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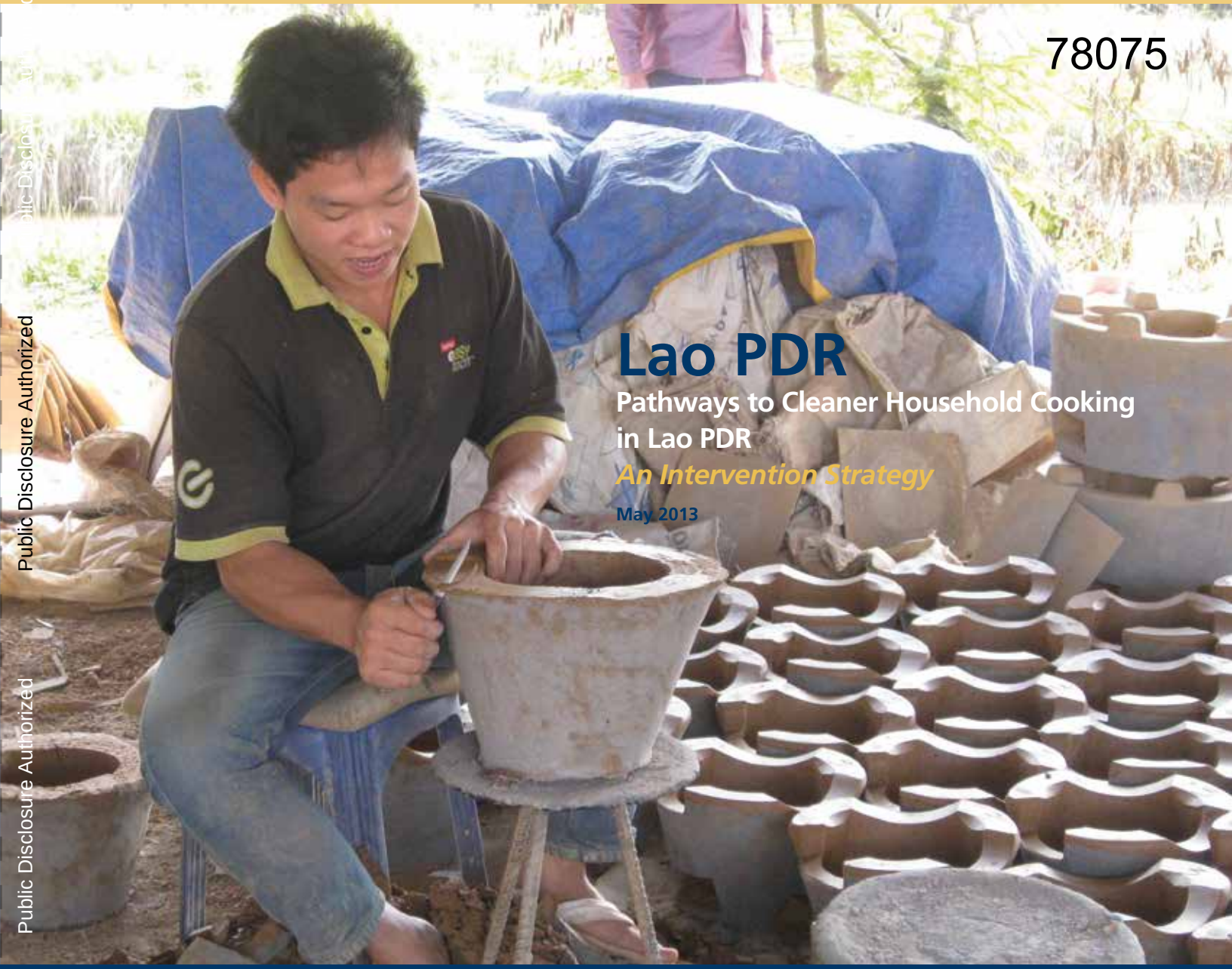

Lao PDR

Pathways to Cleaner Household Cooking in Lao PDR

An Intervention Strategy

May 2013

ASTAE

Australian AID

The International Bank for Reconstruction and Development/
The World Bank Group
1818 H Street, NW
Washington, DC 20433
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Foreword

Today the vast majority of households in Lao People's Democratic Republic (PDR) continue to rely on fuelwood, in the form of firewood and charcoal, as their main source of cooking energy. The widespread use of fuel-inefficient biomass cookstoves has increased the health risk from indoor air pollution for those who spend many hours in the household cooking area, primarily women and their young children, in turn, adding to public health expenditures and global greenhouse gas emissions. Moreover, the opportunity cost of collecting fuelwood deprives women of time they might otherwise use for education or other productive activities. On the supply side, cookstove production is slow and labor-intensive, while smoke generated from poorly designed kilns degrades the quality of the local environment.

These phenomena persist in Lao PDR despite the country's remarkable development achievements in recent decades. From 1995 to 2011, electricity connections increased fourfold, from 18 percent to 72 percent. By 2011, the country had achieved lower-middle-income status within the World Bank Group. Over the past six years, the Lao economy has experienced commendable growth, with gross domestic product rising nearly 8 percent a year on average. Such robust growth has been accompanied by a significant reduction in the incidence of poverty. At the same time, economic development has relied heavily on the growth of mineral and energy exports; and agriculture, which accounts for nearly three-quarters of all employment, is growing at only 4 percent annually, accelerating rural-urban disparities.

This situation is not atypical. Even in such advanced developing economies as China and Mexico, where most people have access to electricity, a large majority of residents continue to rely on solid biomass fuels to meet their daily needs. In China, some 700 million people out of 1.3 billion, including most rural residents, continue to use solid fuels for cooking and heating. Similarly, virtually all of Mexico's rural population—about 27 million people—still depend on biomass for cooking. Various socioeconomic factors account for rural households' reluctance to adopt modern cooking methods; key among them are affordability, along with fuel availability and accessibility and cultural acceptability.

The prospects for moving toward modern forms of cooking energy in Lao PDR remain limited, particularly in rural areas where there is an abundance of readily available firewood that can be freely collected from the local environment. By contrast, most households consider electricity too expensive for cooking, and the use of liquefied petroleum gas (LPG) is limited to financially better-off urban areas located close to the LPG distribution networks. Thus, one can expect that firewood and charcoal will remain the dominant cooking fuels in Lao PDR in the years ahead, suggesting an urgent need to introduce and scale up the supply and use of cleaner-burning, more fuel-efficient biomass stoves.

Stove markets in Lao PDR are highly competitive, and there is a fairly high turnover rate. Households expect little from cookstove performance and could afford to pay significantly more for more durable models. Most consumers have no knowledge of the expected technical standards for improved cookstoves, and many are unaware of the health risks linked to indoor air pollution caused by biomass cooking smoke. On the supply side, artisan stove producers are unaware of the energy-efficiency levels of the stoves they make. They lack technological know-how, as well as training in business management and marketing.

In light of these supply- and demand-side realities, the intervention strategy presented in this report focuses on setting and enforcing cookstove standards, raising the awareness of household consumers, building producer capacity, and improving market mechanisms and value chains. The strategy also envisions a scaled-up niche market for biogas cooking, proposing the piloting of an innovative financing mechanism for qualified farming households with livestock. This report reflects the commitment of the World Bank Group and its partners in helping the Lao government to advance pathways to cleaner cooking solutions that will contribute to poverty reduction, sustainable development, and inclusive low-carbon growth.

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Foreword

The Government of the Lao People's Democratic Republic (Lao PDR) is committed to providing all of its citizens pathways to cleaner cooking solutions. The 2011–25 roadmap mandated under the Renewable Energy Development Strategy, approved in 2011, promotes cleaner household energy, focusing on better biomass stoves and biogas systems. Currently, biomass cooking fuels, including mainly wood and charcoal, comprise an estimated 70 percent of total energy consumption. Recognizing the important health and environmental implications of such high dependence on biomass energy, the Renewable Energy Development Strategy promotes the development and market deployment of fuel-efficient and culturally appropriate biomass stoves, whose estimated technical potential could exceed 900,000.

Although our country lacks such conventional energy resources as oil and natural gas, it is endowed with an abundance of renewable energy resources. Our country's large biomass potential includes energy crops; organic waste, including residue from agriculture and forestry production and byproducts of the agroforestry industry; and municipal waste. It has been estimated that livestock waste for biogas production alone could generate the equivalent of 500 gigawatt hours of electricity each year. Our government aims to significantly scale up previous efforts to develop household biogas systems using livestock waste, which could significantly reduce imports of liquefied petroleum gas (LPG) and firewood and charcoal consumption.

This intervention strategy is closely aligned with the objectives and related health concerns of our government's Renewable Energy Development Strategy. We are grateful to the World Bank team, who helped us focus on market mechanisms and business models, without the use of government subsidies, which can ensure the market availability of better cookstoves and program sustainability. In October 2012, we further strengthened our commitment to working with the World Bank and other partner organizations by establishing a task force for clean cookstoves and biogas. This task force is chaired by stakeholders across multiple sectors, including various ministries, academia, nongovernmental organizations, and the private sector. These coordinated institutional arrangements, together with the help of our World Bank team and other partner organizations, have well prepared us for implementing the next steps suggested in this report.

Hatsady Sysoulath
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Lao People's Democratic Republic

Acknowledgments

This intervention strategy report was prepared through the close consultations and collaborative spirit among all stakeholders involved in the Clean Stove Initiative (CSI) for the Lao People's Democratic Republic (PDR). The World Bank task team leader was Jie Tang, Senior Energy Specialist, Sustainable Development Department. The team consisted of Voravate Tuntivate (author of this report), Natsuko Toba (co-task team leader and secondary author), Patricia Ramos Peinado, Veasna Bun, Nuyi Tao, Jaemin Song, Souksavanh Sombounkhanh, and Teri Velilla. Dejan Ostojic, Program Leader of the CSI for the East Asia and the Pacific Region, provided overall guidance. Annette Dixon, Country Director for Lao PDR, Keiko Miwa, Country Manager for Lao PDR, and Julia Fraser, Sector Manager for Lao PDR, provided overall support. The CSI is being undertaken by the Infrastructure Unit of the Sustainable Development Department, East Asia and Pacific Region, under the overall guidance of John Roome, Sector Director, and Vijay Jagannathan, Sector Manager. Aldo Baietti, Lead Infrastructure Specialist and Program Manager of the Australian Agency for International Development (AusAID)-East Asia and Pacific Region Infrastructure for Growth Trust Fund, also provided guidance.

The team wishes to thank AusAID for its generous funding support through the East Asia Trust Fund. For their cooperation in developing the intervention strategy and hospitality, the team thanks the Institute of Renewable Energy Promotion (Ministry of Energy and Mines), Department of Livestock and Fisheries (Ministry of Agriculture and Forestry), Ministry of Science and Technology, Ministry of Health, Ministry of Finance, National University of Laos, Asian Development Bank, Netherlands Development Organisation (SNV), Lao Women's Union, Lao Institute for Renewable Energy, and Participatory Development Training Center.

The team is grateful to the many other colleagues who provided helpful comments and information. Among them are peer reviewers Sameer Akbar and Srilata Kammila of the World Bank, Sumi Mehta of the Global Alliance for Clean Cookstoves, and Konesawang Nghardsaysone, who provided additional data. The team also extends appreciation to Bounthanong Phonethipasa, who conducted a field survey, and Rebecca Kary, who provided initial editorial support. Finally, the team thanks Norma Adams for editing the final version of the report.

The financial support of the Asia Sustainable and Alternative Energy Program (ASTAE) is gratefully acknowledged. Created in 1992 as a Global Partnership Program, ASTAE's mandate is to scale up the use of sustainable energy options in Asia to reduce poverty and protect the environment through promoting renewable energy, energy efficiency, and access to energy. Currently, ASTAE is funded by the Government of the Netherlands, the Swedish International Development Cooperation Agency (SIDA), and the U.K. Department for International Development (DFID). ASTAE and AusAID will co-finance implementation of the CSI intervention strategy.

Acronyms and Abbreviations

ADB	Asian Development Bank
AusAID	Australian Agency for International Development
BPP	Biogas Pilot Program
CSI	Clean Stove Initiative
DEDE	Department of Alternative Energy Development and Efficiency
DLF	Department of Livestock and Fisheries
ESMAP	Energy Sector Management Assistance Program
FAO	Food and Agriculture Organization
GACC	Global Alliance for Clean Cookstoves
IAP	Indoor Air Pollution
ICBS	Improved Charcoal Bucket Stove
IREP	Institute of Renewable Energy Promotion
LAK	Lao Kip (currency)
Lao PDR	Lao People's Democratic Republic
LECS	Lao Expenditure and Consumption Survey
LPG	Liquefied Petroleum Gas
LWU	Lao Women's Union
M&E	Monitoring and Evaluation
MAF	Ministry of Agriculture and Forestry
MEM	Ministry of Energy and Mines
MOF	Ministry of Finance
MOH	Ministry of Health
MONRE	Ministry of Natural Resources and Environment
MOST	Ministry of Science and Technology
NGO	Nongovernmental Organization
NUOL	National University of Laos
PAFO	Provincial Agriculture and Forestry Office
PM_{10}	Particulate Matter up to 10 micrometers in size caused by smoke
PV	Photovoltaic
R&D	Research and Development
REF	Rural Electrification Fund
RENMI	Renewable Energy and New Materials Institute
RWEDP	Regional Wood Energy Development Programme
SNV	Netherlands Development Organisation (Stichting Nederlandse Vrijwilligers)
UN-Habitat	United Nations Human Settlements Programme
WHO	World Health Organization

Currency Equivalents

Currency Unit = Lao kip

LAK 8,000 = US$1

Executive Summary

Today the vast majority of households in the Lao People's Democratic Republic (Lao PDR) rely on solid fuels, primarily firewood and charcoal, as their main source of cooking energy. Census data show that household use of firewood and charcoal for cooking declined only 3 percent between 1995 and 2005. Over that period, a sizeable portion of households, particularly those in more economically advanced urban areas, switched within the fuelwood category, from firewood to charcoal. But as of 2005, close to 90 percent of rural households and well over half of urban ones still depended on firewood to meet most of their cooking needs.

The prospects for using modern fuels as the main source of household cooking energy remain quite limited. Although some high-income urban households have begun using liquefied petroleum gas (LPG), the retail price is high relative to household income. The fuel must be imported, and the distribution network is expected to remain limited to major cities along the border with Thailand and perhaps Vietnam. Similarly, the transition to electricity for household cooking energy has been difficult despite the steady rise in electricity service coverage. Indeed, from 1995 to 2005, electricity as the main source of cooking energy among urban households declined from 10.4 percent to just 3.8 percent, reflecting a steady rise in the retail electricity tariff for cost recovery. Given the high prices of LPG and electricity, combined with the abundance of readily available firewood, it is likely that fuelwood will predominate as a source of household cooking energy in the foreseeable future.

Continued reliance on fuelwood for household cooking underscores the vital role of improved cookstoves in mitigating the health risks from exposure to indoor air pollution (IAP), especially among women and children. Smoke resulting from the incomplete combustion of solid fuels using low-quality stoves in poorly ventilated kitchens contributes to IAP, presenting a significant health hazard to those who spend long hours in the kitchen or cooking area, usually women and their young children (Ekouevi and Tuntivate 2011). A 2007 IAP study conducted in Lao PDR confirms the strong association between high levels of indoor air pollutants and respiratory illness in women and children (Mengersen et al. 2007). Although biomass combustion is not the only indoor activity that contributes to IAP, the study found that concentrations of particulate matter (PM_{10}) and nitrogen dioxide (NO_2) were significantly higher in houses where wood-burning stoves were used, compared to those that cooked with electricity.

The 2011–25 roadmap of the Government of Lao PDR's Renewable Energy Development Strategy identifies improved cookstoves and biogas systems as specific areas for promotion and development. The government recognizes that development of renewable energy is key to ensuring national energy security, socioeconomic development, and environmental and social sustainability. The Renewable Energy Development Strategy promotes policies that focus on small power development for self-sufficiency and grid connection, biofuel production and marketing, and the development of other clean energies (Lao PDR 2011).

The Clean Stove Initiative (CSI), funded by the Australian Agency for International Development (AusAID), contributes to achieving the goals of the Renewable Energy Development Strategy, including its related health concerns. Lao PDR, along with China, Mongolia, and Indonesia—all countries where most households use traditional biomass for cooking, with high numbers of premature deaths attributed to air pollution from cooking with solid fuels and where the World Bank has active clients—were selected for the study. The CSI in each country is implemented in four phases. The first one centers on stocktaking review and market study, followed by development of the intervention strategy in close consultation with government and other stakeholders. The second implements the intervention strategy, focusing on institutional strengthening, capacity building, and raising public awareness. The third implements pilot programs to demonstrate the effectiveness of the institutional, policy, and market development measures in selected areas; while the fourth evaluates their impact and generates lessons to be reviewed with government and other stakeholders and disseminated through a regional forum (World Bank 2011).

This study is the key activity under the first phase of the CSI for Lao PDR. Its broad aim is twofold: (1) taking stock of the current status of IAP and household cookstove use in Lao PDR and (2) proposing an effective intervention strategy to promote improved cookstoves. Stocktaking activities included a case study (i.e., CSI field survey),

while development of the intervention strategy included stakeholder consultations and two consultation workshops. The CSI field survey, conducted in three selected provinces and Vientiane capital, consisted of (1) a household cooking energy survey conducted separately in peri-urban and rural areas and (2) a market survey of biomass cookstoves and the supply chain. In addition to the field survey results, the study relied on a range of published data, interviews with government officials and field experts, and results of two consultation workshops.

Findings from the CSI field survey in Lao PDR confirm that women and young children living in households that use fuelwood for cooking comprise the highest IAP risk-exposure group. Contributing IAP risk factors include whether the cookstove has a chimney or hood, household cooking practices, kitchen ventilation, and family members' awareness of the link between IAP and cooking smoke.

Although improved cookstoves are not yet available on the market in Lao PDR, the CSI stocktaking activities reveal that the technical potential could be as high as 900,000 stoves. The CSI survey results show that current patterns, trends, and preferences for cookstove ownership are favorable for promoting and marketing better stoves. More than half of households in the CSI coverage area own and use more than one cookstove, and household income is positively associated with the total number of stoves owned. Thus, it appears that improved stoves would be affordable for most households. Currently, the tao prayat is the most popular type of commercially available cookstove despite its short service life of about six months. Originally designed as an improved stove in the 1980s, the tao prayat has faced stiff market competition, causing producers to lower their standards to reduce costs, thus compromising the stove's durability. This market failure suggests the need to educate consumers about the health risk of IAP linked to cookstove emissions to generate demand for cleaner-burning, fuel-efficient stoves.

On the supply side, the CSI study reveals key deficiencies in cookstove production, including slow processes and weak quality control. Virtually all cookstove production in Lao PDR utilizes the Artisan Production Model, meaning that each stove is individually made by hand. The increased use of charcoal among urban and peri-urban households has generated greater demand for cookstoves, but profit margins are low; as a result, producers rely on a quick turnover and may not be interested in making more durable stoves. In addition, the majority of producers lack appropriate training in business management and product marketing, as well as the technological know-how to improve their production processes.

