

Japan International Cooperation Agency (JICA)

Electricity of Vietnam

**Renewable Energy Master Plan**  
**in the Northern Part of the Socialist Republic of Vietnam**

**Final Report**  
**Main Report**

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July 2002

**PROACT International, Inc.**  
**Tohoku Electric Power Co., Inc.**

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## Preface

In response to a request from the Government of the Socialist Republic of Vietnam, the Government of Japan decided to conduct a study entitled "Renewable Energy Master Plan in the Northern Part of the Socialist Republic of Vietnam" and entrusted the study to Japan International Cooperation Agency (JICA).

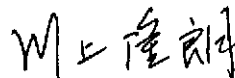
JICA sent a study team led by Mr. Katsuhiko Otaki of Proact International Inc. to the Socialist Republic of Vietnam four times from January 2001 to March 2002.

The team had intensive discussions with the officials of the Government of the Socialist Republic of Vietnam on off-grid rural electrification. They examined renewable electricity model plans from technical, financial and institutional viewpoints, and compiled the final results in this report.

I hope this report will contribute to the promotion of rural electrification in remote areas of northern Vietnam and to the strengthening of bilateral relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Socialist Republic of Vietnam for their close cooperation throughout the study.

July 2002



*Takao Kawakami*

President

Japan International Cooperation Agency

July 2002

Mr. Takao Kawakami  
President  
Japan International Cooperation Agency

Dear Mr. Kawakami,

Letter of Transmittal

I am pleased to submit to you the report of the study on Renewable Energy Master Plan in the Northern Part of the Socialist Republic of Vietnam.

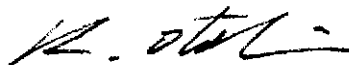
This study primarily aimed at developing feasible plans of off-grid rural electrification in northern Vietnam where people bear hardship in living. We focused on renewable energy sources such as micro-hydro or solar that can be found in target villages because grid extension is viewed impractical in remote mountainous areas. It is important to secure "sustainability" in planning off-grid rural electrification. We thoroughly examined technical issues as well as financial and organizational factors to formulate workable model plans. In addition, for smooth execution of off-grid projects, we designed this report to be practical so that the officers in charge of off-grid rural electrification can refer to it easily.

I highly appreciate the suggestions given to me by the authorities concerned of the Government of Japan and your Agency. Also, comments made from the Electricity of Vietnam and the Institute of Energy, the counterparts of this study, are reflected in this report.

In view of the underlying strong need for rural electrification in Vietnam, it is recommended that the Government of Vietnam push forward the implementation of off-grid rural electrification using the model plans in this report. The necessary steps to be taken early would include developing technical base, strengthening relevant organizations and making financial arrangements.

I would like to take this opportunity to express my sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Economy, Trade and Industry. I also wish to express my deepest appreciation to all the relevant agencies of the Socialist Republic of Vietnam for their friendship and close cooperation during the study period.

Very truly yours,



Katsuhiko Otaki

Team Leader

The Study on Renewable Energy Master Plan  
in the Northern Part of the Socialist Republic of Vietnam

## **Background and Objectives**

Rural electrification is one of the priorities in social development, narrowing the gap between rapidly growing urban areas and underdeveloped areas, and is being strongly promoted by the Government of Vietnam. Also, international aid organizations are shifting their focus to "Basic Human Needs" or "Poverty Alleviation". Rural electrification is highlighted under these goals. The Government of Vietnam has set a goal that all the communes will be electrified by the year 2010. Large-scale grid extension projects have been actively undertaken with foreign aid to electrify more than 700 communes in remote areas within a few years. In contrast, off-grid rural electrification has not been implemented aggressively. There will be more than 200 communes that long for off-grid electricity but where grid extension cannot be expected due to geographic or financial difficulties. These communes are mostly located in northern mountainous areas where the commune electrification is significantly low at around 50%.

Renewable energy such as micro-hydro power and photovoltaic power is drawing a lot of attention from the viewpoint of global environmental issues. If appropriate technologies are available, these renewable resources can be exploited to supply a minimum level of electricity to meet the basic needs of rural people. Also, this effort will contribute to the mitigation of global warming. However, there were very few off-grid renewable electricity projects carried out in Vietnam. In 1999, the Government decided that off-grid rural electrification should be promoted by provincial governments, not by EVN. The provincial governments, therefore, urgently need to prepare for the acceleration of off-grid projects.

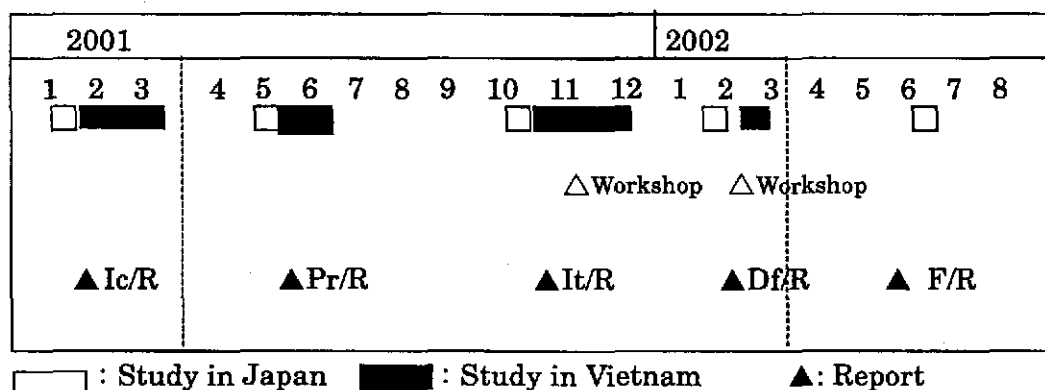
This JICA development study was started amid such background. Its goal was to identify the causes of stagnant off-grid renewable electricity projects and to present concrete ideas on the acceleration of micro hydro and solar projects in northern Vietnam as a means of rural electrification. Targeting the provincial governments that are to spearhead off-grid rural electrification in remote areas, this study aimed at providing useful data and information on off-grid development such as viable off-grid model plans. As a result, this report does not elaborate very much on a "master plan" for long-term off-grid rural electrification. Rather, it proposes a lot of ideas useful for the sustainable development of off-grid electricity in remote areas. In this regard, this study report can be better described as a practical reference book on off-grid development based on the conditions of rural Vietnam.

