4.6 VILLAGE SOCIO-ECONOMIC SURVEY

4.6.1 OUTLINE OF SURVEY

(1) Sites, Sampling and Schedule of Survey

The Village Socio-economic Survey (hereafter the Survey) was conducted in 8 candidate sites of off-grid type small-hydro projects, to clarify the willingness to pay (WTP) and ability to pay (ATP) for electricity, and power demand in the targeted district centers. 60 samples were collected in each site (8 sites x 60 samples = 480 samples). In addition, to identify the current situation in the existing electrified district centers, 150 samples were collected in the selected 3 district centers (50 samples each), where have different electric sources (namely small hydro, isolated diesel, and EDL Grid).

Sites for Village Socio-economic Survey

Province	District	Candidate Site/ Power Source
District Center near by the Candidate Site (60 Samples)		
Phongsaly	Gnot Ou	Nam Ou Neua
	Sampanh	Nam Likna
Luangnamtha	Vieng Phouka	Nam Pha
	Nalae	Nam Heng
Bokeo	Meung	Nam Chong
	Pha Oudom	Nam Hat
Luangprabang	Viengkham	Nam Xeng
Xiengkhuang	Khoun	Nam Xan
Existing Electrified District Centers (50 Samples)		
Luangnamtha	Vieng Phouka	Isolate Diesel
Phongsaly	Phongsali	Small Hydro
Luangprabang	Chomphet	EDL Grid

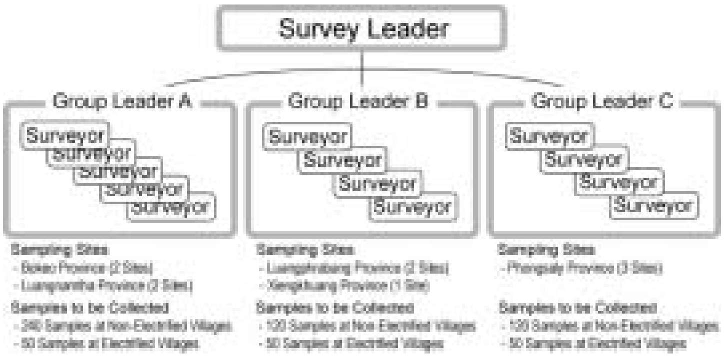
(2) Pre-interview Survey

Prior to the actual interview survey, pre-interview survey was executed from 10 July – 13 July, 2004 at the district centers (Muang Beng and Muang La) in Oudomxay province using the draft questionnaires. The purpose of the pre-interview survey is to a) assess if the respondents can easily and quickly understand the each question, b) assess if the interviewee can easily and quickly understand the each question, c) examine the appropriateness of possible answers in the multiple choice questions, d) know whether the time required for the interview is reasonable of not, and e) verify sequence of the questions.

Based on the pre-interview survey, other factors such as, appointment with interviewee working in the field during day time, and method of random sampling, were also discussed. Pre-interview survey results were reviewed to fine tune the questions, remove redundant sections, reduce and simplify questions and to make final instructions for the enumerators prior to start of the survey.

(3) Survey Schedule of Actual Interview Survey and Mobilization of Subletting Team

The actual village socio-economic survey was conducted during the period from 23 November – 22 December 2004. For the execution of the survey, the sub-contractor was organized three survey groups under the survey leader. A group consists of one group leader and four to five surveyors. Group-A was assigned for four candidate hydropower sites and one existing electrified area in Bokeo and Luangnamtha province.



Survey Team Structure

Group-B was assigned for three candidate hydropower sites and one existing electrified area in Luangprabang and Xiengkhuang province. Group-C was assigned for two candidate hydropower sites and one existing electrified area in Phongsaly province (please refer to the following schematic diagram).

Since the surveyors were employed from local consulting company in Vientiane, they are basically unfamiliar with interview sites. Thus, the survey team enlisted local government staffs and village officials, who are familiar with the interview sites.

(4) Questionnaires Used for the Survey

In this survey, two types of questionnaires were prepared. While household questionnaire is used for individual household, key informant questionnaire is applied for interviewing village head to collect general information about village. Both types of questionnaires were also divided into questionnaire for non-electrified village (used for 8 candidate hydropower sites), and for electrified village (3 district centers electrified by diesel, small-hydro, and the EDL Grid)

<u>Household Questionnaire</u>

Household questionnaire for non-electrified village includes following items (please refer to the Supporting Data Files B for questionnaire formats). Of which, "Block G" - questions bout willingness o pay for electricity - are expected to provide one of the most important information for accessing financial and economic viability of the electrification project. In this survey, "double-bounded dichotomous choice (DBDC)" method was applied for eliciting village people's WTP. The elicitation method is commonly applied for contingent valuation method (CVM), which directly asks people what they are willing to pay for a benefit in a hypothetical market for environmental goods/services. The DBDC method has been utilized for estimating WTP for environmental improvement projects, including sanitation, water supply, and agriculture project. Application of the method for rural electrification fields is considered to be the first attempt. Design of questions and method of analysis will be mentioned in the Section 4.6.4 in detail. In addition, "Block C and E' - questions about consumption and expenditure - are also important questions for estimating ability to pay (ATP) for electricity.

Questionnaire for electrified village does not include "Block G: WTP for Electricity" and include questions about the "Situation and Satisfaction of Current Electricity Service" instead of "Block F: Expectation for the Electrification".

Interview Items for Household Questionnaire (Non-electrified Village)

Block A:	Respondent Characteristics (gender, age, occupation, ethnic group, educational attainment, and etc.)
Block B:	Household Characteristics (major source of income, assets/livestock possessed, house material, sanitation/ water supply, and etc.)
Block C:	Household Consumption (consumption and expenditure of food/non-food considerable and durables)
Block D:	Current Electricity Services (type of service, date of electrification, initial cost paid, monthly expense, service hours, satisfaction with current service, and etc.)
Block E:	Consumption and Expenditure of Energy (major lighting source, type of energy source, monthly expenditure, amount of consumption, and etc.)
Block F:	Expectation for the Electrification (type electric appliances want to purchase after the electrification, envisaged business activities after the electrification, and etc.)
Block G:	Willingness to Pay for Electricity (WTP for connection fee and electricity tariff, how to procure money for connection fee)

<u>Key Informant Questionnaire</u>

Key informant questionnaires for electrified/non-electrified village includes following items, of which, the Block D, E and F are prepared to collect information about potential energy demand for nonresidential consumers (such as commercial, industry, public facilities, and agriculture).

Interview Items for Key Informant Questionnaire (Electrified / Non-electrified Village)

Block A:	Respondent Characteristics (gender, age, position in the village)
Block B:	Basic Information (year of establishment, number of household, ethnic groups, organization, major income source, major restrictions, priority of infrastructure, and etc.)
Block C:	Infrastructure (accessibility to the village, type of water sources)
Block D:	Electricity Services (number of household by electricity service, participation for O&M activities, duration and frequency of interruptions)
Block E:	Education & Health Care (availability of schools and/or medical facilities in the village)
Block F:	Agriculture (major crops, agricultural practice, number of rice milling machine, irrigation area in dry/wet season, electricity demand for pumping irrigation scheme and etc.)
Block G:	Industry and Business (major industries in the village, expected industries after the project)

(5) Training of the Surveyors

Questionnaire for household survey were rather complex (particularly question about consumption, expenditure and willingness to pay). However, since some surveyors were initially unfamiliar with interview techniques. Therefore it was critical that field surveyors and supervisor received adequate training prior to their field survey assignment.

Prior to the actual interview survey, socio-economic expert of the study team, survey leader and each group leader conducted training for all the surveyors. Training was made On the Job Training (OJT) bases along with the following procedures.

On-the-Job Training (OJT) for Surveyors

1. Explanation of questionnaire to surveyors (definition of wording, explain how to reduce bias)
2. Training of calculation of monthly consumption and expenditure using a calculator
3. Survey leader execute interview. The group leaders and all the surveyors observe the interview.
4. Split into two groups, one group was supervised by the survey leader, and the other group was supervised by the socio-economic expert and a group leader.
5. Surveyor start interview individually
6. Check the answers of all the questionnaires, and provide recommendation to surveyors.

4.6.2 ENERGY CONSUMPTION AND EXPENDITURE

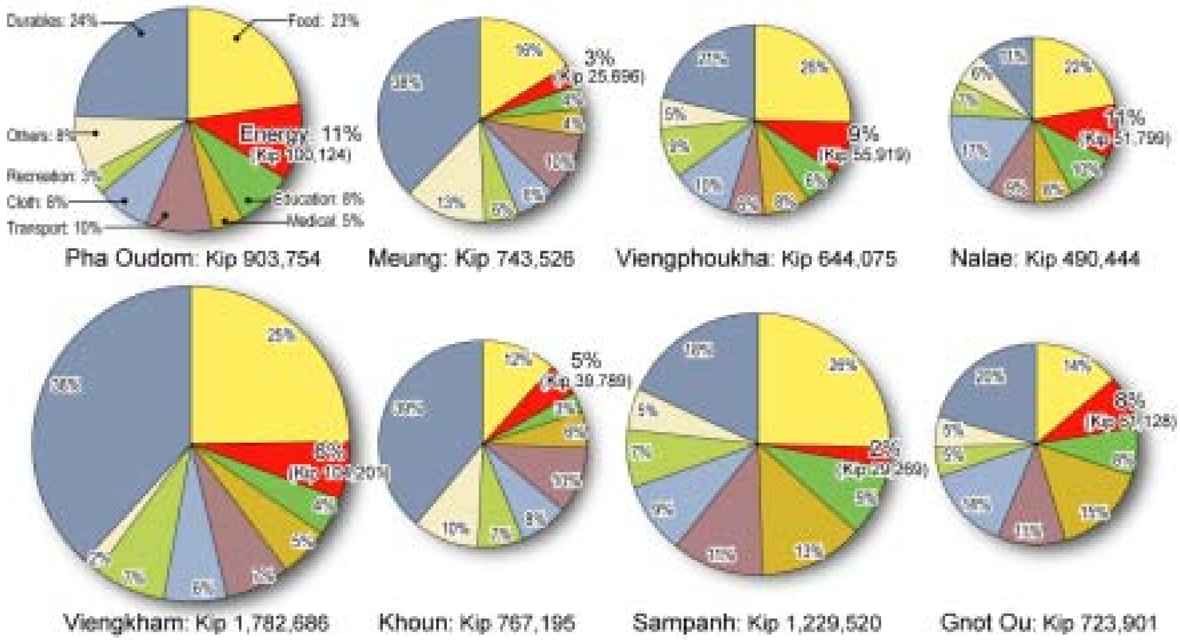
In socio-economic survey, both consumption and expenditure data were collected. Goods and services purchased make up household expenditure, while household consumption is defined as household expenditure plus the value of own produced goods taken out from households' own production. The difference in two concepts is basically caused by own produced rice and other crops, and meat/egg of own domesticated Livestock. Consumption is important to know living standard of household, and is utilized for judging poor and non-poor household in Laos. Expenditure is important data to know capability of household for paying electricity tariff (see the Supporting Data Files B for consumption pattern and the section 2.7.2 of this report for poverty indexes).

(1) Expenditure Pattern

The below circular graphs illustrate difference of the average monthly consumption pattern per household among the survey sites. The diameter of each circular graph indicates size of expenditure.

As shown in the graph, food expenditure accounts for 12 - 26% of total expenditure. Energy expenditure is significantly diverse by the surveyed district, and ranged from Kip 25,696 to Kip l04,20l per household per month, which accounted for 2.4 - 11.1% of total expenditure (detail will be mentioned in the subsequent section).

Except for Viengkham and Sampanh, expenditure level of other 6 sites is less then the national average of Kip 922,578*[1] (US$ 88.9). The gap of expenditure among the district centers' is wider than that of consumption. Household expenditure in Nalae is the smallest (Kip 490,444: US$ 47.3), and is about half of national average and less than one-third of Viengkham (Kip 1,782,686: US$ 171.8).



Monthly Expenditure Pattern by the District Centers

(2) Use of Electricity and Electric Appliances

The somewhat surprising finding of survey is that people in surveyed sites use various types of energy (including electricity), and already have various types of electric appliances. As shown in the following table, three-fourth of households in the surveyed sites have electric light. About half of households have ratio and/or radio-cassette and one-third of households have T V set.

[1] The national average of Kip 779.2 thousand, which was quoted from the Laos Expenditure and Consumption Survey 2002/03 (LECS III), was converted to 2004 price using Consumer Price Index in the country.

Electric Appliances Possessed

District	Pha Oudom*	Meung	Vieng Phoukha	Nalae	Vieng Kham	Khoun	Sampanh	Gnot Ou	Average
Electric Light	63.3%	80.0%	61.0%	96.7%	91.7%	78.3%	96.7%	51.7%	77.5%
TV Set	45.0%	61.7%	26.7%	26.7%	48.3%	41.7%	41.7%	20.0%	35.7%
Radio/Radio Cassette	63.3%	66.7%	58.3%	45.0%	58.3%	65.0%	33.3%	15.0%	48.6%
Stereo	15.0%	16.7%	8.3%	10.0%	16.7%	0.0%	48.3%	16.7%	
Electric Fan	8.3%	18.3%	5.0%	3.3%	31.7%	0.0%	31.7%	5.0%	12.9%
Rice Cooker	1.7%	1.7%	0.0%	0.0%	20.0%	0.0%	1.7%	0.0%	3.1%
Electric Iron	5.0%	6.7%	0.0%	0.0%	20.0%	0.0%	3.3%	0.0%	4.4%

* Pha Oudom had been received electricity from mini diesel grid. However the generator has left unattended after the breakdown.
Source: JICA Study Team

The survey indicates that there is significant demand for electricity services in rural areas that is currently being met with a variety of energy types, but that there is considerable regional variation within this. The table below shows percentage of household by type of electricity services. Only one-fourth (27.6%) of households have no electricity. Remaining households (72.4%) utilize some sort of electric sources.

One-third of surveyed households have their own pico-hydro generators, particularly, most of households in Sampanh (91.7%), Khoun (78.3%), and Meung (73.3%) are using pico hydro. Some villages in the district center of Viengphouka, Nalae, and Viengkham have already electrified by mini grid, and received 2 - 3 hours service per day.

Private Diesel generators are mainly used by wealthy class households (5.8%), and are relatively popular in Pha Oudom (10.5%) and Gnot Ou (13.3%).

Most of households in Nam Heng village, Nalae district have their individual solar panel with capacity of 20 Watt-peak for lighting purpose.

Types of Electricity Service

District	Pha Oudom	Meung	Vieng Phoukha	Nalae	Vieng Kham	Khoun	Sampanh	Gnot Ou	Average
No Electricity	76.7%	20.0%	39.0%	3.3%	8.3%	21.7%	3.3%	48.3%	27.6%
Small Grid	1.7%	0.0%	35.6%	71.7%	91.7%	0.0%	0.0%	0.0%	25.1%
Private Diesel	15.0%	3.3%	8.5%	0.0%	0.0%	0.0%	6.7%	13.3%	5.8%
Photovoltaic Cells	0.0%	0.0%	0.0%	25.0%	1.7%	0.0%	0.0%	0.0%	3.3%
Pico Hydro	3.3%	73.3%	20.3%	0.0%	0.0%	78.3%	91.7%	25.0%	36.5%
Car Battery/ Others	3.3%	6.7%	1.7%	0.0%	3.3%	0.0%	10.0%	13.3%	2.3%

Source: JICA Study Team

(3) Initial Cost and Running Cost of Electric Sources

Particularly majority of households (91.7%) in Viengkham have received electricity from mini grid. Initial cost (connection fee) of these mini grids is depending on distance from electric pole and timing of application. Average initial costs for the mini gird in the three district centers are Kip 218,42I - 261,488 (US$ 21.1 - 25.2). In these areas, electricity service is available only 2.0 - 3.0 hours a day in evening. Electricity tariff is charge at fixed rate by electric appliances used, not at metered rate. Household pays US$ I .5 -2.0 per month of electricity tariff on the average.

Since the solar panel is subsidized by the Government, average initial cost is only Kip 166,000 (US$ 16.0). In addition, a consumer pays flat rate of Kip 10,000 for monthly tariff. Solar panel is mainly utilized for lighting purpose, and has not enough capacity for using TV, electric fan, rice cooker, etc.

Pico hydro generators are widely used among the household in Sampanh (91.7%), Khoun (78.3%), and Meung (73.3%). Average initial cost (cost of equipment) of pico hydro is varied by capacity, and ranged from Kip 215,417 to 476,688 (US$ 20.8 - 45.9). Bigger capacity pico hydro can sometime provide sufficient energy for watching television, but not for refrigerator, electric iron, rice cooker. Running cost of the generator is basically free, since the generator requires no fuel.

Initial Cost and Monthly Cost for Existing Electricity Service

	Sites	Sample Size	Average Initial Cost		Average Monthly Expense	
Mini Grid	Viengphouka	19 H/H	Kip 218,421	(US$ 21.0)	Kip 22,857	(US$ 2.2)
	Viengkham	43 H/H	Kip 261,488	(US$ 25.2)	Kip 19,626	(US$ 1.9)
	Nalae	52 H/H	Kip 221,250	(US$ 21.3)	Kip 15,686	(US$ 1.5)
Solar Panel (PV)	Nalae	15 H/H	Kip 166,000	(US$ 16.0)	Kip 10,000	(US$ 1.0)
Private Generator	Pha Oudom	9 H/H	Kip 5,976,944	(US$ 576.0)	Kip 198,800	(US$ 19.2)
	Gnot Ou	8 H/H	Kip 2,938,750	(US$ 283.2)	Kip 96,000	(US$ 9.3)
Pico Hydro	Sampanh	48 H/H	Kip 476,688	(US$ 45.9)	-	-
	Khoun	47 H/H	Kip 227,596	(US$ 21.9)	-	-
	Viengphouka	12 H/H	Kip 215,417	(US$ 20.8)	-	-
	Meung	42 H/H	Kip 414,333	(US$ 39.9)	-	-
	Gnot Ou	15 H/H	Kip 391,333	(US$ 37.7)	-	-

Source: JICA Study Team


Photovoltaic (PV) Panel (Nalae)


Private Generator (Sampanh)


Pico Hydro (Luangnamtha)


Diesel Generator for Mini Grid (Viengphouka)

Diesel generator is the most expensive energy source in terms of both initial cost and running cost. Even though its generation capacity is enough for using most of electric appliances, it is not utilized for domestic propose, including lighting and watching TV, because its fuel efficiency is substantially lower during low load operation. Thus, diesel generator is utilized mainly for commercial purpose (such as furniture making, rice milling, and repair shop) for few hours in a day. Average purchase price of diesel generators (including second hand machine) are US$ 283.2 in Gnot Ou and US$ 576.0 in Pha Oudom. An owner spends US$ 9.3 - US$ 19.2 for fuel in a month. In addition, they have to spend money for spare parts and for repair/rehabilitation.

(4) Energy Expenditure by Type of Energy

Following table summarized monthly energy expenditure (including candle, firewood, kerosene, dry cell battery etc.) per household in the surveyed district centers. Percentage of energy expenditure among the total expenditure varies greatly with the sites, and is range from a low of 2.38% (Sampanh) and high of l l.08% (Pha Oudom). On the average, a household spend Kip 58,570 (US$ 5.64) or 6.43% of expenditure for energy.

In the district center of Sampanh, Khoun and Meung, most of people obtain electricity for lighting from pico hydro without paying electricity tariff and fuel cost. Accordingly, their expenses for kerosene/ diesel lump and candle subsequently total energy expense are smaller than other sites. While the district centers of Viengphouka, Nalae, and Viengkham received electricity from small electric grid, since the supply hour is only 2.5 - 3.0 hours, they spend certain amount of money for kerosene/diesel lump and candle.

Monthly Energy Expenditure per Household by District Center (Unit: Kip)

District	Pha Oudom	Meung	Vieng Phoukha	Nalae	Vieng Kham	Khoun	Sampanh	Gnot Ou	Average
Firewood	7,667	2,683	7,119	3,683	18,588	6,725	11,250	3,167	7,611
Kerosene/Diesel Lump	8,540	6,330	3,348	2,308	2,917	2,350	2,096	11,400	4,914
Candle	11,561	8,425	17,740	14,215	16,888	5,575	5,690	1,294	10,158
Dry cell Battery	12,233	6,871	6,153	6,400	6,083	5,179	4,608	11,667	7,402
Private Diesel Genset	49,700	0	12,576	11,083	31,733	16,255	5,600	33,600	20,084
Electricity Tariff	0	0	8,136	13,742	16,350	0	0	0	3,436
Others	10,424	1,200	1,797	333	11,651	3,600	0	0	3,629
Total Energy Expense	100,124	25,508	56,867	51,766	104,210	39,685	29,244	61,128	58,570
% of Energy Expense	11.08%	3.43%	8.82%	10.55%	5.85%	5.17%	2.38%	8.44%	6.43%

Source: JICA Study Team

4.6.3 ABILITY TO PAY (ATP) FOR ELECTRICITY

As mentioned, percentage of energy expenditure among the total expenditure is 6.43% on the average. Of energy expenditure, it is assumed that all firewood (mainly used for cooking) and 50% of dry cell battery (used for flashlight) cannot be replaced by electricity. In this case, replaceable energy expenditure by electricity is calculated as Kip 47,258 (US$ 4.55) or 5.19% of total expenditure. Thus, 5.0% of expenditure is considered to be well within household's ability to pay for electricity.

On the other hand, according to the "Lao PDR Institutional Development for Off-grid Electrification"[2], the off-grid households were spending about l0% of their income on electricity and other lighting sources. The EDL Tariff Study[*3] of SPRE II, also mentioned that electricity price should not exceed about l0%oo f the household income. On the assumption that income and expenditure is in the same, level (while some household might deposit a part of income, some other might withdraw their saving for purchase goods), 10.0% of expenditure is considered to be the upside potential of ability to pay for electricity.

Judging from these conditions, ability to pay for electricity is assumed to be 5% - 10% of household

2 Lao PDR Institutional Development for Off-grid Electrification, Energy Sector Management Assistance Program (ESMAP), June 1999. A total of 1,580 households were interviewed, including 720 households with electricity (grid-connected) and 860 households without. The survey of households without electricity was conducted in larger villages in rural areas consisting of about 100 households or more.

3 EDL Tariff Study Final Report, Electrowatt-Ekono Ltd., Switzerland and Fichtner, Germany, December 2004

expenditure. As a result, ability to pay for electricity in the surveyed district centers is estimated as follows.

Ability to Pay for Electricity by District Center

District	Pha Oudom	Meung	Vieng Phoukha	Nalae	Vieng Kham	Khoun	Sampanh	Gnot Ou	Average
Total Expenditure (Kip)	903,754	743,526	644,075	490,444	1,782,686	767,195	1,229,520	723,901	985,032
Ability to Pay (Kip)	45,188 90,375	37,176 74,353	32,204 64,408	24,522 49,044	89,134 178,269	38,360 76,720	61,476 122,952	36,195 72,390	49,252 98,503
Ability to Pay (US$)	4.35 8.71	3.58 7.17	3.10 6.21	2.36 4.73	8.59 17.18	3.70 7.39	5.92 11.85	3.49 6.98	4.75 9.49

Source: JICA Study Team

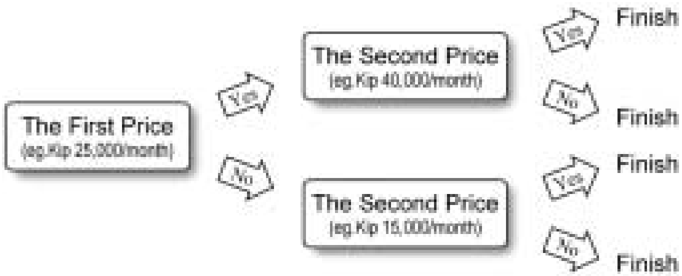
4.6.4 WILLINGNESS TO PAY (WTP) FOR ELECTRICITY

(1) Survey Method and Questionnaire Design

WTP Elicitation Technique Used for the Survey

In order to elicit information about respondent's WTP for electricity service in the survey area, elicitation method of "Double Bounded Dichotomous Choice (DBDC)" was applied. According to the various existing studies, when comparison was made among the elicitation methods (such as payment card, free answer, and interactive bidding game), the method is considered to be one of the best method to reduce bias in elicit respondent's WTP. The elicitation technique is commonly applied by Contingent Valuation Method (CVM)[*4].