The proposed intervention for scaling up the use of improved cookstoves in Lao PDR relies on market-based mechanisms, supported by technical assistance and capacity building for the public and private sectors. It is widely thought that a market-based approach in commercializing improved stoves is the best way to ensure efficiency of interventions and sustainability of programs (Ekouevi and Tuntivate 2011). In Lao PDR, the market mechanisms employed will ensure that truly improved cookstoves are available on the market. It is envisioned that the public sector will work in partnership with the private sector, providing support for setting standards, creating and promoting better technologies, delivering these technologies to households, and promoting information dissemination and public education and awareness. There is a clear need to invest in research and development (R&D) to explore new technologies and provide producers and distributors assistance in moving forward with these options. Finally, disseminating improved cookstoves will require multisector cooperation, with clearly designated roles and responsibilities among multiple stakeholders, including government agencies, academic institutions, nongovernmental organizations (NGOs), and the private sector.

To further promote clean cooking solutions, Lao PDR will explore the potential niche market for the scaled-up use of biogas systems. A critical review of past biogas programs in Lao PDR confirms that high upfront costs have presented the greatest obstacle to uptake among farming households with livestock. Past programs have relied on large, unwieldy subsidies, which have represented up to 31–50 percent of total system costs; yet adoption rates have remained low.

The alternative financing approach for the proposed biogas piloting scheme—significantly cheaper than a direct subsidy—uses interest-free loans or lease-purchase agreements to help households overcome upfront costs. Once funding for the current Biogas Pilot Project (BPP) ends in late 2012, the intervention strategy proposes implementing a pilot biogas scheme, managed by the Ministry of Energy and Mines, using this alternative financing approach and other corrective measures. Limited to 100 biogas systems, the scheme would offer qualified farming households interest-free access to the revolving Rural Electrification Fund to cover upfront costs, with the loan repayable in monthly installments over an agreed-to period. The project would provide an opportunity to build on what has been learned from the BPP in Lao PDR, along with lessons from international experience.

This pilot biogas scheme, together with the proposed approach for promoting a thriving market for better stoves, offers an important pathway to cleaner household cooking. The results of this assessment indicate that a small proportion of wealthier households will be able to access LPG and increasingly more urban households will transition to purchased charcoal as their incomes rise. There is also a promising niche market for biogas systems among qualified farming households with livestock. For most households—including those in the lowest income groups—who will continue to rely mainly on firewood, the proposed approach to creating a thriving stove market offers an important pathway to cleaner cooking. The benefits are fewer premature deaths, healthier and more productive lives, less drudgery for women, and less pressure on the environment.

1

Introduction

Today the vast majority of households in the Lao People's Democratic Republic (PDR) rely on fuelwood, primarily in the form of firewood and charcoal, to meet most of their cooking needs. Each day a rural family consumes an estimated 5 kilograms (kg) of firewood for cooking, amounting to approximately 2 million tons per year. Census data show only a 3 percent decline in the use of firewood and charcoal (from 97 percent to 94 percent) as the main household cooking fuels between 1995 and 2005. Over that decade, a sizeable portion of households, particularly those located in urban areas of the central and southern provinces and a small proportion in northern urban areas, switched from firewood to charcoal. However, as of 2005, more than 88 percent of rural households and well over half of urban ones remained dependent on firewood as their main source of cooking energy.

Access to electricity has expanded significantly over the past two decades; by 2010, virtually all urban households in Vientiane capital had a connection (Annex A). Yet the country's transition from cooking with solid fuels to using modern forms of clean energy has remained slow (Ekouevi and Tuntivate 2011). In fact, between 1995 and 2005, the percentage of urban households using electricity as their main source of cooking energy fell from more than 10 percent to less than 4 percent (table 2.1). Such fuels as liquefied petroleum gas (LPG) and electricity are still viewed as supplemental, rather than alternatives, to fuelwood and are accessible only to higher-income households. Thus, for the foreseeable future, heavy reliance on fuelwood for cooking is likely to continue, suggesting that family members who spend a disproportionate amount of time in the household cooking area—primarily women and their young children—will continue to face the health risks associated with indoor air pollution (IAP).

Overview of Past Stove Programs

Previous efforts to promote the use of improved cookstoves in Lao PDR have been fragmented; yet such programs have had a good track record in commercially disseminating stoves without requiring subsidies. The first program, albeit small, was initiated in 1997 by Thailand's Naresuan University through the Council for Renewable Energy and the National University of Laos (NUOL). With US$10,000 in financial support from the Food and Agriculture Organization's Regional Wood Energy Development Programme in Bangkok, the Council, in close cooperation with NUOL and the Participatory Development Training Center, organized technology

Thai bucket stove

transfer to produce the improved charcoal bucket stove (ICBS), with training provided by Thailand's Department of Alternative Energy Development and Efficiency (DEDE).

Thailand's Royal Forest Department had developed the ICBS in the 1980s. Commonly referred to as the Thai bucket stove, the ICBS has a conversion efficiency of 26–30 percent, compared to only 5–20 percent for the traditional bucket stove, resulting in a 30–50 percent fuel savings. In practice, the ICBS provides a cleaner cooking environment and a faster cooking time than traditional three-stone, steel-ring tripod, or regular bucket stoves. Users who purchase fuel, such as charcoal, especially like the stove. Although the 1997 program is credited with having introduced the first improved cookstove to the Lao PDR market, the Lao version of the Thai bucket stove, known locally as the tao prayat, cannot be considered truly improved owing to a deterioration in quality control over time and a lack of standards and regulations. The reasons for these shortcomings have included stiff competition from regular cookstoves, a profit motive, and lack of appropriate training of producers in the technical requirements for making improved stoves.

Other notable programs have been limited to training conducted in selected provinces. For example, a DEDE-supported program to train local stove producers was implemented in 2006 and 2010 by the Institute of Renewable Energy Promotion (IREP),[1] Ministry of Energy and Mines (MEM). Another training project, funded by the WISIONS initiative of the Wuppertal Institute for Climate, Environment, and Energy in Germany, was carried out by the Technology Research Institute of the Science, Technology, and Environment Agency under the Ministry of Science and Technology (MOST), with technical support provided by the Netherlands Development Organisation (SNV). The most recent program, initiated by the SNV in 2011, is relatively larger and focuses on Savannakhet and Champassak provinces.

Promoting Renewable Energy Development

The Government of Lao PDR recognizes the development of renewable energy as a key component in ensuring national energy security, socioeconomic development, and environmental and social sustainability. Its Renewable Energy Development Strategy, published in 2011 (Lao PDR 2011),[2] promotes policies that focus on small power development for self-sufficiency and grid connection, biofuel production and marketing, and the development of other clean energy sources. The strategy's road map for 2011–25, which identifies specific areas for promotion and development, includes improved cookstoves and biogas systems.

Improved Cookstoves

The government's strategy recognizes that biomass cooking fuels represent an estimated 70 percent of Lao PDR's total energy consumption, with major implications for human health and quality of life, local forest degradation (Annex B), and the global climate. To address these issues, the strategy promotes the development and market deployment of the most energy-efficient, culturally appropriate cookstoves.

The specific types of activities called for include an initial market assessment and technical studies for improved cookstoves in the country and preparing a program that includes a service delivery framework and appropriate business model; technology design, standardization and labeling; capacity building; and an information campaign. Subsequent activities include identifying projects for pilot demonstrations and preparing feasibility studies; implementing demonstration projects, information campaigns, and training programs; and scaling up the improved cookstove program.

To support the 2008 Ministry of Health (MOH) recommendations on reducing the adverse health effects of IAP caused by smoke emitted from traditional cookstoves (Mengersen et al. 2007), the strategy also calls for raising women's awareness of the associated health risks of using energy-inefficient stoves, improving stove efficiency and ventilation in the household cooking area, and developing and disseminating information and educational materials.

Biogas Systems

The government's strategy also envisions reducing the country's heavy dependence on LPG imports by supporting the promotion and development of biogas systems for household and industrial use.[3] There is significant potential to develop biogas systems produced from livestock, agroindustrial, and municipal solid waste, as well as wastewater treatment. Various donor organizations have funded demonstration projects using livestock and other animal waste. To sustain these initiatives—and

1. Formerly the Department of Electricity.

2. The strategy identifies the MEM as having major responsibility for coordinating renewable energy development.

3. As of 2006, LPG imports for household and industrial-scale use totaled 871,800 kg.

thus reduce reliance on LPG imports, as well as fuelwood for cooking—the government aims, by the year 2025, to have increased the number of households using biogas by 50,000.

To achieve this goal, the government will strengthen the capacity of an agency or organization charged with scaling up small-, medium- and large-scale biogas systems. In partnership with private entrepreneurs and nongovernmental organizations (NGOs), it will first conduct technical studies, identify the most appropriate business model and support mechanisms, and prepare a long-term program that includes monitoring plans for scaling up household biogas systems. Subsequently, it will conduct an information campaign and training for system installation and use, develop an accreditation scheme to certify installers, secure program financing, and pilot-test the new business model. Finally, it will promote replication on a national scale.

The strategy for biogas system promotion and development, like that for improved cookstoves, supports related MOH initiatives. For example, an ongoing effort by the Environment and Occupational Health and Sanitation Department, working with the Center for Environmental Health and Water Supply, improves household hygienic conditions by constructing pour-and-flush latrines and carefully managing waste (e.g., requiring that all human and animal waste be outside a 30-meter radius of water sources). The health benefits of using human and animal waste in biodigesters include reducing parasites, viruses, bacteria, and vector-borne diseases.

Study Background and Objective

Lao PDR is one of four countries participating in the World Bank's Clean Stove Initiative (CSI) for East Asia and the Pacific. The program aims to promote clean, energy-efficient cooking solutions for Lao PDR, China, Indonesia, and Mongolia. In each country, the CSI takes a three-phase approach: (1) initial stocktaking to develop an effective intervention strategy; (2) implementing the strategy, with a focus on capacity building, enhancing the national enabling environment, and preparing pilot investment projects; and (3) implementing the pilot investment projects and scaling up improved stove use (box 1.1). The initial stocktaking phase is critical not only for developing each country's intervention strategy; it is also vital to designing subsequent activities and establishing policy dialogue with the respective countries' institutional focal points. Throughout each phase, the CSI for East Asia and the Pacific supports regional-level knowledge sharing.

This study is the key activity under the first phase of the CSI for Lao PDR, which is funded by the Australian Agency for International Development (AusAID). The study's broad aim is twofold: (1) taking stock of the current status of IAP and household cookstove use in the country and (2) proposing an effective intervention strategy to promote improved cookstoves. The results will contribute to the government's Renewable Energy Development Strategy and its related health concerns (e.g., IAP vulnerability of women and children).

Study Method and Survey Instruments

This study's stocktaking activities included a case study (i.e., CSI field survey), while development of the intervention strategy included stakeholder consultations and two consultation workshops carried out in Vientiane. The study relied on four major data sources. The first comprised a range of published information, including literature and field reports on improved cookstove dissemination, IAP, and household energy studies in Lao PDR, as well as data from the Lao PDR Population and Housing Census. The second source of information was derived directly from interviews with government officials and experts in the field. The third was taken from

BOX 1.1 TERMINOLOGY CLARIFICATION

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

- **Cookstove** refers to a biomass cookstove.
- **Improved cookstove** refers to a clean-burning, energy-efficient cookstove.
- **Advanced cookstove** refers to one that meets indoor air pollution and safety criteria, along with those for combustion and fuel efficiency.
- **Fuelwood** includes firewood and charcoal.
- **Firewood** comprises firewood, wood residues, and other woody biomass.

Source: Author.

the two consultation workshops, which provided essential input for developing the proposed intervention strategy. The fourth was provided by results of the CSI field survey, which was conducted in four selected provinces.

The CSI field survey consisted of two parts: (1) a household cooking energy survey conducted separately in peri-urban areas and rural areas and (2) a market survey of biomass cookstoves and the supply chain. Both parts were conducted in the Vientiane capital and the provinces of Bolikhamsai, Khammouane, and Vientiane. The first part focused on household demand for cooking fuels and cookstoves, including questions related to the types of fuels and stoves used, cooking practices, and household awareness of health risks from biomass cooking smoke. The second part, which aimed to better understand the entire market supply chain, was conducted among stove retailers, wholesalers and traders, and producers (Annex C).

Structure of This Report

The structure of this report reflects the directional organization of the study. Chapter 2 offers a detailed descriptive analysis of national- and regional-level household fuelwood use, supplemented by a detailed analysis of fuelwood consumption and expenditure among rural and peri-urban households. Chapter 3 discusses the health- and gender-related issues linked to IAP exposure resulting from use of energy-inefficient cookstoves. A detailed analysis of potential exposure and risk factors is given as an example, using data from the case study. Chapter 4 analyzes household demand for cookstoves and the supply chain in the case study area, while chapter 5 presents the proposed intervention strategy to promote improved cookstoves. Chapter 6 proposes a complementary pilot project for promoting the use of household biogas systems utilizing an alternative financing approach. Finally, chapter 7 concludes.

2

Overview of Household Cooking Fuels

Households in Lao PDR use a complex mix of cooking fuels. Based on national census results, this chapter begins by examining recent trends in rural and urban fuel switching, including regional variability. Then, based on the CSI survey findings, it presents a profile of cooking fuels used by households, identifying the major drivers of fuel selection and consumption and expenditure disparities between rural and peri-urban areas.

National Trends

Changes in the use of household cooking fuels in Lao PDR over the past two decades reflect shifts in national policies and regulations and resource availability. In the past, urban households took advantage of the low retail electricity tariff,[4] using electricity as their main cooking fuel; however, the gradual rise in the tariff witnessed in recent years has caused these households to revert to using fuelwood (firewood and charcoal) as their main source of cooking energy. At the same time, the use of sawdust,[5] which was preferred among low-income households, has virtually disappeared owing to changes in logging policies and regulations (table 2.1).

Another notable trend has been the shift within the fuelwood category from firewood to charcoal. In rural areas, where nearly three-quarters of the population live, the use of charcoal as the main household cooking fuel rose more than fourfold between 1995 and 2005. Over the same period, the increase in urban areas was more than threefold (table 2.1). This trend is expected to continue, given that charcoal emits less smoke than firewood, is cleaner to use, and is affordable among middle-income households, particularly those in urban areas.

4. Previously, the electricity tariff was significantly lower than the overall cost of production (i.e., generation, transmission, and distribution).

5. In the past, freely available sawdust was collected from around sawmills, many of which have since closed down.

TABLE 2.1 SHIFT IN HOUSEHOLD COOKING FUELS IN URBAN AND RURAL AREAS OF LAO PDR (PERCENT)

	1995			2005		
Main cooking fuel	Urban	Rural	Total	Urban	Rural	Total
Electricity	10.4	0.1	1.9	3.8	0.1	1.1
Firewood	68.3	97.7	92.7	55.1	88.5	79.1
Charcoal	10.0	1.6	4.3	34.6	7.4	14.9
Sawdust	2.7	0.3	0.7	0.3	0.0	0.1
LPG	0.0	0.0	0.0	0.0	0.0	0.0
Other	1.6	0.3	0.5	6.2	4.0	5.8

Source: NSC 2005.

Regional Variations in Fuel Switching

The proportion of firewood and charcoal used for household cooking in Lao PDR varies by region (map 2.1). The findings highlighted in the subsections that follow confirm that households overall are switching from firewood to charcoal as their main source of cooking fuel. Furthermore, the pace of this fuel switching is faster among urban households than rural ones. It is accelerated in the capital city and economically well-off urban centers in the southern provinces, while more gradual among urban households in the northern provinces.

Northern Provinces

Firewood use predominates in the northern provinces; however, households in urban areas are gradually switching from firewood to charcoal. Five provinces—Phongsaly, Luang Namtha, Oudomsai, Xiang Khoang, and Houaphan—rely nearly exclusively on firewood as their main household cooking fuel (map 2.1). In 1995, virtually all households in these five provinces depended on firewood. By 2005, that proportion had declined only about 2 percent, with the exception of Houaphan.[6] In the other three northern provinces—Bokeo, Luang Phrabang, and Sayaboury—the proportion of households using firewood dropped to about 90 percent over the same period; according to the 2005 Population and Housing Census (NSC 2005), about 10 percent had switched to either charcoal (4–5 percent) or other fuels (4–5 percent).[7]

6. As of 2005, 94 percent of households in Houaphan used firewood as their main cooking fuel; the prior decade witnessed a slight increase in the use of other, non-specified fuels (NSC 2005).

7. Field observations suggest that these non-specified cooking fuels tend to be site-specific and may include crop residue (e.g., corncob), other biomass residue, coal, and coal briquette.

Central and Southern Provinces

The census data indicate that, between 1995 and 2005, the switch from firewood to charcoal for cooking in the central and southern provinces was far faster among urban households than rural ones (NSC 2005) (map 2.1). Over that decade, significant numbers of urban households in the selected provinces of Khammouane, Bolikhamsai, Saravane, and Sekong shifted away from firewood and toward charcoal for cooking. However, by 2005, the vast majority of rural households still relied heavily on firewood, with only a modest rise in charcoal use (table 2.2).

Among urban households in these four provinces, Sekong and Saravane saw the largest decline in firewood use, at 32 percent and 31 percent, respectively, and the largest rise in charcoal use, at 29 percent and 31 percent. Among rural households, the decline in firewood use was a modest 6 percent on average, while the average rise in charcoal use was under 2 percent, with the exception of Saravane, which saw a 7 percent increase (table 2.2).

For households in Vientiane and Attapeu provinces (map 2.1), the census data reveal the same trend as for the four above-mentioned provinces; however, the proportion of households that continued using firewood is somewhat higher, while the proportion that began using charcoal is lower. By 2005, a large majority of urban households in Vientiane and Attapeu (84 percent and 78 percent, respectively) still used firewood, as did 96 percent of rural households in the two provinces.

TABLE 2.2 SOLID FUEL USE FOR HOUSEHOLD COOKING IN SELECTED PROVINCES, 1995 AND 2005 (PERCENT HOUSEHOLDS)

Cooking fuel/ household area	Khammouane		Bolikhamsai		Saravane		Sekong	
	1995	2005	1995	2005	1995	2005	1995	2005
Firewood								
Urban	73	50	91	77	73	42	93	61
Rural	98	93	98	92	99	89	99	95
Charcoal								
Urban	25	43	7	16	23	54	7	36
Rural	1	3	2	3	1	8	0	1

Source: NSC 2005.

MAP 2.1 LAO PDR, 2004

Source: World Bank.

Household kitchen with LPG stove in peri-urban area of Vientiane capital

Household cooking with charcoal stoves (tao dum)

Economically Advanced Areas

In the three most economically well-off areas of the country—Vientiane capital and the southern provinces of Savannakhet and Champassak—fuel-use patterns differ markedly from those of the other provinces (map 2.1). In the larger urban centers of these three areas, charcoal is the dominant household fuel. In 2005, about half of urban households in Vientiane capital and some 60 percent in Savannakhet and Champassak mainly used charcoal, reflecting a 25 percent decline in firewood use over the prior decade. By 2005, only about a third of urban households in each of the three areas used firewood. Interestingly, some urban households began using LPG despite its relatively high price, including about 5 percent of those in Vientiane capital and about 2 percent and 1.4 percent, respectively, in Savannakhet and Champassak provinces. Also noteworthy was the decline in electricity use owing to the steady rise in the retail electricity tariff. By 2005, only 8 percent of urban households in Vientiane capital used electricity as their main source of cooking energy, which was 14 percent less than a decade earlier.

A majority of rural households in these three areas still rely on firewood for cooking; however, between 1995 and 2005, firewood use declined an average of 5 percent (from 86 percent to 81 percent), while charcoal use rose by about 8 percent (from 9 percent to 17 percent), suggesting a significant switch from firewood to charcoal. The most dramatic shift over that decade occurred in Champassak province, where firewood use declined 24 percent (from 98 percent to 74 percent) and charcoal use rose 21 percent (from only 2 percent to 23 percent).