## Outline of Study

This study project was intended to work out feasible ideas for sustainable renewable electricity development—model plans—and to transfer these ideas to the people who are responsible for promoting rural off-grid electrification in Vietnam. First, we concentrated on collecting data on un-electrified communes, and created a database on those communes. At the next stage, model plans for off-grid electricity development were examined from the viewpoints of sustainability and replicability. During the course of this study, we tried as much as possible to transfer our findings and recommendations to provincial government officials who are supposed to lead off-grid projects from now on.

### 1. Study schedule

In the original timetable, this study was scheduled to be completed in December 2002. However, considering the urgency of rural electrification in northern Vietnam, the study schedule was reviewed after the first visiting to Vietnam in February 2001 and changed to finish five months earlier.



**First survey in Vietnam : Visiting 17 provinces to identify un-electrified communes / (January to March 2001) Study on rural electrification policy**

A presentation was given to EVN and IE on our experience in off-grid rural electrification. Work-flow and timing of this study were discussed. We visited all the target provinces and had discussions with provincial governments.

**Second survey in Vietnam : Detailed survey at candidate communes. (May to June 2001)**

Detailed data necessary for off-grid model plans were gathered through a series of site surveys. The data on un-electrified communes were updated.

### **Third survey in Vietnam : Discussions on model plans / Technical workshop**

(October to December 2001)

Preliminary model plans on micro-hydro and solar systems were discussed with a focus on sustainability. Cost estimation on micro-hydro model plan was done intensively for financial evaluation. Also financial arrangement for off-grid projects was discussed with the World Bank and JBIC. We held a technical workshop inviting the 17 provinces to present our plans for off-grid electricity.

### **Fourth survey in Vietnam : Discussions on Draft Final Report /**

(February to March 2002) **Workshop on rural electrification by renewable electricity**

We presented our basic concepts for off-grid electrification: Village Hydro and Village Solar.

## **2. Study team**

EVN was the formal counterpart organization of this study. EVN organized a working group including the Institute of Energy (IE) and Power Company 1. Dr. Pham Khanh Toan, deputy director of IE, acted as chief coordinator on the Vietnamese side. Thanks to his arrangements, our study went smoothly and generated good results.

On the Japanese side, a joint team between PROACT International and Tohoku Electric Power conducted this study. The study team members and their responsibilities were as follows.

<u>Responsibilities</u>	<u>Name</u>
Team leader / Rural electrification planning	Katsuhiko Otaki
Micro hydropower / Wind power	Adam Harvey
Photovoltaics	Akio Shiota
Hydrology	Kazunari Oshima
Electric equipment	Hitoshi Kashiwagi (until September 2001)
Electric equipment	Yasumasa Yamazaki (from October 2001)
Institutional development /Socio-economic survey	Noriyuki Yoshida
Socio-economic survey	Chiyoko Miyata
Financial planning/Economic and financial analysis	Kentaro Yamaza
Program coordination	Yoshihiro Ogasawara



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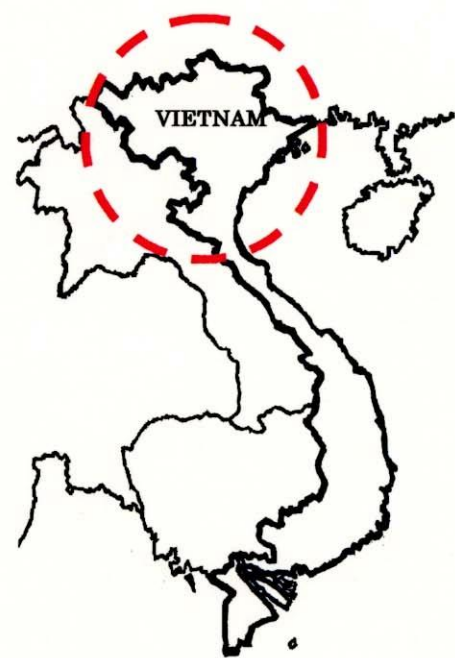
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## Acronyms and abbreviations

ADB	Asian Development Bank
AFD	Agence française de Développement
BCS	Battery Charging System
C/C	Charge Controller
CDM	Clean Development Mechanism
CEMMA	Committee for Ethnic Minorities and Mountainous Areas
CEU	Community Electricity Unit
CO <sub>2</sub>	Carbon Dioxide
DSI	Development Strategy Institute
DOI	Department of Industry
DOSTE	Department of Science, Technology and Environment
EIA	Environmental Impact Assessment
EIRR	Economic internal rate of return
ELCB	Earth Leakage Circuit Breaker
EVN	Electricity of Vietnam
FIRR	Financial internal rate of return
FRP	Fiber Reinforced Plastic
F/S	Feasibility Study
GIS	Geographic Information System
GOV	Government of Vietnam
HH	Household
IE	Institute of Energy
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
LED	Light Emitting Diode
MARD	Ministry of Agriculture and Rural Development
MCB	Miniature Circuit Breaker (Over-current breaker)
MOF	Ministry of Finance
MOI	Ministry of Industry
MOSTE	Ministry of Science, Technology and Environment
MOLISA	Ministry of Labor, Invalids and Social Affairs
MPI	Ministry of Planning and Investment
NPV	Net Present Value
NGO	Non-Governmental Organization
ODA	Official Development Assistance

O & M	Operation and maintenance
OJT	On-the- job training
PC	Power Company
PCF	People's Credit Fund
PPC	Provincial People's Committee
PRSP	Poverty Reduction Strategy Paper
PV	Photovoltaic
PVC	Polyvinyl Chloride
REAP	Renewable Energy Action Plan
RSES	Registration for Securing Environmental Standards
SHS	Solar Home System
TA	Technical Assistance
UNDP	United Nations Development Program
\$	US dollar (\$1=15,000VND as of March 2002)
VAT	Value Added Tax
VBARD	Vietnam Bank for Agriculture and Rural Development
VBP	Vietnam Bank for the Poor
VND	Vietnamese Dong
VPB	Voltage Protection Board
VWU	Vietnam Women's Union
135 Program	Program on the Socio Economic Development in Mountainous, Deep-lying Bs Remote communes, with special difficulties (Decision No,135/QD-TTg of July 31,1998)
Off-grid	Stand-alone power supply (not grid-connected)
Pico-hydro	Inexpensive 100W class propeller turbine generator for individual household
Pico-plus	Upsized Pico-hydro generator, the capacity of which is 2kW or less, with a voltage controller
Village Hydro	A concept of micro-hydro scheme sustainable for power supply in rural communities, which is proposed in this report
Village Solar	A concept of photovoltaic systems having SHS and BCS to serve public building and individual battery users in rural communities, which is proposed in this report

# Study Area



# **Section 1 Rural Electrification in Northern Vietnam**

## **Chapter 1**

---

### **Rural Electrification in Northern Vietnam**

#### **1-1 Current Status of Rural Electrification**

##### **1-1-1 Background**

Like other developing countries, the Government of Vietnam (GOV) has been making strenuous efforts to provide electricity to rural people to improve their standard of living and to increase their incomes. The Prime Minister's Decision No.22/QD-TTg of 1999 set a goal that all districts, 80% of communes and 60% of rural households in Vietnam would be electrified by the year 2000. In fact, at the end of 2000, 96.4% of districts, 81.9% of communes and 73.5% of rural households benefited from the national power grid. Table 1-1-1 shows that the electrification of communes in the Red River Delta, Mekong Delta and Southeast regions is almost completed. However, in other regions the ratio of commune electrification is still low, and the northern part of Vietnam, in particular, has the lowest figure of less than 65%.

