EMPRESA NACIONAL ENERGIA ELECTRICA
REPUBLIC OF HONDURAS

SURVEY AND STUDY
ON
HYDROPOWER STRENGTHENING PROJECT
THE REPUBLIC OF HONDURAS

FINAL REPORT

APRIL 2012

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
NEWJEC INC.

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CHAPTER 1 INTRODUCTION

Republic of Honduras (hereinafter “Honduras”), in recent years, has a growing economy according to external demand and direct investment (manufacturing in bonded processing zone). Average GDP growth rate from 2003 to 2007 was 6.4%. The economy was affected by the global financial crisis from 2008 to 2009, but it was recovered due to external demand as well as positive fiscal and the demodulation of the investment, and recorded a positive growth of 4.2% in 2010. On the other hand, basic infrastructure such as power supply is still inefficient or underdeveloped, and it becomes a reason of decreasing attraction as a foreign direct investment destination. Therefore, improving power supply is one of the immediate agenda for continuous economic growth in the future. However, Honduras largely depends on thermal power generation because most of new power development in the last decade has been concentrated in private-driven thermal power generation due to the generator-oriented power purchase conditions since Framework Law of the Electricity Subsector (Decree no. 158-94) was promulgated in 1994. As a result, coupled with rising price of fossil fuel in recent years, it has a negative impact on the economy and cause macroeconomic imbalance by expanding deficit of current account and fiscal pressure due to disbursement of electricity subsides. Total installed capacity of power generation at the year-end of 2010 in Honduras is 1,610MW, in which 1,084MW (including 91MW biomass) for thermal power and 526MW for hydropower according to the publication of Empresa Nacional Energia Electrica (“ENEE”), state-owned electricity supplier and distributor.

Under this circumstances, the government of Honduras plans to lower the rate of thermal power generation in energy balance and promote power generation by renewable energy, which governmental policy was announced in the Country Vision 2010 to 2038. As one of the encouraging projects for materializing that governmental target, ENEE plan to implement a project of rehabilitation and output enhancement of the power generation facilities (turbines, generators, and other equipment) of existing Cañaveral and Río Lindo Hydroelectric Power Plants (HPPs) (“Project”) which had been developed and operated by ENEE. Draft of Feasibility Study (F/S) has been prepared by ENEE and submitted to JICA for seeking Japanese ODA loan. JICA has determined to consider the application and hired consultant (“Consultant”) for confirming applicability of the Japanese ODA loan to the Project.

This study aims to provide review and advices based on technical and economical verifications for the Project to assist ENEE, who will play a role as a counterpart, for preparation of the project implementation plan.

CHAPTER 2 IMPLEMENTATION OF SURVEY AND STUDY

2.1 MEMBERS OF THE TEAM (FIRST SURVEY)

The members of the Consultant's team for the first survey ("Team") are as follows;

Name	Assignment	Organization
Mr. Shigeru TSUNEKI	Team Leader (Electrical Equipment and Hydraulic Machinery)	NEWJEC Inc.
Mr. Junya YAMAMOTO	Civil Work	NEWJEC Inc.
Ms. Yoshiko OISHI	Environmental/Social Consideration	NEWJEC Inc.

2.2 MEMBERS OF THE TEAM (SECOND SURVEY)

The members of the team for the second survey are as follows;

Name	Assignment	Organization
Mr. Shigeru TSUNEKI	Team Leader (Electrical Equipment and Hydraulic Machinery)	NEWJEC Inc.
Mr. Junya YAMAMOTO	Civil Work	NEWJEC Inc.
Mr. Takamu GENJI	Economic Evaluation	NEWJEC Inc.

2.3 ITINERARY OF TEAM FOR FIRST SURVEY

The itinerary of the Team for the first survey is shown in Table 2.3-1.

