A STUDY ON A SMALL SCALE JATROPHA BIOFUEL IN CAMBODIA TO INCREASE INCOME GENERATING AND ELECTRICITY SUPPLY IN PAOY CHAR COMMUNE

By

CHAP Sopornetra

THESIS

Submitted to
KDI School of Public Policy and Management
in partial fulfillment of the requirements
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Committee in charge:

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Approval as of September, 2011

ABSTRACT

In Cambodia, almost 90% of the rural population is living without access to an electricity grid. Capacities to significantly expand Cambodian electricity grids in the coming years are building up at slow speed. This situation creates possibilities for Rural Electrification Enterprises to set up isolated small electricity grids and supply individual communes with electricity. The use of renewable energy such as Jatropha oil is a sustainable way to set up such a system.

This paper aims to present the case study of biofuel growth in Cambodia, particularly Jatropha curcas plantation at household level given the selected location in Paoy Char commune, Phnom Srok District, Banteay Meanchey Province; to find out whether Jatropha biofuel will lead to affordable electricity for the rural population and at the same time increasing income and employment in Paoy Char commune through the extended business activities.

The finding delivers adequate solid proof to realize that the scenarios of both developing Jatropha and running electricity in Paoy Cha commune are very favorable. However, the lack of markets and too low prices of Jatropha seeds are the household's concern.

ACKNOWLEDGMENT

I would like to deeply express my gratitude and sincere thanks Prof. Dong-Young, Kim who supported my initial interest in this study and guide me to the end of this research paper.

Many thanks to Lecturer Nyda Chhinh, Department of Environmental Science, Royal University of Phnom Penh Cambodia, who provided me all the useful information and helped shaping my knowledge about Jatropha Curcas during this study.

This Research Report could not have finished without the great help contribution made by GIZ, Renewable Energies programme that allows me to use the internal usage resources of the User survey and assessment of the Jatropha GIZ project. Big thank to Mr. Peter Bolster, Project Team Leader; Ms. Zimm Caroline, Junior Advisor; and Mr. War Samnang, Technical Advisor who helped directing and encouraging my work.

Last but not least, I greatly appreciate the support from the villagers in Paoy Char commune for the questionnaire and interview sessions, Mr. Tham Bun Hak for one on one interview, my research team would have been a great help during the study other individual and institutions that provided support and assistance for the study.

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LIST OF ABBREVIATIONS

ADB: Asian Development Bank

CEA: Cambodia Economic Association

CEE: Compagnie de Eaux et d'Electricete

CFKE: Compagnie Franco-Khmer Electricete

CRCD: Cambodian Research Center for Development

DATe: Development and Appropriate Technology

DTi: Department of Trade and Industry

EDC: Electricete du Combodge

EIA: International Energy Agency

FAO: Food and Agriculture Organization

GTZ: Deutsche GesellsChaft fur Technische Zusammenarbeit

GIZ: Deutsche GesellsChaft fur Technische Internationale Zusammenarbeit

JDI: Japan Development Institute

LEP: License Electricity Providers

MC: Ministry of Commerce

MEP: Multifunctional Platform

NIS: National Institute of Statistics

MIME: Ministry of Mine and Energy Industries

NGO: Non-governmental Organization

REEs: Rural Electricity Entrepreneurs

REG: Rural Electrification Fund

RGC: Royal Government of Cambodia

SME: Small and Medium Enterprise Cambodia

SVO: Straight Vegetable Oil

UEI: Union d'Electricete d'Indochine

UNIDO: United Nations Industrial Development Organization

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Chapter I

INTRODUCTION

In order to develop a country, energy sector plays an important role. However, Cambodia mainly depends on the imported fossil fuel for electricity production from the neighboring countries like Thailand and Vietnam. According to MIME (Ministry of Mines and Energy), from 1997-2003 the need in Cambodia for diesel petroleum imports averagely increased by 33% (Williamson, 2006). Accordingly, diesel fuel price has been rising rapidly from $32 per barrel in 2003 to $80 per barrel in 2007 (FAO, 2008). On 19th June 2011, the price reached at $93 in Asia (Kennidy, 2011).

Consequently, this situation affects negatively the economic development and poverty reduction which arethe main goals of the Cambodian government. As the world has realized the significance of Renewable Energies; biofuel becomes one of the main sources for the petroleum substitute. The worldwise use of biofuel has dramatically increased from 147 million gallon in 1975 to 11,855 million gallons in 2005, which accounts for 28.7 percent increase per year. And the United States, Brazil and China are the most biofuel production countries (ADB, 2009). In addition, UNIDO (2009) opened the international conference on green energy in Asia absolutely focused on biofuel that can enhance economic of developing countries.

The Jatropha Curcas “Lhong Kwong- in Cambodian language” is commonly grown as protection fence in Cambodia. Yet the idea of using jatropha as biofuel comes along only within the recent past few years in 2004 by an NGO- DATe (Development and Appropriate Technology) which then the interest has been widespread up until now. However, even with

the jatropha biofuel promotion and its potential, there is no existing market and enough information of jatropha biofuel knowledge know how in Cambodia. It is rather case studies of several existing projects.

Therefore, I intend to explore the possibility of biofuel industry in Cambodia as a green growth strategy by analyzing the small-scale production of Jatropha biofuel in Cambodia. This thesis tries to answer the question of whether biofuel industry will be beneficial to investors, national economic development, environment, and rural villagers in terms of electricity supply and extra income. From here, I would like to advance my arguments by introducing next chapters, where chapter II a brief summary of the previous studies will be stated such as the study on energy sectors in Cambodia, the role and the important of Renewable Energy Development in Cambodia, furthermore the description of Jatropha biofuel would be explained in this chapter. Following by Chapter III, the Methodology, which will be basically explained how the research has been implemented. Next is Chapter IV, An overview of Jatropha in Banteymenchey Province with an overview idea why the area was selected. Then Chapter V, Data Analysis, Major Finding, and discussion will be studied by providing tables of facts and figures through the survey with a clear explanation. Last but not Least, the last Chapter VI, conclusion and recommendation will be given by showing that Jatropha Biofuel does give significant impact in Cambodia.

1.1 Background

Cambodia depends on almost 100% of oil fuel from overseas (ECFA, JDI & KCP, (2007). Therefore, the Royal Government of Cambodia pays more attention on renewable energy in teams of poverty reduction by electrification and link with agricultural activities since 2003. The government also encourages famers to grow crops which are convertible to energy, so they are able to increase their incomes and access to electricity. In 2020 if just 10% of

biodiesel was substituted conventional diesel, Cambodia would save 30 million USD (JDI, 2007).

Jatropha, which is able to grow on marginal land and drought-resistant, is recommended for a new raw material for biodiesel instead of palm oil tree. Through its ability to grow well on marginal land, jatropha is grown on abandoned area; so farmers still plant food crops on their farm. Therefore farmers will earn more cash from jatropha and have no threat from changing arable soil to jatropha plantation.

Due to the lack of transportation and irrigation infrastructure, agricultural development in Cambodia is limited. Jatropha, however, is an appropriate plant for rural development, because it is planted, transported and used in the local areas, especially it has low inputs. Farmers sell jatropha seed for money; consequently, electricity will be available and the socio-economic community is also developed. The money from selling the seed is transformed into electricity in rural areas. As long as farmers have money, then they can buy electricity which is already generated enough. At the moment, however, the seed has no market yet.

The production price of biodiesel is approximately USD 0.43/liter (ECFA, JDI & KCP, (2007). Biodiesel contributes into the national economy by reducing imported petroleum and using abandoned land. Consequences for national economic from the use of biodiesel such as the energy from biodiesel-driven generators will be cheaper which stimulate the industrial development and providing job for local people (ECFA, JDI & KCP, 2007).

Biodiesel reduces greenhouse gas emissions because it is recyclable. The use of chemical fertilizer and pesticide in the jatropha plantation is harmful to environment. This can be decreased by reduction the use of synthetic substances.

1.2 Problem Statement

The following problems and questions have been pursued:

Problems/Questions:

- Is jatropha is a sustainable solution for Cambodia economically and environmentally?

  With an eye to biofuel's significances in economic, it also supplies something so crucial for our environment that concerned everyone as regard many potential aspects. Exactly, biofuel is harmless fuel compared to burning fossil fuel, which releases the polluted gas to the atmosphere although there is any spillage in transportation in as much as it is decomposable; therefore it will be decomposed and be captivated without any effects on water or soil. The production of jatropha biofuel takes no contrary impacts on the climate Change. However, the process should be monitored and clean so as to obtain the most perfect quality (Williamson, 2006)

- Is jatropha biofuel a source of Rural Electricity Entrepreneurs for electricity supply in the rural areas where government grid has not reached in the next 10-12 years?

  Creating and expending grid across Cambodia is not an economically viable option at the current stage. Consequently, for large-scale electricity supplying in rural areas, renewable energies are encouraged by the governmental replacing the electricity grids based primarily on fossil fuels, and import of electricity (NEDO, 2002)

- Is jatropha biofuel an additional income beside their main income for rural villagers?

  Cambodian people can cultivate jatropha for selling seeds adding to their

household income, improving the soil to increase its productivity or else they can be employed as workers at biofuel refining factories. If the farmer plant Jatropha we can reduce the poverty by improving the agriculture sector. When the agriculture sector had improved the agriculture baskets it is expanded to include biofuels because the energy market is so much larger (FAO, 2010). Biofuel production can be especially beneficial to poor producer in remote area far from consumption center that inputs are more expensive and lower price, thus marking production, by and large, non-competitive. The cultivation of Jatropha for seed production expands livelihood option with the opportunity to earn income for smallholder grower (FAO, 2010).

1.3 Study Objective

As a consequence, Cambodia, a developing country, tries to enhance the economic by producing biofuel from Jatropha Carcus. In royal government's vision, they explicitly expect to exploit from this sector. Based on this target, Cambodia will gain the tremendous advantages such as slashing the oil price and pollution, providing more occupations, and advancing the wide export market (Schott, 2009). Therefore, the jatropha biofuel introduction is not only solving the global environment concern and fuel crisis, but also to decrease poverty in countryside regions. For these reasons, the study will assess and establish the following factors:

- Whether there are sufficient potential of the small-scale production of jatropha biofuel in Cambodia.
- Whether jatropha biofuel is a petroleum substitute for REEs (Rural Electricity Enterprises) in term of electricity supply.
- Whether there is an additional income for villagers in the rural areas that can contribute to rural poverty reduction.

- What general and specific strategies/policies can improve and promote jatropha biofuel in Cambodia?

1.4 Significance of the Study

The study will review the previous studies of biofuel status in Cambodia that will show the benefit and the potential of biofuel, its market and who are the stakeholders such as the government, producers (Entrepreneurs), users, etc., and this will be one of useful resources for the next researcher who would love to further study about jatropha biofuel in Cambodia especially in term of the large-scale production- Commercial size.

Moreover, this study intends to provide the evidence on the feasibility of the small scale jatropha biofuel as environmental and economical solution for Cambodia, which will meet the goal of Cambodian government to reduce poverty and the positive impacts for the electricity supply in the remote areas. This is showed in data analysis section. Therefore, this study will contribute to the decision where jatropha biofuel should be broaden encouraged to the development of the country's economy with the strengthen policies and strategies by spreading more small scale model across Cambodia.

1.5 Scope of the Study

This study will mainly focus on Jatropha Curcas despite the other feedstock existing in Cambodia since every household in the rural areas grow jatropha as their protection plant and it will not compete with the food crop. Therefore, this plant will be an economically viable for the poverty reductions as stated by many previous authors (Chhinh, 2011). . The study concludes only from the collecting jatropha seeds to usage, however not the whole production process of jatropha biofuel.

The paper will cover only on household plantation, small scales. Namely, Banteay Meanchey one of the provinces of Cambodia is selected for the study. Specially, in Paoy Char commune, Phnom Srok district Banteay Meanchey province by examined whether local residents, in this sense, would either provide to create electrical power by growing jatropha and sell the seeds to the private electricity suppliers, or exchange in turn seeds for electricity use as there is an existing entrepreneur establishing a jatropha oil based mini grid which could in turn deliver electricity through jatropha plants, one of the renewable energy sources. However, the business does not go well due to the lack of jatropha seed to extract oil. The further explanation will be discussed in the data analysis.

Chapter II

Literature Review

2.1 Energy Sector in Cambodia

Electricity is very important to human. In order to develop the country economic to grow rapidly, each country necessarily needs the electricity or energy. The energy is used in many sectors from small families to big institutes, and it is the enormous power on the region or the country development (Ouwen, 2006). In addition, energy leads us to the new economic action providing more profits and employment, but there is a common the problem that some countries did not have enough electricity yet, especially in the remote areas. For instance, huge parts of Africa, Latin America, and Asia continent often do not have enough electricity in supplying (Beerens, 2007). Kees daey ouwen said in position paper that "Total number of people that lack of access to such a supply today is lied between 2 and 3 billion" (Ouven, 2006). Also in Cambodia, only a smaller number of 15% of population has electricity in their home and much of users are in the city. In order to meet their demand in living, they use other energy such as fire wood (90%), 5.3% of Charcoal, 1.8% of kerosene, 1.7% of liquid petroleum gas. The major resources of light are come from kerosene. Phnom Penh gets more electricity than that in the provinces. Some provinces such as Prei veng, Kandal have their own generation to provide electricity charging 6.2% (Lopez, 2003).

Even though people have a lot of demand in electricity, there are few electricity suppliers in Cambodia. Among them, there are three suppliers that do main role in providing electricity to households and industries. They are Electricete du Cambodge (EDC), License Electricity Provider (LEP), and Rural Electricity Enterprise (Kallback, 2008). EDC is a big electricity provider for Cambodia. It was separated into three utilities:

- Compagnie de Eaux et d'Electricte(CEE) provided in Phnom Penh
- Compagnie Franco-Khmer Electricite(CFKE) conducted in Battambong
- Union d'Electricite d'Indochine (UEI) operated for other provinces. (Kallback, 2008).

The problem is that EDC operated alone for providing electricity in Phnom Penh and other provinces. Because of working alone, EDC lose their finance around two million dollars. Some provinces in which are near the border get electricity from neighboring countries, such as Vietnam and Thailand (Lopez, 2003). The price of electricity in Cambodia is from US$ 0.09 to US$ 0.33 for government service and higher than this price for private suppliers and this price is higher than other countries in Asia (Williamson, 2006).

EDC cannot support electricity to rural areas that is why these areas depend on diesel generation, wind power generation or biomass generation to make electric. In some areas the unofficial suppliers provided the electricity. It can provide 3-5 hours of electricity per day for a small number of users. The prices of electricity in Phnom Penh are from 350-650[1] Riel (US$ 0.085 – 0.158) per kWh. For other areas the prices from EDC are 500-900 Riel (US$ 0.122 – 0.219) per kWh. EDP prices are from 1200-1500 Riel (US$ 0.292 – 0.365) per kWh (NEDO, 2002). The prices are getting higher from urban to rural. The price of electricity in Cambodia is the most expensive if compare to that of other countries in Asia. The demand of electricity in rural areas is increasing from day to day. Because Cambodia almost depends 100% on imported petrol from oversea (ECFA, JDI & KCP, 2007), the prices of electricity are high. Because of this reason, renewable energy can be encouraged. For such Jatropha biofuel which can be used by small scale diesel generator now.