The official definition of "rural electrification" in Vietnam is that a commune is electrified when its center gets electric power service either from the grid or stand-alone generation system. It is important to note that there are many villages—outskirt villages—left un-electrified in a commune that is already "electrified".

Renewable electricity development is surging in both industrial and developing countries. It has been drawing a lot of attention because tackling the global warming problem has become a major topic in the international society. Vietnam is endowed with small hydro power and solar power resources, both having considerable potential

to supply electricity to rural households. In remote isolated villages, such renewable energy is viewed more cost effective as a means of electricity supply compared with the conventional method of grid extension.

**Table 1-1-1 Electrified communes in Vietnam**

Region	Number of Communes		Electrification Rate
	Total	With grid access	
Northern midland, mountainous areas	2636	1709	64.8%
Red River Delta	1388	1388	100%
North central coast	1632	1419	86.9%
South central coast	810	713	88.0%
Central Highland	501	389	77.6%
South-east	402	401	99.8%
Mekong Delta	1202	1200	99.8%
<b>Whole Vietnam</b>	<b>8571</b>	<b>7219</b>	<b>84.2%</b>

Source: EVN data (as of December 2001)

In Vietnam rural electrification has been promoted primarily by grid extension so far, which has been carried out by Electricity of Vietnam (EVN) and regional Power Companies (PCs). In addition, two major grid extension projects, financed by loans from the World Bank Group and Agence Francaise de Developpment (AFD), have started with an aggressive goal of covering 90% of rural households by 2005. These projects will, of course, significantly contribute to raising electrification rates in rural Vietnam. However, there will still remain a number of remote communes where the grid cannot be extended for technical or financial reasons. Those communes have no choice but to go for off-grid electrification.

Long time ago, off-grid electrification by micro hydropower, usually combined with irrigation facilities, used to be carried out by Provincial People's Committees (PPCs), under the financing and supervision of the Ministry of Agriculture and Rural Development (MARD). There was a period of EVN's overall responsibility for rural electrification, both on-grid and off-grid, before the Decision No.22 was issued in 1999. Now, implementing off-grid electrification projects has returned to the responsibility of PPCs. Given this situation, EVN will no longer invest in off-grid electrification on their own, rather they will act as a coordinator of promoting off-grid projects and focus on technical support in the design, operation and maintenance of off-grid electricity.



Unfortunately there are only few off-grid electrification projects carried out under the initiative of PPCs in the last decade. Therefore, the capability of PPC engineers to implement off-grid electrification, from project planning to construction and operation, is lacking. This will be a major obstacle in accelerating off-grid projects in the future.

At the request of EVN, the Japan International Cooperation Agency (JICA) started this study — Renewable Energy Master Plan in the Northern Part of the Socialist Republic of Vietnam — in January 2001 to assist EVN and 17 Provinces in northern Vietnam to implement off-grid projects on a large scale. The focus of this study has been placed on developing concrete ideas and their implementation plans of sustainable off-grid renewable electricity schemes suited for rural Vietnam.

### 1-1-2 Rural electrification in northern Vietnam

A series of field interviews at 17 PPC offices and Power Company 1 (PC1) branch offices revealed that 277 communes will remain not connected to the national grid in northern Vietnam even after the year 2005 (See Table 1-1-2). We may call those communes as “off-the-grid communes”. Meanwhile, the number of the off-the-grid communes may change because the commune-level grid-extension plan in each province has not been finalized yet.

**Table 1-1-2 Target provinces and off-the-grid communes**

	Province	March 2001	After 2005 *
1	Hoa Binh	50	13
2	Bac Giang	17	0
3	Phu Tho	77	25
4	Thai Nguyen	25	0
5	Bac Can	69	7
6	Son La	127	38
7	Cao Bang	42	14
8	Lai Chau	125	52
9	Ha Giang	110	40
10	Lao Cai	113	31
11	Yen Bai	59	7
12	Lang Son	68	1
13	Quang Ninh	37	7
14	Thanh Hoa	108	21
15	Nghe An	60	21
16	Ha Tinh	2	0
17	Tuyen Quang	12	0
	Total	1,101 <sup>1</sup>	277

\*As of November 2001

<sup>1</sup> According to PC1, 100% of communes in Ha Tinh province have been connected with grid in June 2002 and the number of off-the-grid communes in the remaining 16 provinces is 1017.

### **1-1-3 Grid extension and financing**

So far, EVN has been investing, on average, \$10 million in rural electrification every year. In addition, the two big loans from the World Bank (\$150 million targeting whole Vietnam) and ADF (\$17 million targeting southern Vietnam) will accelerate grid extension in remote areas, and more than 700 communes will be newly electrified by the year 2005. After that, EVN is going to shift their investment focus from “electrification of commune center” to “electrification of outskirt villages”, rather than extending the grid much further. Negotiation with the World Bank to secure necessary funds to upgrade the existing rural grid network is now underway. As mentioned earlier, EVN is no longer responsible for off-grid rural electrification. Therefore, those communes not included in the current grid extension plan must consider off-grid electrification, which is to be led by provincial authorities.

### **1-1-4 The Renewable Energy Action Plan**

Apart from the \$150 million grid extension project, the World Bank has been promoting a comprehensive plan for rural electrification by renewable energy. This project is titled “the Renewable Energy Action Plan (REAP)”, and has the following component programs.