A dichotomous choice payment question asks the respondents if he would pay $ X to obtain the good/ service, and the respondents are requested to answer" yes" or "no". In the single-bound format each respondent is asked once whether he would be willing to pay a specified bid amount, and in the double-bound format, after the single-bound question, he is asked once again whether he would be willing to pay another bid amount. In the latter case, the second price is set on the basis of the subject's response to the first price. If the subject responds "yes" the first time, the second price is some amount higher than the first price; if the initial response is "no," the second price is some amount lower.



Question of Double Bounded Dichotomous Choice

Setting the Bid Prices

Setting of the bid prices level presents for respondents has great influence on reliability of analysis. In order to obtain statistically meaningful results, four types of answer (”Yes - Yes”, ”Yes - No”, ”No -

4 Contingent Valuation is a method of estimating the value that a person placed on a good. The approach asks people to directly report their WTP to obtain a specified good, rather than inferring them from observed behaviors in regular market places.

Yes", and "No - No") should be dispersed. If the setting of bid price is not adequate, answer of respondent's may concentrate on "Yes - Yes" or "No - No", which will resulted in erroneous estimation.

The bid prices used for the Survey were prepared base on pre-test of interview survey, price of alternative energy sources, and existing electricity tariff (see the table below). Five set of bid prices were prepared for connection fee and for monthly electricity tariff. There are 25 patterns (5 x 5) of questionnaires, which have different combination of the bid price options. The surveyors were requested for using those questionnaires randomly, regardless of respondent's standard of living.

Bid Price for Connection Fee

	1st Bid Price	2nd Bid Price (Upper)	2nd Bid Price (Lower)
Option 1	Kip 250,000 (US$ 31.0)	Kip 350,000 (US$ 43.4)	Kip 150,000 (US$ 18.6)
Option 2	Kip 350,000 (US$ 43.4)	Kip 500,000 (US$ 62.0)	Kip 250,000 (US$ 31.0)
Option 3	Kip 500,000 (US$ 62.0)	Kip 650,000 (US$ 80.6)	Kip 350,000 (US$ 43.4)
Option 4	Kip 650,000 (US$ 80.6)	Kip 800,000 (US$ 99.2)	Kip 500,000 (US$ 62.0)
Option 5	Kip 800,000 (US$ 99.2)	Kip 1,000,000 (US$ 124.0)	Kip 650,000 (US$ 80.6)

Source: JICA Study Team

Bid Price for Monthly Electricity Tariff per kWh

	1st Bid Price	2nd Bid Price (Upper)	2nd Bid Price (Lower)
Option 1	Kip 4,000 (US$ 0.50)	Kip 6,000 (US$ 0.74)	Kip 2,600 (US$ 0.32)
Option 2	Kip 6,000 (US$ 0.74)	Kip 17,200 (US$ 2.13)	Kip 4,000 (US$ 0.50)
Option 3	Kip 17,200 (US$ 2.13)	Kip 25,800 (US$ 3.20)	Kip 6,000 (US$ 0.74)
Option 4	Kip 25,800 (US$ 3.20)	Kip 51,600 (US$ 6.40)	Kip 17,200 (US$ 2.13)
Option 5	Kip 51,600 (US$ 6.40)	Kip 90,000 (US$ 11.16)	Kip 25,800 (US$ 3.20)

Source: JICA Study Team

Method of Payment

When presenting bid price to respondents, we have to explain method of payment. In the case of electricity tariff, we explained to respondent that tariff should be paid in accordance with their monthly consumption every month.

It is sometime difficult for poor household to pay connection fee in lump sum. Thus, provision of install payment for poor households may be required for project implementation. However, when we prepare question that enable respondents' to select lump sum or install payment, number of samples for the reliable analysis will substantially increase. For this reason, in the questionnaire payment method for connection was assumed as lump sum payment at inception. Instead, following question is added in the questionnaire; "If you don't have enough cash for paying connection fee now, what will you do?" (1. Save money regularly, 2. Lend money from relatives/friends, 3. Lend money from money lender, 4. Lend money from commercial bank, 5. Sell my livestock or other assets, 6. Give up buying other goods, and 7. I don't know).

As same as actual situations, electricity tariff was assumed to be paid by monthly basis based on the energy consumption.

Questions to Elicit WTP for Connection Fee

In order to avoid the various biases, and to elicit WTP of respondents as accurate as possible, surveyor explained following points prior to the question; i) you have to pay the amount in one lump sum at the time of application, ii) you need to answer the question taking your current saving amount into consideration, iii) if your saving amount is not enough, you may force to sell your livestock, or borrow money from bank/your relative, iv) your household also have to pay monthly electricity tariff in accordance with your energy consumption, and v) even if you answers are “no” and “no” for the first and second bid prices, you have no need to worry about exclusion the right to apply electricity service.

F-1 If you were to receive "satisfactory electricity services 24 hours a day", would you be for or against paying ________ Kip for connection fee? In answering the question, please be consider your saving amount.
If your saving is not enough, you may force to sell your livestock, or borrow money from bank/your relative. Note that your household also has to pay monthly electricity tariff in accordance with your energy consumption.

2nd Price Suggested: 300,000 Kip "Yes" or "No"

1st Price Suggested: 500,000 Kip "Yes" or "No"

2nd Price Suggested: 750,000 Kip "Yes" or "No"

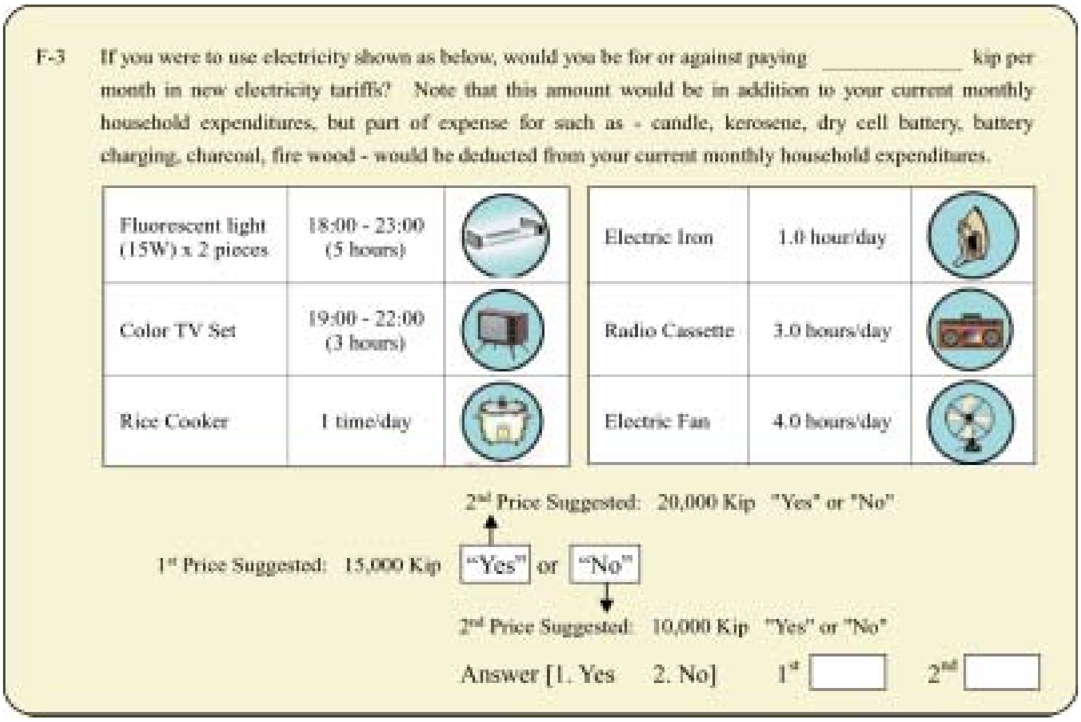
Answer [1. Yes 2. No] 1st ☐ 2nd ☐

Question to Elicit WTP for Connection Fee

Questions to Elicit WTP for Electricity Tariff

It is impossible for respondent to answer the question such as, “How much money you can pay for electricity per kWh?”. In addition, to elicit true WTP, respondent is required to understand what the electricity service is like. The electricity services how to respondents should be realistic and be easy for them to understand/ imagine. Taking these conditions in to consideration, in this survey, model case consumption pattern of electricity is assumed as follows, and is presented to respondents. Then, surveyor asked the question.

Prior to the question about WTP for electricity tariff, a surveyor explained following points; i) you have to pay electricity tariff monthly basis, ii) while the amount is added to your monthly expenditure, part of expense- such as candle, kerosene, dry cell, battery charging expense, charcoal, and fire wood would be deducted from your monthly expense, iii) if you want to use much more electricity, you have to pad additional amount, and iv) to enjoy the service, you have to purchase the electric appliances separately.



F-3 If you were to use electricity shown as below, would you be for or against paying ____________ kip per month in new electricity tariffs? Note that this amount would be in addition to your current monthly household expenditures, but part of expense for such as - candle, kerosene, dry cell battery, battery charging, charcoal, fire wood - would be deducted from your current monthly household expenditures.

Fluorescent light (15W) x 2 pieces	18:00 - 23:00 (5 hours)		Electric Iron	1.0 hour/day	
Color TV Set	19:00 - 22:00 (3 hours)		Radio Cassette	3.0 hours/day	
Rice Cooker	1 time/day		Electric Fan	4.0 hours/day	

2nd Price Suggested: 20,000 Kip "Yes" or "No"

1st Price Suggested: 15,000 Kip "Yes" or "No"

2nd Price Suggested: 10,000 Kip "Yes" or "No"

Answer [1. Yes 2. No] 1st ☐ 2nd ☐

Question to Elicit WTP for Electricity Tariff

To calculate unit WTP for electricity tariff, estimated WTP for the following service were divided by the energy consumption of the above-mentioned service of 25.8 kWh/month*5.

(2) WTP Estimation Results

WTP for Connection Fee

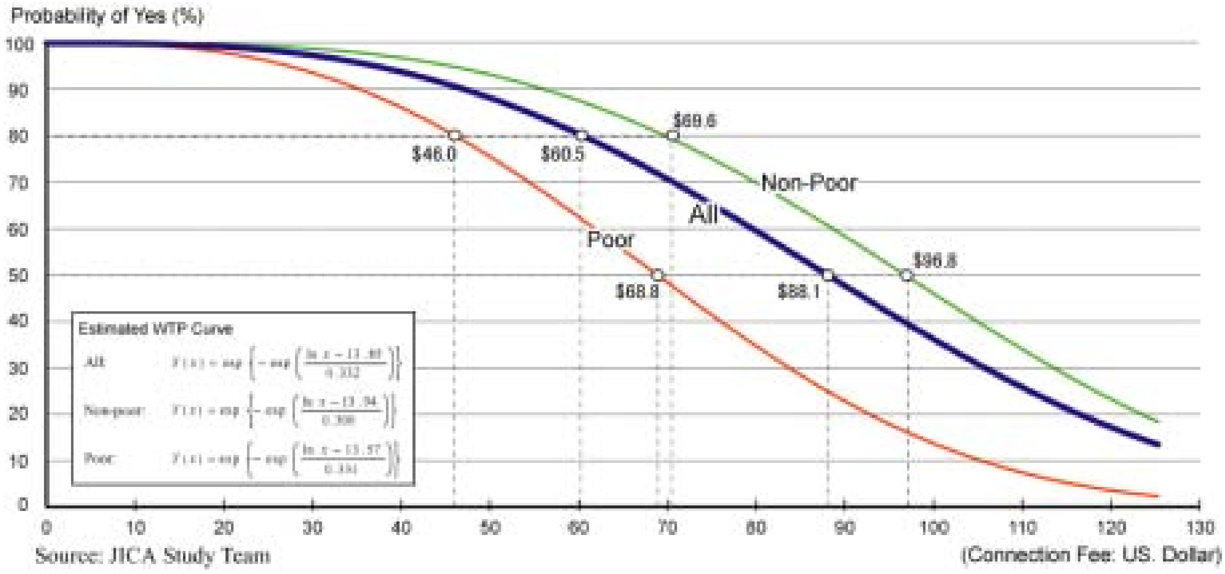
Following figure illustrates WTP curve for connection fee by poor strata (sample size: n=124), non-poor strata (n=355), and all households (n=479). Weibull model was applied for the distribution of WTP for connection fee, because the model explained WTP for connection fee in the study area more than the Logistic model. While horizontal axis indicates the connection fee, vertical axis indicates "probability of acceptance (Yes)" for the bid price. As indicated in the graph, probability of answering "yes" is decreased as the bid price increase. Point at intersection of the WTP curve and vertical line of 80% of yes indicates that 80% of household have willingness to pay against he bid price. Intersection with 50% of yes represents median WTP. On the other hand, average WTP can be calculated as the area below the WTP curve (integration value of the curve).

When using entire samples (n=479) for analysis, average WTP of US$ 88.8 is worked out. Average WTP was also calculated separately for poor household strata (n=124) and non-poor households strata (n=355). They were estimated to be US$ 69.8 and US$ 96.8, respectively.

According to the WTP curve, it is estimated that 80% of households agree to pay connection fee of US$ 60.5. This price is slightly exceeded connection fee of US$ 50.0 on ADB's "Northern Area Rural

[5] Power consumption of each electric appliance was assumed based on the market survey in the district centers. (Fluorescent light: 15 W, Color TV Set: 60 W, Electric Rice Cooker: 400 W, Iron: 400 W, Radio-cassette: 10 W, and electric fan: 50 W)

Power Distribution Project". While the ADB's project is targeted for not only district centers but also rural villages, the Study aims only to electrified district center, where is much wealthy than rural villages. Therefore, the WTP estimated in this survey is not necessarily expensive.



Estimated WTP Curve for Connection Fee of poor strata, non-poor strata, and All

Estimated WTP for Connection Fee of Poor strata, Non-poor strata, and All

Items	Sample Size	Coefficient α (p-value)	Coefficient β (p-value)	Log Likelihood	WTP (US$)		
					Median (50% Yes)	Average	80% Yes
lAll Samples	479	13.85 (0.00)	0.33 (0.00)	-375.2	88.05	88.82	60.45
Poor Households	124	13.57 (0.00)	0.33 (0.00)	-92.6	68.84	69.82	45.98
Non-poor Households	355	13.94 (0.00)	0.30 (0.00)	-252.1	96.78	96.75	69.57

Source: JICA Study Team * Exchange Rate Used: U.S$ 1= Kip 10,376.5 (End of 2004, IMF International Financial Statistics)

In this survey, 60 samples were collected in a district center. However, the sample size is not enough to estimate WTP by district center individually. Therefore, WTP in each district center is estimated based on the weighted average of poverty ratio (calculated based on the consumption) of each district center and WTP of poor/ non-poor.

Estimated WTP for Electricity Tariff by District Centers

District	Pha Oudom	Meung	Vieng Phoukha	Nalae	Vieng Kham	Khoun	Sampanh	Gnot Ou
Poverty Ratio (%)	26.7%	28.3%	15.3%	38.3%	10.0%	33.3%	8.3%	31.7%
Average WTP (US$)	89.6	89.1	92.6	86.4	94.1	87.8	94.5	88.2
WTP 80% Yes (US$)	63.3	62.9	66.0	60.5	67.2	61.7	67.6	62.1

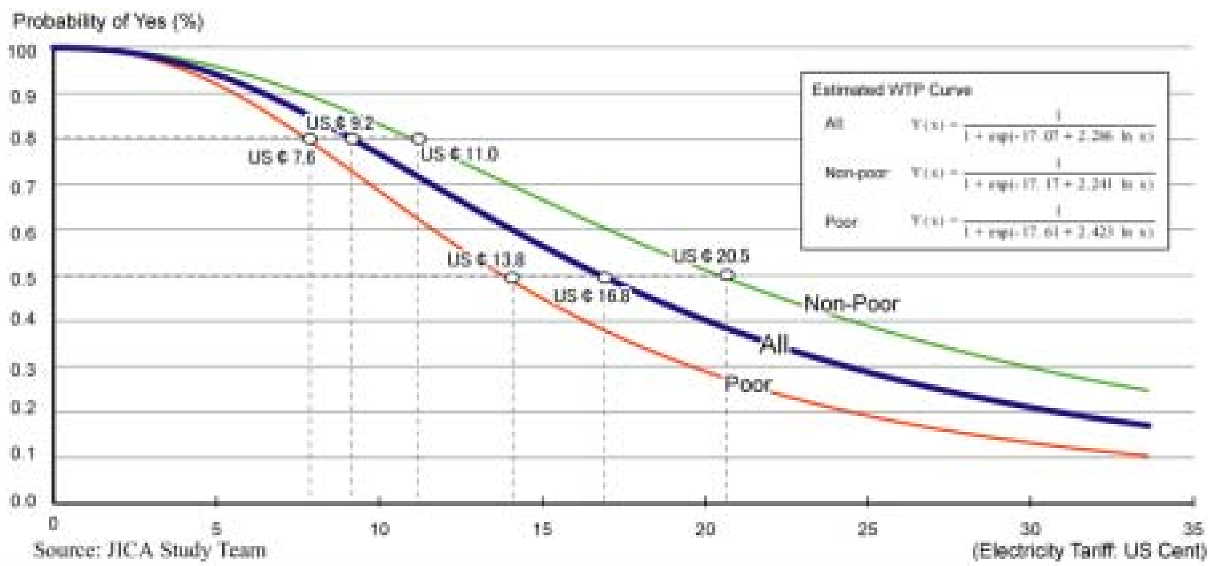
Source: JICA Study Team

<u>WTP for Electricity Tariff</u>

Figure below illustrates WTP curve for electricity tariff by poor strata, non-poor strata, and all households. Logistic model was applied for estimating the distribution of WTP curve for electricity tariff. When using entire 479 samples for the analysis, average WTP was estimated US¢ 23.56 /kWh. When using only poor sample (n= 124) and non-poor sample (n= 355), average WTP was estimated to be US¢ 18.64 and 29.13 /kWh, respectively.

These prices are higher than the existing electricity tariff of isolated diesel generator gird (Kip 1,000 - Kip 2,000/kWh or US¢ 9.6 - 19.3/kWh). In order to establish electricity tariff which is agreed by 80% of households, the tariff need to decrease to US¢ 11.8/kWh. This price is cheaper than that of isolated diesel grid, but is considerably higher than EDL's residential consumer category tariff (US¢ 1.1 for 0-50 kWh/month, US¢ 2.6 for 51- 150 kWh/month, and US¢ 7.4 for above 150 kWh/month) [*6].

If compared with WTP for connection fee and that for electricity tariff, while there are relatively narrow gap of WTP for electricity tariff between poor and non-poor, there are substantial gap of WTP for connection fee between them. So that means, although poor households have relatively similar WTP with non-poor household for paying tariff monthly bases, it is difficult for poor household to pay sizable amount of money for connection fee. In this Survey, lump sum payment was adopted as the methodology of payment of connection fee. Such assumption might be discouraged poor households from paying higher price.



Source: JICA Study Team

Estimated WTP Curve for Electricity Tariff of poor strata, non-poor strata, and All

Estimated WTP for Electricity Tariff of Poor strata, Non-poor strata, and All

Items	Sample Size	Coefficient α (p-value)	Coefficient β (p-value)	Log Likelihood	WTP (US.¢ per kWh)		
					Median (50% Yes)	Average	80% Yes
All Samples	479	-17.07 (0.00)	2.29 (0.00)	-388.0	16.82	23.56	9.17
Poor Households	124	-17.61 (0.00)	2.42 (0.00)	-116.7	13.84	18.64	7.60
Non-poor Households	355	-17.17 (0.00)	2.24 (0.00)	-240.8	20.48	29.13	11.0

Source: JICA Study Team * Exchange Rate Used: U.S$ 1= 10,376.5 (End of 2004, IMF International Financial Statistics)

As same as the connection fee, WTP for connection fee in each district center was estimated based on the weighted average of the poverty ratio of each district center and the WTP of poor/ non-poor (see the table below).

[6] Source: Electricité de Laos (EDL) as of February 2005. Exchange Rate Used: US$ 1= Kip 10,376.5

Estimated WTP for Electricity Tariff by District Centers

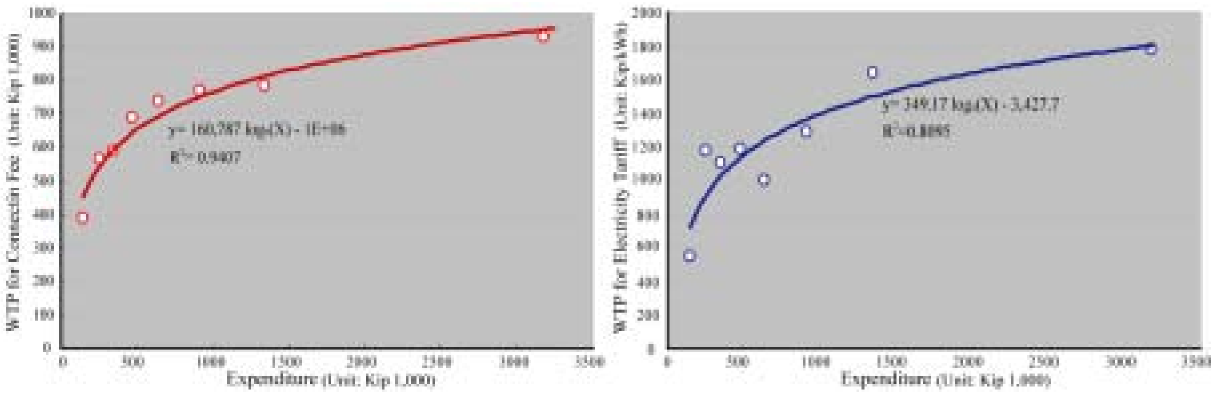
District	Pha Oudom	Meung	Vieng Phoukha	Nalae	Vieng Kham	Khoun	Sampanh	Gnot Ou
Poverty Ratio (%)	26.7%	28.3%	15.3%	38.3%	10.0%	33.3%	8.3%	31.7%
Average WTP (US¢/kWh)	23.39	23.28	25.59	22.64	26.81	22.96	27.20	23.07
WTP 80% Yes (US¢/kWh)	9.12	9.08	9.84	8.88	10.24	8.98	10.36	9.01

Source: JICA Study Team

(3) Reliability of Estimation Results

The figure below shows correlation between household expenditure and WTP. In this analysis, entire sample was divided into 8 groups based on the household expenditure level. WTP (80% yes) was calculated for each group. Then, the average expenditure of those groups and their WTP were plotted on horizontal and vertical axes, respectively. The figures below indicate that the higher expenditure level of household groups, the higher WTP they have. This essentially means, the respondents were certainly answered the question of WTP taking into consideration of their budget size. Accordingly, WTP estimation results are judged to be reasonable.

In the case of the lower expenditure strata, WTP is rapidly increased along with the increase in the expenditure level (slope of the fitted curve is steeper). The slope of the fitted curve becomes gradually gentle for higher expenditure strata. That is to say, the elasticity of WTP to expenditure is bigger for lower expenditure strata, and is smaller for higher expenditure strata.



Source: JICA Study Team

Correlation of Expenditure and WTP (Left: Connection Fee, Right: Electricity Tariff)

On the other hand, when analyzing the correlation between current energy expenditure and WTP, we found that there is no particular correlation between them. That is to say, WTP for electricity of a household is considered not to depend on the current energy expense, but to depend on the total expenditure of the household.