Table 2.3-1 Itinerary of Team for First Survey

No.	Date	Day	Itinerary		Stay
1	2/05	Sun	Move to Honduras		
2	2/06	Mon	Move to Honduras	(PM) Meeting with JICA Honduras Office	Tegucigalpa
3	2/07	Tue	(AM) Kick-off Meeting with ENEE		Tegucigalpa
4	2/08	Wed	Collection and review of the feasibility report, relevant information, data, papers and documents Review of the rehabilitation/expansion project		Tegucigalpa
5	2/09	Thu	Inspection of the existing equipment of Cañaveral and Rio Lindo hydropower stations Review of the scope of the rehabilitation/expansion project		Site
6	2/10	Fri	Inspection of the existing equipment of Cañaveral and Rio Lindo hydropower stations Review of the scope of the rehabilitation/expansion project		Site
7	2/11	Sat	Move to Tegucigalpa Review of the scope of the rehabilitation/expansion project		Tegucigalpa
8	2/12	Sun	Review of implementation schedule and procurement plan of the rehabilitation/expansion project		Tegucigalpa
9	2/13	Mon	Review of the cost estimates and their supporting evidences	Verification of environmental/social consideration	Tegucigalpa
10	2/14	Tue	Review of implementation schedule and procurement plan Review of ENEE's the implementation structure	Evaluation of applicability of JICA environmental/social standard	Tegucigalpa
11	2/15	Wed	(AM) Report to ENEE	(PM) Report to JICA Honduras Office	Tegucigalpa
12	2/16	Thu	Move to Japan		
13	2/17	Fri	Move to Japan		
14	2/18	Sat	Move to Japan		

2.4 ITINERARY OF TEAM FOR SECOND SURVEY

The itinerary of the Team for the first survey is shown in Table 2.4-1.

Table 2.4-1 Itinerary of Team for Second Survey

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Date</th><th rowspan="2">Day</th><th colspan="3">Itinerary</th><th rowspan="2">Stay</th></tr>
<tr><th>S. Tsuneki</th><th>J. Yamamoto</th><th>T. Genji</th></tr>
<tr><td>1</td><td>3/04</td><td>Sun</td><td colspan="3">Move to Honduras</td><td></td></tr>
<tr><td>2</td><td>3/05</td><td>Mon</td><td colspan="3">Move to Honduras
(PM) Meeting with JICA Honduras Office</td><td>Tegucigalpa</td></tr>
<tr><td>3</td><td>3/06</td><td>Tue</td><td colspan="3">Kick off Meeting with ENEE
Collection and review of additional relevant information, data, papers and documents
Verification of the procurement policy with supporting information</td><td>Tegucigalpa</td></tr>
<tr><td>4</td><td>3/07</td><td>Wed</td><td>Discussion and finalization of the scope and the cost estimates of the rehabilitation/expansion project</td><td>Verification of the power sector structure, power supply and demand balance and power development plan</td><td>Confirmation of ENEE's financial status</td><td>Tegucigalpa</td></tr>
<tr><td>5</td><td>3/08</td><td>Thu</td><td colspan="3">Inspection of the overhaul work of El Cajon Hydropower Station</td><td>Site</td></tr>
<tr><td>6</td><td>3/09</td><td>Fri</td><td colspan="3">Inspection of the existing equipment of Cañaveral and Rio Lindo hydropower stations
Review of the scope of the rehabilitation/expansion project</td><td>Site</td></tr>
<tr><td>7</td><td>3/10</td><td>Sat</td><td>Study of updated project implementation schedule</td><td>Verification of the power sector structure, power supply and demand balance and power development plan</td><td>Review of project cost and O&M cost after the rehabilitation/ expansion</td><td>Tegucigalpa</td></tr>
<tr><td>8</td><td>3/11</td><td>Sun</td><td colspan="3">Review of Site information</td><td>Tegucigalpa</td></tr>
<tr><td>9</td><td>3/12</td><td>Mon</td><td>Discussion and finalization of the cost estimates of the rehabilitation/ expansion project</td><td colspan="2">Evaluation of ENEE's financial capability of pay back</td><td>Tegucigalpa</td></tr>
<tr><td>10</td><td>3/13</td><td>Tue</td><td>Discussion on the consultancy services</td><td colspan="2">Preparation of draft financial evaluation</td><td>Tegucigalpa</td></tr>
<tr><td>11</td><td>3/14</td><td>Wed</td><td colspan="3">Discussion on Overall information of the project</td><td>Tegucigalpa</td></tr>
<tr><td>12</td><td>3/15</td><td>Thu</td><td colspan="2">Verification of ENEE's the implementation structure for the rehabilitation/ expansion project</td><td>Move to Japan</td><td>Tegucigalpa</td></tr>
<tr><td>13</td><td>3/16</td><td>Fri</td><td colspan="2">Study of implementation structure and Financial evaluations</td><td>Move to Japan</td><td>Tegucigalpa</td></tr>
<tr><td>14</td><td>3/17</td><td>Sat</td><td colspan="2">Preparation of report</td><td>Move to Japan</td><td>Tegucigalpa</td></tr>
<tr><td>15</td><td>3/18</td><td>Sun</td><td colspan="2">Preparation of report</td><td></td><td>Tegucigalpa</td></tr>
<tr><td>16</td><td>3/19</td><td>Mon</td><td colspan="2">Discussion on draft report/ Discussion and clarifications</td><td></td><td>Tegucigalpa</td></tr>
<tr><td>17</td><td>3/20</td><td>Tue</td><td colspan="2">Finalization of final draft report</td><td></td><td>Tegucigalpa</td></tr>
<tr><td>18</td><td>3/21</td><td>Wed</td><td>(AM) Report to ENEE</td><td>(PM) Report to JICA Honduras Office
(PM) Embassy of Japan</td><td></td><td>Tegucigalpa</td></tr>
<tr><td>19</td><td>3/22</td><td>Thu</td><td colspan="2">Move to Japan</td><td></td><td></td></tr>
<tr><td>20</td><td>3/23</td><td>Fri</td><td colspan="2">Move to Japan</td><td></td><td></td></tr>
<tr><td>21</td><td>3/24</td><td>Sat</td><td colspan="2">Move to Japan</td><td></td><td></td></tr>
</table>

