Powering Up Productivity in Rural Lao PDR

Stimulating Small and Medium Enterprises To Use Electricity for Income Generation

FINAL REPORT

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Contents

Tables

Figures

Boxes

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Executive Summary

To be cost effective both economically and financially, investments in rural electrification require strategies to promote productive uses that generate income. Lao PDR's rural electrification program, like similar projects elsewhere, suffers from poor revenue yield from relatively large investments. Electricity loads are usually low and electricity use, to a large extent, is limited to lighting. Successful programs in countries with similar rural conditions, such as Thailand, suggest how Lao PDR might incorporate strategies to promote productive uses.

This marketing study's broad goal was to identify opportunities to stimulate small and medium enterprises in rural villages of Lao PDR to use the benefits of electricity more fully. The study team analyzed current businesses and services, as well as major agro-processing and other income-generating activities in six selected central and southern provinces connected to grid-based electricity and in 10 rural villages of a remote northern district dependent on renewable energy–based, off-grid power supply.

The vast majority of the business owners surveyed recognize the benefits of electricity access and its potential for expanding their enterprises. Despite their positive outlook, many of these business owners face critical challenges, including high upfront investment costs; insufficient information on which electric equipment to buy; and lack of qualified local electricians, locally available equipment, and know-how in equipment operation. To overcome these obstacles, ***program strategies to promote productive uses of electricity should focus on consumer education, technical assistance, financing and credit, and facilitation of business investment and expansion.***

Lao PDR's overall increase in rice production over the past decade has barely kept pace with population growth. The prolonged dry period in 2010 severely affected production, most of which relies on rainfall. In addition, rice production is unevenly distributed: A surplus in one area may not meet supply shortages in others. Since farmers grow rice mainly for household consumption and sell the excess, only a small portion is marketed, meaning that rice markets tend to be small and fragmented. As a result, highly localized food insecurity continues to affect rural communities and districts.

Despite these challenges, growth in rice production, and thus processing, is expected to continue. Modern, energy-efficient processing machines could reduce post-harvest losses, which would directly help to achieve food self-sufficiency at the local level. But surveys of rice-mill owners reveal that ***most mills rely on outdated processes and techniques and wrongly-sized, poorly maintained motors, resulting in low recovery rates.***

Similarly, the business outlook for coffee processing is bright; yet many smallholder growers use highly inefficient machines and equipment. Most of those surveyed prefer to process their coffee before selling it; however, many do not own both pulping and hulling machines, and few use electric motors to power their equipment. ***Thus, a top priority for a***

productive use program would be to convince rice-mill owners and smallholder coffee growers to switch to or adopt energy-efficient electric motors and equipment. Other key priorities would include providing basic knowledge and information on electric motor use and maintenance and easing the upfront connection costs required to upgrade equipment.

The national utility company, EdL (Electricité du Laos), as part of its efforts to promote productive uses, would need to regularly monitor electricity demand load and conduct billing analysis of its customers, especially those in newly electrified rural villages. This would allow EdL to assess how productively the rural villages are using electricity and identify opportunities to increasing productive uses and thus generate more revenue. Basic marketing tools should include (i) incentives to help customers overcome upfront connection costs; (ii) direct personal contact with customers; (iii) coordination with a range of stakeholders; and (iv) education and training, information dissemination, and technical assistance.

In areas connected to the national grid, promoting productive uses of electricity is equivalent to increasing daytime load. This increases the revenue of the utility company and resolves the low-load factor of recently electrified households. ***But in remote areas powered by isolated off-grid systems***, ***productive use strategies require demand management.*** In the case of Muang Mai, for example, this survey found that 5–10 percent more rice could be produced by switching from many small, outdated hulling machines to a few larger mills that use up-to-date techniques. But the combined electricity demand of the larger mills might exceed power-generation capacity, making demand management a necessity.

Promoting productive uses of electricity to generate income is integral to the ultimate success of any rural electrification program. Large numbers of productive use customers can improve the economic rate of return on investment, minimize financial losses, and relieve the utility company of its financial burden, ultimately helping it to maintain a sound financial standing. Developing and implementing this study's suggested strategies to stimulate Lao PDR's small and medium enterprises to expand their productive uses of electricity can create a win-win situation for all stakeholders involved, including poor rural villagers, EdL, and the government.

Chapter 1. Introduction

Actively promoting the productive uses of electricity to generate income is an integral part of successful rural electrification programs. International experience and lessons from previous projects show that simply waiting for the benefits of electricity provision to trickle down to the poor is an uncertain approach that hardly justifies such large investments. Welfare outcomes cannot be expected to flow from such project outputs as energy supply or institutional development without specific strategies to promote load development, demand management, and low-cost supply connections, among others. For the poor to reap the full benefits of rural electrification, distribution companies must have a strong consumer focus and work with communities over time to solve problems (Barnes 2007).

Well-planned, carefully targeted, and effectively implemented programs can open up opportunities for low-income rural people to increase their incomes and thus accelerate rural development while, at the same time, improving the financial return from the rural electrification investment. Access to electric lighting, for example, means that rural people can extend their working hours and shop owners can stay open longer. Switching from diesel- to electricity-powered tools and equipment can increase the quantity and quality of agricultural products, and such appliances as refrigerators and freezers make it possible for small commercial and cottage industries to produce more goods and services.

Despite the vast array of potential benefits, at least four-fifths of electricity consumption in rural areas is limited to lighting and television. The 2008 IEG report, *The Welfare Impact of Rural Electrification: A Reassessment of the Costs and Benefits*, noted that World Bank–supported rural electrification projects intended to reach the poor have often failed to include such key components as enabling grid connections for poorer households and consumer education, which would help to achieve this objective. The report noted that past projects have often lacked geographically equitable coverage, instead favoring larger communities located close to the existing grid to ensure least-cost supply. It cited balancing system expansion with financial sustainability as a major challenge (IEG 2008).

The Challenge for Lao PDR

Like similar projects elsewhere, the rural electrification program in Lao PDR suffers from poor revenue yield from relatively large investments. Electricity loads are usually low, and electricity use, to a large extent, is limited to lighting. Despite the high costs of both grid and off-grid expansion, much work remains. More than one-third of the country's 6.8 million people, including many poor women-headed rural households, still lack a connection. The government aims to provide electricity to 90 percent of households by 2020, yet coverage in agriculture-dominated rural areas, where four-fifths of the people live, remains low.

Box 1.1 Promoting rural electricity use: Learning from Thailand's success

From the outset, Thailand's Provincial Electricity Authority (PEA) regarded load promotion and demand management as integral parts of the country's rural electrification program. The PEA regularly monitored electricity demand load and conducted billing analyses of its customers. It relied on extensive market research to assess whether rural villages were using electricity productively or at its highest potential. Load promotion focused on promoting (i) electricity use for revenue growth, (ii) the efficient use of electricity, and (iii) expansion of household connections.

Based on its market research of potential power loads in rural villages, the PEA concluded that electric motors in rice mills were the best candidates for load promotion and demand management and would provide the company the best return on its load promotion investment.

To improve the economic rate of return, the PEA offered direct incentives to rice-mill owners willing to convert from diesel engines to electric motors. It worked with Thailand's Bank of Agriculture and Agricultural Cooperatives to make loans available to rice-mill owners to cover the high initial investment costs of conversion. A main incentive was spreading connection fees over a year-long period, paid in equal monthly installments with no interest.

To achieve the highest possible connection rates, the PEA's representatives capitalized on direct personal contact with villagers during construction. To provide them an incentive to connect, the PEA established low connection fees and provided a credit line for homeowners to cover both connection fees and house-wiring costs. It used local contractors for lower-level technical tasks to improve and build up local private-sector capability and to cut its own costs. After a few years, local contractors replaced the PEA's need to continue providing such incentives.

Source: Tuntivate and Barnes (2007).

To be cost effective from both economic and financial perspectives, investments in rural electrification require strategies to promote productive uses that generate income. Success stories in such countries as Thailand, where rural conditions were similar to those of Lao PDR today, suggest how the country might incorporate such strategies into its program (Box 1.1).

Study Goal and Objectives[1]

This study's broad goal was to identify opportunities for promoting productive uses of electricity in existing as well as among new small and medium enterprises (SMEs) in the rural villages of Lao PDR to generate income for rural people and promote economic development. To this end, the study team conducted a market analysis of current businesses and services, as well as major agro-processing and other income-generating activities in (i) six selected central and southern provinces connected to grid-based electricity and (ii) 10 rural villages of a remote northern district that rely on renewable energy–based, off-grid power supply. Based on the survey results, the study team identified opportunities for the SMEs to switch to or adopt electricity for productive purposes; major obstacles faced by the SME owners in utilizing electricity more

[1] This study recognizes that electric water pump used for irrigation has played an important role for rice production especially, in the six central and southern provinces during the dry season. However, components and condition fundamental to success (or failure) and strategies to promote electric pump for irrigation scheme are different from promoting the uses of electric motor among rice mill, business owners and coffee growers. It is excluded from this study, because it requires different strategies and approaches.

fully; and suggested ways to overcome these barriers, including the facilitating role of EdL (*Electricité du Laos*, the country's national utility company.

Study Method and Survey Instruments

This study relied on a social marketing survey conducted in February 2011 as the primary data source. It also drew from literature reviews and information gathered from government agencies and international organizations. Three sets of field surveys were conducted. The first set focused on rural villages with access to grid electricity whose main crop is rice; the surveys covered three central (Bolikhamxai, Khammouan, and Savannakhet) and three southern (Salavan, Champasak, and Attapue) provinces. The second set focused on rural villages with access to grid electricity whose main crop is coffee; the surveys covered the same three southern provinces (Salavan, Champasak, and Attapue). Finally, the third set focused on 10 rural villages in the Muang Mai district of Phongsaly province (Sobnaon, Houayvangkao, Nakang, Houaychik, Naxong, Sobhoun, NamNga, Xongneua, Sensaat, Nakham), which are served by an isolated grid system (Figure 1.1).

Figure 1.1 Map of Lao PDR

The first two survey sets each consisted of three surveys. First, a village survey was conducted with the village head to collect general socioeconomic and demographic data; information on major business and agricultural activities; and data on rice-growing or coffee production, including total area of paddy field or arable land used, varieties grown, and annual production. Second, a business survey was conducted with business owners and operators to identify current types of business establishments, cottage industries, and manufacturing activities; types of equipment and appliances used; and obstacles to making full use of electricity for productive purposes.

Finally, a survey was conducted with either rice-mill owners or coffee-growing households. In the six central and southern provinces, 400 rice-mill owners in the rural villages surveyed were asked detailed questions about their milling technology, equipment and motive power, investment costs related to electricity connection, and monthly energy bills. In the three southern provinces, 74 heads of smallholder, coffee-farming households were asked about the total amount of each variety produced and sold (including revenue), types of pulping and hulling equipment owned, whether their equipment was powered by diesel or electricity, and motor size.

The third survey set consisted or four surveys. The first three were similar to those carried out in the rice-growing villages with access to grid electricity (i.e., village, business, and rice-mill owner). In addition, a household survey was conducted to collect detailed data on household electricity consumption and expenditure, types of electric lights and use levels, current and planned electric appliance ownership, total annual rice and paddy production, and a range of other socioeconomic data.