[1] Riel : Cambodian Currency
US$ 1 = 4100 riel as of today currency rate (May 19, 2011)

The Ministry of Industry, Mines and Energy (MIME) provides electricity for 10 provinces; while EDC provides for 14 provinces (include Phnom Penh). Generator owner in rural area can serve 30-2000 local households. Nowadays there are around 600 generator owners who support around 12000 households. There are only a few people who live in rural areas estimated about 9% who can get access to the national grid while most of them would buy electricity from the private supplier which is only part time mini grids or using the battery charging services. The government understands the potential of the energy demand that is why electricity investors in the remote areas are highly promoted in a place of meeting the development need of electricity and accomplish the national electricity goals and targets. The government believes that Rural Electricity Enterprise (REEs) plays an important role for rural electrification with the same agreement from the World Bank who states on highlighting about greater private sector involvement. REEs are now looking for a long-term license phases from the EAC to permit them to approach ahead and realize capital return over a continuing period, which would benefit them to decrease their electricity tariffs (NEDO, 2002).

2.1.1 Rural Electricity Enterprise

Currently in Cambodia there are 600 REEs are working for 60,000 customers and the capacity 8 MW for 13,000 consumers. The problems are

- Customers need more power from electricity but suppliers are not enough
- The price of electricity in the provinces is higher than in Phnom Penh that make people in rural area have no ability to use electricity.
- REEs cannot contribute their electricity to remote area. They only give in small number of people.

Lopez said about other problems include “little or no safety, lack of discipline in construction and maintenances, high system losses, and poor billing and collection practices” (Lopez, 2003). Moreover electric supply is based on diesel fuel. This makes the problem worse and worse on the environmental impact (Kallback, 2008).

2.2 Renewable Energy Development in Cambodia

Since October 1994, Cambodia Government has set the target policy of energy sector in Cambodia as below:

- Provide the low price and satisfactory of energy all over the country
- Make certain for the price of electricity supply
- Urge the research and development of energy sector in Cambodia
- Use the energy that is harmless to the environment

Because less than 9% of the entire Cambodian people are supplied with elecltricity grid, Government sought to find the resources that can be transferred to electricity in order to develop rural infrastructure. Renewable energy, the first priority to insert in practice in electricity in Cambodia, was dominated in 2003. This idea is more interesting in 2004 which stimulates the government decision to issue the renewable energy policy in 6 purposes. The expectation that can be exploited from the natural resources consist of solar energy estimated to install 10,000 solar power systems, hydro-energy, thermal energy, and biofuel production. However, biofuel development is not found the detailed law to support this idea, but owing to the Kyoto protocol, Government of Cambodia decided to participate the condition illusory (Ung, 2009).

Primarily, the underlining government policy of promoting alternative renewable energy is linked with reducing poverty by supplying energy and power to the poor especially in the remote area. As one of the supply sources of power to rural communities, the use of locally

available recoverable energy is considered to be ideal in line with supporting local agricultural activities. 85% of the population in most rural areas has no access to electricity, and currently the most is poor and engaged in agricultural activities. Their available source of power is supplied by either automotive–type batteries or expensive small and medium diesel generator installed at provincial cities, and towns. In this regard, the government motive to develop agro-based recoverable energy is encouraged in that the local farmer can gain both income and economically reasonable power by producing agricultural crop which is convertible into a fuel. Therefore, development of recoverable fuel for mobilizing small and medium diesel power generator in order to reduce the use of oil, firewood, and charcoal in responding to the needs of energy, in particularly, in the area where there is no access to power supply is along the nation's interest. In line with this, the Rural Electrification Fund (REF) having adopted in 2004 may also be a financial option for accelerating production of agricultural crop as far as a pilot energy project from crop production and its use for power generation was successfully demonstrated (Urooj, 2009).

2.3 Introduction to Biofuel

Biofuel is the liquid fuel that make from biological resources. There are most common biofuel were known such as straight vegetable oils (SVO), Biodiesel and Ethanol. SOV was made from pure vegetable oil, peanut oil or olives. Biodiesel make through "Trans-esterification of suitable biological oils". Biodiesel is paralleled to fossil fuel. It can use in diesel engine without adjustment. Ethanol can make from plant substance by using difficult chemical procedure. Ethanol is used assorted with petrol (Williamson, 2006).

Biofuel is the new subject that attract many countries on the world to be interested in. According to JDI mentioned in the paper that "The world production of biodiesel increases rapidly by 28.7% in manual rate, and reaches even 3.8 million KL in 2005, although biodiesel

total production in the world about 11.000KL in 1991" (JDI, 2007). EU produced biodiesel 86% of the whole world and The United States comes the third rank of the main producers then Italy, Czech, furthermore now Thailand and India begin to grow jatropha and produce the oil from it (JDI, 2007).

International Biofuel market now established and well growth in the world such as in Germany is increasing yield biofuel by 50% per year. Brazil manufactured ethanol about 4 billion liters per year and sell to other countries by 2010. China constructed biggest ethanol plant in the world. Biofuel production by using jatropha seed is now well known in India, African and South American sub-countinent (Williamson, 2006).

Biofuel market in Asia is expected to be bigger and bigger. Biofuel land in the world will increase up to 166 million hectares in 2020 (Schott, 2009). Jatropha has been grown in some nations like some parts in Africa countries, India and Cambodia. Farmers in north western of Thailand are encouraged to grow biofuel for exporting. In some places farmers take a big risk if they plant jatropha because the market is not stable and lack of transportation. The oil that extracts from jartropha is cheaper than the diesel 400 Riel or 500 Riel (US$ 0.097 – 0.122). Biofuel price is around 0.53$ per liter. The cost of biofuel in Cambodia depends on the world oil market. In 2006 the price of jatropha increased up to 2$ per kg. Many farmer planted jatropha in 2007, and then stopped planting in the following year because there is no market for jatropha seeds. Farmers reported that jatropha can get high yield to 2,500 kg/ha and was estimated that Cambodia can produce 17,000t of oil annually (Gadaheldam, 2007).

2.3.1 Production of Biofuel from Jatropha

Studying the features and necessities of oil crops, for biodiesel production in Cambodia only oil palm and jatropha are showed to be the most appropriate. In Kompong Speu, Battambang, Banteay Meanchey, Kompot, Kep (Kampot), Siem Reap, Prey Veng where Jatropha is being

planted and there are properly in others provinces that are not yet noticed of it yet. According to ADB states about jatropha that: "*The trees are not difficult to grow and their rainfall requirements are 300 mm to 1,500 mm per year. In Cambodia, the normal range is between 1,000 mm and 3,512 mm per year*." Since jatropha has no other commercial values compared to other plants that is edible, it is very practical for biodiesel production, which does not distress economic value adding and food security. At the present that, according to ADB jatropha seizes a very little percentage of the 3.8 million ha of land presently used for Cambodian agriculture (ADB, 2009).

2.3.2 Jatropha Curcas

Jatropha found in Cambodia is used as a fence. It is a drought resistance plant that can live up to 50 years. Jatropha oil can replace diesel. Jatropha seed cake can become a high quality fertilizer, while its yield is around 2500Kg per hectare. There are a few investors investing in jatropha in a small scale in Cambodia. Jatropha yield depends on farming technique. By using appropriate technique, we will get the yield of 9kg of seed per year per plant when it matures (5years after planting). The yield also depends on species so if we need a high yield plant, we have to improve the variety to reach a good variety. In Cambodia we grow jatropha about 3.8 million hectares. Farmers can sell jatropha seeds 500 Riel (US$ 0.122) per kg. If the climate is suitable, jatropha can grow everywhere (Ung, 2009).

2.3.2.1 Jatropha Biofuel Applications

Mostly, jatropha biofuel is utilized for old diesel machines that use "straight instillation" method of fuel integration and distribution. These models of machines are very usual in Cambodian countryside and can be located in many stationary functions such as: electricity generation, which commonly used by Rural Electricity Entrepreneurs who manage mini-grids for rural households; Power generation for business activities such as rice mills, ice making

factories; and last but not least for water pumping, for drinking and irrigation system (Williamson, 2006).

2.3.2.2 Production Process

Conformably to Mr. Williamson who describes the process of jatropha oil extraction, it follows the following steps:

- Seed Harvesting: keep the seeds until mature in order to make it full of oil content.
- Seed Drying: dry the seeds on the concrete slab or other materials flat.
- Seed Cleaning: examine the seeds in case it has some mold or other ruin materials affecting to oil quality and machine.
- Oil Extraction: the oil extraction machine can split oil from the seed cake.
- Seed Filtering: this step filter the seed out of the oil. It is the end of the process, so pure oil can be achieved.
- Packaging: keep the oil in clean airtight plastic. Chemical plastic is recommended (Williamson, 2006).

2.3.2.3 Benefit

Since the Cambodian people almost live in rural area with poor technique in their lifestyle, for instance, the way of cooking depends on fuel wood, The Royal Government of Cambodia (RGC) tries best to seek for the clean energy solution in order to meet the requirements for development. It is particularly focused on renewable energy including biofuel, biogas, biomass, Pico-hydro, and solar which worth $41.8 million. (ADB, 2009). According to Enriqueta (2006) and Brittain (2010), better Characteristic of jatropha in biofuel production bring much more advantages in raw material in manufacture, medicine, and miscellaneous etc. In biofuel production and in by-product summarize as: production of soap, candle, illuminant and lubricant, shade of vanilla, green manure, seed cake: used as fertilizer, biogas production,

fodder (non-toxic species), seed husk: combustible fuel, organic fertilizer, fruit pericarp: soil ameliorant or mulch, biogas production, fast in growing if compared to other tree-borne oilseed, Oil is used in soap production, medicine, pesticides. Owning to its toxic, it is used as living fence not to feed animals. (Daniel Ribeiro & Nilza Matavel, 2009). Furthermore, it is also used as boundary demarcation (Enriqueta, 2006).

Jatropha plays a key role in four principle agents to the rural development such as:

- Increase women's jobs: provides more income in growing jatropha and in energy procession (Karlesson & Banda, 2009).
- Poverty reduction
- Soil conservation
- Biofuel supply (Reinhard, 2004).

Among these, a role as biofuel is very crucial not only in Cambodia but also all over the globe. Since jatropha biofuel are natural fuel which at first is only used to fill the machine in electrical production in rural area, but now it, amazingly, can be used as transportation fuel; nevertheless, it is also expected to be used with train and airplane engine (Schott, 2009).

Relating to economic of jatropha as electric in Cambodia, entrepreneurs get benefit from oil to run their engines, so they can share this to over 80 houses and the price is lower than running on diesel generation (Karlesson & Banda, 2009). As shown in the case study of Africa, time and money saving by using jatropha biofuel make their lives easier and easier on the ground that it saves their time in doing household work in food and agricultural actions; thus, they can spend some times with their children, do off-farm activities, have chances to join in community, and etc. (Karlesson & Banda, 2009). For the case of Mr. Tham Bun Hak's experience on extracting jatropha into pure plant oil, he lessened the electric's price by 20 percent, and he also observed that men and women in the village become more active than

before. In the past, the villagers have to spend time travelling to buy fuel for using daily life, but it is different now. They can grow as well as produce it, and it does not follow the international oil price. Moreover, it can support the places even though they are far away from countryside with the cheap price. In terms of economic condition, jatropha plantation requires less capital in fertilizer application, irrigation, and resistant to drought. However, in hope to gain yield in Jatropha, it needs nutritional soil containing nitrogen, potassium, calcium with pH> 5, and pest control (Daniel & Nilza, 2009). It is resistant to drought, whereas it won't stand frost (Reinhard, 2004).

2.4 Existing projects

Table 2.1: Summary of Jatropha Project in Thailand

Project Title	The role of Jatropha Curcas in support of the Thai Government's National Policy for Bio Diesel
Project Objective	To monitor the value of Jatropha Carcus plantation on environment and socio-economic in the country.
Project Location	North East of Thailand
Project Duration	6- 7 years (start 2005 to end 2011/2012)
Project Funding	The UK Government Department of Trade and Industry
Lead Organization	Government of Thailand Department of Energy
Partner Organization	Japan, United States, Malaysia , Singapore, EU

Activity

- Research on jatropha was funded by Government of UK DTi (Department of Trade and industry). And the process of reporting with the assistance of various educational institutions, Government of Thailand ministries and department.
- The North East of Thailand is an appropriate place for case study of Jatropha Curcas.
- Grown on a national scale, over 4 Million H/a's of planting would generate 2.4 million jobs. "Global production of bio diesel is ramping up, moving from around 2 billion liters in 2003 to about 5 billion (2005).
- It is possible to envisage two tons of Biological residue for every ton of (Oil extraction) Bio Diesel.
- Many entrepreneurial business operators will seek to grow Jatropha Curcas commercial.
- The Thai ambition is currently targeted for a 10% Bio Diesel contribution by the year 2011/12.
- Advertise Jatropha Curcas to farmers.

(Source: Efficiency, D. G. (2005). *The role of Jatropha Curcas in support of the Thai Government's National Policy for Bio Diesel.* Thailand, Retrieved from http://www.akha.org/content/environment/jatrophacurcasagriculturetoindustrythailand.pdf)

Table 2.2: Summary of Jatropha Project in Africa

Project Title	The potential for pro-poor Development
Project Objective	To contribute to poverty reduction through adopting sustainable systems of jatropha production and utilization.
Project Location	Sub-Saharan Africa (West Africa, East Africa)
Project Duration	6 years (start 2002 to end 2008)
Project Funding	GTZ
Lead Organization	GTZ
Partner Organization	KakuteLtd, one of the organizations promoting jatropha for oil production

Activity
• A study found that 1 m of hedge produced about 1 Kg of seeds which yielded 0.2 litres of oil. • In 1987, GTZ launched a development project to improve the utilization of jatropha hedge within the framework of a renewable energy programme. • GTZ (2002), based on its experience in Mali and Zambia, noted that certain local condition s must be for the jatropha system to be successful. • The GTZ project found soap production to be quite profitable. Three liters of oil could be extracted from 12 Kg of jatropha seed, producing 4.7 Kg of soap worth USD 4.20 and 9 Kg of seed cake worth USD 0.27 factoring in the cost of seeds, Caustic soda labour which totaled USD 3.04, it still resulted in a profit of USD 1.43 that could be made from five hours work (Henning 2004b). • A number of organization installed multifunctional platforms (MEPs) in rural areas with plans to scale up the program. For example, the towns of Engaruka and Leguruki both had MFPs in 2008.

(Source: Brittaine, R. (2008). *The potential for pro-poor Development.* Rome, FAO).

Table 2.3: Summary of Jatropha Project in Cambodia, JDI

Project Title	Jatropha Bio Fuel and Power Generation Project in Cambodia
Project Objective	Income generation in rural communities by effectively using unused or unproductive land and designed industrial park to host domestic and foreign manufacturing with total support of utilities and legal duties in Phnom Penh, Cambodia.
Project Location	Phnom Penh
Project Duration	2 years (start 2005 to end 2007)
Project Funding	JBIC
Lead Organization	JDI
Partner Organization	EDC, CBEDC
Activity • Since there is little public control of fuel price in Cambodia, the cost of the electricity is critical issue for many serious manufacturing in Cambodia. • The proposed project is likely to contribute to the rural communities' economic rather than other investment projects in Cambodia. • Contribution to Cambodia sustainable development • Jatropha bio-energy and power generation project in Cambodia. • Feasibility of the proposed Project. • Considerations of Co- benefit CDM in Cambodia that the project can analyze about increasing use of gasoline and HFO for transportation and power generation would be a potential serious issue for human health in Cambodia.	

