Data Collection Survey
On
Energy Sector
In
The Republic of El Salvador

Final Report
(Summary)

March 2014

Japan International Cooperation Agency

Nippon Koei Co., Ltd.
KRI International Corp.

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14-010

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Currency conversion rate

1US$ = 102.35 yen

(As of February 26, 2014)

LOCATION MAP (EL SALVADOR)

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Location Map

Abbreviations

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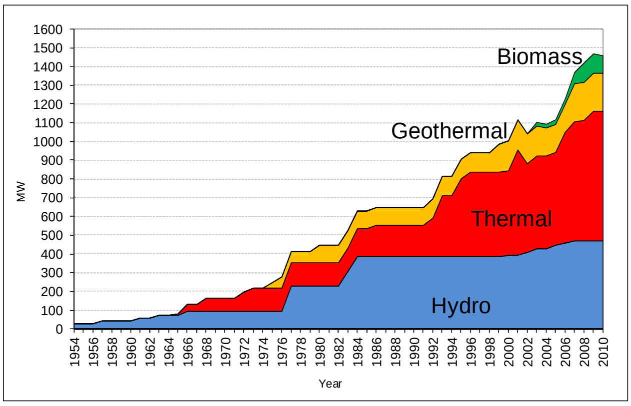
Abbreviations

Abbreviations	Spanish	English
AES	Corporación AES	AES Corporation
ANDA	Administración Nacional de Acueductos y Alcantarillados	National Administration of Aqueducts and Sewers
B/C	Costo/Beneficio	Benefit/Cost
BANDESAL	Banco de Desarrollo de El Salvador	El Salvador Development Bank
CECSA	Compañía Eléctrica Cucumacayán S.A. de C.V.	Cucumacayán Electric Company Inc
CEL	Comisión Ejecutiva Hidroeléctrica del Río Lempa	Hydroelectric Executive Committee of the Lempa River
CNE	Consejo Nacional de Energía	National Energy Council
DD, D/D	Diseño Detallado	Detailed Design
DELSUR	Distribuidora de Electricidad del Sur, S.A. de C.V.,	Distributor of Electricity of South Variable Capital Company
EIA	Evaluación de Impacto Ambiental	Environmental Impact Assessment
FS, F/S	Edtudio de Factibilidad	Feasibility Study
GAL	Galón (3.785 litro)	Gallon (3.785 liter)
GWh	Gigawatts hora	Gigawatt hour
HPMV	Mercurio de alta presión	High Pressure Mercury Vapour
IDB (BID)	Banco Interamericano de Desarrollo	Inter-American Development Bank
IRR	Tasa Interna de Retorno	Internal Rate of Return
JICA	Agencia de Cooperación Internacional del Japón	Japan International Cooperation Agency
kW	Kilo watt	Kilo watt
kWh	Kilowatt hora	Kilowatt hour
LED	Diodo Emisor de Luz	Light Emitting Diode
LNG	Gas Natural Lícuado	Liquefied Natural Gas
MARN	Ministerio de Medio Ambiente y Recursos Naturales	Ministry of Environment and Natural Resources
MEGATEC	Modelo Educativo Gradual de Aprendizaje Técnico y Tecnológico	Gradual Learning Educational Model Technical and Technological
MP, M/P	Plan Maestro	Master Plan
MW	Megawatts (=1,000 kW)	Megawatt (=1,000 kW)
MWh	Megawatts hora	Megawatt hour
NPV	Valor Presente Neto	Net Present Value
Pre-F/S	Estudio de prefactibilidad	Pre Feasibility Study
SIGET	Superintendencia General de Electricidad y Telecomunicaciones	General Superintendency of Electricity and Telecommunications

1. Background of the Survey

The energy demand of El Salvador was recorded at 5,650 GWh in 2010, which was fulfilled by an energy matrix composed of hydropower (36.8%), thermal (34.9%), geo thermal (25.1%) and biomass thermal (3.2%). According to the forecast by the National Energy Council (CNE), the energy demand is expected to increase with an annual average growth rate of 4.7% until 2026. Recently, the increased power demand has been covered through the power production of diesel power plants which were invested by the private sector in El Salvador. However, as the diesel power plants electricity is susceptive to the fuel price which is highly volatile, shift to low-cost energy sources and introduction of renewable energy which is indigenous to the country is increasingly important.



Source: SIGET Power Statistics (June 2010)

Figure 1.1.1 Historical Variation of Power Source (2010)

According to the energy policy of El Salvador which was formulated in 2010, the diversification of the energy matrix, the promotion of energy savings, and regional energy integration are taken account as important agendas. Along with the diversification of the energy matrix, the government of El Salvador promotes renewable energy and the study of the introduction of LNG to the country. Under such circumstances, JICA conducted the study of “The Project for Master Plan for the Development of Renewable Energy in the Republic of El Salvador” (herein after referred as “Renewable Energy MP”) in 2012. After the Renewable Energy MP it is expected that the small hydropower projects listed in the MP are to be realized.

On the other hand, JICA and IDB have been working together supporting Central America and the Caribbean region under the scheme of “the Co-financing for Renewable Energy and Energy Efficiency” (hereinafter referred to as “CORE Scheme”). El Salvador is included as one of the CORE scheme countries. As base policy material for energy sector support, IDB intends to prepare the “Note of the Energy Sector for El Salvador” (hereinafter referred to as Sector Note) jointly with JICA as a partner of the CORE Scheme.

Considering the possibilities of Japanese technology application in El Salvador, small hydropower and energy savings are the prospective technologies, and IDB is also interested such themes. Under such circumstances, JICA decided to conduct this survey jointly with IDB to collect required information for examination of prospective and priority projects to be developed.

2. Objectives of the Survey

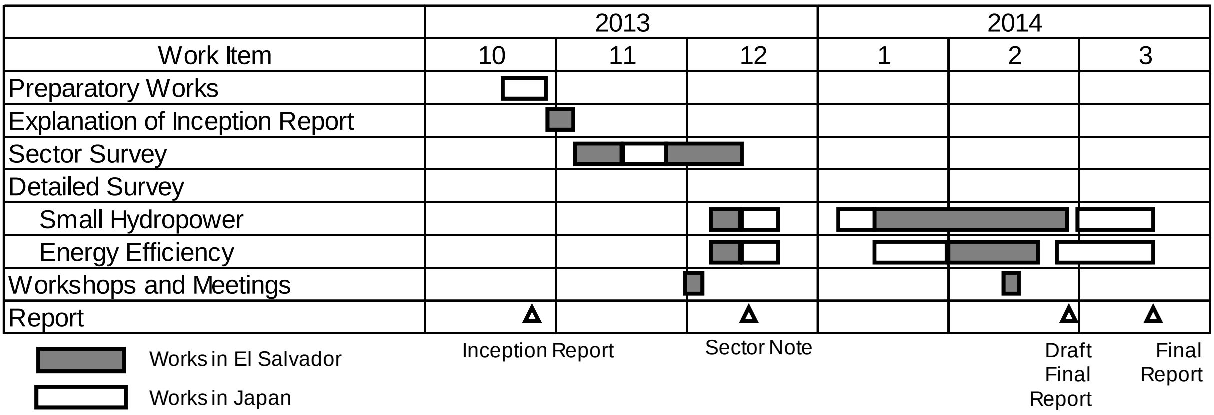
The purpose of the survey is composed of following three items.

a) Preparation of the Sector Note by studying the current situation and issues in the energy sector in El Salvador
b) Data collection, and analysis for formulating projects on energy savings and renewable energy (small hydropower) in view of future candidates for yen loan. (Detailed Survey)
c) Preparation of the materials for political dialogue on energy sector for the new regime in June 2014.

Of the above three items, compiled results of item a) "current situation and issues in the energy sector in El Salvador" are not included in this report, considering the convenience of the Government of El Salvador and the Inter-American Development Bank (IDB) who is closely related with this survey, because such results are to be used for the dialogue with the new government which is scheduled to take place in June 2014.

3. Overall Workflow of the Survey

The survey was conducted from the middle of October 2013 to the end of March 2014. The overall schedule of the survey at the time of inception report preparation is as shown below:



4. Detailed Survey on Small Hydropower

4.1 Purpose of the Detailed Survey on Small Hydropower

The detailed survey aims to select prospective projects as the model small hydropower project to be implemented by the public sector, and to propose plans for small hydropower development.

In the detailed survey, the current situation and issues, related laws and regulations for small hydropower development were confirmed, then the prospective potential sites as future candidates for the model project were selected through screening of small hydropower potential sites in El Salvador.