Structure of This Report

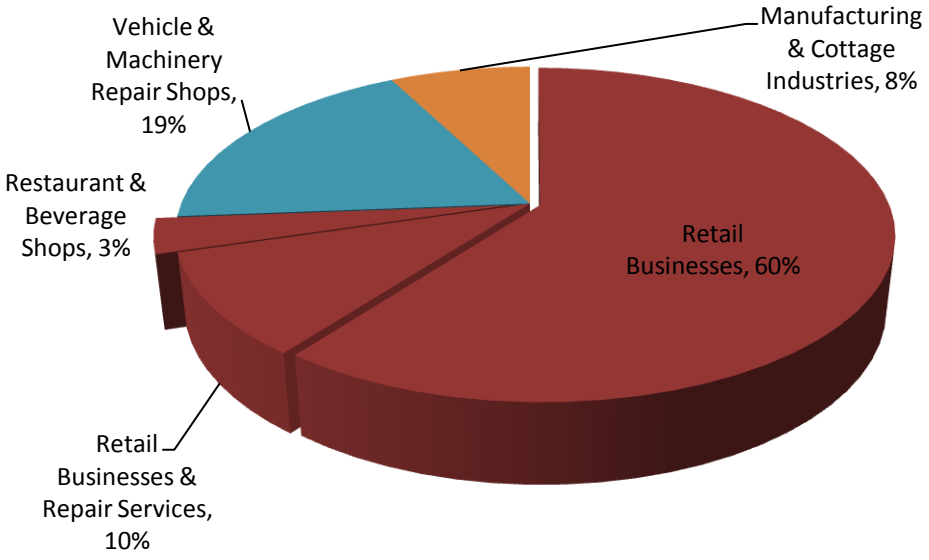
Source: www.ezilon.com/maps/asia/laos-maps.html

The structure of this report reflects the organization of this study's marketing survey. Chapter 2 offers a detailed descriptive analysis of the characteristics of rural village businesses, services, and other income-generating activities in the six central and southern provinces surveyed. Chapters 3 and 4 present the respective challenges and strategies for improving rice-milling and coffee processing. Chapter 5 outlines the key components of a program designed to promote productive uses of electricity for income generation. Chapter 6 then considers the special requirements of promoting productive uses of electricity in areas that rely on off-grid power supply, focusing on the case of Muang Mai. Finally, Chapter 7 concludes.

Chapter 2. Rural Village Businesses

The business surveys conducted by this study, covering 282 villages in all, confirm that productive activities to generate income in rural villages of Lao PDR are relatively small. These business establishments tend to focus on services for people living in or nearby the village. Activities fall into three major categories: (i) retail businesses; (ii) vehicle (car, truck, and motorcycle) and machinery repair shops; and (iii) manufacturing and cottage industries. Owing to the small size of rural villages, retail business owners and operators tend to combine their productive activities in order to capture a larger market base, often providing both goods and services (Figure 2.1).

Figure 2.1 Types of Business Activities in Rural Villages, Lao PDR



Source: Business Owners Survey in Rural Villages of Lao PDR (2011).

Retail businesses account for nearly three quarters of all business establishments in the surveyed rural villages of the six central and southern provinces. These businesses sell groceries and other essential goods used for everyday living. To increase their market base, many also provide repair services or sell beverages, snacks, and cooked food; restaurant/noodle and beverage shops account for 3 percent of all business establishments. The second most prevalent business establishments, representing close to one-fifth of the total, are vehicle and machinery repair shops, which provide repair services (and sale of spare parts) for cars, trucks, motorcycles, as well as machinery.

Shop with gasoline and diesel fuel for sale

Since rural villages are usually located far from the main road, where gasoline and diesel stations are located, many repair shops also sell gasoline and diesel fuel. Eight percent of business establishments engage in small manufacturing and cottage industries; the most common types are furniture making and carpentry services; others include welding and metal-working services, small ice-making factories, cookstove manufacturing, noodle making, and incense production.

Retail Businesses

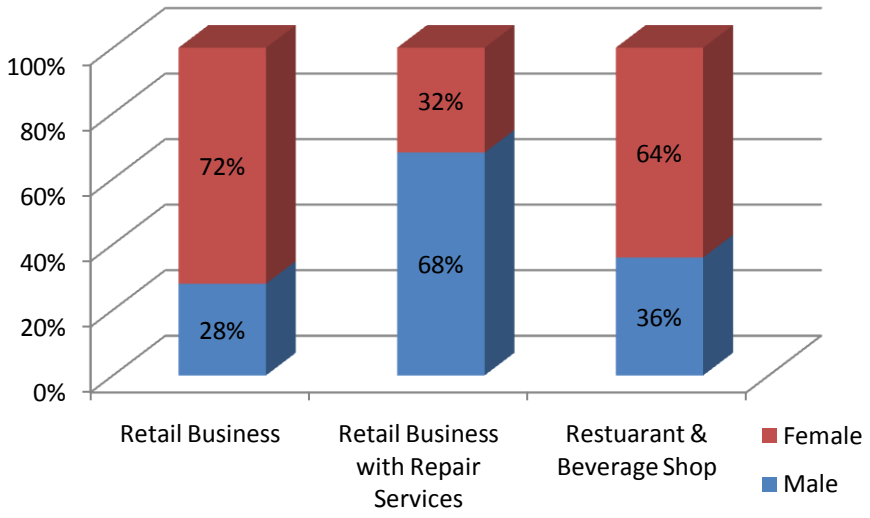
Each village usually has at least one or two retail businesses or convenience shops, which tend to be family owned and operated. On average, these businesses have been operational only within the past five years. Their emergence is apparently linked to the rapid pace of rural and economic development over the past decade, including rural electrification, which has accelerated in the past five years.

Village convenience shop

Gender Differences in Ownership

The business surveys conducted for this study found that ownership and operation of retail business types in rural Lao PDR tend to divide along gender lines. Women own and operate nearly three-quarters of small retail businesses and close to two-thirds of restaurant/noodle and beverage shops found in the villages surveyed in the six central and southern provinces. Conversely, men own and operate more than two-thirds of the retail businesses that include vehicle and machinery repair services (Figure 2.2).

Figure 2.2 Retail Business Ownership and Operation, by Gender



Source: Business Owners Survey in Rural Villages of Lao PDR (2011).

These findings highlight the need to incorporate gender sensitivity into the design of promotional campaigns aimed at stimulating SMEs to use electricity in more productive ways that generate income.

Electric Appliance Ownership

Retail Businesses. The business surveys confirm that all retail businesses with a grid connection use electricity for their business activities. As expected, the most common electric appliances owned are refrigerators, freezers, and electric fans, as well as small cooking appliances. About 90 percent of retail businesses have refrigerators and electric fans. Ownership of freezers depends on the type of retail business; for example, about 86 percent of restaurant/noodle and beverage shops, compared to only about 46 percent of village convenience stores, use freezers to store food.

Most of the refrigerators and freezers used by these retail businesses are designed for household use. The typical refrigerator is only about six cubic feet in size. Refrigerators and freezers are usually imported from Thailand or China and are moderately priced, starting at about US$200. Thus, these appliances are within reach of retail business owners.

Retail Businesses with Repair Services. The business surveys confirm that retail businesses that also provide repair services use a wide variety of electric tools, along with the electric appliances typical of retail businesses (i.e., refrigerators, freezers, and fans). For example, about 70 percent use air compressors and electric heat pads to repair punctured tire tubes, and 60 percent use welding machines.

Many of these businesses begin operating as soon as the village gains access to grid electricity. This suggests that productive use campaigns to generate income should occur at the time the national utility company, EdL, mobilizes villagers to receive an electricity connection via education and information dissemination on efficient electricity uses.

Restaurant and Beverage Shops. The business surveys reveal that restaurant/noodle and beverage shops tend to be located in larger villages or those located along major transportation routes. As expected, these shops have fully utilized electricity for refrigeration (i.e., food storage and cooling beverages). About 90 percent own a refrigerator, a freezer, or both appliances. Ownership and use of other electric appliances required by such businesses—fans, rice cookers, and hot water makers—are nearly universal.

More than three-quarters of repair shops have opened in the past four years.

Vehicle and Machinery Repair Shops

The business surveys show that vehicle and machinery repair shops account for nearly one-fifth of business establishments in the rural villages of the six central and southern provinces.[2] Depending on the village size and location, many such repair shops also repair agricultural machinery, as well as sell spare parts, gas and diesel fuel, and oil and lubricants.

Shop Features

The majority (87 percent) of repair shops are owned and operated by men in their mid-thirties. To capture the market, these shops tend to be located in larger villages along key routes and intersections. The sizes of such businesses vary by clientele. For example, a smaller repair shop may only sell gasoline for motorcycles or may only repair punctured motorcycle or bicycle tires; while a larger one may repair cars, trucks, and agricultural machinery. The surveys in the six central and southern provinces confirm that each village has one repair shop, on average, whose size and services vary.

[2] Another 10 percent of businesses combine retail and repair services that focus on smaller, less complicated repairs.

Electrical Equipment Use

The types, number, and sizes of electrical equipment used by vehicle and repair shops in the rural villages are relatively limited. About 87 percent of shops own an air compressor, while 70 percent have a welding machine, electric sander or buffer, and a heat plate for repairing punctured inner tubes of tires; as expected, none have other electric machine tools commonly found in the repair shops of larger urban areas. In addition, none that sell gasoline or diesel fuel use electric fuel pumps; even the larger shops that sell fuels use hand pumps from 200-liter barrel containers.

Manufacturing and Cottage Industries

As mentioned above, manufacturing and cottage industries account for only 8 percent of all business establishments found in the rural villages surveyed in the six central and southern provinces. About four-fifths of these industries focus on furniture making (doors, windows, and frames), carpentry services, and building contractors. In addition to these industries, the business surveys identified four small ice-making factories, one welding shop, one cookstove manufacturer, one noodle factory, and one incense factory, none of which employ more than a few workers.

Electric Tools Ownership

The electric tools considered essential by the vast majority of furniture makers and carpentry services in the rural villages surveyed are the electric drill and wood plane. About 95 percent of furniture makers use electric drills, while some 88 percent use electric wood planes. More than two-thirds of furniture makers and carpentry services use electric circular saws, while less than one-third use electric routers and sanders for woodworking.

Electrical Equipment Use

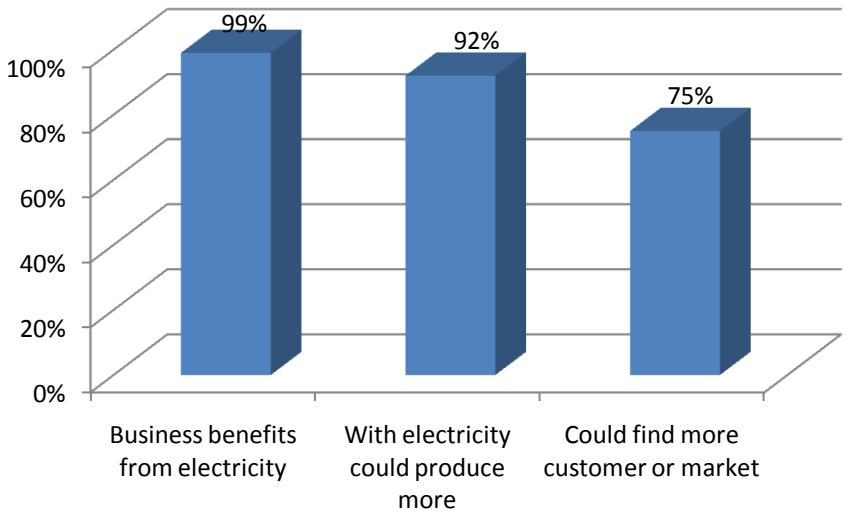
Among other small manufacturing and cottage industries, electrical equipment is used relatively extensively. Ice-making factories use electric water pumps and motors to make and crush ice, respectively. Noodle factories use electric motors to grind grain into flour, while cookstove manufacturers use them for mixing clay. Metal welding shops use both welding machines and air compressors for spraying paint.

Outlook of Business Owners and Operators

Virtually all of the business owners and operators surveyed agree that their businesses benefit from having access to electricity, and 92 percent believe that having an electricity connection will enable them to produce or sell more products. About three-quarters are confident about their prospects of reaching more customers or adding markets if they should choose to expand their product lines, production, or services; and the vast majority believe that electricity can play a vital role in this effort (Figure 2.3). This encouraging finding reflects the longer-term trend of

economic development and infrastructure investment, including the expansion of rural electrification, in both rural and urban areas of Lao PDR.