(Source: Godilano, E.C. (2007), *Strategy for Biofuel Enterprise Development Using Jatropha Curcas. A project proposal developed for the Royal Government of Cambodia*. Phnom Penh, Cambodia. March 2007.)

Table 2.4: Summary of Jatropha Project in Cambodia, DATe

Project Title	Biofuel for Sustainable Development and Poverty Alleviation in Rural Cambodia
Project Objective	To trial a business model based on Jatropha oil production in a small rural village setting.
Project Location	4 villages of Ponley District, Kampong Chhnang Province, Cambodia
Project Duration	17 months
Project Funding	The Canada Fund plus Private Donor
Lead Organization	Development and Appropriate Technology (DATe)
Partner Organization	GERES Cambodia (www.geres.free.fr)

Activity

- One small "Komet" oil expeller was imported from Germany for initial trials in December 2004
- Basic chemical analysis conducted on samples of 1 litre of Jatropha Oil and 1 litre of Kapok Seed Oil in January 2005
- A Jatropha nursery was established in the Buddhist Pagoda at the first project village of Ponley with around 400 trees in March 2005
- A small diesel engine was fitted to the Komet expeller in order to raise output and test oil performance, and it is now running well on local supply of Kapok Seed oil in April 2005
- A larger Chinese oil expeller was bought locally with 1.5 tonne per day seed capacity, and a small diesel engine was fitted to it in May 2005
- Village meetings were held to introduce the project to the locals and invite them to participate in the trials by collecting seeds from around their properties and selling them to the project for 350 Riels per kg (approx US$0.09 per kg). Villagers were provided with free promotion t-shirts and collection sacks to improve awareness of the concept and the project in June 2005.

(Source: Williamson, A. (2006). Biofuel:A Sustainable Solution for Cambodia. Phnom Penh: CRCD. Retrived from http://www.nri.org/projects/biomass/conference_papers/biofuel_in_cambodia.pdf)

Table 2.5 Summary of Jatropha Project in Cambodia, GIZ

Project Title	Jatropha Based Rural Electrification
Project Objective	To increase income and employment opportunities people living rural areas of Cambodia.

Project Location	Cambodia, Banteay Meanchey, Phnom Srok district, Paoy Char commune
Project Duration	July. 2006 – present
Project Funding	GTZ-PSP (Public Private Partnership), GIZ-RE
Lead Organization	GIZ
Partner Organization	REE, MIME

Activity

- The conversion of the generator pump to run on crude Jatropha oil.
- Feedstock comes from see purChase from farmers which then will produce electricity in an affordable prices for them.
- Suggest: update national policy on electricity extension plan and produce appropriate business plan using the facts and figures from feasibility.
- Promote community framework (promoters/collectors, social representatives and farmers) by providing critical skills and knowledge accordingly.
- Relevant stakeholders at community level aware a common problems and help to solve them with participatory approach.
- Farmers need appropriate skills on jatropha plantation and cultivation techniques
- Jatropha increases value-adding for businesses and other benefits to local communities
- Increase additional income for community
- By product are sold to community as organic fertilizer.

(Source: GIZ Internal Usage, 2008)

Chapter III

METHODOLOGY

3.1 Research Design

This particular research is conducted combining research on primary and secondary data.

The study examines the beneficiary, partners and stakeholders feedback about the Jatropha-Based Rural Electrification in Paoy Char commune in order to find problems and space to improve. The research team undertook an intensive six days field survey at eight villages in Paoy Char commune in which six villages have covered by power grid such as Paoy Snoul, Paoy Char, Trapang Thmor Kang Thbong, Trapang Thmor Kandal, Trapang Thmor Kang Choeng, and Ta Ong and the other two villages where Jatropha-Based grid does not cover are Sambour and Pungror.

Interviewing households, key relevant local authorities and electricity supplier/1 Rural Electricity Enterprise (REE) were conducted in entire eight villages by using a structured questionnaire. Besides household survey, focus group discussion using SWOT analysis tool was employed in stakeholder dialogue to understand the internal and external environment of Jatropha-Based Rural Electricity in Paoy Cha commune.

3.2 Method of Data Gathering

The primary data was collected by a field survey. A set of questionnaire was used to gain useful information from the respondents in order to meet the objectives of the study and to answer the research problems of this study (See Appendice for detail). And interview was made to provide additional information in better analyzing.

The secondary data was collected from different sources such as the Internet, Library, books and various institutes. Most of the references were dated 2004 to 2010.

3.3 Sample Size

A total of 214 households were selected for the survey including 100 existing electricity users, 100 non-electricity users from grid covered villages, 12 households from villages where jatropha-based grid does not cover, one commune chief, and one Rural Electricity Enterprise (REE). Selecting households, the survey team leaders obtained the name list of electricity users' households in six villages where power grid covered from REE. Then, the systematic sampling was drawn up and intended to ensure that all six villages were equally represented. The odd number of the households on the list was first selected and then they were removed one every eight to get 100 electricity users' households.

Non electricity users were selected on the right hand side of every user's household. The survey encountered some problems this is because local people are busy with the beginning of rice cultivation and a small number of households were not at home and not available. However, those were replaced by the household nearby. Therefore, interviews could still be done with most of the selected households.

3.4 Data Processing Method

For the secondary data, they were used as references in analyzing the primary data. On the other hand, the results of the personal interview were summarized. In some parts, primary data results were summarized based on their direct translation from Cambodian answers of the respondents.

3.5 The Survey Team and responsibility

The author facilitates and coordinates with the research team under the name of GIZ Renewable Energies Project throughout the discussion, questionnaires to interview session

from 14-19 May 2011 in Paoy Char Commune. Therefore, in the data analysis section, information and sources are GIZ internal Usage.

Detail information about the project: The German Development Cooperation's Program for "Renewable Energies in SME" (GIZ-RE) in cooperation with the Rural Electricity Enterprise (REE) and Local Commune Council in Paoy Char have set-up Jatropha-Based Rural Electrification in Paoy Char commune, Phnom Srok district Banteay Meanchey province. The project has been implemented since mid of 2008. The purpose of this project is to establish a jatropha oil based mini grid which could in turn provide electricity through renewable energy sources based on jatropha plants. Local residents, in this sense, would either contribute to generating electrical power by planting jatropha and sell the seeds to the private energy suppliers, or exchange in turn seeds for electricity use.

Chapter IV

AN OVERVIEW OF JATROPHA IN BANTEAY MEANCHEY PROVINCE

Cambodia is situated in Southeast Asia. The total land of Cambodia is 181,035 square kilometers. Cambodia is border by the northwest to Thailand, Vietnam on the east, Lao on the northeast, and the Gulf of Thailand is on the southeast. Cambodia is separated into 23 provinces including one capital city. Cambodia is in the range of 65th of most population in the world, with the population over 14.8 million. In 2010 Cambodia's per capita income is quickly rising but it is lowest than other neighboring countries in the region. Cambodia per capita income is $2,470 in PPP and in nominal per capita is $ 1,024. Most people in the rural area are depending on agriculture sectors. The amount of 57% (2011 estimate) is below poverty line (Peter, 2011).

Banteay Meanchey is located in the northwest of Cambodia spreading over 6,679km^2 equal to 667,700ha, farmed land 216,000ha, forested land 358,350ha, lake area 80,850ha, and urban area 12,500ha (Model Court High Level Working Group, 2009) whose province center is Serei Saophoan. Poipet is the international check-point border next to the Thailand. Banteay Meanchey has a special meaning which Banteay is referred to Fortress while Chey means Victory (REG, 2009). It is divided into 9 districts, Krong Serei Sophorn and Krong Poi Pet, 625 villages, and 55 communes (MC, 2009) and conformably to the National Committee for Sub-National Democratic Development (NCDD, 2009) as described below in the table:

Table 4.1 District Information

District	Total Land Area (ha)	Forest Land Area (ha)		Cultivation Land Area (ha)	Construction Land Area (ha)	Other Land Area (ha)
		Total	Flooded Forest Area			
Mongkol Borei	26,097	17,103	-	7,803	1,153	38
Phnum Srok	80,732	28,638	2,605	44,726	7,368	-
Preah Netr Preah	74,365	34,690	-	24,862	1,493	13,320
Ou Chrov	112,802	24,404	24,171	61,072	2,090	25,236
Serei Saophoan	55,088	26,399	-	25,851	2,660	178
Thma Puok	24,584	-	-	18,448	5,209	927
Svay Chek	108,953	43,561	-	31,278	4,550	29,564
Malai	81,341	50,218	-	25,844	1,450	3,829
Paoy Paet	50,058	12,858	-	35,200	2,000	-
Total	**614,020**	**237,871**	**26,776**	**275,084**	**27,973**	**73,092**

Source: *District Information System, DoLA*

In accordance with the source in 2008 on population in Banteay Meanchey province showed that it was increased by 22% compared to that of in 2007 including 843,306 people and 165,913 families, in which 15,714 families was headed by females. They work as farmers, sellers, traders, government officers, staffs, workers, and furniture crafters, etc. in summarized in the table 4.2. Besides this, some of them raise animals for daily life. Pigs, chickens, ducks, goats, sheets,horses, cattles, buffalos, fish and so on are fed as livestock. In Monkol Borei, three familys can raise prawn that one familiy has one pond (NCDD, 2009).

Table 4.2 Occupation Information

Description	2006	2007	2008	
	%	%	%	Number
Families whose main occupation is agriculture	81%	79%	69%	114,715 Families
Families whose primary occupation is rice farming	73%	72%	63%	103,909 Families
Families whose primary occupation is cultivating long-term crops	1%	0%	0%	738 Families
Families whose primary occupation is cultivating short-term crops	5%	5%	4%	7,333 Families
Families whose primary occupation is cultivating vegetable	1%	1%	1%	1,346 Families
Families whose primary occupation is fisherman	0%	0%	0%	437 Families
Families whose primary occupation is livestock farmer	1%	1%	1%	913 Families
Families whose primary occupation is NTFP collection	0%	0%	0%	39 Families

Families whose main occupation is craft work	0%	0%	0%	438 Families
Families, whose main occupation is in furniture craft, wooden, rattan, vine, bamboo	0%	0%	0%	144 Families
Families whose main occupation is in metal, aluminum, glass goods production	0%	0%	0%	84 Families
Families whose main occupation is food production	0%	0%	0%	70 Families
Families whose main occupation is tire, plastics and rubber goods production	0%	0%	0%	1 Families
Families whose main occupation is textile, clothing goods production	0%	0%	0%	59 Families
Families whose main occupation is in other production, not listed above	0%	0%	0%	80 Families
Families whose main occupation is services	10%	15%	13%	21,887 Families
Families whose main occupation is trade	6%	6%	5%	7,899 Families
Families whose main occupation is repair	1%	1%	1%	1,252 Families
Families whose main occupation is providing transport services	1%	1%	1%	1,941 Families
Families whose main occupation is providing other services	1%	7%	7%	10,795 Families
Families whose main occupation is not clear (or multi)	9%	6%	17%	28,873 Families

Note: *The occupation percentages are calculated on the basis of the total number of families.*

(Source: NCDD, 2009: Banteay Meanchey Data Book: p. 16)

In agriculture sector, arable land in this province offers the potentially industrial crops throughout the province, some of which are almost cultivated in order that they can be refined as the agro-industry products. On the other hand, the demand for these crops is worldwide acceptable for export market and especially Thailand and Vietnam are the target marketing for exported input. Among those crops, soybean, green bean, and cassava have been popularly cultivated. Surprisingly, cassava plantation is grown on cultivated land around 25,000ha. Soybean is second to cassava and is cultivated on 3,500ha while green bean is only 1,050ha (MC, 2009).

Banteay Meanchey' infrastructure has been noticeably advancing for the last two years from 2006 to 2008. Electricity, bridges, roads, hospital, sewerage pipes, irrigations have been developed from time to time, for instance, houses with electricity was only 22% in 2006,

but increased to 33% in 2008 equals to 49,455families. However, it is not enough. There are still around 46% houses run with battery light (NCDD, 2009).

Table 4.3 Electricity connection information

Electricity	BMC	Mongkol Borei	Phnom Srok	Preah Netr Preah	Ou Chrov	Serei Saophoan	Tma Puok	Svay Chek	Malai	Paoy Paet
Total number of electricity connections to households	**21,216**	490	500	410	n/a	12,300	2,214	n/a	752	4,550
Total number of electricity connections to agencies, companies, organizations	**71**	20	0	3	n/a	9	0	n/a	20	19
Total volume in KWh of electricity consumed last in 2008	**9,234,048**	2,508,937	36,000	57,204	n/a	738,328	83,579	n/a	110,000	5,700,000
Total amount collected from users for consumed electricity	**1,534,326**	597,366	1,786	47,970	n/a	N/A	71,474	n/a	1,445	814,286
Per capita electricity consumption in 2008 in Kwh	**64**	15	1	1	n/a	9	1	n/a	3	51

(Source: NCDD, 2009: Banteay Meanchey Data Book: p. 98)

4.1 Overview of the research site

Paoy Cha is one of the six communes of Phnom Srok District. It is bounded with Odor Meanchey Province in the North, with Srah Chik commune in the South, with Tean Kam Commune in the East, and with Namtao and Ponley Commune in the West. It is located 64 km Northwest of Banteay Mean Chey provincial town. The commune has 8 villages and has been recently added an annexed village, called Kon Kleng, which is located 15 km away from the commune centre and was not integrated in the sample (CEA, 2009).

According to Cambodian Economic Association, Paoy Cha is moderately a sizeable commune with 8,353 population and 1,733 households. As in the whole Cambodia, it is also a young population: those aged up to 15 numbered 2,501, compared with 860 people aged over 15. Between male and female populations there are no substantial variations, except in Paoy Char village (CEA, 2009).

There are 65% of the households that used on kerosene for their core basis of lighting and 34% on battery due to the fact that the grid electricity service is not accessible in the commune. To indicate of a good socio-economic position and living condition, durable assets are considered as such livestock and machinery. Based on the figures from the household survey

in 8 villages, Paoy Cha commune had 780 TVs, 617 motorbikes, 380 mobile phones, 373 koyuns, 327 wooden boats, 51 tractors, 51 rice mills including the small ones for household use, 20 cars and 18 threshers which indicates that there are the demand for fuels or Jatropha biofuel. Presently, there are 15 generators consuming about 5,000 litres of diesel per year. However, they mainly use for themselves but not to supply for the whole commune which this private household usages accounts for less than 1% (GIZ Internal Usage, 2008).

For the assessment of jatropha production, land is one of the key factors. Based on both the household survey and administrative data's commune, Paoy Char commune is rich land. Due to the fact from the Socio-Economic Survey 2004, there were 20% of the Cambodian households in countryside landless and in Paoy Char household without farming land were 3%. In Cambodia, a rural household averagely owned 1.5 ha of agricultural land, while household in Paoy Char on average owned 3.27 ha. And only a few households that had almost 80 ha each (NIS, 2004).

There has been no agreement on the cost of producing Jatropha on one hectare of land in Cambodia, which is critically important for analysis of profitability. This reflects the early stages of introduction of Jatropha to Cambodia. The cost of Jatropha production per hectare in the first one year varies from US$214 to $1,500. Land preparation, manure, seeds, fertilizer, pesticides and irrigation equipment inputs are required considerable under different circumstances. Jatropha seeds with high quality price from US$10/kg mostly imported from from Thailand, China, Malaysia and India by many private entrepreneurs. Nevertheless, seeds available locally at about US$3/Kg are also produced (GIZ Internal Usage, 2008).