(4) Comparison of WTP and ATP for Electricity

Average electricity tariff payment per month is estimated based on energy consumption of 25.8

kWh/month[*7] and unit electricity tariff determined with referring to the WTP curve. Average payment amount per month is calculated to be US$ 6.03 per month. Average electricity tariff payment is estimated to be the highest in Sampanh (US$ 7.02) and the lowest in Nalae (US$ 5.84).

When comparison was made between WTP and ATP, the average WTP for the sample electricity service is slightly higher than the ability to pay in Nalae and Viengphouka. However, except for these district centers, the average WTP for the sample electricity service is within the range of ability to pay. For these reasons, estimated WTP and ATP are again judged to be reasonable.

Comparison of WTP and ATP for Electricity

District	Pha Oudom	Meung	Vieng Phoukha	Nalae	Vieng Kham	Khoun	Sampanh	Gnot Ou	Average
Total Expenditure (US$)	87.10	71.65	62.07	47.26	171.80	73.94	118.49	69.76	94.93
Average WTP for 25.8 kWh (US$)	6.03	6.01	6.60	5.84	6.92	5.92	7.02	5.95	6.03
Ability to Pay (US$)	4.35 ~ 8.71	3.58 ~ 7.17	3.10 ~ 6.21	2.36 ~ 4.73	8.59 ~ 17.18	3.70 ~ 7.39	5.92 ~ 11.85	3.49 ~ 6.98	4.75 ~ 9.49

Source: JICA Study Team

4.6.5 POTENTIAL ELECTRICITY DEMAND FOR BUSINESS & INDUSTRIES

(1) Potential Electricity Demand for Business and Industry

Table below indicates major industries/ business in the interviewed 30 villages. Currently, there are several types of small-scale businesses and industry (including grocery store, eatery repair shop, furniture making shop, handicraft, weaving, silver smith, brick making, and rice-alcohol brewer) in the surveyed villages.

In these villages, some households are using electricity for business activities such as weaving, grocery store, and eatery only for lighting purpose. In addition, some households run businesses, such as welding shop, motor bike repair shop, furniture making shop, using electricity from private diesel generator. These private diesel owners are, however, suffering from high fuel cost and frequent outage of generator.

In the case of Viengkham, Nalae and Viengphouka, although some of people receive electricity from mini grid, they still utilize diesel generator for productive purpose due to limited service hours (2-3 hours/day) of the grid. Because of the limited service hours, owner of restaurant and grocery store cannot use refrigerator.

Village heads expect that 24hours electricity supply will provide some chance to promote the establishment of small-scale industries. According to the information collected form village heads using village questionnaire, they expected that electricity will provide an entrepreneurial chance to start small scale industries and business (such as food processing, ice plant, furniture shop, repair shop, and grocery store) in the village.

7 Estimated monthly energy consumption of the model case electricity service (please refer to the section 4.6.4)

Major Industries and Businesses by District Center

	Existing	Expected after the Electrification
Pha Oudom	Handicraft and Weaving, Grocery Store, Repair Shop	-
Meung	Handicraft and Weaving, Grocery Store, Rice Alcohol Brewer (Lao-Lao), Furniture Making	Ice Plant, Repair Shop, Furniture Making, Eatery,
Viengphouka	Handicraft, Grocery Store, Furniture Making, Eatery, Repair Shop	Weaving, Repair Shop, Eatery, Grocery Store
Nalae	Handicraft, Grocery Store, Furniture Making	-
Viengkham	Handicraft and Weaving, Silversmith, Furniture Making, Repair Shop,	Furniture Making, Eatery, Repair Shop, Rice Milling, Food Processing, Handicraft
Khoun	Handicraft and Weaving, Dry Fruits, Furniture Making	Handicraft and Weaving, Furniture Making, Repair Shop
Sampanh	Handicraft and Weaving, Eatery, Grocery Store, Repair Shop	-
Gnot Ou	Brick Making, Furniture Making	-

Source: JICA Study Team

Small Scale Industry Using Electricity in Hat Sa Village, Phongsaly Province

Hat Sa village in Phongsaly province is located along the Nam Ou River, upstream of district center of Sampanh. In the case of the village, 19 households out of 74 households fetch sand from the riverbed by using diesel pump. They earned their living by selling it to construction companies.

If there is suitable access road to the market and suitable geographical condition, after the electrification, people in the candidate sites may be able to start same business with utilizing electric pump during off peak hours. Currently except for the district center of Viengkham, there are no district center where have paved access road. If access road to district center of Sampanh is completed, people may be able to start same business.

Fetching Sand from the Nam Ou River

(2) Potential Electricity Demand for Irrigation and Agro-industry

Most of village heads cited rice as the primary crops in the villages. Maize and Cassava are also cited as major crops, are some time substitute for rice, and are also used for livestock feed. In addition, most of households grow vegetables for their own consumption. In the case of Pha Oudom, Viengkham, Gnot Ou, Meung, and Nalae, cash crops (including sesame, tobacco, and cardamom) are widely cultivated.

In the Northern Laos, up land rice cultivation had been extensively executed by slash and bum (shifting) farming. However the Government of Laos decided to prohibits lash and burn farming in order to prevent forest devastation. For this reason, 25 out of 30 villages are executing sedentary farming. Although three villages in Sampanh and 2 villages in Viengkham are still executing slash and burn farming, they already decided to quit the practice. Foreign aid agencies implemented training for cultivation techniques o f substitute cash crops and distribution of seed for these villages.

As a result, up land cultivation has gradually reduced, and paddy rice cultivation has progressively increased. In the case of survey sites, paddy rice is planted in 1,573.2 ha of irrigated area during wet season. On the other hand, irrigated area in dry season of 263.7 is less than one-fifth of wet season.

Major Crops and Agricultural Practice

District	No. of Villages	Major Crops				Major Agricultural Practice*
		1st	2nd	3rd	Other Crops	
Pha Oudom	4	Rice	Vegetables	Sesame	Banana, Cassava	Permanent (4)
Meung	3	Rice	Vegetables	Maize	Sesame, Cassava	Permanent (3)
Viengphouka	4	Rice	Maize	Vegetables	Cassava	Permanent (4)
Nalae	3	Rice	Maize	Vegetables	Banana, Tobacco	Permanent (3)
Viengkham	4	Sesame	Cassava	Maize	Rice, Teek-wood	Permanent(2), Shifting (2)
Khoun	3	Rice	Maize	Vegetables		Permanent (3)
Sampanh	3	Rice	Vegetables	Cassava	Maize	Shifting (3)
Gnot Ou	6	Rice	Maize	Cassava	Vegetables, Cardamom	Permanent (6)

Source: JICA Study Team *Figure in parentheses indicates number of villages

Out of 30 village heads interviewed, only 4 village heads in Gnot Ou district expressed interest in the electrically pumped irrigation. Remaining villages thought it difficult for pumping irrigation because of i) lack of sufficient budget for developing irrigation facility and electric pump, ii) pumping irrigation is expensive thus un-payable, and iii) there are no suitable land for irrigation because the village located in the mountain side. In addition, self-sufficient agriculture is prevailing in the most of surveyed area instead of commercial based agriculture, owing to small irrigation area (average irrigation area in wet season is 0.54 ha per household) and bad accessibility to market.

For this reason, village heads are not interested in the pumping irrigation. On the other hand, in the case of the district center of Gnot Ou, average irrigation are per household is relatively large (1.28 ha), and 95% of household answered rice cultivation as their primal income source[*8]. Out of 6 villages surveyed, 4 village heads already have an irrigation plan (141 ha in the wet season and 181 ha in the dry season).

Irrigated Area by Season and Number of Rice Mill Machines

District	No. of Villages	No. of Households	No. of Rice Mill	Irrigated Area (ha)		Irrigation Plan (ha)		Average Irrigated Area per H/H
				Wet	Dry	Wet	Dry	
Pha Oudom	4	440	55	269.9	0.0	0.0	0.0	0.61 ha
Meung	3	185	21	182.5	0.0	0.0	0.0	0.99 ha
Viengphouka	4	643	50	244.5	20.0	0.0	0.0	0.38 ha
Nalae	3	399	35	197.0	0.0	0.0	0.0	0.49 ha
Viengkham	4	444	16	33.4	1.2	0.0	0.0	0.08 ha
Khoun	3	108	37	66.5	0.0	0.0	0.0	0.62 ha
Sampanh	3	249	12	24.5	0.0	0.0	0.0	0.10 ha
Gnot Ou	6	434	123	554.9	252.5	141.0	181.0	1.28 ha
Total	30	2,902	349	1,573.2	273.7	141.0	181.0	0.54 ha

Source: JICA Study Team

There are 349 of diesel engine powered rice milling machine in the surveyed sites. While replacement with electric powered facility needs some cost, running cost of electric powered facility is considerably cheaper than diesel. Accordingly, when villages are electrified, electricity demand will be expected to increase along with the replacement.

8 In the 8 surveyed sites, majority of households (89.4%) have land for agriculture. However, since the all or some of the harvests are for captive consumption their income source is not necessarily agriculture.

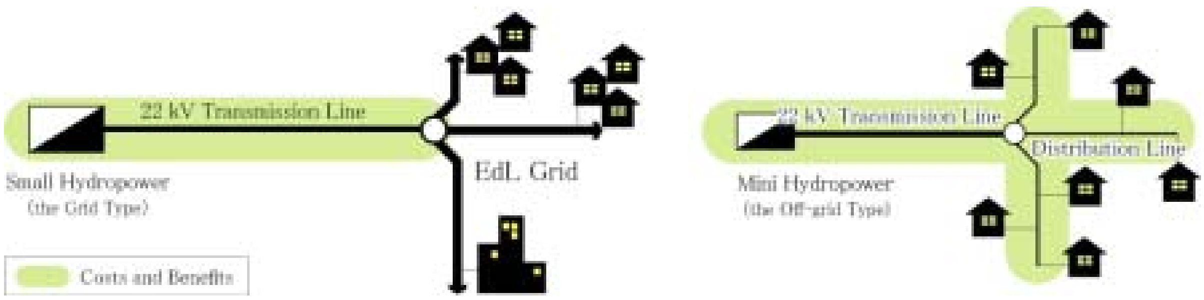
4.7 FINANCIAL AND ECONOMIC ANALYSIS

4.7.1 FINANCIAL ANALYSIS

(1) General

The Financial Internal Rate of Return (FIRR) for the 5 Grid type projects and the 6 Off-grid type projects are calculated for a 30 year and 20 year period, respectively. Financial analyses of the candidate projects are undertaken in real terms using constant 2004 prices. All cost and benefit stream are expressed in US dollar[*9]

In the case of the Off-grid type projects, since generated electricity will be directly sold to consumers, costs should be included consumer end facilities and benefits are evaluated at consumer end. On the other hand, the Grid type project, are generally profitable, and thus the projects may attract private investors. So, it is assumed that Independent Power Producers (IPPs) will own and operate the power plants and then generated electricity will be transmitted through 22 kV line and sold to EDL. Given assumptions, while costs are determined as the sum of capital costs of power station and 22 kV additional transmission line, benefits are measured at the end of 22 kV transmission line, where is connected with the existing EDL grid (please refer to the figures below).



Range of Cost and Benefit (Left: Grid Type, Right: Off-grid Type)

(2) Calculation of Financial Cost

Financial costs of the candidate projects are broadly divided in to 5 groups; i) construction costs of hydropower station, 22 kV transmission line and related substations, ii) construction cost of 400 kV distribution line, iii) installation costs of house wring and electric meter for each customer, iv) operation and maintenance cost, and v) rehabilitation cost. While costs of the grid type projects include i), iv) and v), costs of off-grid type projects include all the five groups.

Construction cost and unit construction cost per kW of capacity of each project is summarized as below tables. When focus on unit construction cost per kW, while that of the Grid type projects are within the range from US$813-2,125/kW, that of the Off-grid type projects are as high as US$4,587-

9 Exchange rate used for financial and economic analyses are US$1.0= Kip 10,376.5 (as of November 1st 2004)

8,985/kW. The grid type projects have advantage of scale economy and can be located at ideal site, where have good geographical and hydrographical condition. On the other hand, the Off-grid type projects have no other choice but to select from vicinity of the district centers, and consequently the selected project sites doesn't necessarily have ideal conditions.

Annual O&M costs are assumed to be 2.0% of capital costs, which covering salary of staffs, spare parts for routine maintenance, and consumables for operation. Rehabilitation is supposed to be executed 10 years and 15 years after the completion of the Off-grid type projects and the Grid type projects, respectively. Rehabilitation costs are assumed to be 40% of electronic and mechanical equipments cost and 20% of civil work cost.

Cost of the On-Grid Projects

	Nam Boune 2	Nam Long	Nam Gnone	Nam Ham 2	Nam Sim
Construction Cost (US$)	5,823,581	3,515,003	1,275,232	1,888,824	6,502,610
Unit Const. Cost (US$/kW)	1,456	1,406	2,125	1,889	813
O&M Cost (US$/year)	116,472	70,300	25,505	37,776	130,052
Rehabilitation Cost (US$)	1,468,900	889,888	353,843	484,989	1,583,895

Source: JICA Study Team

It is assumed that 80% of household in the supply area will apply electricity service. House wiring and electric meter costs are assumed at US$ 60.0 per connection, which consists of electric meter (US$ 50.0) and low voltage distribution line (US$ 10.0).

Cost of the Off-Grid Projects

Projects	N. Likna	N. Ou Neua	N. Chong	N. Xeng	N. Xan 3	N. Hat 2
Construction Cost (US$)	198,273	1,587,867	229,359	988,300	462,633	1,018,823
Unit Const. Cost (US$/kW)	6,609	6,107	4,587	8,985	5,783	8,490
House Wiring & Meter (US$)	7,380	74,340	12,960	30,180	20,640	33,240
O&M Cost (US$/year)	3,965	31,757	4,587	19,766	9,253	20,376
Rehabilitation Cost (US$)	61,822	461,788	81,328	238,381	139,876	299,745

Source: JICA Study Team

(3) Setting Electricity Tariff and Calculation of Financial Benefit

<u>Financial Benefit of the Grid Project</u>

It is hoped that the Grid type projects are constructed, owned and operated by IPPs. For this reason, financial benefit is determined as the total expected energy sales to EDL at the end of 22 kV transmission line. Benefit of the Gird type projects is calculated using following formula.

Financial Benefit = Average Generation x (1 – Total Loss[*10]) x Unit Wholesale Price

According to EDL, if the wholesale price is US¢ 4.0 - 4.5 /kWh, they have willingness to purchase electricity from IPPs. On the other hand, in Thailand, EGAT (Electricity Generating Authority of

[10] Total Loss = Availability Ratio x (1 – Internal Loss) x (1 – Transmission Loss)

Thailand) has decided to purchase electricity at the uniform rate of US¢ 4.5 /kWh from privately owned renewable energy power plans -including hydropower- with installed capacity of below 10.0 MW. With referring to these conditions, wholesale price to EDL are tentatively determined at US¢ 4.5 /kWh.

22 kV transmission losses are estimated from routing and distance to grid, and are computed 2.15% - 3.26% by project sites. Availability ratio of power station and internal loss are assumed to be 95%, and 1.0%, respectively. As a result, revenue from sales is worked out as follows;

Annual Generation and Revenue of the Grid Type Projects

Projects	Nam Boune 2	Nam Long	Nam Gnone	Nam Sim	Nam Ham 2
Rated Capacity (kW)	4,000	2,500	600	8,000	1,000
Annual Generation (kWh/year)	27,708,672	16,782,480	2,923,922	34,671,744	6,299,304
Availability Ratio (%)	95.00%	95.00%	95.00%	95.00%	95.00%
Internal Loss (%)	1.00%	1.00%	1.00%	1.00%	1.00%
Transmission Loss (%)	2.15%	3.26%	2.95%	2.87%	2.21%
Total Loss (%)	7.97%	9.02%	8.72%	8.65%	8.03%
Energy Sold to EDL (kWh/year)	25,499,716	15,269,367	2,668,825	31,672,903	5,793,564
Revenue from Sales (US$/year)	1,147,487	687,122	120,097	1,425,281	260,710

Source: JICA Study Team

Financial Benefit of the Off-grid Projects

Benefits of the Off-grid type projects are determined as the total expected revenue from sales of energy and revenue from connection fee.

Revenue from Connection Fee= No. of H/H in the villages x application ratio x connection fee

Revenue from Electricity Tariff= Generation Volume x T/D Loss x Electricity Tariff

a. Amount of Energy Sold

Amount of energy sold to village people is calculated as which ever is smaller of a) available energy, and b) energy demand. Application Ratio, total energy loss ratio, and load factor are assumed as 80%, 10%, and 50%, respectively. These values are assumed to be common among the sites. Peak demand per household is assumed to be 90W at the inception of electrification and be progressively increased and then catch up with national average by 2015. Routing of distribution lines, electrification targeted villages, are determined using GIS database. Number of customers is estimated based on 80% of application ratio and number of households in the target villages.

Energy Demand= No. of H/H x Application Ratio x Peak Demand per H/H x Load Factor x 8,760 hours
Available Energy= Generation Volume x (1 – Total Loss Ratio)

b. Setting of Connection Fee and Electricity Tariff

As mentioned, sales volume of energy is calculated based on the 80% of application ratio. Thus, connection fee and electricity tariff used for financial analysis should be set so as to be agreed by 80% of household. In this study, connection fee and electricity tariff are decided based on the WTP (willingness to pay) curves, which are estimated through village socio-economic survey. As a result, connection fee of each site is decided from US$ 60.45 to 67.61. Electricity tariff is also decided between the rage from US¢ 8.98 to 10.36/kWh (please refer to the following table).

Connection Fee and Electricity Tariff by District Centers

Projects	Nam Likna	Nam Ou Neua	Nam Chong	Nam Xeng	Nam Xan 3	Nam Hat 2
Electricity Tariff(US¢/kWh)	10.36	9.01	9.08	9.17	8.98	9.12
Connection Fee (US$)	67.61	62.10	62.89	60.45	61.71	63.28

Source: JICA Study Team

(4) Calculation of Financial Internal Rate of Return (FIRR)

EIRR, net present value and benefit-cost ratio, using discount rate of 10%, are calculated for all the 11 candidate projects. Unit generation costs are computed based on cost and generation stream with discount rate of 10.0%. The table below summarized the results of the financial analysis.

In the case of the Grid type projects, except for Nam Gnone, EIRR of the remaining 4 projects are well above the minimum standard (FIRR>10%, NPV>0, and B/C>1.0), and thus considered to be financially viable. In particular, the unit generation costs of Nam Boung 2, Nam Sim, and Nam Long are in the US¢ 2 ranges, and these projects are judged to be good projects (EIRR of these projects exceeds 18%).

Summary of Financial Analysis of the Grid Type Projects

Projects	Nam Boung 2	Nam Long	Nam Gnone	Nam Ham 2	Nam Sim
Generation Cost (¢/kWh)	2.44	2.48	5.18	3.53	2.20
Benefit Cost Ratio	1.693	1.539	0.746	1.086	1.728
Net Present Value	4,384,778	2,061,076	-353,899	176,174	5,146,162
FIRR (%)	21.36	18.87	5.45	11.44	21.95

Source: JICA Study Team

On the other hand, unit generation costs of all the Off-grid type projects exceed US¢20/kWh. In the same way as with other off-grid projects in the developing countries, all the financial indicators show very bad performance, and accordingly all the off-grid projects are judged to be financially not viable.

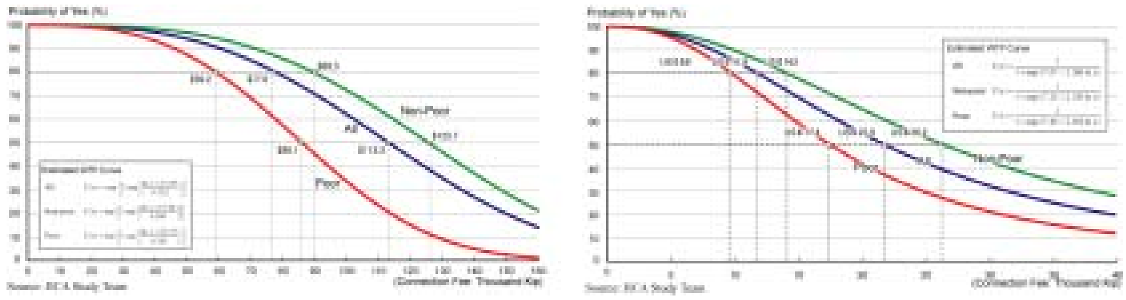
Summary of Financial Analysis of the Off-grid Type Projects

Projects	Nam Likna	Nam Ou Neua	Nam Chong	Nam Xeng	Nam Xan 3	Nam Hat 2
Generation Cost (¢/kWh)	24.7	20.2	25.8	29.8	20.8	29.2
Benefit Cost Ratio	0.332	0.359	0.334	0.276	0.344	0.169
Net Present Value	-152,941	-1,175,004	-181,074	-789,471	-351,259	-868,882
FIRR (%)	-8.08	-6.87	-10.77	-11.30	-7.53	-12.75

Source: JICA Study Team

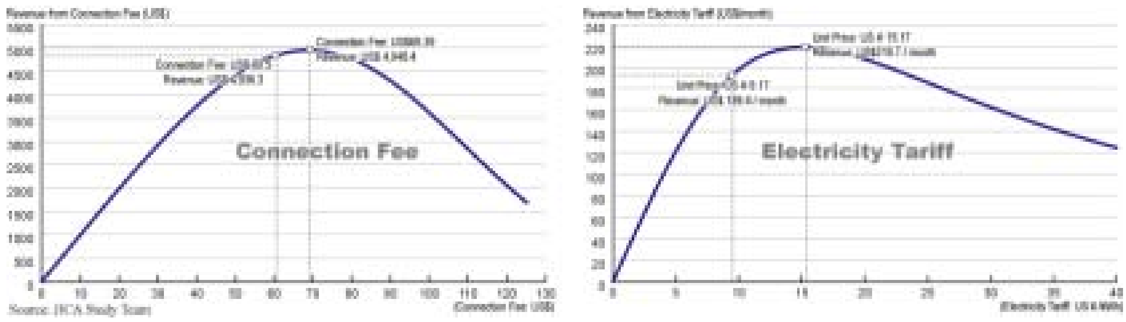
Relation among Tariff Level, Revenue and Social Equity for the Off-grid Type Projects

In general, when connection fee is expensive, number of customers or electrification ratio is less. And the cheaper connection fee, the more customers will apply for the service. Same can be said for electricity tariff. That is to say, tariff levels have certain influence on number of customers and energy consumption, and then subsequently affect financial revenue. Under the village socio-economic survey, WTP curve for connection fee and for electricity tariff in the Study area has already estimated (see the below figure). These curves imply the relation between the demand and the price level. In this column, relation among tariff level, revenue, and social equity are examined using the estimated WTP curve.



Estimated WTP Curve for Connection Fee (left) and Electricity Tariff (right) by poor strata, non-poor strata and all

The figures below show the relation between connection fee/electricity tariff level and revenue from them. These curves were prepared from WTP curve*[11]. As the graphs indicate, as the tariff and connection fee increased, revenue is also increased till certain level, and then revenue begins to decrease along with the reduction of customers and consumption. If only the maximization of revenue is important, tariff should be set on the peak of the curve (connection fee: US$ 69.39, electricity tariff: US¢15.1/kWh). In this case, application ratio and average electricity consumption are calculated 71.3% and 18.1 kWh/month, respectively.



Relation between Revenue and Tariff Level (Estimated Based on the WTP Curve)

In the financial analysis, tariff level was set to fulfill 80% of households WTP. As a result connection fee and electricity tariff were assumed to be US$ 60.45 - 67.61, and US¢ 8.98～10.36/kWh, respectively. There are not big differences between connection fee used for financial analysis and that for maximization of revenue (US$ 69.39). Thus, as illustrated in the above graph, increase in connection fee will not result in distinguished revenue increase. On the other hand, in the case of electricity tariff, there is upside potential for revenue increase from increase in electricity tariff.