CHAPTER 3 CURRENT STATUS OF POWER SECTOR

3.1 POWER SECTOR STRUCTURE

ENEE was established in February, 1957 (Decree No. 48) as an autonomous public service institution having responsibility for generation, transmission, distribution and electricity sales. ENEE developed hydropower and fossil power plants, but because of natural resources of Honduras, power generation was relying on imported fuel, which made fragile financial condition of ENEE together with high rate of electricity loss.

A Framework Law of the Electricity Subsector (Decree No. 158-94; “Electricity Law”) was adopted in November 1994. The main purpose of the law is to deregulate the electric energy generation, transmission, distribution and to create electricity market. The Electricity Law also includes vertical and horizontal unbundling of ENEE, introduction of competitive market and encouraging private participation to power sector. As a result of the Electricity Law, some fossil power plants were developed by private investors. The electricity sector reforms, however, only partially materialized as of March 2012. ENEE is still a monopolized state-owned company in distribution and transmission sector. In generation field, private companies are allowed to develop power plants to supply energy directly to big consumers, mining companies, industrial park etc. utilizing ENEE’s transmission line with paying some wheeling charge to ENEE. Most of the private independent power producers (“IPP”) currently have contracts to sell all energy to ENEE through power purchase agreement (“PPA”).

Renewable Energy Law (Decree No. 70-2007) was enacted in 2007, which encourage development of renewable resources by private investment. Honduran government offer tax incentive, attractive contractual conditions of power purchase agreement. The purchase price of electricity from renewable energy source is determined based on short-term marginal price of power generation at contract year with 10% of incentives for first 10 years and some escalation, for instance. Together with privatization policy of Electricity Law, biomass (sugarcane) fueled power plants, wind power, geothermal and many small to middle scale hydropower are developed/under development.

The Electricity Law defined institutional structure of power sector. Energy Cabinet, Secretaría de Recursos Naturales y Ambiente (“SERNA”) and Comisión Nacional de Energia (“CNE”) were created as a policy making and regulatory entity. Table 3.1-1 shows functions of each organization.