The prospective requirement of Jatropha oil in the commune is huge as it is a higly economical substitute to diesel since the price is highly expensive for the households to be able to use for everyday activites. Even in the Paoy Cha commune, utilization of diesel is

about 400,000 litres annually, which would require about 1.2 million tons of Jatropha seeds. However, there are no clear markets at present as there is no sizable production available for the market yet (GIZ Internal Usage, 2008).

Most of the households who decided to plant jatropha; their first main concern are no existing market and the comparison of other crop is price. Since they believe there no market existing at the moment where no buyers would come and buy from them and at the same time instead of waiting 3 year periods comparing to others food crops which they could then receive the money accordingly.

Paoy Cha commune is moderately prosperous of equipments owing due to the reason that it depends strongly on agronomy on promising sizes of land. For this, it is favrorable for the local Jatropha production in the replacement of the diesel, which there would be numerous consumers. There is not yet a active market value of locally Jatropha oil producer at present because of the scarity of the Jatropha production.

The main idea is to have both Jatropha production and electricity for villagers in the commune. Needless to say, energy is crucially significant for rising the living standard of people and for verity of business activities and the economic development. It has been proved that small-scale electricity suppliers can run Jatropha seeds to process generators which then supply electricity to villagers. It is imperative to assess this possibility in the commune, where both enormous amounts of land availability and employment readiness are there.

Chapter V

DATA ANALYSIS, MAJOR FINDING AND DISCUSSION

5.1 Households Profile

The team interviewed a total of 212 households (excluded REE and Chief of Commune) for both electricity user and non-user households in Paoy Char Commune (Table 5.1). The majority of interviewees (51%) are women, and aged between 18 to 69 years old. On average, households have approximately 5 family members. The main occupation of the respondents is farmer which represents up to 78% of respondents. This is followed by the 12% of the government official including teacher, soldier, policeman, nurse. The others such as groceries seller, worker, fisherman, student, taxi driver etc., makes up 10% (Table5.2).

Table 5.1: Interviewed Households in Paoy Char Commune

Name of village	Total number of households in each village	No. of Actual Electricity User in Each Village	Number of households surveyed	
			Electricity Users	Non electricity Users
Paoy Snuol	334	75	28	28
Paoy Cha	219	37	17	17
Trapaing Thmar Tbong	286	70	23	23
Trapaing Thmar Kandal	170	40	14	14
Trapaing Thmar Cheung	138	33	12	12
Ta Ong	209	7	6	6
Sambour	104	-	-	6
Pongror	273	-	-	6
Chief of Commune	-	-	1	-
REE	-	-	1	-
TOTAL	**1,733**	**262**	**102**	**112**

(Source: GIZ Internal Usage, 2008)

Table 5.2: General Profile of Interviewees/Households

Sex	51% Women
Age	18-69
Average size of HH	5 People
Occupation	78% Farmer 22% are government official, groceries seller, worker, fisherman etc

(Source: GIZ Internal Usage, 2011)

The main income sources of household are from several activities. Rice cultivation is the most important of others. It contributed an average of 94% annually. Cash crops including cassava, bean, fruit and vegetable are rated as the next important income sources. It makes up approximately 48%. This is followed by government official, fisherman, taxi driver, plowing service providing which comprises of 46%. While sewing and weaving contributed of 42%. Other extra activities to generate income are including groceries selling, electronic repairing etc which would make up around 44% (Table 5.3).

Table 5.3: Income Activities

Income activities	**Percentage**
Rice cultivation	93.9
Cash crops: Cassava, bean, vegetable, fruit tree, corn	47.6
Others (government official, fisherman, taxi driver, plowing services...etc.)	45.8
Sewing	29.2
Animal raising	24.1
Weaving	12.7
Grocery selling	11.3
Workers	8.5

(Source: GIZ Internal Usage, 2011)

For electricity user households, their income earning between mid-2008 up to now is 43% increased, while 35% is stable, and 22% is decreased. Mainly, the increasing of their income is from the increasing of rice yield, weaving and sewing activities, and more income earners per household. However, household's income is decreased due to the higher payments for children school fee. Moreover, they have spent more on health treatment, more family members with same income, and the increasing price of goods. This indicates that since

Jatropha-based Rural Electrification Project was implemented in the commune, it could not influence much to local residents' income.

5.2 Rural Electricity Enterprise/Electricity Supplier

REE has started its business in Paoy Char commune since April 2010, and it was under control by electricity authority of Cambodia. This is the Jatropha-based Rural Electrification Project, which its purpose is to use jatropha oil to generate electricity. However, since jatropha oil is not enough to generate electricity, REE has used diesel as a supplement to jatropha fuel. According to the interview with REE, the electricity has generated by 80% of diesel and 20% of bio fuel (jatropha oil). In general, REE produces electricity around 2,500 kWh per month. Nevertheless, it can be sold only 1,525kWh in March 2011. The price per kWh is recently 3,600 Riel (US$ 0.878). According to the price allowed by electricity authority, the recent price of electricity could be increased to 3,700 Riel (US$ 0.9) per kWh, comparing to the market price of diesel. However, REE still keep the old price, 3,600 Riel (US$ 0.878).

Mr. Seng Bun Ley, the electricity supplier, explained that the mentioned price is applied only to households who use electricity from 4 kWh onward. If the consumption of the number of connection is less than 3 kWh, the electricity cost is calculated up to 3 kWh, 10,800 Riel (US$ 2.634). This minimum consumption is set in order to ensure the electricity business is survived. That was the reason why REE Charged for the minimum use and encourage people to use at minimum of 3 kWh.

Nevertheless, households who use electricity less than 3 kWh would pay to actual used if they could exChange with jatropha crops. The exChange is 1 kWh used equals to 4kg of jatropha, 2 kWh used equals to 8kg of jatropha respectively. This is another good concept/strategy to encourage people to plant/plant more or collect jatropha in the community.

Table 5.4: Previous Electricity Prices in Paoy Char (Since inception in 2010 up to February 2011)

Current Electricity Prices Charged by REE	Riel per kWh
1-5 kWh	4,000 (US$ 0.975)
5-9 kWh	3,500 (US$ 0.853)
10-19 kWh	32,00 (US$ 0.78)
>=20 kWh	3,000 (US$ 0.73)
Minimum used <=3 kWh	12,000 (US$ 2.926)

(Source: GIZ Internal Usage)

Table 5.5: Current Electricity Prices in Paoy Char (From March 2011 to present)

Current Electricity Prices Charged by REE	Riel per kWh
Normal price for all level of consumption	3,600 (US$0.878)
Minimum used <=3 kWh	10,800 (US$ 2.634)

(Source: GIZ Internal Usage)

REE's business has faced with several Challenges. Firstly, jatropha oil, which is the important raw material to generate electricity, is not enough. Although REE bought additional jatropha from other places like Phnom Srok, Srah Chik, Svaysisophon etc, it could not reach to demand as planed. Therefore, REE have to use diesel as additional support. Since the market price of diesel is increased, and households who have connected to electricity are still limited, it is hard to make profits.

Since REE has started his business in the commune, the result is not good. Based on the below Chart, the maximum electricity selling was only 739 kWh in 2010 (Figure 5.1), and 1,525 kWh up to April 2011 (Figure 5.2), while generator can produce electricity around 2,500 kWh per month. If we look at the profit and loss of the business, REE got loss on an average of 1,114,700 Riel per month in 2010 (April–December 2010), and 1,399,650 Riel per month in 2011 (January-February[2]). However, based on the figure 5.2 and the interviewing

[2] The The expenditure of March and April is not available. However, because of the consumption rate is increased, it can be assumed that REE would gain profit from March up to present.

with people in the commune, there will be more households interested in connecting to electricity. Therefore, the consumption rate in 2011 keeps increased. REE's business will be better, and profits will be bull for the upcoming months.

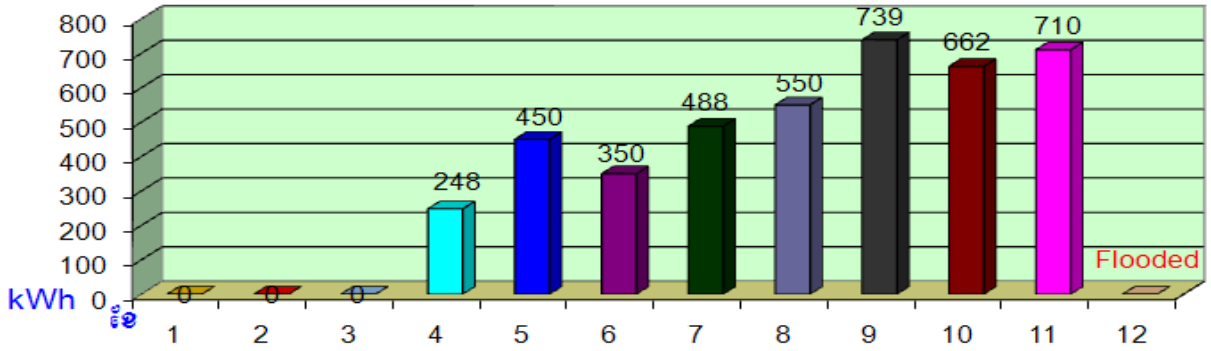

Figure 5.1: Electricity Selling in kWh in 2010

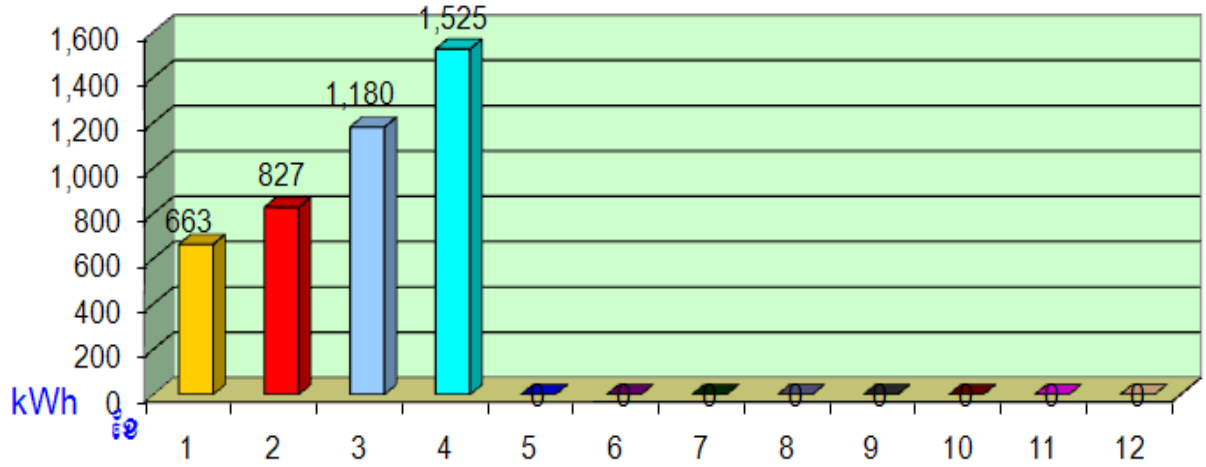

Figure 5.2: Electricity Selling in kWh in 2011

Even though the business progressed very slowly, REE has planed to expand their business throughout the community including Sambour and Pongror villages which have currently yet to install any electricity pole. Additionally, REE planed to enlarge electricity equipment/materials shop which can provide every material if needed and that would lead to additional income for REE.

5.3 Electricity Use

5.3.1 Electricity User

Up to May 15, 2011, there are 262 households connected to the electricity. 46% has connected since 2010, and 54% has connected in 2011. The connection cost including services fee, circuit breaker, and post box was 250,000 Riel (US$ 60.975) from April 2010 to February 2011, and 150,000 Riel (US$ 36.585) from March 2011 to present. The connection cost is varied by the distance from the villager's house to the electricity pole. Based on the interview, households' expenditure for electricity connection fee, and electricity equipment for installation including wires, lamps, plugs etc., was approximately 607,100 Riel (US$ 148.073) in 2010 and 428,800 Riel (US$ 104.585) in 2011. The connection in general would take around one day. Only 24% of respondents mentioned that it would take between 2-10 days.

Picture 5.1: Electricity user

Before connecting to current electricity, the majority of respondents (93%) used battery as their energy source for lighting their house and for other purposes to generate income. This is followed by kerosene lamp which represents 37%, while generator was used 6%, and candle was used 4%.

Generally, the majority of people spent for energy used between 8,000-15,000 Riel (US$ 1.951 – 3.658) (46%), while 30% of responded households spent more than 20,000 Riel (US$ 4.878), and 16% spent between 15,100-20,000 Riel (US$ 3.682 – 4.878). Only 8% of

respondents said they spent less than 8,000 Riel (US$ 1.915) per month. This energy was used for lighting (100%), TV (72%), and fan (9%). It is also used for other activities to generate income including sewing, weaving, and groceries selling (23%). The usage was in average of 3 hours, 2 hours, 4 hours, and 3.5 hours respectively.

After connecting to current electricity grid, the cost which has spent for energy usage is different (Table 5.6). In April 2011, 40% of households spent for the electricity cost more than 20,000 Riel, while 31% of responded households spent between 15,100-20,000 Riel (US$ 3.682 – 4.878), and 28% spent from 8,000-15,000 Riel (US$ 1.951 – 3.658), and no household spent less than 8,000 Riel (US$ 1.951).

This electricity was used for lighting (100%), TV (86%), and fan (35%). It is also used for other activities to generate income including sewing, weaving, and groceries selling (24%). The usage was in average of 4 hours, 3 hours, 3 hours, and 3 hours respectively. In addition to the electricity, the majority (52%) of households has also used battery as their substitute energy mainly for fan and TV/VCD during the day time and night after electricity cut off. It is also preserved for occasionally used. This is followed by kerosene lamp and candle (26%), battery lantern (8%), and generator (2%).

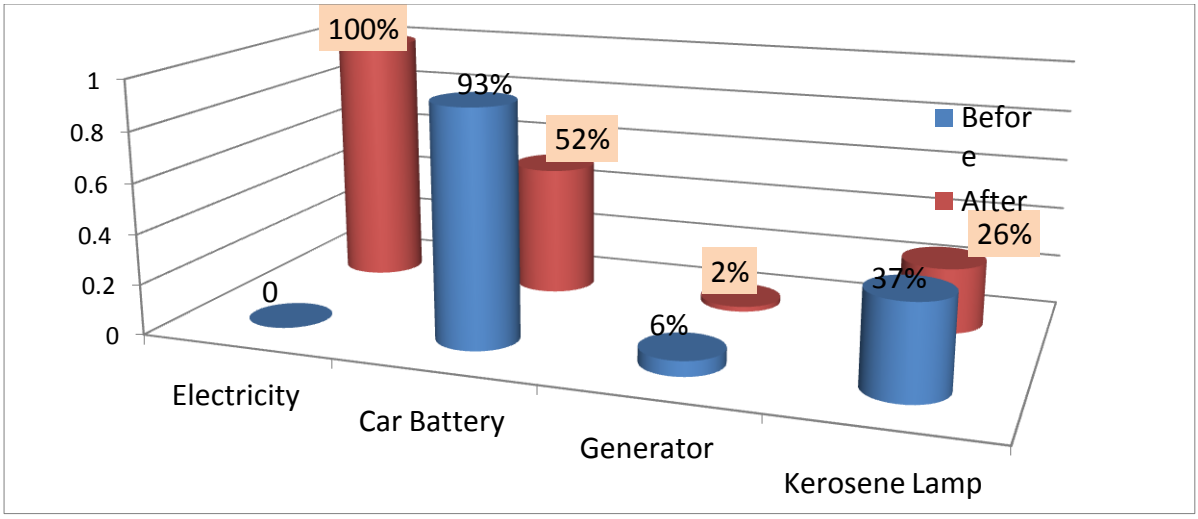

Figure 5.3: The uses of electricity before and after connection to jatropha-based electricity

Table 5.6: The Different of Energy Expenditure Before and After the Electricity Connection

Amount spent	Before (%)	After (%)
<8,000 Riel (US$1.951)	8	0
8,000-15,000 Riel (US$ 1.951 – 3.658)	46	29
15,100-20,000 Riel (US$ 3.682- 4.878)	16	31
>20,000 Riel (US$ 4.878)	30	40

Household consumption on electricity is increased after the jatropha based electricity has been implemented. This is proofed that the connected electricity has led to having new electricity demands. These are including the use for entertainment and income generation purposes. However, the poor household who used to spend for energy source less than 8,000 Riel (US$ 1.951) has increased their expenditure to 12,000 Riel (US$ 2.926).

