security. Aware of the couple's situation and interest in making new stoves, YDD trained the couple in making the Jolentho, a large pottery liner designed for both households and small producers in the palm



sugar industry; they also learned to make an improved two-hole pottery wood stove. As Mr. and Mrs. Sutrars honed their skills, YDD promoted the couple to others and supported them financially by purchasing their stoves for distribution elsewhere as part of an effort to develop an open market for better stoves. The NGO's support incentivized the couple to continue on.

Several years later, as nearby households became aware of the Anglo Supra's high heat and fuel-saving benefits, the market began to open up. In 2009, one local wholesaler, Mr. Irawan, spotted a business opportunity. At that time, kerosene prices had spiked, and many households

were nervous about switching to LPG stoves because of the accidents that had occurred. Mr. Irawan decided to start purchasing 200–250 large and small Anglo Supra stoves from Mr. and Mrs. Sutrars every three weeks, which he then sold to retailers in and around Magelang city, about 43 km north of Yogyakarta. He began demonstrating the stoves in the marketplace. Since then, sales have steadily increased, and today the Anglo Supra has no real competition in the market. Once sales of the Anglo Supra were guaranteed, Mr. and Mrs. Sutrars stopped producing brick roof tile. Marketing is not an issue since demand often exceeds the couple's monthly production capacity.

Mr. and Mrs. Sutrars own a 100-stove capacity kiln, which they fire three times each month. If Mrs. Sutrars were available to help her husband full-time—she must also attend to household chores and various other activities—the couple's daily production at full capacity would be about 20 stoves. But lacking working space for enlarging their product output, the couple, like many other small-scale producers, decided not to hire paid labor; instead, they do everything themselves, limiting their monthly production output to 300 stoves. At this rate, the couple's average monthly income is IDR 4.17 million, significantly higher than the region's minimum wage (IDR 800,000). The couple's economic progress is evidenced by their recent house renovations.

The main monthly production costs are those for the clay (IDR 20,000 per m³); digging and grinding (12 m³ at IDR 240,000 per 300 stoves); kiln firing (1.5 m³ of firewood or 100 pieces at IDR 100,000 x 3); fixing the outer liner, which requires sand and cement (IDR 75,000 per 30 stoves) and zinc (IDR 15,000 per large-sized stove and IDR 10,000 per small-sized stove); and transport to market in Magelang city (IDR 1,000 per stove).

(Continued next page)

CASE STORY 3.2 (CONTINUED)

Based on their production processes and required materials, Mr. and Mrs. Sutrass calculate the total cost of making the Anglo Supra stove at IDR 24,300 for a large-sized stove and IDR 19,300 for a small one. The cost breakdown is shown below:

Production cost item	Large stove (IDR)	Small stove (IDR)
Clay	300	300
Digging and grinding	1,000	1,000
Sand and cement	500	500
Zinc pail	15,000	10,000
Labor*	5,000	5,000
Transport	1,000	1,000
Other	1,500	1,500
Total cost	24,300	19,300

* Estimate based on 2 workers at IDR 50,000 per person per day; i.e., 2 workers making 20 stoves per day = IDR 5,000 per stove.



Anglo Supra (Thai Bucket) stove

Mr. and Mrs. Sutrass sell some of their improved stoves to households located nearby at a price slightly less than retail. For these direct buyers, the couple sells the large-sized Anglo Supra for IDR 65,000, yielding a profit of IDR 40,700 per stove; while they sell the small-sized version for IDR 50,000, making IDR 30,700 per stove. The couple earns the most per stove from these few sales.

The couple's profit from selling to Mr. Irawan, the wholesaler, is significantly less, as shown below:

Anglo Supra stove size	Production cost (IDR)	Selling price (IDR)	Profit per stove (IDR)
Large	24,300	38,000	13,700
Small	19,300	32,000	12,700

Mr. Irawan's profit from selling to retailers is quite high compared to what he makes from selling regular cookstoves, owing to the low final selling price of traditional models and stiff market competition.

Anglo Supra stove size	Purchase price (IDR)	Selling price (IDR)	Profit per stove (IDR)
Large	38,000	60,000	22,000
Small	32,000	50,000	18,000

For these same reasons, retailers admit that they earn higher profits from selling the Anglo Supra.

Anglo Supra stove size	Purchase price (IDR)	Selling price (IDR)	Profit per stove (IDR)
Large	60,000	70,000	10,000
Small	50,000	60,000	10,000

Although Mr. and Mrs. Sutrass cannot fill the steadily rising household demand for the Anglo Supra improved charcoal stove, other small artisanal producers in the area have expressed no interest in making the stove, which they perceive as being difficult and troublesome. Even today, Mr. Irawan, whose primary motivation in selling the stove was to turn a higher profit, remains the only wholesaler of the Anglo Supra.

Other factors that the wholesalers and retailers interviewed considered important were related to a stove's functionality or performance (i.e., high power and thus ability to cook food faster), as well as durability. The Keren wood stove, which has all of these features, was most often recognized by both wholesalers and retailers as the best-selling stove. The Anglo charcoal stove, which shares these features to an extent, was considered the second most popular stove. At the same time, nearly one-quarter of retailers could not identify which stove model was the best-selling one.

Conclusion

Results of the Indonesia CSI stocktaking survey, which traces stove supply links from producers to wholesalers and retailers, show that the largest number of biomass stove producers and users are found in Central and East Java, where demand for wood-burning cookstoves is higher than regional supply. Stove supply chains tend to deal in traditional cookstove models, including the wood-burning Keren and charcoal-burning Anglo stoves, which are produced and sold by traditional family-based businesses mainly through cash-based transactions.

Price mark-ups are taken at each level of the supply chain. High price margins between stove production costs and final sale price could incentivize the supply chain to produce more improved stove models; however, a variety of models that fit households' needs should be made available once their demand for new technology has increased.

Traditional stove producers, wholesalers, and retailers have longstanding business relationships, usually having worked together for many years. They operate through informal business agreements based on mutual trust. Their business practices (i.e., who sells stoves to whom, how stoves are transported, and price margins taken at each level) are deeply embedded in these relationships.

As can be expected from such a geographically and culturally diverse country, Indonesia exhibits strong regional variations in business and stove purchasing practices. Key contributing factors include stove costs at each point of sale, final stove cost to users (i.e., what users are accustomed to paying), and the types of stoves primarily sold (particularly the type of material). The rate of stove production and business size vary by province, and production patterns and business relationships differ by area,

as do supply-and-demand relationships, which affect the supply chain's readiness to produce and distribute new models and households' willingness to use them.

The traditional cookstove supply chain generally lacks knowledge about new and improved stove models and stove performance. Although some of the supply chain members surveyed said they were aware of new stove designs, the ones they were referring to were not always improved, suggesting the supply chain's lack of a clear concept about what constitutes an improved or clean stove.

Despite the interest expressed by the supply chain in producing and selling clean stove designs, profit is the major concern for producers, wholesalers, and retailers alike. Since consumers are used to buying stoves at cheap prices, suppliers are interested in selling as many stoves as possible, not just those that might be the most fuel-efficient. Introducing a new stove model would need to be linked with a higher profit margin. It would also require training the supply chain in business development so members could maximize the benefits of participating in selling new models and thus be incentivized to continue with their trade into the future.

In terms of future intervention strategies, the areas with pre-existing stove supply chains, as discussed in this chapter, should be treated differently than areas without established stove supply chains, where users are accustomed to making their own traditional-style stoves. Therefore, two strategies are proposed: one involving training and use of existing supply chains to produce and distribute new stove models and the other developing national capacity to mass-produce and disseminate clean stove models. In determining which strategy might be most appropriate for a given area, it will be important to consider the driving factors behind both stove supply (e.g., profit and user acceptability) and household demand (e.g., high heat, ability to use multiple fuels, and ready availability of fuels).

Finally, considering the dominance of traditional stoves and longstanding family business practices in the sector, there is a need to introduce and attract new suppliers to scale up the dissemination of clean stoves. However, in the process of scaling up the clean stove business, one must protect against driving traditional stove producers out of business. Therefore, in addition to engaging existing producers in the clean stove business, appropriate safeguards and social protection mechanisms should be established.

Policies, Programs, and Institutional Players: Lessons Learned

This chapter reviews the extent to which biomass cooking energy has been addressed in Indonesia and the gaps in policies and institutional strengthening that future intervention programs will need to fill. The next sections present an overview of current laws and policies related to biomass cooking energy and stoves, followed by a review of key programs and institutional players. The chapter then reviews lessons from two highly successful programs that have promoted clean cooking solutions in Indonesia, including features that can be applied to household energy and health interventions.

Overview of Laws and Policies

Since clean biomass cooking solutions involve a variety of cross-cutting issues, this review focuses on current laws and public policies, the regulatory framework, and practices covering a range of issues, including access to modern energy, promotion of energy efficiency and renewable energy, biomass utilization, business development and renewable energy investment, and public health. The review confirms that Indonesia has several laws that address equitable access to modern energy. The country also has policies that directly aim to promote the development and use of renewable energy. For example, there are policies that provide financial and non-financial incentives, both direct and indirect, to ensure private-sector involvement and encourage its investment in renewable energy. These incentives are related to taxation, access to financing, and regulatory regimes to provide an enabling environment, as well as training and capacity building. In addition, there are national-level governmental provisions that address

product standardization and certification, as well as services related to renewable energy and energy efficiency.

While a recently issued public health decree (Decree No. 1077/Menkes/PER/5/2011) recognizes the problem of household air pollution (HAP), its concerns are limited to the need for indoor air quality, citing smoke from cooking activities as a factor affecting household members' respiratory illnesses. Unfortunately, the suggestions to improve indoor air quality refer only to fuel switching (e.g., from kerosene to liquefied petroleum gas [LPG]). In reality, this option is impractical for about 40 percent of the country's households that currently rely on biomass fuel for cooking. As previously discussed, LPG is unaffordable, even at the subsidized price, for the vast majority of such households, particularly those in rural areas. Also, distribution networks are usually limited to urban and peri-urban areas and are thus inaccessible to most rural households.

A thorough review of these laws and policies confirms that none specifically addresses biomass cooking energy and cookstoves. Their usefulness is limited to providing a high-level policy framework for clean biomass cooking solutions. However, past experience and empirical evidence suggest that, without specifics on biomass and clean cooking solutions and recognition of the reality that nearly half of the country's population uses biomass, the problem—involving a number of cross-cutting issues—will continue to be overlooked. Experience from the Kerosene-to-LPG Conversion Program and the Indonesia Domestic Biogas Programme demonstrates that successful programs require focused policy with a specific mandate and concerted efforts.

Limitations of Past Programs and Institutional Players

Over the past 25 years, various improved stove programs have been implemented in Indonesia; however, such efforts have tended to be fragmented and sporadic, focusing only on small areas. Most have been donor-funded programs implemented by nongovernmental organizations (NGOs); in virtually all cases, the programs ended when funding ceased. In the early 1990s, Indonesia's Directorate General for Electricity and Energy Utilization (DJLPE) first introduced the concept of improved cookstoves to the market. The DJLPE launched projects that centered on improved stove design competitions, producer training, and development of performance benchmarks. Unfortunately, these efforts were implemented on a project-by-project basis and were never institutionalized. Furthermore, they lacked appropriate follow-up and monitoring and evaluation (M&E) to provide the feedback needed for successive projects and programs. Owing to these shortcomings, past programs by numerous NGOs, donors, and governments have largely failed, and biomass-using households continue to rely on traditional cookstoves.

In recent years, there has been renewed private-sector interest in developing and producing improved cookstoves, with an emphasis on fuel efficiency and emissions reduction. A few private-sector entrepreneurs in Indonesia have independently tested the market with a limited number of advanced biomass cookstoves. However, since there is no market for these stoves, production remains at the experimental or testing stage, with stoves produced only to fill orders. Without any intervention, it is unlikely that new advanced stoves will reach the market or households.

Even with renewed private-sector interest, improved stove programs and activities still remain small, fragmented, and sporadic. Recently, various global aid agencies and NGOs, including Mercy Corps, the United Nations Development Programme, and the Netherlands Development Organisation (SNV)/Humanist Institute for Development Cooperation (HIVOS), have embarked on clean cookstove programs. Yet these programs' scope and activities, like past efforts, remain limited to certain areas. To date, they have been unable to create a sustained market or attract interest in clean cookstove technology among households. Most programs have targeted Java, and some cover Sumatra, Sulawesi, and other areas of the country. Unfortunately, none have moved beyond their own distribution networks to create a commercial market for a particular improved cookstove model.

Successful Program Experience

In the past five years, two noteworthy programs promoting clean cooking solutions in Indonesia have enjoyed successful outcomes: (i) the Kerosene-to-LPG Conversion Program and (ii) the Indonesia Domestic Biogas Programme (IDBP). The LPG conversion program, initiated and developed by the Indonesian government and implemented by Pertamina, the state-owned oil and gas company, is considered one of the world's largest clean cooking solution programs. The 2010 national socioeconomic survey conducted by the BPS and the 2010 census confirm that the program has successfully converted more than 22 million households that use kerosene as their main cooking fuel to LPG (Annex A). The IDBP was initiated by the Government of Indonesia through the Joint Energy Working Group under bilateral cooperation between the Indonesian government and the Kingdom of the Netherlands. The program is funded by the Dutch government and facilitated by the Government of Indonesia. HIVOS, an international NGO, was appointed by the Dutch government as Program Manager, with technical support provided by SNV, another international NGO with broad experience in domestic biogas programs. Over a three-year period (May 2009–May 2012), the IDBP installed more than 8,700 biogas systems throughout the country (Annex B).

Kerosene-to-LPG Conversion Program

The highly successful Kerosene-to-LPG Conversion Program offers useful lessons for future national programs related to household clean cooking (box 4.1). The main factors contributing to the program's success are outlined below.

Strong Government Commitment and Firm Policy Objective.

In 2006, the Indonesian government was under tremendous fiscal burden to continue a rapidly rising kerosene subsidy. Under such pressure, the government urgently searched for an alternative, which the conversion to LPG provided. In 2007, the government acted swiftly to implement the Kerosene-to-LPG Conversion Program, completing the initially proposed six-year program in just three years. The government's strong program commitment has been evidenced by its willingness to reorganize program execution when any aspect has been found ineffective. For example, initial program coordination, which included four ministries, was reduced to a single one (i.e., Ministry of Energy and Mineral Resources [MEMR]) when it became clear that coordination among the ministries was ineffective. Such swift corrective action enabled the program to complete on time. Also, the government

BOX 4.1 KEROSENE-TO-LPG CONVERSION PROGRAM

Indonesia's Kerosene-to-LPG Conversion Program, launched in May 2007 in Jakarta, has succeeded in reducing the nation's kerosene consumption by encouraging households and small- and medium-sized enterprises (SMEs) to switch to LPG. Historically, kerosene has been heavily subsidized in Indonesia. By 2006, the kerosene subsidy accounted for 57 percent of all subsidies for petroleum products. The rationale for switching to subsidized LPG was based on the end-use caloric value of delivered cooking energy and the subsidy per unit of fuel, which is significantly lower for LPG. Although based on energy-equivalent calculations, the government chose to equate 1 liter of kerosene with 0.39 kg of LPG (instead of 0.57 kg of LPG) to determine the subsidy.

The Indonesian government's main activity for promoting the conversion program has been distributing ready-to-use start-up packages (*paket perdana*), each consisting of a filled 3-kg LPG cylinder, a gas stove, hose, and regulator. Supporting activities have included education and socialization, data collection, and monitoring use of the start-up packages among beneficiaries. By 2010, more than 27 million households were using LPG as their main cooking fuel, about five times as many as in 2007.

As of 2011, the conversion program had distributed some 53 million start-up packages. Infrastructure planning and implementation occurred swiftly to ensure that supply and distribution networks could meet the new demand. Pertamina, the program's sole implementing agency, invested with the private sector to improve and expand all stages of the LPG supply chain, from production, bulk transport, and storage facilities (LPG depots), to filling stations and wholesale and retail distribution. By June 2012, Pertamina had withdrawn 8.2 million kl of kerosene, having replaced it with 3.2 million tons of LPG. The program has reached 23 provinces, with 53.9 million start-up packages distributed. A total of 13 provinces have been designated as "closed and dry," meaning that distribution of start-up packages has been completed and all subsidized kerosene withdrawn (Annex A).

Source: Susanto 2012.

was convinced that replacing kerosene with LPG would provide a win-win situation for all parties involved. As a result, the government stayed on course with a firm policy of replacing 1 liter of kerosene with 0.39 kg of LPG, as well as providing financial support for the program.

Effective Marketing and Public-Awareness Campaign. The implementation arrangement for the Kerosene-to-LPG Conversion Program consists of one main activity—distribution of the LPG gas stove, hose, regulator, and one filled 3-kg LPG cylinder—supported by various sub-activities, all of which are designed to promote the adoption and safe use of LPG as the main household cooking fuel. Pertamina has placed equal weight on the main activity and supporting activities.

To better understand how consumers and the public at large would respond to the massive conversion program, Pertamina conducted extensive market research and testing. In August 2006, the first market test was carried out in Cempaka Baru village in Kemayoran, a subdistrict of Central Jakarta. Pertamina distributed free start-up packages to 500 eligible households, whose total household income was less than IDR 1.5 million. Pertamina worked with an independent marketing research firm to assess household acceptance, perception, and related issues. The market test also allowed Pertamina

to determine whether kerosene distribution agents in the village could be used to distribute LPG. Four months later, a second market test was conducted, covering 25,000 households. Finally, in February 2007, a third test was conducted, whereby 10,000 start-up packages were distributed to flood victims in Jakarta. No survey research was conducted for the second and third tests since the overall goal was to test the distribution model. In addition to market testing and research, Pertamina has carried out public-awareness campaigns through the mass media, which have proven quite effective in changing public perception from skepticism to acceptance.

Assured Availability of Fuel Supply. From the start, Pertamina has been fully aware that an uninterrupted supply of LPG would be required to gain public acceptance and ensure the full conversion of households and SMEs. For this reason, Pertamina officials involved in the program emphasized development of the LPG supply chain infrastructure, recognizing that the existing infrastructure was inadequate to accommodate such a large program. The tenfold increase in LPG demand over a four-year period has necessitated expanding the supply chain at all levels, including (i) refinery production supplemented by imports when needed, (ii) bulk transport, (iii) storage depots, (iv) filling stations with to-and-from transport, and (v) sales agents or retail and distribution.

Based on lessons learned from the market testing, Pertamina was able to determine whether its existing networks of kerosene agents could be used for the LPG program. Fortunately, non-subsidized LPG had already been available in the market prior to launching the conversion program. Instead of Pertamina having to build all new LPG supply infrastructure, it had only to expand the existing supply chain and create agents for subsidized LPG. However, expanding the supply chain required massive investment at all levels. Pertamina was able to use its status as the country's only national oil company, combined with the government's firm commitment and policy, to convince private-sector actors at every level to invest in expanding the LPG supply infrastructure.