However, utility rate should be set taking not only profitability but also social equity into consideration. For example, in the case of the Nam Likna project, if tariff is financially optimized, while FIRR improves from -6.87% (base case) to -1.28%, EIRR changes for worse from 11.77% to 8.28% because of decrease in number of applicants and in energy consumption. This case implies such tariff increase will contribute for improve financial performance but decrease economic performance and social equity.

[11] Calculated based on the Number of household 100 and average energy consumption of 50 kWh/month

4.7.2 ECONOMIC ANALYSIS

The Economic Internal Rate of Return (EIRR) for 5 on-grid projects and 6 off-grid projects have been calculated for a 30 year and 20 year period, respectively. Economic analyses of the candidate projects are undertaken in real terms using constant 2004 prices. All cost and benefit stream are expressed in US dollar[*12].

(1) Economic Costs

Economic costs of the candidate projects were broadly divided in to 5 groups; i) construction costs of hydropower station, 22 kV transmission line and related substations, ii) construction cost of 400 kV distribution line, iii) installation costs of house wring and electric meter for each customer, iv) operation and maintenance cost, and v) rehabilitation cost. Of which, ii) and iii) were included only for the Off-grid type projects.

Costs of civil works were assumed to be 100% of local portion, while costs of electronic and mechanical equipments are assumed to be 100% of foreign portion. In calculating economic price, the foreign costs are valued at CIF (cost, insurance and freight) price, and local costs (non-tradable costs) are converted into boarder price using the Standard Conversion Factor (SCF) of 0.9[*13].

Annual O&M costs were assumed to be 2.0% of capital costs. Rehabilitation was supposed to be executed 10 years and 15 years after the completion of off-grid hydro and on-grid hydro, respectively. Rehabilitation costs were assumed to be 40% of electronic and mechanical equipments cost and 20% of civil work cost.

Costs of the Grid Projects Source: JICA Study Team

	Nam Boung 2	Nam Long	Nam Gnone	Nam Ham 2	Nam Sim
Construction Cost(US$)	5,393,315	3,280,406	1,204,209	1,765,851	6,040,269
O&M Cost(US$/year)	107,866	65,608	24,084	35,317	120,805
Rehabilitation Cost(US$)	1,382,847	936,807	368,047	509,584	1,676,363

House wiring and electric meter costs were estimated only for off-grid projects, and are assumed at US$ 60.0 per connection, which consists of electric meter (US$ 50.0) and low voltage distribution line (US$ 10.0). The number of applicants was estimated based on the 80% of households in the supply area.

Costs of the Off-grid Projects Source: JICA Study Team

	Nam Likna	N. Ou Neua	Nam Chong	Nam Xeng	Nam Xan 3	Nam Hat 2
Construction Cost (US$)	189,529	1,501,188	224,152	922,722	440,044	964,931
House Wiring & Meter (US$)	7,380	74,340	12,960	30,180	20,640	33,240
O&M Cost (US$/year)	3,791	30,024	4,483	18,454	8,801	19,299
Rehabilitation Cost (US$)	60,073	444,453	80,287	227,843	135,358	288,966

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[12] Exchange rate used for financial and economic analyses are US$1.0= Kip 98,000 (as of November 1st 2004)
[13] Same SCF was applied for "Northern Area Rural Power Distribution Project", which is financed by Asian Development Bank.

(2) Economic Benefit

<u>Economic Benefits of the Off-grid Type Projects</u>

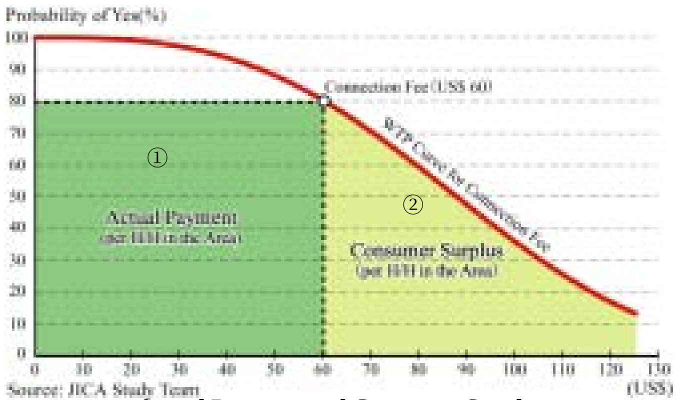
Sum of average WTP for connection fee and electricity tariff are regarded as economic benefits of the Off-grid type projects. These benefits were calculated as following formulas;

Benefit from Connection = No. of H/H x Application Ratio x Average WTP for Connection Fee
Benefit from Electricity Consumption = Energy Consumption x Average WTP for Electricity Tariff

Differences of WTP used for financial analysis and economic analysis are explained as follows. For example, when setting connection fee as US$ X, only household having more then US$ X of WTP will apply the service. WTP adopted for financial analysis is determined to satisfy WTP of 80% of households. And the financial benefits were computed based on the actual payment from consumers, and can be illustrate as the quadrangle① in the following figure.

On the other hand, even if a household having US$ 90 of WTP, they will pay US$ 60. In this case, remaining US$ 30 is regarded as consumer surplus of the household. Economic benefit includes not only actual payment of US$ 60 but also consumer surplus of US$ 30. Actual payment① and consumer surplus② can be illustrated as the figure below.

Also, average WTP used for economic analysis is average value of consumers (occupied 80% of total household), and thus different from average WTP of all households calculated in chapter 4.6.4. Consumer's average WTP can be calculated as a sum of actual payment amount and consumer surplus shown in the figure and then divided by 80%. Following formula was prepared base on the WTP curve prepared in the socio-economic survey, and was adopted in calculating the customer's average WTP.



Actual Payment and Consumer Surplus

$\text{WTP}_{CF} = \left\{ \int_{T=t_1}^{\infty} \exp\left\{ -\exp\left(\frac{\ln T - 13.58}{0.332} \right) \right\} dT + t_1 \times 80\% \right\} \div 0.8$	Where: WTP_{CF} = Consumer's average WTP for Connection Fee T= Connection Fee (variable) t_1= Actual Connection Fee Levied on Consumers
$\text{WTP}_{ET} = \left\{ \int_{X=x_1}^{\infty} \left\{ \frac{1}{1 + \exp(17.07 + 2.286 \ln X)} \right\} dX + x_1 \times 80\% \right\} \div 0.8$	Where: WTP_{CF} = Consumer's average WTP for Electricity Tariff T= Electricity Tariff (variable) t_1= Actual Electricity Tariff Levied on Consumers

Formula to Calculate Consumer's Average WTP for Connection Fee and Electricity Tariff

Using the methodology, consumer's average WTP for connection fee and electricity tariff, and economic benefits in each Off-grid project site was calculated as follows;

Average WTP for Electricity Tariff of the Applicants and Economic Benefit from Sales

Items	Nam Likna	N. Ou Neua	Nam Chong	Nam Xeng	Nam Xan 3	Nam Hat 2
Average WTP for Elec. Tariff (US¢/kWh)	32.27	27.32	27.59	27.92	27.19	27.72
Energy Sold (kWh/year)	105,790	1,032,998	118,818	419,782	292,874	457,420
Economic Benefit from Energy Sales (US$/year)	34,138	282,215	32,782	117,203	79,633	126,797

Source: JICA Study Team

Average WTP for Connection Fee of the Applicants and Economic Benefit from Application

Items	Nam Likna	N.Ou Neua	Nam Chong	Nam Xeng	Nam Xan 3	Nam Hat 2
Average WTP for Connection Fee (US$)	104.17	97.74	98.66	99.85	97.28	99.12
Number of Applicants (Households)	123	1,239	216	503	344	554
Benefit from Connection (US$)	12,813	121,100	21,311	50,226	33,464	54,912

Source: JICA Study Team

Economic Benefits of the Grid Type Projects

In the case of the Grid type projects, benefits were determined as the replacement cost of alternative energy sources. Before the grid connection cost of import energy is regarded as benefit. On the other hand, after the interconnection with the EDL grid, long-run marginal cost of generation and transmission of the EDL grid with due consideration of transmission loss is regarded as benefit.

Long-run marginal cost of EDL grid is quoted from "EDL Tariff Study[*14]" (generation: US¢ 3.44/kWh and 115 kV transmission: US¢ 1.56/kWh). Transmission loss of 115 kV is calculated based on the loss from Nam Gum hydropower station, which has biggest installed capacity within the EDL grid.

In the case of Nam Boung 2, Nam Long, Nam Gnone, and Nam Hat 2, there are enough electricity demand even before the interconnection, thus it was assumed that commercial operation will commence from 2007 – 2009. On the other hand, since there is only small demand around the Nam Sim project, the power station was assumed to be completed in 2015, when EDL grid will connect with the site.

Before Inter-connection: Unit price of Imported Electricity x Energy Sold
After Inter-connection: LRMC of EDL Grid x (1 – T/L loss) x Energy Sold

Basis for Calculating Economic Benefits of the 5 Grid Type Projects

Projects	Nam Boung 2	Nam Long	Nam Gnone	Nam Ham 2	Nam Sim
Import from	Vietnam	China	Thailand	Thailand	Vietnam
Unit Price of Import Electricity (¢/kWh)	6.00	5.64	5.02	5.02	6.00
Anticipated Year of Grid Connection	2010	2008	2015	2008	2015
115 kV Transmission Line Loss (%)	2.1%	1.6%	0.4%	0.5%	1.5%
Supply Cost from Grid (US¢/kWh)	5.11	5.08	5.02	5.02	5.08

Source: JICA Study Team

14 EDL Tariff Study Final Report, World Bank, December 2004, p 2-4 long-run marginal cost of generation (Kip 357 /kWh) and 115 kV transmission line (Kip 162/kWh). Exchange rate used: US$ 1.0= Kip 10,376.5

(3) Calculation of Economic Internal Rate of Return (EIRR)

Calculated EIRR, net present value and benefit-cost ratio, using discount rate of 10%, for 11 candidate projects are summarized as following tables.

In the case of Grid type projects, except for Nam Gnone, the EIRR of remaining 4 projects are well above the cost of capital in Laos (10.0%) and standard set by the ADB (12.0%), and thus economically viable. In particular, Nam Boung 2, Nam Sim, and Nam Long are judged to be good projects (EIRR of these projects are exceeding 20%).

Summary of Economic Analysis for the Grid Type Projects

Projects	Nam Boung 2	Nam Long	Nam Gnone	Nam Ham 2	Nam Sim
Benefit Cost Ratio	1.904	1.897	0.881	1.296	2.097
Net Present Value (US$)	5,298,819	3,208,366	-157,126	569,485	7,208,307
EIRR (%)	24.86%	25.44%	7.92%	14.92%	28.13%

Source: JICA Study Team

On the other hand, in the case of Off-grid type projects, out of 6 projects, Nam Likna, Nam Ou Neua, and Nam Xan 3 were confirmed as having economic viability. The EIRR of these projects exceeds 10%, but this is below the 12% standard set by the ADB. In addition, Nam Chong shows better economic performance (EIRR: 9.42%). However, Nam Xeng (7.19%) and Nam Hat 2 (5.47%) are obviously not viable from the perspective of national economy.

Summary of Economic Analysis for the Off-grid Type Projects

Projects	Nam Likna	Nam Ou Neua	Nam Chong	Nam Xeng	Nam Xan 3	Nam Hat 2
Benefit Cost Ratio	1.029	1.095	0.974	0.863	1.041	0.777
Net Present Value (US$)	6,312	165,179	-6,868	-139,790	21,040	-247,324
EIRR (%)	10.54%	11.77%	9.42%	7.19%	10.77%	5.47%

Source: JICA Study Team

4.7.3 SENSITIVITY ANALYSIS

The sensitivity of the FIRR and EIRR to several adverse movements in key assumptions has been computed to access the robustness of the financial and economic analysis.

a) 10% and 20% increase in capital cost
b) 10% and 20% decrease in annual generation
c) replacement of turbine and generator due to outage (3 and 5 years after the completion)
d) 20% increase in operation and maintenance cost

Analysis was made for 4 Grid type projects (Nam Long, Nam Sim, Nam Ham, Nam Boung 2) having financial and economical feasibility, and for 3 Off-grid type projects (Nam Likna, Nam Ou Neua, Nam Xan 3) having economical feasibility in base case. The below table summarized the results of the analysis.

Summary of Sensitivity Analysis

Projects	Grid Type								Off-grid Type		
	Nam Long		Nam Sim		Nam Ham 2		Nam Boung 2		Nam Likna	Na Ou Neua	Nam Xan 3
	FIRR	EIRR	FIRR	EIRR	FIRR	EIRR	FIRR	EIRR	EIRR	EIRR	EIRR
Base Case	18.9%	25.4%	21.9%	28.1%	11.4%	14.9%	21.4%	24.9%	10.5%	11.8%	10.8%
a. Capital Cost Overrun											
10% decrease	16.8%	22.7%	19.6%	25.2%	10.0%	13.2%	19.1%	22.2%	9.0%	10.2%	9.3%
20% decrease	15.1%	20.4%	17.7%	22.7%	8.8%	11.8%	17.2%	20.1%	7.7%	8.8%	8.0%
b. Decrease in Generation											
10% decrease	16.4%	22.1%	19.1%	24.6%	9.6%	12.8%	18.6%	21.7%	8.7%	9.8%	8.9%
20% decrease	13.8%	18.8%	16.3%	21.1%	7.7%	10.6%	15.8%	18.6%	6.7%	7.8%	6.9%
c. Replacement of Turbine and Generator											
3year after completion	17.8%	24.0%	20.1%	25.9%	10.4%	13.7%	20.1%	23.4%	6.9%	10.8%	8.9%
5year after completion	18.1%	24.5%	20.7%	26.7%	10.6%	14.0%	20.5%	23.9%	7.3%	11.0%	9.2%
d. O&M Cost Overrun											
20% overrun	16.9%	23.4%	20.0%	26.1%	10.9%	13.0%	19.4%	22.9%	10.0%	11.3%	10.3%

Source: JICA Study Team

Out of 4 Grid type projects, 3 projects (Nam Long, Nam Sim, and Nam Boung 2) are found to be financially and economically remain robust under all the adverse sensitivity conditions. In the case of the Nam Ham 2 project, increase in construction cost 20%, decrease in generation 10% and 20% will render financial feasibility.

Economic feasibility of the 3 Off-grid projects are found to be vulnerable. Adverse conditions such as increase in construction cost, decrease in generation, and unexpected replacement of turbine and generator will render economic feasibility.

Generally, while decrease in generation will severely affects financial and economic feasibility, increase in operation and maintenance cost have minor impact on them.

4.7.4 LEAST COST ANALYSIS FOR OFF-GRID ELECTRIFICATION

(1) General

In the case of the EDL grid, there are numbers of candidate power plants including large-scale power plant, such as the Nam Ngiep hydropower (260 MW) and Hongsa Lignite (720 MW). Accordingly, if a Grid type project proposed by this survey is judged to be not financially and economically viable, there is no need to execute the project. On the other hand, in the case of the Off-grid type project, if the project is economically viable and there are no cheaper alternative energy sources but to construct the Off-grid type hydropower project, the project is worth execution even if the project is not profitable.

To find the least cost alternative for off-grid electrification, and to know competitiveness of the proposed Off-grid type projects in supply cost, average unit supply cost throughout the project lifetime are calculated for i) mini gird powered by diesel generator, and ii) extension of 22 kV transmission line from the EDL grid. Unit supply cost is valued not at generation (supply) side, but at consumer (demand) side.

(2) Diesel Mini Grid

Costs of diesel generator and its mini gird fall into 4 categories; i) construction cost of diesel generator, ii) construction cost of 22kV and 400V distribution line and associated transformers, iii) operation and maintenance costs, and iv) fuel cost. Costs of distribution line are calculated same methodology as the Off-grid type projects. Basis for calculation are as follows;

Capital Cost of Diesel Generator: US$ 1,000 per kW
Fuel Efficiency of Generator [liter/kWh]: 0.135 x G_{LF} + 0.172/G_{LF} [*15]
Load Factor of Generator (G_{LF}): 18:00 - 21:00= 100%, 0:00 - 18:00, 21:00 - 24:00= 40%
Fuel Costs in each site is collected during the village socio-economic survey (see the table below)

Price of Diesel Fuel at Off-grid Sites (Kip/Liter)

Nam Likna	Nam Ou Neua	Nam Chong	Nam Hat 2	Nam Xeng	Nam Xan 3
6,750	7,102	7,109	6,139	6,111	7,000

Source: JICA Study Team

Unit supply cost of diesel mini gird can be calculated using following formula

$$UC = \sum_{t=1}^{20} \frac{Ca_t + M_t + Fc_t}{(1+\varphi)^t} \div \sum_{t=1}^{20} \frac{De_t}{(1+\varphi)^t}$$

UC= Unit Supply Cost
De_t= energy demand in year "t"
ε= transmission and distribution loss: 10%
φ= discount rate: 10%
Ca_t= capital cost in year "t"
M_t= operation and maintenance cost in year "t" (equivalent to 5.0% of capital cost)
Fc_t= fuel cost in year "t"

Given the assumptions, unit supply costs of diesel mini grid are calculated as follows. Unit supply costs are varied from US¢ 35.29 (Nam Likna) to 41.67/kWh (Nam Chong).

Basis of Calculation and Calculated Supply Cost (Diesel Mini Grid)

Projects	Nam Likna	Nam Ou Neua	Nam Chong	Nam Xeng	Nam Xan 3	Nam Hat 2
Fuel Consumption per kWh (Liter/kWh)	0.276	0.290	0.291	0.251	0.250	0.286
Unit Generation Cost (US¢/kWh)	30.32	31.04	34.19	27.65	27.75	30.86
Unit Supply Cost (US¢/kWh)	35.29	41.67	40.77	37.64	35.67	39.44

Source: JICA Study Team

(3) Grid Extension

It is assumed that 22 kV transmission line will construct along with the existing main load and will electrify surrounding villages (approximately 1 km within the line).

Annual operation and maintenance cost of additional transmission facilities is assumed 3.0% of

[15] Source: Grid Connected Photovoltaic Electricity Supply on Tokelau PV Project Final Report, UNDP/UNESCO, August 2003

construction cost. Incremental generation and 115 kV transmission cost is assumed to be 5.002¢/kWh (generation: 352 Kip、115 kV transmission: 162 Kip)*[16], based on the Long-run Marginal Cost (LRMC) during from 2005 to 2015. Unit supply cost of grid extension can be calculated using following formula.

$$UC = \sum_{t=1}^{20} \left\{ \frac{Ca_t + M_t + LRMC \times \dfrac{Pe_t \times 8760 \times LF \times HH}{(1-\varepsilon)}}{(1+\varphi)^t} \right\} \div \sum_{t=1}^{20} \left\{ \frac{Pe_t \times 8760 \times LF \times HH}{(1+\varphi)^t} \right\}$$

Pe_t= peak demand per household in year "t" (same assumption as the off-grid type projects)
LF= load factor: 50%
HH= number of electrified household
ε= transmission and distribution loss
φ= discount rate: 10%
Ca_t= capital cost in year "t"
M_t= operation and maintenance cost in year "t"
LRMC= long-run marginal cost of generation and 115 kV transmission

Basis of Calculation and Calculated Supply Cost (Grid Extension)

Item	Nam Likna	Nam Ou Neua	Nam Chong	Nam Xeng	Nam Xan 3	Nam Hat 2
Grid Extension Cost (US$)	818,192	2,667,583	844,184	2,165,591	762,155	701,072
T&D Loss (%)	12.21	12.12	12.36	12.06	12.60	12.32
Electrified Household	532.00	1,600.00	383.00	1,176.00	913.00	814.00
Energy Demand (kWh)	487,003	1,464,672	350,606	745,152	1,076,534	835,778
22 kV-end Required Energy (kWh)	546,442	1,642,249	393,934	836,969	1,206,375	941,095

Source: JICA Study Team

Given the assumptions, unit supply costs in 6 project sites are worked out as follows. Since the Nam Xan 3 and Nam Hat 2 located relatively near from the existing EDL grid, unit supply costs at those sites by grid extension are well below US¢ 20 /kWh. Unit supply costs at Nam Xeng and Nam Chong are exceeding US¢ 30/kWh.

Unit Supply Cost of Grid Extension

Item	Nam Likna	Nam Ou Neua	Nam Chong	Nam Xeng	Nam Xan 3	Nam Hat 2
Unit Supply Cost (US¢/kWh)	27.45	29.34	37.21	31.89	17.17	17.55

Source: JICA Study Team

(4) Least Cost Option for Off-grid Electrification

Out of the 6 Off-grid type projects, 4 projects (Nam Likna, Nam Ou Neua, Nam Chong and Nam Xeng) have competitive advantage in supply cost.

However, in the case of Nam Xan 3 and Nam Hat 2, since they are located relatively near the EDL grid, electrification through grid extension was selected as the least cost alternative. In reality, since

[16] Quoted from the Southern Provinces Rural Electrification Project II "EDL Tariff Study", Final Report, December 2004, World Bank

the Pre-F/S, the Bokeo Provincial Government has already decided to extend the transmission line toward Pha Oudom, which is near the Nam Hat 2 project site.

Comparison of Supply Cost by Alternatives (Unit: US¢/kWh)

Projects	Nam Likna	Nam Ou Neua	Nam Chong	Nam Xeng	Nam Xan 3	Nam Hat 2
Off-grid Type Hydropower	24.74	20.15	25.82	29.83	20.79	29.23
Diesel Mini Grid	35.29	41.67	40.77	37.64	35.67	39.44
Grid Extension	27.45	29.34	37.21	31.89	17.17	17.55

Source: JICA Study Team

4.7.5 SELECTION OF PRIORITY PROJECTS

(1) Priority Projects of the Grid Type

In the case of the Grid type project, if there is enough electricity demand around the project sites, these projects should be implemented in descending order of financial and economical feasibility. On the other hand, is there are not enough demand around the project sites, there is no rush to construct these power stations. In addition, unlike the Off-grid type projects, if profitability of a project is not confirmed, the project should not be implemented. In this light, priority projects are selected as follows;

Selected Projects (Grid Type)

Priority Projects	Nam Long (2,500 kW: Luang Namtha province), Nam Ham 2 (1,000 kW: Bokeo province)
Candidate Projects	Nam Boung 2 (4,000 kW: Phongsaly province), Nam Sim (8,000 kW: Huaphanh province)
Excluded Projects	Nam Gnone (600 kW: Bokeo province)

Reasons for Selection

Out of 5 Grid type projects, Nam Gnone was excluded from the list because it was financially and economically not feasible. In the case of Nam Sim, and Nam Boung 2, there is not enough demand around the project site before the grid connection, and thus the projects have smaller revenue and import substitute effect during the period. Thus, these projects should be completed in 2015 (Nam Sim) and in 2010 (Nam Boung 2), when the EDL grid is extended to the project sites.

On the other hand, according to EDL’s plan, the EDL grid will extend to Long district in 2008, where the Nam Long project site is located. In addition, EIRR and FIRR of the Nam Long project shows good performance, and thus can be selected as one of the priority projects. In the case of Nam Ham, there is sufficient energy demand even before the connection with the EDL grid.

(2) Priority Projects of the Off-grid Type

Unlike the Grid type projects, all of the Off-grid type projects are financially not feasible. Accordingly, priority projects were selected with the emphasis on economic feasibility as well as socio-economic conditions of the project sites. In addition, if there are cheaper alternative energy source in a project site, the hydropower project is removed from consideration.

Selected Projects (Off-grid Type)

Priority Projects	Nam Ou Neua (260 kW: Phongsaly province), Nam Likna (30 kW: Phongsaly province)
Candidate Projects	Nam Chong (50 kW: Bokeo province), Nam Xeng (110 kW: Luangprabang province)
Excluded Projects	Nam Xan 3 (80 kW: Xiengkhuang province), Nam Hat 2 (120 kW: Bokeo province)

Reasons for Selection

Out of 6 Off-grid type projects, Nam Xan 3 and Nam Hat 2 are excluded from the list, because the grid extension has been selected as the least cost alternative. Of the remaining 4 projects, Nam Ou Neua (EIRR: 11.77%) and Nam Likna (10.54%) have been selected as priority projects, because the EIRR of these projects exceeds the cost of capital in the country (10%). While the EIRR of Nam Chong (9.42%) and Nam Xeng (7.19%) are below 10%, these projects are cheaper than diesel generator grid as well as grid extension, and consequently those projects are judged still worth implementation.