Figure 2.3 Businesses' Outlook on the Benefits of Electricity



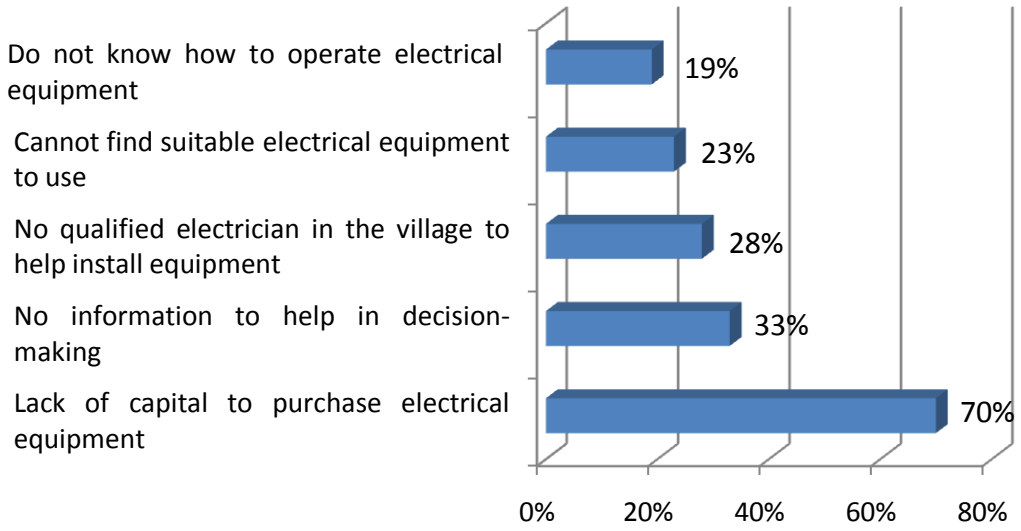
Source: Business Owners Survey in Rural Villages of Lao PDR (2011).

Business owners and operators in the rural villages surveyed clearly have a positive outlook on their business prospects and recognize the vital role that electricity can play in business expansion. At the same time, many face challenges in increasing productive uses for income generation. The five most common problems cited, in descending order of importance, are as follows (Figure 2.4):

1. ***High upfront investment costs***. The lack of capital with which to purchase electrical equipment, reported by 70 percent of the business owners and operators surveyed, is considered the biggest obstacle to expanding productive uses of electricity.
2. ***Inadequate information***. About one-third of business owners and operators reported a lack of information on equipment brand names, types, and sizes, suggesting that those surveyed may not be sufficiently informed about which electric equipment would be most appropriate and efficient for running their businesses.
3. ***Lack of qualified local electricians***. Given that well-qualified electricians tend to concentrate in larger towns and cities, it is not surprising that close to 30 percent of the business owners and operators surveyed reported a lack of qualified electricians in their local areas as an obstacle to using electricity for productive uses.
4. ***Unavailability of electrical equipment***. About one-quarter of business owners and operators reported a lack of appropriate electrical equipment for productive use activities as a major obstacle.

5. ***Lack of know-how in operating equipment***. About one-fifth of those surveyed said they lacked sufficient knowledge in operating electrical equipment, which they considered a barrier to using electricity and electrical equipment more fully for productive activities.

Figure 2.4 Possible Obstacles To Productive Use of Electricity



Source: Business Owners Survey in Rural Villages of Lao PDR (2011).

Summary and Strategies To Promote Productive Uses

The business survey findings reflect the rapid economic development that has occurred in the rural villages of central and southern Lao PDR over the last decade. The fast pace of growth, particularly in the past five years, continues to open up opportunities for small rural business owners and operators to generate income. Their positive economic outlook further reinforces confidence that productive, income-generating activities in rural villages are likely to increase. The business survey results confirm that rural electrification is viewed as key to encouraging and accelerating this momentum. Yet the survey findings also show that many current and prospective business owners and operators face challenges that prevent them from using the wide array of electric appliances and equipment afforded by electricity and thus reaping the full benefits of productive uses.

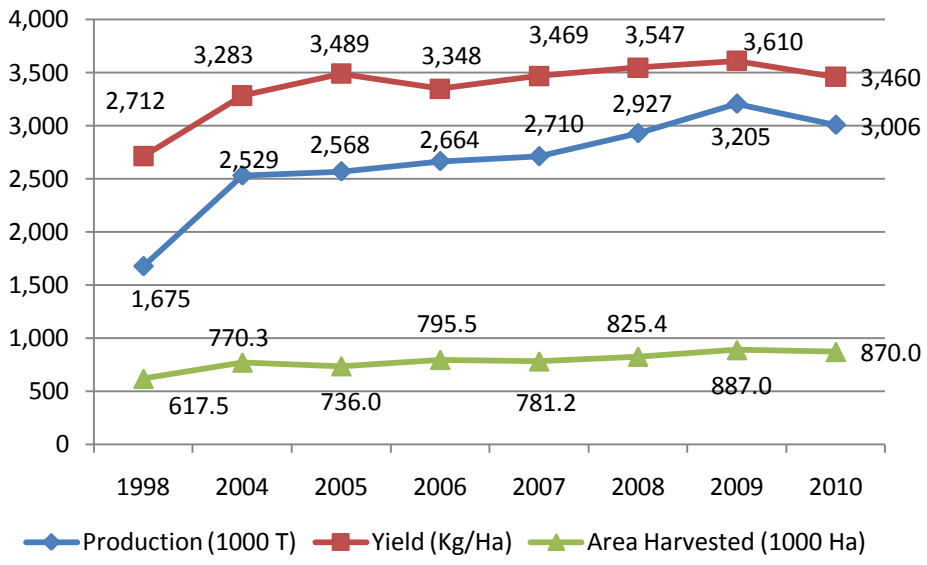
To promote productive uses of electricity for income generation, the following strategies are recommended:

- ***Educate consumers***. Information dissemination campaigns should be implemented to educate retail business owners and operators on appliance types and specifications, efficiency, and local market availability. The aim should be to help them learn how to use electricity to generate income and fill the knowledge gaps previously described.
- ***Provide technical assistance***. Repair shops and cottage industries should be offered technical assistance to promote uses of energy-efficient electric motors. This assistance should be designed to overcome the lack of (i) qualified electricians in the local area to install electric equipment for business activities, (ii) locally available electrical equipment for productive use activities, and (iii) sufficient know-how in operating equipment for productive activities. As a service provider, the electricity distribution company, EdL, can help its customers overcome these obstacles. Given its large pool of capable electricians, it has a comparative advantage in helping to fill the knowledge gap.
- ***Offer financing and credit***. Although business prospects in rural villages are good, many business owners lack sufficient funds to invest in electric appliances and equipment to expand their productive activities or to cover the connection costs required to upgrade their current electricity services. Financing arrangements and credit schemes should thus be promoted and implemented.
- ***Facilitate business investment and expansion***. Given the strong current momentum in rural economic development, EdL can help current and prospective business owners to invest in or expand their businesses. The utility company could offer technical assistance, education, and information on specific electricity applications for income generation. Ensuring that electricity provides rural people far more benefits would enhance the role of rural electrification.

Chapter 3. Rice Milling: Productive Use Opportunities

Rice is the staple crop in Lao PDR. Nearly every rural household grows rice to meet its subsistence needs, and virtually all rural villages have at least one or two rice mills.[3] Rice accounts for more than four-fifths of the country's total cultivable land.[4] Since 1998, paddy production, land area devoted to growing rice, and yield per hectare have all steadily increased. Over a 10-year period (1998–2008), paddy production grew 75 percent (from 1.67 to 2.93 million tons), with an average annual growth rate of about 4.3 percent; over the same period, yield per hectare grew 2.3 percent, while the area used to grow rice grew only 1.9 percent. Production continued to rise in 2009 (to about 3.21 million tons), followed by a decline in 2010, due primarily to the delayed monsoon season in the central and southern provinces (Figure 3.1).

Figure 3.1 Trend in Rice Paddy Production, 1998–2010



Source: Ministry of Agriculture and Forestry (2004).

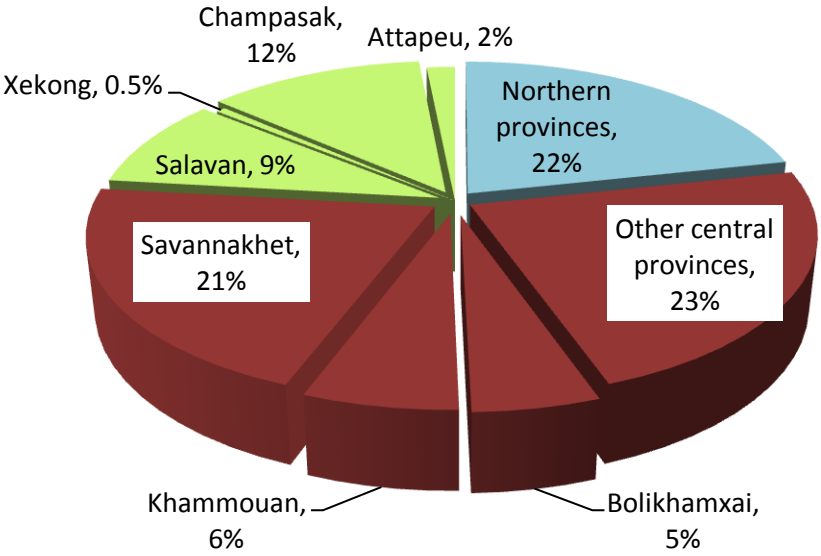
Lao PDR features diverse rice-growing ecosystems. Upland rainfed rice is grown mostly in the mountainous northern areas under a system of shifting cultivation. In lowland areas, more than three-quarters of production, most of which is rainfed, occurs in the central and southern agricultural areas during the wet season. Lowland irrigated rice is grown mainly in provinces located along the Mekong River during the dry season (Pandey 2001). Given this ecosystem diversity, the total land area used to grow rice, as well as the total amount of production and yield, varies significantly by province. The central provinces dominate, accounting for more than half (1.433 million tons) of total production; the three central provinces covered in this study—Bolikhamxai, Khammouan, and Savannakhet—account for about one-third (0.835

[3] With the exception of rural villages in the Bolaven Plateau region, where coffee is the main crop.

[4] In 2009, the total land area used to grow rice in Lao PDR was estimated at 870,000 ha (FAO 2010).

million tons) of total production. In 2003–04, the four southern provinces—Salavan, Xekong, Attapeu, and Champasak—accounted for nearly one-quarter (0.522 million tons) of total rice production (Figure 3.2).

Figure 3.2 Variation in Rice Paddy Production, 2003–04



Source: Ministry of Agriculture and Forestry (2004).

Rice Production and the Rural Economy

Rice plays a significant role in the rural economy of Lao PDR. According to the FAO,[5] more than three-quarters of the country's population (about 4.7 million people) engage in agricultural activities. Given that rice is grown throughout the country and accounts for more than four-fifths of total cultivable land, it can be inferred that the vast majority of people involved in agricultural activities grow rice or rice along with other crops. The predominant rice crop is glutinous (sticky) rice, not the better-known long- or short-grain rice traded and consumed throughout the world. It is estimated that about four-fifths of people grow glutinous rice for their own consumption.

Not surprisingly, the vast majority of rice farmers in Lao PDR engage in subsistence rice farming, with an average farm size of less than 2 ha. Since rice farmers grow rice primarily for their household consumption, they sell only the excess, which is believed to be only a small fraction of the total amount produced. Data from the Lao Expenditure and Consumption Surveys (LECS II), conducted in 1998–99, indicated that 87 percent of total household stocks were for own consumption, 5 percent for seed, and roughly 8 percent for sale.

[5] 2008 data.

Food Security Challenge

Over the 1998–2008 period, the average annual population growth in Lao PDR was 2.4 percent,[6] which means the overall increase in rice production over that decade barely kept pace with population growth. From national-level data, one might conclude that Lao PDR can potentially achieve and maintain self-sufficiency in rice production; however, macro-level quantitative data may be misleading. The country still faces many challenges. For example, the prolonged dry period in 2010 severely affected rice production, more than four-fifths of which relies on rainfall. In addition, production is unevenly distributed. The Asian Development Bank concluded that

> "The small rice market and the poor marketing infrastructure have resulted in a lack of integration of the domestic rice market in the country. Accordingly, prices across provinces vary widely. The price differences across provinces in most cases cannot be explained solely on the basis of marketing costs, indicating that the rice markets in the Lao PDR are segmented spatially. Local demand and supply situations seem to determine price formations, with traders not being able to take advantage of the possibility of arbitrage." (ADB 2006).