Pertamina as Sole Implementing Agency. As the sole implementing agency for the Kerosene-to-LPG Conversion Program, Pertamina, Indonesia's largest state-owned enterprise, is equipped with the financial resources and manpower to implement the program efficiently and effectively, thereby bypassing much bureaucracy. The implementation arrangement requires that the enterprise pay in advance and submit bills to the government for reimbursement. Also, the company has offices located on nearly all of Indonesia's key islands, permitting easy coordination with local governments.

Effective Monitoring and Evaluation. Owing to the conversion program's effective monitoring and evaluation (M&E) processes, the program manager has been able to monitor, evaluate, and respond with corrective measures in a timely manner. For example, the program management team was able to identify the coordination failure among the four initially selected ministries. Market research has also provided useful information for taking corrective measures. For example, the first trial market research showed that consumers wanted more sales locations for refilling the 3-kg LPG cylinders. Market research also confirms that socialization and education on appropriate handling and use of LPG for cooking must continue. As part of the market testing, Pertamina was able to test monitor and evaluate the LPG distribution model.

Indonesia Domestic Biogas Programme

The Indonesia Domestic Biogas Programme (IDBP), known locally as the BIRU (*Biogas Rumah*) program, also provides useful lessons for programs that aim to promote improved biomass cookstoves (box 4.2). The main factors accounting for the program's success are described below.

Market-Based Approach. Based on lessons from past international experience in promoting biogas use, the BIRU program adopted a market-based approach, which is by

far the most important aspect of the program. Believing that market-based solutions provide a more reliable path toward sustainability, the BIRU program has emphasized the development of partnerships with local masons or builders, known as Construction Partner Organizations (CPOs). The CPOs are trained not only in the technical aspects of constructing biogas systems, but also in business development. In both theory and practice, local partners who have completed the training are expected to establish businesses or provide services on constructing biogas systems in the areas where they live. The program relies significantly on local partners to help promote biogas systems in local areas. Since the program emphasizes business development and customer satisfaction, local partners are also trained and expected to provide after-sales service.

Financial Support for Upfront Costs. The BIRU program recognizes that the biggest obstacle to adopting biogas systems is covering high upfront system costs, which are beyond reach for many farming households without access to financing or credit. This reality suggests that a purely commercial approach is likely to capture only a small number of households. To help otherwise qualified households participate in the program and thus capture a larger market share, the BIRU program subsidizes upfront costs and works with financial and other institutions to help households obtain access to credit. Recently, the program has begun to explore additional alternatives to ease access to financing, including the establishment of a revolving fund.

Quality Control and Standards. Recognizing that biogas systems must be of good quality and adhere to technical standards to gain acceptance from farming households, the BIRU program has emphasized the quality of construction, with strict quality control and technical standards. The program has special inspectors who examine the installed systems and provide technical support. To ensure that all of the systems constructed meet the quality standards, local partners are required to make at least two maintenance visits per year. Both the inspection and maintenance reports from the respective quality inspectors and local partners are entered into a comprehensive management information system (MIS), which provides the program an excellent overview of the technical quality of each unit and the work quality of each certified biogas constructor and CPO. The ability to track which masons and organizations do not keep up the required technical standards facilitates identifying them and undertaking needed interventions (e.g., additional technical or management training).

Verification of Results and Procedures. Quality control and inspection are used to verify that a biogas system has been built and meets all technical standards so that

BOX 4.2 INDONESIA DOMESTIC BIOGAS PROGRAMME

The Indonesia Domestic Biogas Programme (IDBP), commonly referred to as the BIRU (*Biogas Rumah*) program, was initiated by the Government of Indonesia under its bilateral cooperation with the Kingdom of the Netherlands. Funded by the Dutch government and facilitated by the Government of Indonesia, the BIRU program is a three-year effort with a one-year, no-cost extension (May 2009–December 2013). The Dutch government appointed the Humanist Institute for Development Cooperation (HIVOS) as Program Manager, with technical support provided by the Netherlands Development Organisation (SNV). The program aims to develop the national biogas market, with a target of 8,000 high-quality biogas units for household use. By May 2012, the program had exceeded its target, having installed more than 8,700 units throughout the country.

To ensure that demand is generated among potential household customers, the BIRU program focuses on awareness-raising and provision of a subsidy to help farmers overcome high upfront system costs. The starting price for the smallest-sized household biogas system (four m³) is about US\$500. To further incentivize interested farming households, the program actively works with financial and other institutions to provide households credit for investing in a unit. In the past, the BIRU program succeeded in helping several dairy farmer cooperatives secure bank loans used to re-lend money to cooperative members to help pay for biogas system units.

On the supply side, the BIRU program selects and trains local masons or construction contractors, called Construction Partner Organizations (CPOs), to actively promote and market household biogas systems and provide high-quality after-sales service. This grooming process includes technical training, introduction to technical innovations, management training, and other training deemed necessary to ensure that the CPOs can satisfy potential user demand. To support this process, the BIRU program develops user-training modules for partners and standard operating guidelines to which partners must adhere to ensure that quality standards are maintained. The program also works with biogas appliance and parts manufacturers to further ensure the development and sustainability of the biogas market.

Finally, the program has developed a comprehensive management information system (MIS) used to accurately track the number of biogas units constructed under the program, their locations and owners, and system sizes and technical features, indicating which units, masons, and partners show quality defaults. The MIS is also used to track and verify the results of biogas units constructed by the CPOs (Annex B).

Source: de Groot 2012.

payment to the constructor or local partner can be made. In addition, the MIS can be used to track payment. It should be noted that final payment is made only when the constructor or local partner has completed the second of the two annual maintenance visits.

Local Management. The BIRU program emphasizes local management to ensure that local staff will be fully capable of running the program after international donor funding ends and thus ensure the ultimate transfer of program operations to the local level.

Summary of Lessons Learned

It is evident that the key ingredients for the success of Indonesia' LPG conversion and BIRU programs can be adapted to designing a program to promote improved biomass cooking solutions in the country. As discussed in the previous section, strong government commitment

and a firm policy objective are critical. With full support from the government, the implementing agency will have full confidence in carrying out its mandate, as in the case of Pertamina. Like the conversion from kerosene to LPG, switching from traditional to fuel-efficient stoves requires strong government commitment, as well as assurance of an ongoing supply of good-quality stoves and after-sales service; otherwise, gaining household acceptance is difficult. Moreover, any promotion of improved stoves that requires specific or unique fuels must be accompanied by activities to ensure the availability of an uninterrupted fuel supply, which is key to program sustainability. The BIRU program's insistence on quality control and adherence to standards are also vital features of any program to promote clean biomass stoves. Other key program components include the use of M&E and a MIS—tools that allow program management to verify results and procedures, take needed corrective actions, and measure program results.

Lessons from the BIRU program confirm that overcoming high upfront costs is vital to making products affordable to most households and thus capturing a larger market share. In the case of more technologically advanced stoves, which obviously cost more than traditional types and models, the high stove price could prevent otherwise interested households from making the investment. The BIRU program demonstrates the effectiveness of combining a market-based mechanism with financial incentives to promote better products whose upfront costs are higher. Finally, the program's success in working with local market players to promote and market new products has the potential for practical application in a program to promote clean biomass cooking solutions.

Conclusion

This review has identified key issues related to Indonesia's existing laws and policies that could be relevant to developing and implementing household energy and health initiatives moving forward. Biomass-related issues will need to be integrated into and expanded within the framework of existing policies. Policies published by the MEMR emphasize improving energy access specifically for remote and poor populations, which, to a large extent, address biomass-using populations, who tend to be poor and/or reside in more remote areas. To date, however, these regulations have been used more for commercial fuel, and have yet to be applied to issues pertaining to household biomass energy. In addition, policies are in place that allow for government support of renewable energy-related topics through various incentives for developing related businesses and markets. But these policies have yet to be applied to household biomass energy. Furthermore, HAP has not yet been recognized as an environmental risk factor in public discussions of preventing acute respiratory infections (ARIs). In short, there is an overall policy gap for the integrated management of household energy and health issues.

Indonesia's national government has previously prioritized minimizing, if not eradicating, pneumonia, an ARI that studies have shown as a major death-causing disease in children under age 5. This health threat to young children has driven various initiatives that aim to alleviate high prevalence of the disease. A program on disease

eradication that targeted pneumonia was outlined in the Strategic Plan of the Department of Health (2005–09). A governmental program (P2ISPA) was also established to eradicate ARI in Indonesia. These initiatives and motivations will be important to public health components of the proposed clean biomass stove initiative; however, like so many other relevant areas in energy policy and planning, ARI-related regulations have yet to recognize biomass energy use as a primary cause of respiratory illnesses. The Ministry of Health, including its key agencies, has recognized HAP, having issued regulations containing guidelines for indoor air quality that identify smoke from cooking activities as a factor affecting household respiratory illness.⁵ Unfortunately, the potential role of clean biomass stoves in overcoming these problems is not yet recognized. Most official suggestions are for households to use LPG, which is not feasible given the widespread, ingrained use of biomass fuel by about 40 percent of the country's households.

At the same time, the health and environmental hazards linked to the use of household biomass energy have been taken seriously by NGOs in Indonesia for several decades. Acting independently and mostly at the grassroots level, various international and local NGOs have run programs seeking to influence communities to use better cooking tools. The biggest challenge for improved cookstove programs in Indonesia remains their inability to enter existing stove markets because of major obstacles on both the supply and demand sides. Indonesia lacks a structured market for improved biomass cookstoves, and efforts to introduce such stoves to the market have been hampered by a lack of access to distribution and retail networks, relying instead on less sustainable, time-limited NGO partnerships. Because households lack awareness and education about improved cookstoves and their substantial health and environmental benefits, consumer demand remains low. To date, efforts by various actors to introduce improved biomass cookstoves have lacked an integrated focus on consumer awareness and demand, product affordability and availability, and producer capability to make uniform products according to standards. Therefore, a clean biomass stove industry has as yet to be established.

5. Ministry of Health Decree (Peraturan Menteri Kesehatan RI) No./Menkes/PER/5/2011.

Toward Universal Access to Clean Cooking: Key Policy Recommendations

As discussed in the previous chapters, the main disadvantages of biomass energy for cooking using primitive cookstoves are linked to incomplete fuel combustion. As previously mentioned, indoor emissions from traditional biomass cookstoves are responsible for about 165,000 premature deaths—mainly those of women and children—each year in Indonesia (Lim et al. 2012). In addition, in areas where demand for biomass fuels exceeds sustainable supply, fuelwood collection can lead to deforestation, land degradation, and desertification.

Yet under conditions of sustainable production and more efficient fuel use, biomass energy is a renewable resource that is affordable to the poor. Biomass fuels are abundant in Indonesia, can be burned without further processing, and are cheaper than most alternative fuels (e.g., gas, kerosene, or electricity). In addition, technologies and techniques for sustainable production and efficient use of biomass energy are available. Thus, if used in an efficient and clean way, biomass stoves could contribute significantly to the country's green growth agenda. This, in turn, could lead to poverty reduction, better health and gender equality, and less pressure on the local ecology and global environment. Now there is a window of opportunity to harness the momentum from the successful LPG conversion program to focus on promoting clean cooking solutions using biomass cookstoves.

This chapter summarizes the main barriers that Indonesia faces in achieving universal access to clean cooking solutions by 2030 and suggests key policies for reaching that goal. These recommendations build on results from the Indonesia CSI stocktaking review, presented in the previous chapters, as well as the two national consultation workshops held with key stakeholders representing central and provincial governments, stove producers,

nongovernmental organizations (NGOs), and academia. The sections that follow present the main barriers to scaled-up access to clean biomass cooking solutions; this initiative's recommended strategy, including an innovative financing approach focused on delivery of results and integration of the identified priorities; and the proposed next steps in moving the country along the road to universal access to clean cooking solutions.

Access Barriers and Strategy Overview

The main obstacles to scaling up access to cleaner-burning, fuel-efficient biomass cookstoves in Indonesia can be grouped according to stove supply, household demand, and institutional issues (table 5.1).

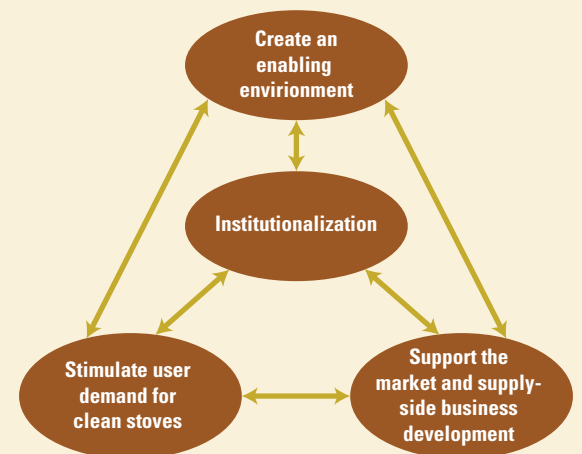
The suggested strategy for the Indonesia CSI comprises several interrelated pillars—creating an enabling environment, stimulating user demand for clean stoves, and supporting the market and supply-side business development—with institutionalization at the center (figure 5.1). This strategy builds on and is consistent with the sector transformation strategy developed by the Global Alliance for Clean Cookstoves (GACC) and the World Bank's "one goal, two paths" approach to achieving universal access to modern energy in the East Asia and Pacific region (World Bank 2011a).

At this stage, institutionalization of clean biomass cooking solutions is vital to designing, preparing, and implementing such a large-scale program. It is essential for supporting all three pillars, whose successful implementation, in turn, will help to reinforce institutionalization, which is critical to the long-term sustainable development of a clean biomass cookstove market. The following

TABLE 5.1 MAIN OBSTACLES TO SCALED-UP ACCESS TO CLEAN BIOMASS COOKSTOVES

Obstacle type	Description of key issues
Stove supply	<ul style="list-style-type: none"> Producers are small-scale and scattered and use the traditional Artisan Production Model; they have limited working capital, are more concerned about stove durability and heat than efficiency, and are hesitant to produce clean cookstoves without demonstrated consumer demand. Producers of advanced cookstoves do not yet have a market/demand for their products. Wholesalers and retailers are mainly concerned about selling stoves and are unaware of stove performance. Supply chain is limited mainly to the islands of Java, Sumatra, and Sulawesi and is missing in areas with the highest biomass fuel use (e.g., Maluku, islands in Nusa Tenggara Timur, Papua, and Kalimantan).
Household demand	<ul style="list-style-type: none"> Household consumers are accustomed to inexpensive stove prices; they are unaware of the harmful effects of HAP on family health and the benefits of various types of stove performance. They often use a mix of fuels.
Institution related	<ul style="list-style-type: none"> Biomass cooking fuel has not been afforded attention and is often neglected when calculating primary energy consumption. To date, no institution has championed clean biomass fuel for cooking, and there is no roadmap for its development. Official data is lacking on cookstoves and producers, and all levels of government lack awareness about the health and environmental effects of biomass fuel use; there are no standards or testing facilities for biomass cookstoves.

Source: Authors.

FIGURE 5.1 OVERALL STRATEGY TO SCALE UP CLEAN BIOMASS COOKSTOVES IN INDONESIA

Source: Authors.

subsections provide more detail on the priorities for institutionalizing clean biomass cooking solutions, as well as for each of the three mutually reinforcing pillars.

Institutionalization

To date, issues related to biomass fuel use have not been afforded attention or understood by many of the actors who must play key roles in the proposed intervention. Until such issues are taken seriously and institutionalized by the central government, the decentralized

activities surrounding the development of clean biomass technology will remain fragmented and sporadic. To institutionalize clean biomass cooking solutions, this study recommends establishing and strengthening (i) an institutional champion; (ii) a cross-sector coordination mechanism; and (iii) a platform for networking, communication, and knowledge sharing.

Institutional Champion. It is recommended that the Directorate-General of New and Renewable Energy and Energy Conservation (EBTKE) of the Ministry of Energy and Mineral Resources take the lead in developing a roadmap or master plan to scale up access to clean biomass cooking solutions in Indonesia. The role of institutional champion is a good fit for EBTKE, given that it has taken the initiative to explore the issue and that clean cooking solutions are part of the household energy agenda and biomass energy is part of the renewable energy agenda. Further support would be needed to strengthen EBTKE's technical and implementation capacity as the lead agency to develop and implement the master plan for the envisioned national program.

Cross-Sector Coordination Mechanism. Considering the cross-sectoral nature of this agenda, a cross-sector coordination mechanism will be needed to coordinate with other government departments. The initiative's long-term success will depend on key areas of technical research, gender equality, and community health promotion, requiring the cooperation of various other government sectors at all levels (i.e., national, provincial, and local). It is recommended that a steering committee for national

clean biomass cookstoves be established, chaired by EBTKE and including ministries representing key areas of involvement. Participating ministries may include, but are not limited to, the following:

- **Ministry for Women's and Children's Empowerment (KPPA).** Women are overwhelmingly the primary users of cooking technology in households throughout Indonesia; thus, any intervention should encompass facets of gender mainstreaming to sustainably embed clean cooking technology into Indonesian communities.
- **Ministry of Health (Kementarian Kesehatan).** A primary driver of the cookstove intervention is family health improvement by reducing high levels of household air pollution (HAP) linked to traditional cooking methods. The Ministry of Health will be instrumental in driving needed community education and awareness campaigns to increase user demand for clean cooking technology. This should include a focus on clean cooking technology, particularly biomass, and involve educating communities about additional ways to combat HAP in households (e.g., better ventilation methods and kitchen designs).
- **Ministry of Research and Technology (RISTEK).** Further research and development will be required for developing and improving available forms of clean cooking technology and fuels. RISTEK could encourage and/or coordinate technical research efforts in both the private and public sectors.
- **Bureau of Standardizations (BSNI).** Developing national

standards for evaluating cookstove efficiency and emissions will be a crucial step in building the initiative's capacity for national change. These standards should be established and governed centrally by Indonesia's Bureau of Standardizations (BSNI). Currently, the BSNI oversees standards for kerosene and LPG fuels and technologies, but has yet to establish similar standards for biomass cookstoves.

- **Ministry of Industry (Perindustrian) and Ministry for Small and Medium Sized Enterprises (Koperasi dan UKM).** These two ministries may be able to compile and monitor stove producers and businesses throughout Indonesia. They may also be instrumental in establishing and ensuring adherence to national stove standards.

Platform for Networking, Communication, and Knowledge Sharing. A national platform, such as an Indonesian alliance for clean cookstoves, should be established to promote networking, communication, and knowledge sharing among all key stakeholders, including the public and private sectors, NGOs, and academia, as well as international partners. Experience from such countries as China demonstrates how such a platform can play an instrumental role in promoting sector development (box 5.1). The platform could be hosted within an established NGO to leverage existing networks and resources. Initial support would be needed for establishing the platform and strengthening its implementation capacity.