The priority projects (Nam Ou Neua and Nam Likna) are located in Gnot Ou and Sampanh districts in Phongsaly province, respectively. According to the National Poverty Eradication Program (NPEP), those districts were selected, not only as poor districts, but also as priority development districts. In addition, a village socio-economic survey has revealed that they have potential industry using electricity. It is hoped that the electrification will remove poverty in these districts. When focusing on poverty alleviation, the poorer district of Nam Ou Neua should be selected as the highest priority project. And if higher affordability and willingness to pay are regarded as important, Nam Likna should be selected as one of the higher priority projects.

Nam Ou Neua (Installed Capacity: 260 kW, Electrified Household: 1,239)

After the completion of Na Ou Neua hydropower station, electricity will distribute to district center of Gnot Ou district and its vicinities. According to the village socio-economic survey, 95% of households in the district center earn their primal income from agriculture (such as paddy rice, maize, and cassava)[*17]. The survey also revealed that 31.7% of household are regarded as poor household, which is higher than average of 8 sites (25.9%). Gnot Ou is designated as one of the poor district, and regarded as priority area for poverty alleviation. Of six village heads interviewed, four village heads showed strong desire for electric pumping irrigation (Gnot Ou is the only sites among the surveyed sites, where hoping electric pumping irrigation). And they are planed to irrigate 141 ha in wet season and 181 ha in dry season. After the electrification, it is hoped that execution of pumping irrigation using surplus energy during day time, and subsequent increase in the production volume and then reduction of poverty.

[17] In the study area, majority of households (89.4%) have land for agriculture. However, since the all or some of the harvests are for captive consumption, their income source is not necessarily agriculture. In reality, only 37.8% of households cited agriculture as primal income source.

Nam Likna (Installed Capacity: 30 kW, Electrified Household: 216)

When completed Nam Likna hydropower station will supply electricity to district center of Sampanh in Phongsaly province. As same as Gnot Ou, Sampanh is designated as one of the poor district, and regarded as priority area for poverty alleviation. Even though, according to the village socio-economic survey, poverty ratio in the district center is as low as 8.3%. Willingness to pay for connection fee and electricity tariff is higher than other surveyed sites. There is no access road, thus nothing but to access by boat. Currently, un-paved access road is under construction with financial help from the American Embassy. The 8m width road is scheduled for completion in the end of 2006.

In the case of Hat Sa village where is situated up stream of the Nam Ou River and has access road, there are lot of households earn their living by fetching sand from the Nam Ou River by using diesel generators. The sand is dried then sold to building constructor through access road. After the electrification, it is hoped that same kind of industry using electric pump will developed in Sampanh.


Sand Fetching in Hat Sa Village

4.8 CDM APPLICATION ON SMALL-HYDRO

4.8.1 CURRENT CDM SITUATION AND POTENTIAL IN LAO PDR

(1) Outlines

Lao PDR ratified the Kyoto Protocol as “accession” level on February 6, 2003 and is categorized non Annex I country which has no obligation to reduce greenhouse gas (GHG). Science Technology and Environment Agency (STEA) is in charge of CDM operation concerned under president’s office in Lao PDR. STEA has two functions; one is administrative function on environment, science and technology, intellectual property, another function is research institute on environment, science and technology.

Lao PDR has plentiful potential of water resource which estimates 18,000 to 26,000 MW on hydropower generation, except mainstream of Mekong River. However, 90% of domestic energy provided with firewood whose amount is 4.38 million m^3 and is increased 3% per year. In order to mitigate the firewood consumption, Lao government has therefore investigated the availability of small-hydro and solar-power in mountainous area which is in demand the firewood for the daily life. MIH in charge of domestic electricity supply has expectation the foreign assistance to implement the off-grid electrification.

So far, New Energy and Industrial Technology Development Organization (NEDO) and New Energy Foundation (NEF) have studied and concerned the CDM potential on development of energy source in Lao, however, there is no project implemented until now.

(2) CDM Application for Sustainable Operation on Hydropower Project

Main problem to obstacle the implementation of hydropower project is raising the initial project cost and operation and maintenance cost. Previous small-hydro projects supported by international organization were only funded the initial construction cost. Then, most of the projects were spoiled due to the breakdown of equipment.

Taking the above into consideration, CDM can assist to convey the new income "as reward of GHG emission reduction" to small-hydro project. The income is different from tariff. Accordingly, CDM application is expected to assist the sustainable implementation of small-hydro project.

To utilize the ODA fund for CDM project, Marrakesh accord (Decision 17/CP.7, preamble) mentioned as follows:

"… public funding for clean development mechanism projects from Parties in Annex I is not to result in the diversion of official development assistance and is to be separate from and not counted towards the financial obligations of Parties included in Annex I".

Accordingly, it is necessary for CDM project to confirm the ODA diversion that budget for ODA is not diverted to CDM without any additional fund and is not contained financial budget of Annex I country.

In the Project Design Document (PDD), the following descriptions shall be mentioned to take approval (1) donor country shall mention that project budget is not diverted from ODA fund and (2) host country shall approve the CDM project with their own approval process. Development Assistance Committee (DAC) in Organization for Economic Cooperation and Development (OECD) decided that result of ODA shall be deducted CER in case of utilizing the ODA budget.

4.8.2 CDM APPLICATION ON SMALL-HYDRO

To utilize the Kyoto Mechanism effectively, the study investigated the application of CDM on small-hydro project which reduce the greenhouse gas (GHG).

Firstly, it is necessary to confirm what kind of existing energy can be replaced by CDM project for the selected 11 projects.

Five (5) grid hydropower projects consists of the following projects: (1) replace the existing power source coming from neighboring country such as Thailand, Vietnam and China through national grid, or (2) strengthen the Lao national grid through newly constructed transmission line. Nam Boune 2 and Nam Long projects are planned to replace the existing hydropower project, GHG emission reduction is therefore zero due to same baseline. Both projects were not applicable to CDM project. Meanwhile Nam Sim is going to replace the imported electricity from Vietnam, however Lao national grid expansion to Nam Sim area will be completed at the same time of the commencement of generation. Baseline of Nam Sim project is regarded as same as Lao national grid which is mostly supplied from hydropower. Accordingly, it is difficult to recognize the Nam Sim project as CDM candidate due to low combined margin emission factor.

Nam Gnone and Nam Ham 2 projects are going to replace the Thailand import energy. Both projects are going to reduce fossil fuel in Thailand. They are regarded as good candidate of CDM application and have no plan to expand Lao national grid like Nam Sim project.

Meanwhile, the existing energy conditions of off-grid projects are going to replace fossil fuel "diesel oil". Therefore, off-grid small-hydro projects can contribute to reduce GHG by project implementation and are regarded as CDM candidates.

No.	Grid connection	Project	Existing energy source	Installed capa.[MW]	CDM application
1	Ongrid	Nam Boune 2	Hydro, domestic	4.00	NO
2		Nam Long	Hydro, domestic	2.50	NO
3		Nam Gnone	Import, Thailand	0.60	YES
4		Nam Sim	Import, Vietnam	8.00	NO
5		Nam Ham 2	Import, Thailand	1.00	YES
6	Off-grid	Nam Likna	Diesel, domestic	0.03	YES
7		Nam Ou Neua	Diesel, domestic	0.26	YES
8		Nam Chong	Diesel, domestic	0.05	YES
9		Nam Hat 2	Diesel, domestic	0.12	YES
10		Nam Xeng	Diesel, domestic	0.11	YES
11		Nam Xan 3	Diesel, domestic	0.08	YES

According to the above table, two on-grid projects and six off-grid projects were selected to study the CDM applicability. These eight projects have installed the generations are less than 15 WM and recognized as "small scale CDM".

4.8.3 CALCULATION OF GHG EMISSION REDUCTION

(1) Baseline Calculation on On-grid Project

Both Nam Gnone and Nam Ham 2 projects are going to replace the import electricity from Thailand. Baseline scenario is therefore regarded as the existing import electricity.

For instance, baseline emission of Nam Ham 2 which will replace import electricity from Thailand, was calculated using the procedure "Appendix B of the simplified modalities and procedures for CDM small-scale project activities - category I. D "Renewable electricity generation for a grid", provided by CDM EB. In this process, there are two ways to calculate GHG emission factor as follows:

(a) The average of the "Approximate Operating Margin (OM) emission factor" and ""Build Margin (BM) emission factor"

(b) The weighted average emission of the current generation mix

Taking the available information disclosed into consideration, (a) "the average of OM and BM" was applied to calculate the baseline emission which consists of four (4) steps mentioned below.

Steps	Contents
1	Calculate the OM emission factor
2	Calculate the BM emission factor
3	Calculate the baseline emission factor
4	Calculate baseline emission reductions

STEP 1：Calculate the Operating Margin (OM)

Operating Margin (OM) emission factor is defined as the generation-weighted average emissions per electricity unit of all generating source serving the system, not including low-operating cost and must run power plants.

Normally, it is desirable to estimate OM emission factor using actual generation data from dispatch center. Therefore, actual Thailand grid data from 2001 to 2003 disclosed and IPCC default value were used to calculate OM emission factor. The following table presents the calculation of year 2001:

Calculations for the Project using 2001 Thai grid data

Type of fuel	Fuel consumption [original]	Net calorific value [TJ/kt]	Electricity generated [GWh]	Fuel consumption [TJ]	Carbon emission factor [tC/TJ]	Oxidation factor [--]	Grid emission [tCO2]	CEF [tCO2/MWh]
Hydropower	---	---	9,196	---	---	---	0	
Natural gas	1,681 MMSCFD	52.30	70,280	13,440	15.3	0.995	39,235,014	0.56
Heavy Oil	783 Mliters	40.19	3,146	760	21.1	0.990	2,337,979	0.79
Diesel oil	46 Mliters	43.33	155	39	20.2	0.990	124,229	0.80
Lignite	15.24 Mtons	12.14	17,307	15,400	27.6	0.980	18,541,548	1.07
Coal, import	0.99 Mtons	26.38	2,475	996	26.8	0.980	2,531,106	1.02
Renewable E			597	---	---	---	0	
Import, Malaysia			9	---	---	---	---	
Total (less least/ must run)			93,363	30,635				
Grand total			103,165				62,769,876	0.65

Remarks : CEF abbreviates Carbon Emission Factor.

From the above table, OM emission factor of Thailand grid in 2001 is estimated 0.65 [tCO2/MWh]. As the same manner, results of 2002 and 2003 are estimated 0.60 [tCO2/MWh] and 0.63 [tCO2/MWh] respectively. Accordingly OM emission factor was calculated **0.63 [tCO2/MWh]** with the average of the Thailand's recent three years data.

STEP 2：Calculate the Build Margin (BM)

Build Margin (BM) emission factor can be decided with the larger generation of "the 5 most recent power plants" or "most recent 20% of power plant". According to the Thailand case, both results show as follows:

The five most recent power plants

Plant name	Plant type	Commencement	Installed capa. [MWh]
SRT GT #1-2	Diesel	May 2001	3,435
RB CC #1-3	Natural gas Diesel	Apr 2002	11,761,691 22,091
Bowin	Natural gas	Jan 2003	3,216,497
EPEC	Natural gas	Mar 2003	1,469,755
KA TH #1	Heavy oil	Feb 2004	144,755
Total			16,618,134

Most recent 20% of power plants

Plant name	Plant type	Commencement	Installed capa. [MWh]
RB TH #1-2	Natural gas Diesel	Oct 2000	6,435,337 552,213
SRT GT #1-2	Diesel	May 2001	3,435
RB CC #1-3	Natural gas Diesel	Apr 2002	11,761,691 22,091
Bowin	Natural gas	Jan 2003	3,216,497
EPEC	Natural gas	Mar 2003	1,469,665
KA TH #1	Heavy oil	Feb 2004	144,755
Total			23,605,684

From the above tables, data of most recent 20% of power plant (23,605,684[MWh]) is larger than the five most recent power plants (16,618,134[MWh]). Based on data of most recent 20% of power plant, the BM emission factor "**0.61 [tCO2/MWh]**" was estimated with IPCC default value.

STEP 3：Calculate the Baseline Emission Factor

Baseline emiossion factor is calculated with the average of OM and BM emission factors as follows:

Baseline emission factor [tCO2/MWh] = (OM emission factor + BM emission factor) / 2
= (0.63 + 0.61)/ 2 = 0.62 [tCO2/MWh]

STEP 4：Calculate the Baseline Emission

Baseline emission of Nam Ham 2 is calculated with the above result and annual generation of Nam Ham 2 hydropower plant.

Baseline emission [tCO2/year] = Baseline emission factor [tCO2/MWh] x annual generation of Nam Ham 2 [MWh]
= 0.62 x 5,794 = 3,592 [tCO2/year]

(2) Project Emission and Leakage of Grid Project

Generally construction of hydropower plant needs not only large area but large amount of concrete to construct it, therefore project emission and leakage shall take account for GHG emission calculation.

＜Project Emission＞

(i) Methane emission from turbine, (ii) Loss of sink, (iii) Methane emission from reservoir

＜Leakage＞

(i) CO2 emission due to cement production, (ii) CO2 emission due to transportation from factory to project site

All the hydropower projects planned in the study are run-of-river type and small scale hydropower (less than 15 MW). According to the CDM rule, GHG emission "project emission" inside project boundary is not taken care. In addition to the above, factor of leakages can be also negligible because it will emit temporary "CO2 emission due to transportation" and its amount is very small "CO2 emission due to cement production". Accordingly, both project emission and leakage are not taken into account of.

(3) Baseline Calculation on Off-grid Project

Off-grid hydropower project is aiming at electrification of un-electrified villages. If the off-grid hydropower project will not be implemented, the diesel power generation will be promoted to use like a few villages electrified by diesel power already. Off-grid project will therefore reduce GHG emission from diesel generation by CDM application.

For instance, baseline emission of Nam Ou Neua which will replace diesel generation was calculated using the procedure "Appendix B of the simplified modalities and procedures for CDM small-scale project activities - category I. A "Renewable electricity generation by the user", provided by CDM EB. In this process, there are two ways to calculate GHG emission factor as follows:

(a) $E_B = \Sigma_i (n_i \times c_i) / (1 - l)$

(b) $E_B = \Sigma_i Q_i / (1 - l)$

E_B : annual energy baseline in kWh per year
Σ_i : the sum over the group of "i" renewable energy technologies
n_i : number of consumers supplied by installations of the renewable energy technology belonging to the group of "i" renewable energy technologies during the year.
c_i : estimate of average annual individual consumption observed in closet grid electricity systems among rural grid connected consumers belonging to the same group of "i" renewable energy technologies.
Q_i : the estimated annual output of the renewable energy technologies of the group of "i" renewable energy technologies installed (in kWh per year)
l : average technical distribution losses

In this case, all the area to be off-grid-electrified, it is expected that the diesel generation would be under utilized. Baseline emission factor is estimated easily with IPC default value 0.9 [kg-CO2/kWh]. Ways of baseline calculation is presented below.

Baseline emission [tCO2/year] = Baseline emission factor x Installed capa. of Nam Ou Neua
[tCO2/MWh] [MWh]
= 0.90 x 1,026 = **924 [tCO2/year]**

(4) Project Emission and Leakage of Off-grid Project

As the same manner of ongrid project, off-grid hydropower project is also anxious for project emission and leakage. All the hydropower projects in this study are categorized run-of-river type and small scale CDM. Therefore, it is negligible to estimate project emission and leakage which emits CO2 by cement production and cement conveyance.

(5) Effect on GHG Emission Reduction

Calculation results of the planned 11 projects in the study are presented below. To estimate the CDM income selling CER with conversion rate " 5.0 USD/t-CO2 " .

Project name	Installed capa. [MW]	Annual generation* [MWh]	CO2 emission reduction [t-CO2/年]	CER [USD]	CO2emission reduction per construction cost [USD/t-CO2]	Rank [among same category]
Ongrid						
Nam Boune 2	4.00	25,500	---	---	---	---
Nam Long	2.50	15,269	---	---	---	---
Nam Gnone	0.60	2,669	1,655	8,273	810	2
Nam Sim	8.00	31,673	---	---	---	---
Nam Ham 2	**1.00**	**5,794**	**3,592**	**17,960**	**600**	**1**
Off-grid						
Nam Likna	0.03	106	85	423	4,398	6
Nam Ou Neua	**0.26**	**1,026**	**821**	**4,106**	**3,175**	**1**
Nam Chong	0.05	119	95	475	3,429	4
Nam Hat 2	0.12	457	366	1,830	3,503	2
Nam Xeng	0.11	416	332	1,662	4,575	5
Nam Xan 3	0.08	293	234	1,171	3,463	3

Remarks : * Loss of generation was deducted from annual generation.
** Nam Boune 2, Nam Long, Nam Sim are not satisfied with criteria of CDM application, therefore they were excluded from calculation of GHG emission reduction.

From the above table, Nam Ham 2 project in grid and Nam Ou Neua project in off-grid are the most effective projects in each category.

For Nam Ham 2 and Nam Ou Neua hydropower projects, draft Project Design Document (PDD) were prepared.

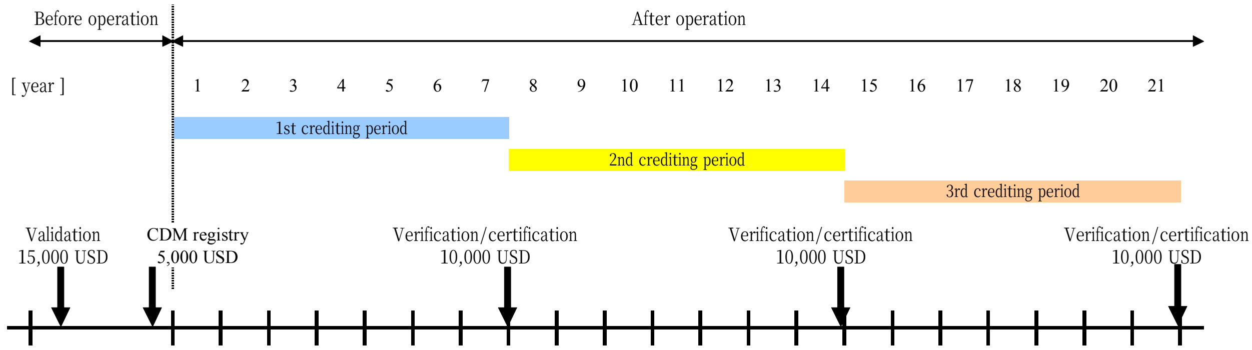
4.8.4 FINANCIAL ANALYSIS ON CDM APPLICATION

(1) Necessary cost for CDM application

When CDM is applied to not only for small-hydro project but for others, the CDM effect can be measured by financial analysis. In order to apply the CDM to the hydropower project, some excesses have to be taken account for. The following expenditures "transaction cost" are estimated with average cost with DOE interview and so on.

- validation cost : 15,000 USD
- CDM registry cost : 5,000 USD, except Nam Sim project
- verification/certification cost : 10,000 USD, once in seven years

Transaction cost will be born at the following timing and totally estimated approximately 50,000 USD.



(2) Financial Analysis

In the previous Chapter 4.10.2, Nam Long project is not satisfied with condition of CDM application. Therefore financial analysis was carried out for the three projects: Nam Ham2, Nam Ou Neua and Nam Likna.

According to Japan Kyoto Mechanisms Acceleration Program (JKAP) which is established to realize the effective CDM application, up-front payment which pays for CER in advance can be available to assist the project finance. Therefore financial analysis carried out the three (3) cases: without CDM case, with CDM and without up-front payment case, and with CDM and with up-front payment case, on the assumption of 21 years project period. When up-front payment is utilized, the project developer can acquire 50% of CER credit at the commencement of construction period.

Analysis of CDM Application

Projects	Nam Ham 2		Nam Ou Neua		Nam Likna		Ou Neua + Likna	
	FIRR	NPV	FIRR	NPV	FIRR	NPV	FIRR	NPV
Base case, without CDM	11.44%	---	-6.87%	---	-8.08%	---	-7.00%	---
With CDM credit (w/o up-front payment)	12.38%	+115,154	-6.42%	+6,951	-9.33%	-19,695	-6.57%	+10,225
With CDM credit (w/ 50% up-front payment)	13.36%	+200,400	-6.59%	+24,996	-9.54%	-21,554	-6.70%	+30,128

Source : JICA study team

For Nam Ham 2 project, FIRR is increased 0.94% to 1.92%, and NPV with 10% discount rate is also increased 115,154 to 200,400 USD. For Nam Ou Neua project, profitable conditions can be slightly improved, on the other hand case of Nam Likna get worse (negative) due to unbalance of transaction cost and CDM income.

Taking the bundling method of small scale CDM rule into consideration, both off-grid projects "Nam Ou Neua and Nam Likna" are regarded as one project. According to the table, the result of financial analysis on both off-grid projects gets indicates the improvement with deduction of the burden of transaction cost.

4.8.5 PREPARATION OF PROJECT DESIGN DOCUMENT (PDD)

(1) Contents of PDD

To prepare PDD, the small scale CDM was applied because all the installed capacities of 11 hydropower projects are less than 15 MW. Items to be mentioned in PDD are described below, as a part of Supporting Data Files (PART F).

A : General description of the small-scale project activity Title of the project, project participants, location of the project activity, type and category of the project activity, brief explanation of how the GHG to be reduced, public funding, confirmation of unbundling, etc.
B : Application of a baseline methodology Type and category of project activity, additionality, barriers, project boundary, details of baseline, etc.
C : Duration of the project activity/ crediting period Starting date and crediting period of project activity, etc.
D : Application of a monitoring methodology and plan Name and reference of monitoring methodology, data to be monitored, name fo person/entity determining the monitoring methodology etc.
E : Estimation of GHG emissions by sources Formulae used, table providing values obtained when applying formulae etc.
F : Environmental Impacts Documentation on the analysis of the environmental impacts of the project activity, if required by the host party.
G : Stakeholders' comments Brief description of how comments by local stakeholders, summary of comments received, report on how due account was taken of any comments received.
Annex 1 : Contact information on participants in the project activity Project participants, Address, person in charge etc.
Annex 2 : Information regarding Public Funding

(2) Outlines of PDD on Grid Project

As grid connection project, Nam Ham 2 project was selected. Outlines of PDD draft is presented table below.

Project site	Houaphan province, Viengxay district
Outline	Renewable electricity generation (run-of-river type hydropower) project for replacement of import electricity from Vietnam. Installed capacity：1.00 [MW], Annual effective generation：5,794 [MWh]
Type of CDM activity	Type：I Renewable Energy Projects D Renewable electricity generation for agrid
Barriers	Budget shortage/policy barrier: Nam Ham2 will construct to replace import electricity from Thailand. Power demand of Thailand is increasing 7% per year based on Thailand Power Development Plan, 2004-2015 prepared by EGAT, and increasing portions are thermal power plant of natural gas and coal. Therefore, it is expected to increase the Thailand's power demand in the future. To avoid the import electricity is expansion of Lao national grid, however, Lao government does not have enough budget make political decision at this moment. Accordingly, GHG emission is going to increase unless Nam Ham 2 is constructed.
Project boundary	Nam Ham2 power house, newly constructed transmission lines and national grid of Thailand
Leakages	Not applicable
Project Emissions	Not applicable
Data to be monitored	Electricity generation of the project delivered to the grid (unit：MWh, measure, recording frequency : monthly, period of data archiving : 2 years after verification)
Calculation of GHG emission reduction	1) calculation of carbon emission factor with average emission factor of OM and BM 2) calculation of GHG emission reduction with carbon emission facto and annual effective generation.
GHG emission reduction	3,592 [t-CO2/year]

(3) Outlines of PDD on Off-grid Project

As off-grid connection project, Nam Ou Neua project was selected. Outlines of PDD draft is presented table below.