- ① Policy and Institutional Development
- ② Individual Household/Institutional System
- ③ Community Isolated Hydro Grids
- ④ Grid-connected Renewable Electricity
- ⑤ Technology/Market Development

This JICA study and the REAP, therefore, are closely related to each other. Exchange of information has been undertaken between both parties in many occasions. The final REAP report to address future focus areas and action plans was published in June 2001. To follow through the REAP report, the World Bank is discussing a special financial arrangement and some pilot projects with the Ministry of Industry (MOI) and EVN. Also, some provinces have been involved in the discussion. The MOI has already established the Project Management Board as an ad-hoc organization to promote off-grid projects with the World Bank. The first phase of World Bank funding for off-grid projects will come into reality in late 2002.

## 1-2 Poverty Alleviation

### 1-2-1 Poverty status in Vietnam

There have been dramatic reductions in the incidence of poverty in Vietnam during the 1990's. Table 1-2-1 shows that the proportion of people whose per capita expenditure was under the total poverty line<sup>2</sup> (1,160,000VND in 1993 / 1,789,700 VND in 1998) dropped from 58% in 1993 to 37% in 1998. However, the poverty rate still remains high, especially in northern Vietnam and Central Highlands where a large number of ethnic minority people live under harsh natural conditions and social infrastructures are not well developed.

**Table 1-2-1 Incidence of Poverty by Region (1993 and 1998)**

Region	1993	1998
Northern midland, mountainous areas	79%	59%
Red River Delta	63%	29%
Northern area of Central Vietnam	75%	48%
Central Coastal Area	50%	35%
Central Highlands	70%	52%
Eastern area of Southern Vietnam	33%	8%
Mekong Delta	47%	37%
<b>Whole Vietnam</b>	<b>58%</b>	<b>37%</b>

Source: Vietnam: Attacking Poverty (Vietnam Development Report 2000) World Bank

### 1-2-2 Government policy on poverty alleviation

The GOV recognizes poverty alleviation is a key social policy target, and has implemented relevant measures to reduce poverty and improve the living standard of people. Especially, the National Target Program on Hunger Eradication and Poverty Reduction for 1998-2000 (HEPR) (Decision No.133/QD-TTg of 1998) was effectively implemented, and extended to other relevant policy measures.

<sup>2</sup> Total poverty line is one of the methods to define the poverty line (covering food commodities and non-food commodities), based on international standards.

**Table 1-2-2 Primary programs for poverty alleviation**

Policy title / Program	Leading organizations
Socio-economic development plan for 2001-05 Socio-economic development strategy for 2001-10	DSI <sup>3</sup> /MPI <sup>4</sup>
Hunger Eradication and Poverty Reduction Plan for 2001-05 Hunger Eradication and Poverty Reduction Strategy for 2001-10	MOLISA <sup>5</sup>
Program on the socio-economic development in mountainous, deep-lying and remote communes with special difficulties 1998-2005 (135 Program)	CEMMA <sup>6</sup> / MPI/MARD <sup>7</sup> and other ministries

In addition, the Program on the Socio-economic Development in Mountainous, Deep-lying and Remote Communes with Special Difficulties (Decision No.135/QD-TTg of 1998) has been implemented as one of the prime poverty-alleviation programs for the ethnic minorities in extremely poor areas. This program is called "135 Program" after the decision number, and targets ethnic minority communes with special difficulties mostly in mountainous or border areas (2,325 communes as of 2001). It aims to improve living standards by increasing agricultural production, income and enhancing social services. Normally, infrastructure projects such as road improvement or irrigation system development are carried out under this program with an average yearly budget of 400 million VND per commune. It is clear that most of the target communes of this study overlap the communes supported by the 135 Program.

### 1-2-3 Poverty Reduction Strategy Paper

The Poverty Reduction Strategy Paper (PRSP) has been drafted by the GOV with strong support from the World Bank. The PRSP is an official document in which economic development policies and poverty reduction measures are addressed. In the Interim-PRSP, which was completed in March 2001, the GOV clearly expressed their intension to promote the support programs on improving infrastructures for ethnic minorities more than before. When the Full-PRSP is formulated near future, it will have much influence on foreign donors' policies about poverty alleviation.

In the process of formulating the PRSP, the GOV reviewed poverty reduction measures on each socio-economic sector in cooperation with foreign donors. As for

<sup>3</sup> Development Strategy Institute

<sup>4</sup> Ministry of Investment and Planning

<sup>5</sup> Ministry of Labor, Invalids and Social Affairs

<sup>6</sup> Committee for Ethnic Minorities and Mountainous Areas

<sup>7</sup> Ministry of Agriculture and Rural Development

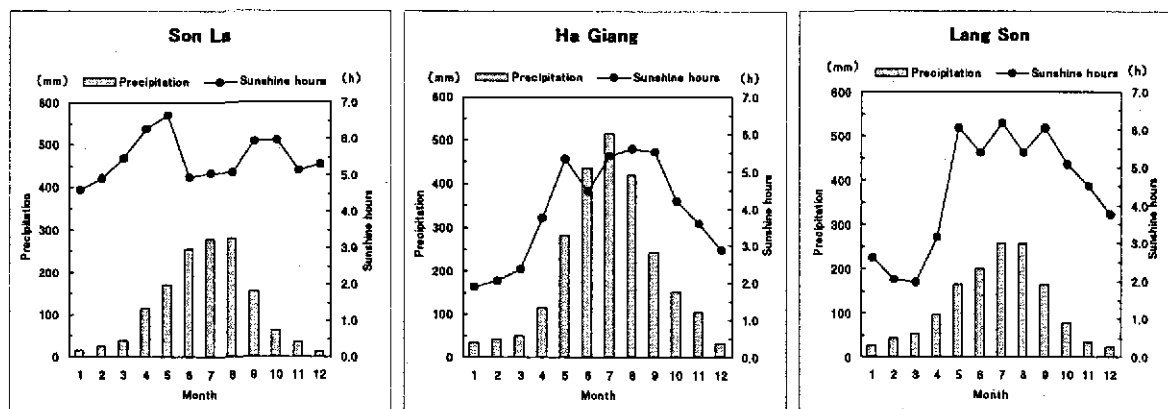
“rural electrification” in the field of infrastructure, it is indicated that more than 200 communes located in remote areas will be excluded from future grid extension plans and, therefore, require off-grid projects. Thus, off-grid rural electrification that had been lagging behind is becoming a focus in the social development of Vietnam. A comprehensive action plan on off-grid rural electrification needs to be formulated.



Status of the Study Area

2-1 Natural Conditions

Northern Vietnam belongs to the tropical-monsoon climate, but has change of seasons. During the rainy season from May to October, it is hot and humid, and rainfall in Hanoi reaches 300mm per month. On the other hand, in the dry season from January to March, cloudy weather continues with haze and drizzle. Daily sunshine hours, therefore, are very short in most of the region, from December to March in particular. In mountainous areas, rainfall is more than that in the plain, and temperature is lower. However, the average wind speed is only 1 or 2 meters per second in this region except for the coastal areas.