BOX 5.1 CHINA ASSOCIATION OF RURAL ENERGY INDUSTRY

The China Association of Rural Energy Industry (CAREI), also known as the China Alliance for Clean Stoves, which it initiated, has played a critical role in developing China's stove industry. Founded in 1992 when the country's national stoves program was under way, CAREI is the country's only national-level organization focused on the rural energy industry. Affiliated with the Ministry of Agriculture, CAREI has 1,076 members, representing enterprises, research institutes, universities, and societies engaged in technology R&D, manufacturing and processing, construction, and marketing and sales. In addition to an editorial office that publishes news and reports, the association has six specialized committees across various rural energy-related fields, including solar thermal utilization, energy-saving stoves, biogas, bioenergy conversion technology, small-scale electricity power, and novel liquid fuels and associated burners.

CAREI's main functions are to safeguard the legitimate rights and common interests of its members, reflect the aspirations and demands of enterprises, implement national policies and regulations, play a bridging role between government departments and its members, and assist the government in carrying out industry management. Through advancing industrial technology, improving product quality, and strengthening technical and economic cooperation domestically and internationally, the association comprehensively improves the quality and economic benefits of the entire industry; realizes rural energy services with a focus on energy conservation, renewable energy development, and comprehensive utilization of resources; improves the ecological environment; and promotes the country's sustainable development.

Sources: CAREI 2012 and CAREI Platform 2012.

Creating an Enabling Environment

In addition to the institutionalization priorities described above—by far the most critical ingredients to creating an enabling environment for clean biomass cooking solutions—support is required for (i) establishing and strengthening stove standards, testing, and certification; (ii) conducting research and development on improved and advanced stoves and fuel processing technologies; and (iii) developing a master plan for a national clean biomass cookstoves program.

Stove Standards, Testing, and Certification

International standards and testing protocols are in the process of being formulated for biomass stoves. For example, the International Workshop Agreement, issued in February 2012, provides an intermediate rating framework that includes four performance indicators (fuel efficiency, total emissions, indoor emissions, and safety) and five tiers (0–4). Indonesia needs to actively participate in formulating international standards and making its national standards compatible with the international framework so that certified national clean stoves can be recognized internationally. It is recommended that the EBTKE, together with the BSNI, establish national standards and testing protocols and actively participate in the discussion and formulation of international standards.

Testing centers need to be created for evaluating stove performance (i.e., whether stoves meet standards) and recommending continuous improvements in stove design and development. Such centers could be hosted by research centers, universities, or NGOs with multiple functions (e.g., testing, education, research and development, and advisory service for design development). In addition, competitions could be organized to identify top-performance stoves.

A certification system that is open, fair, and transparent needs to be established to ensure stove quality. Testing centers that are qualified to conduct stove certification need to be accredited, and the accreditation process must be open, fair, and transparent. This will be particularly important when stove certification is linked with government incentives.

Research and Development

Numerous NGOs, individual researchers, and institutions have developed improved cookstoves in Indonesia; to date, however, such decentralized efforts have been scattered and uncoordinated, with a lack of resources. Tackling these barriers to at-scale dissemination of clean cooking technology in Indonesia requires further research and development (R&D) on improved and

advanced cooking technologies appropriate to the country's diverse conditions. R&D is also needed for developing fuel-processing technologies since many advanced biomass stoves require processed fuels to ensure better performance. In such cases, advanced biomass stoves can even compete with LPG stoves to mitigate the government's fiscal burden of LPG subsidies.

Master Plan Development

A master plan is recommended to harness the momentum from the successfully implemented Kerosene-to-LPG Conversion Program to focus on developing a national clean biomass cookstoves program with clear targets and related government policy and financial support. Like the LPG conversion program, strong government commitment, including the possibility of issuing a presidential decree to provide a policy foundation, will be critical to the success of implementing the national program.

Stimulating User Demand for Clean Biomass Stoves

Survey results and field inquiries reveal a low level of public awareness throughout Indonesia about the health hazards of HAP linked to biomass cooking smoke and the many benefits of clean stoves and cooking technology. Without consumer demand coming to permanently influence the clean stove market supply, any market intervention is unlikely to be sustainable. However, if the public can be educated about the characteristics and benefits of using modern, high-quality stoves over inefficient traditional technologies, changes in user preferences can influence the direction of market development (box 5.2).

The required large-scale public health campaign must be a far-reaching, comprehensive effort, involving multiple sectors. It will require cooperation among officials and representatives from both technical and health-related fields. Possible venues for a public health intervention could include local health clinics, with the involvement of physicians and other medical authorities who play a day-to-day role in the public health of communities. Women's groups should be involved or targeted since women, the primary users of household cooking technology, often influence the types used.

Public outreach may include road shows and campaigns released through various media channels that emphasize the link between clean cooking technologies and benefits for family health. Employing public health methods in campaigning can help to spread awareness about the detrimental health effects of inefficient fuel technologies and encourage families to reject traditional

BOX 5.2 SOCIAL DRIVERS FOR ADOPTING IMPROVED STOVES: FIELD ASSESSMENT IN YOGYAKARTA

A field assessment was conducted in DI Yogyakarta to better understand the social factors that influence household adoption of improved stoves. Two villages, one rural and the other peri-urban, were selected to study differences in stove-use patterns and identify distinct adoption challenges. Each area had prior exposure to improved cookstoves via NGO activity, yet neither had achieved universal adoption. A conceptual framework was developed to identify key social drivers—social processes/arrangements central to community practices reflective of sociocultural norms, structures, and values—that can be modified to change stove practices and thus lower HAP within a specific community. Structural drivers, which were identified based on prior research, were explored through field research and analyzed for their potential impact on influencing stove adoption. The assessment results were organized around these structural drivers and non-health outcome (see table below).

Cooking practices and perceptions	Awareness of HAP health effects	Fuel availability and cost	Availability of improved cookstoves
<p>Consumer needs vary greatly if cooking for household use only versus household and industrial use.</p> <p>Demonstrations may convince users that the new stoves are truly effective, especially with regard to appropriate heat.</p> <p>Consumers may need to alter their cooking behavior.</p> <p>Appropriate training on how to operate new stove models will be needed.</p> <p>Adoption will be influenced by continuous promotion and community-based learning.</p>	<p>Most users are unaware that smoke from cooking with biomass is linked to health problems, such as respiratory illnesses.</p> <p>Influencing adoption must include HAP education for policy makers, health providers, and local community leaders.</p> <p>Health providers are trusted local sources of information.</p> <p>Sanitarians who track household ventilation could also spread information about HAP prevention.</p>	<p>Biomass, especially wood, will still be a major fuel source in rural areas due to its abundance and availability.</p> <p>Switching fuels from biomass to gas (LPG) is more likely to occur in peri-urban areas and among the young generation.</p> <p>Rural populations, especially palm sugar producers, are unlikely to switch from wood to gas, meaning that improved cookstoves will be important for this group. This reality is less understood by better-educated, urban populations.</p>	<p>Improved stove designs that are compatible with the target community needs will be easier to disseminate.</p> <p>Information about stove availability should be distributed proactively and widely, without assuming that people will share this information.</p> <p>Sustainability can be achieved by involving local stove producers and convincing consumers to purchase their own stoves (e.g., through credit schemes).</p>
Gender norms	Community cohesion/social structure	Physical structures/built environment	Non-health outcomes
<p>Relevant health data should be reported by sex and age.</p> <p>Men are an important target group for stove-related information, especially when stoves are linked to household income. Men have shown interest in technical aspects of stove design, as well as the damaging health effects of biomass fuel smoke.</p>	<p>Introducing new cookstoves at a level higher than the village should be considered to ensure that people feel included and demonstrations are conducted with all relevant subgroups.</p> <p>Charismatic and enthusiastic promoters can be influential, if not critical, in converting communities to new technology.</p>	<p>An easy first step for many households would be opening up a ventilation window in the ceiling or installing a chimney.</p>	<p>Economic benefits derived from improved cookstoves may drive their adoption.</p> <p>Saving fuel may not motivate switching to an improved stove model, especially in areas where biomass fuel is freely available.</p> <p>Saving time collecting firewood and/or cooking will appeal more to women in peri-urban areas, where younger women are more likely to earn an income outside the home.</p>

The study found a general lack of awareness among government officials about the links between poor health and HAP caused by biomass fuel smoke. Where they were aware of the health links, they and other community members—even doctors—had not taken action toward preventing or improving harmful conditions. The findings also show that communities may be unwilling to switch to new fuels when wood is freely available. They may not trust using a stove without a visible fire or the ability to directly touch the cooking pot, and local social networks can either help or harm communication channels. Thus, an effective strategy will consider the influences of age, geography, available resources, opinions of locally respected authorities (e.g., doctors and community leaders), adequate stove supply and availability, and public perceptions about new technology.

Source: FHI 360 2012.

and dangerous cooking methods in favor of modern, cleaner options. Any public campaign should be aware of the gender implications of its messages to maximize the impact on technology adoption. Finally, the campaign could organize such promotional events as competitions, exhibitions, and seminars.

Supporting the Market and Supply-Side Business Development

Since most households that rely on biomass fuel for cooking reside in rural areas and are relatively poor, the stove business that targets these customers is not profitable and may not be fully commercialized. Therefore, it is necessary that the government support and direct the sector to produce and sell better and cleaner stoves. However, government support needs to fit Indonesian conditions and target long-term sustainability.

Be Sensitive to Regional Differences in Cookstove Supply Chains. The supply of biomass stoves varies regionally in Indonesia. In Java, Sumatra, and some parts of Kalimantan and Sulawesi, the commercial sale of cookstoves has long been present through pre-existing supply chains comprising traditional stove producers, wholesalers, and retailers. However, in such regions as East Nusa Tenggara, Papua, Maluku, and other parts of Kalimantan and Sulawesi, the commercial sale of cookstoves would be unprecedented. Households in these communities cook mainly on three-stone open fires, which they construct themselves. Thus, developing and implementing a national program strategy should take these two distinct conditions into account.

Where Stove Supply Chains Already Exist, Build Awareness and Capacity. Survey results demonstrate that, while some cookstove suppliers are aware of clean cookstoves, most have not yet come into contact with more efficient models and are content to continue producing the traditional models demanded by communities. Most suppliers are reluctant to produce new models without benefiting financially, but would be eager to expand their product offerings if doing so would result in a profit. Further R&D is required to develop highly efficient stove models that, in turn, can be easily and safely replicated by local producers throughout Indonesia.

Where Stove Supply Chains Do Not Exist, Bring Cookstove Supply Chains to New Communities. In communities where households build their own cookstoves and lack access to the stove market and supply chains, significant time and resources will need to be invested in building local supply chains and educating both producers and users

about the benefits of using the new stoves. Without this investment of time and training, it will be difficult to achieve the full behavioral change required to convert cookstove users to the new technology.

Provide Training within the Cookstove Supply Chain. The initiative's public health goals will be more sustainable if Indonesia's cookstove supply chain can be trained to recognize, create, and market clean cookstove models. In addition to campaigning among producers to raise awareness about clean cookstove models, the entire supply chain (i.e., producers, wholesalers, and retailers) should be the focus of training on the benefits of the more efficient models and how to produce them. Owing to the decentralized character of the Indonesian cookstove market, reaching remote producers to be trained in creating and marketing new cookstove models presents an enormous challenge.

Ensure Quality Control over Clean Cookstoves. Establishing quality control mechanisms is critical to ensuring that producers creating new cookstove models are doing so in accordance with stove efficiency and emissions standards, which must be tied to established public health standards. In this regard, stove production methods may also need to be improved. Currently, most stove designs are produced manually. Semi-mechanical production is limited to mixing clay with other materials, while stove construction is still done manually. Some models (mostly improved stoves) are created using a mold to ensure uniformity of size, thickness, combustion chambers, and other aspects. Whether stoves are produced locally or remotely, quality control mechanisms must be established and integrated into each stage of the supply chain to ensure that stoves reaching consumers comply with national and international efficiency standards. Imperfect field implementation of an otherwise optimally-designed laboratory stove model could fail to deliver the desired health effects to communities where stoves have been disseminated.

Develop and Provide Training on New Business Models and Entrepreneurship. While it is hoped that public campaigns will influence consumer demand for cooking technology, this could be strengthened by working with the supply chain to develop effective promotional and marketing techniques for stove products. Most producers in Indonesia use traditional business methods, and do not keep records or track calculations that would enable them to appropriately price a cookstove according to production and market conditions. Therefore, producers may need to be trained in entrepreneurship and business in order to improve the quality of stove products and business

practices. Survey results have shown there is a desire among suppliers, particularly retailers, to develop more effective business models and marketing techniques to further develop their businesses. Incorporating clean cooking technology into these new business models could promote the overall supply of clean cooking technology, particularly if members of the supply chain view the new technology as having greater potential for profit.

Provide Financial Incentives for Delivering Clean Cooking Solutions to Households. To direct the current biomass stove market toward cleaner and more efficient stoves, it is necessary to provide financial incentives to attract more suppliers to deliver clean cooking solutions to households. The traditional subsidy approach uses a public-procurement procedure to purchase clean stoves and disseminate them to households for free or at a low

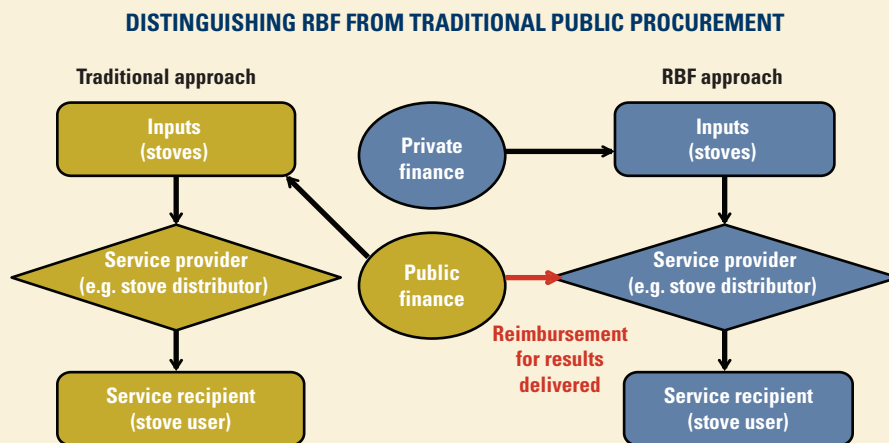
price. This approach can quickly aggregate demand and deliver stoves; however, problems are likely to result. For example, users may not like the stoves and decide not to use them. Users may not cherish the free stoves and fail to properly maintain them. Households who did not receive free stoves may expect to receive them in the future and thus decide to stop purchasing stoves.

International experience has shown that more innovative subsidy schemes are required to develop a sustainable market and thus make government funding support more effective and efficient. One such scheme is Results-Based Financing (RBF), which disburses public resources against demonstrated, independently verified outputs or outcomes instead of project inputs. This distinguishing feature can mean more effective and efficient use of public funds and improved support of market interventions (box 5.3).

BOX 5.3 WHAT IS RESULTS-BASED FINANCING?

Results-Based Financing (RBF) is a concept comprising a range of public policy instruments, whereby incentives, rewards, or subsidies are linked to the verified delivery of pre-defined results. RBF is often used to enhance access to and delivery of basic infrastructure and social services, such as improved access to water and sanitation, energy, and health care. In most cases, the funding entity—typically a government, development agency, or other agent—deals directly with the service provider (e.g., private firm, public utility, civil society organization, or financial institution). Some of the better-known RBF approaches include output-based aid (OBA), conditional cash transfers, carbon finance, and advance market commitments.

Unlike traditional public procurement, which uses public resources to purchase the inputs and contract service providers to deliver them to users, the RBF approach uses private-sector resources to finance the inputs and service delivery and public resources to reimburse the service provider upon delivery of the pre-defined results. This key difference gives RBF the potential to improve the efficiency and effectiveness of disbursing public resources and support of market-based interventions (see figure below).



Source: Adapted from Brook and Petrie 2001.

Support Market Research. The promotion of clean cooking solutions should understand market segmentations, adapt to local conditions, and be consistent with and adjust to long-term development patterns. Therefore, it is recommended that market research be supported to better understand market needs that can be used to design government-supported programs and help stove suppliers adjust their products.

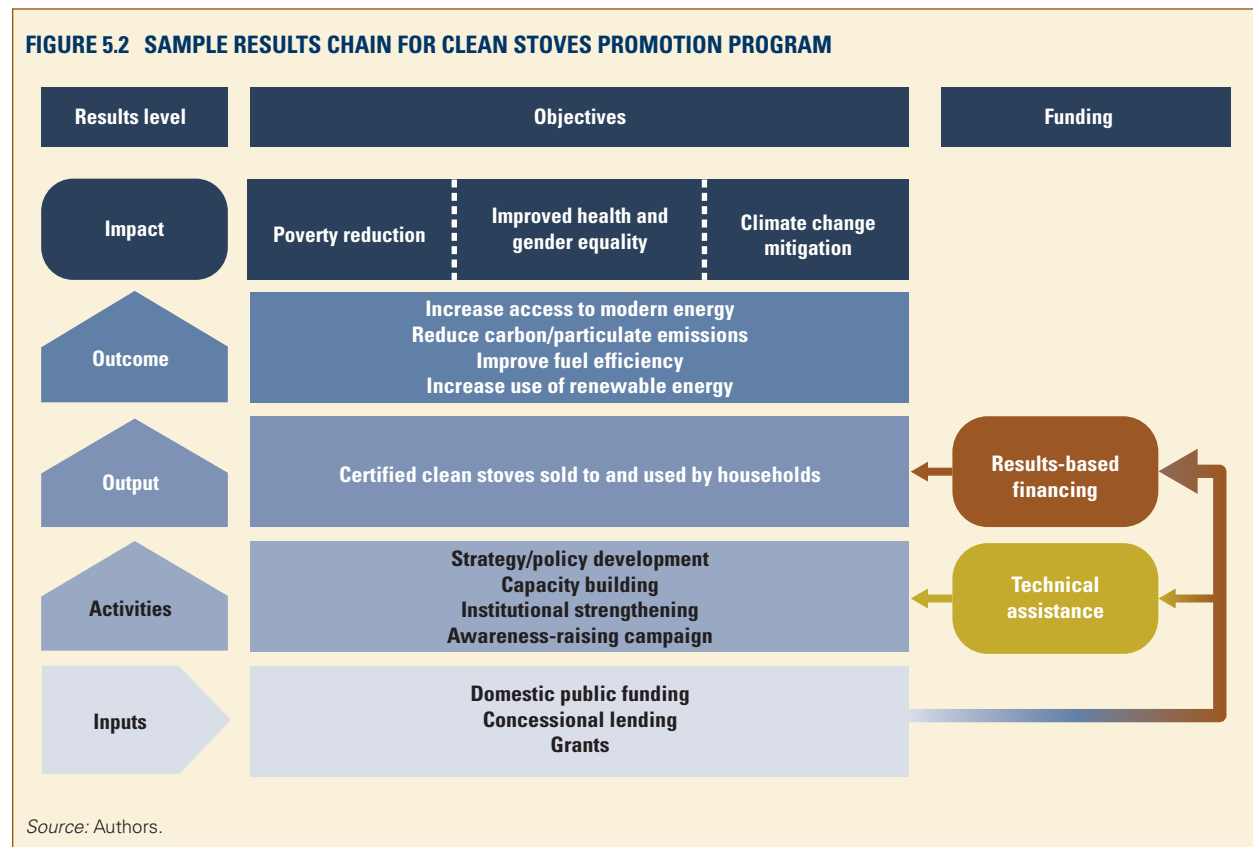
A New Approach to Promoting Clean Stoves: Results-Based Financing

The traditional public-procurement approach to promoting clean stoves makes public entities responsible for the technical specifications of stoves and identifying eligible service providers, delivery methods, and end users to receive the subsidized stoves; payments are made against the stoves purchased and associated delivery service. By contrast, under the RBF approach, public entities specify the intended results, verification methods, and associated subsidies, and the service provider is paid against verified delivery of the stoves and their operational performance.