Project site	Phongsaly province, Gnod Ou district
Outline	Renewable electricity generation (run-of-river type hydropower) project for replacement of diesel generation Installed capacity：0.26 [MW], Annual effective generation：1,140 [MWh]
Type of CDM activity	Type：I Renewable Energy Projects A Electricity generation by the user
Barriers	Budget shortage/policy barrier: Most off-grid project is located mountainous area and a remote corner of the country, it is therefore difficult to expand the national grid to there. In case of grid expansion, it is required to construct transmission line and so on with additional expense. On the other hand, amusement facilities such as television, radio etc. are spread among the mountainous area, and they are operating with diesel fuel generation. That is why fuel demand in there is going to increase in the future. Accordingly, GHG emission is going to increase unless Nam OuNeua is constructed.
Project boundary	Nam Ou Neua power house and newly constructed transmission line
Leakages	Not applicable
Project Emissions	Not applicable
Data to be monitored	Electricity generation of the project delivered to the grid (unit：MWh, measure, recording frequency : monthly, period of data archiving : 2 years after verification)
Calculation of GHG emission reduction	Based on the default value 0.9 [kgCO2/kWh] which is referred to type I A. Electricity generation by the user in UNFCCC Appendix B of the simplified modalities and procedures for small-scale CDM project activities, GHG emission reduction is calculated with annual generation [kWh].
GHG emission reduction	924 [t-CO2/year]

4.8.6 SUGGESTION OF EFECTIVE CDM APPLICATION

As a one of the countermeasure of global warming, applicability of CDM on hydropower project was investigated. It means whether CER contributes to the financial condition or not. However expense by transaction cost disturbs the CDM improvement. To prevent the obstacles, effective applications of CDM are presented below.

(1) Suggestion for Cost Reduction in terms of Transaction Cost

Main transaction cost is DOE cost concerned such as validation, verification etc,, and other expenses are preparation cost for CDM registration fee and so on.

Category	Outlines	Items
Search cost	Cost for identification/survey of the prospective CDM project by project developers and investors.	Site survey cost Selection cost for DOE etc.
Negotiation cost	Cost for negotiation activities to reach mature agreement between developers - investors, developers - local communities relating to the CDM activities.	Negotiation cost for CDM project participants, workshop cost etc.
Approval cost	Cost for the activities relating to the DNA approval from host/donor countries.	DNA approval cost, preparation cost for DNA application form etc.
Design cost	Cost for PDD preparation activities, such as site survey, EIA study etc.	PDD preparation cost etc.
Enforcement cost	Cost for legal activities, such as law suit, engaging the lawyer etc.	Cost for lawsuit and legal procedure etc.
Insurance cost	Cost for compensation for local community and admission fee for insurances to avoid accidents etc.	Land acquisition, forest fire insurance etc.
DOE cost	Cost for implementation the validation and verification by DOE etc.	Validation cost, verification cost etc.
Monitoring cost	Cost for identification the baseline/project emission based on their scenario etc.	Cost for above-ground biomass, dead wood litter measurements etc.

In accordance with the above items, reduction idea can be utlized as follows:

Problem	Idea
In case of feeling misgivings of extra cost for validation etc.	To grasp DOE requirement in advance: Due to misunderstanding and insufficient understanding of the CDM rules, DOE work volume shall be increased. As a result, transaction cost shall also be increased. Preliminary understanding can reduce the extra expenses of the project.
In case of feeling misgivings of stakeholder's objection etc.	To establish mature relationship with local community: In the pre-survey stage, the project participants shall announce the CDM project and its activities to local community through local workshop etc. With negligence, it is expected to have accidents and troubles between project developer and local community. As a result of the good situation, additional expenses for lawsuit will be increased tentatively. However project participants will save extra expenses totally.
In case of feeling misgivings of cost reduction	To utilize the local power/cooperation: To hire the local staff/consultant can reduce the project expenses totally. According to the EB19 (May 2005) "Unilateral CDM", non-Annex I countries can promote CDM by themselves until CDM project registration. So non-Annex I countries has opportunity to deal with a CER as export goods. Accordingly, it is expected that transaction cost can be reduced through unilateral CDM.

(2) Suggestion for Cost Reduction in terms of CDM Application

Except the direct cost for CDM procedure, other reduction idea can be utilized as follows:

Problem	Idea
In case of some similar projects and small GHG emission etc.	To execute bundling: As a merit point of small scale CDM, it is approved that plural/similar CDM can be bundled. With this idea, CDM cost such as transaction cost can be reduced effectively.
In case of simplifying the CDM process and saving the extra cost.	To execute small scale AR-CDM: To utilize the features of small scale AR-CDM, such as application approved methodology on small scale AR-CDM, it is expected the project cost to reduce.
	To utilize the default values in monitoring stage: There are many authorized default value. To reduce the time and cost, default values shall be utilized as much as possible. Positive utilizations of the said incentives are good clues to implement the CDM economically.
	To utilize the approved methodology: It takes long time and cost to establish the new methodology and monitoring method. So the best way to save time and cost is utilized approved methodology/monitoring method as much as possible. Then the project will not only save the budge but refrain the extra expenses.

4.9 ENVIRONMENTAL IMPACT ASSESSMENT

4.9.1 INTRODUCTION

The development of the Pre-F/S sites proposed should follow the Environmental Impact Assessment System of Laos, as well as the JICA Guidelines for Environmental and Social Consideration (2004) because the Study in funded by JICA. Outlines of both the Environmental Impact Assessment System in Lao PDR and the JICA Guidelines for Environmental and Social Consideration are summarized in the tables in the following sections.

4.9.2 ENVIRONMENTAL IMPACT ASSESSMENT SYSTEM IN LAO PDR

(1) Legislative Framework for Environmental Impact Assessment in Laos

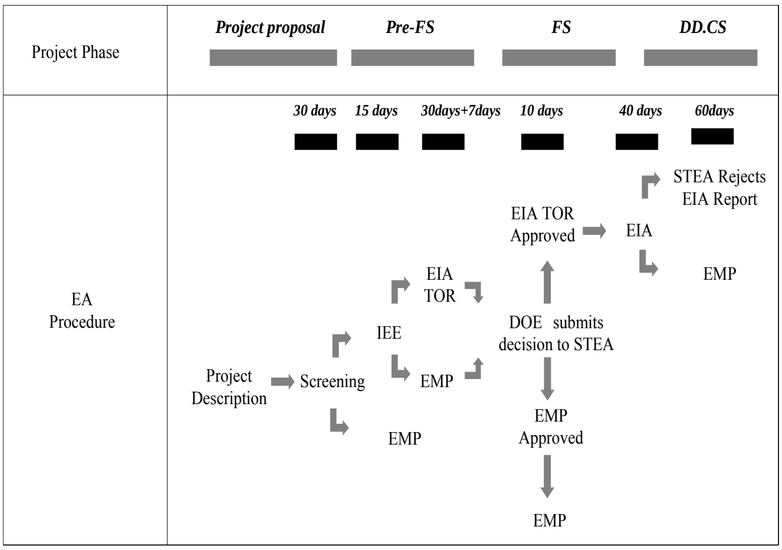
The table below shows the laws and guidelines relevant to procedure and requirement of environmental impact assessment for electricity projects in Lao PDR.

Relevant Laws and Guidelines Regarding EIA for the Power Sector in Lao PDR

No	Name	Date
1	Electricity Law	April 1997
2	Environmental Protection Law	April 1999
3	Decree on the Implementation of the Environmental Protection Law	April 1999
4	Regulation on Environmental Assessment in the Lao PDR	October 2000
5	Regulation on Implementing Environmental Assessment for Electricity Projects in Lao	November 2001
6	Environmental Management Standard for Electricity Projects	Jun 2003
7	Power Sector Environmental Policy	October 2001
8	Forestry Law	October 1996
9	Land Law	April 1997
10	Road Law	April 1999
11	Water and Resources Law	October 1997

(2) Procedure of Environmental Impact Assessment

According to "Regulation on Implementing Environmental Assessment for Electricity Projects in Lao PDR (November 2001)", the environmental impact assessment process for the power sector in Lao PDR is regulated as following.



Environmental impact assessment process for electricity sector in Lao PDR

4.9.3 JICA GUIDELINES FOR ENVIRONMENTAL AND SOCIAL CONSIDERATION

A project is categorized into three categories according to the JICA Guidelines for Environmental and Social Consideration as shown in the table below.

Project category of JICA guidelines for environmental and social consideration

Category	Project
A	Projects are classified as Category A if they are likely to have significant adverse impacts on the environment and society. Projects with complicated impacts or unprecedented impacts, which are difficult to assess or which have a wide range of impacts or irreversible impacts, are also classified as Category A. Projects are also classified as Category A if they require a detailed environment impact assessment by environmental laws and the standards of the recipient governments. The impacts may affect an area broader than the sites or facilities subject to physical construction. Category A, in principle, includes projects in sensitive sectors (i.e., characteristics that are liable to cause adverse environmental impact) and projects located in or near sensitive areas.
B	Projects are classified as Category B if their potential adverse impacts on the environment and society are less adverse than those of Category A projects. Generally they are site-specific; few if any are irreversible; and in most cases normal mitigation measures can be designed more readily.
C	Projects are classified as Category C if they are likely to have minimal or little adverse impacts on the environment and society.

Source: JICA Guidelines for Environmental and Social Consideration

The outline of the environmental and social consideration for the project categorized as A or B is summarized as follows.

Outline of Environmental and Social Consideration for a Project Categorized as Category A or B (M/P)

1. JICA involves a member(s) for environmental and social considerations in study teams for Category A and B studies;
2. JICA collects relevant information and conducts field surveys covering a wider area than that of the preparatory study stage, holds consultations with the recipient governments, and prepares drafts of scoping;
3. For Category A studies, JICA consults with local stakeholders in collaboration with the recipient governments after disclosure of drafts of scoping, and incorporates results of consultation into TOR. The consultation widely covers the needs of projects and the analysis of alternatives. For Category B studies, JICA consults with local stakeholders in collaboration with the recipient governments after the disclosure of drafts of scoping when necessary;
4. The TOR includes an understanding of needs, the impacts to be assessed, study methods, an analysis of alternatives, a schedule and other matters. JICA endeavors to incorporate the concept of Strategic Environmental Assessment into such studies. JICA then obtains an agreement on the TOR with the recipient governments through consultations;
5. In accordance with the TOR and in collaboration with the recipient governments, JICA conducts IEE-level environmental and social considerations studies, and analyzes alternatives including a “without project” situation. During studies, JICA incorporates its results into related reports prepared in a process accordingly;
6. For Category A studies, when preparing a rough outline of environmental and social considerations, JICA holds a series of stakeholder consultations in collaboration with the recipient governments after information disclosure and incorporates the result of consultation into these studies. For Category B studies, JICA consults with local stakeholders after information disclosure in collaboration with the recipient governments, when necessary;
7. Based on the above-mentioned procedure, JICA prepares drafts of the final reports incorporating results of environmental and social considerations studies, and explains them to the recipient governments to obtain their comments. For Category A studies, JICA discloses the drafts to and consults with local stakeholders in collaboration with the recipient governments, and incorporates the results of that consultation into the final reports. For Category B studies, JICA consults with local stakeholders in collaboration with the recipient governments after disclosure of drafts of the final reports when necessary;
8. JICA prepares final reports incorporating results of study, and submits them to the recipient governments after confirming that the reports meet the requirements of the guidelines; and
9. JICA discloses final reports promptly after their completion, on its website and at the JICA library and a relevant overseas office.

Source: JICA Guidelines for Environmental and Social Consideration

4.9.4 OUTLINE OF ENVIRONMENTAL IMPACT ASSESSMENT

(1) Screening of Pre-F/S Projects

The results of screening of the Pre-F/S sites are shown in the table below.

The system of screening based on Environmental Impact Assessment in Laos PDR was conducted by DOE by reviewing the project description. Although there are no official criteria for screening in Laos, DOE judged the IEE requirements based on whether the installed capacity is over 500kW or not, except for the projects which cause serious environmental impacts such as involuntary resettlement.

It was judged that IEE is not required for the Pre-F/S projects less than 500 kW, because they are not located within an environmental protected area nor cause involuntary resettlement.

On the other hand, screening in accordance with JICA Guidelines for Environmental and Social Consideration was conducted based on project categorization judged by the JICA Environmental and Social Considerations Section. All projects were identified as requiring IEE-level environmental and social considerations studies, as they are all categorized as Category B.

No	Project Name	Capacity (kW)	Requirement of IEE	
			Laos	JICA
1	Nam Boun2	2000-4000	○	○ (B)
2	Nam Ou Neau	200	×	○ (B)
3	Nam Long	2500	○	○ (B)
4	Nam Gnone	500	○	○ (B)
5	Nam Hat 2	120	×	○ (B)
6	Nam Xeng	110	×	○ (B)
7	Nam Ham 2	800-2000	○	○ (B)
8	Nam Xan	80	×	○ (B)
9	Nam Likna	30	×	○ (B)
10	Nam Chong	50	×	○ (B)
11	Nam Sim	2000-6000	○	○ (B)

Result of Screening ○: IEE is required, ×: IEE is not required

(2) Outline of IEE

The results of IEE conducted are summarized as follows.

The table below shows the survey items and their corresponding chapters in the Supporting Data Filess (Supporting Data Files-D Draft Report on Initial Environmental Examination for Laos PDR, Supporting Data Files-E Rough Outline of Environmental and Social Considerations for Development Study (M/P or FS) for JICA).

Survey Items conducted in IEE

Survey Items	Corresponding Chapter in the Supporting Data Filess	
	Draft Report on Initial Environmental Examination	Rough Outline of Environmental and Social Considerations for Development Study (M/P or FS)
Outline of the Project	Chapter 1 Introduction	3.Outline of the Project
Overall Environmental and Social Condition on the Project Area	Chapter 4 Description of the Social Environment Chapter 5 Description of the Natural Environment	4. Overall Environmental and Social Condition on the Project Area

Survey Items	Corresponding Chapter in the Supporting Data Filess	
	Draft Report on Initial Environmental Examination	Rough Outline of Environmental and Social Considerations for Development Study (M/P or FS)
Adverse Environmental and Social Impacts	Chapter 6.1 Impact Matrix and EIA necessity	5. Adverse Environmental and Social Impacts
Evaluation of Alternatives	Chapter 3 Study of Alternatives	6.Key Impacts Identified and Mitigation
Key Impacts Identified and Mitigation	Chapter 6.2 Possible Mitigation Strategy Chapter 6.3 Environmental Management Plan	7.Analysis of Alternatives(including without project option)
Public Consultation	Chapter 7 Public Involvement	8.Consultation

The details of the study are explained in Supporting Data Files-D and -E, while their summaries are as follows.

(i) Outline of the Project

All proposed Pre-F/S projects are run-of-river schemes and small-hydro projects. The installed capacities range from 30 to 8,000 kW. Project components are the intake, waterway, power station, transmission line and access road. Nam Boun 2 project and Nam Sim project are river diversion schemes.

(ii) Overall Environmental and Social Condition of the Project Area

All Pre-F/S projects are located in the mountain forests of northern Laos. There are many villages of ethnic minorities near the project areas. However, involuntary resettlement is not anticipated as a result of the projects. In addition, there are no protected areas in the project sites.

(iii) Adverse Environmental and Social Impacts

The adverse environmental and social impacts differ according to each project. However, the main and common impacts caused by the projects are impacts on water usage such as irrigation or sightseeing of waterfalls, impacts on aquatic biodiversity and disposed soil generation.

(iv) Evaluation of Alternatives

Four options were considered according to various criteria as shown in the following table.

Evaluation of four options

Valuation items	Small-hydro	Alternative option		
		Diesel power	Solar power	Without project
Impact on environment	C	C	B	A
Construction cost	C	B	B	—
Operation and Maintenance cost	B	C	A	—
Project cost per MW	A	B	C	—
Power generation	A	A	C	—
Effective utilization of domestic resources	A	B	B	C
Contribution to the improvement of the electrification level	A	A	B	C

A：no impact, low costs, high power, useful, better contribution
B：relatively negative impact, reasonable costs, moderate power, relatively useful, much contribution
C：negative impact, high costs, low power, less useful, less contribution
— ：no costs, no power generation

A diesel power project is the most likely alternative against a small-hydro project. However, the project cost of diesel power is relatively more expensive than that of small-hydro due to the increasing oil price. Also, diesel power project is less effective in respect of utilization of domestic resources. Therefore, the diesel power alternative was rejected.

Solar power projects are superior to the proposed small-hydro projects in the sense that there is less environmental impact, but power generation is very low (20-40W). As this Study aims to raise the electrification ratio of the district center, the project cost would be highly expensive if the electricity demand of the district center were to be supplied solely by a solar power. Therefore, the solar power alternative was rejected.

The option of no project has no impact on the environment but does not contribute to the improvement of the electrification ratio. Therefore, this option was rejected.

(v) Key Impacts Identified and Mitigation

Since the adverse environmental and social impacts differ according to each project, the mitigation measures differ according to each project. However, the main mitigation measures are as follows.

Riparian flow (maintenance flow) is required in order to ensure water usage such as irrigation or sightseeing of water falls. The muddy water during construction is to be treated accodingly to protect the aquatic biodiversity, while the disposal site for generated soil is to be established far from the residences and rivers.

(vi) Environmental Management Plan

In order to monitor the effectiveness of planned mitigation measures, environmental management plans are proposed. The main items of the environmental management plans are as follows.

To monitor the effectiveness of the installation of the facility to protect against discharging of muddy water, (i) Inspection by DOE or an institution nominated by DOE and (ii) Implementation of water quality surveys by an institution for the operation once per a year, are planned.

(vii) Public Consultation

Workshops were held on two occasions in Vientiane and one in Luanphrabang in order to explain to the stakeholders the project features and the possible environmental impacts foreseen, and to take note of the opinion of the stakeholders. These workshops were held inviting participants from DOE and PDIH of the northern provinces and other concerned parties inviting participants. The general outlines of the Workshops are as follows:

The JICA Study Team would request the Government of Lao PDR to hold public consultations for the local people in the project area for the eleven (11) Pre-F/S studies in line with JICA policy.

Outline of the Workshop

Items	1st Workshop	2nd Workshop	3rd Workshop
Schedule	March 4-6, 2004	March 7, 2005	November 2-3, 2005
Place	EDL hall in Vientiane	EDL hall in Vientiane	Provincial Hall in Luangphrabang
Participants	About 80 participants including central and local government officials, EDL branch office, international agencies (JICA, ADB, WB etc), and other concerned parties.	About 70 participants including central and local government officials, EDL branch office, international agencies (JICA, WB etc), and other concerned parties.	About 100 participants including central and local government officials, EDL branch office, international agencies (JICA, ADB, WB etc), and other concerned parties.
Presentation	Brief explanation of the IEE for the Project.	Study results of IEE for Pre-F/S study.	Importance of IEE at the beginning stage of the projects.

5. CAPACITY BUILDING ON SMALL-HYDRO DEVELOPMENT

5.1 INTRODUCTION

5.1.1 BACKGROUND AND SUBJECT FOR CAPACITY BUILDING

The background on the necessity for capacity building on small-hydro is the Lao national target to raise the national electrification ratio to 90% by 2020 and to contribute to poverty alleviation in the rural mountainous areas where more than 80% of the population resides. The electrification ratio at present is 36% at the national level and 20% in the rural areas, whilst that of the northern eight (8) provinces (61 districts, approximately 5,000 villages and 272,000 households) stands at a mere 15%.

The department in charge of off-grid rural electrification is DOE established 8 years ago, responsible for (i) formulation of a small-hydro development plan, (ii) planning of hydropower schemes utilizing irrigation facilities, and (iii) hydrological investigation entrusted by IPP developers. However, as the department's staff capability is inadequate, the development of their capability is a prerequisite, and capacity building of the DOE engineers has been pledged by the Lao Government.

Another player who should be active in the promotion of efficient rural electrification is PDIH, but their understanding of small-hydro at the moment is very limited.

With the above background, the capacity building of the counterparts was viewed as one of the prime objectives of the Study. Thus, the counterparts targeted for capacity building on small-hydro through this Study were the DOE engineers and the PDIH engineers.

5.1.2 POLICY AND METHODOLOGY OF CAPACITY BUILDING

(1) Policy on Capacity Building

It is believed that the transfer of technology can only become effective when there is an opportunity for the skill to be acquired and only if there is strong will to learn those skills to develop their capacity. In the case of this Study, there is a positive attitude on the part of the Lao counterparts to develop their capacity, and thus the above conditions for capacity building were satisfied. Furthermore, an effective capacity development platform is provided through this Study as it involves lectures and on-the-job training (OJT) where transfer of technology is generally much more effective.

(2) Methodology of Capacity Building

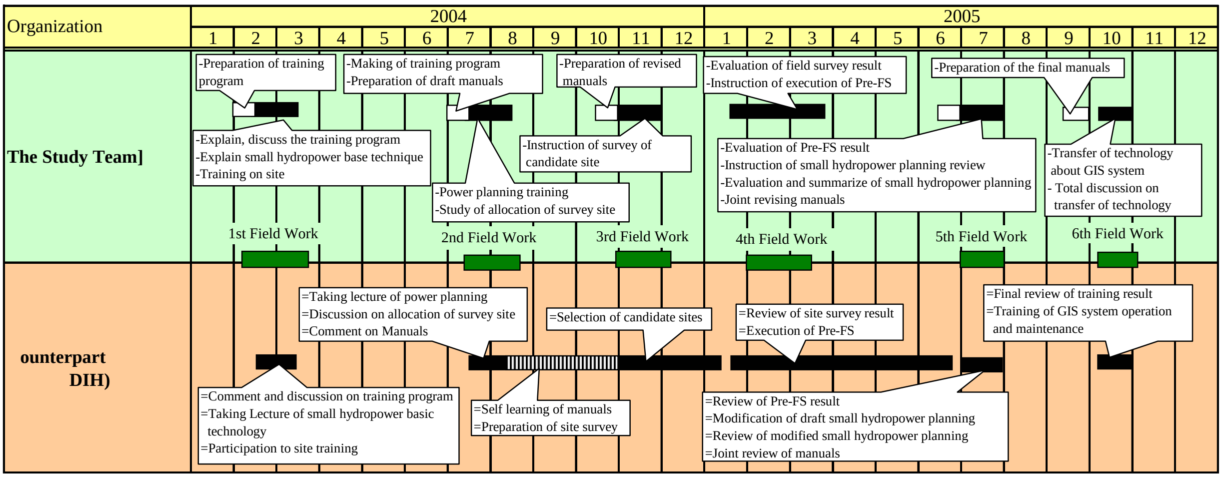
The capacity building conducted through this Study can be categorized into lectures and OJT. The former includes classroom lectures and workshops aiming at the capacity building of the PDIH engineers. The latter, on the other hand, involves site reconnaissance, planning and design at the Pre-F/S level targeting DOE engineers with relatively higher skills. In addition, counterpart training in Japan has been conducted twice aiming to enhance the understanding of small-hydro.

Furthermore, in order for the counterpart engineers to utilize the acquired skills and to continue to improve them after the Study is over, the Study Team has prepared not only a Manual of Small-Hydro Planning, but also several calculation programs that act as useful tools.

5.1.3 INSTITUTIONAL FRAMEWORK AND SCHEDULE

The lectures were mainly held at the DOE meeting room in Vientiane. While the Hydropower Training Planner holds overall responsibility for the lectures, the other members of the Study Team assisted with the lectures in their respective fields of expertise. The counterparts attending the lectures were 2 engineers from PDIH from each of the 8 provinces in addition to the DOE engineers. The PDIH engineers attending the lecture were obliged to accompany the site reconnaissance in their respective provinces.

The figure below illustrates the schedule of the capacity development, and the responsibility of the Study Team and DOE.



Work Demarcation and Schedule of Capacity Building

5.1.4 PLAN FOR TRANSFER OF TECHNOLOGY

The items for transfer of technology in this study were as shown in the table overleaf.