When we asked if they know what kind of fuel does the electricity owner has used to generate electricity, 45% of the respondents said they do not know at all about this, while 36% said that it has generated by diesel. However, only 27% of respondents mentioned that electricity has generated by bio-fuel (jatropha oil). This reflects that the awareness of local people on the Jatropha-Based Rural Electrification Project and its benefits to them is limited.

5.3.2 Non Electricity User

Currently, the majority of respondents, up to 78%, use battery as their energy source for lighting their house and for other purposes to generate income. This is followed by kerosene

lamp which consists of 60%, and other like small electric machine, candle, gas, and battery lantern, candle and generator represents around 10%.

Picture 5.2: Non electricity user

This energy sources are used for lighting (100%), TV (36%), and fan (9%). It is also used for other activities to generate income including sewing, (24%).

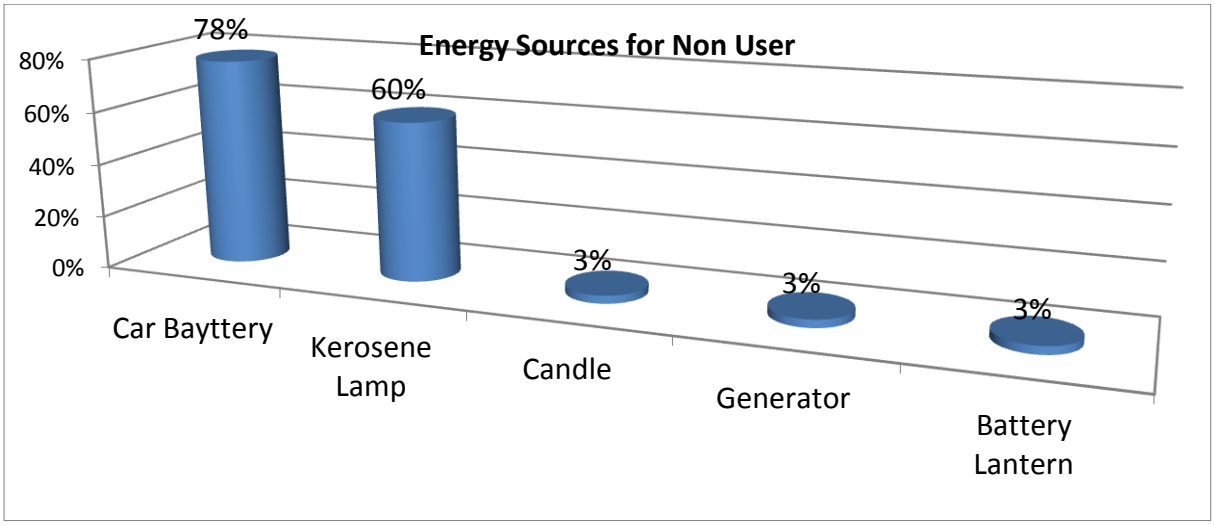

Figure 5.4: Energy sources for Non-User

In general, the majority of respondents (35%) have spent for their energy source less than 8,000 Riel (US$ 1.951) per month, while 32% have spent from 8,000-15,000 Riel (US$ 1.951 – 3.658), and 17% have spent from 15,100-20,000 Riel (US$ 3.682- 4.878). Only 16% have spent more than 20,000 Riel (US$ 4.878) per month.

Table 5.7: Energy Expenditure for Non Electricity User

Amount spent	No. of Respondents (%)
<8,000 Riel (US$1.951)	35
8,000-15,000 Riel (US$ 1.951 – 3.658)	32
15,100-20,000 Riel (US$ 3.682- 4.878)	17
>20,000 Riel (US$ 4.878)	16

When we asked reason why they do not connect to electricity grid, 85% of respondents expressed that the electricity cost and the connection fee is too expensive, they could not effort with such high cost. Although some people think that electricity is needed and they can effort, but the connection fee is still high to them (428,800 Riel (US$ 104.585) in 2011). Meanwhile, 21% of respondents said that the electricity pole is not available near their house, while 10% mentioned that they use their own energy source (they just bought new battery, small generator,...etc.). However, the survey found that 97% of respondents want to connect to electricity in the future. Given this high percentage of local people want to connect to the electricity, the Jatropha-based Rural Electrification Project will be successful if the promotion of jatropha plantation is well achieved.

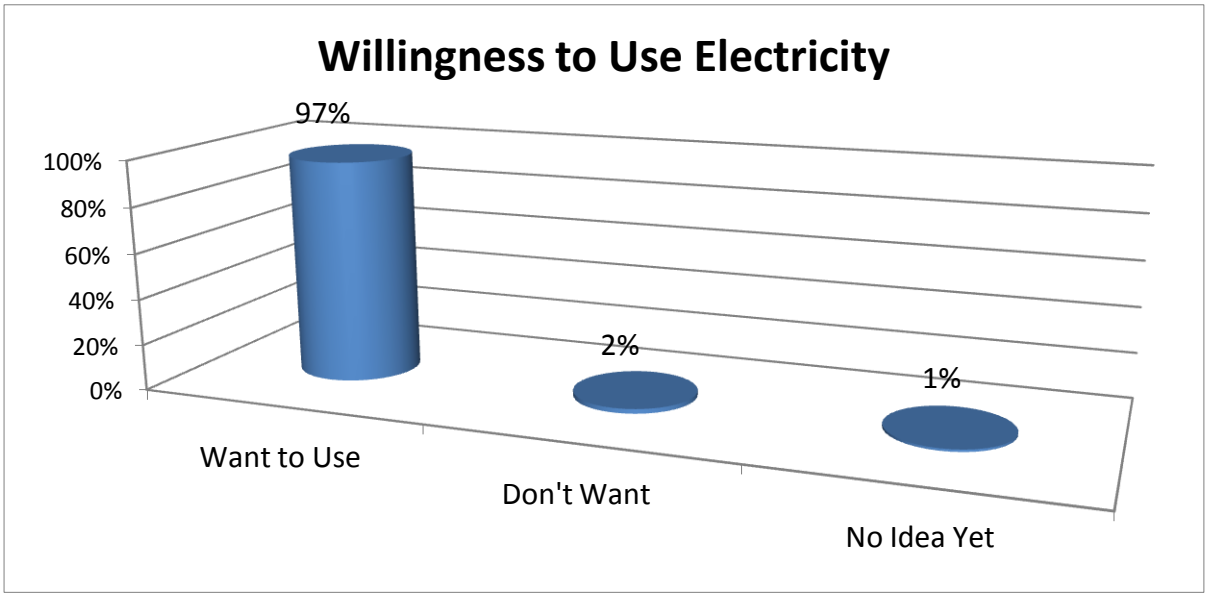

Figure 5.5: The Willingness to Use Electricity by Non Electricity User

5.4 Awareness of Jatropha and Willingness to Grow It

Jatropha has been well-known to most villagers in the commune. 99.5% of the respondents said that they know Jatropha. The majority of respondents (61%) reported that jatropha crops could be produced to get oil to generate electricity, while 48% said that jatropha is good for living fence, and 8.5% expressed that it would help to germinate mushroom, make dishwashing liquid, and jatropha leaf is also good for papaya salad. The minority of people (7.5%) mentioned that jatropha is commercial crops, while 4% of respondents pointed out that it is useless tree.

Table 5.8: Level of Understanding of Jatropha

Level of Understanding	% of respondents
Knows Jatropha	99.5%
Jatropha crops could be produced to get oil to generate electricity	61%
Jatropha is good for living fence,	48%
Germinate mushroom, make dishwashing liquid	8.5%
Mentioned jatropha is commercial crops	7.5%
Jatropha is the useless tree	4%

Picture 5.3: Jatropha curcas

Above figure indicates that most people understand the usefulness of jatropha. In

addition, it has shown that 15% of households have already plants jatropha. Some of them have planted since 2000. However, the peak time for planting was in 2009 and 2010, it made up to 75% of other years. People had grown jatropha along the fence of their house and in Chamkar land. It had been planted approximately 3,550 trees in 1.83 hectare of land which boundary is excluded. Nonetheless, 85% reported that they have not grown it due to several seasons. The majority of non jatropha grower (48%) said they do not have land, 9% stated that they do not have enough labor to grow and maintain the trees, while 8% mentioned that there is no market available, and no profit, and 7% expressed the difficultly of having seed, and seedling. Planting technique is also the problem, 7% of non jatropha grower stated that jatropha is difficult/do not know how to grow, and take long time to get yield.

When asked if they have plan to grow/plant more jatropha, 27% of respondents showed their willingness to grow around 11,570 trees in 18.5 hectares of farming land (details of households who is willing to grow jatropha is in appendix C), whereas 73% reported that they are not interested in growing jatropha because of several reasons.

- Firstly, it is due to the limitation of land. 85% claimed that they do not have more land available
- Secondly, people expressed their concern on the profit received from jatropha production. Data shows that 11% of non planted respondents pointed out that growing jatropha provide less profit
- Lastly, it is because of the lacking of jatropha growing techniques and lacking of labor. The data shows that 6% of non-planted respondents mentioned that it is difficult to maintain/grow, and 3% said that they do not have enough labor

According to above figure, the percentage of people who plan to grow or to grow more jatropha is quite low. This is by reason of the recent high price and demand of cassava.

Recently, 48% of respondents have planted cassava on their farming land. Cassava can produce more or less 17 tonnes per hectare with the price of 600,000 Riel (US$ 146.431) per tonne (the price as of the survey date). Therefore, planting cassava with one hectare of land can in turn provide income approximately 10,200,000 Riel (US$ 2487.804) annually.

Unlike cassava, there is no data found about the yield of jatropha per hectare. However, based on the jatropha growers, jatropha could contribute in cash much less than cassava. (See the bellow economic comparison between growing jatropha and cassava)

Table 5.9: The Economic Comparison between Jatropha and Cassava Plantation

Factor of Comparison	Jatropha	Cassava
Yield/hectare	Non- 500 kgs in the 1st year	10-20 tonnes
Market price	700 riel/kg (US$ 0.17)	600 riel/kg (US$ 0.146)
Estimates income /ha	0-350,000 riel (US$ 85.365)	6 M – 12 Millions riel (US$ 1463.414- 2926.829)
Duration of growing	>= 1 year	8 months

When asked if they know the Challenge of growing jatropha, the majority of people (44%) said that they do not know, while 13% pointed out that growing jatropha is easy. Nevertheless, some people also expressed their concern on the duration of planting. 21% said that one among other Challenges of growing jatropha is taking too long time to get income and low market price as the result. In addition, natural disaster such as not enough water/too much water (flood), and disease is another Challenge, the data shown up to 14% of respondents. Meanwhile, some people were concerned about technical issues. 9% of respondents said that lack of planting and fertilizing skills is also the Challenges.

5.5 Problem Analysis

Some problems/weaknesses of the Jatropha-Based Rural Electrification Project were found during the survey period. The root course is due to jatropha takes too long time (more than a year) to get yield. In addition, technical skills in growing jatropha and using fertilizer are needed to grow jatropha. However, local people do not have those skills. In addition, natural disaster such as drought or flood, and disease is another challenge that jatropha growers have faced with.

As the result, jatropha growers did not satisfy with the yield received compare to the time spent. This would discourage them to grow jatropha. When jatropha production is less, the electricity supplier has to add diesel to generate electricity. This would affect to the price of electricity as well. The survey found that 85% of non-electricity users and 25% of electricity users complained that the electricity cost is too expensive, 3600 Riel/kWh (US$ 0.878). They find that they are difficult to perform income generating activities with such electricity cost. Besides the high price of electricity, the connection cost is also expensive from local people's perspective, approximately 428,800 Riel (US$ 104.585) in 2011 on average.

Moreover, the electricity pole is still limited. It is available only along the main roads. Households who live an inside along the small road have to pay much higher cost for cable connection depends on how far their houses are. The limitation of electricity served is another weakness; it is not meet local people's demand. In general, electricity has served 5 hours/day which start from 6-11pm. During this time, the power has been cut off very often (2-4 times/nights) which has led to break of electronic devices of users sometime. Many user respondents up to 17% complained about this. In this case, most villagers have thought that electricity supplier intended to do so as it could push kWh of users. In addition, many users do not accept with what electricity supplier have minimum charged 3 kWh price for

households who have consumed less than 3 kWh without any notice in advance. Generally, when asked about users' satisfaction on services provided by electricity supplier, 42% of user's respondents expressed that they do not satisfy with service that electricity has offered.

5.6 Benefit Analysis

According to group discussion, the Jatropha-based Rural Electrification Project in Paoy Char Commune has the following strengths.

- Firstly, the electricity supplied in the commune is produced by Jatropha biofuel, at least 20% recently, it would help to reduce dependency of external raw materials, diesel for instance, which its price is keep increasing. The 20% of biofuel uses is changed to be the income for community.
- Secondly, the commune has land available for growing jatropha. Based on the assessment of the feasibility of growing jatropha in the commune in late 2007, the estimate was that a total of 670 hectares of land can be used to grow Jatropha (GIZ Internal Usage, 2008). Among those, a total of 343 hectares was free land without crop. When villagers could maximize the land they have, their family income would be increased.
- Thirdly, the project is in cooperation with between GIZ Renewable Energies in SME (GIZ-RE), and Rural Electricity Enterprise (REE), and Local Authority of Paoy Char Commune. It has received technical and financial support from (GIZ-RE). In addition, local people are encouraged to grow jatropha with several buyers in the commune. Electricity supplier/REE is the core person in buying all jatropha crops or even could exchange with the electricity (4 kg of jatropha crops equals to 1 kWh of electricity). The electricity price could be decreased when the jatropha is available and sufficient to operate generator. Thus, villagers could use this electricity to perform additional income generating activities in their families.

- Fourthly, the electricity is lined (currently along the main roads) in the commune which could help local people to save time and cost, this means they are not necessary to recharge their battery as often as before, and the electricity cost is not much more different.
- Lastly, electricity supplier has provided a quick service in the connection when needed. In addition, the electricity business is legal and has license which is under controlled by electricity authority.

Picture 5.4: Teaching in the evening with the light on

Additionally, having electricity in the commune has provided good opportunity for many local residents.