The RBF approach focuses on results that the public sector cares about and rewards the private-sector suppliers who can deliver them. Investment and performance risks shift from the public to the private sector. In turn, private-sector suppliers have the flexibility to innovate in designing, producing, and selling defined clean stoves that are eligible for targeted incentives. This flexibility is vital to stoves market development since stoves must fit local conditions, including customary cooking practices, affordability, and availability of local resources and after-sales service. The success of stove suppliers depends on understanding such local conditions.

Chain of Results

Promoting clean stoves can contribute to the broader development objectives of reducing poverty, improving health and gender equality, and mitigating climate change (figure 5.2). Replacing fuel-inefficient, polluting stoves with those that have better energy-combustion properties can help poor households climb out of poverty by reducing their fuel expenses. The health of family members who spend long hours in the household cooking environment—primarily women and their young



children—will benefit from reduced HAP. Women’s freed-up time from collecting fuelwood and preparing meals with traditional cookstoves can be spent on more productive activities. The local ecosystem and global environment also benefit from fewer carbon emissions and less black carbon due to the burning of solid fuels.

To achieve these impacts, the RBF incentive would be linked to the verifiable output: certified clean stoves sold to and used by households. Also critical to success would be technical assistance activities for strategy and policy development, capacity building, institutional strengthening, and awareness-raising campaigns.

RBF Framework

The conceptual framework for using RBF in programs to promote clean stoves could include three key building blocks—defined clean stoves, results-based incentives, and a monitoring and verification (M&V) system—supported by the pillars of institutional strengthening/capacity building and awareness-raising campaigns (figure 5.3).

Building Blocks

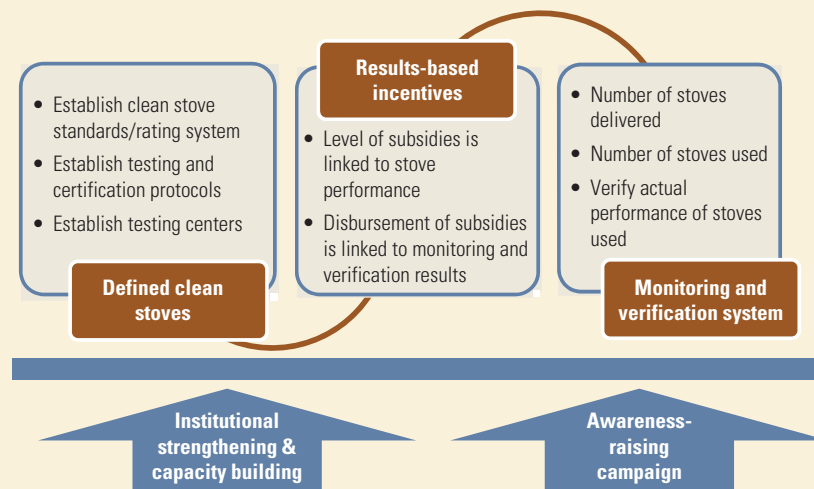
Defined Clean Stoves. Defining a clean stove requires establishing a standards/rating system, testing and certification protocols, and testing centers. The standards/rating system should consider compatibility with the rating framework provided by the International Workshop Agreement, which includes four performance indicators (fuel efficiency, total emissions, indoor emissions,

and safety) and five tiers (0–4). Laboratory and field testing might be included, and the certification process should be transparent and fair. A research center or university with multiple functions (e.g., testing, education, research and development, and advisory service for design development) could host the testing centers to ensure their sustainability. Also, competitions could be organized to identify top-performance stoves.

Results-Based Incentives. The level of incentive (subsidy) should be linked to stove performance and its disbursement to monitoring and verification of results. Eligibility criteria should be clearly outlined and the amount adjusted according to the level of stove performance and geographic preferences. Those who apply for incentives (the market aggregators) are those willing to take investment and performance risks. These may include producers, wholesalers, retailers, and project sponsors. To receive payment, they must produce stoves that can be certified as “clean,” design according to customer preferences, and convince customers to buy and use the stoves.

Design of an incentive payment system requires a thorough understanding of the cost structure and profit margin (supply side) and consumers’ willingness to pay (demand side), as well as the economic benefits of the incentive provided. Advance disbursements could be designed to help finance stove suppliers. The incentives could be implemented through a financial institution to leverage the existing network and traditional financing instruments.

FIGURE 5.3 RBF FRAMEWORK WITH THREE BUILDING BLOCKS AND TWO SUPPORTING PILLARS



Source: Authors.

Monitoring and Verification System. A critical part of the RBF design is monitoring and verification (M&V), which triggers payments. The M&V system could combine self-reporting and third-party verification, using sampling methods to balance the trade-offs between accuracy and costs. To incentivize efforts to achieve sustainable clean cooking, results-based incentives could be linked to specific stages of M&V results, including stove installation, operation, and performance (figure 5.4). The detailed design of the M&V system can also benefit from the experience of carbon finance methodology for clean stoves projects. However, carbon finance focuses exclusively on carbon emission reductions, while clean stoves are also related to other benefits, as illustrated in figure 5.2; therefore, RBF can be designed more flexibly to fit program objectives.

Supporting Pillars

Institutional Strengthening and Capacity Building.

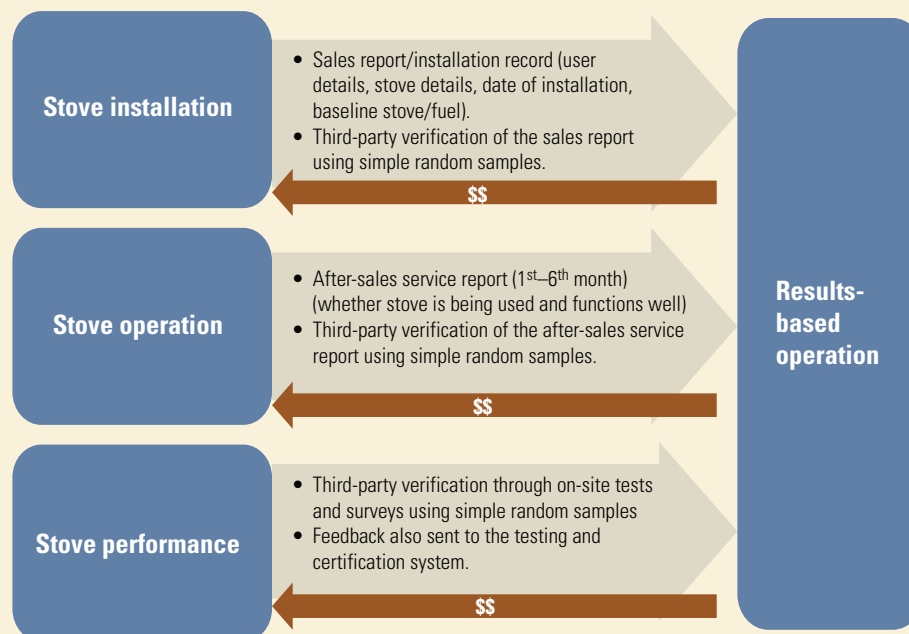
Institutionalizing clean stoves would be an important step toward providing an enabling environment. Key elements could include an institutional champion; a cross-sector coordination mechanism; and a platform for communication, learning, and cooperation. Technical assistance in capacity building is also needed to improve the performance of all market players, ranging from designers and producers to market aggregators, financiers/investors, testing professionals, and M&V specialists.

Awareness-Raising Campaigns. To motivate both supply and demand, awareness-raising campaigns should be conducted at all relevant levels. Campaigns could focus on informing the public about the program and the availability of results-based subsidies and other associated program benefits and raising awareness about the negative health impacts of HAP linked to biomass cooking smoke. Using a celebrity ambassador could be an effective way to raise such public awareness.

The RBF framework not only integrates all of the identified priorities described under the initiative's overall strategy; more importantly, it helps to clarify the roles of government and the private sector in delivering the results: Government plays a facilitating role to provide policy support and financial incentives to motivate market development, while the private sector responds to the incentives and delivers the results.

However, it should be noted that the RBF approach may not always be the most effective or efficient way to achieve results. The traditional government procurement approach has the advantages of easy demand aggregation and fast implementation. For the more remote and poorer areas, characterized by little market activity, high delivery costs, and low affordability, which cannot attract the private sector, the traditional government procurement approach, which can be integrated into poverty

FIGURE 5.4 EXAMPLE OF LINKING RESULTS-BASED INCENTIVES TO MONITORING AND VERIFICATION STAGES



Source: Authors.

alleviation or social programs, is probably the most efficient and effective way to achieve results. Similar cases might include post-disaster relief programs. For the traditional public-procurement approach, it is recommended that bidding documents and contract arrangements be carefully designed in terms of technology selection, delivery method, and post-delivery service. It is also important to keep options and approaches open.

In addition, other innovative financing mechanisms may be developed and utilized based on local conditions. For example, many communities in Indonesia have long employed supportive community groups and communal financial mechanisms, which could be tapped for financing clean stoves. Various credit schemes and soft loans may also be explored for their potential use in promoting clean cookstoves.

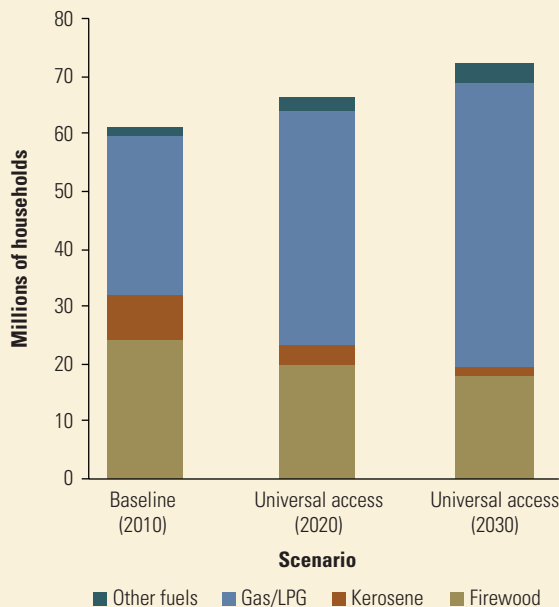
Vision Toward Universal Access to Clean Cooking Solutions by 2030

Indonesia has made significant progress toward achieving universal access to clean cooking solutions in recent years, thanks in large part to the successful implementation of the Kerosene-to-LPG Conversion Program. Yet 40 percent of primarily rural households, who lack access to affordable modern fuels, are expected to continue using traditional biomass fuels with low-efficiency,

high-emission cookstoves for years to come. Thus, achieving universal access to clean cooking solutions by 2030 will require scaled-up adoption of clean biomass cookstoves, in addition to the continued expansion and improved sustainability of the LPG conversion program and biogas adoption in areas with suitable conditions.

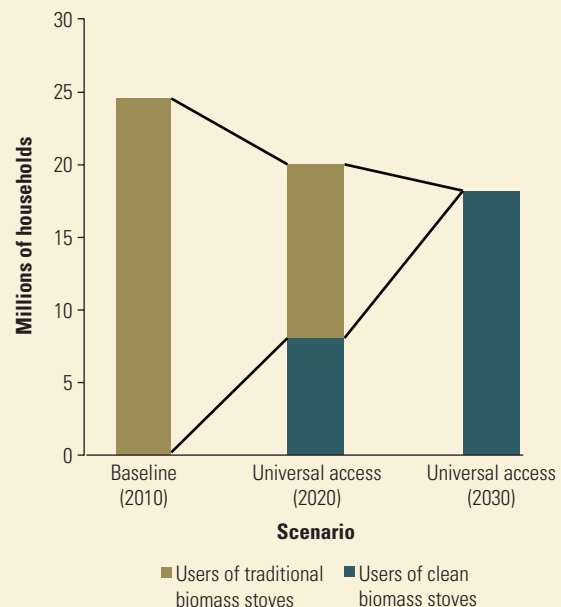
To estimate how many clean biomass cookstoves would be needed to achieve universal access to clean cooking solutions by 2030, this study conducted a scenario analysis. The year 2010 was taken as the baseline, at which time approximately 24.5 million households used biomass as their primary cooking fuel and penetration of clean cookstoves was minimal (figure 5.5). Under the universal access scenario, which accounts for continued population growth and urbanization and increased adoption of LPG as the primary cooking fuel due to better infrastructure and higher income levels, it is estimated that approximately 20 million households would still use biomass as their primary cooking fuel by 2020 and 18 million by 2030. Forty-percent market penetration of clean biomass cookstoves by 2020 would mean 8 million households using clean biomass cookstoves (figure 5.6). Considering that multiple cooking fuels and cookstoves are common in Indonesia, it is estimated that at least 10 million clean biomass cookstoves would need to be delivered by 2020 to be on the path to universal clean cooking solutions—100 percent market penetration—by 2030.

FIGURE 5.5 SCENARIO ANALYSIS OF HOUSEHOLD PRIMARY COOKING FUELS



Source: Authors.

FIGURE 5.6 SCENARIO ANALYSIS OF HOUSEHOLDS USING PRIMARILY BIOMASS FOR COOKING



Source: Authors.

To reach such an ambitious target, it is recommended that two consecutive national programs be implemented. These will require a high level of government commitment and financial support and adoption of a market-based mechanism to support development of the clean biomass stoves sector, using a phased approach with gradual geographical expansion (figure 5.7).

Next Steps

The overall Indonesia CSI strategy, the proposed RBF approach for implementation, and the vision for achieving universal access to clean cooking solutions by 2030 were discussed at the second CSI national consultation workshop held in Jakarta in July 2012. The public and private sectors agreed with the overall strategy and expressed great interest in the RBF approach. It was agreed that the approach will be piloted in selected areas and the master plan will be prepared for the scaled-up national program. Thus, to support strategy implementation to scale up access to clean stoves, it is proposed that four areas of activity, described below, be undertaken under phase II of the initiative.

Establish Stoves Standards/Testing/Certification System

Defining “clean stoves” is a priority for promotion programs, but Indonesia does not yet have standards and testing protocols. Thus, the priority for phase II is to establish stoves standards, testing, and a certification system. Activities would include (i) developing a roadmap for setting up the stoves standards, testing, and certification system; (ii) establishing a biomass cookstove

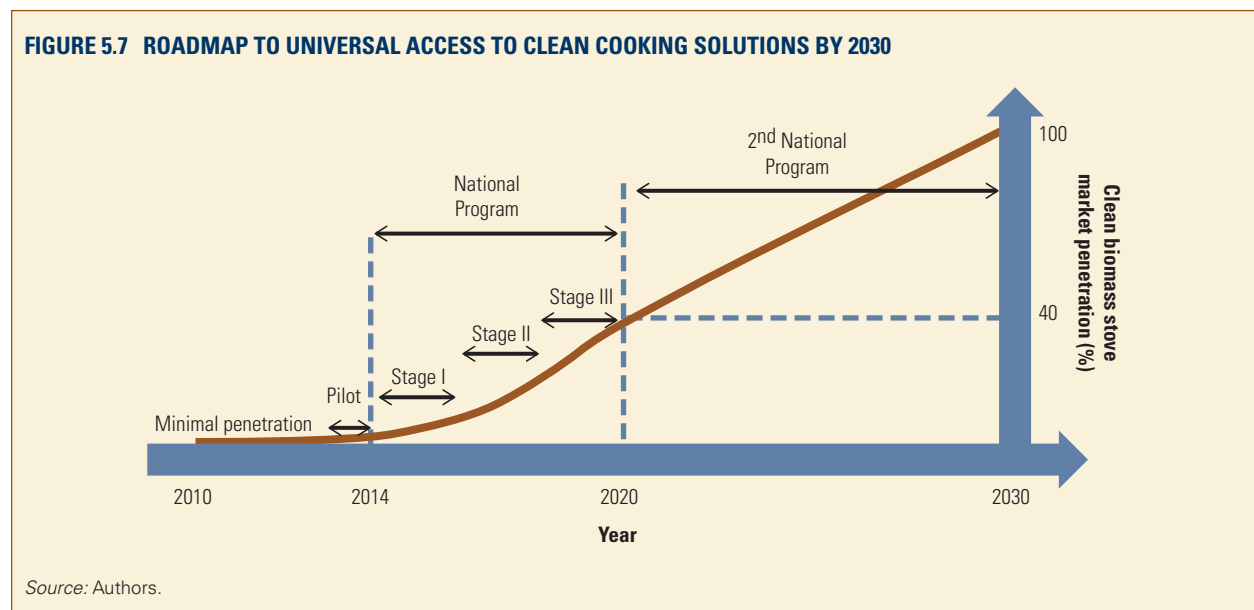
laboratory that certifies eligible stoves for pilot promotion; and (iii) establishing a biomass cookstove testing laboratory that provides advisory services for stove design improvements and organizes stove competitions to identify top-performance biomass cookstoves. Furthermore, as international standards for clean stoves are being formulated, efforts will be made to encourage Indonesia to actively participate in the process and make its national standards compatible with the international framework so that certified national clean stoves will be recognized internationally.

Strengthen Institutions and Build Stakeholder Capacity

Phase II will also involve strengthening and building Indonesia’s institutional capacity to address biomass energy for cooking. An Indonesian Alliance for Clean Stoves will be established, with support provided to key institutional players across Indonesia’s energy landscape. Training activities will be provided to key market players, with learning activities organized at both regional and international levels. Sample activities may include advisory services for design improvement, market analysis/consumer behavior analysis for market aggregators, training and study tours for testing professionals, marketing advice, and a service to match designers and investors.

Design and Implement Pilot Program

Indonesia’s national program will be preceded by a pilot program rolled out in two areas selected for their representativeness and scalability: the central Java area and Sumba Island. The design of the pilot program’s RBF approach will include selecting eligible stoves for



promotion based on a trial standard/testing/certification system, allocating performance-based subsidies, and implementing a M&V system. A public campaign will be conducted to raise awareness and stimulate demand for clean cooking technologies, and advisory services will be provided to key market players.

Design and Prepare Master Plan for National Program

The scaled-up national program for clean biomass cookstoves, phase III of the Indonesia CSI, is envisioned to begin in 2014. Support will be provided to design the master plan for the national program. The detailed implementation plan and preparation activities will be developed in consultation with key stakeholders.