4.2 Current Situation and Issues of Small Hydropower

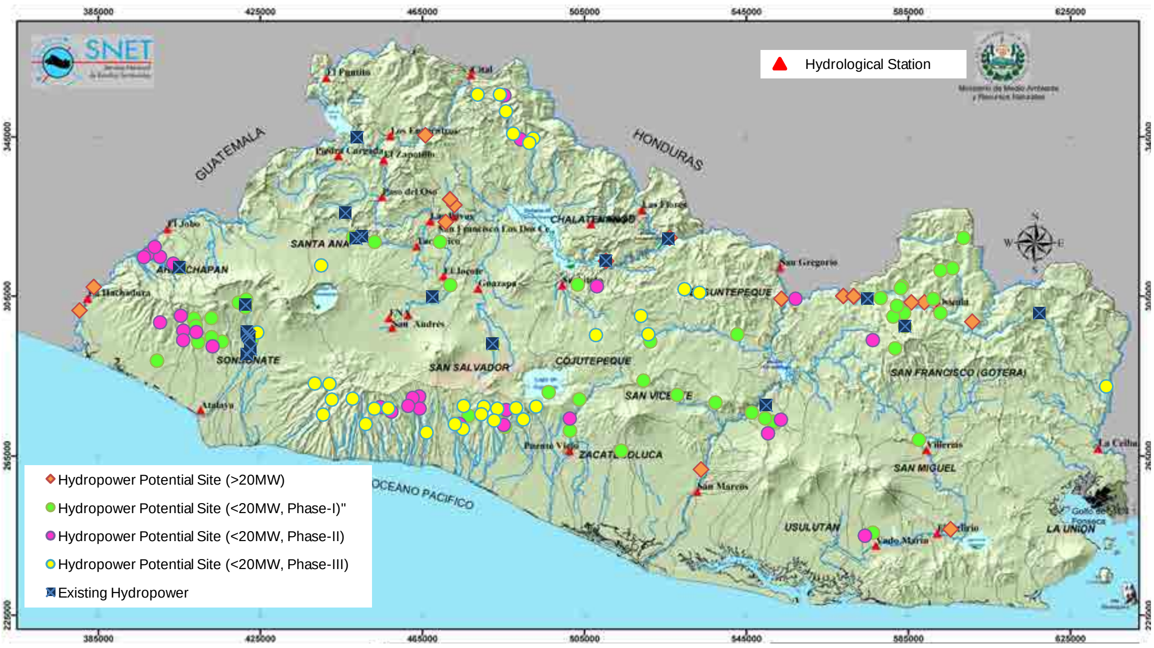
4.2.1 Current Situation of Small Hydropower

(1) Existing Small Hydropower Stations

According to information provided by SIGET, there are 16 small hydropower stations in operation as of January 2014 with a total installed capacity of 15.4 MW.

(2) Potential of Small Hydropower

According to the renewable energy master plan prepared in 2012 by CNE-JICA, 209 sites were identified for potential development. Total capacity is estimated at 180.8 MW and the estimated mean annual energy is 756 GWh. Most of the potential sites are located in the western region, especially in the Departments of Ahuachapán, Sonsonate and La Paz. Of the identified 209 sites, 123 sites were selected as candidate projects for the master plan to be implemented in three phases as shown in the figure below.



Source: Renewable Energy Master Plan, CNE-JICA, 2012

Figure 4.2.1 Location Map of Selected Small Hydropower Potential Sites for Master Plan 2012-2027

4.2.2 Issues on small hydropower development

Initiated by an introduction of electricity market mechanism that started in 1996, participation of private companies became possible in the field of power generation. Through such mechanism, it was expected that introduction of power generation projects including small hydropower development would be positively promoted.

However, in reality, a lot of diesel power generation projects were introduced because of their low initial investment costs and relatively easy repayment of the initial investment costs. Development of small hydropower has not implemented as expected.

A survey was made to know the reasons why small hydropower development is not well implemented, through the review of existing materials and interview survey to relevant organizations. The results are as follows:

1) Longer time required for studies on small hydropower development, and longer time for obtaining development concession from the government, compared with thermal or biomass power generation.
2) Due to insufficient discharge observation data, it is rather difficult to estimate accurate power generation amount of small hydropower, and it is difficult to judge the viability of the development.
3) In case of small hydropower development by a private company, there is less chances for dialogue with local residents, which makes it difficult to grasp the expectations and needs of the local residents to the development. In this connection, it is difficult to obtain the local residents' understandings and cooperation to the development.
4) There are cases of leak of information related to the development, which results intentional land occupation required for the small hydropower development.

To settle the above mentioned issues, and for smooth implementation of small hydropower development, it is hoped that the public sectors including the government should actively participate in the development. It is hoped to implement a model project that can take up the needs of local residents for smooth implementation of the development. Lessons learnt from the model project should be reflected to the future small hydropower development projects.

4.3 Laws and Regulations Related to the Small Hydropower Development

(1) List of laws and regulations related to small hydropower development

The laws related to renewable energy that includes small hydropower are covered by various aspects, particularly laws and regulations of environment, concession and constitution are of important for small hydropower development. The list of the laws and regulations related to the small hydropower development is shown in Table 4.3.1 in the main report.

(2) Environmental Categorization of Small Hydropower

The hydropower developers are mandated to carry out the environmental impact assessment. According to MARN, the requirement of environmental consideration differs to the scale of the project. Such requirement is classified to the categories as follows:

Table 4.3.1 Group and Category of Environmental Requirement

Group	Category and Requirement
Group A	*Low environmental impact,* which means that the holder of the project *need not* submit environmental documentation
Group B	Category 1: low potential environmental impact, *which does not require the submittal of an EIA but simple environmental study is required.*
	Category 2: moderate or high potential environmental impact, *requiring the submittal of EIA*

Source: MARN

For the case of hydropower development, the hydropower with its installed capacity less than 100 kW is classified to Group A. The project with its capacity greater than 100 kW and less than 1MW is classified to Category 1 in Group B. The project with its capacity over 1MW is classified to Category 2 in Group B. As shown in Table 4.3.1, the hydropower project which is categorized to Category 1 in Group B is not required to submit the EIA report; instead it is required to submit the simple evaluation report of environmental impact assessment. According the hearing to hydropower developers in El Salvador, the duration of obtaining environment permit for category 1 is in between two to six months, meanwhile for category 2 in Group B, the duration is in between eight to ten months.

(3) Concession Awarding Procedures

The small hydropower developers are required to obtain the concession no matter the developer is private or public. The current law of concession does not stipulate the duration of the time for evaluation and approval of awarding concession. There are several cases that take years to obtain the concession in El Salvador.

4.4 Related Institutions for Small Hydropower Development

There are various institutions in El Salvador which are related with small hydropower development. Especially, SIGET and MARN are the important institutions for small hydropower development. The list of the related institutions for small hydropower development is shown in Table 4.4.1 in the main report.

4.5 Small Hydropower Potential

4.5.1 Small Hydropower Potential indentified in Renewable Energy Master Plan Project

As mentioned in the section 4.2.2, the renewable energy master plan prepared in 2012 by CNE-JICA, identified 209 sites potential development. Total capacity is estimated at 180.8 MW and the estimated mean annual energy is 756 GWh. Of the identified 209 sites, 123 sites were selected as candidate projects for the master plan.

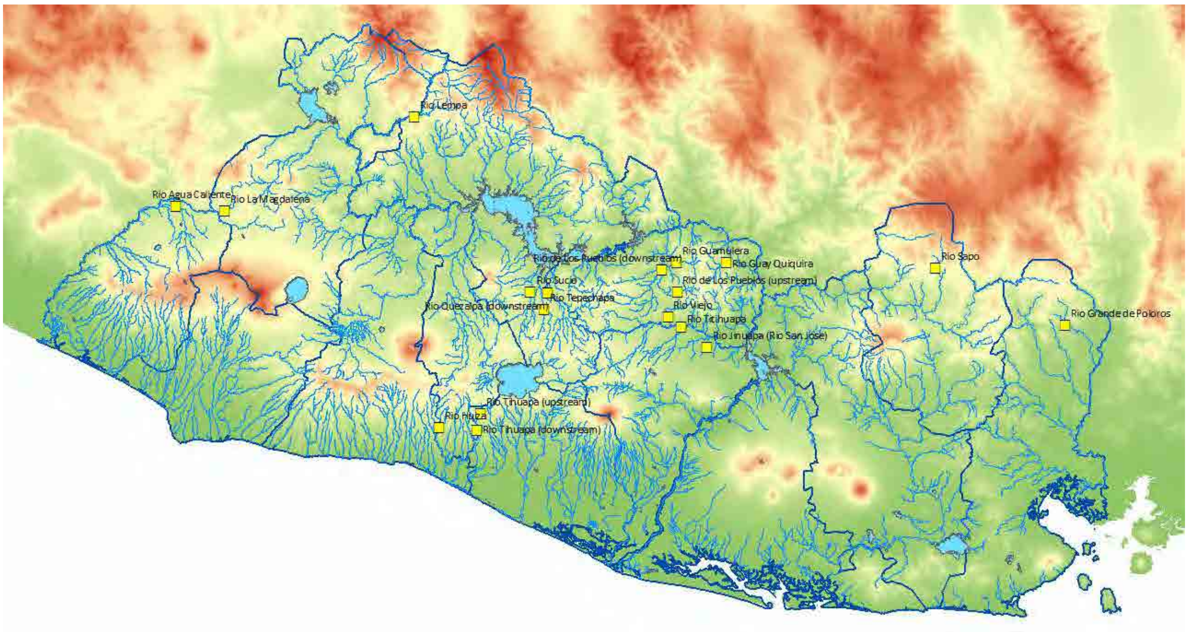
4.5.2 Identification of Small Hydropower through Desk Study

In the existing hydropower studies, there are many projects conducted by universities and private companies without information on catchment areas, discharges and heads. To clarify such information and to review prospective small hydropower potential sites all over the country from the view point of catchment areas and heads, the desk study was conducted. 54 topographic maps with 1/50,000 scale covering the entire country were used for the desk study.