List of Items for Transfer of Technology

	Item	Period	Aim and Contents	Methodology	Evaluation
1	Visit to 5 PDIH	1st Field Work	Understanding on present status through visit to PDIH (Organization, Provincial electrification plan and technology), Programming of Lectures	Questionnaires and interviews	Evaluation of questionnaire and reflection to training program
2	1st Workshop (Presentation)	1st Field Work	Sharing the contents of the Study through presentation of the Inception Report, sharing of electrification strategy and target through presentation by MIH/EDL/NGD, and understanding of the electrification status of the northern 8 provinces through presentation by PDIH.	Presentation by participants from each PDIH, questionnaires on capacity building.	Evaluation of questionnaire, and discussion on results.
3	1st Workshop (Visit to Hydropower Project)	1st Field Work	Site visit of construction site of Nam Mang 3 HP for study on hydropower equipment and civil structures.	Site visit to Nam Mang 3 HPP under construction.	Interview with participants on understanding.
4	Discussion on Training Program	1st Field Work	Understanding the present situation and identification of issues on capacity building.	Discussion during the workshop, implementation of questionnaires.	Evaluation of questionnaires and minutes of meeting.
5	Procurement of Equipment	1st Field Work	Installation of equipments and OA system.	Discussion on specifications of equipment and joint installation of OA system (LAN)	-
6	Installation of the Staff Gauge	Before 2nd Field Work	Transfer of discharge measurement method from DOE to PDIH.	Staff gauge installation at MW class potential sites conducted jointly between DOE and PDIH. Required materials was procured at sites.	Confirmation of installation and measurement data at 3rd and 4th field investigation.
7	Preparation of the Training Program	1st Home Work	Preparation of the Training Program.	Preparation of the Training Program based on discussions held in 1st Field Work.	Discussion with DOE on the contents.
8	Drafting of the Small Hydropower Development Manual	1st Home Work	Drafting of the manual. Draft manual will be used for lectures.	-	Discussion with DOE on the contents.
9	Lectures on Basic Skills on Small Hydropower Development	2nd-3rd Field Work	Lectures on basic skills on small hydropower development for DOE/PDIH based on the lecture material.	Lectures combined with exercises. Lectures materials were translated by DOE and interpretation also made by DOE. Power point is used.	Questionnaires on contents of training manual. Evaluation of understanding range at the beginning of 3rd field investigation.
10	Selection of Sites for Site Reconnaissance	2nd Field Work	Selection of priority sites for site reconnaissance for evaluation of feasibility.	Site selection made not only on hydropower potential but also appropriateness from the viewpoint of OJT. Various types and scales were selected, so that DOE/PDIH will be able to conduct reconnaissance by themselves in the future for the remaining 6 sites out of 24 sties selected through map	Evaluate Pre-FS results which DOE implement mainly .
11	Site Reconnaissance	3rd-4th Field Work	Site reconnaissance is carried out at selected small-hydro potential sites. Investigation on condition of sites for structures, river discharge, topography, geology, irrigation, condition of water usage and access, etc., which will become basis for the Pre-FS planning and design.	Transfer of skills to DOE/PDIH through OJT, where discharge measurement, water use survey, head measurement, selection of sites for major structures, environmental evaluation, etc are taught. DOE/PDIH will conduct reconnaissance alone for 2 provinces where Study Team is not permitted to enter.	Conclusion of site reconnaissance results. Site reconnaissance results of 6sites carried out by DOE including records, data, photo and drawings are reviewed and evaluated.
12	Pre-FS	4th Field Work	Transfer of skills on topographic survey, discharge measurement, meteo-hydrological analysis, optimum scale planning, power generation planning, preliminary design, economic/financial evaluation, initial environmental evaluation, etc.	Pre-FS and site reconnaissance including topo survey and discharge measurement conducted jointly between Study Team and DOE, where the task is regarded as OJT for understanding of procedure and practical planning method.	Evaluation on Pre-FS results made by DOE.
13	Evaluation of Pre-FS	5th Field Work	Enhance further understanding on basic concept, technical study results, drawings, calculation and reporting of Pre-FS through revision made by Study Team on Pre-FS conducted by DOE.	Revision of DOE Pre-FS by Study Team and comparison with those conducted by Study Team aiming at further level up of DOE.	Confirmation at 4th lecture
14	Revision of the Small Hydropower Development Manual	5th Field Work	Understanding of contents of the manual through joint revision by Study Team and DOE.	Translation by DOE, preparation of novice section for PDIH, customization according to Lao's unique conditions.	Confirmation at 2nd Workshop.
15	Transfer of Technology on GIS	2nd-6th Field Work	Transfer of technology on effective use of GIS.	Transfer of technology on maintenance of system through review of GIS system data and operation manual. Technical lecture is held as required.	Actual operation of GIS, preparation of map, print out, preparation of materials for Pre-fs and workshop.

5.2 CAPACITY BUILDING THROUGH LECTURES

5.2.1 INTRODUCTION

The lectures mainly targeted the PDIH engineers to acquire basic knowledge and skills on small-hydro planning. There were 16 PDIH engineers attending the lecture from the eight (8) provinces.

This lecture also targeted the DOE engineers, but they were also the trainers since they were responsible for the translation of the lecture materials into Lao and for the interpretation of the lecture. Since DOE lacked expertise in some fields, the Study Team conducted a "trainer training" prior to the lectures, which helped enhance the understanding of the DOE engineers.

5.2.2 CONTENTS OF LECTURE

(1) Schedule and Contents of Lecture

Lectures have been conducted four times in July 2004, March 2005 and July 2005. The schedule and contents of the lectures are shown below:

Schedule and Contents of the Lecture

Name of Course	Period	Date	Lecture Contents	
			AM	PM
DOE/PDIH Training 1	July 5-9, 2004	Jul 5	Introduction, Outline of M/P,	Explanation on Candidate Sites
		Jul 6	Hydrological Analysis	Hydrological Analysis
		Jul 7	Hydrological Analysis	Hydrological Analysis
		Jul 8	Power Demand Forecast,	Hydropower Planning
		Jul 9	Hydropower Planning	Map Study Exercise
DOE/PDIH Training 2	July 19-23, 2004	Jul19	Topographic Map Reading	Map Study Exercise
		Jul 20	Demand Forecast	Design of Generating Equipment
		Jul 21	Visit to Nam Ngum HPP	Visit to Nam Ngum HPP
		Jul 22	Lao Electric Power Technical Standards	Tariff System
		Jul 23	Summary	Q&A, Questionnaire
DOE/PDIH Training 3	Mar. 1-5, 2005	Mar 1	Review of Site Recon Results	Hydropower Planning, Survey Exercise
		Mar 2	Design of Civil Structures	Cost Estimate of Civil and E&M
		Mar 3	Operation & Maintenance	Economic/Financial Analysis
		Mar 4	Discussion on M/P at Provincial Level	Summary, Q&A, Questionnaire
		Mar 5	Visit to EDL Training Center	Visit to EDL Training Center
DOE/PDIH Training 4	July 18-22, 2005	Jul 18	Review of Small-Hydro Planning	Financial and Economical Analysis
		Jul 19	GIS Exercise	GIS Exercise
		Jul 20	GIS Exercise	GIS Exercise
		Jul 21	Outline of CDM	CDM Procedure
		Jul 22	CDM Application on JICA Study	Sample of CDM Study

(2) Methodology of Lecture

Before holding the lectures, the Study Team conducted a "Training Needs Analysis (TNA)" in order to grasp the level of skill of the PDIH engineers as well as the tasks they need to be able to handle. The TNA helps to structure an effective lecture program which can strengthen the skills which are actually required. The Study Team visited PDIH offices in 5 provinces in February 2004 where the PDIH engineers were requested to fill out a questionnaire regarding their skills, experience and tasks. Furthermore, a questionnaire was also distributed during the 1st Workshop (March 4-5, 2004) and their results and the drafted training program was discussed at the venue and acquired consensus amongst the participants. Details of the questionnaire are explained in Chapter 5.3 below.

The basis for the lecture material was the Small-Hydro Planning Manual drafted in June 2004, but the materials were prepared on Microsoft Power Point so that the participants will be able to better understand the contents. In order to further enhance the understanding of the PDIH engineers, the lectures included numerous exercises, outdoor exercises and visits to hydropower projects. It may be noted that the lecture materials were translated in advance into Lao by the DOE engineers, so that the language barrier did not hinder their understanding.

At the same time, comments on the lecture and the manual were collected and the feedback was reflected on to the lectures to come and for the updating of the manual.

5.3 CAPACITY BUILDING THROUGH WORKSHOP

5.3.1 INTRODUCTION

The prime objective of the workshops was to report and share the progress of the Study to the parties concerned such as the Lao Government agencies, EDL, ADB and WB, and to receive feedback from the participants. However, the workshop also acted as a place for capacity building in the sense that PDIH engineers made presentation regarding the electrification status of their province and DOE enginners on the progress of the Pre-F/S that they were conducting. In addition, the workshop was used to conduct the TNA and also for making visits to hydropower projects aiming at the capacity buillding of the PDIH engineers.

The descriptions of the workshops were explained hereunder.

5.3.2 1ST WORKSHOP (MARCH 2004)

Presentation and Discussion

The 1st Workshop was held at the EDL hall during March 4-5, 2004, inviting DOE, PDIH of the 8 provinces and other parties concerned. With consideration to the lack of English proficiency of the PDIH engineers, the presentations were made with simultaneous interpretation and Power Point presentation shown in English and Laos on separate screens.

The following presentations were made during the Workshop.

(i) Activities of MIH/DOE (Presenter: DOE)

(ii) Existing condition of the power grid and expansion plan (Presenter: EDL)

(iii) Contents of the Study, capacity building, power sector policy and institution, small-hydro planning, economic/financial issues in rural electrification, socio-economic survey, environmental impacts (Presenter: Study Team)

(iv) Electrification status of the northern 8 provinces (Presenter: PDIH)

(v) Mekong GIS database (Presenter: NGD)

An active discussion was held following the presentations, and the slogan for the Study was decided to be ”Large Hydro for the Country, Small-Hydro for the People”. The slogan aims at the simultaneous development of small-hydro for poverty alleviation such as those targeted in the Study and large hydropower projects which can earn foreign currency such as the Nam Ngiep I project presently being promoted by Nippon Koei as an IPP scheme.

Large Hydro for the Country
together with
Small-Hydro for the People

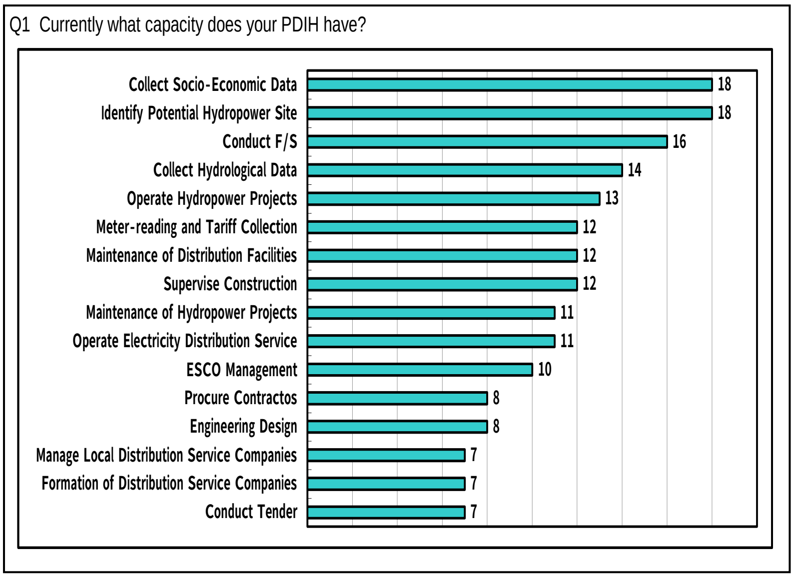
Slogan Presented at the Workshop

Presentation by DOE (March 4, 2004)

Group Photo of the Participants (March 5, 2004)

Training Needs Analysis (TNA)

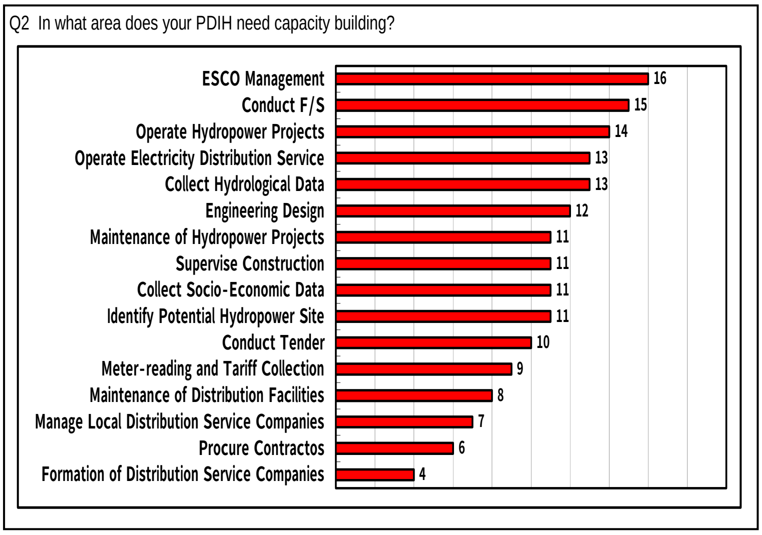
For the smooth and effective implementation of the lecture targeting the PDIH engineers, a “Training Needs Analysis (TNA)” was conducted during the Workshop. Here, the questionnaire asked the PDIH engineers particularly on two subjects: (1) what skills they already have, and (2) what skills they wish to acquire. Twenty questionnaires were collected for analysis.



Analysis of Q1

The first question asking the type of skills already possessed by PDIH, some of the most frequent answer included social survey and hydrological survey. However, there might have been a misunderstanding of the question as "areas where assistance is necessary". Therefore, these results unfortunately may not represent actual skills possessed by PDIH.

For the second question regarding the areas in which capacity building are required, there was a tendency for PDIH to have interest in management such as the management of the ESCOs (electric service companies), power station and distribution services. On the other hand, there was relatively small interest manifested for the organization of the ESCOs. These results reflect the present situation where the formation of a village cooperative is not a difficulty, while their sustainable management is a major issue.



Analysis of Q2

It may be noted that the Study Team had visited 5 provinces as part of the TNA prior to the Workshop. The questionnaires distributed on this occasion included questions on the following: name of representative, number of staff, number of electrical engineers, civil engineers and others, English proficiency, planned hydropower, will to participate in the Study, electrification policy, area of districts, village numbers, population, household number, electrification status, location and capacity of power source, small-hydro potential, etc. The Study Team helped fill in the areas where data were already available and asked PDIH to check those items.

The results of the questionnaire were analyzed and shared during the Workshop, and for those provinces that were not visited, the PDIH participants were requested to fill out the form during the Workshop. Shown below is a sample of the questionnaire.

Meeting at PDIH Xayabury Province (Feb. 23, 2004)

Meeting at PDIH Luangphrabang Province (Feb. 23, 2004)

Questionnaire for PDIH of Xayabury Date:

1	**Representative of PDIH**				
2					
3	**Participants for Workshop of Small Hydropower in Northern Laos**				
4	**Information of PDIH**				
		Number of PDIH Staff	Understanding of English	Existing Measurement Works for Hydropower Project	Willingness of Measurement Works for JICA Small Hydropower Project
i	Electrical Engineer	1			
ii	Civil Engineer	0			
iii	Other Staff	15			
iv	Total	16			

5 Existing Condition of Districts & Plan of Electrification

	District	Area (km2)	Nos. of Villages	Household	Distance from Xayaboury (km)	Existing Condition of Power Supply	Number of electrified villages	Number of electrified HH	EDL (Grid) Connection Plan (by 2010)	PDIH Plan (Off-Grid)	Candidate of Small Hydropower Plan of JICA
i	Xayabury	3,153	112	11,347	68,110	Diesel (2x400kW) in 1990 (Tariff 1,800 kip/kWh) After connection with Grid, Diesel is kept for standby for event EDL TL 115kV 192km from Louangphrabang in 2003 May At connection tariff was 50,000kip/HH and later EDL tariff	44	4,339			Nam Houag (650kW) Nam Met (1.8MW)
ii	Khorb	698	33	3,146	17,507	Diesel (20kW) in 1993-2000 (Because of TL system, cost of diesel, old generator) TL from Thailand is under construction and will be completed in May 2004. TL is constructed by PPA between EGAT and EDL	21	1,270			
iii	Hongsa	1,605	59	4,282	25,774	Diesel (50kW) in 1993 New diesel (155kW) in 1997 22kV TL from Thailand was connected in Sep. 2003.	7	544			Nam Ken (1.2MW), Nam Ngeun 1 **Nam Ngeun 2, Nam Khop** Nam Yang Resettlement matter should be considered in [illegible]
iv	Ngeun	728	29	2,468	14,093	Diesel (44kW) in 1994-2000 (Tariff 7,000 kip/20W lamp-month) Electricity from Thailand from Feb. 2001 Control of EDL with EDL tariff	19	1,214		Nam Oun at Phadeng village	
v	Xienghone	1,187	57	4,702	25,561	Diesel (50kW) from 1994 to 2000 (5,000 kip/20W lamp-month) 22kV TL from Thailand will be extended from M. Khop by EDL at end of 2004	20	1,800			
vi	Phiang	2,970	60	7,788	45,362	Diesel (192kW) from 1989 to 2003 (stopped due to generator problem) (Tariff 4,000 kip/20W lamp-month) 22kV TL from Xayaboury by EDL PTD 1 to Ban KM18 from center of Phieng dis. in Dec. 2003	22	2,460			
vii	Paklai	1,865	77	10,552	59,240	Diesel (250kW) 1994 - 1997 New Diesel (155kW) 1997- 2000 (Tariff 6,000 kip/20W lamp-month) EDL 22 kV TL from Kenthao dis. was connected in June 1998 by EDL	18	1,896	PTD 3 - 115 kV		**Nam Lay (1.2 MW)**, Nam Fhoun (650kW) Nam Gnam (kW), Nma Gnang (kW)
viii	Kenethao	1,265	58	7,076	34,853	Electricity from Thailand in June 1997 Transformer of EDL : 650kVA - 1, 100kVA - 4, 50kVA - 5	32	2,803			
ix	Botene	1,001	32	3,496	17,325	Nam Ham Micro Hydropower in 1992 (2x90kW) was made by province finance and stopped in 1998 because of TL connection (Tariff 100 kip/kWh : province decided on the basis of subsidy) TL from Kenthao dis. was connected in Dec. 1998	24	1,304			**Nam Ham 2 (2~3MW)**
x	Tongmixai	1,050	16	1,542	8,565	Diesel (20kW) in 1996 for 2 months because of machine trouble TL from Paklay dis. In July 2003	9	490			
	Total	15,522	533	56,399	316,390		216	18,120			

6 Remarks

Solar home system is supported by private company.
Districts of Hong Sa, M. Ngeun, Parklai, Kenthao, Botene and Thongmyxay were connected with 22 kV TL from Thailand. EDL loss 300 million kip/month due to high import cost and lower tariff in Laos.
Acoording to PDIH opinion, the hydropower development inside NBCA is not allowed.
There are two alternatives which are Paklay - Xainabouri by 2008 and Paklay - Non hai by 2005. EDL is negotiating regarding these two alternatives with Chinese investor, and

Sample of Questionnaire (Xayabury Province)

<u>Site Visit to Hydropower Project Construction Site</u>

In order to familiarize the PDIH engineers with hydropower, a visit to a hydropower project construction site was organized during the 1st Workshop. The project visited was Nam Mang 3 HPP (30,000 kW) which was at the time under construction with work progress at 60%. After receiving general information on the project from the project office staff, the participants inspected the intake, main dam, saddle dam, etc. Explanation was provided at site on basic concepts of the study, planning and design of a hydropower project. In addition, the resettlement issue was explained at the villages where resettlement actually was planned.

Visit to the staff gauge at the planned inundation area and village to be resettled (March 5, 2004)

Site visit to Nam Mang 3 HPP main dam site (March 5, 2004)

5.3.3 2ND WORKSHOP (MARCH 2005)

The 2nd Workshop was held at the EDL hall in Vientiane on March 7, 2005 in the same manner as the 1st Workshop. The main objective of the 2nd Workshop was to present the progress of the Study, mainly the Master Plan and the Pre-F/S. Presentations were made by the Study Team and DOE.

Participants from PDIH did not have the opportunity to make a presentation but showed keen concern towards the progress of the Study especially the Pre-F/S planning and the initial environmental evaluation (IEE). In the discussion session following the presentation, PDIH participants gave comments and explanation on the electrification status and the problems faced by the existing hydropower plants in their respective provinces.

5.3.4 3RD WORKSHOP (NOVEMBER 2005)

The 3rd Workshop was held at the Luangphrabang provincial hall which locates at center of northern 8 provinces on November 2 and 3, 2005 with participation of DOE, each PDIH, international donor, private sector interested in rural electrification. In this workshop, not only the presentation of study results by the JICA Study Team and DOE, but also the panel discussion was held as a new trial. As the results of that, the necessity of rural electrification based on sustainability and village people participant, and importance of the establishment of fund for the rural electrification in short period were confirmed. The panelist consisted of MIH vice Minister, MIH Director General of DOE, Vice Governor of Luangphrabang Province, MOF Director General of Policy Department, MFA deputy

Director General of International Corporation, WB representative of Energy and Mining Section and JICA Senior Adviser. The JICA Study Team members acted as the chairperson.

At the end, the vice Minister of MIH declared about the promotion of the rural electrification aiming at 90% of household electrification as of 2020, and the Director General of DOE handed over the memorial flags having rural electrification promotion logo to representatives of PDIH, DOE and JICA Laos before closing.

The engineer of DOE took in charge of the presentation of the results of the master plan and the Pre-F/S and they explained to the point. Though there was no opportunity of presentation by PDIH staff, their knowledge about fund for small-hydro including the method of financing was leveled up through the listening of opinion of panelists in panel discussion with translation in Lao language. Further, the GIS maps were printed out and distributed to the PDIH staff to meet the demands of PDIH staff during the 2-day workshop. The PDIH staff intended to take them back to their office and use them as the basic information for the planning of rural electrification.

5.4 CAPACITY BUILDING THROUGH PRE FEASIBILITY STUDY

5.4.1 INTRODUCTION

The following tasks were included in the Pre-F/S itself or during the process of selecting priority projects for the Pre-F/S. A capacity building component was incorporated in each of the tasks with close link to the contents of the lectures held simultaneously.

Capacity Building through the Pre-F/S

Task	Period	Role of Counterparts	
		DOE	PDIH
Study on Electrification Status	1st Field	Conducted together with S/T	Provided S/T with information
Map Study	1st Field		Exercise during Lecture No.2
Installation of Staff Gauge	2nd Field	Conducted by DOE	Learned hydrological investigation
Site Reconnaissance	3rd Field	Conducted together with S/T. S/T provided explanations, formats, computer programs to enhance the understanding of DOE.	Conducted together with S/T
Preparation of Site Recon Memo	3rd Field		Presented in Lecture No.3 by S/T
Selection of Priority Pre-F/S Sites	3rd Field		Examples used in Lecture No. 3
Pre-F/S Planning	4th -5th Field		
Pre-F/S Design	4th -5th Field		
Pre-F/S Cost Estimate	4th -5th Field		
Pre-F/S Economic/Financial Analysis	5th Field		Presented in Lecture No. 4
Pre-F/S Evaluation	5th -6th Field		Presented in 3rd Workshop by S/T and DOE
Pre-F/S Presentation	6th Field		

As shown above, the capacity building through the Pre-F/S mainly targeted the DOE engineers, and the Study Team and DOE have been working closely together both in office and in the field.

The expertise of the PDIH engineers, on the other hand, was not yet sufficient to conduct the Pre-F/S, and therefore, the capacity building was limited to sharing information on the progress of the Pre-F/S aiming to enhance their understanding of its process and to acquire basic skills.