Cooking Fuel Profile of Rural and Peri-Urban Areas

In accordance with the recent census observation, CSI survey results confirm the popularity of charcoal use for cooking in urban areas and the continued prevalence of firewood in rural areas. Some 85 percent of peri-urban households and 72 percent of rural ones said they used charcoal for cooking; conversely, 80 percent of rural households, compared to only 56 percent of peri-urban ones, reported using firewood. Most households use a combination of firewood and charcoal to prepare their meals, often supplemented by LPG and electricity.[8] Among the households surveyed, all four sources of cooking energy were identified (figure 2.1).

8. In practice, most households in Lao PDR rely on a combination of cooking fuels. In Vientiane capital, for example, about 69 percent of urban households were found to use several types of cooking fuels (ESMAP 1993).

BOX 2.1 RICE COOKING PREFERENCES IN LAO PDR

Nearly all Lao PDR households in the CSI survey area own and use an electric rice cooker, recognizing its advantages of time savings, convenience of use, and inexpensive operation. But the rice preferred by most people in both peri-urban and rural areas is glutinous rice, which cannot be prepared in the traditional way using a rice cooker. Thus, even though rice is the country's main staple food, the rice cooker is used only occasionally to prepare long grain rice.

Source: CSI survey results.

Among the large majority of households that use firewood and charcoal, about three-quarters always use these fuels to prepare their meals. By comparison, only 9–14 percent of the 85 percent of households that use electricity for cooking do so regularly (box 2.1). Electricity tends to be used only occasionally; 69 percent of those surveyed agreed that electricity is too expensive to use for cooking. Among the 6–12 percent of households that cook with LPG, which must be imported, less than half use it regularly owing to its high price (figure 2.2).

An analysis of the cooking fuel mix in the CSI survey area allows us to classify households into four groups: (1) charcoal and firewood; (2) firewood only; (3) charcoal only; and (4) firewood, charcoal, and LPG (figure 2.3).

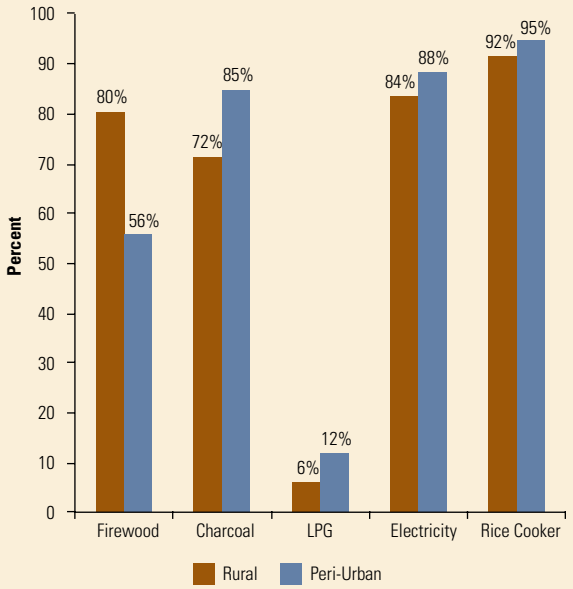
In line with the census results, the CSI survey findings confirm that about 92 percent of rural households rely on firewood, charcoal, or a combination of the two as their main source of cooking fuel, compared to about 88 percent of peri-urban households (figure 2.3).

What Drives Household To Select Cooking Fuels?

The CSI survey results reveal that key determinants of households' choice of cooking energy in Lao PDR are resource availability and fuel pricing, along with ease of use, convenience, and cleanliness. The survey results confirm that fuelwood is inexpensive. About 96 percent of rural households and 79 percent of peri-urban ones indicate that firewood is readily available. Some 93 percent of all firewood is freely collected by users from around the house, in the household garden or nearby forest, or on public and private lands; most rural households do not purchase firewood, while those in urban areas both collect and purchase it.

With regard to charcoal, about 5 percent of rural households make their own. Those that purchase charcoal typically buy it in large fertilizer bags, each weighing about 20–30 kg, depending on the type of wood used to make the charcoal. The average retail price per bag is about LAK 25,000–30,000, with a slightly higher price in urban areas. Modern forms of cooking energy—primarily LPG, which is imported, and some electricity—are considered expensive by most households. The average retail price for 15 kg of LPG is about LAK 160,000. Currently, LPG is available primarily along the borders with Thailand and Vietnam and its use is limited to a small minority of financially better-off households.

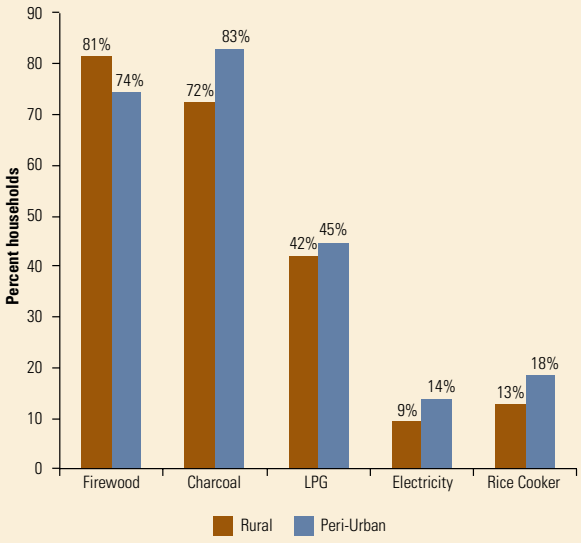
FIGURE 2.1 ENERGY SOURCES FOR HOUSEHOLD COOKING



Source: CSI field survey.

Note: Results are from rural and peri-urban areas in Vientiane capital and Vientiane, Bolikhamsai, and Khammouane provinces.

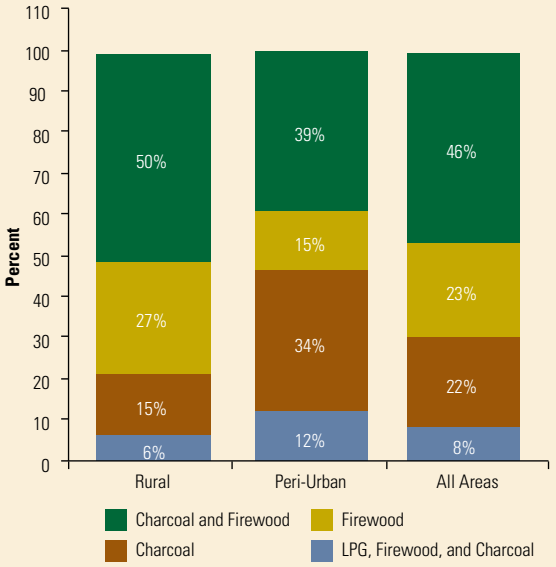
FIGURE 2.2 FUELS ALWAYS USED TO PREPARE MEALS



Source: CSI field survey.

Note: Results are from rural and peri-urban areas in Vientiane capital and Vientiane, Bolikhamsai, and Khammouane provinces.

FIGURE 2.3 HOUSEHOLD COOKING FUEL MIX IN RURAL AND PERI-URBAN AREAS[a]

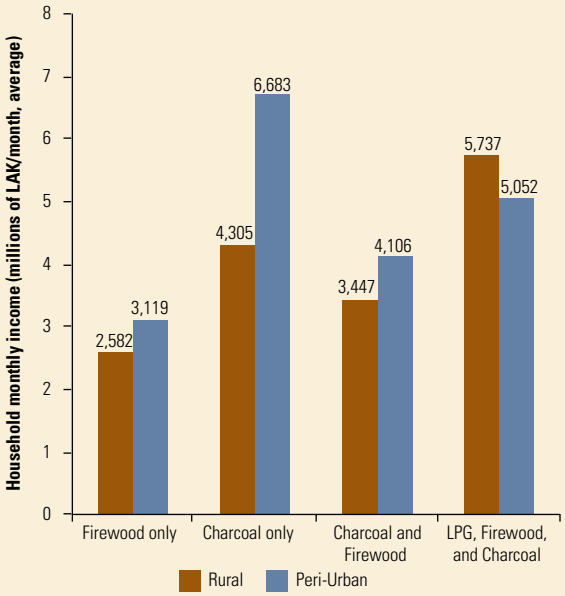


Source: CSI field survey.

Note: Results are from rural and peri-urban areas in Vientiane capital and Vientiane, Bolikhamsai, and Khammouane provinces.

a. About 1 percent are unidentified, including some combination of firewood, charcoal, biogas, electricity, and other fuel types.

FIGURE 2.4 COOKING FUEL CHOICE AND HOUSEHOLD INCOME



Source: CSI field survey.

Note: Results are from rural and peri-urban areas in Vientiane capital and Vientiane, Bolikhamsai, and Khammouane provinces.

Predictably, in both rural and peri-urban areas, those households with the lowest average monthly incomes tend to use firewood only or some combination of firewood and charcoal, underscoring that firewood users generally are among the country's poorest households. Conversely, those households with the highest average monthly incomes tend to use either charcoal only or a mix of firewood, charcoal, and LPG (figure 2.4).

Cooking Fuel Consumption and Expenditure

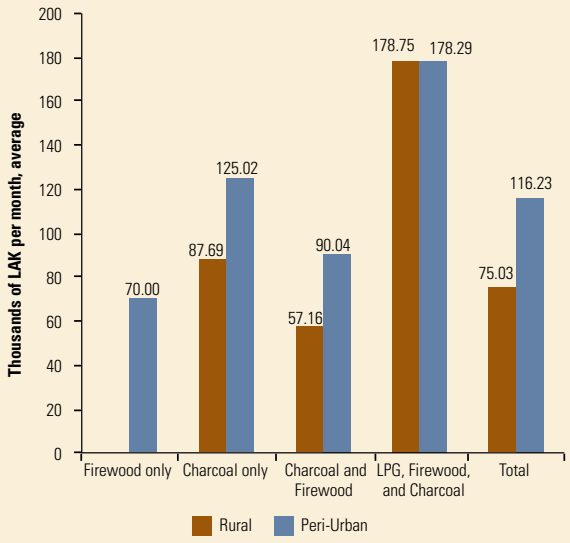
The CSI field survey reveals that the average monthly consumption of firewood is slightly higher for a rural household, at 183 kg, than a peri-urban one, at 178 kg. This per-household consumption level is equivalent to 5–6 kg per household per day, which is about the same as the national average. For charcoal, the average monthly consumption is higher for an urban household, at 70 kg, than a rural one, at about 56 kg. The average monthly, per-household expenditure on charcoal is LAK 94,000 in urban areas, compared to about LAK 65,000 in rural ones. In terms of LPG consumption, a peri-urban household spends an average of LAK 98,000 per month, compared to LAK 91,000 for a rural household.

In reality, most households in Lao PDR use a mix of cooking fuels, which is reflected in the monthly expenditure on all cooking fuels. In rural areas, the average per-household expenditure on cooking fuels is LAK 75,025 per month, more than one-third less than in peri-urban areas, at LAK 116,231 per month (figure 2.5).

The disparity between rural and peri-urban areas observed in monthly household expenditure reflects several key features of the two main cooking fuels. That is, most rural

Charcoal sold in large fertilizer bags

FIGURE 2.5 HOUSEHOLD EXPENDITURE ON COOKING FUELS



Source: CSI field survey.

Note: Results are from rural and peri-urban areas in Vientiane capital and Vientiane, Bolikhamsai, and Khammouane provinces.

households use firewood, which they freely collect. In addition, most peri-urban households use charcoal, which they must purchase. Finally, the price of charcoal in peri-urban areas is slightly higher than in rural areas.

Summary Remarks

Results of the CSI survey in Lao PDR, which confirm data from the recent national census, show that the vast majority of households continue to rely on fuelwood—primarily firewood and charcoal—as their main source of cooking energy. The abundance of firewood that can be freely collected, combined with the high cost of modern energy, suggests that the switch to modern forms of

Cooking with firewood in peri-urban area

cooking energy may not be easily achieved. LPG must be imported, and the distribution network is limited to major cities along the border with Thailand and Vietnam; also, the fuel price is quite high relative to household income, limiting use to a small segment of financially better-off urban households. Despite the steady increase in access to electricity service, greater use of electricity for household cooking is hampered by its high cost, owing to the increased retail tariff to ensure cost recovery.

As the census data show, urban households in economically advanced areas are rapidly switching from firewood to charcoal as their main source of cooking energy; even in the northern provinces, urban households are slowly shifting from firewood toward greater charcoal use. The lowest-income households continue using firewood, along with charcoal, suggesting that, for the foreseeable future, most households will meet their cooking needs using a mix of fuelwood, supplemented by limited amounts of modern cooking energy. These findings have important health implications for those most at risk from indoor pollution, which is the subject of the next chapter.

3

Health Risks from Indoor Pollution and Household Cooking Environment

Recent research on indoor air pollution (IAP) in Lao PDR supports mounting worldwide evidence of the causal linkages between indoor pollution from biomass combustion emissions and a range of respiratory and other diseases, with the household members who regularly breathe such cooking smoke disproportionately affected. This chapter summarizes the key findings from this study (Mengersen et al. 2007), along with supporting statistical data from recent national surveys and other studies (Lao Department of Statistics 2009; LWU 2001), before turning to the CSI survey results, which identify those groups most affected by IAP and the contributing health risk factors in the household cooking environment.

IAP Evidence in Lao PDR Households

The IAP study conducted by Mengersen et al. 2007 revealed that many households in Lao PDR exhibit high concentrations of particulate matter (PM_{10}) and nitrogen dioxide (NO_2) many times higher than the World Health Organization (WHO) guidelines. The study also showed that IAP is much higher in households that use fuelwood as their main cooking energy and that women and children in such households are at greater risk of a range of respiratory illnesses.

The study showed that the mean household value for PM_{10} was 1,295 micrograms per cubic meter (µg per m^3) in Vientiane and 1,060 µg per m^3 in Bolikhamsai. These PM_{10} concentrations are about 25 times higher than the WHO 24-hour mean guideline value of 50 µg per m^3 and up to 65 times higher than the annual mean guideline of 20 µg per m^3. For NO_2, the mean household value was 1,196 µg per m^3 for Vientiane households and 574 µg per m^3 for those in Bolikhamsai. These concentrations were about 2–6 times higher than the WHO 1-hour mean guideline value of 200 µg per m^3 and about 14–30 times higher than the annual mean guideline of 40 µg per m^3. PM_{10} and NO_2 concentrations were significantly higher in houses that used wood-burning cookstoves, compared to those that used electricity. Among those dwellings that used cookstoves, PM_{10} concentrations were significantly higher in houses whose stoves lacked a chimney.

The study also confirmed a strong link between higher IAP concentrations and respiratory illnesses in women and children, with the associated health outcomes particularly strong for women. Incidence of virtually all health outcomes considered in the study was more than triple for women living in dwellings with higher NO_2 concentrations. A health survey conducted under the study showed that nearly half of women spent one-three hours per day in the cooking area, while nearly a quarter spent more than six hours a day in this location. Nearly three-quarters (72 percent) of children spent more than five hours each day in the cooking area,[9] while 17 percent spent more than five hours close to the fire. Based on the survey results, the study concluded that the more time women and children spend close to the fire, the higher their risk of respiratory illness (e.g., cold, fever, runny nose, stinging or watery eyes, coughing, itchy rash or eczema, bronchitis, and pneumonia).

9. Contrary to expectations, the study observed that children living in households where the cooking area is located in a separate building experienced greater health risks; the reason may be that dispersal of pollutants in the separate building may have been poorer than in the main residence.

Women's Time Allocation and Firewood Collection and Cooking

Like many women throughout the developing world, women in Lao PDR shoulder most of the household burden for biomass collection and cooking. As previously mentioned, some 90 percent of the country's households use firewood as their main cooking energy and most rural households collect the firewood they use, suggesting a heavy responsibility for women. The most recent Lao Expenditure and Consumption Survey (LECS), conducted in 2007–08, confirms that women spend twice as much time as men collecting firewood (i.e., an average of 12 minutes versus 6 minutes per day) (Lao Department of Statistics 2009). While 12 minutes a day may seem like a small amount of time, this figure represents the national average, including those households that spend no time collecting firewood. The survey found that women's average firewood collection time had fallen by 6 minutes a day since the 2002–03 LECS was conducted, which may reflect the shift from firewood to charcoal use in urban and some peri-urban areas.

In the five years between surveys, the average household collection time remained the same, at 12 minutes per day. However, one should not conclude from this finding that overall fuelwood supply remained unchanged. The reality is that forest land distribution and thus firewood availability has been uneven (Annex B). Empirical evidence shows that, in areas where fuelwood utilization is intensive (e.g., peri-urban and other zones with high concentrations of brick-making, lime-making, and other commercial activities), women are walking longer distances to collect firewood. In addition, firewood collection is more intensive during the dry season, when families stock up (box 3.1).

The 2007–08 survey results also indicate that women spend a disproportionate amount of time involved in food preparation activities, averaging about 1 hour per day, compared to only 6 minutes a day for men. Since nearly 90 percent of households use firewood as their main cooking fuel, women, who bear the larger share of household cooking responsibilities, are more heavily exposed to the health risks of IAP.

Potential IAP Exposure and Results of the CSI Survey

The CSI survey results in Lao PDR confirm that, in households that use fuelwood as their main cooking energy, women and their young children are at greatest risk from IAP. Based on the survey findings, the following subsections offer a profile of this high-risk group and describe contributing IAP risk factors, including stove and kitchen characteristics, cooking practices, and awareness of and attitudes toward the harmful health effects of cooking smoke emissions.

Identifying Those at Greatest Risk

In 98 percent of the households surveyed, women are responsible for daily meal preparation. In both rural and peri-urban areas, women who cook for family members are typically about 38 years old and spend about 2.25 hours each day on meal preparation, meaning that this group is especially vulnerable to IAP exposure. While cooking, these women also tend to their young children (i.e., under 6 years of age), who may stay in or near the cooking area. Among rural households, 30 percent reported the presence of young children in the cooking area when women are cooking, compared to only 16 percent of peri-urban households. This finding, combined with rural households' greater use of firewood for cooking—which emits more smoke than charcoal—suggests that young rural children are more vulnerable to IAP exposure than their peri-urban counterparts.

BOX 3.1 WOMEN'S DISPROPORTIONATE BURDEN OF FIREWOOD COLLECTION

A 2001 case study conducted by the Gender Resource Information and Development Center of the Lao Women's Union (LWU) found that women's firewood collection time was significantly higher in the villages surveyed than the national average. Conducted in four villages of as many provinces—Pu Din Daeng (Vientiane), Nam Tuan (Sayaboury), Khangdone (Xiang Khoang), and Kang Phosi (Savannakhet)—the study concluded that women living in a household of 5–6 people spend 1–3 hours per day collecting firewood. Each year, these women carry 120–150 loads, each weighing 15–20 kg. Wood is carried on the back or shoulder, which is an especially arduous task for women who are pregnant or caring for small children, the sick, or disabled.

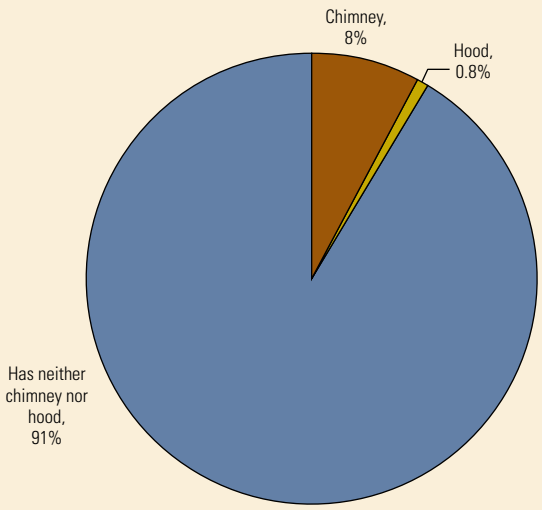
Source: LWU 2001.