- Firstly, on one hand, the availability of the electricity could help improve income generating activities in the commune at night. Those are mainly sewing, weaving, groceries selling, and part-time teaching, chicken selling etc, which lead to increase household income. It also provides opportunity to some residents who need to use computer and photocopy machine at night. On the other hand, electricity supplier could also gain more profits while people use more kWh of electricity.

- Secondly, since electricity is generated by jatropha oil, local people could

generate income from jatropha selling.

- Lastly, having electricity is useful for children to study at night. Moreover, fluorescent light would increase social relations among household members and other members in community. The family would have more entertaining/fun in the bright house with color TV; they can also do chore and other things when needed, and it is of course easier than using battery or other energy sources. When asked about users' satisfaction on services provided by electricity supplier, 41% of user's respondents demonstrated that they satisfy with what it has been offered.

Picture 5.5: Studying with light on

5.7 Finding

The survey found that the majority of people understand the usefulness of jatropha. Nevertheless, only 15% of responded households stated that they have planted jatropha with approximately 3,550 trees in 1.83 hectare of land (boundary is excluded), while most people up to 85% of respondent reported that they have not grown it. This is by the reason of they do not have land available, have not enough labor, some do not know about the market, and some expressed their concern over technical issues. Although there are some concerns raised, 27% of respondents showed their willingness to grow or to grow more jatropha around 11,570 trees in 18.5 hectare of land. The percentage of people who plan to grow/grow more jatropha is quite low. This is because of the current high price and demand of cassava. 48% of respondents have planted cassava, it can produce around 17 tones per hectare which can contribute around 10,200,000 Riel

Picture 5.6: Extra income

(US$ 2487.804) annually. Unlike cassava, there is no data found about the yield of jatropha per hectare. However, based on the jatropha growers, jatropha could contribute in cash much less than cassava.

Jatropha-Based Rural Electrification has been implemented is to use jatropha oil to generate electricity. Since jatropha plantation is limited, REE have used diesel to up to 80% of raw material. This would affect to the price of electricity as well as diesel is much more expensive than jatropha oil. Data shows that up to 85% of non-electricity users and 25% of electricity users complained about the current high electricity cost in the commune, and the high price of connection fee. According to the interview with REE, the connection fee including counter/meter, circuit break, and post box is only 150,000 Riel (US$ 36.585). This fee is valid since March 2011. However, most of villagers still do not know about the updated price set by REE. Therefore, based on the interview, 42% of user's respondents expressed that they do not satisfy with service that electricity has offered.

Mr. Tham Bunhak, electricity supplier, demonstrated that the cost of electricity is also based on the number of connection/use. Up to 15 May 2011, only 262 out of 1,356 households have connected to the electricity. When more households connect to electricity, the price would be cheaper. More importantly, he would encourage people to grow more jatropha which in turn could provide benefits to both parties.

Although there are some concerns expressed above, many local residents expressed their positive feeling in having electricity in the commune. It could help to improve income generating activities at night for local residents, on one hand. Those are including sewing, weaving, groceries selling, teaching, chicken selling, computer using, and photocopying. On the other hand, REE could also gain more profits while people use more kWh of electricity. Local people could also generate income from jatropha selling because high demand of

jatropha oil. Furthermore, having electricity is useful for children to study at night; households have more fun with fluorescent light which would increase social relations among household members and other members in community. Up to 41% of user's respondents demonstrated that they satisfy with services that REE has been offered.

Chapter VI

CONCLUSION AND RECOMMENDATION

As mentioned in IMF Working Paper (Strand, J., 2007), the method to obtain the energy by substituting the fossil fuel to renewable energy can bring 3 essential goals. First of all, involved in energy policy, it aims to reduce the amount of Carbone dioxide. Second, it urges to alleviate the energy production cost and the third is to encourage the energy-importing countries to produce the renewable production for their demand better than to import it. However, "More than 800 million people in Asia and Pacific still have no access to electricity" (ADB, 2009).

The reason why they try to use biofuel because the price of fossil fuel is getting higher and higher and using fossil fuel damage the environment. Therefore, there is a competition between fossil fuel and biofuel. The world biofuel increases from 4.8 billion gallons in 2000 to 16 billion gallons in 2007. This amount is about 3% of the world fuel (Urooj, 2009). The main producers of biofuel are the United State, European Union (EU), and Brazil. These countries produce about 90% of biofuel. Asia produces 6% of biofuel in 2007 (Urooj, 2009).The high oil price makes biofuel develop in the Great Mekong Subregion. Biofuel production in some countries like Cambodia, Lao and Myanmar is at the experimental stage. Cambodia has a very little experience on biofuel so we need to improve the technique know how from the first stage to the final usage of biofuel procedure that we could learn from other countries especially the neighboring countries such as Thailand. To meet energy security we need biofuel. If using biofuel then Cambodia can reduce oil importing; moreover, biofuel can attract investor to invest in our country. We then can develop rural area by creating more job opportunities, this will create more income for rural people.

In short, the benefits of Jatropha biofuel in Cambodia, like many other countries, provide advantages in economic, environment, and society. Although the jatropha oil cannot completely reduce the oil import or Carbone Dioxide emission, it takes a major rule to minimize the rural poverty, expand the environment conservation, provide more income, and create the job promotion.

Like the case of in Paoy Char, by using jatropha biofuel based mini grid has reduced the consumption of diesel fuel, which then the rural people will have wider opportunity to get access to electricity with an affordable price. For that reason, the existing business could be upgraded through using electricity and new business could be created. Large areas of land that are not used at the moment can grow jatropha without creating competition to other food crops. The living standard of the villagers will be improved; the activities during the evening will be more active such as teaching and studying. And by seeing the success of the project in Paoy Char, this will encourage other commune or areas to develop this concept, which then can be widespread through out the country. Moreover, government should strengthen and make new policy about the Jatropha promotion. Research and Development of jatropha plantation is requirement so that the plan of building the jatropha industry will be possible. The way to succeed is to alleviate the seed price and to gain more yield. The documents should be created to talk about the influence of jatropha on economic as well as environment, and promotion through TV and radio should be made.

The following recommendations would be considered in order to improve the Jatropha-Based Rural Electrification Project in Paoy Char Commune:

First of all, based on an estimate from village chief, 87% of households is medium and poor, only 13% of households is better off[3]. Therefore, the basic needs are vital for the medium and

[3] GIZ Internal Usage, 2008

poor. Since jatropha takes too long time (more than a year) to get yield, people prefer to plant other crops like cassava, bean, corn etc which can generate income as quick as possible. Furthermore, there are only 27% of respondents being aware that the current electricity is generated by jatropha oil.

The majority of people do not know that growing more jatroopha in the community could reduce the electricity cost.

- Therefore, local people should be promoted to be more understandable of the benefits of jatropha and its relation to the electricity
- The promotion, of course, should be done by the main stakeholders (GIZ , REE and commune council) of the project

Second: Contract Farming between REE/other contractor and local communities (farmers and local authorities) would be useful.

- Agreement should be done between these two parties with support/certify by local authority. To do contract farming, jatropha growers would feel strongly confident that their products will be absorbed by REE with the market price
- Technical supports to grower and correspondent set up in order to ease growers to consult with when the support is needed. Growers wish to have strong jatropha network which could help them to approach technical assistances and marketing. Following are the suggestions for the support from the respondents:
    - Planting, ground preparation skills and harvesting techniques (24%)
    - Fertilizer and pest control (18%)
    - Pure seed/seedling (15%)

Third, many local residents claimed that there are some people in the commune having planted jatropha and waiting to see the results. These including the total yield collected per annum and its profit gained.

- Therefore, it would helpful if the project assists current jatropha growers to create the Model of the Jatropha Plantation. The modal farm will become a demo farm that the project could do some other awareness activities in the future.
    - These will not only a Chance to show the actual results received by growers and economic analysis to local people, but it also can be a good model to display for outside visitors who are interested in jatropha plantation
    - As a result, the good model of jatropha growers will understand about the benefits and disseminating information to others which in turn jatropha should be sustainable in the commune
- School and pagoda should be the best model of the existing jatropha growers. Therefore, the project should continues support and makes use of them. The following activities should be considered:
    - The Jatropha Collection and Promotion of Jatropha Plantation Campaign should be introduced to the local people
    - Pagoda and schools students could help to do the campaign of jatropha collection and expansion of jatropha plantation
    - Few active teachers/key villagers should be provided training regarding technical skills on jatropha plantation, collection, and its marketing. They will be the core persons at the commune whom local people can access when they need some technical assistance on jatropha issues

- More importantly, REE itself should plant more jatropha as the model for others people in the commune.
- In addition, jatropha growing techniques and market demand dissemination should be more creative and comprehensive. Sign board like "buying jatropha" including the price/kg, exChange with electricity, contact number … etc. should be taken care by REE

Fourth, Promotion of Jatropha Collection and its Market Price: The survey team is searching the price of jatropha in several sources.

- Mr. San You, Executive Director of Development Appropriate Technologies (DATe)[4]. He stated that DATe is buying jatropha from villagers in Kampong Chhnang and some other nearby provinces. He mentioned that there is no exact market price of jatropha. DATe is sometimes hired workers/villagers to collect jatropha along the street or along the fence in each village. The labor cost is around $3/day. The total collection per day is around 10-20kg. Thus the cost of jatropha collected is between 600-1,200 riel (US$ 0.146- 0.292) per kg
- H.E Chao Chamrong, the Chairman of Chamrong Phalla Co, Ltd.,[5] mentioned that his company is currently buying jatropha from villagers which its price is around 1,000 to 1,200 riel (US$ 0.243 – 0.292) per kilogram. The variance is depended on the quality of the jatropha crops.

The two experts are also willing to provide technical know-how and support to the villagers who are planting jatropha.

[4] Mr. San You, Executive Director of DATe 012 851 161
[5] H.E Chamrong, Chairman of Chamrong Phalla Co. Ltd. Mobile Phone: 012 393 138

Since the starts of the electricity project, the price of diesel is 3,200 riel (US$ 0.78) per litter. Within that time Mr. Tham Bunhak/REE bought jatropha 700 riel (US$ 0.17) per kg[6]. Up to now, the diesel's market price is increased to 4,700 riel (US$ 1.146) per litter but he is still buying 700 riel (US$ 0.17) per kg.

- Thus REE should set the buying price of jatropha following the Changes of the market price of diesel in order to encourage villagers to grow and collect jatropha for sale or exChange with electricity use. Diesel price is increased the price of jatropha should also be increased in any specific amount calculated by REE and by compared to the price of jatropha market (ex: Chamrong Phalla Co. Ltd)

Fifth, ownership strengthening to relevant stakeholders should be considered to the implementation. There and agreement was made between GIZ, REE and Commune Councilor in Paoy Char commune mentioned the roles and responsibilities of each stakeholders. However, involvement of civil society/villagers in the process would be helpful to the success of the project.

- Awareness raising campaign or the re-orientation of the project to all relevant stakeholders. This campaign should be mainly focused on the main actors who are the implementers and beneficiaries of the project. (Villagers, REE and local authorities are the implementers, and beneficiary of the project. The success or the failure of the project is the responsibilities of all stakeholders)
- A Multi-Stakeholders Dialogue should be made in order to identify the common interest of all actors in the project. This dialogue is suggested due to the issues identified in the SWOT analysis meeting. Each actor has its own concerns and suggestions. The multi-stakeholders dialogues will lead them to set the common

[6] GIZ Internal Usage 2008

goals and that would lead to some actions that each stakeholder will share responsibilities and join implementation of those identified activities.

Sixth, the electricity pole is still limited. It is available for only along the main roads. People have to pay more for cable connection if their house is located a bit inside near the main roads. However, households along the small roads could not connect to electricity even though they want to do so.

- Thus, electricity poles should be expanded throughout the 6 villages in Paoy Char commune. Of course, it needs a lot more finance, but the electricity poles installation can be prioritized to the location
  - Identified and prioritized places could be done through the collaboration between each village chief and REE
  - Then, the pole settlement can be done step by step. As the result, on one hand, REE could get more electricity connected households which lead to deduction of electricity price and get more income
  - When the price per kWh is decreased, people will use more electricity, especially for income generation activities including welding, radio, TV, VCD, and computer repair, photocopy, hair salon, auto machine of sewing etc.
  - Thus, it is also possible to serve electricity during the day time. The first pilot should be started at the day time at weekend. This in turn could provide benefits to both parties, supplier and users

Seventh, due to the high percentage of people complained about the high price of the connection cost, approximately 428,800 Riel (US$ 104.585) in 2011 on average. Although

since March 2011 the connection fee including counter/meter and post box is only 150,000 Riel (US$ 36.585), most villagers still do not know about the updated price.

- Therefore, REE should improve their communication with local people, and announce openly to villagers about the Change on the current price
- REE has a lot of strengths points. Bookkeeping is performing by the well developed software system. However, the business development services should be provided to REE. Mr. Seng Bunley, Mr. Tham Bun Hak's son, is responsible to manage electricity's business. He is quite active and talent. However, marketing - selling skills and communication skills is needed to improve. REE should also know technical know-how on growing jatropha and ability to promote jatropha plantation and collection. He should also able to manage the collectors in each village in order to increase jatropha buying from villagers

Many electricity users complained about the power which has been cut off very often (2-4 times/night), and the over Charging for households who use electricity less than 3 kWh. This has led to build untruthfulness of users to supplier.

- Therefore, REE should inform users about the reason why the electricity has often cut off. All any Changes of generator line should be well informed in advance
    - Furthermore, all Changes can be officially recorded in the receipt/invoice that is given to users every month
- The minimum Charge of 3 kWh per month should be written in the contract that electricity supplier and users make for the connection. To do this, users are earlier informed about the condition, so that users could make decision whether they should connect to electricity or not

- The updated price from electricity authority or any minimum Charge should be announced by sticking it in public places such as schools, pagodas, commune office, other particular places, and distributed and announced to all village chiefs in order to pass on to villagers.