The desk study was conducted by taking into account of two major aspects, i.e., (i) the candidate sites should have at least around 40 km^2 of catchment area in view of securing required discharge for power generation, and (ii) the candidate sites should have at least 40 m heads in the topographic maps.

As a result of the desk study, 18 sites were selected as prospective candidate sites for small hydropower development.

The hydropower potential sites identified in the JICA Study Team are as shown in Figure 4.5.1.



Source: JICA Study Team

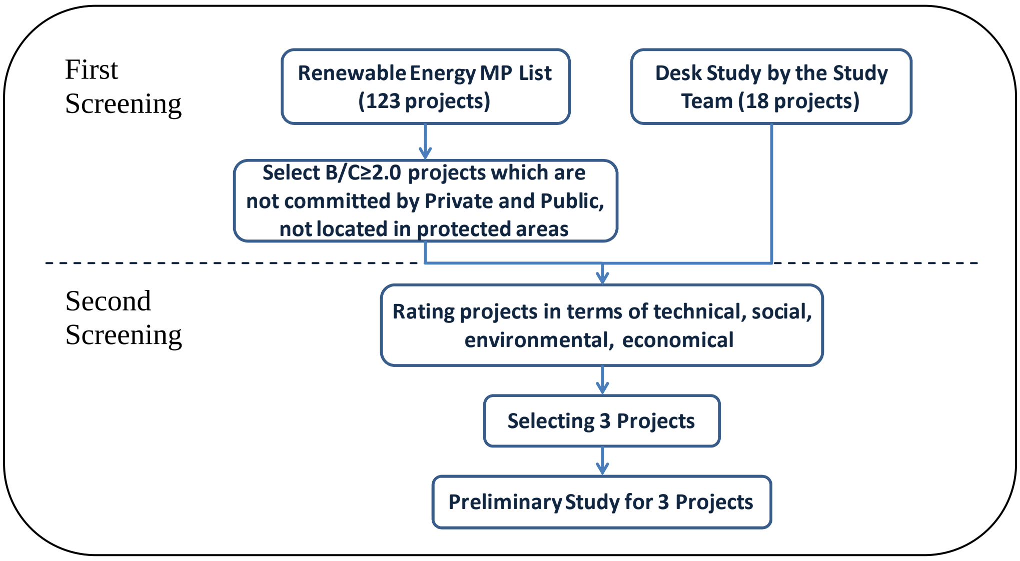
Figure 4.5.1 Small Hydropower Potential Sites Identified in the Study

4.6 Screening of Small Hydropower Potential Sites

(1) Procedure

The hydropower potential sites which are listed in the renewable energy master plan and the hydropower potentials identified in this study are further examined to find potential sites for future candidate of the small hydropower investment by JICA-IDB. In the first screening, the projects which have B/C value more than around 2.0 were selected from the hydropower potential list in the renewable energy master plan. For this selection, potential sites located in the natural protected area were excluded. And the potential sites where private developers or public company has already committed for development were also excluded. These 21 projects, and 18 projects which were described in sub-section 4.5.2, were selected as the result of the first screening. As second screening, 39 small hydropower potential sites selected in the first screening were further evaluated with respect to criteria of technical, social environment, natural environment, and economic. As the result of the evaluation, three projects were selected for further detailed survey.

The procedure of the project screening is shown in Figure 4.6.1.



Source: JICA Study Team

Figure 4.6.1 Procedure of the Project Screening

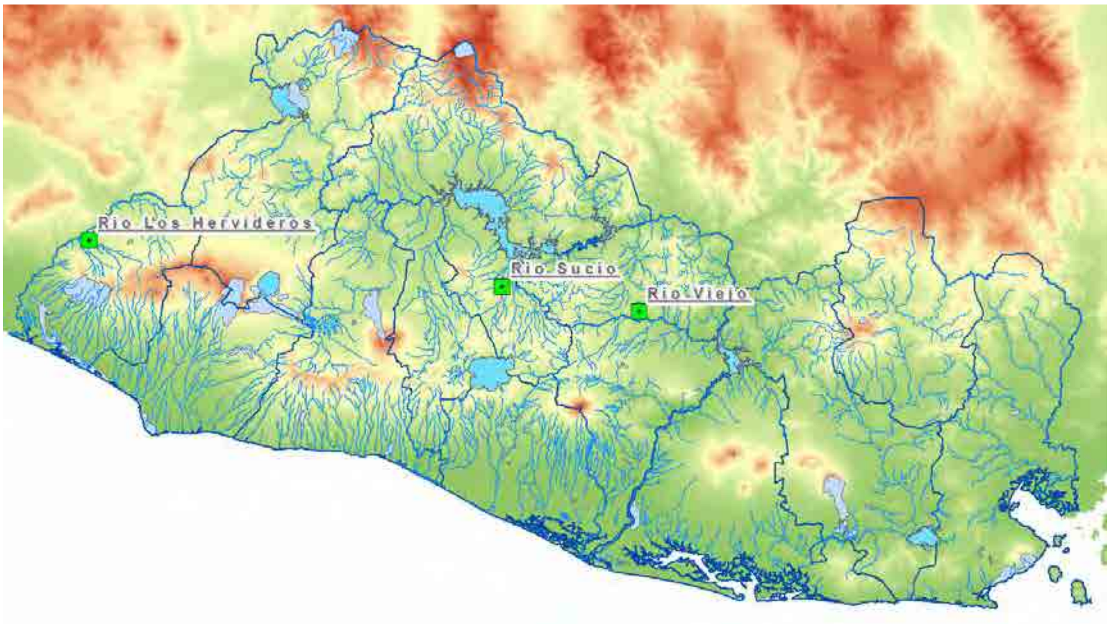
(2) Screening Result

As the result of screening, the overall ranking of the small hydropower potential sites was obtained as shown in Table 4.6.1. As shown in the table, top three potential sites are located in the Ahuachapán department. This is due to that the mountain range in Ahuachapán department has abundant hydropower potentials due to stable flow quantity throughout the year by large annual precipitation and by the abundant groundwater runoff. However, since the projects will be implemented as pilot projects to demonstrate the hydropower development in El Salvador, it is preferable that the projects are selected from entire country rather than those from one department. Therefore JICA Study Team selected only one project located in Ahuachapán department. As the result, JICA Study Team selected Los Hervideros I in Ahuachapán department, a potential site located along Rio Sucio in the Cucatlan department, and a potential site located along the Rio Viejo in Cabañas. The locations of the selected three potential sites are shown in Figure 4.6.2.

Table 4.6.1 Selection of Three Projects

Overall Ranking		Department	Selected
Ranking	Project Location		
1	Los Hervideros I	Ahuachapan	✓
2	Rio Agua Caliente	Ahuachapan	
3	Copinula III	Ahuachapan	
3	Rio Sucio	Cuscatlan	✓
3	Rio Viejo	Cabañas	✓
6	Malancola	San Salvador/La Paz	
7	Loma de San Juan	San Salvador/La Paz	
8	Rio Sapo	Morazan	
8	Rio de Los Pueblos (downstream)	Cabañas	
8	Rio Quezalpa (downstream)	Cabañas/Cuscatlan	

Source: JICA Study Team



Source: JICA Study Team

Figure 4.6.2 Selected Project for Detailed Survey

4.7 Detailed Survey of Three Small Hydropower Potential Sites

The detailed survey of the three small hydropower potential sites was conducted by a local consultant under the supervision of the JICA Study Team. The work schedule of the detailed survey is shown in Figure 4.7.1.

Work item		1st Week	2nd Week	3rd Week	4th Week
0	Collection of Data				
1	Field Survey (Leveling Survey, Discharge Measurement)				
2	Selection of method of hydropower generation				
3	Preliminary Design				
4	Cost Estimate				
5	Economic analysis				
6	Preparation of Report				

Source: JICA Study Team

Figure 4.7.1 Work Schedule of Detailed Survey of Three Small Hydropower Projects

4.7.1 Design Assumption

The assumptions used for the preliminary design are as described below.