Soot-lined kitchen walls surrounding firewood stove

Deficiencies in the Physical Cooking Environment

The CSI survey results revealed that the cookstoves used by 91 percent of households in both rural and peri-urban areas lack both a chimney and a hood. These deficiencies are about 5 percent more prevalent among urban households (93 percent) than rural ones (about 89 percent). In addition, cookstoves with chimneys account for only 8 percent of the households surveyed, while those with a hood represent less than 1 percent of respondents (figure 3.1).

FIGURE 3.1 COOKSTOVE FEATURES (PERCENT HOUSEHOLDS)



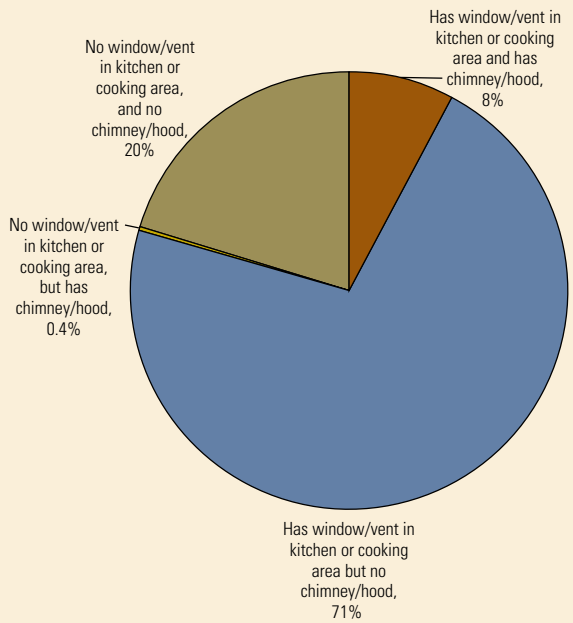
Source: CSI field survey.

Note: Results are from rural and peri-urban areas in Vientiane capital and Vientiane, Bolikhamsai, and Khammouane provinces.

Deficiencies in the physical cooking area, combined with the stove deficiencies described above, suggest that most Lao PDR households need to improve their cooking conditions to eliminate, or at least minimize, the IAP threat from indoor cooking smoke. One-fifth of the households surveyed exhibit deficiencies in both their cookstoves (i.e., lacking a chimney and/or hood) and physical cooking area (i.e., lacking a window and/or vent). These combined deficiencies suggest that this group has especially poor cooking conditions (i.e., there is no way for the smoke to escape) and thus relatively high IAP exposure. Cooking conditions are comparatively better for the majority of households (71 percent) surveyed, who indicated that their cooking area has a window and/or vent. Only a small minority of households (8 percent) are relatively better off, having both a chimney and/or hood for their cookstoves and a window and/or vent in their cooking areas (figure 3.2).

Whether a household has a chimney or hood for their cookstoves or a window or vent in their cooking area does not appear to influence their decision to cook inside or outside the house. Among households that cook exclusively inside or outside the house (16 percent and 13 percent, respectively), about half in each group lack

FIGURE 3.2 COMBINED FEATURES OF COOKSTOVES AND COOKING AREAS (PERCENT HOUSEHOLDS)



Source: CSI field survey.

Note: Results are from rural and peri-urban areas in Vientiane capital and Vientiane, Bolikhamsai, and Khammouane provinces.

Typical three-ring steel tripod (kieng) in rural kitchen with dirt floor

both a chimney/hood for their cookstoves and a window/vent in their cooking area, while the other half have a window/vent but lack a cookstove chimney/hood.

Risk Awareness and Attitudes

The CSI survey results indicate that a relatively large percentage of the households surveyed do not clearly recognize the harmful health effects from breathing the smoke emitted from the incomplete combustion of solid fuels used for cooking. About 50 percent agreed and 34 percent disagreed that they experience difficulty breathing as a result of using fuelwood for cooking, and about 15 percent had no opinion. While 54 percent strongly agreed that smoke is harmful to a person's health, 30 percent disagreed and 16 percent had no opinion. Only 14 percent strongly agreed that cooking smoke is a big problem for their families, compared to 25 percent that agreed and about 50 percent that disagreed. These findings highlight the need for appropriately targeted education, awareness-raising campaigns, and information dissemination.

Summary Remarks

The CSI survey findings confirm the results of earlier IAP research, identifying women who use firewood and charcoal for cooking and their young children as the groups most at risk from IAP exposure (Mengersen et al. 2007; Lao Department of Statistics 2009). Women are especially vulnerable since, in addition to spending long hours in the household cooking area, they are responsible for collecting and carrying the fuelwood used for cooking. The survey also identified contributing IAP risk factors, including key deficiencies in the cookstoves households use and their physical cooking environment, as well as family members' lack of awareness of the health risks from indoor cooking smoke. That cooking conditions are particularly poor for one-fifth of the households surveyed and that a large proportion of households are unaware of the health risks from IAP suggest the need for a well-targeted awareness-building campaign to educate family members on the harmful effects of breathing smoke from the burning of solid fuels and the importance of changing their current cooking practices.

4

Household Demand for Cookstoves and Supply-Side Issues

Given that heavy reliance on fuelwood for cooking accounts for some 90 percent of Lao PDR's more than 1 million households (Annex A), the country's potential technical demand for improved cookstoves could total more than 900,000 stoves. Promoting the use of improved cookstoves would undoubtedly increase market potential to the same level or near technical potential. This chapter examines the cookstove ownership preferences among households, the stove types and models currently available on the market, and production methods and other key supply-side issues to better understand the potential for promoting improved stoves.

Profile of Cookstove Ownership

The CSI survey findings estimate household cookstove demand at about 1.7 stoves, meaning that many households own more than one stove. More than half (52 percent) of the households surveyed in both rural and peri-urban areas own and use two cookstoves, while a smaller percentage—15 percent in urban areas and 8 percent in rural ones—own and use more than two. Most households maintain more than one stove as a precaution against breakage since the stoves are not durable, lasting only about six months on average.

Variations of the tao prayat (charcoal and tao cement)

Stove Types and Models

The CSI survey identified eight cookstove types and models used by households in Lao PDR, all of which are portable and commercially available (table 4.1). Also, various non-commercial stoves are made by users at home. Stoves are available in small, medium, and large sizes according to cooking needs and preferences. For example, large-sized stoves are used for cooking a large quantity of food at one time and thus may be used in food stalls, restaurants, and noodle shops, as well as for group functions (e.g., wedding parties and religious ceremonies).

Household kitchen in Bolikhamsai, featuring (from far left) firewood stove, rice cooking pot, and tao prayat (charcoal)

TABLE 4.1 COOKSTOVE TYPES AND MODELS ON THE MARKET IN LAO PDR

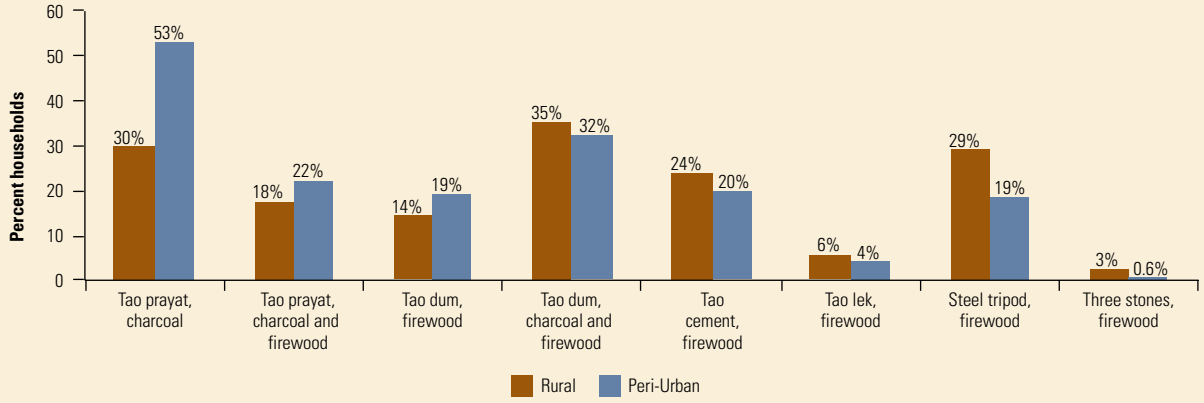
Stove type/model	Description
Tao prayat/charcoal	Bucket-shaped, clay stove
Tao prayat/firewood and charcoal	Bucket-shaped, clay stove
Tao dum/charcoal	Cylinder-shaped, clay stove
Tao dum/firewood and charcoal	Cylinder-shaped clay stove
Tao cement/firewood	Bucket- or cylinder-shaped concrete stove
Tao lek (steel)/firewood	Bucket- or cylinder-shaped steel rod and metal sheet
Kieng (tripod)/firewood	Ring-shaped, metal tripod
Sao sam khon/firewood	Three-stone stove

Sources: CSI field survey and interviews with stove producers in Vientiane capital and Vientiane, Bolikhamsai, and Khammouane provinces.
Note: tao = stove; prayat = saving; dum = black; sao = post; sam = three; khon = pieces.

The most popular type of cookstove is the tao prayat (charcoal model), which is owned and used by more than four-fifths of all households and more than half of peri-urban ones, followed by the tao dum (firewood and charcoal model), used by more than two-thirds of all households and over one-third of rural ones. Less than half of households, at 48 percent and 44 percent, respectively, use the steel tripod or tao cement stove types, both of which use firewood only. The tao prayat (firewood and charcoal model) is used by two-fifths of households, while the tao dum (firewood model) is used by about one-third of households. Only one-tenth of households use the tao lek, while use of the three-stone stove is limited to 3 percent of rural households and less than 1 percent of those in peri-urban areas (figure 4.1).

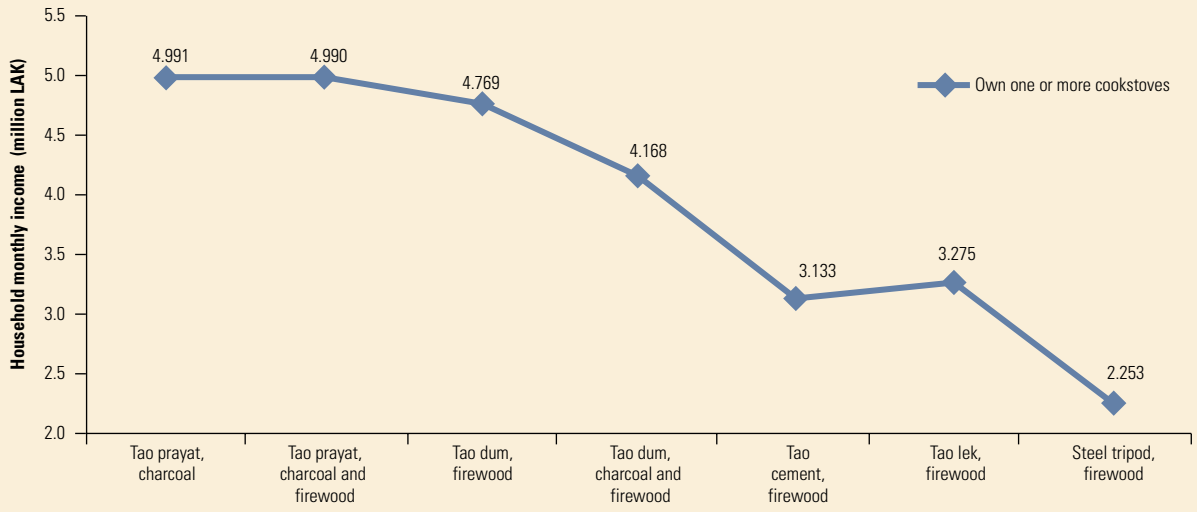
Interestingly, ownership and use of the charcoal version of the tao prayat is 23 percent greater among peri-urban households than rural ones (53 percent versus 30 percent). By contrast, the steel tripod, which uses firewood, is owned and used by 10 percent more rural households than peri-urban ones (29 percent versus 19 percent) (figure 4.1). Also noteworthy is that financially better-off households tend to use the charcoal version of the tao prayat, while lower-income households tend to prefer the tao cement, tao lek, and steel tripod, all of which use firewood exclusively (figure 4.2).

FIGURE 4.1 COOKSTOVE OWNERSHIP IN RURAL AND PERI-URBAN AREAS



Source: CSI field survey in rural and peri-urban areas of Vientiane capital and Vientiane, Bolikhamsai, and Khammouane provinces.

FIGURE 4.2 COOKSTOVE OWNERSHIP PREFERENCES BY HOUSEHOLD INCOME



Source: CSI field survey in rural and peri-urban areas of Vientiane capital and Vientiane, Bolikhamsai, and Khammouane provinces.

Household Affordability

The CSI survey findings show that peri-urban and urban households in the areas studied can afford all of the cookstove types and models, which are widely available in local markets and neighborhood retail shops. But due to the stoves' short service life, households may spend at least LAK 50,000–70,000 (US$6–9) per year for two cookstoves. For poorer households in rural areas, this price range may be beyond reach. Household income is positively associated with the number of stoves owned. For rural households that own one, two, or more than two cookstoves, the average monthly income is LAK 3.3, 3.6, or 4.4 million, respectively, compared to LAK 4.1, 4.7, or 7.4 million in peri-urban areas.

Stove Durability and Customer Satisfaction

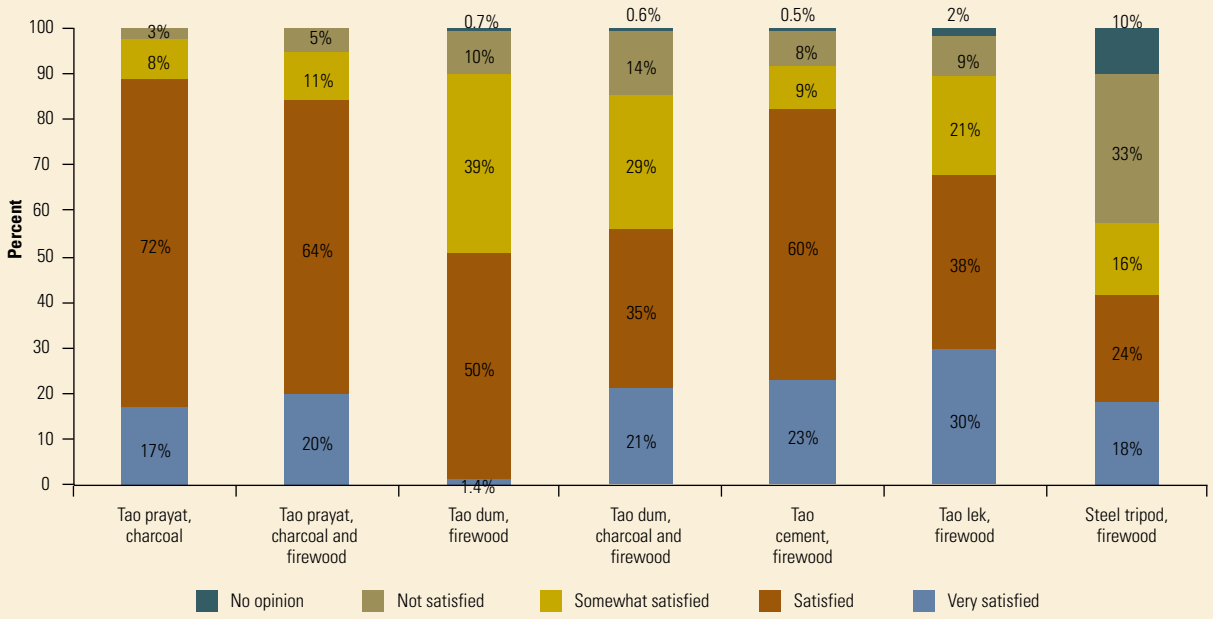
The short service life of most cookstoves—about six months on average—has both advantages and disadvantages. From the stove producer's point of view, the short service life results in high turnover, meaning that producers can make and sell more stoves, albeit with a thin profit margin. From the household customer's perspective, cookstoves must be replaced every six months, but they are inexpensive and affordable, with no upfront cost issues. However, households seldom take into account—and many are unaware of—the added (and usually hidden) transaction costs that frequent repair and replacement of stoves will incur.

BOX 4.1 EVIDENCE OF POTENTIAL DEMAND FOR BETTER STOVES

As originally designed, the tao prayat cookstove has a durability of up to two years, but most of the types and models currently sold on the commercial market in Lao PDR last only about six months. Compared to regular bucket stoves, the tao prayat process requires more steps. Even though the stove costs more to make, its wholesale price is the same as that of regular bucket stoves. Owing to stiff market competition and low profit margins, stove producers have cut costs by reducing the tao prayat's needed insulation, grate thickness, and number of grate holes. Not surprisingly, the grate is usually the first component that requires replacing. Despite the failure to conform to original specifications to ensure quality and durability, the tao prayat remains quite popular among buyers. Stove producers continue to make the tao prayat, albeit in small quantities, while retail shop owners lack sufficient supply to meet customer orders, suggesting a large potential market for truly improved cookstoves.

Sources: CSI market survey and interviews with stove producers in Vientiane capital and Bolikhamsai, Khammouane, and Vientiane provinces.

FIGURE 4.3 HOUSEHOLD SATISFACTION LEVEL WITH COOKSTOVES OWNED



Source: CSI field survey in rural and peri-urban areas of Vientiane capital and Vientiane, Bolikhamsai, and Khammouane provinces.

Despite the durability issue, most surveyed households expressed satisfaction with the cookstoves they own and use. The level of satisfaction varied slightly by type and model. The tao prayat models—both charcoal (72 percent satisfaction) and firewood and charcoal (64 percent satisfaction)—were the clear winners. The tao cement, which uses only firewood, was another winner, with a satisfaction rate of 60 percent. One-third of households were dissatisfied with the steel tripod, which had the highest overall dissatisfaction rate (figure 4.3).

Local artisan edging clay of the tao prayat

Although most owners of the tao prayat and tao dum cookstoves were satisfied (figure 4.3), about three-fifths agreed that these stove types have a short service life. These somewhat contradictory findings suggest that consumers may not expect much from the performance of these cookstoves or have never experienced the true tao prayat, as originally designed, which meets expected levels of quality and durability (box 4.1).

Cookstove Production

The CSI market survey confirms that all commercially available cookstove types and models described above are based on the Artisan Production Model.[10] Interviews with stove producers on the outskirts of Vientiane capital and in Bolikhamsai, Khammouane, and Vientiane provinces reveal that cookstoves sold on the market are individually made by local artisans in small family-owned businesses. Owners and workers are trained by other

10. The Global Alliance for Clean Cookstoves (GACC) defines the Artisan Production Model as one where "stoves are made locally by small enterprises—often by trained artisans building mud stoves in place in people's homes, typically based on a fixed design. The scale of production here is typically on the order of 100s to low 1,000s per year…." Details are available at http://cleancookstoves.org/overview/what-is-a-clean-cook stove/.

artisans, apprentice with other cookstove producers, or are self-taught.

Typically, a production facility consists of one large shed without a wall and one or two kilns, depending on the scale of production, which is usually small given that stoves are handmade. Key stovemaking materials are mud, clay, cement, rice ash (black and white), and metal sheet. Most producers use clay as their main material to make and sell a terra-cotta cookstove, the most common types of which are the tao prayat and the tao dum. They also use cement to make the tao cement stove and steel to make the tao lek, both of which are portable. The main energy inputs for the terra-cotta stove types are rice husk and/or firewood, depending on the type of kiln used, along with an electric-powered motor for mixing the clay. This machine is also used to mix cement for the portable tao cement stove.