The Road Ahead

Achieving universal access to clean cooking solutions by 2030 requires actions on several key fronts. It is recommended that the LPG distribution network be strengthened and expanded and ensure subsidies are well targeted. The biogas program should also be expanded where appropriate, based on community resources. Developing a successful clean cookstove market requires overcoming significant supply- and demand-side obstacles, as well as institutional constraints. To influence clean stove adoption, an enabling environment must be created that allows for the institutionalization of biomass-related issues, increased demand for clean cooking technology, and improving or creating clean biomass cookstove supply throughout Indonesia. Within these broad goals, the

following concrete steps can be taken to further develop a sustainable intervention: (i) institutionalize biomass fuel and clean stoves with strong centralized guidance from the national government, (ii) establish one or more clean biomass cookstove testing centers and determine national stove testing protocols and standards, (iii) select areas for conducting a small-scale pilot program, (iv) select the clean stove designs to be disseminated, (v) develop appropriate RBF methods, (vi) increase user awareness of clean cookstove benefits, and (vii) apply rigorous monitoring and quality control mechanisms during all program phases. As phase I of the Indonesia CSI concludes and the lead-up to the national program accelerates, phase II will focus on establishing stove standards and testing protocols, strengthening institutional capacity, supporting pilot programs, and designing and preparing for the national program rollout in phase III.

Over the next 10–20 years, it is expected that national economic development will continue to enrich Indonesian citizens and influence the increased adoption of LPG. It is also expected that those who continue to use biomass fuel will do so with a clean stove. By 2020, a target has been proposed for achieving 40 percent use of clean biomass stoves (10 million stoves delivered), with momentum leading to 100 percent penetration by 2030. The private sector—including stove designers, producers, wholesalers, and retailers—is in the best position to know its customers; thus, the public sector will provide the private sector sufficient incentives and support to enable it to reach its customers. Ultimately, the market should decide which customers and locations to target and what types of technologies and fuels to focus on, with the freedom to innovate over time.

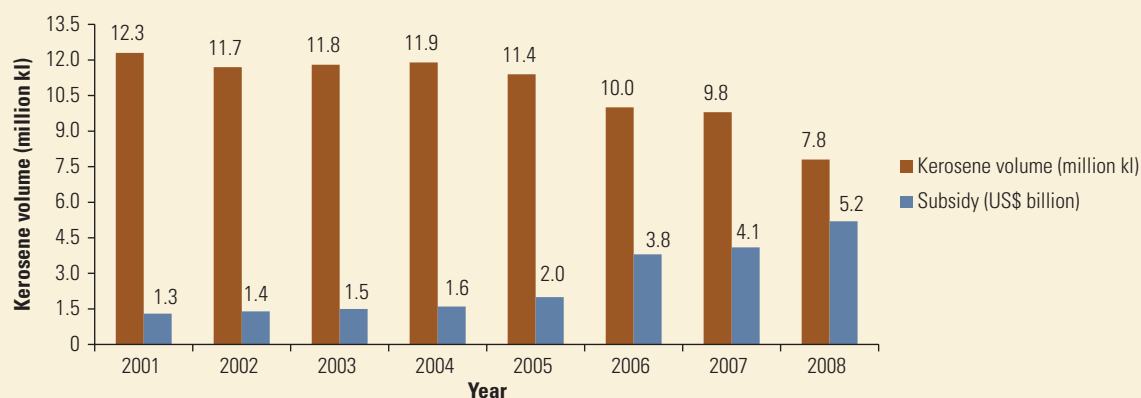
Kerosene-to-LPG Conversion Program: Case Study Summary⁶

Indonesia's Kerosene-to-LPG Conversion Program is considered one of the world's largest efforts to promote cooking fuels. Since its inception in 2007, the program has succeeded in changing the landscape of Indonesia's household cooking fuels. By 2011, more than 50 million households and small and medium enterprises (SMEs) had been encouraged to switch from kerosene to liquefied petroleum gas (LPG) as their main cooking fuel, with a total of 53 million start-up packages distributed. Compared to kerosene, LPG burns more efficiently and cleaner and has a higher heating content. Over the 2007–11 period, the proportion of households using LPG as their main cooking fuel grew by 35 percent (from 11 to 46 percent), while the proportion using mainly kerosene

for cooking declined by 25 percent (from 37 to 12 percent). By late 2011, subsidized use of LPG totaled some 3.26 million tons.

Historically, kerosene, like other petroleum products, was heavily subsidized by the Indonesian government. Before 2005, households and SMEs without access to electricity used kerosene as their main cooking and lighting fuel. Although parliament imposed a quota on the volume of kerosene use, the subsidy rose along with oil prices and, to some extent, a growing population. The government removed the kerosene subsidy for industrial consumers in mid-2005, yet government spending on the subsidy continued to rise (figure A.1). Despite

FIGURE A.1 RISING COST OF INDONESIA'S KEROSENE SUBSIDY, 2001–08



Source: Pertamina.

6. This annex summarizes the August 2012 report, "Indonesia: Kerosene to LPG Conversion Program," by Voravate Tuntivate of the World Bank, which, in turn, is based on the report "LPG Case Study in Indonesia," by Edi Susanto, a local consultant under supervision of Yusep Caryana, Directorate General of Oil and Gas (MIGAS), Ministry of Energy and Mineral Resources (MEMR) (Susanto 2012). Supplemental data from other studies was also collected and analyzed for the case study.

successful attempts to reduce subsidies on transport fuels, the kerosene subsidy still accounted for more than half of all subsidies for petroleum products.

Thus, to further reduce kerosene consumption, the Indonesian government was prompted to launch the Kerosene-to-LPG Conversion Program in 2007, encouraging households and SMEs to switch to LPG for cooking. The program has been highly successful, with subsidy savings in the first four years averaging more than US\$1 billion annually.

Implementation Arrangements

The Presidential Decree (“Keppres”) for the Conversion Program, No. 104/2007, was released in December 2007, five months prior to the official launch date. Initially, implementation arrangements involved Pertamina, the state-owned national oil company, and four ministries (i.e., the Ministry of Industry was assigned to procure gas stoves, hoses, and regulators, the Ministry of Small and Medium Enterprises was in charge of distributing LPG start-up packages, the Ministry of Women’s Empowerment was assigned to carry out socialization activities, and the Ministry of Energy and Mineral Resources [MEMR] was to coordinate program implementation). As coordination among these ministries became increasingly difficult, it was decided that the MEMR would lead overall coordination of the program with Pertamina, while the other three ministries would be assigned supporting roles. The conversion program’s budget is appropriated annually; Pertamina, the sole executor, finances all implementation activities and is subsequently reimbursed by the government (box A.1).

Conversion Policy

Justification for reducing the government’s subsidy burden is based on a few simple concepts. First, the end-use caloric value of energy delivered is higher for LPG than for kerosene, requiring households to use less energy to cook. Second, the subsidy per unit of fuel is significantly lower for LPG, meaning the government allocates less of its budget to subsidize LPG than kerosene since the unit of LPG used for household cooking is smaller than that of kerosene. In terms of energy equivalence, 1 liter of kerosene is equal to 0.57 kg of LPG. However, in designing the conversion program, the Indonesian government chose to equate 1 liter of kerosene with 0.39 kg of LPG,⁷ meaning that every liter of subsidized kerosene withdrawn is replaced by 0.39 kg of subsidized LPG. Based on the 2006 subsidized and non-subsidized prices of kerosene and LPG, every liter of kerosene withdrawn would save the government US\$0.285.⁸

Program Eligibility and Activities

Presidential Decree 104/2007 designated the conversion program’s beneficiaries as those households and SMEs that have been using kerosene as their main cooking fuel and have never used LPG. To receive the start-up package, heads of households and SME owners are required to have valid identity or seasonal resident cards and family cards registered in the program conversion area, with a

7. This ratio is based on research and laboratory experiments conducted by the University of Trinity (Universitas Trisakti) in Jakarta and the State Ministry for Women’s Employment.

8. Based on an exchange rate of US\$1 to IDR 9,450 and an LPG price of IDR 4,250 per kg.

BOX A.1 INDONESIA’S FUEL SUBSIDIES PROCESS

Each year the Indonesian government announces the cost of fuel subsidy in its Annual State Fiscal Plan, which is then sent to parliament for approval. BPH Migas, the downstream regulatory body for oil and natural gas, calculates the subsidy cost by estimating the quantity of fuels to be subsidized and the international market price for the coming year. The state budget is commonly adjusted during the fiscal year. How often changes are made to the amount allocated to fuel subsidies depends on the stability of international crude prices, the exchange rate between Indonesian and U.S. currencies, and the subsidy policy.

Pertamina is Indonesia’s sole distributor of fuel products. At the end of every three months, it is reimbursed for the below-market products it has sold during the period. Payment size is based on monthly reports the company must submit to the Ministry of Finance, detailing the volume and value of the subsidized fuel sold and the international benchmark price. The process is audited once a year by the Audit Board of the Republic of Indonesia, known as BPK (*Badan Pemeriksa Keuangan*).

Source: Beaton and Lontoh 2010.

maximum income of about US\$166.7 per month (provable by salary receipts, monthly expenditure not exceeding this amount, or statement from subdistrict authority regarding insufficient funding to support activities).

To promote LPG adoption, the government introduced one main activity—distributing a start-up package (*paket perdana*) consisting of a filled 3-kg LPG cylinder, one single-burner gas stove, hose, and regulator—and various supporting activities designed to increase public acceptance (e.g., education on the benefits of using LPG as the main cooking fuel and safe use, monitoring and evaluation, ensuring distribution of start-up packages to target audiences, and ensuring adequate LPG infrastructure and uninterrupted supply).

To avoid supply disruption and thus potential hardship for households and SMEs, kerosene withdrawal is carried out only in areas where conversion packages have been completely distributed in systematic steps (Budya and Arofat 2011). The withdrawal is accomplished by gradually cutting agents' allocation and supply.⁹ For example, if conversion packages have been distributed to 80 percent of the targeted beneficiaries in an area, then a 50 percent withdrawal of the kerosene allocation is carried out the following month. In the weeks that follow, the withdrawal amount is increased a minimum of 10 percent, taking any special field situations into account, until complete. If withdrawal causes any serious disturbances in the local community, kerosene is temporarily restored in the amount of 10 percent of the total kerosene withdrawn from the area.

Costs and Benefits

The conversion program has significantly reduced the fiscal burden of the kerosene subsidy. From 2007 to 2011, the cumulative total program cost was high, at about US\$2.3 billion;¹⁰ yet over that period, about 23.4 million kl of kerosene were withdrawn and replaced by only 8.3 million tons of LPG.¹¹ Beyond the reduced volume of subsidized cooking fuel, the cost of the subsidy per kilogram of LPG is lower than the cost of the subsidy per liter of kerosene.

9. In accordance with this process, agents and retailers also function to supply LPG to converted areas.

10. Including the investment cost of the start-up packages and recurring subsidy cost for LPG refilling.

11. The amounts of kerosene withdrawn provide direct financial benefits since they are reallocated to sell in more profitable markets (e.g., jet fuel).

Supply and Demand

By 2011, total LPG demand in Indonesia had reached more than 4.3 million tons. The subsidized portion to meet the cooking needs of low-income households and SMEs (distributed in 3-kg cylinders) represented three-quarters of this demand. Non-subsidized LPG to meet the cooking needs of middle- and upper-income households (distributed in 6- and 12-kg cylinders) accounted for another one-fifth of demand. Only 5 percent was being used by the commercial (3 percent) and industrial (2 percent) sectors, down from 30 percent in 2000–07. Thus, as a result of the conversion program, the household sector and SME subsector dominate Indonesia's LPG market, accounting for 95 percent of total demand.

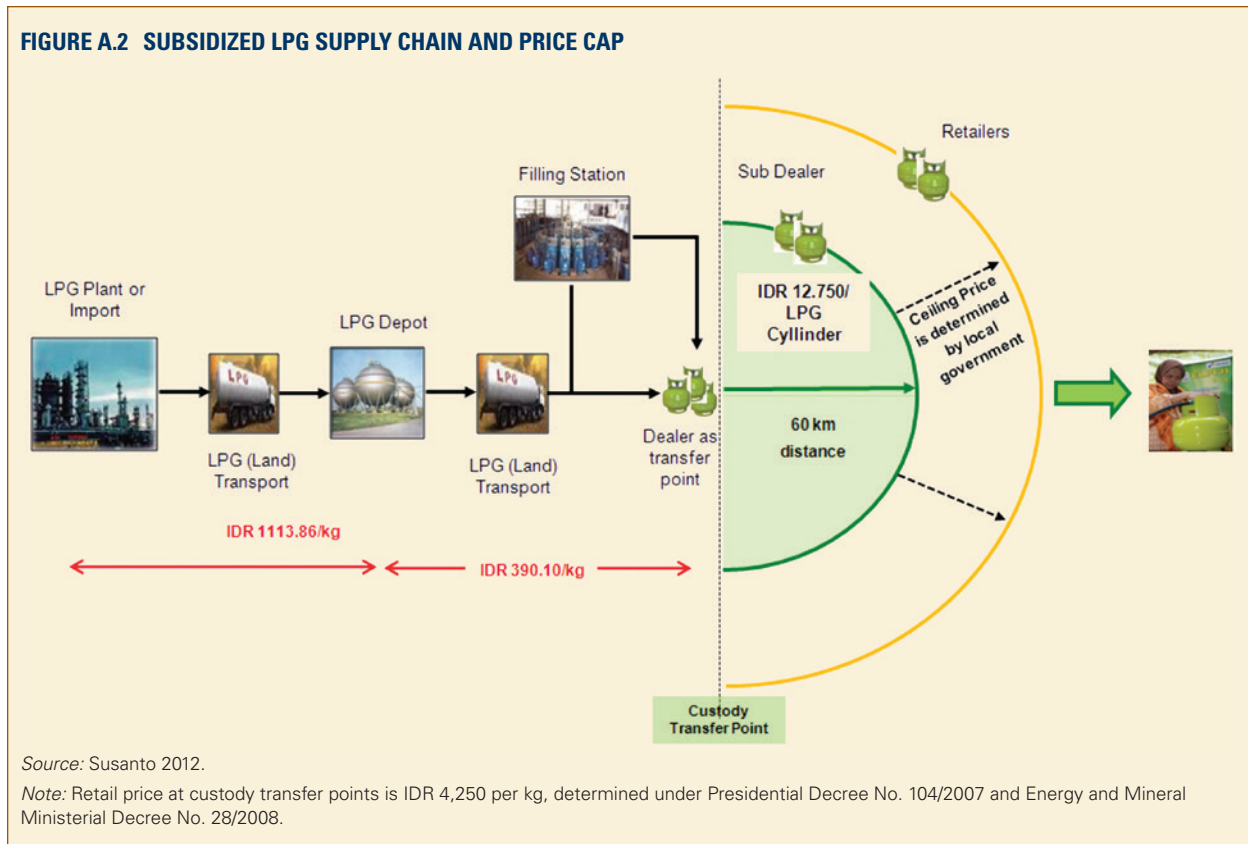
From 2000 to 2005, Indonesia had been a net exporter of LPG; however, the domestic demand created by the conversion program has outpaced domestic production.¹² To meet the added demand, Indonesia has become a net importer of LPG, having started importing about 1 million tons a year since 2008. The government can easily manage the level of LPG subsidy on the non-imported portion of demand due to the domestic LPG price regulation. But there is potential difficulty in managing the imported portion owing to fluctuations in the international market price of LPG and currency exchange rates; that is, the larger the portion that would have to be imported to meet local demand, the harder it would be for the government to manage the LPG price subsidy. Despite the potential for longer-term fiscal challenges, the price subsidy burden is significantly less for LPG than kerosene.

LPG Price Regulations

The retail price for LPG in 3-kg cylinders for households and SMEs at agent (*penyalur*) is IDR 12,750, including taxes and marketing margin for the agent (i.e., *penyalur* margin). This ceiling price is applied within a 60-km radius of the dealer as transfer point (figure A.2). The retail price cap is equivalent to IDR 4,250 per kg (about US\$0.45).¹³ Beyond this 60-km radius, the local government determines the retail price ceiling.

12. LPG production from oil refineries has been relatively stable over the past decade, at about 700,000–800,000 tons per year; however, production from gas refineries has fluctuated, with total production dropping from a high of about 2 million tons to only 1.4 million tons in 2006–07.

13. Based on an exchange rate of US\$1 to IDR 9,450.



The retail price for non-subsidized LPG (i.e., sold in 6-, 12-, and 50 kg cylinders) fluctuates periodically; however, there is a de facto price cap, which Pertamina proposes to the government using the reference international LPG price (CP Aramco). Prices are settled after discussion with the government and approval by parliament. Currently, the price of 6- and 12-kg cylinders at the dealer as transfer point is IDR 5,850 per kg (US\$0.62 per kg), while that of 50-kg cylinders is IDR 7,355 per kg (US\$0.78 per kg).¹⁴ These figures reflect the latest price settlement of October 2009. The settled prices appear relatively stable, while the international price has fluctuated considerably. In recent years, there has been an overall upward price trend, exceeding US\$1,000 per ton; subsequently, the price declined to about US\$600 per ton (April–July 2012).¹⁵ When the international price changes, Pertamina absorbs any losses or gains. The price cap is considered a key factor that may inhibit private businesses from investing in the LPG market.

14. Based on an exchange rate of US\$1 to IDR 9,450.

15. The state-run Saudi Aramco sets the monthly contract prices for propane and butane, which, in turn, provide a benchmark against Middle East sales of LPG to the Asia market. Aramco prices set for March 2012 reached a peak of US\$1,230 and \$1,180 per ton, respectively, having since dropped to \$575 and \$620.

Supply Chain Infrastructure: Expansion and Development

As a result of the conversion program, LPG demand has increased more than tenfold in just four years (2007–11). To accommodate the new demand, the existing supply-chain infrastructure must be expanded at all levels and new infrastructure must be built in most parts of the country. The LPG supply chain consists of refinery, transport, and storage facility or depot; while the distribution chain consists of filling station, agent (*penyalur*), and sub-agent (*subpenyalur*). Both domestically produced and imported LPG are usually transported by tanker for bulk supply transport to LPG storage facilities or depots located strategically throughout the country, thus ensuring available market supply. Generally, volumes larger than 10,000 tons are refrigerated during transport and storage, while a high-pressure tank is used for volumes smaller than 3,000 tons. A transport vessel with semi-refrigeration is used for medium-sized volumes (3,000–10,000 tons). In most cases, transport from the storage depots to the filling stations is over land using a skid tank; however, in areas without a storage facility, sea tankers are used. Distribution from the filling station to consumers is carried out by the LPG sales agent (*penyalur*) or sub-agent (*subpenyalur*).

Pertamina is fully aware that gaining consumers' acceptance of LPG requires that an uninterrupted supply be available at all times. Thus, it has moved rapidly, often working with the private sector, to invest significantly in improving and expanding all stages of the LPG supply chain—from production, bulk transport, and storage at the LPG depots to transport to filling stations and wholesale and retail distribution.