(1) Intake Weir

The type of intake weir was assumed to be fixed concrete weir type. The type of energy dissipater was set to be of ski jump type or endsill type depending on the riverbed material.

(2) Maximum Design Discharge

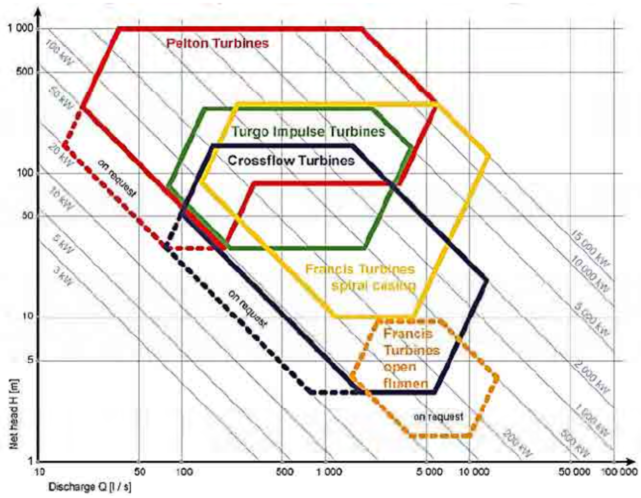
The maximum design discharge of the plant was set at 25% of flow duration curve, as the design discharge of the plant were generally in between 20% and 30% in El Salvador.

(3) Hydraulic Head

The hydraulic head was measured from the head tank water level to the center of the turbine. The loss of hydraulic head includes friction loss and miscellaneous losses such as screen loss at intake.

(4) Turbine Type Selection

The type of the turbine was selected using monogram with hydraulic head and maximum design discharge per unit as shown in Figure 4.7.2.



Source: Ingendehsa S.A. de C.V.

Figure 4.7.2 Design Monogram for Selection of Turbine

(5) Construction Cost

The construction cost was estimated using the relation between the cost and the weir size, or between the cost and the channel size which were generally applicable in Latin American region. The cost of distribution line was estimated at 20,000US$/km which included land acquisition and construction cost.

(6) Financial Evaluation

The financial evaluation of the project assumed the conditions that project life to be 50 years, interest of loan to be 8%, the grace period to be 2 years, and repayment years to be 10 years after the grace period. The selling price of electricity was set considering the average price of energy that of CLESA (a distribution company) which was US$ 0.158/kWh, with an annual increase of 3% based on price changes for the above period.

4.7.2 Result of the Detailed Survey

The result of the detailed survey of the selected three small hydropower projects is shown in Table 4.7.1.

Table 4.7.1 Result of the Detailed Survey for Selected Three Small Hydropower Projects

Item	Unit	Project Name		
		Los Hervideros I	El Manzano	Los Coyotes
River Name		Rio Los Hervideros	Rio Sucio	Rio Viejo
Catchment Area	sq.km	95.94	73.68	28.79
Average Discharge	cms	3.10	0.83	0.46
Dam height	m	5.00	2.50	2.50
Waterway length	m	2,900	1,100	1,900
Turbine Type		Francis	Crossflow	Pelton
Capacity of Turbine	kW	935	664	687
Nos. of unit	unit	2.00	1.00	1.00
Total Capacity	kW	1870	1870	687
Annual Energy	kWh	9,177,706	2,223,247	1,771,104
Design Discharge per unit	cms	2.00	1.25	0.70
Effective Head	m	55	67.00	123.00
Transmission Line	km	11.00	4.00	6.00
Generator Type		Synchronous, 3phase	Synchronous, 3phase	Synchronous, 3phase
Project Cost	US$	7,900,000	2,400,000	2,700,000
Project IRR	%	24.8	10.0	1.2
Repayment Year	year	5.7	7.2	10.1

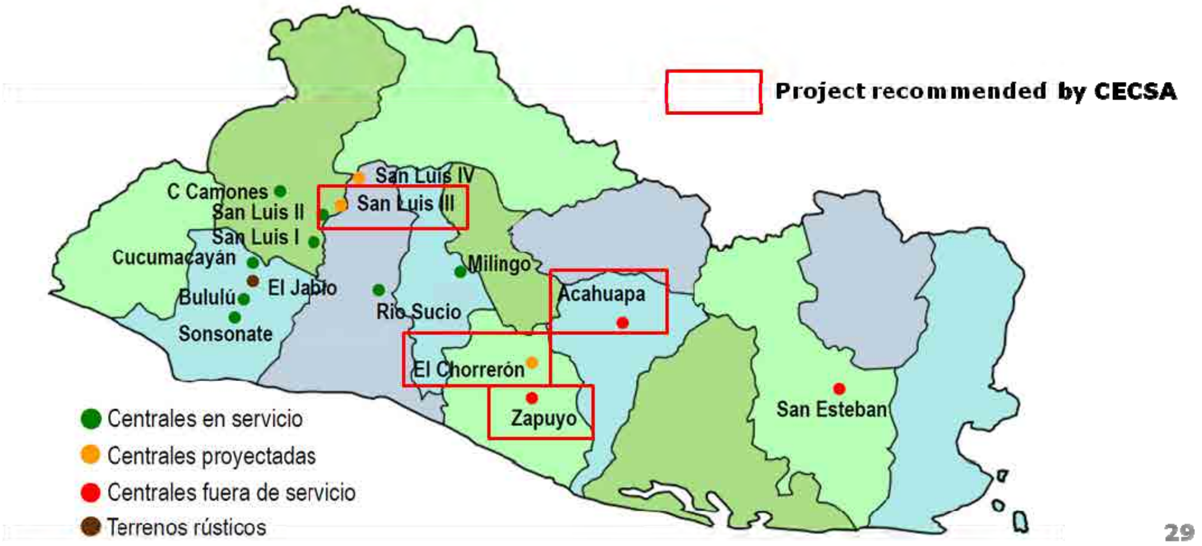
*Assuming selling electricity at 0.15US$/kWh, zero interest rate.

Source: JICA Study Team

As shown in the table, Los Hervideros I is economically the most prospective of the three projects. El Manzano shows that the project is not financially attractive, and the project may have a geological risk in the foundation. Therefore, careful consideration is necessary for determining project implementation of El Manzano. For Los Coyotes project, the project is not financially feasible therefore the project is not recommended for implementation.

4.8 Projects of CECSA

In order to examine the existing small hydropower studies developed by the public sector, the JICA Study Team received four feasibility study reports from CECSA. The locations of the projects provided by CECSA are shown in Figure 4.8.1.



Source: CECSA

Figure 4.8.1 Location of Projects Provided by CECSA

After reviewing the contents of the provided feasibility study reports, the JICA Study Team found that the feasibility study of Zapuyo and Acahuapa were not complete because the final design was not clearly defined although alternative studies were conducted in the feasibility study report. The feasibility study of El Chorreron project showed the project features of the final design, but the layout plan of facility and profile of project structure was still not clear, and it was judged that the study was still incomplete.

It was found that the feasibility study of San Luis III was still insufficient as the geology of the project site was not assessed in the study, however, since the principle feature and layout of the project was clearly defined, it was expected that the study could be completed with additional survey such as geological survey. In this connection, San Luis III project was taken up in this detailed survey as a prospective project. However, since the study reports were provided from CECSA just before the end of field survey in El Salvador, the JICA Study Team did not conducted the field survey of San Luis III due to limited available time, the content of the study should be confirmed through the field survey by consultants prior to the project implementation.

The project feature of the San Luis III project is summarized in Table 4.8.1.

Table 4.8.1 Summary Project Feature of San Luis III

Project Name	Unit	Value/Name
Project Name		San Luis III
River Name		Suquiapa
Catchment Area	sq.km	165.47
Average Discharge	cms	5.0
Dam height	m	-
Waterway length	m	626
Turbine Type		Crossflow
Capacity of Turbine	kW	405
Nos. of unit	unit	2
Annual Energy	kWh	1,804,626
Design Discharge	cms	5
Effective Head	m	9.63
Transmission Line	m	1
Generator Type		Synchronous, 3phase
Project Cost	US$	1,400,000
Project IRR	%	19.9
Repayment Year	Year	5.2

Source; CECSA

4.9 Small Hydropower Development in ANDA Facility

(1) Small Hydropower Potentials in ANDA

The JICA Study Team received the information on the small hydropower development plan by ANDA. The candidate sites and expected installed capacities are summarized in Table 4.9.1.