Production Limitations

Production processes are slow and labor-intensive, incurring high costs; while quality control, based on visual inspection, is weak. An analysis of production costs, collected from the CSI market survey and interviews with producers, indicates that producers have a thin profit margin; since they rely on fast turnover, they may not be interested in stove durability. At the same time, the increased use of charcoal as the main source of cooking energy among urban and peri-urban households has created greater stove demand. Market competition is stiff, with truly improved cookstoves having to compete against regular bucket stoves and cheaper imitations.[11]

Most stove producers lack appropriate training for making the tao prayat and even regular bucket stoves. Production technologies have not progressed since the tao prayat was first introduced, and most producers use trial-and-error methods. Most do not understand the technical requirements for firing/baking or the most suitable types of kilns. In addition, they are unaware of the energy-efficiency levels of the stoves they produce. Lack of training and technological know-how, combined with stiff market competition and low profit margins, has led producers to cut corners to reduce costs. As a result, the quality and durability of stove types and models have deteriorated and fail to meet expected standards (box 4.1).

11. Cookstoves sold in the market are relatively inexpensive; the retail price range for small- and medium-sized stoves for family use is about LAK 25,000–35,000 (about US$3.00–4.40), with no price difference between the so-called tao prayat and regular biomass cookstoves.

Tao cement, tao dum, and tao prayat for sale in neighborhood retail shop

The CSI market survey and interviews with cookstove producers confirm that most stove producers have low capital and limited or no access to credit. Many producers indicated that, owing to a lack of capital, it would be difficult for them to invest in new production techniques and technology. At the same time, virtually all producers expressed a keen interest in learning how to improve their stove production techniques and processes.[12]

Supply Chain Features

The CSI survey reveals that stove producers rely on two channels to market their stoves. The first one is to deliver directly to retail shop owners, who in turn must pay the producers in full (in cash) upon delivery. Using this channel requires that the producers own a truck for transporting stoves to the retail shops; however, they receive a better price. The second channel—by far the most common—is to rely on wholesalers/traders, who purchase

Cookstove factory outside Vientiane capital

12. With appropriate training, cookstove producers could produce the same number of high-quality tao prayat as traditional cookstoves in the same amount of time.

Tao dum (at right) sold alongside bagged charcoal in neighborhood shop on the outskirts of Vientiane capital

stoves in bulk from producers, at about 200 stoves per visit, and transport them to the retail shops, where they are sold.

Given that stove producers seldom own a truck for transporting stoves and usually lack knowledge and means of marketing, wholesalers/traders play a key role in the cookstove supply chain. Since virtually all wholesalers/traders protect their sources, the cookstove producers usually depend entirely on those they consider most reliable to market their stoves. Some retail shop owners located in the main market or along the main road receive offers from other wholesalers/traders to supply cookstoves to their shops. In the areas surveyed, more than four-fifths of cookstoves are purchased from the market, which functions as the hub of cookstove supply and demand; 15 percent are purchased from village or neighborhood retail shops, and less than 5 percent are bought from traders.

The supply-chain analysis confirms that cookstove producers require assistance in learning how to better market and sell their products. As part of the effort to improve supply-chain efficiency, there is a need for better communication and information flow between stove users and producers. With user feedback, producers would have a clearer understanding of how to improve their stoves to satisfy customers' needs and preferences. Currently, producers lack access to such information, which the wholesalers/traders (middlemen) usually screen.

Conclusion

The current patterns and trends of cookstove ownership in the CSI field survey area reveal favorable conditions for promoting better stove alternatives. First, the vast majority of households purchase their cookstoves. Second, the steel tripod (kieng) and tao lek, although more durable than the other models and types, are used by far fewer households, either because of their poor performance (i.e., the steel tripod is perceived as performing worse than the three-stone stove) or safety concerns (i.e., the tao lek lacks insulation). Third, the tao prayat, originally designed as an energy-efficient cookstove, has the advantage of its recognized name. Finally, there is ongoing demand for the tao prayat, reflecting consumers' willingness to pay for what they perceive to be a better stove.[13] Even if prices doubled, the cookstoves currently available on the market would be affordable to most households. The current annual outlay for cookstoves among urban and peri-urban households suggests significant potential for introducing more energy-efficient stoves that are affordable.

Concurrent with promotional campaigns to introduce the improved stoves, parallel efforts are required to increase efficiencies at all levels of the supply chain (e.g., correcting for market failure of the tao prayat to meet energy-efficiency and durability standards and building the capacity of stove producers and distributors) to ensure that improved stoves are commercially available at an affordable price. Based on these findings, the next chapter proposes an intervention strategy for scaling up household access to clean cooking solutions.

13. More than half of all of the households surveyed said they would be willing to pay LAK 10,000 more for a tao prayat than a tao dum.

5

Strategy to Promote Improved Cookstoves

Findings from the CSI stocktaking activities show that existing market conditions in Lao PDR cannot create supply and demand for improved cookstoves. As discussed in the previous chapters, key market deficiencies must be corrected. On the demand side, there is a significant need to educate household members about the link between the health effects of indoor air pollution (IAP) and energy-inefficient cookstoves and thus generate demand for better stoves. On the supply side, it is important to work with manufacturers to up their game and raise stove producers' awareness of the potential for scaling up their businesses. The government has a role to play in setting and monitoring the rules of the game, while financing institutions need to step up, seeing interest from the supply and demand sides.

Unlike past efforts to promote the use of improved cookstoves, which were rather fragmented and small in scale, the proposed intervention strategy will cover all provinces. Scaling up will utilize a market-based approach, which is the most efficient way to ensure the ongoing availability of improved cookstoves at affordable prices in the market. The public sector has an important role to play in enhancing market mechanisms to correct for past deficiencies. The sections that follow describe the capacity-building and technical-assistance activities needed for the public and private sectors, along with the supporting institutional arrangements that stakeholders agree are needed to ensure success.

Building Public-Sector Capacity

Public-sector capacity building and technical assistance will focus on advising staff of national and local governments and academic institutions on establishing and enforcing standards, labeling, and certification for improved cookstoves, as well as setting up a national cookstove testing laboratory. In addition, through support for Research and Development (R&D), consumers will be offered better stove choices.

Cookstove Standards, Labeling, and Certification

Results of the CSI market survey, combined with a historical review of the cookstove market, confirm that the original durability and energy-efficiency standards for the improved stove models introduced in 1997 have not held up, indicating the need to institute and enforce national standards, labeling, and certification criteria. To be aligned with international clean cookstove standards, the proposed standards for Lao PDR are expected to consist of basic criteria on energy efficiency, emissions, safety, and IAP. Given the country's current socioeconomic and stove market conditions, the clean cookstove standards will account for existing levels of stove production technology and pricing to ensure that local producers can meet these standards and customers can afford to purchase the stoves. In addition, flexibility will be built in so that standards can be raised as production technologies improve and more models and options for clean cooking become commercially available. This means that standards will be regularly reviewed and updated to reflect changing conditions.

Before establishing and enacting these cookstove standards, thorough consultations must be held with all key stakeholders. The Institute of Renewable Energy Promotion (IREP) of the Ministry of Energy and Mines (MEM) and the Renewable Energy and New Materials Institute (RENMI) of the Ministry of Science and Technology (MOST) will manage the consultation process and establish the process for issuance of certification, labeling, and enforcement. This will ensure that cookstoves sold on the market meet energy-efficiency and emission standards and consumers are informed about whether the stoves they purchase are truly improved. In addition, the proposed intervention calls for MEM and MOST to set up mechanisms to implement and enforce stove standards, certification, and labeling.

National Cookstove Testing Laboratory

The proposed intervention also calls for RENMI and the Faculty of Engineering, National University of Laos (NUOL) to establish the first national cookstove testing laboratory. Given past experiences of cooperation between academic institutions and MOST, it is expected that these two institutions will be able to share knowledge and technologies. The laboratory will be used to assist the government in establishing cookstove testing protocols to ensure that standards and methods are uniformly applied throughout the country. The laboratory will both test the cookstoves and issue certificates for those that meet the standards.

The laboratory will also function as a center for R&D on improved cookstoves and a training center for national and provincial government officials to test existing cookstoves in national and local markets and new ones about to be introduced to the market. The laboratory will lead the effort to increase the number of cookstove models available on the market to better meet demand from all market segments. As a training center, the laboratory will ensure that government officials in all provinces are capable of running cookstove testing laboratories.

It is expected that RENMI and the NUOL Faculty of Engineering will jointly establish and operate the national cookstove testing laboratory. Once established, the laboratory will eventually expand to key provinces and ultimately all provinces, where it will share lessons learned. The main functions of the provincial testing laboratories will be to (1) test cookstoves sold in the respective provinces and (2) issue certification and labeling.

Educating Consumers and Offering Better Stove Choices

As discussed in chapter 4, consumers who purchased the tao prayat models were unaware that the majority of these stoves failed to meet the fuel-efficiency combustion and durability standards of the original type and models. Thus, the proposed intervention strategy includes public education and information dissemination campaigns to correct for such market failures and ensure the free flow of information. Currently, the two tao prayat models—designed for either charcoal or firewood and charcoal use—are the only ones on the Lao PDR market that could be considered for improvement and promotion as improved cookstoves. But as originally designed, the tao prayat focused only on fuel savings and did not directly address the harmful health impacts of cooking smoke. Thus, for this cookstove to be considered truly improved, such deficiencies would need to be corrected.

This suggests that more types, models, and technologies with different energy-efficiency levels and emissions standards should be available to meet all segments of market demand. These designs should reduce both indoor air pollution (IAP) and fuel consumption. To promote cookstove innovation, the proposed intervention will support R&D for developing and adapting new improved models, engaging RENMI, academic and research institutions, and the private sector in both Lao PDR and abroad. In addition, IREP, RENMI, and the provincial offices of their respective ministries (MEM and MOST), along with the private sector and other project partners, will ensure that all models of improved cookstoves are promoted and disseminated throughout the country.

Building Supply-Chain Capacity

As discussed in chapter 4, stocktaking activities show that all cookstove production in Lao PDR is based on artisan production techniques and processes. Local stove producers have limited capacity and technological know-how. Most have never been trained to produce improved cookstoves. None have the capacity to use advanced technical designs beyond the tao prayat for developing and producing improved stoves. Thus, a major focus of accelerating the dissemination of improved cookstoves on the supply side is building stove producer capacity.

Training Stove Producers

The proposed intervention will engage private- and public-sector institutions—with RENMI and the NUOL Faculty of Engineering expected to serve as lead agencies—to work in partnership to train producers in new stove technology, techniques, and processes. As part of this effort, a technology development and training facility for improved stoves will be established where shortcomings in meeting fuel-efficiency and combustion standards will be addressed.

As previously mentioned, the stovemaking process is labor- and energy-intensive, involving about a dozen steps. These include mixing clay with carbonized rice husk, hand-molding to form the stove shape, carving to shape the stove, air and/or semi-sun drying, making grates, baking, and installing insulation and a metal sheet as the wraparound.

The CSI survey findings show that some producers have received complaints from neighbors about the smoke emitted when baking stoves and have had difficulty finding rice husks as the primary energy source for baking. Given this context, producer training will focus on exploring alternative production processes and techniques, baking and baking energy sources, and kiln designs. It is expected that RENMI will conduct these training activities since the institute has conducted research on improved cookstoves and stovemaking in the past, including the design of large kilns for baking stoves.

Traditional brick dome kiln

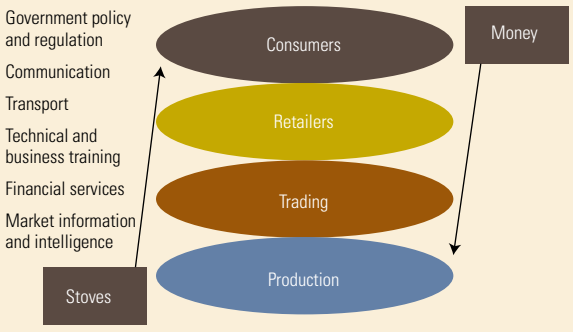
Ensuring Producer Access to Financing

The CSI survey reveals that the majority of stove producers have limited access to financing for investing in new equipment to improve or expand production, and nearly all rely on their personal savings to start their businesses. All of the producers surveyed expressed strong interest in improving their production processes and techniques if it were possible. Their major hindrances are lack of capital and access to credit. To ensure that the skills they learn at the training facility can be applied, the proposed intervention will help qualified producers gain access to credit through a revolving fund that would allow them to take out interest-free loans over an agreed period of time. The revolving fund, originally set up to help households overcome the high upfront cost of solar photovoltaic (PV) home systems, is operated by the IREP. Consultation with the institute confirms that it would be possible to utilize this Rural Electrification Fund (REF) for the CSI. The proposed intervention seeks to mobilize donor funding to be added to the REF earmarked specifically for the CSI.

Improving Market-Chain Efficiency

The proposed intervention will help cookstove producers develop business plans and a producer network to gain access to market information and intelligence and thus understand marketplace dynamics. This activity is vital to improving efficiency of the cookstove market chain: the numerous links that connect all actors and transactions involved in the movement of cookstoves from producers to consumers (figure 5.1).

FIGURE 5.1 COOKSTOVE MARKET CHAIN

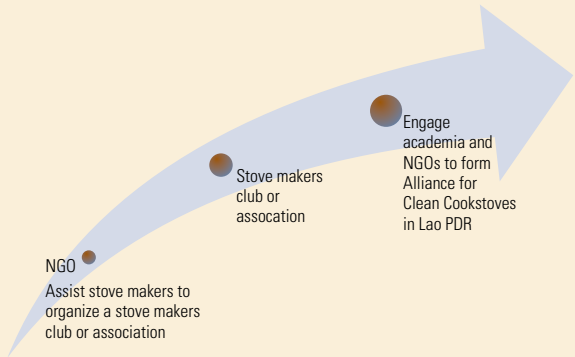


Source: Author.

Simple walled kiln

Efficiency of the market chain generally depends on how well information flows among actors in the market chain. Improved cookstoves flow up the chain, while money flows down the chain. The proposed producer training and capacity building would likely increase the supply of improved cookstoves on the market. But getting the right balance between supply and demand in the marketplace takes more than a production focus. All too often, the market is unable to absorb rapid or sudden increases in supply that exceeds demand, often resulting in reduced prices or a price collapse. To claim and maintain a competitive advantage, stove producers must have sound business plans and decision-making based on dynamic information. In short, the cookstove production business must be managed with due attention to new market opportunities, changing needs of consumers, and how market trends influence buying. Therefore, training in business operations is as important as technical support to improve production techniques.

FIGURE 5.2 PROPOSED PROCESS TO FORM ALLIANCE FOR CLEAN COOKSTOVES



Source: Author.

Cutting tin-coated, metal sheet wraparounds for stoves in family-owned business outside Vientiane capital

The proposed intervention strategy will pay attention to which types of market information should be generated for which actors in the market chain and how to make it accessible. This information flow will also include feedback from consumers up the value chain. The proposed strategy will include market surveys, focus group interviews, and demonstrations to link producers with consumers and the participation of and support to women and community groups. Information from these activities will be fed back to retailers, wholesalers, and producers through capacity building provided to these actors.

Establishing an Alliance for Clean Cookstoves in Lao PDR

In response to the CSI survey finding that virtually all cookstove production in Lao PDR is based on the Artisan Production Model, the intervention strategy will support the organization of cookstove producers into an alliance for clean cookstoves, which will allow members to exchange ideas and knowledge about their stove businesses. A nongovernmental organization (NGO) experienced in working with producers in the country could act as a focal point for alliance members to gain access to knowledge and ideas. The NUOL, which will play a key role in stove testing, R&D, and training, could provide additional support. If established, the Lao PDR alliance would enable members to share knowledge and experiences with other alliances in the region and ultimately the world (e.g., through the Global Alliance for Clean Cookstoves) (figure 5.2).

Cooking with the tao dum at storefront outside household

Raising Public Health Awareness and Marketing

To further promote adoption of improved cookstoves, the proposed intervention will inform the public of the links between using cookstoves and the health impacts of IAP. Past promotion programs limited their focus to reducing fuel needs and improving hygiene. As discussed in chapter 3, the CSI findings confirm people's lack of awareness of the links between IAP exposure and respiratory and other illnesses despite evidence documented by the Ministry of Health (MOH), which recommended raising women's awareness of the health impacts of using energy-inefficient stoves; increasing stove efficiency; improving household ventilation, especially in kitchens; and developing and disseminating information, education, and communication (IEC) materials.[14]

Empirical evidence elsewhere has shown that sensitizing households to the risks incurred from cooking with inefficient stoves and inferior fuels requires particular focus on campaigns designed to raise public health awareness, including the use of IEC materials. Past programs that assumed households would spontaneously adopt improved stoves often ended in failure since households need to be convinced of the direct and indirect benefits of using the improved cookstoves (Ekouevi and Tuntivate 2011). Thus, the overall intervention strategy will begin with community- or village-level campaigns, reinforced by those at the national level.

International experience shows that, without the active participation of all stakeholders—from local communities and NGOs to governments and the private sector—household energy projects cannot succeed. Thus, the proposed intervention will foster partnerships and cooperation among a broad array of stakeholders—ranging from the improved cookstove retailers and the Lao Women's Union (LWU) to key ministries, including the MOH and MEM—to develop and implement public-information, education, and marketing campaigns to raise household awareness about the problem of IAP and cookstoves and promote adoption of improved stoves. Supported by the public awareness campaigns and related activities, the broad marketing campaign will include activities and materials designed to help retailers market and sell improved cookstoves, accompanied by more targeted support to entrepreneurs for developing competitive marketing strategies.

Institutional Arrangements

The introduction and dissemination of improved cookstoves require both multidisciplinary expertise and multisector cooperation among all stakeholders, requiring a common objective and policy. For cooperation to be efficient, all stakeholder institutions must have clearly defined roles and responsibilities. The subsections that follow detail the proposed institutional setting at the policy level and the roles and responsibilities of the implementing institutions.

Policy Context

During stakeholder consultations, it was agreed that a CSI working committee should be established and chaired by the MEM (Director General of IREP). Other key member ministries and organizations will include the Ministry of Agriculture and Forestry (MAF); MOST; Ministry of Information, Culture, and Tourism; MOH; Ministry of Natural Resources and Environment (MONRE); NUOL; Ministry of Finance (MOF); Ministry of Industry and Commerce; and LWU. The IREP will serve as secretary of the working committee, whose protocols (e.g., regular meeting schedule and agenda) will be decided during the early

14. Using the same background studies as Mengersen et al. (2007), the Environment and Occupational Health and Safety Division of the Department of Hygiene and Prevention reported in 2008 on the vulnerability of women and children to the health hazard of indoor pollution from cookstove smoke.