This suggests that surplus rice production in one area or province may not necessarily meet supply shortages in other ones. Since only a small proportion of production is marketed, rice markets tend to be small and fragmented. As a result, highly localized food insecurity will continue to affect communities and districts. Added production constraints include agriculture-related problems (e.g., poor soil fertility, weeds, rodents, and insect pests) and socioeconomic issues (e.g., labor shortage, lack of access to credit, and poor post-harvest handling).

Prospects for Rice Milling

Despite the slight decline in rice production in 2010, the growth trend is expected to continue; accordingly, the demand for rice milling should also increase since the paddy produced will require additional processing for consumption. This suggests good prospects for the rice milling business in both the long and short term. Since rice mills in Lao PDR are located to serve the local community, improved rice processing will doubtless improve rural lives throughout the country. Better rice-milling activities will reduce post-harvest losses, which will directly help to achieve food self-sufficiency at the local level.

[6] The Lao National Statistics Center estimated that annual population growth in the 2000s (about 2.4 percent) would decrease to 2.2 percent in 2010.

Multiple-pass rice milling technology can reduce post-harvest losses and, in effect, increase rice production.

Rice Milling Technology and Investment Costs

Post-harvest handling is a vital component of rice production in Lao PDR. Post-harvest losses, which reduce the rice's commercial value, can be attributed to inefficient milling technologies, along with factors related to cleaning, handling, drying, storage, and marketing. Past studies show that poor milling technologies have accounted for a recovery rate (from paddy to milled rice) of less than 55 percent.

Processes and Techniques

Lao PDR has an estimated 18,000 rice mills. Surveys of rice-mill owners in the six central and southern provinces studied show an average of three-to-four rice mills per village. Daily milling capacity ranges from a few hundred kilograms for smaller mills to more than 6 tons for larger ones.[7] Most mills continue to rely on single- and two-stage milling processes (Box 3.1).

Box 3.1 Rice-milling techniques in Lao PDR

Rice milling is the process of removing the hull and bran layer to produce white rice. Similar to other countries in Southeast Asia, Lao PDR utilizes three rice-milling techniques:

Single-pass: A one-step process that removes the hull and bran directly from the paddy in a single pass to produce white rice.

Two-stage compact: A two-step process that removes the hull and bran separately to produce white rice, with brown rice produced as an intermediate product.

Multiple-pass: A multi-stage process that involves passing the rice paddy through various operations and machines to produce white rice.

In the six central and southern provinces surveyed, 56% of rice mills are two-stage compact, while 30% are single-pass and only 14% are multiple-pass.

Source: Survey of Rice Mill Owners in Lao PDR (2011).

[7] Daily milling capacity ranges are 100–800 kg (bottom quartile), just over 800 kg–1.2 tons (second quartile), 1.3–2 tons (third quartile), and 2–6 tons (fourth quartile); in addition, two relatively large mills have a reported capacity of 8 tons per day.

According to the Rice Milling Training Manual, published by the Agricultural Engineering Unit of the International Rice Research Institute (IRRI), the single-pass process, used by 30 percent of rice mills in the survey, is the least preferred milling method due to the low conversion rate for milling and the low head-rice yield.

The multiple-pass process, used by only 14 percent of mills, is considered the most complete milling process as it combines various operations to produce high-quality, high-yield white rice from paddy. Unfortunately, the required investment is relatively high; a significant portion involves costs associated with the electricity connection, which may include a new transformer and extension of low-voltage distribution lines.

The surveys reveal that 12 percent of all rice mills use small single-pass, steel-huller equipment, which is considered obsolete.[8] Only 67 percent of rice mills that use the two-stage compact process (56 percent of all mills) use rubber hullers, which IRRI classifies as the most efficient mechanical de-hulling method.[9] More than half of the steel hullers used are diesel-powered, and the rest use electric motors. IRRI's Teaching Manual for Rice Milling concludes that the single-pass, steel-huller not only has a low milling recovery rate (50–55 percent), but also a low head-rice yield (less than 30 percent of the total milled rice).[10] Ground rice hull is often mixed in with rice bran, which reduces the market value for rice bran. Clearly, efforts aimed at help rice-mill owners convert from this outdated process and equipment to more efficient ones would significantly improve Lao PDR's rice production. But the upfront investment costs pose a challenge for both existing and prospective mill owners.

Large Investment Costs

The upfront costs of investing in a rice mill are relatively high compared to the income of a rural rice farmer or miller. Most rice-mill owners do not maintain itemized records of their total investments; but they can provide estimated costs of their rice-milling equipment, including installation and transport costs. For the single-pass milling machine, the total investment cost, including installation and transport, is about US$1,566; while land and building-construction costs add another $233, for a total cost of about $1,800. For multiple-pass rice milling, total investment costs reach about US$12,227 (Table 3.1).

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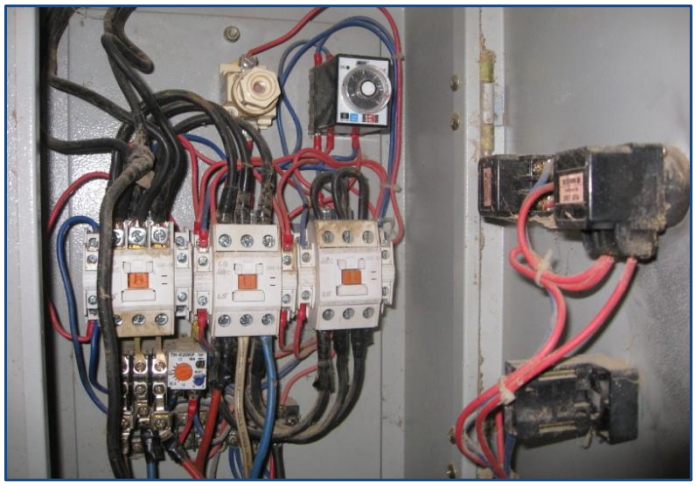
[8] The poor performance of this type of rice milling has led some governments to discourage its use; in many Asian countries, single-pass steel hullers can no longer be licensed to operate as service or commercial mills.

[9] The advantages of the rubber huller include less breakage of milled kernels and sand- and silicone-free by-products.

[10] According to IRRI's Rice Knowledge Bank, the milling conversion (recovery) rate refers to the total milled rice obtained out of paddy, expressed as weight percentage of milled rice (including broken kernels) obtained from a sample of rice paddy. Milling recovery is typically 69–70 percent, depending on the rice variety. The head rice refers to milled rice, whose length is equal to or greater than three-quarters of the average length of the whole kernel, and is often expressed on a percent paddy or rough rice basis (14-percent moisture content). Head rice recovery refers to the weight percentage of the head rice (excluding broken grains) obtained from a sample of paddy. Under controlled conditions, head rice recovery can be as high as 84 percent of the total milled rice or 58 percent of the paddy weight. Commercial rice mills recover 55 percent head rice on average, whereas head rice recovery of village-type rice mills is only about 30 percent (www.knowledgebank.irri.org/rkb/index.php/rice-milling).



Electric control panel for rice mill

Electricity-related investment costs reported by rice-mill owners are significant; they range from US$532 on average for a small mill using single-pass equipment to over US$1,700 for a large mill using multiple-pass equipment. The proportion of electricity-related costs to total investment cost is 30 percent for the single-pass mill and 19 and 14 percent, respectively, for the two-stage compact and multiple-pass mills (Table 3.1).

Table 3.1 Rice-mill Investment Costs in Rural Villages of Lao PDR, by Equipment Type (US dollars)

Investment cost item	Milling equipment type		
	Single-pass	Two-stage compact	Multiple-pass
Rice milling machine (plus installation and transport)	1,566	2,971	10,227
Land and building construction	233	521	2,050
Total investment cost	1,799	3,492	12,277
Electricity-related costs (US$)	532	647	1,714
Electricity-related costs (as % of total)	30	19	14

Source: Rice Mill Owners Survey in Lao PDR (2011).

Note: All costs were reported by survey respondents in Thai Baht or Lao Kip and were then converted to US dollars. Current exchange rates are about 8,000 Lao Kip and 29 Thai Baht per US$; but since the costs provided by the rice-mill owners reflect the original purchase costs, the exchange rates used were 8,600 Lao Kip = 1US$ and 35 Thai Baht = 1US$.

Electricity-related costs include both smaller items (e.g., safety inspection fee, connection fee, meter, and control box), as well as more expensive ones (e.g., transformer and extension of low-voltage network to the mill), which typify larger mills. Since these costs are paid to the electricity distribution company in return for services provided, there is a direct link between improving milling technology to increase rice production and increasing productive uses of electricity for rice milling.

Energy Use Characteristics

The vast majority (92 percent) of rice-mill owners in the six central and southern provinces surveyed use electricity as their milling energy source; the other 8 percent continue to rely on diesel power, even though the villages have a grid connection. Electric motor sizes vary widely,

depending on the types of milling equipment and processes. A single-pass process usually requires a smaller motor using a few kilowatts (the average is about 11 kW), while two-stage compact and multiple-pass processes use larger ones, averaging 14 kW and 24kW, respectively. About half of the electric motors used are imported from China, 30 percent from Thailand, and some from Vietnam. Twelve percent of the rice mill owners surveyed said their electric motors are made in Lao PDR; but since the country has no factories that produce electric motors, the responses indicate that these mills use electric rewind motors, which are highly inefficient.

Rice-mill owners lack awareness of efficiency ratings and information on sizes, types, and brands. They purchase new motors based on cost, information from the salesperson, and word of mouth; as a result, they often end up using oversized, energy-inefficient motors. In addition, their electric motors are poorly maintained. The surveyed mills show that many electric motors are completely covered in dust; however, none of the mill owners were aware that dust prevents ventilation, which can cause motors to overheat and perform poorly, resulting in high electricity bills and early motor failure.[11]

The surveys confirm that rice-mill owners are the largest electricity consumers in the rural villages. Their average monthly electric bill is more than 400,000 Lao Kip (about US$50), representing about 700 kWh of electricity consumption. A small rice mill with a single-pass machine pays more than 200,000 Lao Kip (about US$30) per month, consuming nearly 400 kWh;[12] a medium-sized mill with a two-stage compact machine pays about 400,000 Lao Kip (US$50), consuming more than 600 kWh per month; and the largest mills with multiple-pass machines pay about 900,000 Lao Kip (more than US$100), consuming about 1,500 kWh per month. Since all of the rice mills are open only during daylight hours, all of the electricity consumed contributes to daytime load.

Virtually all of the diesel-powered mills—found in all of the provinces surveyed except Savannakhet—use single-pass, steel-huller machines.[13] The average size of the diesel motor used is about 14–15 hp, with a monthly cost of 400,000 Lao Kip—twice that of a comparable sized mill using an electric motor. Thus, the cost to rice-mill owners is extremely high. If these rice-mill owners converted to electric motors, the direct operating costs would be cut by at least half, eliminating the time and money needed to purchase and transport diesel fuel to the mill.

[11] Given that its largest electricity consumers are rice-mill owners and that it has a large pool of electrical engineers and technicians, EdL, the distribution company, is well-positioned to provide the rice-mill owners technical assistance in this area.

[12] The exchange rate as of February 2011 was 8,000 Lao Kip = 1US$.

[13] Savannakhet is the largest rice-producing province in Lao PDR, accounting for more than one-fifth of total rice production.

Strategies To Promote Productive Uses of Electricity

Given the positive outlook for the rice-mill business and the need to improve rice-milling technology, this study recommends the following prioritized strategies:

Correctly-sized electric motor used to run multiple-pass milling machine

1. ***Convince current and prospective rice-mill owners to switch to or adopt energy-efficient electric motors.*** Given the high monthly electric bills that rice-mill owners currently face, switching to electric motors may not necessarily mean higher bills if they choose the correct motor size.

2. ***Encourage rice-mill owners who use small, single-pass equipment to convert to larger, more modern equipment powered by electric motors***. Again, switching to two-stage compact or multiple-pass equipment may not mean higher electric bills if the mill owners are educated about how to choose the correct motor size.

3. ***Educate rice-mill owners who currently use energy-inefficient electric motors on how to select and maintain motors.*** Given that none of the rice-mill owners surveyed are aware of energy-efficiency ratings, that 15 percent of the rice mills are women owned and operated, and that 12 percent use rewind motors, a gender-sensitive education and information campaign targeting these groups should be developed and implemented.