Table 4.9.1 Hydropower Potential Sites of ANDA

No.	Place	Diameter (inch)	Design Discharge (L/S)	Gross Head (m)	Plant Capacity (kW)
1	T-10 (Santa Tecla A)	36	590	30	157
2	Buenos Aires	30	350	60	185
3	T11 (Santa Tecla B)	24	80	65	45
4	Tanque Corinto	10	55	56	27
5	Planta Chilama	10	80	35	25
6	Río Yamabal		800	20	140
7	Río Apuniam		1000	30	475
8	Río Suquiapa (El Jardín)		3000	9	250
9	Río Amulunca		1000	30	400
10	Río El Rosario		1000	150	1000
11	Río Atehuasias		1500	70	825
12	Las Pavas (Río Lempa)		11000	10	1000

Source: ANDA

The projects from Nos. 1 to 5 in the table are the planned small hydropower projects that connect to water distribution system. The projects from Nos. 6 to 12 are the small hydropower projects to be attached to the existing water intake facilities.

The advantages of the small hydropower in the water supply facilities are 1) impact to social and natural environment is minimal because it is built inside the existing facilities, 2) concession is not required since ANDA already has the right of use of water. Currently, ANDA seeks fund from the international donors. However, the studies given by ANDA are still at conceptual levels. Further pre-F/S and F/S are necessary to promote of these projects. It is recommended to conduct F/S and detailed design (D/D) if the prospective sites are found in pre-F/S.

(2) Preliminary Examination of Financial Viability

To examine the financial viability, the repayment years for the hydropower potential sites shown in Table 4.9.2 is roughly estimated with the unit construction cost in Japan (10,000 US$/kW). In this preliminary estimation, three kind of plant factors namely 60%, 70% and 80% were used, and the price of selling electricity was set at 0.15 US$/kWh, and the interest of the loan was not considered. The benefit of the small hydropower was the saving of the cost of electricity covered by the small hydropower.

Table 4.9.2 Preliminary Estimation of Repayment Year of the Small Hydropower Potential of ANDA

No	Site	Installed Capacity	Investment Cost	Repayment Year (i=0%)		
		(kW)	(1000 US$)	P.F. = 80%	P.F. = 70%	P.F. = 60%
1	T-10 (Santa Tecla A)	157	1,840	11.1	12.7	14.9
2	Buenos Aires	185	2,160	11.1	12.7	14.8
3	T11 (Santa Tecla B)	45	550	11.6	13.3	15.5
4	Tanque Corinto	27	340	12.0	13.7	16.0
5	Planta Chilama	25	320	12.2	13.9	16.2
6	Río Yamabal	140	1,640	11.1	12.7	14.9
7	Río Apuniam	475	5,490	11.0	12.6	14.7
8	Río Suquiapa (El Jardín)	250	2,900	11.0	12.6	14.7
9	Río Amulunca	400	4,630	11.0	12.6	14.7
10	Río El Rosario	1000	11,530	11.0	12.5	14.6
11	Río Atehuasias	825	9,520	11.0	12.5	14.6
12	Las Pavas (río Lempa)	1000	5,770	5.5	6.3	7.3

P.F. = Plant Factor,
Source: ANDA, Modified by the JICA Study Team

As shown in the table, the repayment year exceeded 10 years since ANDA procure the electricity with low unit price in between 0.15 and 0.16 US$/kWh. If the unit price of the electricity exceeds 0.20 US$/kWh then the repayment year becomes less than ten years. If the pre-F/S is conducted, the project financial viability should be carefully assessed considering the plant factor and the unit price of electricity.

(3) Example of the Small Hydropower Development in Water Supply Facilities

The example of small hydropower in Japan and the project currently conducted under JICA grant scheme in Hoduras is introduced, and the details are described in the main report.

4.10 Result of Small Hydropower Studies

The detailed survey of three projects conducted during this study and the study results conducted by CECSA are summarized below.

Table 4.10.1 Summary of Small Hydropower Studies

Item	Unit	Project Name			
		Los Hervideros I	El Manzano	Los Coyotes	San Luis III
River Name		Rio Los Hervideros	Rio Sucio	Rio Viejo	Rio Suquiapa
Catchment Area	sq.km	95.94	73.68	28.79	165.47
Average Discharge	cms	3.10	0.83	0.46	5.0
Dam height	m	5.00	2.50	2.50	-
Waterway length	m	2,900	1,100	1,900	626
Turbine Type		Francis	Crossflow	Pelton	Crossflow
Capacity of Turbine	kW	935	664	687	405
Nos. of unit	unit	2.00	1.00	1.00	2.0
Total Capacity	kW	1870	1870	687	810
Annual Energy	kWh	9,177,706	2,223,247	1,771,104	1,804,626
Design Discharge per unit	cms	2.00	1.25	0.70	5
Effective Head	m	55	67.00	123.00	9.63
Transmission Line	km	11.00	4.00	6.00	1
Generator Type		Synchronous, 3phase	Synchronous, 3phase	Synchronous, 3phase	Synchronous, 3phase
Project Cost	US$	7,900,000	2,400,000	2,700,000	1,400,000
Project IRR	%	24.8	10.0	1.2	19.9
Repayment Year	year	5.7	7.2	10.1	5.2

*Assuming selling electricity at 0.15US$/kWh, zero interest rate.
Source: JICA Study Team, CECSA

Among these four projects, Los Hervideros I and San Luis III are recommended to proceed to feasibility studies. The reasons of selection of these projects are as follows;

1) Los Hervideros I project has an abundant stream flow during the dry season. It is advantageous for project feasibility. The planned installed capacity will exceed 1 MW, and this size of install capacity requires full EIA study. However, it is expected that this hydropower project can contribute to improve the power supply quality in the region because the municipality of Tacuba where the project is located has a low electrification rate of 49%. If this project is implemented, it is expected that the project will improve the electrification rate as well as the electricity supply quality. It is noted that Tacuba municipality is considered being in a group of 100 poorest municipalities in El Salvador. Therefore, there can be a various options for community development, and the project can be a model project for small hydropower development in the poor municipality.

2) San Luis III is located just downstream of an existing small hydropower plant. By this nature, the project does not require weir construction and the project cost can be reduced. As CECSA already possesses the land, no land acquisition issue is anticipated. The municipality of Coatepeque where the project is located, is also in the group of the 100 poorest municipalities in El Salvador. And the electrification rate is as low as 65%, which is far below the national average of 93% of electrification rate. San Luis III project can contributes to improve the electricity supply in the rural area and the project can be a model project for small hydropower development in the poor municipality.

The El Manzano is financially not attractive and the project may have geological risks therefore the project is in low priority. The Los Coyotes project is not recommended due to the low project IRR.

4.11 Implementation Plan

4.11.1 Priority of Implementation

As the result of the detailed survey described in the sections 4.7 to 4.10, it is recommended to implement the projects in the following order;

Priority 1: Los Hervideros I

The result of the detailed survey of Los Hervideros I shows high economic feasibility, and the project may help improving the community development and rural electrification.

Priority 2: San Luis III

The feasibility study of San Luis III has high economic feasibility, but the geological conditions and alignment of waterway should be reviewed prior to implementing the project.

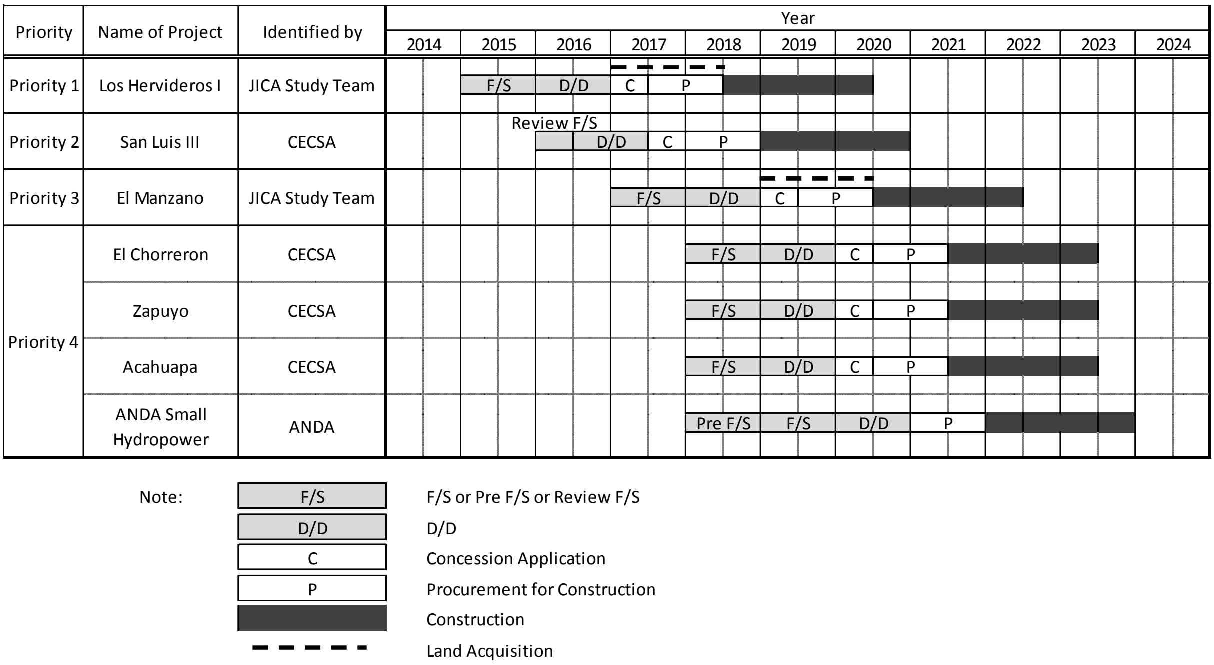
Priority 3: El Manzano

El Manzano may have geological risk for planned intake site and powerhouse site, geology of the project area should be properly assessed for the project implementation.