TABLE 5.1 PROPOSED ROLES AND RESPONSIBILITIES OF IMPLEMENTING INSTITUTIONS

Institution	Activity area/task
Ministry of Energy and Mines (MEM) • Institute of Renewable Energy Promotion (IREP)	Clean Development Mechanism • Serve as the carbon finance coordinating entity for clean cookstoves in Lao PDR if it is found to be eligible for carbon finance Coordination among Agencies • Serve as the coordinating agency for the CSI • Chair (Director General of IREP) the CSI working committee Clean Cookstove Standards • Draft clean cookstove standards and submit the draft standards for RENMI to review and submit to the Department of Standards and Copyright of MOST • Enforce the standards and labeling for clean cookstoves Training and Public Information, Education, Awareness, and Marketing Campaigns • Implement nationwide training, public education, social marketing, and promotion of clean cookstoves
Ministry of Science and Technology (MOST) • Renewable Energy and New Materials Institute (RENMI) • Department of Standards and Copyright National University of Lao PDR (NUOL)	Clean Cookstove Standards (MOST) RENMI • Review, authorize, and submit proposed clean cookstove standards to the Department of Standards and Copyright of MOST for approval and enactment Department of Standards and Copyright • Approve and enact clean cookstove standards and labeling Stove Testing, Labeling, and R&D (RENMI/MOST and NUOL) • Establish and operate the clean cookstove testing facility • Establish stove-testing protocols • Conduct R&D • Train national and local government officials on operating testing facilities Building Private-sector Capacity and Improving Production Techniques and Supply Chain (RENMI/MOST and NUOL) • Operate the clean cookstove training center and train stove producers • Transfer technology and train producers in design and production of clean cookstoves
Ministry of Health (MOH) • Environmental and Occupational Health and Safety Division Lao Women's Union (LWU)	Public Health Campaign and Awareness Raising • Conduct nationwide public awareness and education campaigns and promote behavioral changes
Ministry of Natural Resources and Environment (MONRE)	Clean Development Mechanism • Serve as the designated national authority for approval

Source: Stakeholders Consultation Workshop, May 2012.

stages of implementing the proposed intervention. The Renewable Energy Development Strategy already has a high-level committee in place under the government office, chaired by the MEM minister with members representing all other 17 ministries. The working committee will ensure that policy and strategic directives for the CSI are in line with national policy and the Renewable Energy Development Strategy.

Implementation

Through stakeholder consultations, it has been agreed that the IREP will serve as the CSI focal point and coordinating agency. The proposed institutional arrangements include various ministries, educational institutions, and organizations with grassroots-level support (table 5.1). It is possible that certain roles and responsibilities may overlap. For example, two ministries (MEM and MOST)

and an academic institution (NUOL) have capacity-building and technical-assistance responsibilities. The MOH and the LWU will participate directly in education and awareness-raising campaigns, especially on issues related to public health and the risk of IAP, since both have strong grassroots support from local communities and awareness-raising know-how.

To measure progress and achievements during and following implementation of the proposed intervention strategy, monitoring and evaluation (M&E) will be conducted. Details of the M&E system (e.g., assigning and scheduling tasks and setting indicators and targets) will be developed at the outset of strategy implementation.

Summary Remarks

This chapter has highlighted the importance of a market-based approach as the most efficient way to promote improved cookstoves in Lao PDR. It has underscored the public sector's role in enhancing market mechanisms, including developing new stove technologies to give consumers more and better choices; providing infrastructure to support the dissemination of new cookstoves; establishing national testing standards, labeling, and certification; intervening to correct for market failures; promoting education, training, and awareness-raising activities; and assisting cookstove producers in overcoming deficiencies and barriers. Long-term sustainability of the intervention is closely tied to the country's capacity to carry out these activities. As a result, public- and private-sector capacity building and technical assistance are vital to success. Finally, implementation requires multisector cooperation, entailing close coordination among multiple stakeholders with clearly defined roles and responsibilities.

6

Promoting Biogas Systems

The Government of Lao PDR is keen to establish a national biogas program, building on the achievements of the country's Bigoas Pilot Program (BPP). Over a five-year period, the BPP has installed 2,504 biogas digesters in five provinces, covering 41 districts and 792 villages. The national program would extend coverage to an additional six provinces. The initiative would be scaled up under the Renewable Energy Development Strategy in Lao PDR, with a goal of having significantly greater numbers of qualified farming households using biogas by 2025. Implementing this initiative would, in turn, reduce dependence on LPG imports, as well as firewood and charcoal, for household cooking.[15]

Overview of Biogas Promotion in Lao PDR

Currently, the BPP is the only active biogas promotion program in Lao PDR.[16] This program was initiated in 2006 through a memorandum of understanding between the Ministry of Agriculture and Forestry (MAF) and the Government of the Netherlands. The Netherlands Development Organisation (SNV) provided €1.1 million to support initial implementation in 2007–10, with another €550,000 provided for 2011–12. Major implementing entities include the Biogas Advisory Board (national level); Project Steering Committee (regional level), with representatives of various organizations offering program guidance and coordination; and Provincial Agriculture and Forestry Offices (PAFOs) and district-level coordinators (local level). In addition, the SNV offers technical assistance. The BPP is headquartered in the MAF's Department of Livestock and Fisheries (DLF).

Over the BPP's initial three years (2007–10), 1,996 biogas systems were installed. The initial target of 6,000 systems, which reflected technical potential, was later revised down to 2,000, in line with market potential (table 6.1). Challenges to implementation in 2010–11 included natural disasters (e.g., protracted flooding in Khammouane and Savannakhet provinces) and extreme temperatures (e.g., cold weather, resulting in the death of more than 2,000 cattle).

TABLE 6.1 BIOGAS SYSTEM INSTALLATION

	Systems installed (number)	
Year(s)	Target	Actual
2007–10	2,000	1,996
2011	650	439
2012	450	–

Source: Personal communication with BPP program manager.

15. The Government of Lao PDR has requested funding support from the Asian Development Bank (ADB) to disseminate biogas systems in the six additional provinces; however, at the time of this writing, the ADB had not indicated whether it would be interested in supporting the proposed national biogas program.

16. Prior to the BPP, biogas efforts in Lao PDR were limited to small demonstration projects. Biogas technology was first introduced in 1983, with support from the Food and Agriculture Organization (FAO). Initially, family-sized biogas units were set up by the MAF, with FAO cooperation. Since 1993, the Science, Technology and Environment Agency (STEA) has been involved in developing pilot plants supported by Canada and Thailand. The UN-Habitat built 5 biogas systems in Oudomsai province; while the Lao-Chinese cooperation program installed 4 household-sized systems in Xiang Khoang and 30 systems in Vientiane, all of which are for demonstration purposes.

The BPP is well planned and executed. It builds on the cumulative experience and lessons learned from successful biogas programs in neighboring countries, including Cambodia and Vietnam, and the broader Asia region, including Nepal and China, adapting key components to Lao conditions. Four sizes of biodigesters are offered (4, 6, 8, and 10 cubic meters [m^3]), and the cost range for the system, including the stove, is about US$441–706. Predictably, demand is limited mainly to relatively better-off farming households (i.e., livestock [cattle and pigs] and rice [with several water buffalo]). Typically, these livestock and rice farmers are located in areas without readily available fuelwood, including deforested areas, and lack electricity access.

Surveys of households participating in the BPP illustrate the biodigesters' many economic, environmental, and health benefits (TABI 2011). Economic savings for the average family include 1.5 hours per day in labor, US$89 in annual fuel and chemical fertilizer costs, and at least 44.9 kg of firewood and 32.5 kg of charcoal for cooking each month. Environmental benefits include a reduction in tree-cutting, which supports sustainable forest management, and the treatment of manure for biofertilizer, which enhances soil productivity. In terms of health, the major benefit is a reduction in smoke-borne diseases associated with indoor air pollution (IAP). Added health benefits are better hygiene and sanitation conditions, resulting from the use of animal and human waste to reduce parasites, viruses, bacteria, and vector-borne diseases, thus contributing to the goals of the Ministry of Health (MOH) initiative.[17]

National Program Scale-Up: What Are the Challenges?

Despite the above-mentioned benefits, the BPP has had a low adoption rate. Interviews with the the project manager and an assessment of promotional campaign materials indicate that the project has relied on good practices for social marketing, education, and information campaigns.[18] The CSI field visits show that some of the key barriers to greater customer participation, outlined below, have involved stringent qualification criteria, high upfront system costs and lack of attractive financing terms, uncertainty of the biogas business, unavailability of replacement parts, and various cultural issues.

Inlet for feeding slurry into the household biodigester, Sikhottabong District, Vientiene capital

Stringent Qualification Criteria

To qualify for participation, the BPP requires farming households to have at least 5–6 cattle or at least 10 pigs—about twice the numbers originally required. The new criterion was put in place in response to Lao farmers' preference for having free-roaming cattle penned only at night. The number of livestock may vary by year, and it is quite difficult to foresee whether farmers can maintain the minimum number required to operate the biogas systems. Also most farmers maintain livestock as an investment and liquid asset, and market price risk influences their decision on holdings. Thus, maintaining the required number of animals at all times to supply biogas is not attractive.

High Upfront Costs and Unwieldy Subsidies

Like biogas projects in other countries, the BPP in Lao PDR provides participants a subsidy to defray the upfront cost of the system, whose total investment requirement averages about US$500. The BPP subsidy of US$219 (in kind and cash) is substantially higher than those provided under similar biogas projects in Vietnam and Cambodia, at $60 and $150, respectively. The main justifications for Lao's higher subsidy are the farming households' low adoption rate, difficulty in accessing finance, and low income levels.[19] But even with the large subsidy (about

17. Since 1990, the MOH's Environment and Occupational Health and Sanitation Department, working with the Center for Environmental Health and Water Supply, has been constructing pour-and-flush latrines to improve household hygiene, requiring that all human and animal waste be located outside a 30-meter radius of water sources and be carefully managed.

18. One promotional campaign offers LAK 100,000 to anyone who can successfully bring in one new customer.

19. To date, the total numbers of biogas systems adopted in Vietnam and Cambodia are estimated at 200,000 and 16,000, respectively.

31–50 percent), the initial outlay–ranging from $222 to $487, depending on the size of the biodigester—may make the system unaffordable for many otherwise interested participants. Informal lending may be available in the villages, but interest rates are extremely high. The most preferred collateral for credit is the land deed. No farmer is willing to take such a risk, particularly since alternative fuelwood is cheap or freely available from the local environment.

Lack of Access to Financing

Most Lao farmers lack access to formal lending, and microfinance is not widely available. In 2011, the BPP was able to secure support from the Agriculture Promotion Bank (APB) to provide small loans to program participants. Unfortunately, the APB has decided to suspend this type of lending due to insufficient loan volumes to maintain the lending product. As a result, many interested farmers without savings to pay for the biogas systems will be unable to participate.

Uncertain Sustainability of the Biogas Business

The BPP has succeeded in producing well-trained biogas system builders. Local masons receive extensive training (about three weeks) to ensure quality construction of the systems. As a result, the biodigester tank and entire system are of sound quality. However, for several major reasons, the program has not been able to establish a sustainable biogas business for the local masons. First, due to the low adoption rate, local masons trained by the BPP have been unable to obtain enough construction contracts to stay in business. Second, some masons may lack sufficient capital to establish their businesses. Third, there is competing demand for skilled masons and plumbers in Lao PDR, owing, in part, to the recent construction boom. As a result, many skilled masons trained by the BPP may find it easier to work in the construction industry than to build biodigesters and install biogas systems.

Cattle tethered in farmyard for easy manure collection

Quality Control and After-Sales Service

The BPP has put in place quality control and after-sales service. Masons provide regular service during the first year after construction. After two years, the PAFOs conduct a warranty inspection, and a warranty fee is paid for the mason. About 11 percent of the subsidy is set aside for the warrantee fees and put in an escrow account. Conversations with a few biogas users confirm that their systems are functioning well.

Yet certain issues related to after-sales service have begun to emerge. Some customers noted they could not receive help when problems arose. Also, owing to the small size of both the program and the country, certain system parts and components are unavailable in the local market and must be imported. Replacements for the biogas lamp, an optional add-on part, are unavailable; fortunately, this is not a serious issue since all BPP participants have access to electricity. However, in the long run, the lack of spares and replacement parts will present a challenge, especially if the current pilot project scales up to the proposed national-level program.

Cultural Barriers

National scale-up will also require overcoming various cultural barriers related to customary farming and cooking practices and household time use. Since most livestock farmers do not pen their animals, as previously mentioned, they are not interested in spending extra time each day collecting dung, mixing it with water, and filling a biodigester tank. Even those few farmers who pen their livestock are not interested in taking the time needed to collect dung and take it to the digester tank, particularly since collecting fuelwood each day takes relatively little time.

In terms of cooking practices, households that have adopted biogas systems still use their cookstoves to prepare traditional dishes in preferred ways. In addition, a biogas stove requires that the user assume a standing position; however, the traditional cooking habit in Lao households is to be seated when using the stove. While urban households are gradually transitioning to a standing position, rural households have not made the change.

Biogas use could also require that households reallocate the time use of women and men. Men spend an average of 30 minutes a day tending animals, compared to 18 minutes for women (Lao Department of Statistics 2009); however, women spend about twice as much time as men collecting firewood. Thus, households will have to decide who will assume the added time burden of collecting dung for the biogas system.

TABLE 6.2 SAMPLE FINANCING ARRANGEMENT

	Term of lease	
Subsidy and payment	**Three years**	**Six years**
Initial payment, US$50–100	100	50
Monthly payment, US$6–10	10	6
Total payment	36 x 10 + 100 = 460	72 x 6 + 50 = 482

Source: Author.

Note: The current estimated cost of the smallest biodigester system (4 m^3) is about US$440.

Summing Up

Based on a critical review of the BPP, it appears that lack of access to financing is the most critical barrier to adoption of biogas digesters by otherwise interested farming households. Many of the barriers discussed above are interrelated and could be resolved with access to financing. For example, once households can overcome high upfront system costs, the adoption rate may take off, in turn, bringing local masons more work.[20] The next section offers an alternative strategy to resolve this financing issue.

Proposed Pilot Financing Alternative

The proposed intervention strategy will pilot an alternative financing solution based on the country's experience in off-grid rural electrification. Implemented by the Institute of Renewable Energy Promotion (IREP), the off-grid program makes solar PV home systems available to remote households through hire-purchase agreements. Households can choose from a range of solar PV panel sizes. They pay an installation fee (the lowest is about LAK 130,000 or US$16), lease the system, and make monthly payments of LAK 10,000–25,000 (about US$1–3) over 5 or 10 years, depending on what the household can afford. At the end of the lease period, the household becomes the owner of the system.

Monthly repayments are deposited into the Rural Electrification Fund (REF). As discussed in chapter 5, the REF is a revolving fund established by the government to help off-grid rural households overcome the high upfront costs of solar PV home systems (ASTAE 2012). The REF is considered a central component of Lao PDR's off-grid rural electrification effort. Similarly, the proposed financing solution for biogas will offer farming households interest-free access to the REF to cover upfront system costs,[21] with the loan repayable in monthly installments over an agreed-to period. This pilot program will require cooperation between the DLF, which will implement the program, and the IREP, which will be responsible for financial management (figure 6.1).

Under the proposed intervention strategy, some 100 participants in the proposed pilot scheme would use the REF to finance their biogas systems and enter into hire-purchase agreements. Table 6.2 gives examples of proposed financing arrangements. To reduce management cost, especially for monthly payment collection, it is expected that participants will make their monthly repayments using an experimental cellular phone program.[22]

Institutional Arrangements

The proposed pilot financing scheme for 100 biogas systems will rely on existing institutional arrangements, with the exception of financing, for which the IREP will assume responsibility. The Ministry of Energy and Mines (MEM) will conduct promotional campaigns and social marketing; the MOH may collaborate in raising awareness about the health and safety benefits of biodigesters (e.g., using animal and human waste to reduce parasites, viruses, bacteria, and vector-borne diseases) (table 6.3). Through close monitoring and evaluation (M&E), the

20. Other areas where improvements could be made include (1) promoting the management, use, and sale of slurry as an organic fertilizer to reduce expenditure on chemical fertilizers and generate additional income; (2) emphasizing livestock business management to address potential uncertainties in the livestock market and the size of required livestock holdings for households to participate in the biogas program; (3) addressing after-sales service, especially the availability of spare parts, and consumer outreach; and (4) overcoming cultural barriers through education, awareness-raising, and marketing campaigns.

21. No subsidy is provided for the upfront cost.

22. Currently, the IREP and the World Bank are exploring the development of a monthly bill payment system using cellular phones for customers with off-grid solar PV systems. Likewise, the proposed pilot financing alternative for biogas will test monthly loan repayment to the REF via cellular phone.

TABLE 6.3 PROPOSED INSTITUTIONAL ROLES AND RESPONSIBILITIES

Institution	Activity area/task
Ministry of Energy and Mines (MEM) • Institute of Renewable Energy Promotion (IREP)	• Finance through the Rural Electrification Fund (REF); collect and manage monthly payments • Conduct promotional campaigns and social marketing, possibility in collaboration with the Ministry of Health (MOH)
Ministry of Agriculture and Forestry (MAF) • Department of Livestock and Fisheries • Department of Agriculture	Department of Livestock and Fisheries (DLF) • Promote livestock and bioslurry management • Conduct quality control and inspection Department of Agriculture • Support and coordinate bioslurry management
Local masons	• Construct and install biogas systems • Train and educate users

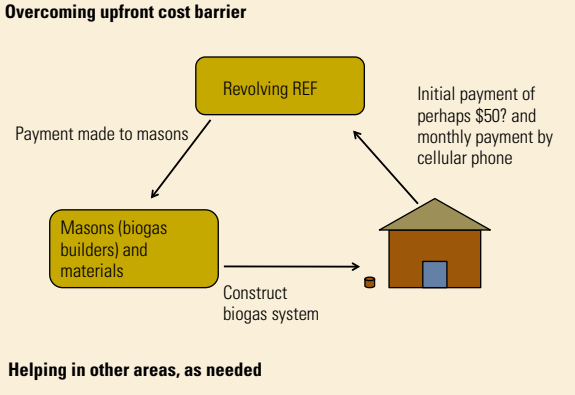
Source: Stakeholders Consultation Workshop, May 2012.

lessons learned on the financing alternative, coordination between ministries, and other issues will be examined for their scale-up potential.

Capacity Building and Technical Assistance

Because the main obstacle to biogas uptake is farming households' lack of access to financing, the proposed capacity building and technical assistance will emphasize making biogas more financially attractive to farmers. This promotional effort will focus on four areas of activity.

FIGURE 6.1 PROPOSED ALTERNATIVE FINANCING FOR PILOT BIOGAS PROGRAM



Source: Author.

First, technical assistance will be provided to the DLF to strengthen its capacity to educate farmers on livestock business management. Second, in coordination with the Department of Agriculture, the use and commercial sale of bioslurry as an organic fertilizer will be promoted to reduce farmers' expenditure on chemical fertilizers, generate farmer income, and possibly increase the value of their agricultural products. Third, the DLF will develop and draft updated standards for biodigesters, which will be confirmed and authorized by the MOST. External support and research may be provided by the SNV, which developed the current standards, and others. Finally, assistance will be provided to improve after-sales service, including quality control and inspection.

Summary Remarks

Uptake of the existing BPP in Lao PDR has been slow, despite the large subsidy. If the current financing approach were continued, covering 10,000 households would require at least US$2.2 million for the subsidy alone. The alternative financing approach presented in this chapter is considerably cheaper and potentially more sustainable and thus should be tried and tested. The proposed piloting of 100 systems will provide an opportunity to examine lessons learned from the BPP to chart a new course for a more sustainable, scaled-up national program.

7

Conclusion

Despite Lao PDR's progress in recent decades to transition toward modern forms of cooking energy, prospects remain limited. The prices for both LPG and electricity are relatively high in proportion to household income, and fuelwood is abundant and readily available, particularly in rural areas. Over the past two decades, increasing numbers of households have begun switching from fuelwood to charcoal as their main source of cooking energy. This shift has been more pronounced in urban areas than rural ones and is accelerated among households in the country's most economically well-off provinces and capital city. Thus, it is likely that fuelwood will continue to predominate as the main household cooking fuel, at least in the foreseeable future.