Table 3.1-1 Function of Power Sector Organization

Role	Institution	Organization	Functions
Policy making	Energy Cabinet	Formed by President office, SERNA, SEFIN, SEIC	Definition of energy policies. Approval of expansion plan.
	SERNA	Ministry	Secretary of GE. ENEE's board president. Formulation and coordination of policies for the use of renewable energy. Establish short-term marginal cost.
Regulation	CNE	Independent regulatory body. Manager is appointed by President.	Approve electricity tariff, regulation, PPA and general supervision.
Service Provider	ENEE	Vertically integrated state-owned company	Generation, transmission and distribution, dispatch control, single-buyer.
	Private Generator	Private companies	PPA with ENEE. Development, construct and operate generation facilities.

SEFIN: Secretaria de Finanzas, SEIC: Secretaria de Industria y Comercio

Source: Quoted from "Honduras Power Sector Update and Revision Study (JICA and IDB, March 2010)" and revised based on interview of each organization.

3.2 DEMAND SUPPLY BALANCE

As of December 2010, total installed capacity of generation facilities in Honduras is 1,610.3MW. 62% of total installed capacity is thermal power plant using mainly imported fuel oil. ENEE is focusing on developing large scale hydropower plant while thermal power plants are owned and developed by private companies. Total generation (excluding import/export) is 6,729GWh in 2010, of which 53% of generation comes from thermal power plants. Table 3.2-1, Figure 3.2-1 and 3.2-2 show breakdown of installed capacity at December 2010 and generation in 2010.

Table 3.2-1 Installed Capacity and Generation: 2010

	Capacity (MW)			Generation(GWh)		
	ENEE	Private	Total	ENEE	Private	Total
Hydro	464.4	62.0	526.4	2,707.5	372.8	3,080.3
Thermal	124.6	867.9	992.5	23.4	3,477.6	3,501.0
Biomass	-	91.4	91.4	-	148.1	148.1
Total	589.0	1,021.3	1,610.3	2,730.9	3,998.5	6,729.4

Source: ENEE (all data in this section)