Priority 4: ANDA small hydropower potentials and small hydropower plan of CECSA

The small hydropower potential of ANDA (12 sites) has no concession and community issues since the projects will be located within the ANDA property land area. It is recommended to conduct pre F/S and screening good projects for conducting F/S. The small hydropower projects of CECSA have no land acquisition issues, therefore it is recommended to review the existing F/S contents and implement the projects which have high economic feasibility.

The possible implementation plan of the above projects is shown in Figure 4.11.1.



Source: JICA Study Team

Figure 4.11.1 Possible Implementation Plan

For formulation of the above figure, the projects were assumed to start in year 2015. The duration of F/S and D/D was assumed to one year for each. For San Luis III project, review of F/S with additional geological survey should be considered to complete the existing F/S. Land acquisition should be conducted in parallel with concession application and procurement for construction. According to the implementation plan, Los Hervideros I will commence the operation in 2020 if the project has no problem in land acquisition and concession awarding. San Luis III may start operation in 2019. For the small hydropower projects of ANDA, it is recommended to conduct pre-F/S of the potential sites and conduct screening to select the good projects for further implementing F/S and D/D.

4.11.2 Issues and Countermeasures on Development of Small Hydropower

In El Salvador, many of the small hydropower projects developed failed by encountering community disagreement. This negative reaction by the community to small hydropower development has been arisen through skepticism of the benefit to the local community. This skepticism was provoked by the experience of hydropower development in El Salvador, as the poverty level of communities near the large scale hydropower plants has not been improved.

(1) Community Involvement

In order to break the negative image of small hydropower development, it is proposed that the following measures are included for project implementation.

a. <u>Development of A Model Structure of Dialogue</u>

It is necessary to build a model structure of dialogue among stakeholders. The structure should be continuous, with dialogue continuing not only during construction phase but also throughout the operation of the plant.

b. Proposing Community Development Measures

Through the dialogue between project owner and the local community, the issues relating to local communities and the range of contribution by the project should be defined. Afterwards, the effective measures for community development should be determined through the consent of stakeholders.

c. Allocate budget for community development

Through the dialogue, the project must determine a satisfactory contribution measure for the community. It is proposed to include the cost for community development at 1 - 3% of construction cost, and 3% of annual electricity sales.

With the experience gained through the implementation of several projects, the model structure of dialogue and the ratio of project cost to be spent for community development will be reviewed and adjusted.

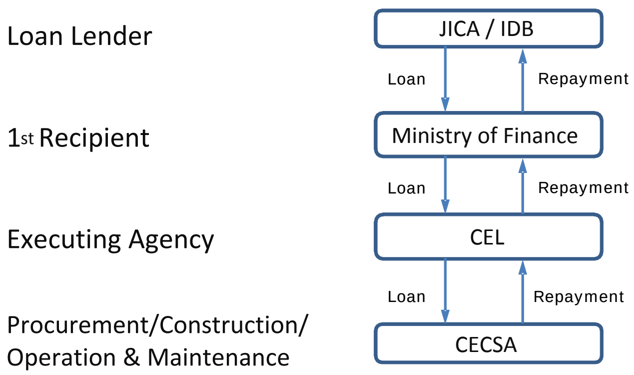
There are several hydropower projects which were able to be implemented with community development successfully. The brief explanation of the examples of community development is presented in the main report.

4.11.3 Implementing Small Hydropower Projects: Funding

The possible options for funding of these projects are considered below. However, the idea presented below is still conceptual level developed by the collected information during the study. The details of the funding scheme should be reviewed prior to the project implementation.

(1) Sovereign Loan to CEL

The first option for funding small hydropower development by public sector is the provision of a Sovereign Loan to CEL from JICA-IDB. The CEL would be the recipient of the loan and the design and construction work would be completed by CECSA. The repayment of the loan would be made by CEL.

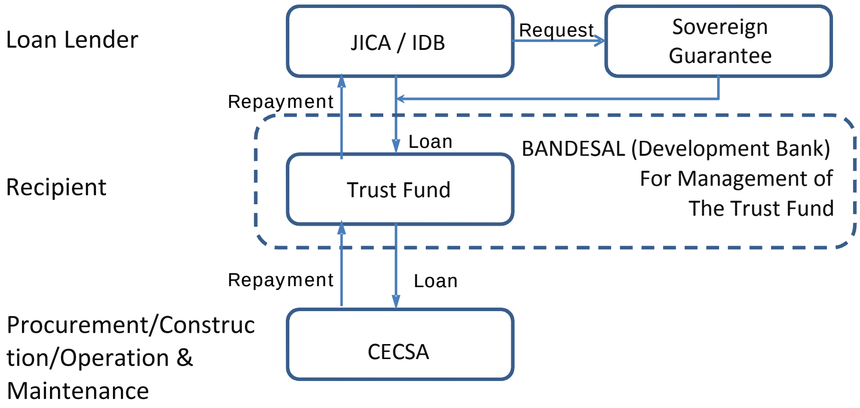


Source: JICA Study Team

Figure 4.11.2 Image of Providing Sovereign Loan to CEL

(2) Sovereign Loan to CECSA

If CEL is unable to accept a Sovereign Loan, the second option would be to provide the loan to CECSA directly. Loans to CECSA could be either Sovereign Loans or Non-Sovereign Loans. In the case of Sovereign Loans, CECSA could receive the loan from a trust fund as generally established by BANDESAL. The trust fund can be established by designation of JICA-IDB. The Sovereign guarantee can be endorsed for the trust fund by the Congress approval.   If the Sovereign guarantee is not provided, CECSA cannot borrow money from the fund or banks until current debt of CECSA is cleared.



Source: JICA Study Team

Figure 4.11.3 Image of Providing Sovereign Loan to CECSA

4.11.4 Recommendation for Future Small Hydropower Development

As described in section 4.2.2, the JICA Study Team found that small hydropower development in El Salvador was stagnated due to opposition from local communities and long duration of concession awarding process.   It is expected that the opposition from local community will be resolved by the experiencing good examples of community involvement during the project implementation. It is also expected that the Government of El Salvador will change the law/regulation of concession awarding procedure to shorten the process duration.

Another identified issue of small hydropower development is that the development under initiative of the private sector may results in un-organized and random development of water resources, which is not preferable for efficient resource exploitation.

For example, a hydropower plant held by CECSA was discarded because another private company started implementing small hydropower project that was located just upstream of the CECSA's planned intake site.   The project would release little water for downstream, thus CECSA's project could not withdraw planned water quantity.

Ideally, there is only one optimum development plan for alignment of hydropower plants in the river. The random development by the private sector possibly deviated from the river's optimum plan, and may result in inefficient resource exploitation.

In order to achieve the small hydropower development along the optimal water resources development, it is recommended to conduct the potential survey by the public sector, and to formulate an optimum development plan of small hydropower which fits to the hydropower potentials of the rivers.   The concession should be awarded only for sites which are listed in the optimum development plan.

Specifically, it is recommended that 1) the project data list, which is presented in the renewable energy master plan, should be updated since some of them do not have enough information or some of the information are uncertain, 2) extracting major rivers which have abundant hydropower potential, 3) and to formulate small hydropower development plan for each river.

In Japan, the hydropower potential sites are thoroughly investigated and much information is disclosed to the public. It is recommended to conduct the potential survey in El Salvador and disclose the information to the public to accelerate the efficient resource development.

5. Detailed Survey for Energy Savings in Public Sectors

5.1 Detailed Energy Audit of Public Sector

In the Survey, JICA Study Team conducted preliminary energy audit for 20 locations and detailed energy audit for four locations of public buildings.

Preliminary audits of 20 locations consist of: 5 schools, 6 health care and medical units, 2 hospitals, 4 office buildings, and 3 pumping stations of ANDA.

Based on the results of 20 locations of the preliminary energy audit, four candidate locations were selected for detailed energy audit one each from ANDA pumping stations, hospitals (including health care units and medical units), schools, and government offices.

The detailed energy audit was conducted to follow up to the preliminary energy audit. The objective of the detailed energy audit was to identify more detailed energy saving potential and to estimate the investment cost though the measurement of electrical parameters and on-site survey.