Continued heavy reliance on fuelwood for household cooking underscores the important role of improved cookstoves in mitigating health risks for household members who spend many hours each day in the kitchen or cooking area, primarily women and their young children. The findings of the CSI field survey reinforce results from Mengersen et al. (2007), which revealed a strong association between indoor air pollution (IAP) and respiratory illness in women and children. The CSI survey findings confirm that women and young children in households that use fuelwood for cooking are in the highest risk group for IAP exposure.

Improved cookstoves are not yet available on the market in Lao PDR; however, the CSI field survey shows that current patterns, trends, and preferences for cookstove ownership are favorable for promoting and marketing better stoves. More than half of the households in the CSI study area use more than one cookstove, and household income is positively associated with the total number of stoves owned. Thus, it appears that improved stoves would be affordable to most households. The tao prayat, the most popular commercially available cookstove, especially among peri-urban households, was originally designed as an improved stove; the market failure to maintain standards for fuel efficiency suggests the need to educate household members about the links between biomass cooking smoke and IAP exposure to generate demand for truly improved cookstoves.

On the supply side, the CSI study revealed key deficiencies that must be overcome in order to build a successful market for improved stoves. Virtually all cookstove production is based on the Artisan Production Model, meaning that stoves are made individually by hand, using slow, labor-intensive processes and low-input technology with weak quality control. Businesses are small and fragmented, and may be difficult to organize. Many are family-owned, with limited or no access to financing. As a result, most cookstove producers lack the financial capacity to invest in new technology. Because of their thin profit margin owing to stiff competition, producers rely on a fast turnover and thus may lack incentive to make more durable stoves. Furthermore, they lack training in business management and marketing, as well as technological know-how to improve their production techniques.

To correct for market deficiencies in both supply and demand, the proposed intervention strategy will use a market-based mechanism, which is widely considered the most efficient way to sustainably promote improved cookstoves. As discussed in chapter 5, it is envisioned that the public and private sectors will work in partnership, with the public sector providing needed research and development (R&D), infrastructure, standards, education and raising of public awareness, and training and

other technical assistance for producers and distributors. In addition, the dissemination of improved cookstoves will require coordination across various ministries and cooperation among multiple stakeholders, with clearly designated roles and responsibilities.

To further promote clean cooking solutions, Lao PDR has an opportunity to promote biogas use among a niche market segment (i.e., farming households with sufficient numbers of livestock to generate enough slurry to create methane gas). As discussed in chapter 6, uptake of the existing Biogas Pilot Program (BPP) has been slow to date, owing mainly to the high system cost, at about US$500, and unwieldy subsidies. The proposed piloting of 100 biogas systems using an alternative financing approach offering interest-free loans and lease-purchase agreements without upfront subsidies is less costly and should be tried. Building on what has been learned from past programs in Lao PDR, along with lessons from international experience, the country has an opportunity to chart a new course for developing a scaled-up biogas program.

Summing up, achieving universal access to clean household cooking solutions in Lao PDR requires a holistic approach. The results of this assessment indicate that a small proportion of wealthier households will be able to access LPG and increasingly more urban households will transition to purchased charcoal as their incomes rise. There is also a promising niche market for biogas systems among qualified farming households with livestock. For most households—including those in the lowest income groups—who will continue to rely mainly on firewood, the proposed approach to creating a thriving stove market offers an important pathway to cleaner cooking. The benefits are fewer premature deaths, healthier and more productive lives, less drudgery for women, and less pressure on the environment.

ANNEX A

Selected Development Indicators for Lao PDR

Province/prefecture	Total population, 2011	Total annual consumption, billion LAK	GDP per capita		Total no. of households	Household electrification, 2010	
			LAK	US$		No. of households with electricity	Percent household access
Vientiane capital	829,206	4,195	8,866,633	1,043	128,207	127,388	99.4
Phongsaly	175,646	422	3,833,634	451	28,531	5,884	20.6
Luang Namtha	168,249	451	4,499,516	529	28,831	6,228	56.3
Oudomsai	306,293	781	4,274,925	503	46,244	21,508	46.5
Bokeo	169,005	411	4,082,970	480	27,606	19,061	69.0
Luang Phrabang	437,583	1,367	4,955,630	583	69,981	46,520	66.5
Houaphan	306,105	703	3,632,037	427	44,813	16,392	36.6
Sayaboury	371,558	1,665	7,229,061	850	66,614	51,978	78.0
Xiang Khoang	262,278	850	5,157,445	607	40,463	22,265	55.0
Vientiane	442,347	1,744	5,998,783	706	83,011	69,098	83.2
Bolikhamsai	269,425	959	6,039,547	711	41,127	33,639	81.8
Khammouane	385,235	1,247	5,411,716	637	61,524	44,636	72.6
Savannakhet	940,885	3,006	5,376,553	633	140,461	101,577	72.3
Saravane	375,282	963	4,308,527	507	78,555	57,623	73.4
Sekong	103,666	233	3,942,238	464	13,772	6,504	47.2
Champassak	685,098	2,558	6,303,044	742	108,568	84,962	78.3
Attapeu	132,236	355	4,588,648	540	22,729	9,328	41.0
Total	**6,360,098**				**1,031,037**	**734,591**	**71.2**

Sources: Lao Department of Statistics 2009; Ministry of Energy and Mines; and World Bank staff estimates.

ANNEX B

Changes in Forested Area Distribution

	Distribution (%)			Change (%)		
Land-use group and type	**1982**	**1992**	**2002**	**1982–92**	**1992–02**	**1982–02**
Current forest	**49.142**	**47.162**	**41.491**	**-1.980**	**-5.672**	**-7.652**
Dry dipterocarp	5.216	5.095	0.563	-0.121	0.468	0.347
Lower dry evergreen	0.374	0.361	0.237	-0.013	-0.124	-0.137
Upper dry evergreen	4.670	4.481	5.861	-0.189	1.380	1.191
Lower mixed deciduous	3.771	3.651	3.720	-0.120	0.069	-0.051
Upper mixed deciduous	32.907	31.463	23.224	-1.444	-8.239	-9.683
Gallery forest	0.383	0.370	0.119	-0.013	-0.251	-0.264
Coniferous	0.584	0.557	0.376	-0.027	-0.181	-0.208
Mixed coniferous	1.237	1.184	2.221	-0.053	1.037	0.984
Tree plantation	--	--	0.169	--	--	0.169
Potential forest	**36.142**	**37.971**	**47.095**	**1.667**	**9.496**	**10.971**
Bamboo	6.153	6.469	2.276	0.316	-4.193	-3.877
Unstocked	27.448	28.680	42.636	1.232	13.956	15.188
Shifting cultivation area	2.523	2.642	2.183	0.119	-0.459	-0.340
Other wooded area	**6.526**	**6.098**	**1.210**	**-0.428**	**-4.888**	**-5.316**
Savannah/open woodlands	4.113	3.853	0.399	-0.260	-3.454	-3.714
Heath, shrub forest	2.431	2.245	0.811	-0.186	-1.434	-1.602
Sum of all forest area	**91.8**	**91.1**	**89.8**	**-0.741**	**-1.246**	**-2**

Source: FAO 2010.

ANNEX C

Field Survey Methodology

The CSI field survey consisted of (1) a **household cooking energy survey**, conducted separately in **peri-urban areas** and **rural areas** and (2) a **market survey of biomass cookstoves and the supply chain**. The survey was conducted in four prefecture/provinces: Vientiane capital, Bolikhamsai, Khammouane, and Vientiane. For peri-urban areas, the total sample size was 300 households. A one-stage sampling method was used, with representative households randomly selected from each village. For rural areas, approximately 600 households were sampled, using a two-stage sampling method. In the first stage, some 30–40 rural villages from four provinces were randomly selected, out of which about 15–20 representative households were randomly selected. The market survey covered the entire cookstove supply chain (i.e., retailers, wholesalers and traders, and producers). More than 80 retail shop owners were surveyed, and for every cookstove producer surveyed, one or two key wholesalers used by that producer were interviewed.

Lao PDR Clean Cook-Stove Initiative

Household Identification Number _____

HOUSEHOLD COOKING ENERGY SURVEY • World Bank Sponsored Project

Name of Province: _____ District: _____ Village: _____

Name of Respondent: _____

Date of Interview: _____/_____/_____ (Date/Month/Year)

Name of Interviewer: _____ Signature: _____

Name of Supervisor: _____ Signature: _____

Name of Field Supervisor/Editor: _____ Signature: _____

Data Key in By: _____ Signature: _____

RESPONDENT AGREES TO BE INTERVIEWED: Time Start: _____

Time End: _____

Section A. Information on Household Member

	Information on Respondent		Var Name
A1	What is the age of the respondent?	_____ years old	A1
A2	What is the sex of the respondent?	Male.....1 Female.....2	A2
A3	What is the educational level of the respondent?	No Formal Education .....0 Primary School.....1 Middle School .....2 High School.....3 College Education.....4 University Education.....5 Post-graduate Education.....6	A3
A4	What is the respondent's relationship with the head of household?	Head of Household.....1 Spouse of Head .....2 Daughter.....3 Son .....4 Daughter-in-Law.....5 Son-in-Law.....6 Parents .....7 Parents-in-Law .....8 Other (specify) _____.....9	A4

If respondent is NOT "Head of Household"

	Information on Head of Household		Var Name
A5	What is the age of the head of household?	_____ years old	A5
A6	What is the sex of the head of household?	Male.....1 Female.....2	A6
A7	What is the educational level of the head of household?	No Formal Education .....0 Primary School (grades 1–3) .....1 Primary School (grades 4–7) .....2 Middle School (S1–S4).....3 High School (S5–S6) .....4 College Education.....5 University Education.....6 Post-graduate Education.....7	A7
A8	What is the marital status of the head of household?	Married/Living Together .....1 Single/Never Married.....2 Widower .....3 Separated/Divorced .....4 Other (specify) _____.....5	A8

If respondent is NOT "Spouse of the Head of Household"

	Information on Spouse of Head of Household		Var Name
A9	What is the age of the spouse of the head of household?	_____ years old	A9
A10	What is the sex of the spouse of the head of household?	Male.....1 Female.....2	A10
A11	What is the educational level of the spouse of the head of household?	No Formal Education .....0 Primary School (grades1–3) .....1 Primary School (grades 4–7) .....2 Middle School (S1–S4).....3 High School (S5–S6) .....4 College Education.....5 University Education.....6 Post-graduate Education.....7	A11

Household Member

	Total number of persons that eat and sleep in the household (fill in according to age).		Var Name
A12	Less than 6 years old	_____ Persons	A12
A13	6–12 years old	_____ Persons	A13
A14	13–18 years old	_____ Persons	A14
A15	19–22 years old	_____ Persons	A15
A16	23–45 years old	_____ Persons	A16
A17	46–60 years old	_____ Persons	A17
A18	61 and older	_____ Persons	A18
A19	Total	_____ Persons	A19
A20	How many persons in your household earn income? (include all income earned by everyone in the households)	_____ Persons	A20
A21	Does your household usually prepare meals for the household's own consumption?	Yes ..... 1 No 2	A21

Var Nam	Household Income Items	Kips	Var Nam	Household Expenditure Items	Kips
A31	Salaries (husband, wife, son, daughter, etc.)		A41	Foodstuffs, beverages, cigarettes, alcohol	
A32	Wages		A42	Clothing	
A33	Income from farming, agricultural activities		A43	Housing, rent, home repairs	
A34	Income from business activities		A44	Transportation	
A35	Remittances received		A45	Health care, medicines	
A36	Government allowances, welfare, pension		A46	Education	
A37	Income from handicrafts		A47	Other (specify) _____	
A38	Other (specify) _____		A48	Other (specify) _____	
A39	Other (specify) _____		A49	Other (specify) _____	
A40	Total household income		A50	Total household expenditure	

Section B. Housing Unit Information

	Housing Information		Var Name
B1	What is the ownership status of this house?	Own ..... 1 Rent ..... 2 Rent Free ..... 3 Parent's/Family's ..... 4 Other (specify) 5	B1
B2	Is any part of your house used for business activity or commercial purposes or home industry, i.e., business owned and operated by you or a member of your household?	Yes ..... 1 No 2	B2
B3	If part of your house is used for business activity, please indicate type.	Hair Salon or Barber Shop ..... 1 Food Stall or Shop (prepare food to sell) ..... 2 Grocery & Beverage Shop ..... 3 Beverage Shop ..... 4 Retail Store ..... 5 Tailor/Dressmaker ..... 6 Clothing Retail ..... 7 Repair/Tool Shop (e.g., Television) ..... 8 Other (specify) _____ 9	B3
	What is the main source of drinking water for this household?	Var Name B4	What is the main source of water used by your household for other purposes, such as cooking and hand washing?	Var Name B5
	Piped Water Into Dwelling ..... 11 In Yard/Plot ..... 12 Public Tap ..... 13 Open Well In Dwelling ..... 21 In Yard/Plot ..... 22 Open Public Well ..... 23 Protected Well In Dwelling ..... 33 In Yard/Plot ..... 34 Public Well ..... 35 Spring ..... 41 Rivers/Stream ..... 42 Pond/Lake ..... 43 Rainwater ..... 44 Tanker Truck ..... 45 Bottled Water 46		Piped Water Into Dwelling ..... 11 In Yard/Plot ..... 12 Public Tap ..... 13 Open Well In Dwelling ..... 21 In Yard/Plot ..... 22 Open Public Well ..... 23 Protected Well In Dwelling ..... 33 In Yard/Plot ..... 34 Public Well ..... 35 Spring ..... 41 Rivers/Stream ..... 42 Pond/Lake ..... 43 Rainwater ..... 44 Tanker Truck ..... 45 Bottled Water 46	
	Kitchen Information		**Var Name**
B6	Does this (fire/stove) have a chimney, a hood, or neither of these?	Chimney ..... 1 Hood ..... 2 Neither 3	B6
B7	Do you have a kitchen or separate room that is used as a kitchen?	Yes ..... 1 No 2	B7
B8	Is the cooking usually done in the house, in a separate room/kitchen, or outdoors?	In the House ..... 1 In a Separate Room/Kitchen ..... 2 Outdoors ..... 3 Other (specify) _____ 4	B8 GO TO B10
B9	Are there any windows or vents in the kitchen area or kitchen	No Windows/Vents ..... 0 One ..... 1 More Than One 2	

	Communication and Transportation		Var Name	
B10	Mobile Phone	YES ..... NO	B10	.....
B11	Fixed Phone	1.....2	B11	.....
B12	Bicycle	1.....2	B12	.....
B13	Car	1.....2	B13	.....
B14	Pickup Truck	1.....2	B14	.....
B15	Motorcycle	1.....2	B15	.....
B16	TV	1.....2	B16	.....
B17	Radio	1.....2	B17	.....
B18	XXXXXXXXX	1.....2	B18	.....
B19	XXXXXXXXXX	1.....2	B19	.....

Section C. Identifying Fuel Types

	Please indicate which of the following fuels your household has used for any activity during the past 12 months.	Used .....Not Used	Var Name
C1	Charcoal	1.....2	C1
C2	Firewood	1.....2	C2
C3	Kerosene	1.....2	C3
C4	LPG	1.....2	C4
C5	Electricity	1.....2	C5
C6	Sawdust	1.....2	C6
C7	Rice Husk	1.....2	C7
C9	Coal Briquette	1.....2	C9
C10	Other (specify)	1.....2	C10
C11	Other (specify)	1.....2	C11
C8	Straw Stalk and Other Crop Residues	1.....2	C8
C9	Three to five years ago, did you use Straw Stalk and Other Crop Residues?	1.....2	C9

Section D. Charcoal

	Information on Charcoal Usage				
	During the past 12 months, did your household use charcoal for any of the following purposes and how often does your household use it?				
	Purposes	Var Name	CODE: [1] = Yes [2] = No	Var Name	Code: [1] = Main Fuel [2] = Sometimes [3] = Rarely
D1	Cooking	D1A		D1B	
D2	Boiling Water	D2A		D2B	
D3	Business Activities	D3A		D3B	
D4	Other (specify)	D4A		D4B	
D5		D5A		D5B	

If answered "NO" to all questions (D1A to D5A), go to Section E.

D6	How does your household obtain charcoal to use at home?	Purchase Only.....1 Make My Own Charcoal.....2 Both Purchase and Make Own Charcoal.....3 Other (specify) _____.....4	If the household only makes its own charcoal, GO TO D7

	Charcoal: Monthly Expenditures and Quantity Used		Var Name
D7	Is the price of charcoal today lower, the same or higher than 3–5 years ago?	Lower than 3–5 Years Ago.....1 Same as 3–5 Years Ago.....2 Higher than 3–5 Years Ago.....3 Do Not Know.....4	D7
D8	On average, how much does your household spend on charcoal each month?	_____ Kips/Month	D8

In which UNIT AND NUMBER OF UNITS does your household usually purchase charcoal?				What are the AVERAGE WEIGHT (kg) and PRICE PER UNIT of charcoal your household usually purchases?					
TYPE OF UNIT CODE: [1] = Kg [2] = Large Bag [3] = Small Bag [4] = Other (specify)		NUMBER OF UNITS		If answered [1] in D9, enter kg in D9A		WEIGHT IN KG PER BAG If answered [2] or [3], [4] enter kg per bag		PRICE IN KIPS PER UNIT	
D9		D10		D11		D12		D13	

D14	On average, how many days does the typical purchase lasts?	_____ Days	D14
D15	On average, how many units of charcoal does your household usually USE per month?	_____ Units/Month	D15

For household that makes his/her own charcoal to use at home or answer [2] or [3] in D6.

	Where did your household obtain wood to make charcoal?	CODE: [1] = Yes [2] = No	Compared to 3–5 years ago, do you have to spend shorter time, the same amount of time, or a longer time to obtain wood to make charcoal?	CODE: [1] = Shorter Time [2] = Same Amount of Time [3] = Longer Time
D16A	Forest		D16D	
D17A	Trees from Own Land		D17B	
D18A	Private Land		D18B	
D19A	Village Forest		D19B	
D20A	Other (Specify)		D20B	

Section E. LPG

Information on LPG Usage

During the past 12 months, has your household used LPG for any of the following purposes and how often does your household use it?

	Purposes		CODE: [1] = Yes [2] = No		CODE: [1] = Main Fuel [2] = Sometimes [3] = Rarely
E1	Cooking	E1A		E1B	
E2	Boiling Water	E2A		E2B	
E3	Public Land	E3A		E3B	
E4	Other (specify)	E4A		E4B	

If answered "NO' to questions (E1A to E4A), Go to SECTION F.

LPG: Monthly Expenditures and Quantity Used

Which size of LPG cylinder does your household usually purchase (kg)? Kilograms		What was the price of LPG per cylinder? Kips/Cylinder		How many days does one LPG cylinder last? Days	
E4		E5		E6	

Section F. Firewood

Information on Firewood Usage

During the past 12 months, has your household used FIREWOOD for any of the following purposes and how often does your household use it?

	Purposes		CODE: [1] = Yes [2] = No		CODE: [1] = Main Fuel [2] = Sometimes [3] = Rarely
F1	Cooking	F1A		F1B	
F2	Boiling Water	F2A		F2B	
F3	Business Activities	F3A		F3B	
F3	Other (specify)	F4A		F4B	

If answered "NO' to questions (F1A to F4A), Go to SECTION G.