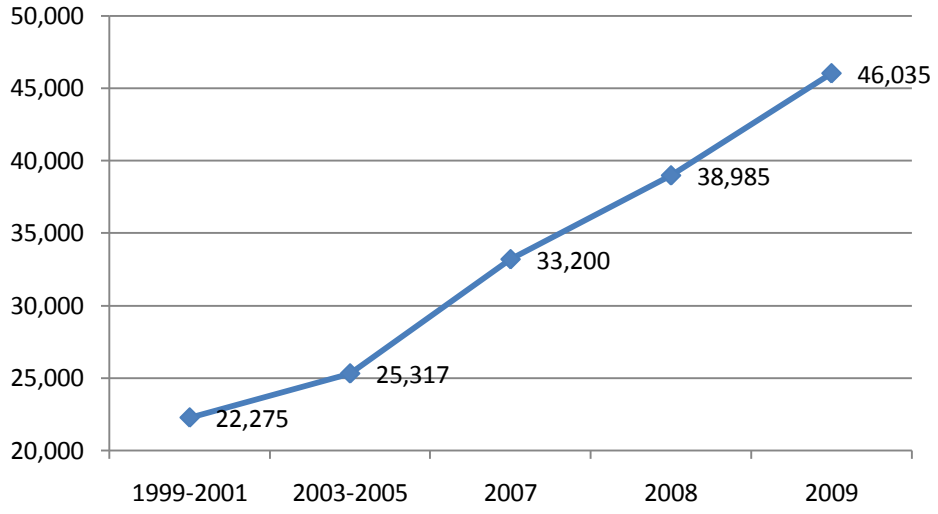
4. ***Develop and implement an education and information-dissemination campaign on how to apply for electricity connection and/or upgrading services and technical standard requirements***. The campaign could begin with publishing and distributing brochure containing information that currents and prospective rice mill owners should know about the processes and steps required for electricity connection and/or upgrading services, as well as technical standard requirements for using electricity for rice milling.

5. ***Assist rice-mill owners with upfront connection costs.*** Given that rice-mill owners have relatively high electricity-related investment requirements, it may be necessary to develop a program to help them overcome some of the upfront costs of electricity connection (e.g., extending connection-related costs over a 12-month period).

Chapter 4. Coffee Processing: Productive Use Opportunities

Coffee, unlike rice, is an export commodity in Lao PDR—the country's fifth largest export earner—whose production is concentrated in the Bolaven Plateau region. About four-fifths of coffee is grown in the Pakxong district of Champasak province, while the remaining one-fifth is grown mainly in the provinces of Salavan and Xekong.[14] Coffee production in Lao PDR doubled over the past decade (Figure 4.1). The land area used to grow coffee expanded from about 29,402 ha in 2000 to more than 45,000 ha by 2009. According to the Lao PDR government, an estimated 210,000 people are involved in coffee production.

Figure 4.1 Coffee Production Growth in Lao PDR, 1999–2009 (tons per year)



Source: FAO (2010).

Southichak (2009) characterizes coffee producers in Lao PDR as the upside-down pyramid: Its base consists of many smallholder coffee farmers operating on only 1–3 ha; some coffee farmers are in the middle operating on 4–10 ha; and, at the tip of the pyramid, a handful of large domestic and foreign-domestic plantations cultivate on 100-ha plots.

This study's surveys focused on smallholder coffee farmers in the Pakxong, Tatieng, and Laognam districts in the respective provinces of Champasak, Xekong, and Salavan. The survey results were used as the primary data source for gaining an in-depth understanding of coffee production and exploring opportunities to increase electricity use for coffee processing.

[14] Since the amount of coffee grown and produced in the southern province of Attapeu accounts for less than 1 percent of the total for Lao PDR, the survey did not include coffee farmers in that province. Insignificant quantities of coffee are also grown and produced in the country's northern provinces.

Characteristics of Smallholder Coffee Growers

Field interviews with the heads of coffee-growing households—smallholder coffee growers—reveal that the average plot size used to grow coffee is an estimated 4.5 ha. The majority of households that grow coffee (about 63 percent of those surveyed) grow it on 1–4 ha plots, while another 20 percent rely on plot sizes ranging from just over 4 ha up to 8 ha. The top 10 percent plant on plot sizes up to 15 ha.[15] The surveys show that smallholder coffee farmers grow three coffee varieties: Robusta, Arabica, and Catimor. Robusta coffee is the most commonly produced variety in the surveyed area. For 2010, 93 percent of survey respondents said they produced and sold Robusta coffee, compared to only 14 percent who said they produced and sold Arabica coffee; 57 percent produced and sold Catimor, a higher-quality variety. Gross revenue from the Robusta coffee sold in 2010 was estimated at about US$2,494 per household. Average annual gross revenue from the sale of Arabica and Catimor varieties, which command higher prices than Robusta, was estimated at about US$3,319 per household. Total gross revenue from all three varieties in 2010 was an estimated US$4,810 per household, suggesting that smallholder coffee growers in the surveyed areas may be better off financially than rice farmers.

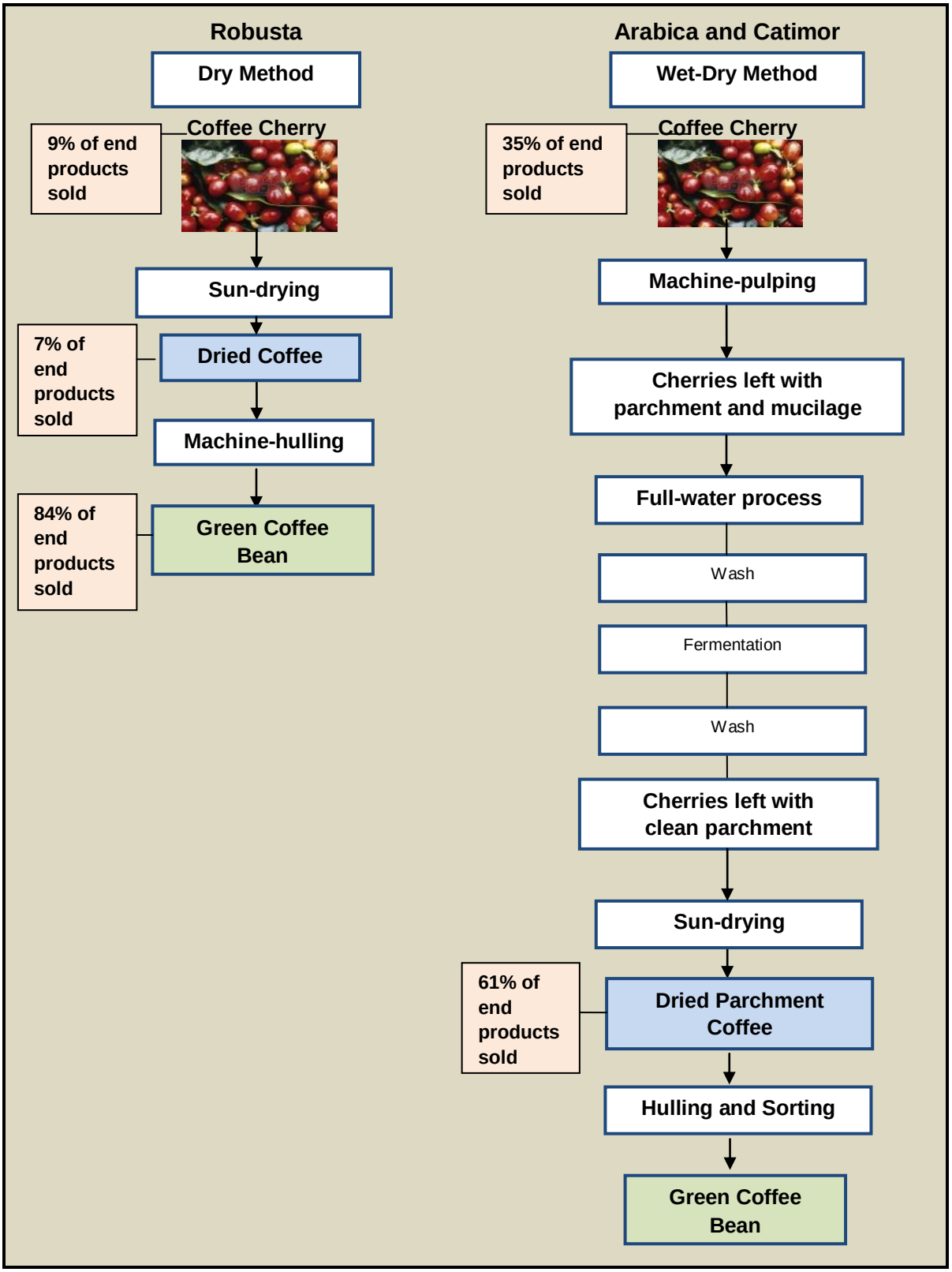
Processing Methods and End Products Sold

The two most common methods smallholder coffee growers use to process their coffee are the dry and wet-dry methods. They can choose to sell their coffee as end products at various stages of processing. For the Robusta variety, the surveyed smallholder coffee growers prefer the dry-method processing. Nine percent of the end products is sold in the form of fresh coffee cherry immediately after being picked from the tree. Another 7 percent is sold as dried coffee. Most (84 percent) is sold as green coffee after the dried coffee is machine-hulled. For the Arabica and Catimor varieties, the survey respondents prefer the wet-dry processing method. Thirty-five percent of the end products is sold as coffee cherry immediately after being picked from the tree, while most (61 percent) is sold as dried parchment coffee (Figure 4.2).

The survey results show that the majority of smallholder coffee growers choose to process their coffee before selling it. This decision is based on an understanding that additional processing steps add value to the coffee, which command a higher market price. In sum, there is significant demand for coffee processing among smallholder coffee farmers in rural Lao PDR.

[15] Two large coffee farmers, who have respective plot sizes of about 26 and 30 ha, are excluded from this analysis since their relatively large operations cannot be classified as smallholder coffee farming.

Figure 4.2 Coffee Processing Methods and End Products by Variety, 2010



Note: For Arabica and Catimor varieties, 4% of the end products sold are a combination of coffee cherry and parchment.

Machine and Motor Ownership

Coffee pulper with exposed electric motor and wires

Most of the smallholder coffee growers interviewed for this study prefer to process their coffee before selling it to coffee traders or exporters; yet most do not own pulping or hulling machines, and few have electric motors to power equipment. Only 30 percent of those surveyed own both pulping and hulling equipment;[16] 14 percent own a pulping machine only, and 21 percent own only a hulling machine. This means some 35 percent must either rent their pulping and hulling machines or hire millers to do these processing tasks. Only three-fifths of those who own pulping machines use electric motors, and electric hullers are rare.[17] Among the one-third who own electric motors, the average size is 5kW (with 0.5–8 kW range).

About 55 percent of smallholder coffee growers own a diesel motor; the average size is 12.6 hp (9.5–18 hp range). Applications from transport to agricultural production and processing are nearly universal for hulling dried coffee. Rural farmers view the diesel motor as flexible. For example, it can be mounted to a wagon or "tok tok" used to transport passengers and agricultural products and then be remounted to a plough machine, coffee huller, thresher, miller, or water pump.

Diesel-powered, coffee-processing equipment

[16] In addition to pulping and hulling applications, small electric motors are also used for pumping the large amounts of water required by the wet-dry coffee processing method.

[17] Only two smallholder coffee growers reported having hulling machines powered by electric motors.

Smallholder coffee growers are quite knowledgeable about diesel-engine mechanics, technical specifications, and brand names; conversely, they have little knowledge about electric motors. But compared to small electric motors, diesel motors have several important drawbacks. First, they are heavy, weighing 90–125 kg, which makes them difficult to move from one application to another. Second, it takes time to set them up and adjust the belt. Third, the operating costs are high; diesel fuel is not always readily available, and fuel prices tend to fluctuate. Several of the coffee growers surveyed indicated a preference for motors dedicated to specific applications. Thus, it appears that electric motors can compete with diesel motors in coffee processing.