From the results of the detailed energy audit, the energy savings and investment cost was estimated at the national level in each sector (ANDA pumping stations, hospitals, schools, and government offices).

5.1.1 The Outline of Detailed Energy Audit

Four locations were selected for the detailed energy audit in consultation with CNE and ANDA in consideration of the energy saving potential, size of facility and data availability as follows.

1) ANDA Pumping Station - Antiguo Cuscatlan

This pumping station has the greatest estimated energy savings potential in the three pumping stations evaluated. This pumping station has adequate flow meters and pressure gauges facilitating the analysis of energy savings in the detailed energy audit.

2) Regional Hospital Santiago de Maria

Their staff has shown a commitment and interest for the efficient and rational use of energy. There are many hospitals with similar size in the suburbs of San Salvador.

3) Customs Headquarters - San Bartolo

This office building represents the greatest estimated energy savings potential of the four buildings evaluated. The building includes office space, warehouse and exterior public places similar to many other buildings in the country.

4) Technical School MEGATEC of Sonsonate

This technical school has the greatest estimated energy savings potential of the five related buildings evaluated. The technical school has the necessary technical conditions such as meters and gauges capable of producing data in order to conduct the detailed energy audit.

The energy consumption data was obtained to study energy saving measures applicable to the facilities during the preliminary audit. In the detailed audit, some measurement devices were installed at the site to obtain more accurate data of the current situation for the analysis of energy quality.

Also, the electricity bills noting the monthly energy consumption were analyzed for the study of energy consumption indicators. With the obtained information and data, and through energy simulation, a base model was estimated. This model was used to identify measures which could be implemented to reduce energy consumption.

5.1.2 ANDA Pumping Station - Antiguo Cuscatlan

(1) General Description

The general description of the Antiguo Cuscatlan Pumping Station is as shown in Table 5.1.1

Table 5.1.1 General Description of "Pumping Station - Antiguo Cuscatlan"

Name of facility	Pumping Station Antiguo Cuscatlán	
Address of facility	Calle Mediterráneo, Avenida Antiguo Cuscatlán, Antiguo Cuscatlán, La Libertad	
Operation hours	22	hours/day
	8,030	hours/year
Electricity consumption	2,650,752	kWh/year
Capacity of water supply	392.50 / 8,635.00	m^3/h, m^3/day

Source: JICA Study Team

(2) Energy Savings and Investment Cost

Table 5.1.2 shows the effect of energy savings by applying the four recommended measures, and required investment costs.

Table 5.1.2 Result of the Detailed Energy Audit for "Pumping Station Antiguo Cuscatlan"

Current Consumption 2,650,752 kWh/year

		Annual Savings		Investment	IRR	NPV	B/C	Simple Payback
		kWh	US$	US$	%	US$		year
1	Replacing existing motors with high efficiency motors	39,001	7,021	45,892	8.6	-2,501	1.53	6.54
2	Replacing existing pumps with high efficiency pumps	268,786	48,390	245,073	14.8	47,511	1.97	5.06
3	Installation of a variable speed device	133,535	24,041	59,897	38.6	79,840	4.01	2.49
4	Replacing existing lamps with LED lamps	2,015	363	2,112	11.3	108	1.72	5.82
	Total	443,337	79,815	352,974	18.5	124,959	2.26	4.42

Energy Savings Percent: 16.7%

Project Period: 10 years
Interest Rate: 10%

Source: JICA Study Team

(3) Energy Savings at the National Level

From the result of the detailed energy audit, the potential energy savings for the pumping stations can be estimated around fifteen percent (15%). The simple payback period is around four point five years.

The annual electricity consumption of the pumping stations alone is estimated at 508,737 MWh based on the data provided by ANDA from 2008 to 2012. From the result of the detailed energy audit, the annual energy savings and the investment cost are estimated at 76,310 MWh/year and 38.2 million dollars as shown in Table 5.1.3.

Table 5.1.3 Energy Savings and Investment Cost at the National Level

Electricity Consumption	MWh/year	508,737
Electricity Payment	US$/year	56,580,399
Energy Savings Rate		15.0%
Energy Savings	MWh/year	76,310
Cost Savings	US$/year	8,487,060
Payback Period	year	4.5
Investment Cost	US$	38,191,769

Source: JICA Study Team

5.1.3 Regional Hospital of Santiago de Maria

(1) General Description

The general description of Regional Hospital Santiago de Maria is as shown in Table 5.1.4.

Table 5.1.4 General Description of "Regional Hospital of Santiago de Maria"

Name of facility	National Hospital "Dr. Jorge Arturo Mena"	
Address of facility	3ª. Calle poniente No. 15, Barrio Concepción, Santiago de María, Usulután	
Type of facility	Service (for health and care)	
Operation hours	24	hours/day
	8,760	hours/year
Electricity consumption	85,403	kWh/year
Total floor area	4,237.12	m^2
Number of Beds	75/100	Current / future
Number of Patients	350/55	External/internal
Number of Staff	205	

Source: JICA Study Team

(2) Energy Savings and Investment Cost

Table 5.1.5 shows the effect of energy savings by applying the three recommended measures for electricity consumption, and required investment costs.

Table 5.1.5 Result of the Detailed Energy Audit for "Regional Hospital of Santiago de Maria" (1)

Current Consumption 281,762 kWh/year

		Annual Savings		Investment	IRR	NPV	B/C	Simple Payback
		kWh	US$	US$	%	US$		year
1	Replacing existing lamps with LED lamps	41,670	10,406	34,867	27.1	26,430	2.98	3.35
2	Lighting control using with occupancy sensors	1,490	368	1,296	25.5	877	2.84	3.52
3	Replacing existing air-conditioners with high efficiency models	48,630	13,563	59,170	18.8	21,972	2.29	4.36
	Total	91,790	24,337	95,333	22.1	49,279	2.55	3.92

Energy Savings Percent: 32.6% (Total)

Project Period: 10 years
Interest Rate: 10%

Source: JICA Study Team

Table 5.1.7 shows the effect of fuel savings.

Table 5.1.6 Result of the Detailed Energy Audit for "Regional Hospital of Santiago de Maria" (2)

Current Consumption 3,072 GAL

		Annual Savings		Investment	IRR	NPV	B/C	Simple Payback
		GAL	US$	US$	%	US$		year
4	Steam line heat loss reduction	345	1,413	2,079	67.6	6,003	6.80	1.47

Energy Savings Percent: 11.2% (Total)

Project Period: 10 years
Interest Rate: 10%

Source: JICA Study Team

(3) Energy Savings at the National Level

The number of hospitals and their overall annual electricity consumption from November 2012 to October 2013 is as shown in Table 5.1.7. The annual electricity consumption of all hospitals in El Salvador is estimated at 8.75 GWh. The data is estimated based on the data from AES and DELSUR (the distribution companies in El Salvador).

Table 5.1.7 Number and Annual Electricity Consumption of Hospitals in the Country

	AES	DELSUR	Total
Number (Service)	29	145	174
Electricity Consumption (MWh/year)	1,026	7,720	8,746
Electricity Payment (US$/year)	249,263	1,825,805	2,075,068

Source: JICA Study Team based on information from AES and DELSUR

From the result of the detailed energy audit, the potential of energy savings for each hospital can be estimated around thirty percent (30%). The simple payback period is around four years.

Based on the annual electricity consumption of all the hospitals in the country assumed at 8,746MWh, the energy savings and the investment cost are estimated at 2,624MWh/year and 2.5 million dollars from the result of detailed energy audit as shown in Table 5.1.8.

Table 5.1.8 Energy Savings and Investment Cost at the National Level

Number (Service)		174
Electricity Consumption	MWh/year	8,746
Electricity Payment	US$/year	2,075,068
Energy Savings Rate		30.0%
Energy Savings	MWh/year	2,624
Cost Savings	US$/year	622,520
Payback Period	year	4.0
Investment Cost	US$	2,490,082

Source: JICA Study Team

5.1.4 Customs Headquarters San Bartolo

(1) General Description

The general description of Customs Headquarters - San Bartolo is as shown in Table 5.1.9.

Table 5.1.9 General Description of "Customs Headquarters - San Bartolo"

Name of facility	Customs Headquarters - San Bartolo	
Address of facility	Panamerican Highway Km 17 1/2, San Bartolo, Ilopango, San Salvador	
Type of facility	Service (Customs for exports and imports)	
Operation hours	8	hours/day
	2,112	hours/year
Electricity consumption	1,866,690	kWh/year
Total floor area	36,980	m^2
Number of floors	3	
Number of users	300	

Source: JICA Study Team

(2) Energy Savings and Investment Cost

Table 5.1.10 shows the effect of energy savings by applying the four recommended measures, and required investment costs.