Source: JICA study team processed data provided by IE

Figure 2-1-1 Precipitation and sunshine in northern Vietnam

Limestone dominates in the geological foundation, which formulates the Karst topography and a complex underground water vein network.

2-2 Characteristics of Target Area

2-2-1 Outline

Table 2-2-1 summarizes the characteristics of communes that will remain not connected to the grid even after 2005. On average, each commune has ten villages and 460 households. Most of the communes have common characteristics such as widely dispersed villages, long distance from the existing medium voltage distribution line and low income per capita, etc. All this clearly makes it difficult to pursue grid extension.

On the other hand, there are rich water resources in northern Vietnam, which implies a good potential for off-grid electrification. However, most potential small hydro sites in those communes have not been surveyed yet, due to difficulty in securing access or insufficient budget.

**Table 2-2-1 Outline of the off-the-grid communes**

	Average number of villages in commune	Average population in commune	Average number of households in commune	Average income/capita (million VND)	Yield (rice) (t/yr)	Dist 1* (km)	Dist 2* (km)	Dist 3* (km)
HaGiang	10	2577	445	1.103	450	4.2	6.0	8.5
CaoBang	11	2066	330	0.947	422	4.1	6.4	17.4
QuangNinh	5	1386	251	1.287	381	2.7	4.7	18.1
BacCan	5	1924	315	1.374	502	4.2	6.5	12.5
YenBai	8	1903	302	1.471	481	8.5	10.5	18.7
PhuTho	7	3833	816	1.767	765	3.5	5.2	13.0
HoaBinh	8	1881	330	1.257	359	3.1	4.3	10.0
SonLa	14	3597	553	1.266	470	5.2	7.2	29.9
LaiChau	11	2634	402	0.759	485	5.6	8.4	35.1
LaoCai	8	2017	316	1.058	386	4.2	6.2	23.5
ThanhHoa	10	3526	631	1.047	760	4.0	6.2	42.8
NgheAn	9	2776	420	1.103	461	7.6	10.0	32.1
<b>Weighted Average</b>	<b>10</b>	<b>2744</b>	<b>460</b>	<b>1.132</b>	<b>500</b>	<b>4.8</b>	<b>7.0</b>	<b>24.2</b>

\*1: Average distance between villages \*2: Maximum distance between villages \*3: Distance from MV grid

Source: JICA study team, 2001

There are many ethnic minorities living in those areas, normally making a self-sufficient life from rice growing and animal husbandry. Infrastructures have not been well developed yet and the poverty rate is relatively high. However, it is said that there is a historically strong communal mechanism in rural Vietnam through collaborative agricultural work and management of communal fields. Owing to this, rural people are quite accustomed to organizational management, which should be taken into account in community development work such as off-grid electricity development.

### 2-2-2 Status of an un-electrified rural area—model commune

In this study, some model communes were studied in depth to formulate the model plans of off-grid rural electrification. Here, the conditions of Mien Doi Commune in Hoa Binh Province are presented to show a good example of an un-electrified commune in northern Vietnam.



(1) Geography

Most un-electrified communes in northern Vietnam are located in mountainous areas where road conditions are poor and access by car is difficult. Mien Doi Commune is located about 20 kilometers from the district center, Lac Son, and has beautifully maintained terraced rice fields. There are nearly 700 households in twelve villages that are scattered out in the commune. To get there in the rainy season is quite difficult because of muddy roads. The average distance between villages is three kilometers. House density in a typical village is low and most houses are located along footpaths. Some houses are found on the slope of hills or near rivers.

Province	Hoa Binh
District	Lac Son
Commune	Mien Doi
Number of Villages	12
Population	3797
Number of Households	707
Ethnic structure	Muong 99%, Kinh
Average income/capita	1,000,000 VND
Distance*	3.0km

\* Average distance between villages

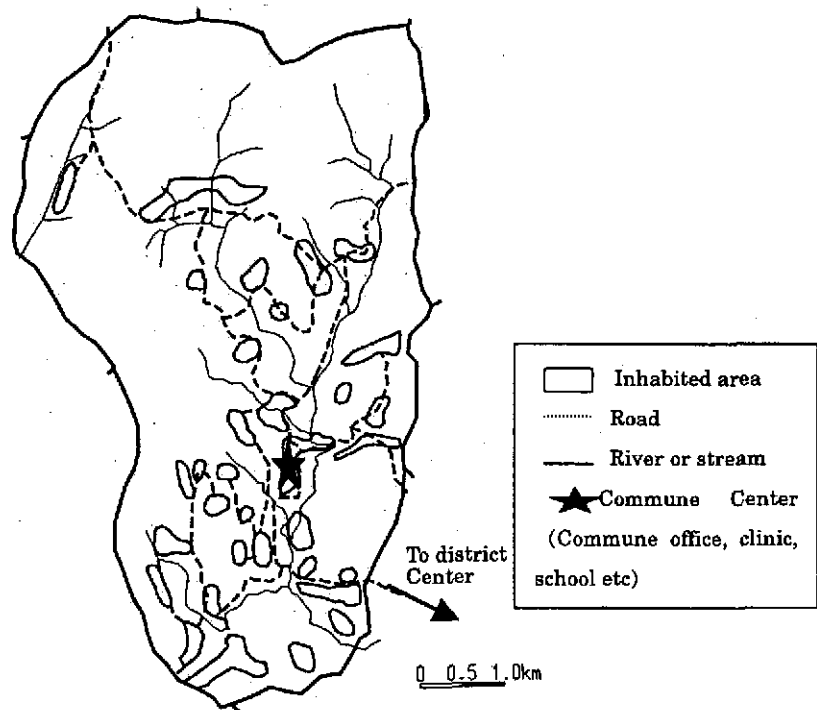


Figure 2-2-1 Village distribution in Mien Doi Commune

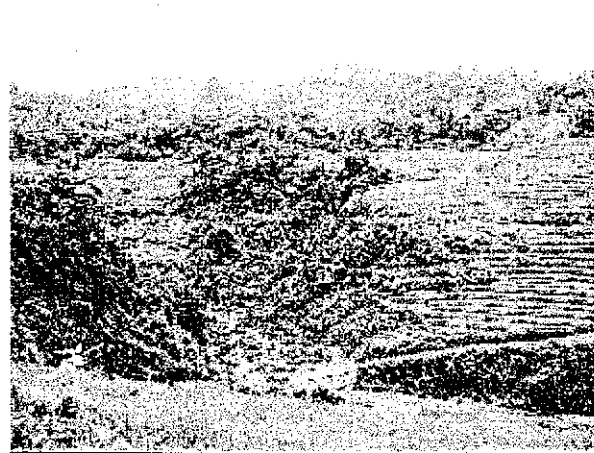


Figure 2-2-2 Terraced rice fields in Mien Doi Commune

## (2) Income

Most people in the commune are engaged in agriculture primarily for self-consumption. They sell livestock and some excess products such as rice, fruits and vegetables to generate cash income. However, their income is limited due to insufficient land for cultivation and under-development of irrigation systems.