Strategies To Promote Productive Uses of Electricity

Like rice production, coffee production is steadily increasing in Lao PDR, which means that demand for coffee processing is also on the rise. Given the large number of smallholder coffee growers who still rent their pulping and hulling equipment and use diesel motors, there are good prospects for promoting energy-efficient electric motors. Attempts in recent years to introduce the demucilager machine also offer an opportunity to promote small electric motors for use in coffee processing. This machine would replace the full wash (wash, fermentation, wash) stage of the wet-dry coffee processing method to obtain clean parchment coffee (Figure 4.2).

Strategies that promote electricity uses for coffee processing should be designed to convince (i) smallholder coffee growers who own processing equipment powered by diesel motors to switch to energy-efficient electric motors and (ii) smallholder coffee growers who rent processing equipment to adopt electricity and energy-efficient electric motors. Specific strategies for these groups are as follows:

- ***Develop and implement an education and information-dissemination campaign on how to apply for upgrading the electricity services and technical standard requirements for installing electric motor***. As an initial step, the campaign should begin with publishing and distributing brochure containing information that the coffee growers should know about the processes and steps as well as technical standard and safety requirements for using electric motor for coffee pulping and hulling.
- ***Develop and implement an education and information-dissemination campaign on energy-efficient electric motors***. This campaign should provide smallholder coffee grower basic knowledge about single- and three-phase motors, motor sizes, efficiency ratings, brand names, and local market availability. The distribution company, EdL, could play a key role in providing technical assistance in these areas.
- ***Ease upfront connection costs***. Financial arrangements and credit schemes should be used to help smallholder coffee growers cover the connection costs needed to upgrade their processing equipment. At a minimum, they should be allowed to extend connection-related investment costs over a 12-month period.

Chapter 5. Recommended Program Strategies

Results of the marketing survey presented in the previous chapters suggest that economic conditions in the rural villages of central and southern Lao PDR are favorable for promoting productive uses of electricity for existing businesses and agro-processing activities. The vast majority of business owners and operators, rice-mill owners, and smallholder coffee growers have a positive outlook on their respective regional economies and opportunities for growing their own businesses. They also perceive that electricity will play a vital role in this effort. To expand their markets, retail businesses, vehicle and machinery repair services, and manufacturing and cottage industries, they will need to acquire additional electric appliances and equipment; similarly, rice-mill owners and smallholder coffee growers will need to switch to or adopt more energy-efficient electric motors and machinery. Despite these prospects, the survey results also show that lack of technical know-how, locally available products and information, and investment capital may bar many of these businesses from harnessing their potential. In short, this study finds that a program to promote productive uses of electricity in the rural villages of Lao PDR must (i) focus on specific electricity applications for targeted end-users and (ii) address key conditions for program success.

Focus on Electric Motors

The marketing survey conducted for this study identified the motor as key to **rice milling** and **coffee pulping and hulling**. In addition, motive power was identified as vital equipment for **vehicle** (cars, trucks, and motorcycles) **and machinery repair shops and manufacturing and cottage industries** (e.g., carpentry and furniture making). Thus, convincing rice-mill owners, smallholder coffee growers, and other interested business owners to switch from diesel motors to more energy-efficient electric motors and equipment would be a top priority. EdL would be well-positioned to promote the appropriate use of energy-efficient electric motors for agro-processing and business activities. In addition, the program would need to coordinate with all relevant stakeholders, including electric-motor vendors and importers; rice-milling, coffee-processing, and other machine makers, vendors, and importers; and other relevant governmental agencies and nongovernmental organizations.

Key Program Components for Success

As part of its efforts to promote productive uses of electricity, EdL would need to regularly monitor electricity demand load and conduct billing analysis of its customers, especially those in newly electrified rural villages. Such an analysis would allow EdL to assess how productively the rural villages are using electricity and identify opportunities to increasing productive uses and thus generate more revenue for the utility. Basic marketing tools should include (i) incentives to help customers overcome upfront costs; (ii) direct personal contact with customers; (iii) coordination with a range of stakeholders; and (iv) education, information dissemination, and technical assistance.

Assist Customers with Upfront Costs

Although a productive use program cannot provide financial services, it can play a facilitating role in helping customers cover upfront costs, which are generally of two types: (i) investment in new equipment, including electric motors and (ii) electricity connection and services upgrade (e.g., transformer and low-voltage network). As the rice-mill owner survey showed, electricity-related investment costs range from an average of US$532 for a small rice mill using a single-phase electric motor to more than US$1,700 for a large rice mill using a 30–40 kW, three-phase electric motor. For investment costs that must be paid to the utility company, it may be possible for the company to provide program participants direct financial assistance.

Another way to help customers overcome upfront costs, as previously recommended, is for EdL to allow consumers to extend connection-related costs; alternatively, it could establish a revolving fund, whereby qualified customers would borrow to pay for electricity-related connection costs. In either case, customers would pay over a 6- or 12-month period, with little or no interest, depending on company policy. In both cases, the productive use program team would be responsible for facilitating, screening, and assisting qualified customers to extend these cost payments.

In many cases, productive use customers may seek loans from financial institutions, such as commercial or development banks or microfinance institutions, which may involve procedures that are more complicated than simply facilitating a loan or application process through EdL. Before initiating this program, it is recommended that the staff's productive use team receive appropriate training and coordinate with financial institutions.

Maintain Good Customer Relations

Reliable, good-quality electricity service is a key condition for any successful productive use program and makes the distribution company's job of maintaining good customer relations much easier. One should also recognize that financial incentives do not guarantee program success. The ways in which programs are promoted and marketed can greatly influence customer responses. Gaining the attention of and addressing the concerns of business and mill owners and prospective investors—which are critical for program success—make it easier for them to participate in the program. Program staff should regularly visit customers in person and by telephone. Although customers may be confident that power outages and excessive voltage fluctuations will not occur, they will nonetheless feel more at ease knowing they can get help from the company if and when needed. In short, customer satisfaction is key to a successful productive use program. Thus, as part of maintaining good customer relations, EdL should work closely with electric equipment suppliers since they are the product provider and a key information source for end-users.

Coordinate with Other Stakeholders

A productive use program comprises a range of stakeholders, whose coordination is essential to program success. They can be classified into six main groups: (i) productive use customers, overall community, and rural villagers; (ii) electric appliance and equipment vendors and importers and local equipment manufacturers and repair services providers; (iii) other offices within the distribution company, including those responsible for new commercial connections, electricians, and electrical contractors; (iv) financial institutions, including commercial and development banks and microfinance institutions; (v) international and local development agencies (public and private); and (vi) government agencies -- including National Committee for Rural Development and Poverty Reduction (established under the Prime Minister Office to ensure coordination between central and local authorities), Ministry of Agriculture and Forestry and Department of Agriculture and Forestry at provincial district level, -- and other nongovernmental organizations.

Provide Education, Information Dissemination, and Technical Assistance

The goal of education within the productive use program is to educate and train customers and the community in electricity applications that serve as the input for outputs that improve the efficiency of electricity use and overall business operations. Such education also aims to help consumers make informed decisions about acquiring new electric appliances and equipment and using and maintaining them properly. Given the marketing survey results for this study, education and information dissemination should focus on the electric motor application. The targeted end-users should include rice-mill owners, smallholder coffee growers interested in using pulping and hulling machines, owners and operators of vehicle and repair services, manufacturing and cottage industries (e.g., carpentry shops), and any other individuals interested in using electric motors for productive uses and business services.

The surveys show that about one-third of end-users lack basic knowledge about local market availability, brand names, appropriate product sizes, and types of electric equipment, which would help them to make informed decisions on which products to buy. Moreover, those who use electric motors and equipment often lack basic knowledge on maintenance and use. This suggests the need for education and information dissemination that target small retail business owners and the overall community on proper maintenance and use of electric appliances and equipment (e.g., refrigerator, freezers, and certain food processing equipment).

Technical assistance, including both technical support and consultation, should be provided to productive use customers at all stages. These include selecting the best equipment for the job, obtaining the best deal and warranty, installing and protecting equipment and electricity upgrades to ensure safe and efficient operation, using and maintaining machinery and equipment properly, and following worker hygiene and safety instructions.

Implementing Productive Use Activities

Implementing the productive use program will require team members to coordinate with a range of stakeholders, conduct field work, and promote productive uses. Specific tasks are as follows:

Coordinate with Other Stakeholders

- Coordinate with the unit or department within the company responsible for new commercial connections, as well as electricians and electrical contractors hired to implement connections and installations.
- Work with current and prospective program participants to determine the terms and conditions of financing arrangements or credit schemes available from the program or utility company.
- Assist and facilitate qualified participants to secure financing or credit.
- Determine the availability of the required electric motors, other equipment, and appliances; and work with retailers and suppliers to stock them so that customers are encouraged to purchase.
- Work with "trade allies"—equipment importers, wholesalers, retailers, and milling equipment manufacturers—to enhance the program.
- Provide technical assistance and training to program beneficiaries.
- Coordinate with other government agencies and nongovernmental organizations.

Conduct Field Work

- Collect, compile, and analyze data related to the market availability of electric motors.
- Actively implement marketing campaign in the rural electrification project area to promote productive uses of electricity.
- Determine what incentives potential program participants would need to switch to more energy-efficient electric motors and modern milling or other agro-processing technologies. One should note that these potential participants include those who already use electricity and customers connected to the grid.
- Provide technical assistance and assist program participants throughout the process.

Promote Productive Uses

- Select the media forms to be used to inform potential end-users about the productive use program and communicate messages on the benefits of switching to more energy-efficient electric motors and equipment.

- Develop education, training, and information dissemination materials, including manuals, pamphlets, photo displays, video presentations, and possibly demonstration units.

Chapter 6. Off-grid Opportunities: The Case of Muang Mai

Muang Mai is a southeastern district ("muang") in the northeastern province of Phongsaly, a mountainous region bordered by China and Vietnam; the entire district extends from the east bank of Ou River to the Vietnam border (Figure 1.1). Most of the population is concentrated in 10 villages ("bans"), which are connected to the Muang Mai isolated electricity grid. The district's small isolated power plant is a hybrid generation system, combining photovoltaic (PV) and micro-hydropower. There is no option for drawing energy from the grid or a nearby power plant or sending excess power to other demand centers. In addition, this isolated system faces the challenge of resource availability: the sun does not always shine and small streams do not typically flow 8,760 hours per year. But unlike thermal power plants and diesel generators, most of the costs are fixed and are incurred whether or not the plant operates.

Overview of the Isolated Grid System

Muang Mai offers one of the best opportunities to develop strategies for promoting productive uses of electricity for isolated grid systems powered by renewable energy. In such cases, the objective is twofold: (i) develop ways to promote productive uses of the excess energy available during periods of low demand and (ii) increase the efficiency of energy used during periods of peak demand and limited energy supply. In term of costs, PV and micro-hydropower, either alone or in combination, require high capital investment costs, but low operating costs (i.e., no fuel costs). Such projects tend to be more economical when users of these technologies can take advantage of the low operating costs. High-capacity plant utilization yields lower kWh costs.[18]

The hybrid off-grid system in Muang Mai is a demonstration project designed to test whether using a technology, known as "double-layered capacitor," will enable Muang Mai's hybrid power-generation system to provide stable year-round power (in both rainy and dry seasons). The double-layered capacitator, which instantaneously charges and discharges energy, is used to offset rapid or short-term output fluctuations from PV supply due to changes in solar radiation, which micro-hydro generators cannot compensate for fast enough to meet power demand.

All 10 villages covered under Muang Mai's isolated grid system (a total of 675 households) are characterized as rural villages. Three are clustered, forming a small rural town called Muang Mai Municipality, which serves as the administrative seat of the district government and the district's trading center. The other seven villages are scattered around the Muang Mai Municipality (Figure 6.1). Between April 2010, when the Muang Mai government started providing electricity services from the hybrid power plant, and November 2010, more than 70 per households (478 households) were connected (Table 6.1).

[18] The PV system for Muang Mai's hybrid power supply is not equipped with battery storage.

Table 6.1 Rural Village Households with Electricity Connection in Muang Mai, Lao PDR

Village	Total households	Households with electricity
Sobnao	60	50
Houayvangkao	44	26
Nakang	85	58
Houaychik	60	51
Naxong	116	109
Sobhoun	98	64
NamNga	75	74
Sensaat	49	8
Xongneua	50	4
Nakham	38	34
Total (no.)	**675**	**478**

Source: Field interviews with village heads in Muang Mai (November 2010).