APPENDICES

Appendix A: Additional Statistical Tables from Household Survey

1. Electricity Users

A1-1: Total income of users

Household income (USD)	N	%	Cumulative percent
250 – 500	2	2.0	2.0
501 – 1,000	19	19.0	21.0
1,001 – 2,000	21	21.0	42.0
2,001 – 5,000	31	31.0	73.0
≥ 5,001	27	27.0	100.0
Mean = 5,303.57 USD; Min.=425 USD; Max.=51,025.00 USD; Std. Deviation = 7,670.92 USD			

A1-2: Number of household connect to grid in different year and their expense

Years	No. HHs	Mean (expense, riels)	Minimum (riels)	Maximum (riels)	Std. Deviation	P-value
2010	45	607,111.11	250,000.00	1,550,000.00	279931.990	<0.000
2011	55	428,840.00	107,100.00	1,300,000.00	203216.292	<0.000

A1-3: Energy source use before connecting to electricity

Source (n=100)	N	%
Battery	93	93.0
Generator	6	6.0
Candle	4	4.0
Kerosene lamp	37	37.0

A1-4: Awareness about fuel use to generate electricity

Kind of fuel (n=100)	N	%
Diesel	36	36.0
Jatropha oil	27	27.0
Don’t know	45	45.0

A1-5: Number of KWHs using after connecting to electricity

KWHs (n=100)	N	%	Cumulative percent
1 – 2	12	12.0	12.0
3 – 5	43	43.0	55.0
6 – 10	32	32.0	87.0
>10	13	13.0	100.0

A1-6: Substitute energy use after connecting to electricity

Substitute energy (n=100)	N	%
Kerosene lamp/candle	26	26.0
Battery	52	52.0
Small generator	2	2.0

Flash light	8	8.0

A1-7: Feeling in connection and usage of electricity

Feeling (n=100)	**N**	**%**	**Cumulative percent**
Satisfy	41	41.0	41.0
Not satisfy	42	42.0	83.0
Both feeling	17	17.0	100.0

2. Non Users Covered by Electricity Grid

A2-1: Income of non users

Household income (USD), (n=100)	**N**	**%**	Cumulative percent
< 250	1	1.0	1.0
250 – 500	8	8.0	9.0
501 – 1,000	29	29.0	38.0
1,001 – 2,000	34	34.0	72.0
2,001 – 5,000	21	21.0	93.0
≥ 5,001	7	7.0	100.0
Mean = 2,286.81 USD; Min.=229.00 USD; Max.=38,442.50 USD; Std. Deviation = 4,287.335 USD			

A2-2: Energy source using

Energy (n=100)	**N**	**%**
Battery	78	78.0
Wood	100	100.0
Gas	1	1.0
Candle	3	3.0
Generator	3	3.0
Kerosene lamp	60	60.0
Others (flash light)	3	3.0

A2-3: Use for

Use for (n=100)	**N**	**%**
Lighting	100	100.0
Cooking	100	100.0
Fan	2	2.0
TV	36	36.0
Battery re-Charge	1	1.0
Sewing	24	24.0
Others	7	7.0

A2-4: Expense for energy use

Expense (Riels)	**N**	**%**	**Cumulative percent**
< 8,000	35	35.0	35.0
8,000 – 15,000	32	32.0	67.0
15,100 – 20,000	17	17.0	84.0
>20,000	16	16.0	100.0

A2-5: Reason of not connect to electricity

Reason (n=100)	**N**	**%**
Too expensive in the connection and price per KWH	85	85.0
No one in form about that	1	1.0
Use my own energy source	1	1.0
No grid available in the village	21	21.0
Others	8	8.0

A2-6: Willingness for future electricity connection

Willingness to use (n=100)	**N**	**%**	**Cumulative percent**
Want to use	97	97.0	97.0
Don't want to use	2	2.0	99.0
No idea yet	1	1.0	100.0

3. Awareness of Jatropha

A3-1: Awareness of Jatropha in the village and community

Awareness (n=212)	**N**	**%**
Know jatropha	211	99.5
Do not know jatropha	1	.5
Know how jatropha use (n=212)		
Living fence	101	47.6
Seed for selling	16	7.5
Generate electricity	129	60.8
Others (germinate mushroom, dishwashing liquid, papaya salad,..)	18	8.5
Useless tree	8	3.8

A3-2: Households have grown Jatropha and reason of growing and not growing jatropha

Household (n=212)	**N**	**%**
Grow	32	15.1
Not grow	180	84.9
Reason of growing (n=32)		
For fencing	16	50.0
For seed	4	12.5
For electricity	6	18.8
For selling	5	15.6
Seed provided to grow	1	3.1
Reason of not growing (n=180)		
Barren land	2	1.1
Used to grow but died do not want to grow more	2	1.1
Difficult to grow, take long time to get yield	9	5.0
Fear have no yield	1	0.6
Do not know how to grow	6	3.3

Lazy	2	1.1
Never grow	1	0.6
No market	11	6.1
No interest	1	0.6
No irrigation	1	0.6
No labor	15	8.3
No land	101	56.1
No profit	6	3.3
No seed, seedling	15	8.3
No time	4	2.2
Not useful	2	1.1
Wait to see others in the village	1	0.6

A3-3: Knowledge about Challenging of jatropha growing

Challenge (n=212)	**N**	**%**
Lack of planting skill	18	8.5
Not enough water/too much water (flood)	15	7.1
Low market price	7	3.3
Disease	1	0.5
Take long time to get income	40	18.9
Others	9	4.2
Have no idea about it	94	44.3

A3-4: Support needed for growing jatropha

Support (n=212)	**N**	**%**
Pure seed	31	14.6
Planting and ground preparation skill	44	20.8
Pruning and harvesting techniques	7	3.3
Pest control	7	3.3
Fertilizer	32	15.1
Irrigation	3	1.4
Market information	12	5.7
Others	1	0.5

Appendix B: Households who planed to grow jatropha

No.	**Village**	**Name of interviewee**	**Age**	**Sex**	**Occupation**	**Family member**	**Position in the family**	**Contact No**	**No. of Tree**	**No. of land (ha)**
1	PSL	Ping Ing	41	M	Farmer	5	Headhh	092 520592	50	0

2	Ta ong	Pan Cheat	32	M	Farmer	5	Headhh		0	0
3	PSL	Kok Khorn	47	M	Farmer	5	Headhh		50	0
4	TTC	Chamroeun Sirom	41	F	Sewer	3	Spouse	012 448709	0	0
5	TTK	Man Bopheak	21	F	Farmer	7	Daughter		200	0.5
6	TTC	Han Heav	43	M	Farmer	5	Headhh		0	0.75
7	PCR	Prim Kali	45	F	Farmer	6	Spouse		50	0.34
8	PCR	Eng Chhai	58	M	Farmer	2	Headhh		1000	0.5
9	TTK	Slorn Chabroeuk	23	F	Teacher	5	Daughter	017 551826	300	0.2
10	TTK	Te Thong	64	M	Farmer	5	Headhh		150	0.16
11	PCR	Pho Sophea	45	M	Farmer	4	Headhh		1000	0.85
12	PSL	Sreb Proeun	44	M	Farmer	5	Headhh	017 956004	100	0
13	PCR	Prorm Prob	61	M	Farmer	6	father		200	0.25
14	PCR	Oun Hour	45	M	Farmer	5	Headhh		200	1
15	PSL	Hay Bunrith	44	M	Doctor	5	Headhh		0	0.5
16	TTC	Tim Sokhoeun	51	F	Farmer	6	Spouse		0	0
17	TTC	Un Kinha	52	M	Farmer	6	Headhh	092 819228	0	0
18	PCR	Un Kary	22	F	Farmer	6	Daughter		100	1
19	PCR	Voeun Keam	47	M	Farmer	6	Headhh		80	0.5
20	TTK	Pen Pork	35	M	Farmer	5	Headhh		100	0.1
21	PSL	Roeun Sophea	28	F	Seller	3	Spouse		0	1
22	TTC	Chrik Chan	40	F	Farmer	8	Spouse	097 5019696	30	0
23	PSL	Duch Chantrea	42	F	Sewer	4	Spouse	092 975277	100	0
24	PCR	Chan Reun	42	M	Farmer	4	Headhh		80	0.25
25	TTC	Thorn Tey	45	M	Farmer	5	Spouse	012 474496	0	0.5
26	PCR	On Saray	29	M	Teacher	7	Headhh		70	0
27	TTK	Ream Chompey	46	F	Farmer	9	Spouse	017 629303	200	0.25
28	PCR	Koeu Sakun	34	F	Farmer	4	Spouse		100	0.5
29	PSL	Taing Kunthea	38	F	Farmer	5	Spouse	017 654308	50	0.03
30	PSL	Nhim Sreymich	39	F	Weaver	6	Spouse		0	0.34
31	SB	Houy Koeuy	52	M	Farmer	6	Headhh		0	0.08
32	PNR	Try Loum	48	F	Farmer	10	Spouse	097 6308519	1000	0
33	SB	Pen Sophy	61	M	Farmer	5	Headhh	097 6174783	300	0
34	PNR	Thy Thouk	40	M	Farmer	5	Headhh		1000	0
35	TTC	Yoeung Chan Thouy	19	F	Groccery selling	5	Daughter		0	0.25
36	PCR	Chan Rith	19	F	Sewer	3	Daughter		50	0.5
37	PCR	Pril Sama	36	F	Fisherwoman	6	Spouse		100	0.32
38	PCR	Dorm Sopheap	37	F	Farmer	3	Daughter		100	1
39	PCR	Lam Sophat	18	F	Student	5	Daughter		100	0.5
40	PCR	Mote Samuth	35	F	Farmer	6	Daughter		150	0.34

41	PCR	Thot Phean	42	F	Farmer	4	Headhh		100	0.5
42	PCR	Neav Savat	31	F	Farmer	4	Spouse		200	0.5
43	TTC	Pel KimHean	29	F	Farmer	6	Spouse		200	0
44	PSL	Buy Chhoeun	65	F	Farmer	6	Spouse	092 28 30 18	0	0
45	PSL	Pich Sruoch	66	M	Farmer	5	Headhh		100	0.05
46	TTK	Leak Sam Chhuon	29	M	Farmer	4	Spouse	017 47 87 63	150	0.25
47	TTK	Chhao Panna	31	M	Farmer	4	Headhh		100	0.125
48	TTK	Khum Yoeun	52	F	Farmer	8	Spouse		100	0.25
49	TTK	Moul Sokpheth	50	F	Farmer	6	Spouse		1000	1
50	TTK	Meas Phang	50	F	Farmer	7	Spouse		300	0.375
51	TTK	Ruth Snat	41	M	Policeman	4	Headhh	017 84 20 37	500	0.5
52	TTK	Thorn Oeung	65	F	Farmer	3	Headhh		100	0
53	TTC	San Synang	43	M	Farmer	5	Headhh		500	0
54	TTK	Vorn Preng	31	M	Farmer	4	Headhh		600	0.5
55	PSL	Chuop Sreypich	22	F	Farmer	4	Spouse		500	1.5
56	PSL	Lim Heang	26	F	Farmer	5	Spouse	097 588 7273	60	0.34
57	PSL	Torn Sokphen	28	F	Farmer	6	Daughter	097 998 3171	50	0.17
Total									**11,570**	**18.57**

Appendix C: Structured Questionnaire

Impact Assessment on Renewable Energy to Increase Income Generation Opportunities
Questionnaire Number: **01**
Interviewee: **Existing Jatropha-Electricity User**

Interviewer: Code number:
Date: ___/____/2011 Time starts: Time ends:
Place of interview: Village, Commune, **P. Srok** District, B. Meanchey Province

PART I: Household Profile

Interviewee Name**:** Age: years old sex:
Occupation: No. of Family Member:

Relationship in the family:_____ Contact No. (if available)_____

PART II: Livelihood Activities

1. I'm going to ask you about the different sources of incomes your household does to make up your living, or to feed and support your family. Could you please tell me what are your important livelihood activities?

Activities	How much you can earn from this per month/year?
1- Grocery Selling …… ☐	1-.....
2- Sewing ..…..……..…… ☐	2-.....
3- Weaving ..……..……..…☐	3-.....
4- Worker ……..…….. ☐	4-.....
5- Jatropha selling ..……..… ☐	5-.....
6- Rice cultivation.…….…… ☐	6-.....
7- Fruit crops farming …….. ☐	7-.....
8- Animal raising ……..…… ☐	8-.....
9- Other (Pls specify)…….…☐	9-.....

2. Let's compare to the earnings, how is the income earning between mid-2008 until now?
1- Stable ☐ 2- Decrease ☐ 3-Increase ☐
Why?.....

PART III: Electricity Use

3. What kind of energy sources for household lightening did you use before connecting this electricity-grid?
a- Sola penal ☐ b-Car battery ☐ c-Small electric machine ☐ d-Candle ☐ e-Kerosene Lamp ☐ f-Other (Please specify):_____☐
4. What do you use it for and for how long per day: 1-Light:____h ☐ 2-Cooking:____h ☐ 3-Fan:____h ☐ 4-TV:____h ☐ 5-Battery reCharge: ____h ☐
For income generating activities: 6-Sewing _____h ☐ 7-Restaurant _____h ☐ 8-Radio, TVs, VCD repair _____h ☐, 9-Teaching (Part-time) _____h ☐, 10-Use for water pump machine for cropping _____h ☐, 11-Other (please specify):_____☐
5. How much did you/HH spend for that energy per month?
a-<8,000 Riel ☐ b-8,000-15,000 Riel ☐ c-16,000-20,000 Riel ☐ d->20,000 Riel ☐
6. When did you connect your current electricity grid (Jatropha-based-electricity)? Since _____
7. How much you spent for the connection? _____Riel
8. How long did it takes to get the connection?_____ Days
9. Do you know what kind of fuel does the owner use to generate electricity? 1-Diesel ☐ 2-Bio-fuel (jatropha oil) ☐ 3-Other: specify _____☐
10. How many KWHs of electricity do you/HH use per month?
1-1-2KWh ☐ 2-3-5 KWh ☐ 3-5-10KWh ☐ 3-More than 10KWh ☐
11. What do you use it for and for how long per day: 1-Light:____h ☐ 2-Cooking:____h ☐ 3-Fan:____h ☐ 4-TV:____h ☐ 5-Battery reCharge:____h ☐
For income generating activities: 6-Sewing _____h ☐ (New ☐, Existing ☐), , 7-Restaurant _____h ☐ (New ☐, Existing ☐), 8-Radio, TVs, VCD repair _____h ☐ (New ☐, Existing ☐), 9-Teaching (Part-time) _____h ☐ (New ☐, Existing ☐), 10-Use for water pump machine for cropping _____h ☐ (New ☐, Existing ☐), 11-Other (please specify):_____ ☐ (New ☐, Existing ☐)

12. Did you employ new staff to help you? 1-Yes ☐, No. of Staff employed _____, 2-No ☐

13. How much money do you/HH pay for monthly electricity use?

a-<8,000 Riel ☐ b-8,000-15,000 Riel ☐ c-15,100-20,000 Riel ☐

d->20,000 Riel ☐

14. What are the substitute energy do you currently use?

1-Kerosene Lamp/ Candle ☐ 2-Solar penal ☐ 3-Car Battery ☐

4-Small electric machine ☐ 5-Other (Please specify): ☐

PART IV: Jatropha Awareness

15. How many ha of cultivation (Chamka and farm) land do you own? _____ha

16. What are the main use of your land?_____

17. Do you know Jatropha?

1-Yes ☐ If Yes, what do you know about it? ☐ a-Living fence, ☐ b-Commercial farm/crops c-Useless trees ☐ d-Use for electricity ☐ e-Other:_____

2-No ☐ If No, do you want to know more about it? Yes ☐(If yes go to Q 27) No ☐

18- Do you grow Jatropha?

1-Yes ☐ What for? _____

2-No ☐ Why? _____

19. (If Yes) How many ha and trees do you plant? _____Tree in _____ha

20. Since when:_____

21. How many Kg of Jatropha have you collected last year? _____Kg?

22. How much per Kg? _____Riel

23. What is the current market demand for Jatropha?

a-Easy to sell ☐ Why? 1-Lots of buyers ☐ 2-Other: Specify ☐

b-Not easy to sell ☐ Why? 1-Only one buyer ☐, 2-No market ☐ 3-Other: Specify ☐

24. Do you satisfy with the yield you have received?

1-Yes ☐ Why?_____

2-No ☐ Why?_____

25. Do you know how to improve the yield? 1-I don't know ☐ 2-I know ☐

26. If you know, who guided/told you? _____

27. Do you plan to grow/plant more jatropha?

1-Yes ☐ For how many/how many more trees _____trees _____/ha

2-No ☐ Why? ☐ a-No more land available ☐ b-Not enough profit earned ☐ c-Difficult to maintain/grow

28. Do you know, what are the Challenges for growing Jatropha?

1-Lack of planting skills ☐ 2-Not enough water/too much water (flood)☐

3-Low market price ☐ 4-Disease ☐ 5-Take too long to get income ☐ 6-Other: specify:_____☐

29. What kind of supports would you need to grow Jatropha?

1-Pure seed☐ 2-Planting and ground preparation skills☐ 3-Pruning and Harvesting Techniques ☐ 4-Pest Control☐ 5-Fertilizer☐ 6-Irrigation☐ 7-Market information☐ 8-Other:_____☐

PART V: Satisfaction and Recommendation

30. What are the benefits you and your family received from Jatropha plantation and/or electricity? _____

31. How many hours does electricity serve per day? .....hours (started at .....ended at .....)

32. How do you feel with services provided by REE? 1-Satisfied ☐

What makes you most satisfy with _____

2-Not satisfied ☐

What makes you most not satisfy with _____

33. What should be improved?

Rural Electricity Enterprise:_____
Customers/none customers:_____
Local authority: _____
Social representatives (school, temple, healthcare center etc.):_____

We would like to profoundly thank you for the interview. We appreciate your sharing information. It is very significant inputs in order to improve and carry out the jatropha project effectively.