## (3) Energy use

They use firewood for cooking and kerosene (diesel oil) for lighting and for operating motors of rice mills, etc. The retail price of kerosene is 4,000 to 5,000VND per litter, and typically two to three litters are consumed per household every month.

About a half of total households use tiny pico-hydro generators (100W class), which are available at about \$20 per unit, for lighting and TV/radio taking advantage of small streams near their houses. (See Table 2-2-2) However, they cannot use the pico-hydro generators all the year round. In the dry season and flood season, they have to use kerosene lamps instead. The rest of households use only kerosene lamps for lighting. Although the power supply from pico-generators is often unstable, people enjoy them. This fact suggests that there is a quite large underlying demand for electricity supply in remote villages. There are few battery users due to difficulty of charging.

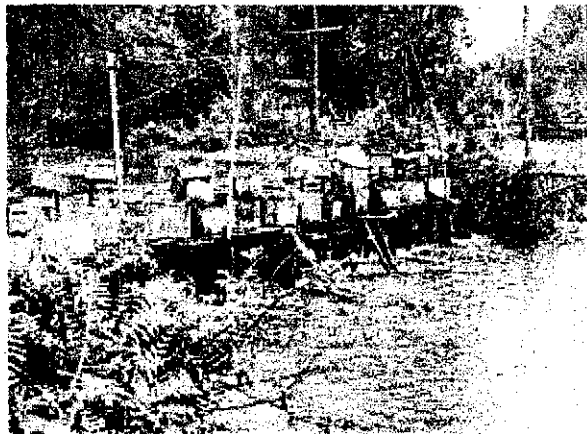


Figure 2-2-3 Pico-hydro generators

Table 2-2-2 Electric appliance usage in Mien Doi

Electric appliance	Light	TV(B/W)	Fan	Radio*
Possession rate	50.1%	29.8%	26.0%	53.4%

\*Including dry battery type

If their village is electrified by a micro-hydro power station, which can supply more stable and constant power, the villagers will appreciate it and agree to pay for electricity. The maximum amount they are willing to pay for electricity supply was investigated through interviews. The survey results are shown in Figure 2-2-4. About 75% of respondents are willing to pay 10,000 to 20,000 VND or even more per month for electricity. Money in that range is nearly equal to or slightly larger than their monthly energy expenses. Additionally, in an interview survey with the commune leaders, they said that average villagers in Mien Doi could afford up to 20,000 VND per month for electricity.

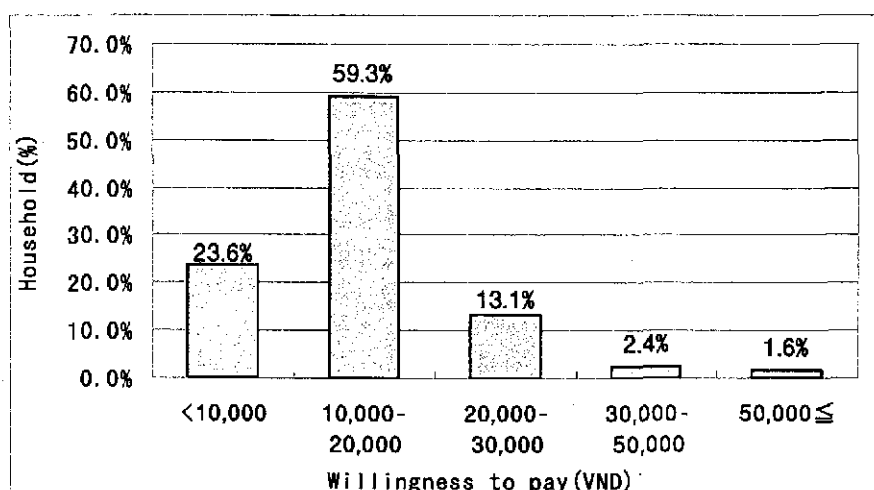


Figure 2-2-4 Willingness to pay for electricity in Mien Doi

According to a survey conducted in the REAP of the World Bank, the willingness to pay for electricity in rural Vietnam is estimated at 1,820VND/kWh. If this figure is applied to a typical consumption of 6kWh/month ( $50W \times 4h \times 30$  days) per household, the monthly payment would be around 11,000 VND. In case of 10kWh/month ( $70W \times 5h \times 30$  days) the monthly payment would go up to 18,000 VND. These figures match our survey results, so that the figure of 1,820 VND/kWh fairly represents the willingness to pay for electricity in rural Vietnam.

## **2-3 Database of Un-electrified Communes**

### **2-3-1 Objective of database creation**

Vietnam has been promoting electrification through the extension of the transmission and distribution network. This approach should be given the first priority from the long-term view of developing a national electricity network and providing reliable electricity supply. Meanwhile, the target communes of this study are not included in the grid extension plans. A financially and technically viable off-grid electrification plan must be formulated for each target commune based on its conditions. A good tool for analyzing off-grid electrification plans would be a computerized database that compiles relevant data of un-electrified communes in a user-friendly format. The rural electrification planners of the government or provincial authorities will be able to check the status of remote villages when they need to draw up or update their electrification plans. By referring to the commune data in the database, they can assess various development ideas and work out a feasible project. With such an objective in mind, we created a database of un-electrified communes by using Geographic Information System (GIS) software.