Like most other rural villages in northern Lao PDR, Muang Mai has limited income-generating activities. The field surveys conducted for this case study in 2010 confirm that business establishments are limited to agro-processing (rice milling) and small retail and service businesses (Table 6.2).

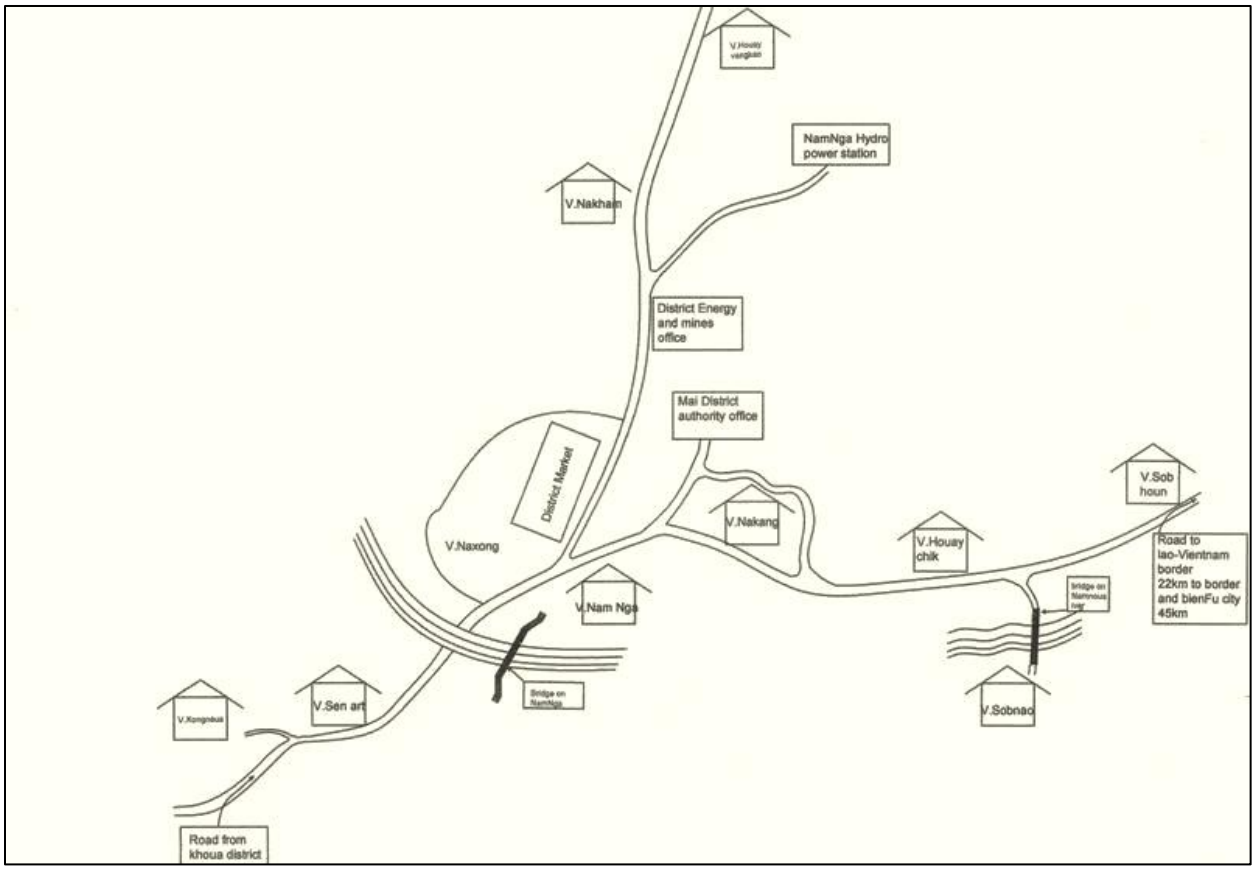
Most businesses lack access to markets for lack of reliable roads, transport, and electricity supply. However, business prospects for Muang Mai's 10 rural villages have brightened in recent months. In April 2010, they gained access to round-the-clock electricity supply and the road that links Muang Khoua to the Vietnam border, which passes through Muang Mai, is being upgraded. Once construction of the bridge crossing the Ou River is completed, Muang Mai will be linked with the rest of the country (Figure 6.1).

Table 6.2 Electricity Uses in Muang Mai Businesses and Agro-processing Activities

Business type	Description	Total no. in 10 villages	Productive uses of electricity
Daily public market	Vendors rent space and set up stall to sell fresh produce, fish, meat and poultry, and cooked food.	Twice daily	None
Grocery/retail shops	Products include sugar, milk, toothpaste, toothbrushes, candies, notebooks, pens and pencils, fish sauce, and chili.	55	All use electric lighting only.
Grocery and agricultural mixed shops	Products include sugar, milk, candies, notebooks, pens and pencils, fish sauce, and chili. Agricultural products include garlic, onions, Chinese cabbage, lettuce, coriander, soil beans, green and yellow beans, and cucumbers.	20	All use electric lighting only.
Retail clothing stores/shops	Items include shirts, short and long pants, and tee-shirts for adults and children.	22	All use electric lighting only.
Motorbike repair shops	-	3	All have air compressors and use electric lighting to repair motorbikes in evening.
Noodle shops	One shop makes traditional noodles; four shops use modern noodles from Vietnam and China.	7	All use electric lighting; three have refrigerators; none have electric appliances.
Guesthouses and restaurants		4	Guesthouses use electric lighting, refrigerator, TV, and fans; only one restaurant (Sengmany2) has a freezer.
Hotel	All 20 rooms are equipped with a ceiling fan, an exhaust fan, and a 2,000-W electric hot-water heater.	1	Hotel uses electric lighting, TV, and fans; it has three air conditioners, but has not yet gotten permission from the District Office of Energy and Mines to install them.
Electric and motorbike shops	Applications include TVs, CD players, motorbikes (Chinese wave), electric drills, and small rice-mill equipment.	5	All use electric lighting in evenings.
Rice mills	All mills use single-pass equipment.	138	Only 10 rice mills in Sobhoun village are connected to electricity; 128 mills use 12-hp diesel engines, mostly made in China and some in Vietnam.

Source: Muang Mai Business Owners and Operators Survey (November 2010).

Figure 6.1 Map of Muang Mai Rural Villages, Showing Roads and Bridges under Construction



The sections that follow present the results of this study's marketing analysis for Muang Mai's current agro-processing, retail and services businesses, handicrafts, and other income-generating activities and strategies for promoting productive uses. They also examine the power-supply constraints of the district's isolated power grid and suggest ways to manage the hybrid system so that productive use demand does not exceed supply limits.

Rice Production and Market

Virtually all households in the rural villages surveyed grow rice as their main occupation, except for Naxong and Nakang, where many people have government-related jobs and only one-fifth of households grow rice. Even though the topography of all 10 rural villages is mountainous, Muang Mai has a sizeable flat area for lowland rice production. The total area of lowland paddy field, including upland rice field, is estimated at about 264 ha.

Montane lowland rice in northern Lao PDR

This system of rice production, referred to as "montane lowland," is common in Lao PDR's mountainous northern region and along the country's eastern border with Vietnam. Rice is grown in small valley bottoms between mountains or on terraced hillsides. Despite its name, the system's management practices differ from those used in lowland rice production. On average, each household has about 0.5–0.7 ha on which to grow rice. The paddy fields are not irrigated; even so, some households in Huayvangkao and NamNga villages are able to grow rice twice a year because their paddy fields are naturally irrigated from mountain springs. The 10 village heads surveyed estimate that total annual rice-paddy production for all 10 villages is about 950 tons, with each household producing 1–2 tons per year (except in Nakang, where average household paddy production is only 600 kg).

Like most rice farmers in Lao PDR, farmers in Muang Mai grow rice primarily for household consumption and sell the excess. In terms of food self-sufficiency, only three villages—Nakang, Sensaat, and Xongneua—said they could not produce sufficient rice to feed everyone in their respective villages. The other seven villages, except for Naxong, indicated they could not only produce enough rice to feed everyone in their villages, but had excess rice to sell to other villages in Muang Mai, as well as to nearby Muang Khoua and for export to villages along the Vietnam border.[19] This study's marketing survey confirms that rice-mill owners in these rural villages usually sell their excess rice in the local market or to middle-men from nearby towns. There is no exact data on whether farmers prefer to sell paddy or milled rice; however, the field interviews conducted with village heads and rice-mill owners confirm that farmers sell their excess rice in both forms. An increase in rice production would result in an extra inflow of revenue for Muang Mai; however, given the limited amount of arable land available for growing rice, any increase in production would have to come from increasing per-hectare yield and/or reducing post-harvest losses, including losses related to rice milling.

[19] Vietnam villagers who live along the Lao PDR border are of the same ethnic minorities as the people in Lao PDR; the glutinous rice grown in Lao PDR is also their main staple, but they also grow regular long-grain rice for commercial sale.

Single-pass, rice-milling machine

Rice Milling Activities

Rice processing in Muang Mai relies exclusively on small, single-pass rice milling machines, which are known for their relatively low rates of rice conversion (from paddy to milled rice) and low head-rice yield. The conversion rate is only 50–55 percent, while head-rice yield is less than 30 percent. Based on this current milling technology, the annual amount of paddy produced is equivalent to about 500–1,000 kg of milled rice per household. Today, the 10 villages have a total of about 140 rice mills, suggesting that rice milling is one of the largest productive use activities in Muang Mai. Village households each mill their own rice and, in some cases, mill rice for neighbors, other villagers, and extended family members in the same village. The vast majority of single-pass rice milling machines run on 10–15 hp diesel motors. Only 10 of the single-pass milling machines are powered by electric motors (about 3 kW in size); all of these rice mills are concentrated in the village of Sobhoun, and the 10 rice-mill owners bought their electric rice-milling equipment just after the village was electrified.

Opportunities To Promote Productive Uses

As suggested above, current rice-milling activities in Muang Mai are inefficient, given that most mills use single-pass steel hullers, now considered obsolete, that are powered by diesel motors. However, the emerging trend in the village of Sobhoun is equally inefficient because the new electricity-powered mills still rely on the small, single-pass steel hullers. Switching to a few larger rice mills that use more modern rice-milling techniques would make it possible to service an entire village, or even several ones. In effect, Muang Mai could produce 5–10 percent more rice because the two-stage compact and multiple-pass milling machines have a conversion rate (from paddy to milled rice) about 60 percent higher than that of the small, single-pass steel huller.

This study's analysis of the rice market and production confirms that the area has sufficient paddy production to accommodate more modern types of rice mills. It also confirms that the rice market is localized with a high local demand for rice milling. Unfortunately, larger rice mills would require larger-sized electric motors, on the order of 20–30 kW. Given the power-supply constraints of the isolated grid, the combined electricity demand of several large rice mills might exceed power-generation capacity. From an investment perspective, having a sufficient supply of reliable electricity at a reasonable cost is a major determining factor. As a result, demand management, which may include regulations and permits for large electricity customers, will be

necessary. In sum, the prospects for promoting electricity use for better rice milling, while limited, are still possible.

Businesses and Productive Activities

As expected, most business activities that generate income in Muang Mai are concentrated in three villages: Nam Nga, Naxong, and Nakang. Virtually all of these businesses can be classified as small retail shops. These include about 70 small grocery stores, shops, and stalls, a large number of which can be regarded as village convenience shops; as well as seven noodle shops/stalls, one restaurant, four guesthouses, and a hotel. In addition, Muang Mai Municipality has a daily public market, located in Naxong, which serves all of the residents of Muang Mai. It opens for two daily sessions, one in the early morning and the other in the late afternoon (closing at dusk). At the daily public market, farmers and merchants sell their fresh vegetables, fruits, cooked food, fish, and meat. The other seven villages have limited businesses activities, with only one or two small grocery shops that serve their respective residents.