Table 5.1.10 Result of the Detailed Energy Audit for "Customs Headquarters - San Bartolo"

Current Consumption 1,866,690 kWh/year

		Annual Savings		Investment	IRR	NPV	B/C	Simple Payback
		kWh	US$	US$	%	US$		year
1	Replacing existing lamps with LED lamps	303,000	63,488	228,752	24.7	146,686	2.78	3.60
2	Lighting control using with occupancy sensors	19,200	4,292	15,211	25.3	10,147	2.82	3.54
3	Replacing existing air-conditioners with high efficiency models	228,700	55,518	241,779	18.9	90,323	2.30	4.35
4	Installation of thermal insulation in Ceilings	45,744	10,101	22,905	42.9	35,601	4.41	2.27
	Total	596,644	133,399	508,647	22.9	282,756	2.62	3.81

Energy Savings Percent: 32.0% (Total)

Project Period: 10 years
Interest Rate: 10%

Source: JICA Study Team

(3) Energy Savings at the National Level

The number of government office buildings and their annual electricity consumption from November 2012 to October 2013 is as shown in Table 5.1.11. The annual electricity consumption of government office buildings is estimated at 95.0GWh. The data is estimated based on the data from AES and DELSUR (the distribution companies in El Salvador).

Table 5.1.11 Number and Annual Electricity Consumption of Office Buildings in the Country

	AES	DELSUR	Total
Number (Service)	9,658	1,419	11,077
Electricity Consumption (MWh/year)	45,027	52,040	95,067
Electricity Payment (US$/year)	8,233,574	12,816,650	21,050,224

Source: JICA Study Team based on information from AES and DELSUR

From the results of the detailed energy audit, the potential energy savings for the office buildings can be estimated around thirty percent (30%). The simple payback period is around four years.

Based on the annual electricity consumption of all the office buildings in the country assumed at 95,067MWh, the energy savings and the investment cost are estimated at 28,520MWh/year and 25.3 million dollars from the result of detailed energy audit, as shown in Table 5.1.12.

Table 5.1.12 Energy Savings and Investment Cost at the National Level

Number (Service)		11,077
Electricity Consumption	MWh/year	95,067
Electricity Payment	US$/year	21,050,224
Energy Savings Rate		30.0%
Energy Savings	MWh/year	28,520
Cost Savings	US$/year	6,315,067
Payback Period	year	4.0
Investment Cost	US$	25,260,269

Source: JICA Study Team

5.1.5 Technical School MEGATEC of Sonsonate

(1) General Description

The general description of Technical School MEGATEC of Sonsonate is as shown in Table 5.1.13.

Table 5.1.13 General Description of "Technical School MEGATEC of Sonsonate"

Name of facility	Educational Complex ESFE / ÁGAPE, Technical School Megatec	
Address of facility	Km 63 Highway San Salvador to Sonsonate	
Type of facility	Education (technical high school level)	
Operation hours	13.25	hours/day
	4,134	hours/year
Electricity Consumption	224,874	kWh/year
Total floor Area	17,809 / 568.64	Total/constructed m^2
Number of Classrooms	16	7 classrooms, 3 workshops & 6 laboratories
Number of Students	700 / 200 / 125	General / speciality / computers
Number of Staffs	70	

Source: JICA Study Team

(2) Energy savings and Investment cost

Table 5.1.14 shows the effect of energy savings by applying the four recommended measures, and required investment costs.

Table 5.1.14 Energy Savings and Investment Cost at the National Level

Current Consumption 224,874 kWh/year

		Annual Savings		Investment	IRR	NPV	B/C	Simple Payback
		kWh	US$	US$	%	US$		year
1	Replacing existing lamps with LED lamps	35,360	7,431	30,010	21.1	14,228	2.48	4.04
2	Lighting control using with occupancy sensors	2,290	509	1,879	23.9	1,135	2.71	3.69
3	Replacing existing air-conditioners with high efficiency models	25,320	5,984	65,807	-1.7	-26,398	0.91	11.00
4	Installation of thermal insulation in Ceilings	10,037	2,330	7,946	26.5	6,368	2.93	3.41
	Total-1	73,007	16,254	105,642	8.7	-5,244	1.54	6.5
	Total-2 of excluding No.3	47,687	10,270	39,835	22.4	21,254	2.58	3.88

Energy Savings Percent: 32.5% (Total)
21.2% (Total of Excluding No.3)

Project Period: 10 years
Interest Rate: 10%

Source: JICA Study Team

Measure 3 is not effective from the results of detailed energy audit. Three measures excluding Measure 3 are recommended for the school.

(3) Energy Savings at the National Level

The number and the annual electricity consumption of government office buildings from November 2012 to October 2013 are as shown in Table 5.1.15. The annual electricity consumption of government office buildings is estimated at 9,716 MWh. The data is estimated based on the data from AES and DELSUR (the distribution companies in El Salvador).

Table 5.1.15 Number and Annual Electricity Consumption of Schools in the Country

	AES	DELSUR	Total
Number (Service)	3,614	991	4,605
Electricity Consumption (MWh/year)	2,516	7,200	9,716
Electricity Payment (US$/year)	742,221	2,013,509	2,755,730

Source: JICA Study Team based on information from AES and DELSUR

From the result of detailed energy audit, the potential of energy savings for the school can be estimated around twenty percent (20%). The simple payback period is around four years.

Based on the annual electricity consumption of all the schools in the country assumed at 9,716 MWh, the energy savings and the investment cost are estimated at 1,943 MWh/year and 2.2million dollars from the result of detailed energy audit as shown in Table 5.1.16.

Table 5.1.16 Energy Savings and Investment Cost on the National Level

Number (Service)		4,605
Electricity Consumption	MWh/year	9,716
Electricity Payment	US$/year	2,755,730
Energy Savings Rate		20.0%
Energy Savings	MWh/year	1,943
Cost Savings	US$/year	551,146
Payback Period	year	4.0
Investment Cost	US$	2,204,584

Source: JICA Study Team

5.2 Public Lighting

According to a census conducted in 2012, there are 262 municipalities with 187,000 lamps in use for public lighting. Almost 80% or 150,000 of these lamps use High Pressure Mercury Vapour (HPMV) at 175W.

Replacing approximately 150,000 mercury lamps with 60W LED lamps will lead to savings of about 74.3 GWh/year. The investment cost would be about 75 million US$.

Table 5.2.1 Energy Savings and Investment Cost of Public Lighting on the National Level

Lamp type		Current Lamp Mercury	Replaced Lamp LED
Power	W	175	60
Number of replace		149,578	
Monthly consumption	kWh	9,423,414	3,230,885
Monthly savings	kWh		6,192,529
	%		65.71%
	US$		1,238,506
Yearly savings	kWh		74,310,350
	US$		14,862,070
Lamp cost	US$		500
Investment	US$		74,789,000
Life hours of lamp	hour		50,000
Payback period	years		5.0

Source: JICA Study Team based on information from CNE

5.3 Conclusion

5.3.1 Summary

Table 5.3.1 summarizes the energy savings, investment cost and feasibility of replacement based on the results of both the detailed energy audit and the study of replacement of public light.

Table 5.3.1 Summary of the Results of Energy Savings for Government Sector

	Number of facility	Current	Saving			Investment	Payback	IRR	NPV
		MWh/year	Potential	MWh/year	Cost (Mil US$)	Mil US$	years		Mil US$
Pumping Station (ANDA)	450	508,734	15%	76,310	8.487	38.2	4.5	17.96%	12.7
Hospital	174	8,746	30%	2,624	0.623	2.5	4.0	21.31%	1.21
Office Building	11,077	95,067	30%	28,520	6.315	25.3	4.0	21.36%	12.3
School	4,605	9,716	20%	1,943	0.551	2.2	4.0	21.46%	1.08
Public Lighting	150,000	113,076	65%	73,499	14.862	74.5	5.0	15.03%	15.3
Total		735,339	25%	182,897	30.838	142.7	4.6	17.19%	42.5

Project Period 10 years
Interest Rate 10%

Source: JICA Study Team

The implementation of energy savings in the five sectors will translate to a total electricity savings of 180GWh. 180GWh represents three percent (3.0%) of total electricity consumption in the country.

5.3.2 Recommendation

Based on the survey results, the following order of implementation is recommended

Priority 1: ANDA Pumping Stations and Public Lighting

These two sectors are heavy electricity users. The implementation of energy savings in each sector will lead to a substantial saving of electricity. The potential energy savings in these two sectors is 150GWh in total. 150GWh represents 2.5% of total electricity consumption in the country.

Priority 2: Office Buildings and Schools

The potential energy savings in these sectors is 20-30% against current values. Further, energy savings programs implemented in these areas will lead to general education in energy conservation.

In the hospitals, there is a 30% savings potential. However, it will be important to consider the needs of the patients first while considering methods of implementation.

The above mentioned priorities were presented by the JICA Study Team during the 2nd workshop on February18, 2014, and there were no particular objections on the priority.