### **2-3-2 Data structure and investigation methods**

The JICA survey team, during its first site survey, identified more than 250 un-electrified communes in northern Vietnam that have no prospects of grid connection before 2005. Based on the data gathered during the first survey, we started to create a database that comprises five different data categories: basic data such as the number of households, income data to assess the payment ability for electricity consumption, village data to estimate costs for distribution network, infrastructure data such as access routes, and potential of renewable electricity. After the first survey, necessary data have been continuously added and updated by a designated local agent. (See Table 2-3-1)

**Table 2-3-1 Data items and survey methods**

Data items	Unit
<b>(1)Basic commune data</b>	
• Latitude and longitude	Degree
• Population	
• Number of households	
• Main ethnic group	Name of ethnic group
• Ratio of dominant ethnic group	%
<b>(2)Income data</b>	
• Average income	×10 <sup>6</sup> VND/yr·capita
• Area of rice fields	ha
• Number of harvests	Time/yr
• Rice yields	ton/yr
• Sales price of rice	VND/kg
<b>(3)Village data in commune</b>	
• Number of villages	
• Average distance between villages	km
• Maximum distance between villages	km
<b>(4)Infrastructure data</b>	
• Project on roads under the 135 Program	Yes/No
• Project on irrigation under the 135 Program	Yes/No
• Transportation in dry season	Vehicle / bike / walk
• Transportation in rainy season	Vehicle / bike / walk
• Road availability throughout year	Yes/No
• Maximum distance for crossing a stream	m
• Clinic	Yes/No
• Elementary school	Yes/No
• Market	Yes/No
<b>(5)Rural electrification data</b>	
• Distance from mid-voltage transmission network	km
• Number of installed pico-hydro generators	
• Micro hydropower potential	Yes/No
• Hours of sunshine in winter	Hour/day
• Micro hydropower potential in the vicinity	kW
• Micro hydropower stations in the vicinity	kW

There are 277 communes in the database, a geographical distribution map of which is shown below. Those communes are mostly located in mountainous border areas.

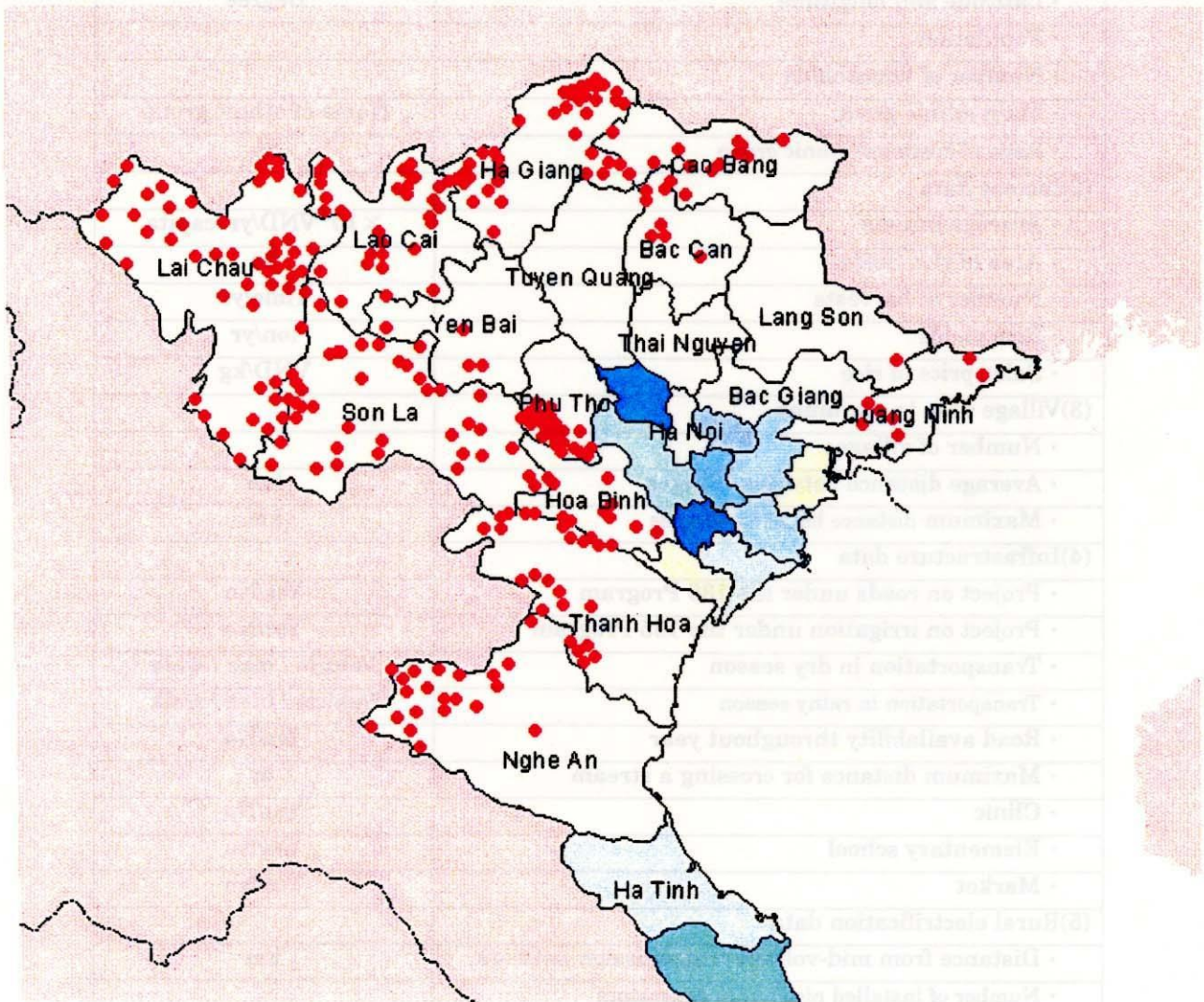


Figure 2-3-1 Distribution map of off-the-grid communes

### 2-3-3 Database software and data screen

The database should contain various information useful for future rural electrification planning. Also, it should have sophisticated search functions to easily find out appropriate communes that meet certain criteria. Therefore, the database was created by using ArcView, popular GIS software. The data screen showing both commune location and its information at the same time makes search and analysis work easy. (See Figure 2-3-2) By using the database, PPC engineers will be able to assess the feasibility of off-grid electrification plans for each commune.