Bulk Transport

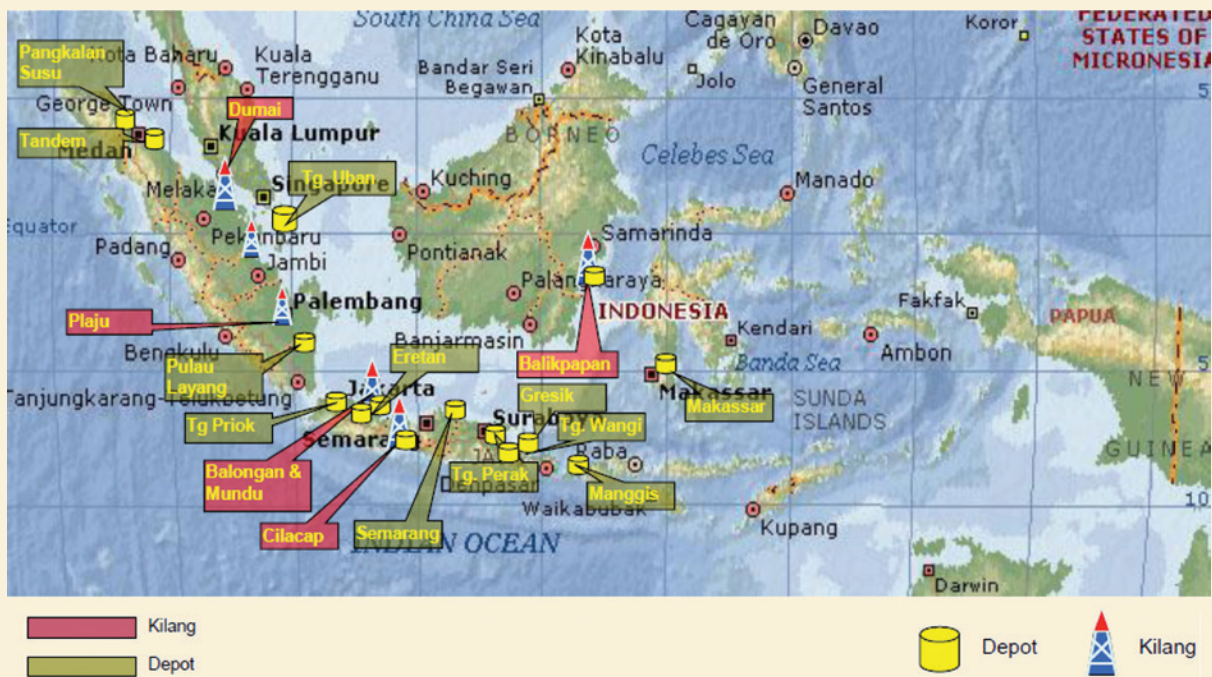
As demand for LPG increases, Pertamina immediately increases LPG production from its gas refineries. Also, LPG transport networks from gas refinery terminals to storage facilities or LPG depots have been added. Currently, LPG bulk transport capacity totals about 300,000 tons. More than two-thirds of all bulk transport is by sea, using special tanker carriers (i.e., five with a 45,000 ton capacity, six with a 10,000 ton capacity, and nine smaller-sized vessels with a 1,800 ton capacity). Economies of scale in the marine transport of LPG translate directly into cost savings for the subsidy program. In addition, pipeline transport is used from the Balongan Refinery to the Balongan Depot.

Depot Storage Facilities

Before being distributed to LPG filling stations and industrial customers, both domestically produced and imported LPG are stored in the LPG depots. In anticipation of the rapidly increasing demand for LPG, Pertamina has also utilized floating storage facilities and has accelerated the construction of storage facilities designed to be expandable. Currently, the storage capacity of all LPG depots totals 147,182 tons.

Pertamina has taken a number of additional steps to further ensure the availability of LPG in all program areas. For example, it has converted two refrigerated LPG terminals in Java that receive both domestic and refrigerated imported supply into the backbone of LPG storage. In addition, it has established pressurized storage terminals to facilitate distribution to filling stations throughout the country. Contracted storage facilities owned by BMU in Eretan, Indramayu, West Java, with a capacity of 10,000 metric tons (MTs), have been in operation since 2008. A contract awarded for pressurized LPG storage at three locations in Java will add storage and filling facilities in Semarang, Surabaya, and Tanjung Wangi, each with a 10,000 MT capacity (figure A.3).

FIGURE A.3 LPG PRODUCTION AND STORAGE INFRASTRUCTURE



Source: Pertamina.

Furthermore, Pertamina has taken strategic steps to ensure LPG supply security and terminal availability (i.e., receipt, storage, conversion, and distribution), working with a supplier to offer 5- and 10-year contracts. Finally, it has encouraged and worked directly with private-sector players to invest in the construction of LPG storage facilities.

Transport to Filling Stations and Filling Station Infrastructure

Each LPG filling station has at least one skid tank, a special storage truck used to transport LPG over land. In addition, many distributors hire skid tankers. Skid tank capacity usually ranges from 8 tons, to 9.5, 15, and 25 tons. There are also skid tanks with a small payload capacity (e.g., 2, 4, and 6 tons) commonly used by sales agents for industrial customers. In areas with adequate road infrastructure, skid tanks with a 15- or even 25-ton capacity are used for bulk transport from the storage depot to the filling station, especially on the Island of Java.

Currently, LPG filling stations are divided according to subsidized and non-subsidized distribution. More than 200 stations service the subsidized 3-kg LPG cylinders—that number is expected to increase significantly—while about 60 service non-subsidized cylinders (i.e., 6-, 12-, and 50-kg capacity), as well as bulk capacity for industrial customers.¹⁶ Since the number of LPG users has outpaced the expansion of new filling stations as a result of the conversion program, those stations that service non-subsidized LPG are also being utilized to fill the 3-kg cylinders. At the government's request, Pertamina has created opportunities for the private sector to invest in building private filling stations for the 3-kg cylinders generally and in specific areas based on throughput capacities ranging from 30 to 50 tons per day. Pertamina is also tasked with setting standards and specifications for the design and construction of filling stations.

Distribution and Retail

Currently, there are 3,000 LPG sales agents (*penyalur*) throughout Indonesia, responsible for LPG refilling and consumer retail distribution, which may also involve sub-agents (*subpenyalur*). The LPG sales agent is an entity with legal status (PT/Cooperative). In practice, the agent buys LPG in cash from Pertamina through a bank. Distribution activities include transporting empty tubes back to the stations for refilling and then distributing/selling to customers either directly or through an agent or

sub-agent. About two-fifths of sales agents are located in Region II, which has the highest number of LPG users.

Typically, sub-agents are owners of local convenience shops or kiosks (*warung*) who provide retail sales directly to consumers. For their services, sub-agents get a fixed margin set by the government. Currently, the marketing margin is set at IDR 300 per kg (IDR 900 per 3-kg cylinder). The number of sub-agents for the 3-kg LPG cylinders has increased rapidly since the end of 2007. The key reasons include the growing demand for the 3-kg cylinders resulting from the conversion program, which the sub-agents view as a business opportunity. Also, investing in a 3-kg cylinder is relatively cheaper than a 12-kg cylinder per unit, allowing the sub-agent to purchase a limited number of cylinders. Furthermore, competition among agents means that one agent may be willing to provide another cylinders in return for it agreeing to act as sub-agent. Finally, since selling 3-kg cylinders does not require a large space, this business can be conducted along with selling other consumer goods.

Summing Up

The Kerosene-to-LPG Conversion Program has created another LPG market tier; namely, a subsidized LPG market with strict price control and a predetermined profit margin. Creating a market-based LPG supply chain with strict price control and a predetermined profit margin is not easy since investors need assurance there will be no reversal of policy that would harm their investment. Perhaps surprisingly, nearly all expansion and development of the LPG supply-chain infrastructure have been carried out by private investors. Key reasons for this success include the government's commitment and firm policy, as well as Pertamina's strong leadership in LPG business development. These factors are discussed in more detail in the section that follows.

Lessons Learned

The Kerosene-to-LPG Conversion Program's lessons in success, described below, offer useful insights for other national programs, especially those related to household fuels.

Government's Strong Commitment and Firm Policy Objective. Under tremendous fiscal burden to subsidize kerosene, the Indonesian government was searching for a good alternative. It was convinced that the conversion

16. The 3-kg cylinders require refilling every 6–8 days.

program would significantly reduce its fiscal burden created by the kerosene subsidy. Amid a rapidly increasing kerosene subsidy, the government acted in an urgent manner. The initial plan, as proposed by Pertamina, was to complete the conversion program in six years; however, the government shortened the implementation time frame to three years. Another sign of government commitment was its willingness to act immediately to reorganize program execution when, during the initial stage of implementation, coordination among ministries was poor and ineffective. As previously discussed, only the Ministry of Energy and Mineral Resources was kept to coordinate the program, with Pertamina appointed as the main implementing agency. Swift corrective action has enabled the program to complete on time. Finally, the government was convinced that replacing kerosene with LPG would provide a win-win situation for all parties involved. As a result, it has continued a policy of replacing 1 liter of kerosene with 0.39 kg of LPG, as well as providing financial support.

Effective Marketing Campaign for Public Awareness, Safety, and Acceptance. Another reason for the conversion program's success has been the equal weight placed by Pertamina on the program's main and supporting activities. Along with the main activity (i.e., distributing the LPG gas stove, hose, regulator and one filled 3-kg LPG cylinder), various supporting activities are designed to promote the adoption and safe use of LPG as the main cooking fuel. To discover how consumers and the public at large would respond to the massive conversion program, Pertamina used three test markets and conducted market research. The first market test was conducted in Cempaka Baru Village, Kemayoran District, Central Jakarta. In August 2006, Pertamina distributed free start-up packages to 500 households, whose total household income was less than IDR 1.5 million. Pertamina worked with an independent marketing research firm to assess household acceptance, perceptions, and other factors. The market test also permitted Pertamina to test the use of existing kerosene distribution agents in the village for LPG distribution.

The second market test, covering 25,000 households, was conducted in December 2006; while the third, which distributed 10,000 start-up packages to flood victims in Jakarta, was conducted in February 2007. No survey research was conducted for the second and third market tests since the overall goal was to test the distribution model. Beyond market testing and research, Pertamina has carried out public-awareness campaigns through the mass media, which have proven quite effective in changing public perception from one of skepticism to acceptance.

Assurance of Available Fuel Supply. Throughout the program, Pertamina has been aware that gaining public acceptance to ensure the complete conversion of households and SMEs from kerosene to LPG requires assurance of an available, uninterrupted fuel supply. Thus, Pertamina officials have emphasized development of the LPG supply-chain infrastructure. Fortunately, non-subsidized LPG was already available on the market prior to the conversion program; thus, Pertamina did not have to build all new supply infrastructure; rather, it had only to expand the existing LPG supply chain and create agents for subsidized LPG. At the same time, supply-chain expansion required massive investment at all levels (i.e., domestic refinery production supplemented by imports, bulk transport, terminal/storage facilities/depos, filling stations and transport to and from them, and sales agents/retail and distribution). Pertamina has been able to use its status as the country's only national oil company, in combination with the government's commitment and firm policy objective, to convince the private sector at every level of the supply chain to invest in expanding LPG supply infrastructure.

Pertamina as Sole Implementing Agency. As sole implementing agency for the conversion program, Pertamina was able to bypass bureaucracy, which might have delayed program implementation. As the largest state-owned enterprise, Pertamina has both financial and manpower resources to implement the program. As previously discussed, implementation arrangements require Pertamina to pay for the conversion program in advance and submit bills to the government for reimbursement. In addition, Pertamina has offices and/or operations in nearly all key islands of Indonesia, making it easy to coordinate with local governments.

Effective Monitoring and Evaluation. The effectiveness of the conversion program's monitoring and evaluation (M&E) processes has made it possible for program management to take corrective measures in a timely manner. Early on, for example, the program management team identified the failure of coordination among the four ministries. Marketing research has also provided useful information for taking corrective measures. For example, the first trial market research showed that consumers wanted more sales locations for refilling the 3-kg LPG cylinders. Market research also confirmed the need to continue socialization and education on the proper handling and use of LPG for cooking. As part of market testing, Pertamina was able to test monitor and evaluate the LPG distribution model.

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Indonesia Domestic Biogas Programme: Case Study Summary¹⁷

Biogas technology, first introduced to Indonesia in the 1970s, did not take off immediately, owing mainly to fuel subsidies provided by the Indonesian government, the high cost of fixed dome biodigesters, and the wide availability of fuelwood. In recent decades, however, stricter enforcement of forest regulations and scarcity of kerosene have increased the economic attractiveness of biogas as an alternate cooking fuel. The cost of chemical fertilizers, although subsidized, has also played a role in potential users opting for biogas. After decades of unsuccessful dissemination efforts, more effective methods are now being developed to introduce and construct household-based biogas digesters as a means of enhancing energy access and reducing greenhouse gas (GHG) emissions. The many direct benefits for farming households include savings on energy, fertilizer, and time spent collecting and cooking with fuelwood; while indirect advantages include better health and a higher quality of life.

Biogas Market: Potential Demand

In 2008, a feasibility study, proposed by the Government of Indonesia and funded by the Dutch government, was conducted by the Netherlands Development Organisation (SNV) to assess the total potential household demand of one million biodigesters. This figure is based on an assessment of the technical market potential, estimated at several million households, combined with key social and economic criteria, including affordability and willingness to pay, as well as an array of contextual factors (price levels, availability of suitable construction

materials, human resources, physical infrastructure, farming practices [e.g., zero grazing], potential partners, and attitude of local government). Dairy cooperatives on the island of Java are viewed as a suitable starting point for developing Indonesia's biogas sector since they indicate areas with high cow densities and well-organized cattle owners familiar with biogas and use of credit.

Indonesia's climate conditions, which feature year-round high temperatures, are favorable for biogas. In such densely populated areas as Java and Bali, cows are stabled day and night. However, in sparsely populated areas with free-ranging cattle or buffalo or in areas with limited water availability or space for the digesters, the potential for biogas is less favorable.

Obviously, financial considerations are vital to a farmer's decision to invest in a biodigester. In the past, the Indonesian government constructed a large number of fully subsidized digester units; however, farmers were unaware of the potential return on the investment. Many farmers on Java could significantly reduce their monthly expenditure on cooking fuels by switching to biogas. For example, the average household cost of subsidized LPG is about IDR 70,000 per month (3–4 small canisters). Those who tend to buy kerosene pay 10,000–13,000 per liter (one day requires up to 1 liter), while fuelwood purchasers spend up to IDR 200,000 a month.

In Indonesia, farmers are accustomed to using credit. Indeed, the current biodigester market is mainly limited to areas where credit is made available—provinces of East

17. This annex summarizes the June 2012 report, "Case Study: Indonesia Domestic Biogas Programme (IDBP)," prepared by Robert de Groot of the Humanist Institute for Development Cooperation (HIVOS) for the Indonesia Clean Stove Initiative.

and West Java—where four-fifths of biogas households utilize the credit system. Repayment of a low-interest loan for a partially subsidized six m³ household biodigester requires a monthly outlay of about IDR 150,000 over a three-year period or IDR 100,000 a month over five years.¹⁸ In addition, if the farmer uses bioslurry as an organic fertilizer, the monthly expenditure on chemical fertilizer can be reduced by about IDR 75,000.¹⁹ A recent biogas user survey finds that the average farming household's energy savings could reach up to 44–71 percent per month (JRI Research 2012).

Biogas Supply

In the past, biogas construction services in Indonesia were limited to a small number of government agencies, nongovernmental organizations (NGOs), and private-sector companies. The Indonesian government invested mainly in pilot programs to showcase the benefits of biogas, while the government and international donors used NGOs to construct biodigesters and work with the beneficiary communities. Only a small number of biogas companies have been developed, and the manufacture of biogas appliances has been limited. Models were usually copied from those in other countries, such as Nepal and India, and the digesters were of low quality. Since the year 2000, however, interest in biogas as a form of renewable energy has increased in response to rising fuel prices and international acknowledgment of the need to reduce carbon emissions.

Developing a Sustainable Biogas Sector: BIRU Program

The Indonesia Domestic Biogas Programme (IDBP), better known as the BIRU (*Biogas Rumah*) program, was initiated by the Government of Indonesia through the Joint Energy Working Group under bilateral cooperation between the Indonesian government and the Kingdom of the Netherlands. The program is funded by the Dutch government and facilitated by the Government of Indonesia. The Humanist Institute for Development Cooperation (HIVOS), an international NGO, was appointed by the Dutch government as Program Manager, with technical support provided by the Netherlands Development Organisation (SNV), another international NGO

18. A six m³ biodigester produces an average of 1,500 liters of gas each day, which can provide six hours of cooking, enough for a household of five.

19. In addition, the farmer could realize savings from increased agricultural output.

with broad experience in domestic biogas programs. The BIRU program aims to develop a commercial, market-oriented biogas sector through which household biodigesters are disseminated as a local, sustainable energy source. Over a three-year period (May 2009–May 2012), the program installed more than 8,700 biogas systems throughout the country. The approach to biogas sector development adopted by the BIRU program has been successfully applied in various Asian and African countries. A key implementation strategy is future institutionalization of the program in a local foundation through a gradual process involving both HIVOS and SNV to ensure that program quality, momentum, and appropriate management are maintained and working in close cooperation with the Ministry of Energy and Mineral Resources (MEMR), donors, and other stakeholders.

The BIRU program focuses on developing both biogas demand and supply. To stimulate farming household demand, the program conducts awareness-raising meetings and other promotional and marketing activities and provides access to credit, making it more economically feasible for farmers to invest in biogas. On the supply side, the program selects and trains partner organizations to become active biogas construction agencies that provide high-quality services to the biogas market.

Promotion and Marketing

The key to developing a sustainable biogas sector is convincing farmers of the benefits of biogas so that they demonstrate a strong willingness to invest in biogas services. If biogas is easily adopted by farmers, institutionalization of the promotion can easily be done by providing initial incentives to Construction Partner Organizations (CPOs), cooperatives, or farmer groups. If promoting the digesters is difficult, it may be necessary to engage commercial promotion/advertisement agencies, NGOs, or other organizations (including government), as well as the CPOs financially and/or in kind to conduct awareness-raising and biogas sensitization meetings to enhance interest.

Access to Credit

Most farmers cannot afford the US\$500 required upfront to purchase a six m³ biodigester, whose total cost is \$720, \$220 of which is subsidized. In 2010, the BIRU program successfully concluded lengthy negotiations with the Dutch RABO Bank Foundation (RBF), which agreed to provide 1.8 million in credits for the majority of the 8,000 planned biodigesters, with an attractive interest rate of 8 percent (effective). The first loan to a dairy cooperative

in Bandung for credit covering 1,000 digesters was actualized in only a few months. However, developing a credit mechanism, including its institutional aspects, for individual farmers proved more challenging. When developing promotional activities for farmers, a concrete credit system is a sine qua non, even if the interest rate is high.²⁰ The BIRU program learned that working with a large Indonesian banking agency that is able and willing to provide small loans to individual farmers is a better option for further upscaling.