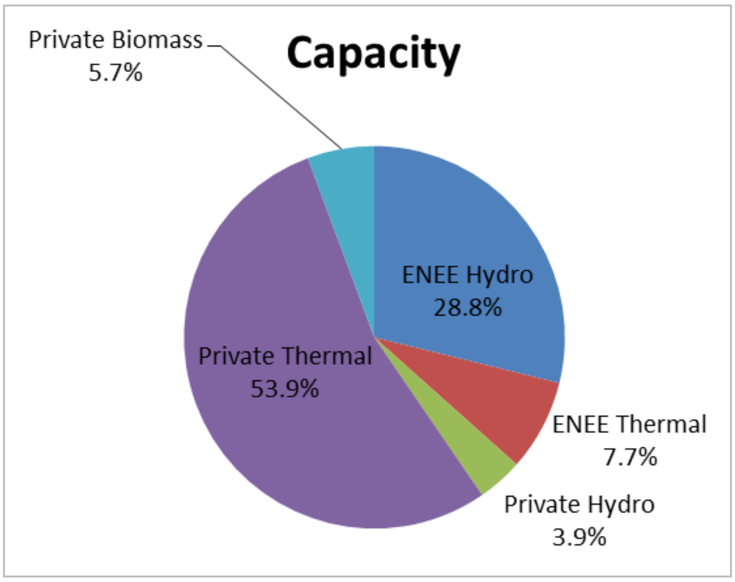


Figure 3.2-1 Installed Capacity Ratio as of December 2010

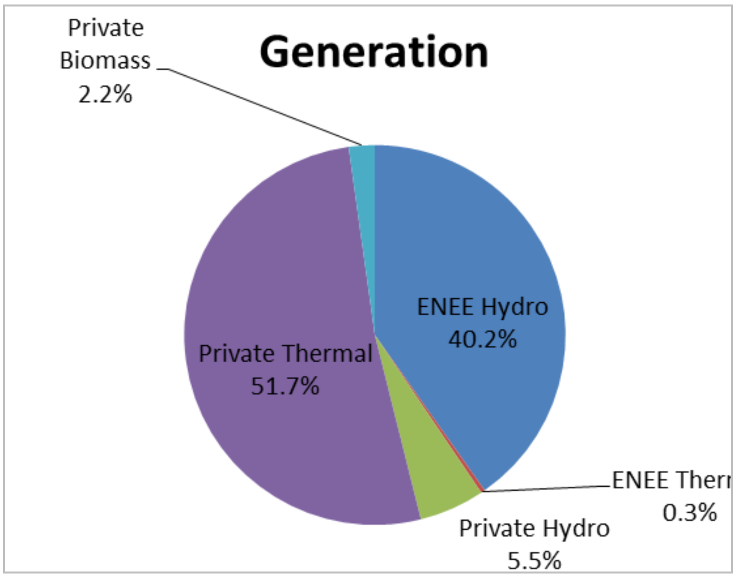


Figure 3.2-2 Generation Breakdown in 2010

Historically, private company participated in the generation business from 1994 with small scale hydropower and diesel generator. Private investment has increased after the enactment of Electricity Law in 1994 and further increased after the Renewable Energy Law in 2007. Currently, as identified in Figure 3.2-2, ENEE concentrates on hydropower generation and expect to purchase electric power from private generators. Figure 3.2-3 shows historical power supply source and annual peak demand from 1991 to 2010.

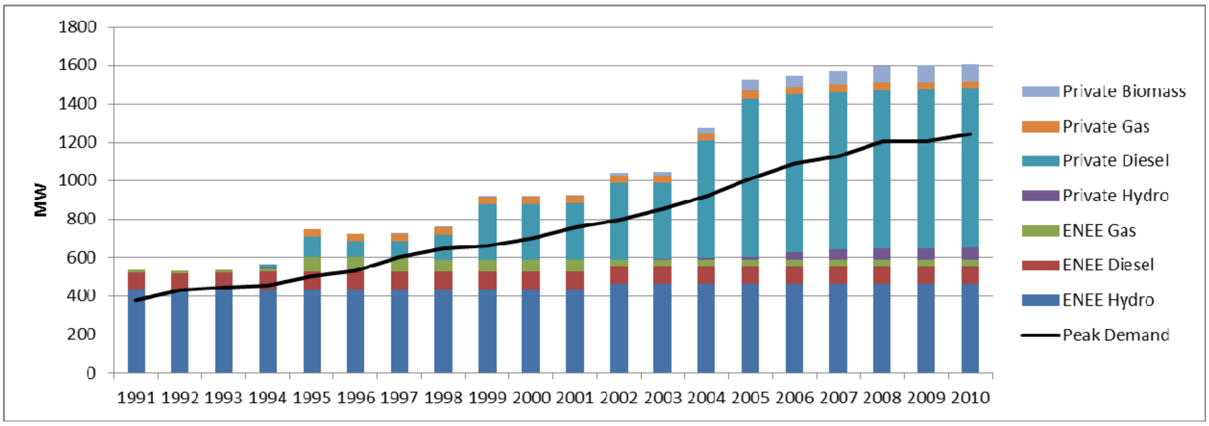


Figure 3.2-3 Historical Electricity Supply Trend by Source

Electricity demand has increased steadily. The average growth rate from 2001 to 2010 is 5.5% in spite of the demand drop in 2008 to 2009 due to political turmoil and world-wide recession. Table 3.2-2 and Figure 3.2-4 shows the generation demand growth.

Table 3.2-2 Generation Demand Growth and Supply Source

Unit: GWh

	ENEE Hydro	ENEE Thermal	Import/ Export	Private Hydro	Private Thermal	Private Biomass	Total	Growth rate
2001	1,903.1	13.7	308.1	0.8	1,957.6	0.0	4,183.3	
2002	1,609.9	9.8	415.2	0.7	2,454.7	4.6	4,494.9	7.4%
2003	1,737.9	32.9	331.6	2.7	2,726.5	20.3	4,851.9	7.9%
2004	1,371.4	12.6	392.2	29.9	3,373.3	43.1	5,222.5	7.6%
2005	1,646.5	6.4	59.4	71.4	3,695.1	76.2	5,555.0	6.4%
2006	1,938.3	64.3	18.8	131.5	3,706.2	99.9	5,959.0	7.3%
2007	2,022.4	51.5	19.7	191.8	3,882.0	114.0	6,281.4	5.4%
2008	2,006.3	3.1	34.5	284.9	4,011.1	185.3	6,525.2	3.9%
2009	2,539.6	28.5	6.5	257.0	3,515.9	219.4	6,566.9	0.6%
2010	2,707.5	23.4	21.3	372.8	3,477.6	148.1	6,750.7	2.8%
							Average	5.5%