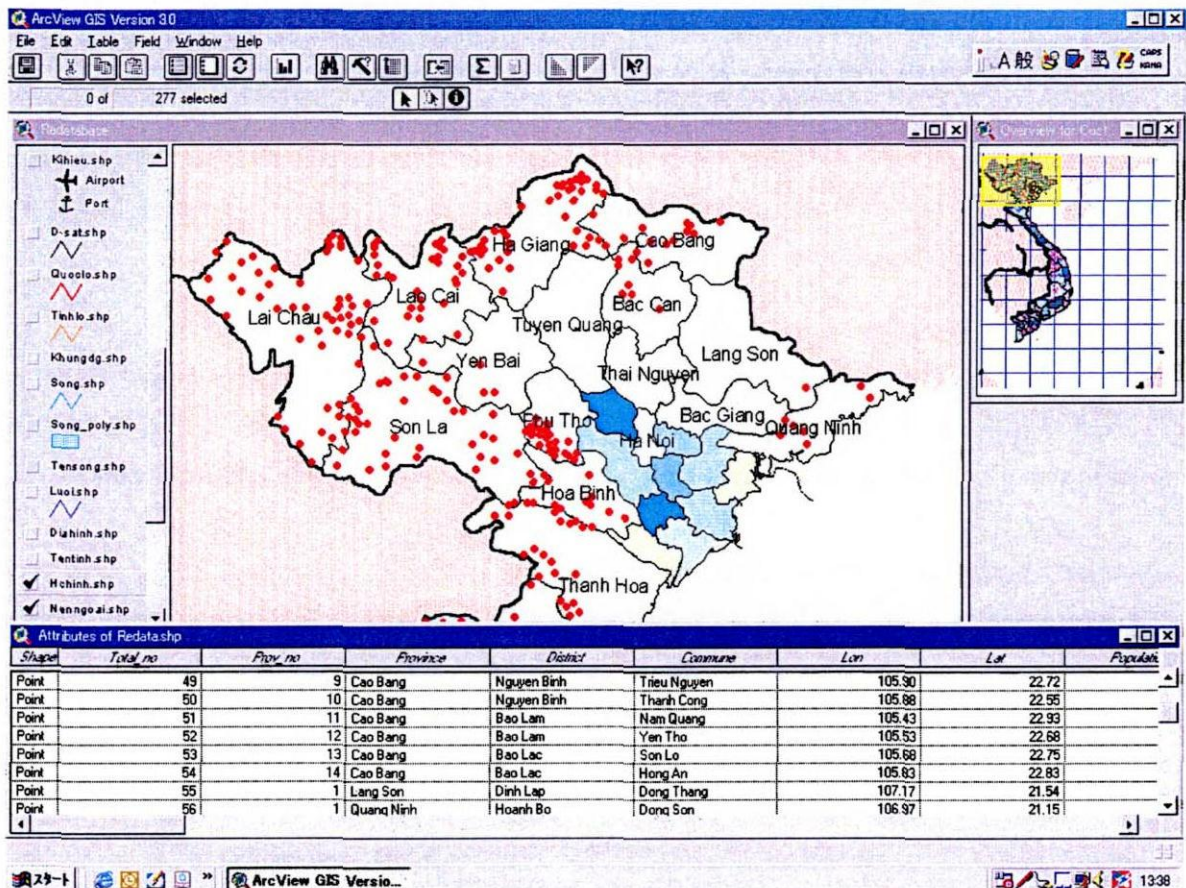


Figure 2-3-2 Data screen

## 2-4 Criteria for Selecting Communes

### 2-4-1 Micro-hydro development

#### (1) Resources

It is unlikely that a 30 to 50kW class hydro site that is suited to cover a whole commune can be easily found in every commune. It is recommended to focus on smaller micro-hydro resources under 10kW. Even if a good micro-hydro site is found in an off-the-grid commune, the next criterion to be met is the distance between the site and the central area of commune. If the distance is quite long, the transmission cost will rise, which undermines the financial feasibility of the micro-hydro project.

#### (2) Coordination with irrigation

Water usage for irrigation purpose should be surveyed before deciding the amount of water to be used for hydropower generation. Necessary volume of irrigation water should be secured. However, when the water resource is limited, a compromise between irrigation and power generation will be necessary.

### (3) Population distribution

In case of micro-hydro development, the cost of the transmission and distribution system has a significant impact on the overall economics of the plan. Densely populated areas should be given priority because those areas can reduce the length of wires and cables per household. For example, communes where houses are clustered along main roads are recommendable for early development.

### (4) Accessibility

Considering the ease of constructing the micro-hydro plant, it is desirable to secure good roads to transport heavy equipment and materials by trucks. It is, therefore, necessary to check the road conditions and methods of crossing streams and rivers.

### (5) Affordability and people's participation

As a rule in Vietnam, villagers need to pay the connection (service drop) fee when they apply for grid connection. In mountainous areas, houses are scattered out so that the wires necessary to connect houses to the low voltage distribution line are usually very long. The applicants, therefore, must pay a substantial amount of money for connection. In this regard, high-income communes should be considered first. At the same time, it is necessary to check the commitment and capacity (leadership and education) of villagers to manage the micro-hydro plant for a long time.

### (6) Economy

By undertaking a rough economic analysis, the proposed micro-hydro project should cost less than alternative electrification methods. In some cases, the project must clear a financial or economic threshold, FIRR or EIRR, for investment approval.

### (7) Securing technical assistance

In order to achieve the sustainability of the micro-hydro plant, it is essential to secure support from local technicians who can check and service generators and turbines, etc. In this regard, communes located in the vicinity of a Power Company branch are preferred.

### (8) Strategic considerations

PPC needs to pay attention to the strategic impacts of the micro-hydro project on local economic development, the abilities of people concerned, technology dissemination, etc. during the process of selecting priority communes. Off-grid projects with bigger strategic implications deserve early implementation.



## **2-4-2 Solar system development**

Solar systems will be considered in the areas where hydro resources are scarce.

### **(1) Resources**

Target areas for solar power are those areas where hydro resources can be hardly found. However, it is important to note that in the mountainous region near China, the sunshine hours during the dry season are very short. The limited sunshine is a very tough condition for solar systems. It is recommended to choose communes that have relatively good sunshine data. Otherwise the solar system capacity needs to be scaled up, but this cannot be easily justified from an economic viewpoint.

### **(2) Affordability and people's participation**

Villagers are requested to buy batteries and other appliances needed to use solar systems, which is not easy in underdeveloped villages. In this regard, high-income communes should be considered first. At the same time, it is necessary to check the commitment and capacity (leadership and education) of villagers to manage the solar system for a long time.

### **(3) Economy**

By undertaking a rough economic analysis using the database, the proposed solar system project should cost less than alternative electrification methods. In some cases, the project must clear a financial or economic threshold, FIRR or EIRR, for investment approval. It is important to note that solar system costs will go down in the future by the emergence of new technologies such as Light Emitting Diode (LED) lamps as well as cost reduction from economies of scale.

### **(4) Strategic considerations**

PPC needs to pay attention to the strategic impacts of the solar project on local economic development, capacity building of people concerned, technology dissemination, etc. in the process of selecting priority communes. Off-grid projects with bigger strategic implications deserve early implementation.