Good Luck!

Survey Guide

Questionnaire Number: **02**

Interviewee: **Jatropha-Electricity Non-User (both community covered and not covered by power grid)**

Interviewer: Code number:

Date: ___/____/2011 Time starts: Time ends:

Place of interview: Village, Commune, **P. Srok** District, B. Meanchey Province

PART I: Household Profile

Interviewee Name**:** Age: years old sex:

Occupation: No. of Family Member:

Relationship in the family:_____ Contact No. (if available)_____

Contact No. (if available)

PART II: Livelihood Activities

1. I'm going to ask you about the different sources of incomes your household does to make up your living, or to feed and support your family. Could you please tell me what are your important livelihood activities?

Activities	**How much you can earn from this per month/year?**
1-Grocery Selling …… ☐	1-.....
2-Sewing ..……..……..…… ☐	2-.....
3-Weavin…..……..…… ☐	3-.....
4-Worker ……..…….. ☐	4-.....
5-Jatropha selling ……..…… ☐	5-.....
6-Rice cultivation ……..…… ☐	6-.....
7-Fruit crops farming ……..… ☐	7-.....
8-Animal raising ……..…… ☐	8-.....
9-Other (Pls specify)…….…… ☐	9-.....

PART III: Electricity Use

2. What kind of energy you are using daily?

1-Solar penal ☐ 2-Car battery ☐ 3-Wood ☐ 4-Gas ☐ 5-Candle ☐ 6-Small electric machine ☐ 8-Kerosene Lamp ☐ 9-Other (Please specify):_____☐

3. What for? 1-Light ☐ 2-Cooking ☐ 3-Fan ☐ 4-TV ☐ 5-Battery Re-Charge ☐ (<u>For income generating activities</u>: 6-Sewing ☐ 7-Restaurant ☐ 8-

Radio, TVs, VCD repair ☐ 9-Teaching (Part-time) ☐ 10-Use for water pump machine for cropping ☐ 11-Other (please specify):_____ ☐
4. Did you employ new staff to help you? 1-Yes ☐, No. of Staff employed _____, 2-No ☐
5. Recently, how much money you spend for energy use per month (i.e. not for cooking)?
a-<8,000 Riel ☐ b-8,000-15,000 Riel ☐ c-15,100-20,000 Riel ☐ d->20,000 Riel ☐
6. Why don't you connect to electricity?
1-Too expensive in the connection and price per KWH ☐ 2-No one inform about that ☐ 3-Use my own energy sources ☐ 4-No grid available here in the village ☐ 5-Other (Please specify):_____ ☐
7. In the future do you want to use jatropha electricity?
1-Yes ☐ 2-No ☐

PART IV: Jatropha Awareness

8. Are you aware of jatropha plantation in your community? 1- Yes ☐
2-No ☐
9. Do you know Jatropha ?
1-Yes ☐ If Yes, what do you know about it? ☐ a-Living fence, ☐ b-Commercial farm/crops Useless trees ☐ c-Use for electricity ☐ d-Other: specify _____
2-No ☐ If No, do you want to know more about it? a-Yes (If yes go to Q19) ☐ b-No ☐
10-. How many ha of cultivation (Chamka and farm) land do you own? _____ha
11. What are the main use of your land?_____
12. Do you grow Jatropha?
1-Yes ☐ What for? _____
2-No ☐ Why? _____
13. (If Yes) How many ha and trees do you plant? ? _____Tree in _____ha
14. Since when:_____
15-. How many Kg of Jatropha have you collected last year? _____Kg?
16. How much per Kg? _____Riel
17. What is the current market demand for Jatropha?
a-Easy to sell ☐ Why? 1-Lots of buyers ☐ 2-Other: Specify ☐
b-Not easy to sell ☐ Why? 1-Only one buyer ☐, 2-No market ☐ 3-Other: Specify ☐
18. Do you satisfy with the yield you have received?
1-Yes ☐ Why?_____
2-No ☐ Why?_____
19. Do you know how to improve the yield? 1-I don't know ☐ 2-I know ☐
20. If you know, who guided/told you? _____
21. Do you plan to grow/plant more jatropha?
1-Yes ☐ For how many more trees _____trees
2-No ☐ Why? ☐ a-No more land available ☐ b-Not enough profit earned ☐ c-Difficult to maintain/grow
22. Do you know, what are the Challenges for growing Jatropha?
1-Lack of planting skills ☐ 2-Not enough water/too much water (flood) ☐ 3-Low market price ☐ 4-Disease ☐ 5-Take too long to get income ☐ 6-Other:specify_____ ☐
23. What kind of supports would you need to grow Jatropha?
1-Pure seed ☐ 2-Planting and ground preparation skills ☐ 3-Pruning and Harvesting Techniques ☐ 4-Pest Control ☐ 5-Fertilizer ☐ 6-Irrigation ☐ 7-Market information ☐ 8-Other:_____ ☐

PART V: Satisfaction and Recommendation

24. What are the benefits you and your family received from Jatropha plantation and/or electricity? _____

25. What should be improved?

Rural Electricity Enterprise:_____

Customers/none customers:_____

Local authority:_____

Social representatives (school, temple, healthcare center etc.):_____

We would like to profoundly thank you for the interview. We appreciate your sharing information. It is very significant inputs in order to improve and carry out the jatropha project effectively.

Good Luck!

Impact Assessment on Renewable Energy to Increase Income Generation Opportunities
Survey Guide

Questionnaire Number: **03**

Interviewee: **Local Authority and Social Groups**

Interviewer: Code number:

Date: ___/____/2011 Time starts: Time ends:

Place of interview: Village, Commune, **P. Srok** District, B. Meanchey Province

PART I: Household Profile

Interviewee Name**:** Age: years old sex:

Occupation: No. of Family Member:

Relationship in the family:_____ Contact No. (if available)_____

PART II: Livelihood Activities

1. What are the three most important income generation activities of the people in your village/commune?

1-Grocery Selling ☐ 2-Sewing ☐ 3-Weaving ☐ 4-Worker ☐ 5-Jatropha selling ☐ 6-Rice cultivation ☐ 7-Fruit crops farming ☐ 8-Animal raising ☐ 9-Other (Please specify):_____ _____ ☐

2. Let's compare to economy of the households in your village/commune, how is the income earning between mid-2008 until now?

1-Stable ☐ 2-Decrease ☐ 3-Increase ☐

Why?_____

PART III: Electricity Use

3. Do you know, when electricity started in your village/commune? Since:_____

4. Do you know, how many HHs have connected/used electricity? _____HHs

5. Why some people do not connect/use electricity?

1-Too expensive in the connection and price per KWH ☐ 2-No one inform about that ☐ 3-Use their own energy sources ☐ 4-Other (Please specify):_____ ☐

6. Do you know what kind of fuel does the electricity owner use to generate electricity?

1-Diesel ☐ 2-Bio-fuel (jatropha oil) ☐ 3-Other: specify _____ ☐

7. Have you encouraged people in your village/commune to use jatropha electricity? 1-Yes ☐ 2-No ☐

If yes, how ? _____

_____

PART IV: Jatropha Awareness

8. Do you support people to grow jatropha 1-Yes ☐ 2-No ☐

If yes, what kind of supports you have done to villagers who have planted jatropha?

1- _____

2-_____

3-_____

9. Have you encouraged people in your village to grow or plant more jatropha? 1-Yes ☐ 2-No ☐

If no, Why ?_____

If Yes, How to promote?

1- _____

2- _____

10. Do you know, what are the Challenges for growing Jatropha?

1-Lack of planting skills ☐ 2-Not enough water/too much water (flood)☐ 3-Low market price ☐ 4-Disease ☐ 5-Take too long to get income ☐ 6-Other:specify_____☐

11. What kind of supports would you think that it is needed to grow Jatropha in your community?

1-Pure seed ☐ 2-Planting and ground preparation skills☐ 3-Pruning and Harvesting Techniques ☐ 4-Pest Control☐ 5-Fertilizer☐ 6-Irrigation☐ 7-Market information☐ 8-Other:_____☐

PART V: Satisfaction and Recommendation

12. How many hours does electricity serve per day? ___.hours (started at _____ended at ___)

13. What do you think about the relationship between REE and the electricity users?

Good ☐: Why?_____

Not so good ☐: Why?_____

14. How do you feel with services provided by REE in your village/commune?

1-Satisfied ☐

What makes you most satisfy with _____

2-Not satisfied ☐

What makes you most not satisfy with _____

15. What should be improved?

Rural Electricity Enterprise:_____

Customers/none customers:_____

Local authority: _____

Social representatives (school/temple etc.): _____

16. How do you think about GIZ program on Jatropha renewable energy in your village/commune?

_____

_____

17. What this program should be improved?

_____

_____

18. What are the benefits from electricity produced from jatropha to

Yourself ? _____

Community? _____

We would like to profoundly thank you for the interview. We appreciate your sharing information. It is very significant inputs in order to improve and carry out the jatropha project effectively.

Good Luck!

Impact Assessment on Renewable Energy to Increase Income Generation Opportunities

Survey Guide

Questionnaire Number: **04**

Interviewee: **Rural Electricity Enterprise (REE)**

Interviewer: Code number:

Date: ___/____/2011 Time starts: Time ends:

Place of interview: Village, Commune, **P. Srok** District, B. Meanchey Province

PART I: Household Profile

Interviewee Name**:** Age: years old sex:

Occupation: No. of Family Member:

Relationship in the family:_____ Contact No. (if available)_____

PART II: Livelihood Activities

1. I'm going to ask you about the different sources of incomes your household does to make up your living, or to feed and support your family. Could you please tell me what are your important livelihood activities?

Activities	**How much you can earn from this per month/year?**
1-Electricity selling ……..☐	1-.....
2-Jatropha selling ……..…….. ☐	2-.....
3-Grocery selling ……. ☐	3-.....
4-Sewing ..…….....…….…… ☐	4-.....
5-Weaving ..…….....……..… ☐	5-.....
6-Rice cultivation ……..……..… ☐	6-.....
7-Fruit crops farming ……..……. ☐	7-.....
8-Animal raising ……..……. ☐	8-.....
9-Other (Pls specify)…… ☐	9-.....

2. Let's compare to the earnings, how is the income earning between mid-2008 until now?

1-Stable ☐ 2-Decrease ☐ 3-Increase ☐ Why?

_____

PART III: Jatropha Awareness

3. How many ha of cultivation (Chamka and farm) land do you own? _____ha

4. What are the main use of your land?_____

5. How many ha of land and trees do you plant Jatropha? _____Trees in _____ha

6. Since when:_____

7. How many Kg of Jatropha have you collected last year? _____Kg?

8. Do you satisfy with the yield you have received?

1-Yes ☐ Why?_____

2-No ☐ Why?_____

9. Do you know how to improve the yield? 1-I don't know ☐ 2-I know ☐

10. If you know, who guided/told you? _____

11. Do you plan to grow/plant more jatropha?
1-Yes ☐ For how many more trees _____trees _____ha
2-No ☐ Why? ☐ a- No more land available ☐ b- Not enough profit earned ☐ c-Difficult to maintain/grow
12. Do you know, what are the Challenges for growing Jatropha?
1-Lack of planting skills ☐ 2-Not enough water/too much water (flood)☐
3-Low market price ☐ 4-Disease ☐ 5-Take too long to get income ☐ 6-Other:specify_____☐
13. What kind of supports would you need to grow Jatropha?
1-Pure seed ☐ 2-Planting and ground preparation skills☐ 3-Pruning and Harvesting Techniques ☐ 4-Pest Control☐ 4-Fertilizer ☐ 5-Irrigation ☐ 6-Market information ☐ 7-Other:_____☐

Part IV: Business operation
14. When did you start your business in this commune? Since _____
15. Do you have business license? 1-Yes ☐ 2-No☐
If No, why you don't make it? _____
16. What sources of energy/fuel do you use to generate electricity? 1-Petrol ☐ 2-Diesel ☐
3-Bio-mass ☐ 4-Bio-gas ☐ 5-Bio-fuel (jatropha oil) ☐ 6-Other ☐ specify _____
17. Where did you buy jatropha from?_____
How much per Kg? _____Riel
18. How many Kg you bought per month? _____Kg
19. Is it enough (raw materials) for electricity producing?
1-Enough ☐
2-Not enough if not enough how many % you can supply? _____%
20. What kind of other sources of energy do you use to supplement jatropha fuel?
1-Petrol ☐ _____% 2-Diesel ☐ __% 3-Bio-mass ☐ _% 4-Bio-gas ☐ %
5-Other ☐ ___ % specify _____

Part V: Business management
21. How many KWs of electricity you produce per month?
1-<100kws ☐ 2-100-<200kws☐ 3-200-<500 kws ☐
4-500-<1000kws ☐ 5-More than 1000kws ☐
22. How many kWs of electricity you sold per month in March 2011? _____ kWs
How much per kWh? _____Riel
23. How many HHs have used jatropha electricity (up to March 2011)? _____HHs
24. How can you manage your income collection?
1-Book keeping ☐
2-Voucher ☐
3-Database ☐
25. How many households are in default/late payment? _____HHs

Part VI: Business plan
26. How much does it cost for connecting the line of electricity? _____ riel
7. Do you promote jatropha plantation and its market? 1-Yes ☐ 2-No ☐
If yes, how to promote? _____
_____
If no, why? _____
28. Do you satisfy with your business result in terms of collecting raw materials?
1-Yes ☐ Why? _____

2-No ☐ Why?_____

29. What are the Challenges for your business?

1-Not enough raw material (jatropha) ☐ 2-Jatropha's price is increased ☐

3-Not many people connect to electricity ☐ 4-Other☐ please specify:_____

30. Are you ready to invest more/ to expand throughout the community? 1-Yes ☐2-Not yet

If yes how many village/community/commune do you wish to? (Please describe details) _____

If not yet, when it should be? _____

31. What is your future business plan in this area?

_____

_____

PART VII: Satisfaction and Recommendation

32. How many hours does electricity serve per day? ___hours (started at ____ended at_____)

33. How do you feel with your electricity services provided to people in the commune?

1-Satisfied ☐

What makes you most satisfy with _____

2-Not satisfied ☐

What makes you most not satisfy with _____

34. What are the benefits from electricity produced from Jatropha to:

Yourself? _____

Community? _____

35. What should be improved?

Rural Electricity Enterprise: _____

Customers/none customers: _____

Local authority: _____

Social representatives (school, temple, healthcare center etc.)_____

We would like to profoundly thank you for the interview. We appreciate your sharing information. It is very significant inputs in order to improve and carry out the jatropha project effectively.

Good Luck!

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