F5	How does your household obtain firewood to use at home?	Collect Only .....1 Purchase Only.....2 Purchase and Collect .....3 Other (specify).....4	F5

Purchase Firewood

The following questions are for a household that purchased firewood, i.e., answer [2] or [3] in F5. If household did not purchase firewood, skip this subsection.

	Firewood: Monthly Expenditures and Quantity Used		
F6	Is the price of firewood today lower, the same, or higher than 3–5 years ago?	Lower than 3–5 Years Ago .....1 Same as 3–5 Years Ago.....2 Higher than 3–5 Years Ago.....3 Do Not Know 4	F6
F7	On average, how much does your household spend on firewood per month?	_____ Kips/Month	F7

In which UNIT AND NUMBER OF UNITS does your household usually purchase firewood?				What are the AVERAGE WEIGHT (kg) and PRICE PER UNIT of firewood your household usually purchases?					
TYPE OF UNIT CODE: [1] = Weight in Kg [2] = Bundle [3] = Stack or Pile [4] = Sack or Bag [5] = Cart Load [6] = Pickup Truck [7] = Other (specify)		**NUMBER OF UNITS**		**If answered [1] in F8, enter total kg usually bought**		**WEIGHT IN KG PER UNIT If answered [2] to [7] in F7, enter kg per unit usually bought**		**PRICE IN KIPS PER UNIT**	
F8		F9		F10A		F10B		F11	

F12	On average, how many days does the typical purchase lasts?	_____ Days	F12
F13	On average, how many units of firewood does your household usually PURCHASE per month?	_____ Units/Month	F13

Collect Firewood

F14	On average, of the total firewood used in a month, how much does the amount of firewood that your household collects account for?	All (Collect Only) .....1 Almost All .....2 More Than Half .....3 Half .....4 Less Than Half .....5 Small Portion.....6	F14

The following are questions for households that collect firewood.
If household did not collect firewood, skip the firewood collection subsection.

In a typical collection, what unit(s) of measure do you use in collecting firewood?		In a typical collection, what is the AVERAGE WEIGHT (in kg) PER UNIT, and how many units does your household usually collect?				How many total days does the typical collection of firewood last?	
TYPE OF UNIT CODE: **[1] = Weight in Kg** **[2] = Bundle** **[3] = Stack or Pile** **[4] = Sack or Bag** **[5] = Cart Load** **[6] = Pickup Truck** **[7] = Other (specify)**		**WEIGHT IN KG PER UNIT** **(I answer [1] in F15 enter total kg usually buy, if answer [2] to [7] in F15, enter kg per unit usually collect).** **KILOGRAM**		**TOTAL NUMBER OF UNITS USUALLY COLLECT UNITS**		**DAYS LAST PER EACH TYPICAL COLLECTION DAYS**	
F15		F16		F17		F18	

F19	How many of these collected units (given in F15) of firewood did you use in a month?	_____ Units/Month	F19

How much total time (hours per week) did the following household members take in collecting firewood or tree residues?

Adult Male		Adult Female		Children (Boys)		Children (Girls)	
F20		F21		F22		F23	

In a typical collection, how many of the following household members are involved in collecting firewood?

Adult Male		Adult Female		Children (Boys)		Children (Girls)	
F24		F25		F26		F27	

F28	Compared to 3–5 years ago, does your household have to spend a shorter time, same amount of time, or longer time to collect firewood?	**CODE:** **[1] = Shorter Time** **[2] = Same Amount of Time** **[3] = Longer Time**	F28

	Where did your household obtain firewood to use at home?		Compared to 3–5 years ago, do you have to spend less time, same amount of time, or longer time to collect wood to use at home?	
		CODE: **[1] = Yes** **[2] = No**		**CODE:** **[1] = Shorter Time** **[2] = Same Amount of Time** **[3] = Longer Time**
F29A	Forest		F29B	
F30A	Trees from Own Land		F30B	
F31A	Private Land		F31B	
F32A	Village Forest		F32B	
F33A	Other (specify)		F33B	

Section G. Electricity

Information on Electricity Usage

During the past 12 months, has your household used electricity and electric cooking appliance(s) for any of the following purposes and how often does your household use them?

	PURPOSES/TYPE OF ELECTRIC APPLIANCE USED	Var Name	CODE: [1] = Yes [2] = No	Var Name	CODE: [1] = Main Fuel [2] = Sometimes [3] = Rarely
G1	Cook Food	G1A		G1B	
G2	Boil Water	G2A		G2B	
G3	Rice Cooker To Cook Rice	G3A		G3B	
G4	Bake Food/Cake	G4A		G4B	
G5	Other (specify)	G5A		G5B	

If the household answered "NO" for G1 to G5, go to the next section.

G6	On average, how much does your household spend on ELECTRICITY per month?	_____ Kips/Month	G6	

Does your household own any of the following electric appliances?

CODE: [1] = Yes
[2] = No

Hot Plate		Oven		Rice Cooker		Electric Hot Water Pot/Dispenser		Electric Hot Pot/Wok	
G7		G8		G9		G10		G11	
Toaster Oven		**Microwave Oven**		**Other (specify)**		**Other (specify)**		**Other (specify)**	
G7		G8		G9		G10		G11	

Section H. Cooking Practices[a]

H1	Who usually prepares meals for the household?	Head of Household.....1 Spouse of Head of Household.....2 Daughter.....3 Son .....4 Daughter-in-Law.....5 Son-in-Law.....6 Mother-in-Law.....7 Maid.....8 Other (specify).....9	H1
H2	What is the age of the person who usually prepares meals for the household?	_____ Years old	H2
H3	How many people does he/she usually prepare meal for?	_____ Persons	H3
H4	How many children under 5 years old are present in the kitchen or cooking area while cooking?	_____ child/children Enter "0" for no children under 5 years old present while cooking.	H4
H5	While cooking, what position do you usually take, standing or sitting?	Sitting.....1 Standing .....2 Use Both Positions 3	H5
H6	Which one do you prefer?	Sitting.....1 Standing .....2 Use Both Positions 3	H6

Does your household prepare meal for household member for the following meals, and how long does it take to prepare each meal?

CODE: [1] = Yes
[2] = No

Breakfast		Time in Minutes		Lunch		Time in Minutes		Dinner		Time in Minutes	
H7		H8		H9		H10		H11		H12	

a. To avoid misreading, the letter "I" was intentionally omitted from the ordering of survey sections; thus, Section H is followed by Section J.

SECTION J. BIOMASS STOVE OWNERSHIP[a]

TYPE OF BIOMASS STOVE	How many does your household own? No. of Stoves Do not have to enter "0" No.	How many months have you been using this stove? Months	How many days have you used this type of stove during the past 7 days? Days	How much (in Kips) did you pay for this stove? Kips	Who did you buy this stove from? CODE Market ..... 1 Local Shop ..... 2 Mobile Trader ..... 3 Stove Maker ..... 4 Made at Home.... 5 Other 6	Has your household ever used this type of biomass stove before? Yes ..... No	How satisfied are you with this stove? CODE Very Satisfied..... 1 Satisfied..... 2 Somewhat Satisfied..... 3 Not Satisfied ..... 4 No Opinion..... 5	How many months did your previous stove last? Months
Tao Prayat (Charcoal)	J1A	J1B	J1C	J1D	J1E	1.....2	J1F	J1G
Tao Prayat (Firewood and Charcoal)	J2A	J2B	J2C	J2D	J2E	1.....2	J2F	J2G
Tao Dum (Charcoal)	J3A	J3B	J3C	J3D	J3E	1.....2	J3F	J3G
Tao Dum (Firewood and Charcoal)	J4A	J4B	J4C	J4D	J4E	1.....2	J4F	J4G
Tao Concrete	J5A	J5B	J5C	J5D	J5E	1.....2	J5F	J5G
Tao Lek (Steel)	J6A	J6B	J6C	J6D	J6E	1.....2	J6F	J6G
Kieng (Steel Tripod)	J7A	J7B	J7C	J7D	J7E	1.....2	J7F	J7G
Khon Sao Sam Khon (Three Stone)	J8A	J8B	J8C	J8D	J8E	1.....2	J8F	J8G
Other (specify)	J9A	J9B	J9C	J9D	J9E	1.....2	J9F	J9G

J9	Please give reasons why you are satisfied or not satisfied with the biomass stove that you have been using the most during the past 7 days.				
	If you can make changes in your cooking condition, which improvement on cooking would you like to see the most? CODE: [1] = First Priority [2] = Second Priority [3] = Third Priority [4] = No Need To Change [5] = No Opinion				
J10	Kitchen Area, Kitchen		J16	Less Soot on Pots and Pans	
J11	More Space For The Cooking Area		J17	Less Smoke While Cooking	
J12	Clean Kitchen Overall		J18	Less Smoke When Starting Fire	
J13	Switch to Charcoal		J19	Time Spent Collecting Firewood	
J14	Switch to LPG		J20	Buy New Stove	
J15	Less Soot on the Ceiling and Wall				

Section K. Attitude

	Statement (Interviewer reads the following statement and asks respondent whether he or she strongly agrees, agrees, disagrees, strongly disagrees, or has no opinion.) **CODE:** **[1] = Strongly Agrees** **[2] = Agrees** **[3] = No Opinion** **[4] = Disagrees** **[5] = Strongly Disagrees**		
	Smoke from stove is good at chasing mosquitoes away.	K1	
	Smoke from cooking fuels is a big health problem in my family.	K2	
	Cooking with firewood is not very convenient.	K3	
	Firewood is expensive for cooking.	K4	
	Cooking with electricity is convenient.	K5	
	I wish TAO PRAYAT would last more than one year.	K6	
	Breathing is more difficult when using firewood for cooking.	K7	
	Smoke from firewood is harmful to a person's health.	K8	
	Cooking with firewood creates better-tasting dishes.	K9	
	Cooking with charcoal is very convenient to use.	K10	
	Cooking with charcoal is harmful to a person's health.	K11	
	Electricity is expensive for cooking.	K12	
	Breathing is more difficult when using charcoal.	K13	
	Charcoal is not expensive for cooking.	K14	
	Firewood is very hard to obtain in the market.	K15	
	LPG is very difficult to obtain in the market.	K16	
	LPG is expensive for cooking.	K17	
	TAO PRAYAT is easy to find in the market.	K18	
	TAO DUM is easy to find in the market.	K19	
	It would be very good if we could use firewood, as well as charcoal, as the fuel for TAO PRAYAT	K20	
	TAO PRAYAT is not durable.	K21	
	TAO DUM is not durable.	K22	
	I am willing to pay 10,000 kips more for TAO PRAYAT than TAO DUM.	K23	
	THREE STONE	K24	

Market Survey of Biomass Cookstove and Supply Chain

To map cookstove producers, market surveys were conducted both up and down the supply chain. To identify the majority of cookstove producers, the approach was to start with retailers and move up the market chain to wholesalers and traders and ultimately the producers. In addition, in collaboration with NGOs who have been working in the region to identify cookstove producers, surveys were conducted down the market chain from the producers identified by the NGOs and up the market chain, starting with the identified producers' retailers (figure C.1).

The types of survey data collected included the geographic location of production, sales, and market coverage and wholesale and retail channels. Information was also collected on business models, financing sources, and market mechanisms; quality assurance methods and barriers to business expansion; and stove types, efficiency and emission levels, and cost range.

Retailer Interviews

The market survey team must select towns and/or communities that serve as the area's trading center or towns and/or communities that have a well-established trading post or market serving the area/community. The survey should include all types of cookstove retailers.[b] The survey data are used to identify specific intervention activities at the retail and wholesale levels, as well as overall intervention strategies. Specific steps for the field interviewer and accompanying questions for the retailers are as follows:

1. **Profile and locate retail shop.**
2. **Explore and examine cookstove sales and marketing in the retail market.**

- How does the cookstove reach the market; that is, how does the retail shop obtain the cookstove to sell to customers?
  The overall goal is to describe the physical structure of the cookstove market supply chain.
- What are the types of cookstoves sold in the market? How many types of cookstoves are available in each of the markets selected (pictures of each stove type found in the market are required)?

FIGURE C.1 MARKET SUPPLY CHAIN: KEY SURVEY ISSUES

Producers	1. Interview owners or key person. 2. Review, examine, and determine the business model for cookstove production and key processes, quality control, marketing strategies, and financing. 3. Determine the cost structure, identify existing constraints/problems facing owner, and explore potential for improvement and expansion.
Wholesalers/Traders	1. Interview wholesalers/traders to identify their role in market distribution. 2. Review and examine wholesale sales and marketing and determine the cost structure at this level.
Retailers	1. Select trading centers and market to find retail shops that carry cookstoves and interview shop owner or key person. 2. Review and examine retail cookstove sales and marketing and determine the cost structure at this level.

Source: Author.

b. For example, in Cambodia, retailers include both shops and peddlers who travel from town to town selling cookstoves and cooking utensils.

- What kinds of stoves sell best? Do you know the different stove features (e.g., efficiency, cleanliness, convenience)? Do you give recommendations to customers? If customers ask for a recommendation, which do you recommend and why?
- Are there any "improved cookstoves" sold in the market?
- What is the retail price of each of these cookstoves?
- How far do these cookstoves have to be transported from source to the retail shop?
  Transport is one of several critical factors in determining retail prices and profit margin (i.e., by ensuring that cookstoves easily and quickly reach the market at the least cost). It is important to check whether retail shop owners must bear the burden of transporting cookstoves from their sources to their shops.
- As part of the cost structure analysis, what is the profit margin (including retail price and cost of the stove to the retailer)?
- How often does the retail shop get supply replenishments?
- How many cookstoves are available and/or on display at the shop?
- How many cookstoves are sold per month?
- Who are the customers within the community or from other towns/villages within a certain radius in kilometers?
  It is important to determine the market area coverage for the study.
- Are the cookstoves sold on consignment basis or must retail shop owners first pay for the stoves (i.e., what are the terms of agreement with wholesalers or stove manufacturers)?
- Who are the retail shop's cookstove suppliers?
  The answer to this question should explain how the producer or manufacturer sells his or her cookstoves (i.e., by supplying the retailer directly or relying on wholesalers or other traders).
- What is the relationship between the retail store owner and cookstove suppliers or manufacturers? How long (years or months) has the shop owner dealt with the particular supplier? Is the relationship strictly business (formal or informal)? Is he/she willing to sell cookstove from other suppliers? Why or why not?

3. Identify whether there are cookstove parts and/or repair services available.

- Does the retail shop sell any spare parts for the cookstove?
- Are there shops or individuals that offer cookstove repair and maintenance services?

4. Identify the upstream market chain or structure for the cookstoves being sold for each retail shop selected for the survey.

- Does the store owner know where the cookstove he/she sells is made? Who makes these stoves (manufacturer or individual artisan)?

5. Identify individuals to be interviewed up the market chain.

- Who are the suppliers for the retailer (wholesalers/ traders and/or producers)?

Wholesaler/Trader Interviews

Information from cookstove retailers and producers from the respective interviews up and down the market supply chain is used to identify the wholesalers and traders to be interviewed. The main aim of surveying these middlemen to gather data on the cost structure of cookstove distribution (i.e., for transport of stoves from producers to the retail market and related logistics), which are used to identify intervention activities at the wholesale and retail levels and overall intervention strategies. The specific steps for the field interviewer and accompanying questions for the wholesalers/traders are as follows:

1. Profile wholesaler or trader.

2. Explore and examine cookstove sales and marketing in the wholesale market.

- What is the wholesale price of the cookstove?
  The wholesale price must be recorded to work out the cookstove's cost structure.
- How far do these cookstoves have to be transported from producer to retail market?
  The answer to this question will determine the approximate distance between production centers and retailers. Transport is one among several key determinants of retail prices, profit margin, and other logistical factors needed to ensure that cookstoves can reach the market easily and quickly at least cost.
- What is the overall transport cost?
- Does he/she know any other similar wholesalers?
  Follow up by interviewing those identified.
- Is he/she is facing any competition from other wholesalers?
- What was his/her means of transporting the cookstove from the place of production to the retail shop?
  A detailed explanation of this process is needed.
- What are the most difficult aspects and/or constraints faced by the wholesalers/ traders (e.g., lack of truck or storage, damage or losses during transport, or required capital or financing)?

- What are the terms of agreement and payment arrangement between wholesalers and cookstove producers?
  This question seeks mainly to determine whether wholesalers face financial obstacles.

3. Ask the wholesaler to identify cookstove producers (i.e., manufacturers and artisans).

The interviewer will use this information to identify individuals for the next level of the cookstove market supply chain (i.e., either producers or retailers, depending on the survey direction).

Producer Interviews

The main objective of the interviews with cookstove producers is to collect information on production (facility location, processes, technology, and cookstove types and models), financing and marketing (capital investment, business model, and cost structure), and quality assurance and constraints to expansion (standards and rating procedure and after-sales service). This information is needed to help identify intervention activities at the production level and overall intervention strategies. To obtain this data, it is necessary to identify and conduct an in-depth interview with the key person at each production facility. The specific steps for the field interviewer and accompanying questions for the cookstove producers are as follows:

1. Profile cookstove producer.

2. Identify the geographic location of production to determine accessibility and potential for expansion.

- What is the address of the production facility?
- Is the production facility accessible by pickup truck or is a larger vehicle required?
- What is the existing space of the production facility? Are there any unused spaces or area that can be used for expansion?

3. Identify all of the cookstoves being produced at each facility.

- What are all of the types and models of cookstoves made by the producer (provide pictures)?

4. Determine how the cookstoves are produced at the facility and sold to the market.

- What are the retail channels? Are cookstoves produced at the facility sold directly to consumers, through middlemen (wholesalers/traders), or directly to the retail shop?
- What is the size of the market in terms of number of cookstoves sold each month and area (identify towns and cities, including distance in kilometers from the production facility)?

5. Identify the producer's business model.

- Is the business model characterized as "industrial production," "semi-industrial production," "artisanal production," or "women-owned business"?
- What is the monthly or annual production capacity?
- Over the past 12 months, how many stoves were produced each month, on average?

6. Determine the source of financing for investment in the production facility.

- What was the total amount of money spent for starting up?
- Did the owner borrow the money to start this business/production facility?
- From whom did he/she borrow the money and what was the amount?
- Does he/she have enough money to expand the business or production?
- If he/she does not have enough money, what is the likely source of financing?
- How was the business started? What was the motivation to become a stove producer (e.g., saw market opportunities, learned the business from friends or relatives)?

7. Identify the ownership of cookstove production.

- Is production owned by one person, a partnership, or a company?
- Is the business registered with the authority? What is the type of registration?

8. Determine the stove types and efficiency/emissions levels.

- Does the owner or key person in the production facility know the efficiency and/or emissions level for each type of cookstove produced in this facility?
- What is the efficiency or emissions level?
- Does he/she know what an improved or clean cookstove is?
- Has he/she ever heard of an improved or clean cookstove?
- Does he/she think that his/her facility can produce improved or clean cookstoves? Why or why not?

9. Determine the cookstoves prices.

- What is the price of the cookstove sold? or What is the price per unit that the owner charges his/her customer (i.e., wholesaler/trader or retailer)?

10. Determine the cost structure and profit margin for cookstoves produced at each facility.

- What are the monthly costs for labor and materials, energy, transport, and taxes (include all variable costs)?
- What are the itemized fixed costs (e.g., land, buildings, machines, and kiln construction)?

11. Identify the production processes.

- What are the production processes?

12. Identify whether the production facility utilizes any marketing mechanism.

- What are the sales processes?

13. Characterize quality assurance and after-sales service.

- What methods and procedures, such as standards and ratings, are used to assure quality?
- What after-sales service is provided?

14. Obtain the owner's opinion about his or her main barriers to expansion or improving quality and production methods.

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