Standardizing Technology and Skills Development

To develop the supply side of the biogas sector, the BIRU program selects the best biodigester model for the target area, provides research and development (R&D) for improving biogas appliances, implements quality inspection protocols, and provides user training. The program selects CPOs for training in biogas construction. Developing a pool of certified masons and supervisors permitted to build biodigesters certified by the BIRU program creates local ownership for the biogas technology, ensuring high-quality construction in the target area.

The program also focuses on developing the appliance manufacturing sector, which is the supplier of general construction materials (e.g., sand, cement, and PVC pipes), along with an array of specific parts, including the main gas valve, galvanized gas pipe, water drain, manometer, gas tap, and the biogas stove and lamp. With the exception of the main gas valve, all items can be produced locally.

Standardizing biogas technology and skills development is the responsibility of the MEMR. Educational institutes impart knowledge and skills through implementing training courses or developing curricula for vocational training at polytechnic and other schools. Basic skills development for biogas users is achieved through user training and bioslurry management training. A train-the-trainers approach is applied, whereby partner organizations are trained to disseminate knowledge, with support and monitoring provided by the BIRU program team.

Institutionalizing Biogas Education and Training

To ensure that high-quality human resources remain available beyond the lifetime of the program, BIRU has selected a center for biogas education and training. The

center ensures that those trained in biogas construction develop a strong awareness of quality and sense of responsibility to ensure that biogas users do not run a risk by investing in a biogas system. The Bandung-based Training Education Development Center (TEDC) has accepted the offer to receive biogas training for its staff and develop a curriculum for training staff of vocational schools. It is expected that these schools in the BIRU target areas will soon be able to provide theoretical and practical on-site training for their pupils.

Bioslurry Management Training

Training in bioslurry management can improve farmers' income while relieving pressure on the environment. Bioslurry has a high level of nutrients, making it an appropriate basis for composting. It can be applied on farmers' fields to enhance yields; it can be processed, dried, and sold or sold immediately to the private sector for processing. Ensuring appropriate use of bioslurry requires numerous interventions, including training in bioslurry use and processing, developing the value chain, meeting the logistical challenge of bioslurry collection, and developing private-sector entities to handle slurry processing and trade.

Gender Mainstreaming

Women and children benefit especially from the BIRU program, given that switching to biogas cooking reduces indoor pollution, is safer to use, reduces cooking time, and results in a cleaner cooking environment. A responsible gender approach is recommended to ensure that women are involved in biogas investment decisions, which can affect technical decisions (e.g., location of the digester and appliances). On the supply side, women play potentially significant roles as masons and bioslurry managers.

Strengthening Management of Biogas Sector Actors

To ensure the development of an independent, market-based biogas sector that is well run, partner organizations, tasked with constructing biodigesters and providing biogas services, must be institutionally strong. While larger cooperatives and other well-established organizations may only require limited support in developing their biogas divisions, newly created entities with limited management experience, organization, and structure are likely to require more intensive support and guidance. Such institutions may have difficulty accessing credit due to their limited bankability from the perspective of fund

20. Interest rates above 12 percent for cooperatives and 16 percent for individual farmers are usually considered high.

providers. Management support, R&D funding, awareness training, and other forms of capacity building will allow them to contribute to developing the value chain and local entrepreneurship, thus helping to build a sustainable biogas sector.

Partner Organizations

The BIRU program has three major types of partner organizations: (i) Construction Partner Organizations (CPOs), (ii) appliance manufacturers, and (iii) Lending Partner Organizations (LPOs). In addition, the program has worked with various government agencies interested in developing the biogas sector and private-sector companies.

Construction Partner Organizations

The development of the CPOs into professional business enterprises is a core goal of the BIRU program. CPOs (including dairy cooperatives, NGOs, and private-sector companies) are selected in areas where a significant biogas potential has been detected based on a market assessment. Selection of the CPOs is based on a set of criteria, as well as practical considerations (e.g., high cow density, availability of water and construction materials, availability of other potential partners, proximity to the field, existing networks, and readiness of local government).

The CPO recruits a team of masons based on prescribed selection criteria. The BIRU program provides an eight-day training session, including theory and practice, which results in the completion of a six m³ biodigester. Subsequently, the CPO begins building biodigesters, with every five masons having a supervisor responsible for maintaining quality of the work and monitoring progress. The CPO makes site visits to assess the eligibility of cattle farmers becoming biogas users. Basic data is registered on a pre-construction form, which is sent to BIRU for review; subsequently, a building permit and plant ID are issued, meaning that the digester is entered into the BIRU program database. The CPO and biogas user enter into a household agreement, which explains the user's rights and obligations, the BIRU subsidy, and the extent to which the farmer can provide materials and labor. After completing the biodigester, the CPO asks the user to sign a completion report (signed by both husband and wife), which, together with a copy of the household agreement, is sent to the BIRU program for registration in the database.

After at least six months, the CPO begins maintenance visits (within the following three years, at least two visits must be made). Upon receiving the CPO's invoice, the BIRU program does not immediately reimburse the organization entirely. Two small portions of the total payment are withheld until the maintenance reports are filed. In this way, the BIRU program keeps better track of maintenance, and the CPO has a commitment to the program. In addition to CPO supervisory practices and maintenance visits, the BIRU program maintains its own quality inspectors, who regularly check the digesters and file reports that are entered into a special database. With such comprehensive data, the BIRU program can score the quality of the digesters and work of the CPOs and masons. Well-scoring CPOs can expect extra benefits, while low-scoring ones can expect training or instruction to improve their results.

Appliance Manufacturers

Developing locally produced biogas appliances is an important part of the BIRU sector development strategy. To the extent possible, the program aims to use local manufacturers to reduce dependence on imported materials. Today, only one of the eight biogas appliances being made, the main gas valve, is imported. KITZ, the brand approved by the BIRU program, is made in Thailand (the brand is known to be imitated) and can be bought in nearly all Indonesian cities. Currently, the program has a limited number of local appliance manufacturers, comprising individual producers, organized home industries, and small and medium enterprises (SMEs). Even though most of the biogas appliances have a fairly low level of technical complexity, manufacturing durable and reliable products requires strong monitoring and accurate technical quality standards. The BIRU partners order such simple tools as mixers and galvanized gas pipes from local workshops. Most water drains, as well as gas taps and simple manometers are made by the company P. T. Khazana Bahari and sold to the other CPOs. Since manometer construction is quite easy, the company has offered to disseminate the scale and have partners make the product or outsource production. One or two other partners also make water drains.

Development of a manufacturing line of approved biogas stoves is a key part of the BIRU program. To date, the program has approved six biogas stoves made by four partners: P.T. Khazana Bahari, Butterfly in Malang, Utama Graha in Solo, and Metalindo in Bogor. An improved model is usually tested and evaluated before being approved. The stoves still exhibit some shortcomings and improvements are needed to satisfy users, who may

complain of corrosion or badly performing units. Indonesian manufacturers have done a good job in developing quality, gas-efficient biogas lamps, based on a few Chinese models. To date, the program has approved two biogas lamps made by P.T. Khazana Bahari and Butterfly. Addresses of these companies are available on the BIRU website.

Lending Partner Organizations

Lending Partner Organizations (LPOs) play the key role of providing access to financing for household biodigesters. Most LPOs are cooperatives, many of which are also CPOs. HIVOS engaged early on with the RABO Bank Foundation, which makes loans available at affordable interest rates. Only a limited number of suitable micro-finance institutions (MFIs) have been identified. Indeed, lack of available LPOs has proven to be a weak link in the BIRU program. More recently, the program has met with various potential funding institutions, including the United Nations Environment Programme (UNEP), Bank Mandiri, and BRI Syariah. As yet, a properly working credit mechanism has not been put in place. Clearly, the program would benefit from close cooperation with a nationwide bank that is able and willing to provide small loans directly to farmers—especially those in remote areas with low cow densities—at a reasonable, preferably subsidized, rate. This would offer the farmer an attractive package: biogas with a subsidy component and affordable credit, combined with a technical guarantee of three years, user training, and guidance on bioslurry management.

Developing a Self-Reliant Sector

To develop a more self-reliant, market-based biogas sector, the BIRU program limits support to its partners. For example, the subsidy support for investment subsidies is limited to 40 percent. Also limited is direct support to promote biogas partners' entrepreneurial efforts (e.g., awareness-raising meetings, development and dissemination of public outreach materials, special media events, and exhibitions). Finally, external support from government, donors, and the private sector is limited for direct investment subsidies on top of the one provided by the BIRU program.

Quality Control

It is vital that farming households receive appropriate training in biodigester management and maintenance. It requires discipline for users to consistently undertake

feeding (in the correct amounts and dung:water ratio), do regular checks, open the water drain every 10 days, and keep the stove clean. Quality control, including after-sales service, is also necessary to keep the biogas market growing. As previously mentioned, the BIRU staff members have a monitoring role as quality inspectors in relation to the CPOs, who are committed to making maintenance visits. CPO maintenance and BIRU inspection reports are entered into a comprehensive MIS, which provides an excellent overview of the technical quality of each digester, as well as the quality of each certified biogas constructor and CPO. By tracking which masons and CPOs do not keep up the required technical standards, decisions can be made for interventions (e.g., added technical or management training).

Standardization

Before being introduced to Indonesia, the fixed dome digester model had already undergone a process of intensive standardization over a 20-year period in many Asian and African countries. In 2011, the MEMR took the initiative to standardize the fixed dome model through a consultative process with various biogas actors, including the BIRU program. By late 2011, discussions had been finalized, and the MEMR confirmed that, in 2012, it would issue the standardized fixed dome model, enforce it, and begin standardizing various biogas appliances, including the biogas stove and biogas lamp.²¹

Cost-Cutting Strategies

The BIRU fixed dome design is cost- and production-efficient, which, using the BIRU construction approach, can be produced at fairly low cost while maintaining quality. A 2010 technical assessment indicated that a six m³ digester, if well-managed, can produce 1,300–2,300 liters of biogas per day, while an average family requires only about 1,200 liters to meet its daily cooking needs. This result led the BIRU program management to start recommending the four m³ digester for households with limited daily cooking times (less than four hours with one stove). Even so, the IDR 4 million required to invest in the four m³ digester, after the subsidy deduction, is beyond reach for many farming households. In addition, many cattle farmers lack the minimum required space, 24 m², for constructing the digester. However, producing a fixed dome made of bricks and concrete smaller than four m³ would not be cost-efficient and would violate technical standards. Recently, drawings have been made and accepted, showing a more creative way of dealing with the slurry pit layout to reduce the required space.

21. At an earlier stage, the fiber digester had been standardized.

Overcoming Upfront Costs

Creating a sustainable biogas market requires financing mechanisms to reduce high upfront costs for potential buyers. The level of investment incentive is based mainly on calculations regarding the return on investment for farmers; however, other factors also play a role. The BIRU program has opted for a flat subsidy of IDR 2 million (about US\$220), which represents about 37 percent of the market price for the smallest digester (4 m³) and 23 percent of the price for the largest one (12 m³). In addition to the investment incentive, access to credit/financing is a secondary option to reduce upfront costs. As mentioned above, the BIRU program has an agreement with the Dutch RABO Bank Foundation, which provides loans to cooperatives and microfinance agencies that can be used to make loans to biogas users at affordable interest rates. In areas where the program has not been able to create access to credit, traditional savings systems are a possible financing solution. In East Java, dairy farmers can obtain interest-free credit through their cooperatives' milk buyer, PT Nestle Indonesia. In addition, inputs from biogas users themselves (e.g., construction materials and labor) can lower expenses. For low-income groups, government agencies may provide partial funding for construction of units. Finally, in more remote and poorer areas, investment subsidies of up to 80 percent are provided directly to local funding partners by donors' corporate social responsibility (CSR) departments.

Lessons Learned

Development and penetration of the biogas market in a country as vast as Indonesia takes time. While it is relatively easy to convince wealthier farmers to invest in a biodigester, poorer farmers are more reluctant, despite high-quality construction standards and reliable after-sales service. Many farmers have been disappointed in the past by failed biogas systems. In addition, they tend to wait for government initiatives to provide support for farming innovations, for which credit is readily available. Even if interested, farmers tend to prioritize other production and consumption investments. For many, neither the immediate financial nor the non-financial gains are obvious. While they can imagine the benefits of spending less time collecting fuelwood or cooking, they are less aware of the potential benefits of a cleaner kitchen, better health, or a better environment. That said, interest in biogas continues to grow. As fuel subsidies become larger and more unwieldy, it is expected that farmers will increasingly become interested in the benefits of a quality biodigester constructed of high-quality parts and the availability of good organic fertilizer from bioslurry.

Scaling Up

The untapped potential for expanding Indonesia's household biogas market is quite large. Over the 2013–17 period, the BIRU program anticipates constructing another 30,000 biogas units. Ensuring the creation of a strong, market-based biogas sector requires addressing key technical, financial, and institutional issues identified during the program's first phase. In terms of technical innovations, a smaller yet efficient digester is being designed for farmers with only two cows and limited funds. Manufacturing will continue to focus on developing better-quality appliances, particularly the biogas stove. The program will work closely with a nationwide bank to extend credit to individual farmers. The average farming household will need a loan of about IDR 5 million at an effective interest rate below 12 percent, with a repayment period of up to five years. Under these terms, a farmer's monthly installment would be about IDR 100,000, which is less than the average monthly cost of cooking fuel plus chemical fertilizer. After five years, the farmer would still have 10 years of free use of the digester.

As envisaged, institutional localization can be achieved by establishing a local foundation dedicated to developing biogas or renewable energy in Indonesia. Setting up such a foundation can achieve local ownership, with HIVOS and SNV available to provide support for fundraising, management, technical assistance, and monitoring. If needed, the foundation could act as a coordinating and management entity for a carbon credit mechanism. A legal option is to have a company under the foundation function as the actual implementing agency. The Indonesian government will play a key facilitating role in supporting the foundation's work (e.g., introducing it to regional government branches and networks). The government can also play a mediating role where cooperation with other government agencies (e.g., husbandry, agriculture, public works, and environment) is required.

Financial autonomy and commercial self-reliance are long-term aspirations of the BIRU program; yet scaling up will not be possible without first providing considerable external funding. Over the next four years (2013–17), the additional 30,000 biodigesters will require about US\$16 million (including subsidies) in external funding. Farmers will invest a total of US\$20 million (30,000 x IDR 6 million, including interest); while carbon revenue, estimated at US\$2 million through 2017, can be used to train farmers or assist them with subsidies.²²

22. Carbon money is obtained from farmers who relinquish their credit rights to the program.

Developing a sustainable and viable, market-based biogas sector in Indonesia requires more time and investment. Localization of the program and credit component; phasing out of subsidies; and strengthening of partners and the profitability and viability of their business, appliance manufacturing, and bioslurry management are all areas deserving of further review and discussion to enhance program quality and scale-up. Developing the biogas sector in a decentralized way requires continued support of the program partners, especially in the initial stages, to ensure sustained, localized development in all target areas. Thus, the need for capacity building remains strong.

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Biomass Cookstoves in Indonesia: Case Study Summary²³

Today a majority of households in Indonesia continue to rely on solid biomass fuels to meet their daily cooking needs. Biomass resources are freely or cheaply available, particularly in rural areas, and are less costly than such alternate fuel choices as electricity or gas. According to recent surveys by the Renewable Energy, Environment, and Solidarity Group (GERES) and Yayasan Dian Desa (YDD), more than three-fifths of Indonesia's 23 million rural families, in addition to several million more households in semi-rural and urban areas, use biomass fuel. In all, 42 percent of the country's 59 million households or 24.78 million households—85 percent of whom live in rural areas—rely on biomass as their primary cooking fuel. The numerical majority of solid biomass users reside on the island of Java, Indonesia's most densely populated island; yet biomass use is proportionately higher in less developed areas, including islands in the eastern part of the country and rural areas generally.

Trends in Household Fuel Use

Recent household energy-use surveys conducted by GERES and YDD have sought to characterize biomass fuel and stove use in the provinces of Central Java and DI Yogyakarta. The surveys reveal that many households depend on fuelwood, supplemented by LPG and kerosene, for cooking. A family's choice of fuels depends on such factors as geography, the area's level of economic development, and local availability and cost of cooking fuel. Biomass use tends to be higher in lower-income

areas; for example, there are more biomass fuel users in Central and East Java, compared to West Java, where income levels are higher overall. In urban areas, households particularly favor LPG as a result of the Indonesian government's recent Kerosene-to-LPG Conversion Program. Urban areas usually benefit from more developed fuel access and distribution networks, which make cleaner fuels like LPG easier to obtain. Despite urban-rural disparities and geographical variations in fuel choice, biomass is likely to remain a key component of the country's household fuel mix for years to come.

Household Air Pollution and Incomplete Combustion of Biomass Fuel

Although biomass accounts for 70 percent of household energy consumption in Indonesia, it is being used inefficiently. Owing mainly to the use of traditional biomass stoves, a significant amount of potential biomass energy is wasted during the combustion process. As a result, the more than 24 million households that rely on the traditional biomass cooking technology are exposed to large amounts of household air pollution (HAP). Exposure to pollutants generated from the incomplete combustion of household fuels has been associated with the increased risk of acute lower respiratory infections (ALRI), including pneumonia, chronic obstructive pulmonary disease (COPD), and tuberculosis (TB). The World Health Organization (WHO) has found strong evidence linking solid

23. This annex summarizes the draft report, "Biomass Fuel Use in Yogyakarta and Central Java, Indonesia: A Case Study," prepared by Yayasan Dian Desa (YDD) for the Indonesia Clean Stove Initiative in June 2012.

fuel cooking with an increased risk of ALRI in children under age 5. In Indonesia, ALRI currently accounts for 20 percent of all deaths among children 0–14 years of age. A recent meta-analysis found that children living in households using solid fuels have 1.78 times the odds of ALRI compared to children in homes without solid fuel use (Dherani et al. 2008). Recent research also highlights the many potential health benefits associated with improved stove combustion and reduced exposure to cooking smoke (Smith, Mehta, and Maeusezahl-Feuz 2004; Fullerton, Bruce, and Gordon 2008; Rehfuess, Bruce, and Smith 2011).

The YDD survey showed that 82 percent of households in Indonesia cook inside a kitchen. In 45 percent of Indonesian households, the kitchen is an integral part of the house, meaning that cooking smoke enters all house spaces. Although no detailed study has been conducted on the relationship between HAP and kitchen layout, it was found empirically that smoke becomes highly concentrated in kitchens that are closed with little or no ventilation. Such associated HAP mainly affects women, who are usually the primary cooks, and their young children, who stay close to their mothers in the cooking area. Indonesia’s Ministry of Health has issued a decree that provides guidelines on achieving healthier indoor household air. Decree PMK no. 1077, 2011 raises key issues about biomass fuel consumption and its impact on health, even mentioning the need to develop appropriate technologies, such as smoke-free stoves, to treat it. It is well established that LPG will not reach all Indonesian households over the next decade, given the prohibitive cost of extending the LPG network to more remote and sparsely populated rural areas. Thus, any successful intervention will need to provide alternatives to households’ current methods of burning biomass fuel.