5.4.2 CONTENTS OF TRAINING

The contents of the capacity building conducted in each of the abovementioned steps of the Pre-F/S are described hereunder.

(1) Investigation on Electrification Status in the Northern 8 Provinces

The Study Team jointly with DOE visited PDIH offices in 5 of the 8 northern provinces subject for the Study, where interviews were made on the electrification status and rural electrification planning in each of the provinces. Through the discussion, PDIH acquired knowledge on the type of data required for the planning of rural electrification schemes.

During the 2nd Field Work, discussions were held with DOE on how to reflect the collected data on to the GIS and how DOE will update them. Through such discussions, transfer of knowledge and skill on the use of GIS and relating skills such as demand forecast and data management was made.

(2) Map Study

The map study based on GIS was conducted mainly by the Study Team, while that based on 1:100,000 maps and study on existing investigation reports were conducted mainly by DOE. The results of the two approaches were compared and analyzed through numerous discussions, where relative transfer of knowledge was made.

The process and the result of the map study were presented at the lecture to the PDIH participants, and map study exercises were provided to enhance their understandings.

(3) Staff Gauge Installation and Discharge Measurement

The locations to install the staff gauges were selected jointly with DOE based on the map study results. The installation of the staff gauges and the discharge measurements were conducted by DOE who already possess experience and expertise. The skills were transferred from DOE to the PDIH engineers who accompanied them to the site.

(4) Site Reconnaissance, Site Reconnaissance Memo and Selection of Sites for Pre-F/S

The site reconnaissance of the sites selected through the map study was conducted jointly between the Study Team and DOE. The set of the first site reconnaissance was defined as an OJT for the DOE engineers where the Study Team members instructed them on the process of site reconnaissance, items to investigate and other issues relating to the site reconnaissance.

The Study Team prepared several formats prior to the site reconnaissance, so that the DOE engineers will be able to understand the type of information they needed to collect during the reconnaissance. The use of these formats was explained in advance and also at the site.

Formats for the Site Reconnaissance Prepared by the Study Team

Name of Format	Contents
Hydro Checklist	A format providing items to be confirmed at site regarding the civil engineering and hydrological aspect of the reconnaissance.
Distribution and Transmission Line	A format for the investigation of distribution and transmission line route.
Environmental Impact	A brief description and checklist of possible environmental impacts due to hydropower development.
Detailed Key-Information Questionnaire	A questionnaire format aimed at collecting socio-economic information from a key-informant such as the village leader.
Simplified Key-Informant Questionnaire	Same as above, but a simplified version with only major items.
Explanation figures of Hydropower	Visual introduction to micro hydropower to be used for the explanation of the project to the district officers and the local population.
Site Recon Memo	A format to summarize all the above collected information and data from the site recon.

As a result of OJT-style capacity building in the fields assisted by the various formats, DOE engineers were able to strengthen their skills on site reconnaissance, and were able to collect sufficient information through the site reconnaissance they conducted alone for the three sites in Huaphan and Xiengkhuang Provinces where the Study Team was not permitted to enter due to security reasons.

It may be noted that the site for the first set of site reconnaissance conducted jointly was selected so that there were similarities between those and the sites in which DOE was to conduct reconnaissance by themselves, and so that there was diversity. Therefore, the sites first visited were of diverse nature with different types of schemes with various scales of development.

The site reconnaissance was also an opportunity for the PDIH engineers to acquire hands-on experience of site reconnaissance. The engineers from PDIH were obliged to accompany the reconnaissance in their own respective province, and there they gained experience on how to conduct a site reconnaissance for the identification of a potential hydropower site and on the process of village socio-economic survey.

The Study Team also prepared a format to summarize the result of the site reconnaissance. This format is intended for the use by DOE in the future as well.

As described above, efficient capacity building was made possible through OJT and through the use of formats to assist the task, and DOE engineers are now prepared to conduct site reconnaissance in a more comprehensive manner than before.

(5) Small-Hydro Planning, Design and Cost Estimate at the Pre-F/S Level

The Pre-F/S of the 11 sites commenced in February 2005, and finished by the Study Team on 6 sites and by DOE on the remaining 5 sites.

As mentioned earlier, the Study Team prepared several simple computer programs to assist the process. As these programs were intended for the capacity building of the DOE engineers, extensive explanations were provided prior to their use.

List of Programs Prepared by the Study Team to Assist Pre-F/S by DOE

Name of Program	Platform	Contents
Hydro Planner Module A	Microsoft Excel VBA	Hydrological analysis, power generation simulation for micro/small hydro as off-grid electrification schemes
Hydro Planner Module B	-//-	Hydrological analysis, power generation simulation for small hydro as grid schemes
Waterway Dimensions	-//-	Calculation of dimensions of major civil structures
Transmission Line	Microsoft Excel	Calculation of required quantities of transmission line, substation, etc., as well as their cost estimate
Construction Cost	Microsoft Excel VBA	Rough quantity calculation of civil structures by formulae

Through the use of these programs, DOE engineers became to be equipped with more technical skills required to conduct the Pre-F/S, and because of the simplicity of the programs, they were highly appreciated by DOE. Details of the programs are described in Section 4.8.

In the 5th Field Work, the Study Team reviewed the progress of the Pre-F/S conducted by DOE. The items subjected for review were the planning, design, drawings, cost estimate and reports on the sites where Pre-F/S were conducted. The results of the review with comparison with those prepared by the Study Team were shared broadly and extensively with members of the DOE in order to develop the capacity of the DOE engineers.

(6) Economic/Financial Analysis and Overall Evaluation at the Pre-F/S Level

The planning, design and cost estimate at the Pre-F/S level were continued throughout the 5th Field Work, as well as their economic/financial evaluations and overall evaluations. This continued to be conducted jointly, with focus on the transfer of skills on economic/financial analysis. The results of the Pre-F/S were presented by the JICA Study Team and DOE engineers during the 3rd Workshop.

5.5 CAPACITY BUILDING BY SMALL-HYDRO MANUAL

5.5.1 SMALL-HYDRO PLANNING MANUAL

The manuals to be prepared in the Study range from those targeting DOE with relatively higher skills on small-hydro development to those targeting PDIH with only limited understanding. Therefore, in order for the manuals to be utilized by both DOE and PDIH, a novice section was prepared apart from the main sections of the manual of relatively higher technical level.

The manual, the Small-Hydro Planning Manual, had already been in use by DOE throughout the Pre-F/S tasks. Comments and suggestions from DOE and PDIH were being reflected as they were received during the process of the Pre-F/S and the lectures.

5.5.2 OPERATION & MAINTENANCE MANUAL

According to the preliminary study conducted by JICA prior to this Study, DOE had requested for capacity building on operation & maintenance (O&M). This was because there were many small-hydro plants where the inadequate O&M had resulted in operations well below their rated output. In order to satisfy the Lao requests, the O&M manual was prepared. This manual was based on the manual prepared through the JICA Study on the Introduction of Renewable Energy in the Rural Areas of Myanmar, and customized to suit the Lao conditions.

In addition, as the increase in electrification ratio by small-hydro was viewed as a means to accomplish a higher goal of developing the rural areas, the manual was also incorporate issues on tariff for small enterprises as well as the management of electric power service entities, to assist PDIH.

5.6 TRANSFER OF TECHNOLOGY ON GIS

5.6.1 SMALL-HYDRO DEVELOPMENT ON GIS

The data and information collected on villages, districts and provinces as well as topographic data and data related to small-hydro planning were compiled as a database in electronic format. This database was linked with GIS intended for the use by DOE after the termination of this Study. The development of the GIS database was conducted jointly between the Study Team and DOE, where relevant technology on GIS was transferred.

5.6.2 LECTURES ON GIS

The course was not just a presentation by the team member in charge but rather took the form of the participants' also directly familiarizing themselves with the GIS equipment introduced in the project. The course dealt with items such as those indicated below in an intensive manner over a period of two days. It was decided that the layouts of the output maps be made by the PDIH staff each as regards his own province of the eight northern provisions involved.

Day 1 :	Morning	: Methods of Display of GIS Data and Lecture aiming at Making of Output Maps
	Afternoon	: Output of Data Prepared for Output Maps
Day 2 :	Morning	:Output of Data Prepared for Output Maps (continuation of the day before)
	Afternoon	: Explanation of Methods of Editing of Existing Data

The following were the reasons for which the main topic treated in the lecture course was making of output maps:

(i) Since it is easy to get the results in concrete form in one's hands by making output maps, that gives the user a real sense of actual accomplishment in using GIS.

(ii) Since the lecturer allows the participants free choice of colors and map symbols in making their output maps instead of forcing preferences of expert on them, that makes it possible to reduce sense resistance to work using GIS and gives them a feeling of closeness and familiarity with it as well as making it more fun.

(iii) Since the PDIH offices do not yet have maps, it will be possible for the participants to make their own for their offices.

During and after making of the output maps the participants were seen to actively exchange opinions among themselves on color used, data layout, etc. of the different provinces, which would appear to indicate attainment of the above-mentioned 3 goals of the lecture course.

Participant checking his output map made by himself

5.7 CDM SEMINAR

As a counter part training to Lao PDR, CDM seminar was held to enlighten the CDM theory and application of hydropower. To join the seminar, approximately 60 persons attended from DOE, EDL, STEA and so on.

Program of the seminar is presented below.

July 21, 2005 (Thu)

No.	Time	Events	Person in charge
1	08:00-08:30	Registration	EDL 6th Floor Hall
2	08:30-08:40	Orientation	Facilitator: Ms. Bousavanh
3	08:45-08:50	Opening Speech 2	Mr. Araki / JICA study team
4	08:50-09:35	What is Global Warming?	Mr. Ishikawa / JICA study team
5	09:35-10:20	Kyoto Protocol	Mr. Ishikawa / JICA study team
6	10:20-10:50	Coffee Break	-
7	10:50-11:30	Kyoto Mechanism	Mr. Ishikawa / JICA study team
8	11:30-11:50	CDM Activities in Japan	Mr. Ishikawa / JICA study team
9	11:50-12:00	Free Discussion	Facilitator: Ms. Bousavanh
10	12:00-13:30	Lunch Time	EDL Canteen
11	13:30-14:05	What is CDM?	Mr. Ishikawa / JICA study team
12	14:05-14:40	CDM Procedure	Mr. Ishikawa / JICA study team
13	14:40-15:10	Coffee Break	-
14	15:10-15:40	What is CDM/PDD?	Mr. Ishikawa / JICA study team
15	15:40-15:45	Current Situation of CDM	Mr. Ishikawa / JICA study team
16	15:45-15:55	Free Discussion	Facilitator: Ms. Bousavanh
17	15:55-16:00	Closing	Mr. Araki / JICA study team

July 22, 2005 (Fri)

No.	Time	Events	Person in charge
1	08:00-08:30	Registration	EDL 6th Floor Hall
2	08:30-08:40	Orientation	Facilitator: Mr. Sanhya
3	08:40-09:10	Review of 1st Day Seminar	Mr. Ishikawa / JICA study team
4	09:10-09:50	Sample GHG Calculation	Mr. Ishikawa / JICA study team
5	09:50-10:20	Coffee Break	-
6	10:20-10:50	CDM Application on Nam Ngiep HPP	Mr. Araki / JICA study team
7	10:50-11:20	Small-Hydro in Northern Lao	Mr. Kataoka / JICA study team
8	11:20-11:35	CDM Potential in Lao	Mr. Ishikawa / JICA study team
9	11:35-11:55	Free Discussion	Facilitator: Mr. Sanhya
10	11:55-12:00	Closing Speech	Mr. Houmphone / DOE

List of attendance, questions and answers, snaps are presented below.

Questions and Answers

No.	Questions	Answers
1	Is there any obligation to non-ratified country on Kyoto Protocol?	There is no obligation. Only Annex I country has during 1st commitment period.
2	Is there any difference between GHG target (-6%) to EU and GHG allocation to EU countries?	In Kyoto Protocol, 15 EU countries have the same target to reduce 6% from 1990 level firstly. Then, internal conference of EU made decision the allocation of their target depend on their emission situation and so on (e.g. UK: -12.5%, Germany: -21.0%).
3	Which tool of Kyoto Mechanism (CDM, JI, ET) is applied to Lao PDR?	At present, Lao PDR can join the CDM only.
4	Is it possible to carry out CDM by Lao local company in Lao PDR and sell to the others CER?	Normally, CDM has been implemented with donor and host countries. However, unilateral CDM which carried out by host countries is under discussion.
5	How much the approval cost of DNA? * DNA：Designated National Authority	DNA Lao does not prepare any approval system and CDM criteria yet. For instance, there is no charge in case that Japanese company gets the governmental approval. As for DOE cost concerned, validation and verification : 30,000 USD, CDM registry to CDM EB : 5,000 to 15,000 USD. Off course, these values are dependent on project scale and so on.
6	Is it applicable to refrain the illegal logging and slash-and-burn farming in mountainous area?	These are not worth of being CDM project. In case of stop illegal logging and slash-and-burn farming, present fossil fuel is not going to reduce.
7	Hydropower project has been approved as CDM, run-of-river type or reservoir type?	Most of approved project as CDM are run-of-river type. At present, the reservoir type is not approved due to some problem. However, reservoir type of hydropower has large potential to reduce GHG.
8	Can CER be lost?	For energy sector CER, it is not lost. However, CER from AR-CDM will be lost based on the AR-CDM's rule.
9	What kind of CDM projects are approved so far?	Most of CDM projects are renewable energy project, Land fill gas capture project and so on.
10	Which countries does have CDM project?	So far 125 candidates, only 22 projects are approved. They are from Latin America countries, West Europe (former soviet union countries) and Asian countries.
11	How do you calculate GHG emission?	Normally, GHG emission is calculated with reduction fuel, replaced/switched fuel, and GHG emission coefficient.

Remarks: Except the above, there are some questions accepted. For instance, how to promote the sewerage and LFG project to apply CDM, CDM process for small-hydro and so on.

The Master Plan Study on Small Hydropower in Northern Laos
CDM SEMINAR ~ Attendance List ~

As of July 22, 2005

	Name	Position/Province	Organization	Signature	
I. DOE					
1	Mr. Houmphone BULYAPHOL	Director General	MIH/DOE	-	○
2	Mr. Chansaveng BOUNYONG	Division Chief	DOE/PSPD	○	○
3	Mr. Khonephet XAMONTI	Engineer	DOE/PSPD	○	○
4	Mr. Litthanoulok LASPHO	Engineer	DOE/PSPD	○	○
5	Mr. Sanya SOMVICHIT	Engineer	DOE/PSPD	○	○
6	Mr. Akhomdeth VONGSAY	Engineer	DOE/PSPD	○	○
7	Mr. Khanthara SISAMOUTH	Engineer	DOE	○	○
8	Mr. Viengsay CHANTHA	Electrical Eng.	DOE	○	○
9	Mr. Khansing	Engineer	DOE	○	○
10	Mr. Syvaj XAYYAVONG	Engineer	DOE	○	○
11	Miss Santisouk PHIMPHACHANH	Engineer	DOE/EMD	○	○
12	Mr. Xayphone Bounsou	Engineer	DOE/EMD	○	○
13	Mr. Phonepasong SITHIDETH	Engineer	DOE/MIH	○	○
14	Mr. BouaIom SAYSANAVONG	Engineer	DOE/MIH	○	○
15	Mr.Thamnanune NAKIVITH	Engineer	DOE/MIH	○	○
II. STEA					
16	Mr. Khamphoui SIVONGXAY	Deputy Head of EDC, ERI	STEA	○	○
17	Mr. Kadingthoug SINGDALA	Technical	STEA	○	○
18	Miss Virany SENGTIANTHR	Technical	STEA	○	○
19	Mrs. Ammaly ALATHEP	technical	STEA	○	○
20	Mr. Bounpone BOUAPHENG	Officer	STEA	○	○
21	Mr. Phonexay SIMMALAVONG	STEA	STEA	○	○
III. The Other Central Government					
22	Mr. Somnuk CHANTHASETH	Director of Division	DOI	○	○
23	Mr. Soulignet Visaysongdeth	Engineer	DOR, MCTPC	○	○
24	Mr. Lamkha SAIGNASANE	Engineer	DOR, MCTPC	○	○
25	Mr. Houmphanh PHADOUANGDETH	Engineer	DOR, MCTPC	○	○
26	Mr. Souphanh GNABANHDITH	Staff	DOR, MCTPC	○	○
IV. EDL					
27	Mr. Khamphanh VANLASY	Engineer	EDL	○	○
28	Mr. Visien SINGHAPHANL	EWV Unit	EDL	○	○
29	Mr. Viraphanh NANDAVONG	System	EDL	○	○
30	Miss Daovone SONKSOUEHTH	Development	EDL	○	○
31	Ms. Saysavanh SOVDACHANH	Development	EDL	○	○
32	Mr. Khounphila	Engineer	EDL	○	○
33	Mr. Keovougsovong SONLIYODEF	GMO	EDL	○	○
34	Mr. Vanthonh KHAMCOONVILAYCONG	Dept. Mng. NNP	EDL	○	○
35	Mr. Noukoune NANTHARATH	Dept. Mng. NM3	EDL	○	○
36	Mr. Visien SINGHAPHANG	Env.Unit Head	EDL	○	○
37	Ms. Maniloth	Engineer	EDL	○	○
V. The Other Organizations					
38	Mr. Kheunsone PHILAVONG	Tuhnical	LNMCS	○	○
39	Mr. Phetsamone KHANOPHET	Technical	LNMCS	○	○
40	Mr. Yoichi IWAMI	Advisor	MRC	○	○
41	Mr. Keudioua	Envi. Specialist	MRC	○	○
42	Mr. Xay XAYSETHA	Maintenance Engineer	Nam Leuk	○	○
43	Mr. Khanmanh	Engineer	SEMD	○	○
VI. PDIH					
44	Mr. Vanhla VONGMANY	Oudomxay	PDIH	○	○
45	Mr. Sayseng CHINDAVONG	Oudomxay	PDIH	○	○
46	Mr. Ounneua SIVANPHENG	Phongsaly	PDIH	○	○
47	Mr. Seumsay LIVONGKHAM	Phongsaly	PDIH	○	○
48	Mr. Syphanh DUANGPASEUTH	Luangnamtha	PDIH	○	○
49	Mr. Sengdeuan SIMMANIVONG	Luangnamtha	PDIH	○	○
50	Mr. Thongdy PHOMPANYA	Bokeo	PDIH	○	○
51	Mr. Boonma SILIPANYA	Bokeo	PDIH	○	○
52	Mr. Khamkay VONGSY	Xayabury	PDIH	○	○
53	Mr. Ounheun KANTHAVONG	Xayabury	PDIH	○	○
54	Mr. Misayphon VILAYHONG	Luangphrabang	PDIH	○	○
55	Mr. Alounkone PHOTHIPANYA	Luangphrabang	PDIH	○	○
56	Mr. Bountheuang PHOMMAVONGXAY	Huaphanh	PDIH	○	○
57	Mr. Ketvilay PHOMMALY	Hoaphane	PDIH	○	○
58	Mr. Khamkeut PHOSAVANH	Xiengkhuang	PDIH	○	○
59	Mr. Khonkeo PHUNTHONGSAY	Xiengkhuang	PDIH	○	○
VII. JICA					
60	Mr. OGAWA	JICA Expert	JICA	○	○
61	Mr. Masayuki SEINO	JICA Expert	JICA	○	○
62	Mr. Masatoshi KAIMASU	Coordinator	JICA	○	○
VIII. The International Organizations					
63	Mr. Phoulhanoulhong XAYSOMBATH	RE	SNV	○	○
64	Mr. Auke Koopmans	Advisor	SNV. TRI	○	○
65	Mr. Mantes DAISER		WB	○	○

5.8 DOE/PDIH COUNTERPART TRAINING PROGRAM

5.8.1 INTRODUCTION

The counterpart training program in Japan has been held twice in October 2004 and June 2005, as part of the capacity building for the engineers of DOE and PDIH. The former program was conducted jointly with the program under the JICA expert's responsibility, where two participants from DOE and five from PDIH came to Japan. For the latter, one participant from DOE and three from PDIH came to Japan for training. It may be noted that the participants from PDIH were selected evenly from each of the eight (8) Northern provinces.

List of Participants for the Counterpart Training Program

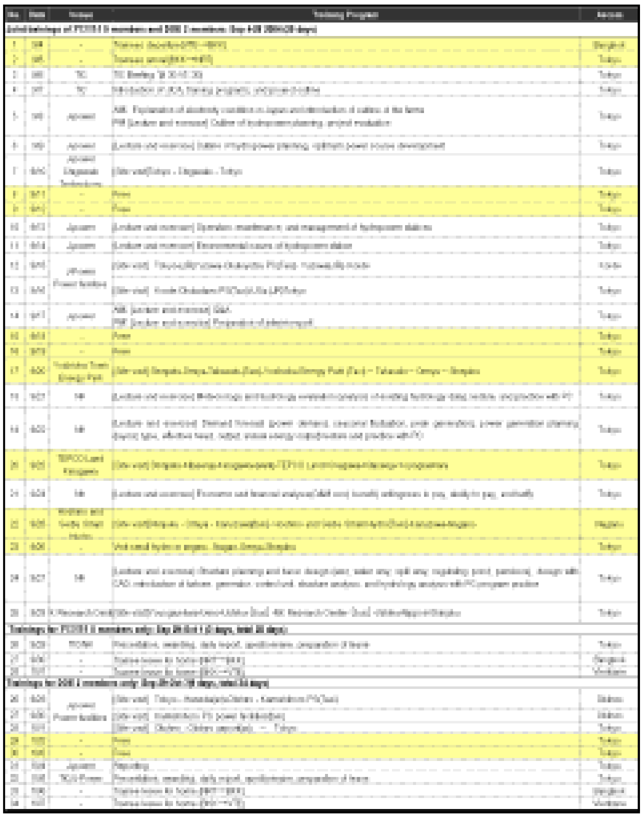
Name of Course	Period	Participants: Name	Participants: Affiliation	Remarks
Counterpart Training (FY No. 2)	Sep 4 ~ Oct 1, 2004 (28 days)	Mr. Chansaveng BOUNYONG	MIH DOE	JICA Expert CP Training
		Mr. Chantho MILATTANAPHENG	MIH DOE	
		Mr. Ounneua SIVANPHENG	PDHI Phongsaly	JICA Study Team CP Training
		Mr. Thongdy PHOMPANYA	PDIH Bokeo	
		Mr. Misayphon VILAYHONG	PDIH Luanphrabang	
		Mr. Bountheuang PHOMMAVONGXAY	PDIH Huaphanh	
		Mr. Khamkeut PHOSAVANH	PDIH Xiengkhuang	
Counterpart Training (FY No. 3)	May 29 ~ Jun 25, 2005 (28 days)	Mr. Sanhya SOMVICHITH	MIH DOE	
		Mr. Sengdeuan SIMMANIVONG	PDIH Luannamtha	
		Mr. Vanhla VONGMANY	PDIH Oudomxay	
		Mr. Khamkay VONGSY	PDIH Xayabury	

5.8.2 CONTENTS OF THE TRAINING PROGRAM

The counterpart training program focused on contents that are only possible in Japan, or only possible because of the small number of participants. More specifically, the training program encompassed extensive visits to the various existing small-hydro projects of different characteristics, visits to factories manufacturing small-hydro equipments, and exercises using advanced computer software for the planning of a small-hydro scheme and for the optimization of a mini-gird. For the lectures and exercises using the computer software, a computer was provided to each of the participants.

In addition, new attempts were implemented such as the presentation by the participants to university students studying international development, and a presentation also by the participants at the end of the training program.

The two counterpart training programs in Japan were highly appreciated by the participants and the acquired knowledge and skills are hoped to be utilized to the maximum extent in order for rural electrification by small-hydro to prevail in the northern provinces of Lao PDR.



1st Counterpart Training Schedule (October 2004)

2nd Counterpart Training Schedule (June 2005)