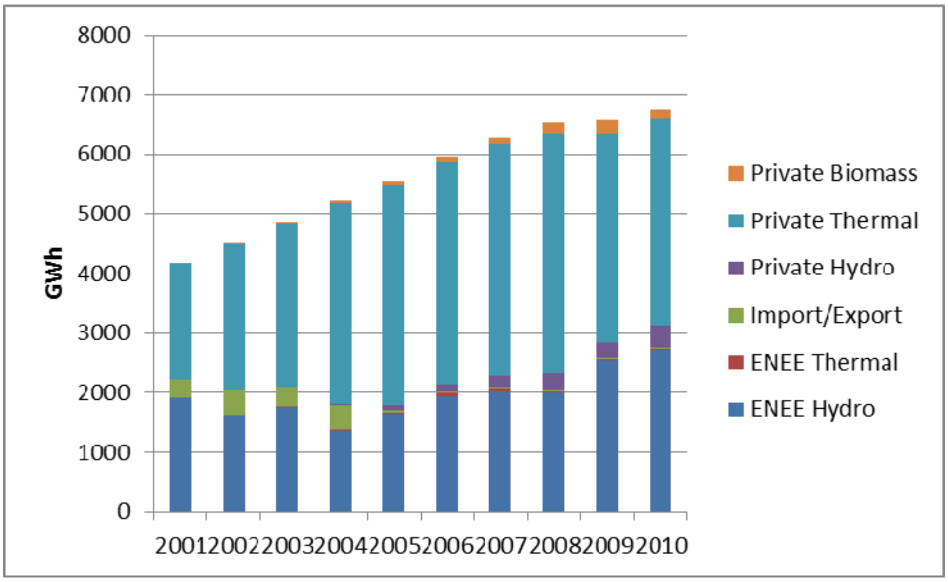


Figure 3.2-4 Generation Growth and Supply Source

3.3 DEVELOPMENT PLAN

In order to accommodate rapid growth of electricity demand and to reduce high rate of dependency on imported fuel thus establish stable electricity supply at reasonable pricing, Honduran Government consider enhancing renewable energy development including large-scale hydropower plants. According to Country Vision 2010 to 2038 established by newly elected president Porfilio Lobo Sosa in November 2009, Honduran Government set the target of renewable energy ratio in electricity generation to be more than 80% by 2038.

For long-term and short-term plan, ENEE established following two documents:

1) Plan Indicativo de Expansión Sistema de Transmisión y Distribución 2011-2022 dated December 19, 2011
   (Indicative plan for transmission and distribution system expansion 2011-2022)

2) Plan Estratégico Empresa Nacional de Energia Eléctrica 2011-2014 dated January 2012 ("Strategic plan ENEE 2011 -2014")

These documents are attached as Attachment -7 and Attachment-8.

ENEE also forecasted demand growth from 2010 to 2030, established generation expansion plan 2011 to 2025, which includes ENEE's own development (large scale hydropower projects) and private development for renewable energy and fossil power energy. Demand growth forecast is associated with supply forecast considering generation expansion plan and annual dispatch simulation.

Figures 3.3-1 and 3.3-2 shows ENEE's demand growth and supply source for energy and peak power, respectively.