Status of Improved Cookstove Technology

Improved cookstove technology has been known in Indonesia since the early 1980s. The first improved stove was the owner-built mud stove. Until the 1990s, few organizations addressed matters relating to improved stove technology. YDD—among the most active nongovernmental organizations (NGOs) promoting improved cookstoves—was the first NGO to introduce the mass production of pottery stoves, as well as the concept of using existing supply chains to move improved cookstoves through the commercial market. Since the early 1990s, Indonesia’s Ministry of Energy, through the office of the Directorate General of Electricity and New and Renewable Energy (DJLPE), has focused on the benefits of improved stove

technology. In 1991, the DJLPE opened a competition to find the best performing cookstove. The winner was a two-pothole pottery stove developed by YDD, known as the Sumarni stove, later referred to as the SAE stove. Although the DJLPE and YDD wanted to disseminate the SAE stove to other areas of the country, a market was lacking for the product. Subsequently, various NGOs initiated their own improved stove programs; however, those were small in scale, scattered, and covered only limited geographic areas. In addition, stove testing did not include emissions, focusing only on stove efficiency and thermal-heat and fuel-saving characteristics.

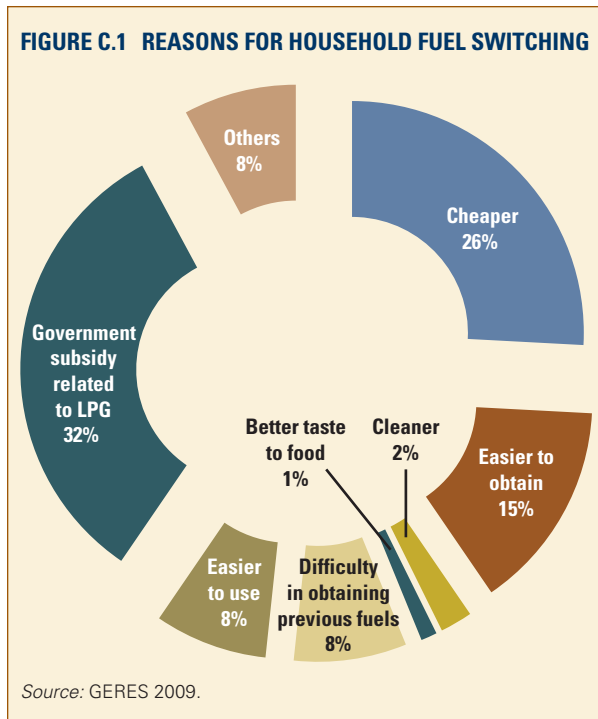
Currently, Indonesia has various improved, or even advanced, stove designs that may have higher levels of efficiency; however, due to a lack of testing, the actual performance of these stoves remains unknown. Various private-sector actors who recently embarked on producing advanced stoves have since determined that market demand is insufficient to sustain new stove production. Local producers make a limited number of advanced stoves based on the orders they receive; however, such stoves are not yet available on the open market.

Characteristics of Biomass Fuel Use in Central Java and Yogyakarta

In Central Java and DI Yogyakarta, the rate of fuelwood use is currently 40 percent; yet the region’s high population density means that this percentage represents a large number of households. An estimated four million households in these areas still rely on biomass as their primary household fuel. Owing to the Indonesian government’s Kerosene-to-LPG Conversion Program, which heavily targets provinces in Central Java and Yogyakarta, LPG is taking a greater market share, while kerosene use has decreased sharply.

Drivers of Household Fuel Choice

Both the YDD and GERES surveys demonstrate that a household’s fuel choice is based mainly on accessibility and cost. For example, in the YDD survey, “easy to obtain” and “economy” were each cited by 38 percent of respondents as reasons for choosing cooking fuels; “availability” and “safety” were each cited by 13 percent of respondents. In the GERES survey, the reasons respondents gave for switching fuel use were also related mainly to accessibility or availability and cost; 26 percent of respondents said they were looking for a cheaper fuel, 32 percent switched because of subsidy changes (also related to cost), and 15 percent changed because the new fuel was easier to obtain (figure C.1).



In rural areas of Central Java and Yogyakarta, most survey respondents reported fuelwood as their preferred cooking energy because it is abundantly available, usually free of charge, and alternate fuels may not be available. The GERES survey found that, in rural areas, 74 percent of respondents use fuelwood, followed by kerosene (19 percent) and LPG (3 percent). In urban areas, only 26 percent of respondents use fuelwood as their main cooking fuel. In Yogyakarta, 80 percent of rural households use fuelwood as their main cooking fuel, although kerosene and LPG are frequently used to supplement it. Very few households—mainly those in peri-urban or urban areas—purchase their fuelwood.²⁴ This reality makes household expenditure for a megajoule of usable energy of fuelwood effectively zero and thus the most cost-effective option for households within easy access of collecting fuelwood.

Obtaining Fuelwood and Division of Labor

The GERES survey results show that a majority (69 percent) of households that use solid biomass for cooking—mainly lower-income households—collect it from around their houses or in their fields. Only a small percentage (9 percent) of families in Central Java obtain their fuelwood from the forest; among those that do, fuelwood

collection consists mainly of cutting branches and twigs (71 percent) or picking up dead wood lying on the forest floor (20 percent); only 9 percent involves cutting down whole trees. Thus, fuelwood collection is done sustainably and is not contributing to large-scale deforestation. The survey shows that the gender division of labor is quite well-divided in these provinces. About three-quarters of fuelwood collection, considered a heavy task, is done by the household's father figure or adult male over 25 years of age; while one-fifth is done by women over 25 years of age. Among children, sons have more responsibility (6 percent) than daughters (1 percent).

The average quantity of fuelwood collected per trip shows a large amount of variation. The average small-quantity collection is about 25 kg per trip, with 86 percent carried by hand (either on the collector's back or shoulders) or by bike. The average large-quantity collection is 1,630 kg, usually carried on a small truck. The overall average collection per trip is 212 kg. Given the distance needed to travel to collect fuelwood (up to 1 km), the vast majority of households collect in small quantities.

Features of Household Cookstove Use

Families that use biomass stoves as their primary stove often have a second stove in their household, which is usually fueled by kerosene, gas, or electricity (e.g., rice cooker). In most cases, wood-burning stoves are the household's primary stove. Other stoves, such as an LPG one, often function as a family's secondary stove, used for fast or small-quantity cooking (e.g., boiling water to make tea or coffee).

Households generally use two methods to obtain their primary stove. About 45 percent make their own out of mud or brick and cement, based on their own knowledge. The other 55 percent generally buy their stoves in nearby markets or small shops. The types of stoves vary, and some households use more than one. The survey results show that mud stoves (i.e., homemade mounds of mud formed in accordance with the user's knowledge) are the most commonly used primary stove, cited by 40 percent of respondents; 33 percent use cement to make their own stoves, while 18 percent use other materials, including stone, scrap metal, and recycled oil drums. As mentioned above, many households use LPG stoves as their secondary stove. Like fuel choice, the types of stoves selected are closely related to level of household income.

Among the households that purchase their stoves, 49 percent buy in the local market, 21 percent purchase from mobile traders, 16 percent buy directly from the producer, and 12 percent purchase from local shops.

24. This analysis found that, when fuelwood is purchased, it is not the cheapest form of cooking energy. Per megajoule of potential power, the upfront cost of wood energy is lowest; however, burning fuelwood subjects it to the inefficiency of wood-burning cooking appliances and subsequently a large loss of usable cooking energy.

The stoves available on the market tend to be of traditional designs and inefficient. The average lifetime of a household's primary cookstove is 3.7 years. However, when larger groupings of the average stove lifetimes are observed, it is found that stoves are commonly used for either 1–2 years or 4 or more years. These figures may reflect that homemade stoves are repaired on an ongoing basis and can thus remain usable for many years. Also, there is a tendency for households to believe that a stove can continue being used as long as it functions.²⁵

Low Stove Efficiency and Limited Awareness of Incomplete Fuel Combustion

Most traditional biomass stoves used for cooking are notably inefficient. The GERES survey found that, when wood is actually burned in a kitchen stove, only a portion of its potential energy is converted into usable heat for cooking, with the rest lost to heat and pollution. Indeed, such incomplete combustion in most biomass stoves often converts just 15 percent of the fuel's potential energy into usable energy for cooking. This figure correlates closely with national data, which shows that fuelwood (comprising nearly 75 percent of Indonesia's national household energy share) serves about the same number of households as LPG (comprising only 9 percent of the nation's household energy share) owing to its low efficiency. Thus, by improving the efficiency of biomass stoves, more primary energy can be obtained from the biomass burned and thus save energy overall.

Households generally have limited awareness about the inefficiencies and health risks associated with traditional biomass fuel use, explaining why demand for traditional cookstoves remains quite high. Smoke in the kitchen is considered a common occurrence. However, when asked for more detail, women who serve as the primary household cooks identified some inconveniences related to smoke production during cooking.

Cookstove Supply Chains in Central Java and DI Yogyakarta

In 2012, YDD conducted a survey that sought to characterize cookstove supply chains in Central Java and Yogyakarta. Completed in the same areas of the 2009 GERES biomass survey, the YDD survey analyzed the business

activities and behavior of cookstove producers, wholesalers, and retailers in order to better understand the trends and issues affecting cookstove supply. These three categories of the cookstove supply chain were questioned about their business practices, the price and cost of their business transactions, challenges faced, and their knowledge about and interest in new and/or improved cookstove models.

The survey found that the regional demand for cookstoves is higher than the area's production capacity, especially for fuelwood stoves. This is demonstrated by the willingness of wholesalers and retailers to pay cash for stoves, with some even making advance payments to obtain their stove supplies. In Central Java, annual stove production is about 77,500, while biomass fuel users total some 3.5 million. Despite the long usable lifetime of a stove, typically 3.7 years, there remains a large gap between cookstove supply and demand in Central Java. By contrast, in Yogyakarta, supply and demand are more balanced, with about 267,300 stoves produced each year to supply some 415,200 biomass-using families. Demand for biomass-burning technology remains quite high for the foreseeable future, and has the potential to generate profitable businesses for cookstove producers, wholesalers, and retailers.

Strong cookstove supply chains through which biomass stoves of various designs are sold already exist in Central Java and Yogyakarta. The materials used to make the stoves vary from pottery to stone, while the stoves' main fuel types tend to be wood, charcoal, and sawdust. Wood is the most commonly used fuel and also the most in demand, reflecting the resource's abundant availability in these areas.

Producers

Cookstove producers, scattered among two districts in Yogyakarta province and several districts in Central Java, tend to run small-scale, family-based businesses using traditional methods. The YDD survey results show that 94 percent of producers are continuing their family businesses, which are passed down from one generation to the next, and that 93 percent of the stove production process is done manually. These family businesses are also managed traditionally, with no records or bookkeeping and no mechanism for recording production inputs (e.g., the cost of labor, materials, firing, and space used). The survey results show that 89 percent of producers do not calculate their labor costs, and 63 percent do not even calculate the cost of input materials. The only business calculations involve the cash payments they need to produce their next stoves. Using such traditional business

25. Ninety-three percent of survey respondents reported using their primary stove every day of the week.

practices, it is not possible to calculate the cost of constructing a single stove, which may explain why stove prices in the local markets tend to be quite low. Many stoves lasting six months to a year cost less than IDR 10,000.²⁶

Most producers do not employ paid workers and tend to work in the production center themselves. Though most do not actively market their products, they do not experience any problems in selling their products due to their well-established relationships with stove wholesalers and retailers. Patterns of payment and business transactions among producers, wholesalers, and retailers indicate that the stove market, however small-scale and locally based, is quite healthy. The Indonesian government's Kerosene-to-LPG Conversion Program does not seem to have influenced the traditional stove market. According to 87 percent of the producers surveyed, biomass stove sales have remained stable since the conversion program began in 2007, while 3 percent reported increased demand. Sufficiently high demand for biomass stoves means that a number of wholesalers and retailers must issue advances in order to obtain their stove supplies.

Among the traditional artisanal producers surveyed, about 80 percent said they construct fewer than 100 stoves per month. Their operational weaknesses include limited work space, labor, and capital. Most reported having a working area of about 50 m², a limitation that may affect their readiness to produce new stove types or designs. Nearly half of the producers interviewed do not have their own kilns, which may also limit production capacity. In addition, the geographic area of coverage tends to be small, with less than 9 percent of producers in Central Java selling their stove products outside their province or between provinces and none from Yogyakarta doing so.²⁷

Given that most producers lack extensive access or networks beyond their home village, few are aware of new cookstove designs. Even so, nearly three-quarters of the producers interviewed expressed interest in producing a new stove design. Most tend to believe that exploring new cookstove models would require stove samples, market demand, equipment, materials, and capital.²⁸

26. About half of all wood and charcoal stoves are sold from the producer at IDR 4,500 or less; about 20 percent sell for IDR 4,600–7,000, and only 6.4 percent sell for more than IDR 40,000. The most expensive stoves, which tend to be constructed of stone, sell for about IDR 60,000 or more.

27. This may indicate that demand for stoves in Yogyakarta exceeds the production capacity of the province's local stove producers.

28. The request for stove samples should be carefully weighed since, without appropriate training and quality control, an imperfectly produced stove could result in a "look-alike" version that appears to be improved without providing the associated benefits.

Wholesalers

More than half of wholesalers have been in the stove business for more than 30 years, demonstrating that cookstoves are a good business option and that the market is stable. Seventy-eight percent of wholesalers pay producers cash, while 8.5 percent make advanced cash payments before receiving stoves from the producers, demonstrating that (i) market demand is good enough that wholesalers are willing to pay cash, even in advance and (ii) producers may not have enough capital to produce and stock stoves.

The majority of wholesalers are small-scale; 44 percent of those surveyed supply stoves to 2–6 retailers. About four-fifths of the wholesalers interviewed reported purchasing and selling 50 or fewer stoves per month. The small minority of larger-scale wholesalers may supply more than 22 retailers. Forty-two percent of wholesalers use their own homes for stocking and selling the stoves. Others pick the stoves up from the producer rather than maintaining a stock and transport them directly to the retailers. Still others double as retailers; that is, they maintain stocks at home and also sell stoves in the market or small shops. The per-stove price margin taken by the wholesaler ranges from IDR 1,000 to 25,000, depending on the stove model and size. The business models used are predominately direct and traditional, with most wholesalers preferring cash payments.

Most wholesalers bear the cost of transporting the stoves from the producers. However, in cases where producers deliver the stoves directly to the wholesalers, the costs tend to be divided. To transport a stove shipment, wholesalers typically use motorbikes equipped with a bamboo container on the back or rented pick-up trucks. Thirty-eight percent of the wholesalers interviewed reported difficulty in maintaining stove quality during transport, indicating that many stoves break in transit, and producers do not usually make guarantees or offer to replace the broken ones. In addition, 21 percent of wholesalers had difficulty transporting the stoves, mentioning that renting the pick-up trucks used to transport them adds to the cost.

Most wholesalers have limited knowledge about the performance of the stoves they sell. When asked about stove performance related to efficiency, 79 percent of respondents said they did not know. Likewise, when asked which stove was the more durable, 81 percent said they did not know. Wholesalers' limited knowledge about cookstove performance is further demonstrated by their not providing buyers any advice on which stoves they consider worthwhile or a good choice.

Like producers, wholesalers have little knowledge about new stove designs; however, among those surveyed, the vast majority (98 percent) expressed a willingness to sell new types of biomass stoves if doing so would be profitable. Eighty-nine percent estimated the price of such a cookstove at more than IDR 65,000, while 11 percent said the price would be more than IDR 35,000.

Retailers

Cookstove retailers are variously located in markets, shops, and smaller shops (*warungs*). Others travel from house to house on motorbike or bike to sell their stoves. Among the retailers surveyed, about half have been involved in cookstove retailing for at least 20 years. Forty-seven percent depend on wholesalers to obtain their stove stock, while 51 percent buy directly from producers. The business relationships between retailers, wholesalers, and producers are informal, based on mutual trust, with most transactions conducted in cash payments. Just 0.6 percent of producers—mainly the largest producers who sell across provinces—utilize formal contracts. Retailers that receive their stove supplies directly from producers typically cover the transport costs, while wholesalers that supply retailers usually bear such costs. More than four-fifths of retailers sell 10 or fewer stoves per month, while less than 1 percent sell 30 or more.

Like wholesalers and producers, retailers have limited knowledge about stove performance and are primarily concerned with how many stoves they are able to sell. Nearly three-quarters of the retailers surveyed were unaware of which stoves they sell are the most durable or efficient. Also similar to wholesalers and producers, retailers' knowledge about new stove designs is quite limited; at the same time, the majority (70 percent) expressed interest in learning about new stove designs.

Cookstove Supply Chain: Summing Up

There is limited knowledge about stove performance throughout the supply chain, with most producers, wholesalers, and retailers primarily concerned with selling as many stoves as possible, without regard for the stoves' efficiency or fuel-saving features. Most of these actors lack a strong concept of what an improved or clean stove might be. Thus, a new stove model's acceptability to the

supply chain would depend on its ability to be sold. Price would also factor into the decision to sell a new stove design since customers are used to purchasing stoves at quite low prices. Finally, the survey results demonstrate that introducing a new stove model would require training supply-chain members in production design and quality, as well as business development. Given the strength of the existing traditional supply chain, it is vital to involve these actors in the distribution of clean stove designs.

Scaling Up

A sustainable intervention to influence clean biomass fuel use in Indonesia should involve the growth and support of a healthy improved stove market driven by user demand and supplied with clean stoves of standardized quality. Such a successful intervention will need to involve areas of institutionalization, public knowledge and education, stove supply development, and innovative financing methods, all of which will be improved and enforced by ongoing research and development (R&D). Cooperation among various sectors and levels of government, as well as key public- and private-sector players, should be institutionally embedded within the government and promoted by a national clean cookstove network, which has access to similar international networks. National standards of efficiency and testing protocols for biomass combustion methods must be established, possibly through one or more centralized stove testing centers. User demand for clean stoves should be fostered through public-awareness campaigns and events, while bolstering stove supply should be a regionally sensitive effort emphasizing quality control and achieving set standards of efficiency, probably involving training and business development to members of the existing stove supply chain. The clean stove models and available technologies should continue to be developed and diversified through R&D. Financial intervention and possible subsidies can be justified by the negative externalities associated with indoor biomass combustion, but should be developed carefully using a results-based approach.

All of these principles should be channeled into a pilot program undertaken in two geographic areas of Indonesia: one with a pre-existing supply chain and one without. The pilot program should be carefully monitored and evaluated in order to better plan a future at-scale national intervention.

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