Daily public market (morning session) in Muang Mai Municipality

Electricity Use Demand

The marketing survey reveals that about three-quarters of business owners and operators in the 10 rural villages of Muang Mai utilize electricity in their business activities; they perceive that electricity benefits their businesses, yet most use it only for lighting. Only a handful of shop owners have opted to purchase refrigerators and freezers for storing fresh produce, fish, and meat and providing their customers cold drinks. These business owners and operators have a positive business outlook; more than three-quarters are quite confident they will be able to find a market if they decide to expand their business outputs or services. In addition, well over half of those surveyed agreed that electric appliances and equipment will enable them to increase their business outputs or services; nearly two-thirds believe that electric appliances and equipment will enable them to operate their businesses more efficiently.

Despite their positive attitude toward using electricity to expand their businesses and service operations, a significant number of those surveyed identified obstacles to achieving this objective. Specifically, they indicated a lack of:

- Capital with which to purchase electric equipment for business activities; as expected, survey respondents considered the upfront investment cost as the biggest obstacle facing business owners and operators.
- Direct access to electric appliance and equipment markets and familiarity with brand names, sizes, and appliance and equipment types, which would help them to make more informed purchases. Business owners said they must travel to Muang Xai in Udomxai province (a 5–6 hour drive) to shop for and purchase electric appliances and equipment; in many cases, electric appliances are purchased by placing orders with middle-men.
- Know-how in operating electric equipment for productive use activities.

The daily public market does not utilize electricity. Clearly, fish and meat stalls, as well as fresh produce stalls, would benefit greatly from having access to refrigeration. Fish and meat prices usually drop significantly at the end of the day simply because merchants have no way of refrigerating them. Thus, it is reasonable to conclude that there is a demand for renting refrigerators for overnight storage of fish, meat, and produce.

Potential Electricity Demand for Handicrafts

The Tai Dum and Tai Daeng ethnic minorities in the rural villages of Muang Mai produce an array of non-commercial handicrafts within the household; these products include traditional embroidery, woven cotton and silk, baskets, pillows, and mattresses. Current demand is derived only from local villagers and is met by outputs from within the village. Interviews with craftspeople in several villages indicate much interest in creating outputs for sale, but they do not know where to sell their products.

Currently, any additional output would have difficulty reaching markets beyond Muang Mai due to poor road access to Muang Khoua. However, the transportation problem is in the process of being resolved. Roads are being built, linking Muang Mai with Muang Khoua in the west (the gateway to the rest of Lao PDR) and with Vietnam in the east. In addition, a plan is under way to build a bridge across the Ou River to Muang Khoua. Once the new road and bridge to Muang Khoua are completed in a few years, significantly more people, particularly foreign tourists, and goods will pass through Muang Mai on their way to and from Vietnam. In sum, the potential market for commercial handicrafts, and thus related electricity demand, appears bright.

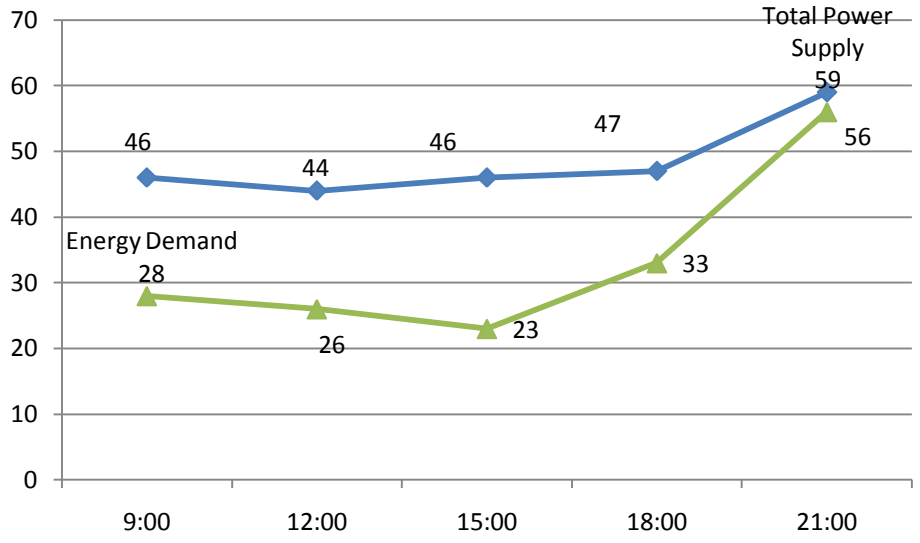
Need for Demand Management

To ensure that the power supply capacity of Muang Mai's isolated grid is sufficient to meet electricity demand, it is critical to analyze the load profile. A profile of power supply and demand load for July 28, 2010 shows that end-user electricity demand starts to increase at about

3:00 pm and peaks at 9:00 pm (Figure 6.2). This suggests that household customers begin using electricity more intensively during the early evening hours, with evening demand peaking at about 9:00 or 10:00 pm. Daytime electricity demand ranges from a high of 28 kW in the morning to a low of 23 kW in the afternoon. Since daytime demand is significantly less than power supply, this unmet supply, accounting for about 20 kW of electricity, is available during the day for productive use activities.

Although 20 kW of excess power supply seems large, the District Office of Energy and Mines, which is responsible for managing demand in Muang Mai, must ensure that all end-users who utilize electricity for income generation have sufficient supply and that demand does not exceed supply. High demand during evening hours should be carefully observed since excess capacity is small at this time. The household survey conducted for this study in November 2010 showed that the average monthly electricity consumption was about 40 kWh and that about 5 percent of household customers were consuming more than 100 kWh per month.

Figure 6.2 Power Supply and Demand (kW) in Muang Mai (July 28, 2010)



Source: District Office of Energy and Mines, Muang Mai, Phongsaly Province, Lao PDR

In addition, household customer demand is likely to increase; about half of the household customers surveyed indicated they are planning to purchase new electric appliances within the next 12 months. Therefore, a demand shortfall during the evening peak load is probably unavoidable. Furthermore, another 25 percent of households covered by the isolated grid are waiting to be connected. At the time of the survey, the estimated total monthly electricity consumption for all customers was about 17,265 kWh. Assuming peak demand during the month at about 56 kW (the same as for July 28, 2010), the monthly load factor was estimated at 0.43 or 43 percent.

Managing electricity demand during evening hours is a priority. Currently, households in Muang Mai use a combination of fluorescent tubes and compact fluorescent lights (CFLs) as their main lighting sources. Results of the household survey show that few households use incandescent or other types of lighting. About 20 percent use 40-W fluorescent tubes, and 94 percent use 20 watts; 85 percent of all households in Muang Mai use CFLs. The collected survey data reveals an average lighting demand from 40-W fluorescent tubes of 62 watts per household (including ballast). The reason is that several households that use 40-W fluorescent tubes use more than one tube. Assuming that every household uses 40-W fluorescent tubes at the same time, the estimated total electricity demand from 40-W fluorescent tubes is estimated at 5.9 kW. Replacing 40-W fluorescent tubes with CFLs would reduce evening peak demand for lighting by at least 3 kW.

It is critical that the District Office of Energy and Mines implement specific measures to manage electricity demand in Muang Mai during evening hours. Demand management should include promoting the use of energy-efficient lighting appliances, as well as productive and efficient uses of electricity during the daytime. Additional measures might include implementing a license and permit system for operating large electric appliances and equipment, along with limiting the use of certain types of lighting appliances. The implementation of such measures would need to be strictly enforced.

Strategies To Promote Productive Uses of Electricity

Based on the survey results in the 10 rural villages of Muang Mai, this study finds that electricity use can be promoted for a variety of income-generating activities, including (i) multiple-pass rice-milling equipment, (ii) refrigeration of products sold at the daily public market and in small retail groceries shops and restaurants, and (iii) motive power for machines used in repair services shops and businesses. Specific recommendations are as follows:

- ***Assess the demand of each productive use on power supply***. Each of type of proposed or potential productive use requires a detailed analysis of electricity demand to assess its impact on the power supply. The limited reserve power-supply margin during evening peak hours means that one must proceed with caution in promoting any productive use that would increase electricity demand during that time. For example, any increased use of refrigerators and freezers must be compensated by reduced lighting demand during peak evening hours, which potentially can be managed.
- ***Regulate daytime use of rice milling machines and consider fewer, larger mills.*** It is critical that rice-mill owners who use electricity work closely with the District Office of Energy and Mines to ensure that demand load does not exceed power supply. Currently, some 10 rice mills in Sobhoun village use 3-kW motors. Any significant increase in the number of machines that use electricity will negatively affect the power supply during daytime load. Therefore, some form of regulation on the use of such machines must be enacted and strictly enforced. To avoid establishing many small and inefficient

electricity-using rice mills, one possible solution may be to open one or two multiple-pass rice mills with sufficient capacity to service the community. This would make it easier for rice-mill owners and operators to coordinate with power plant operators and thus better manage electricity demand.

- ***Control the addition of refrigerators and freezers at the daily public market***. Clearly, access to refrigeration services at the daily public market would open up opportunities for local merchants to earn more; however, increased use of refrigeration would contribute to evening peak demand. Given the low margin during evening peak hours, the number of refrigerators and freezers added to the daily public market must be carefully controlled. It may also be necessary to power off many refrigerators and freezers during evening peak hours.
- ***Link marketing of handicrafts with local infrastructure and tourism.*** Using electricity for handicrafts would have the least impact on power supply; yet, the small margin during evening peak hours would limit the potential for making handicrafts at that time. Organizing stalls and local handicrafts shops at the bus stop nearby the daily public market would be a good start to the commercial sale of handicrafts for tourists and travelers passing through Muang Mai.
- ***Educate and train end-users in demand management and energy efficiency***. Increasing end-users' knowledge of demand management and energy efficiency calls for designing and implementing an education and training campaign. It should be designed to fill the knowledge gap regarding which types and sizes of appliances and equipment to purchase and use.

Chapter 7. Conclusion

This study confirms that economic development in the rural villages of the six central and southern provinces of Lao PDR has progressed significantly over the past decade, especially in the last five years. The pace and momentum of economic development are opening up more opportunities for rural people to generate income, which is an encouraging sign. The survey findings show that rural electrification has played a key role in this process and that business owners are confident that productive activities for income generation are likely to increase.

The survey results suggest that promoting electricity for use in improved rice-milling technology can enable EdL to further fulfill its social responsibility. Currently, post-harvest handling, including rice milling, is one of several constraints to increasing rice production to ensure food self-sufficiency in Lao PDR. As discussed in the previous chapters, improving rice-milling technology will require switching from diesel engines to electric motors and adopting more modern, energy-efficient milling machinery and equipment.

Similarly, the survey results indicate good prospects for promoting the use of more energy-efficient electric motors and modern machinery for coffee pulping and hulling. As previously discussed, coffee is Lao PDR's fifth largest export commodity, and demand for coffee processing among smallholder coffee growers is significant. Motive power is also critical for vehicle and machinery repair shops and manufacturing and cottage industries. EdL is uniquely equipped to provide the technical assistance needed to help these agro-processing and business entities choose, install, operate, and maintain energy-efficient electric motors to power their equipment.

Since most productive uses of electricity for income generation occur during the daytime, promoting productive uses is equivalent to increasing daytime load, which increases the revenue of the utility company and resolves the low-load factor of recently electrified rural households. However, in more remote areas like Muang Mai, where rural villages are served by isolated grid system and draw energy from renewable energy source, the twin objectives must be to develop productive uses of excess energy, which are available during periods of low demand, and to increase the efficiency of energy use during high-demand periods with limited supply. In addition, promoting productive uses of electricity in the villages served by the isolated grid requires a careful assessment of electricity supply and demand, and in almost all of the cases implementation of productive uses activities must be accompanied with electricity demand and power supply management. This is due to the fact that isolated grid does not have the option of drawing energy supply from the grid or power plants nearby, or sending excess power to other demand centers.

Promoting productive uses of electricity to generate income is integral to the ultimate success of any rural electrification program. Large numbers of productive use customers can improve the economic rate of return on investment, minimize financial losses, and relieve the utility company of its financial burden, ultimately helping it to maintain a sound financial standing.

Developing and implementing this study's suggested strategies to stimulate Lao PDR's small and medium enterprises to expand their productive uses of electricity can create a win-win situation for all stakeholders involved, including poor rural villagers, EdL, and the government.

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