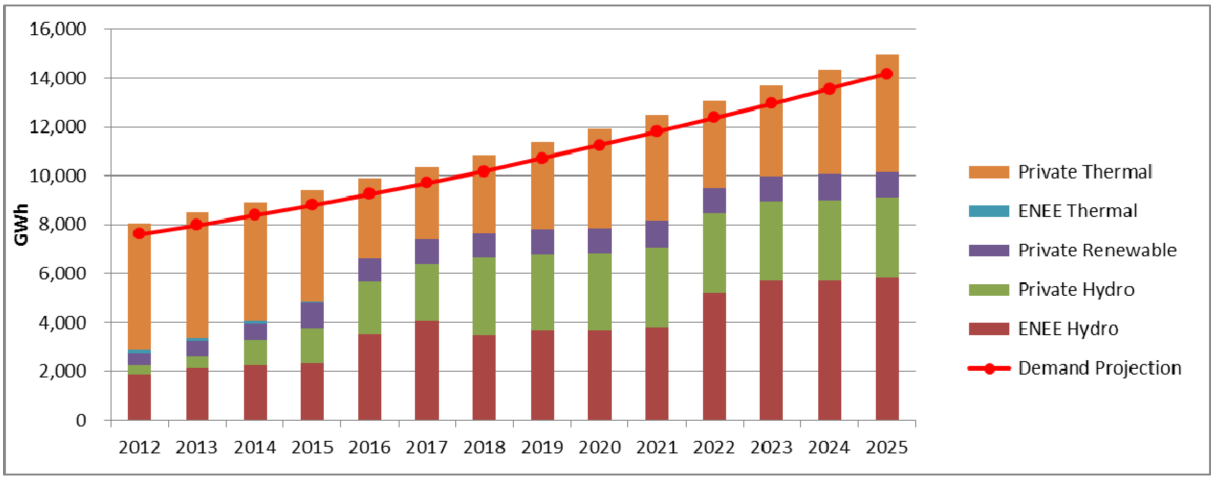


Figure 3.3-1 Energy Demand Supply Balance Projection

Source: ENEE "Projection Purchasing And Generation For ENEE March 2010" and "Proyección de Demanda de Energía Eléctrica 2010-2030"

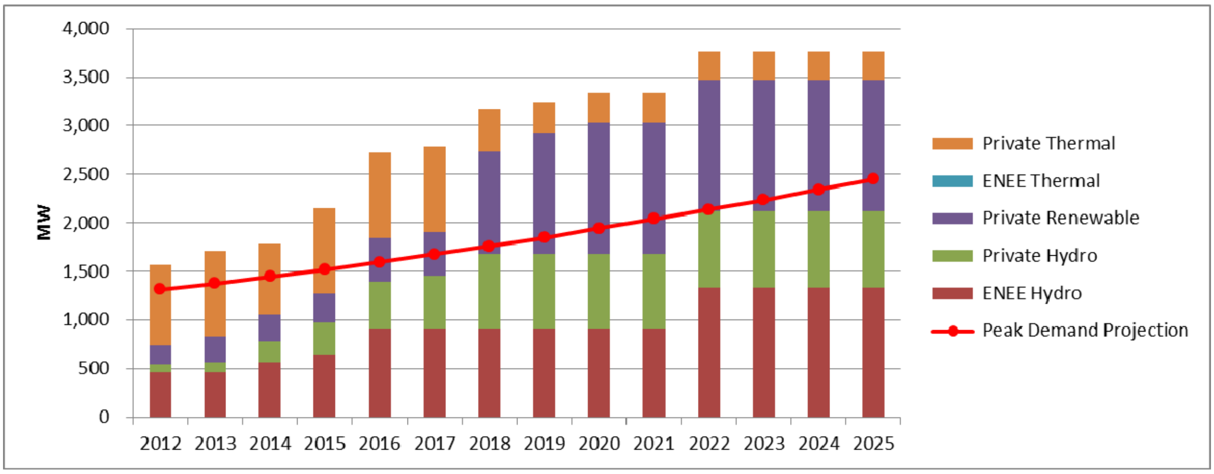


Figure 3.3-2 Peak Power Demand Supply Balance Projection

Source: ENEE "Projection Purchasing And Generation For ENEE March 2010" and "Proyección de Demanda de Energía Eléctrica 2010-2030"

Renewable ratio in generation is planned to be 67% in 2025 compared with current ratio of around 30%.

Table 3.3-1 shows generation expansion plan 2011 to 2025.

Table 3.3-1 Generation Expansion Plan

(Unit: MW)

PLANTS ADDED TO THE SYSTEM (MW)																	
PLANT	**FUEL**	**Developer**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Westport diesel	Diesel	Private		50													
Westport gas	LPG	Private			98.9												
CECHSA (carbón)	Coal	Private					150										
Small hidropower	Hydro	Private	4.8		4.6	6.2	8.3										
Mesoamerica Wind	Wind	Private		100	25												
Electrotecnia	Wind	Private			50												
Renewable bid	Renewable	Private	16	0.7	15	113	137	149.2	40.0	230				15			
Wind power	Wind	Private								400	200						
Biomasa	Biomass	Private						150		200		100					
Tablón	Hydro	Private							20								
Piedras Amarillas	Hydro	ENEE				100											
Cajon expasion	Hydro	ENEE					75										
Llanitos	Hydro	ENEE(co-invest)						98									
Jicatuyo	Hydro	ENEE(co-invest)						173									
La Tarrosa	Hydro	ENEE												150			
Valencia	Hydro	ENEE												270			
TOTAL			**21**	**151**	**194**	**219**	**370**	**570**	**60**	**830**	**200**	**100**	**0**	**435**	**0**	**0**	**0**
Retired Power			**0**	**85**	**50**	**151**	**0**	**0**	**0**	**440**	**140**	**0**	**0**	**0**	**0**	**0**	**0**
Net Addition			**21**	**66**	**144**	**68**	**370**	**570**	**60**	**390**	**60**	**100**	**0**	**435**	**0**	**0**	**0**

Source: ENEE

ENEE informed that all of the thermal plants, wind power, renewable project and small-scale hydro are to be developed by private companies, because Electricity Law in 1994 prohibits ENEE to develop thermal power plants and Renewable Energy Law in 2007 encourage private investment to renewable energy. Honduran government invited tender from private investment in renewable energy development in 2009. Projects totaling 743.5MW capacity applied to the bid and 225.6MW projects entered into contact with ENEE in 2010. Remaining 517.9MW projects were given option either to supply energy to ENEE or directly to private consumers. Large-scale hydropower development, however, is still considered as a governmental responsibility.

The development plan in Table 3.3-1 is only an indicative target because i) ENEE does not control private investment for developing thermal and renewable energy and ii) Large-scale hydropower development schedule tends to delay due to lack of financial sources of ENEE. For steady development of large-scale hydropower, ENEE is considering private participation to the development.

The Strategic Plan ENEE 2011-2014 was established to recover ENEE’s financial conditions. It depicts reduction of transmission/distribution loss, revision of tariff schedule, distribution/transmission system expansion, development of some hydropower projects, introduction of liquefied natural gas (LNG), implementation of sector efficiency enhancement program (“PROMEF”, funded by World Bank) among other things.

As shown in Table 3.3-1, large-scale hydropower development is expected to meet rapid growth of the electricity demand. The Strategic Plan ENEE 2011-2014 indicates that:

1) Piedras Amarillas or Patuca 3 project was developed initially by private company (Synotech, Taiwanese company) in line with governmental support from Taiwanese government. ENEE recently signed a memorandum of understanding with Chinese company, Synohydro for construction of the project and Synohydro has started site preparation. ENEE told that Honduran government acquires the project land and is negotiating a loan from Chinese EXIM bank.

2) Llanitos and Jicatuyo projects are initially identified by private company (TYPSA, Spanish company) and to be developed under co-financing scheme of ENEE, the Central American Bank for Economic Integration (CABEI), the National Bank of Economic and Social Development of Brazil (BNDES) and the construction company, Norberto Odebrecht (CNO).

3) La Tarrosa or Patuca 2A and Valencia or Patuca 2 projects are classified as a middle-term target. They are located at the same basin of Piedras Amarillas or Patuca 3. Synohydro may be appointed as a construction company after the construction of Piedras Amarillas.

4) El Tablón project is a multi-purpose project composing flood control, irrigation and power generation (possibly portable water in the future). Honduran government is planning to build the dam and expecting private participation in the power facility. This project is also classified as a middle-term target.

According to the demand-supply forecast, ENEE expects electricity supply of 5,820GWh from ENEE's hydropower plant, which is 39% of total demand. Out of 5,820GWh, 3778GWh or 65% is to be produced by future-developed hydropower project. Figure 3.3-3 shows expected generation from ENEE's hydropower plants in 2025.

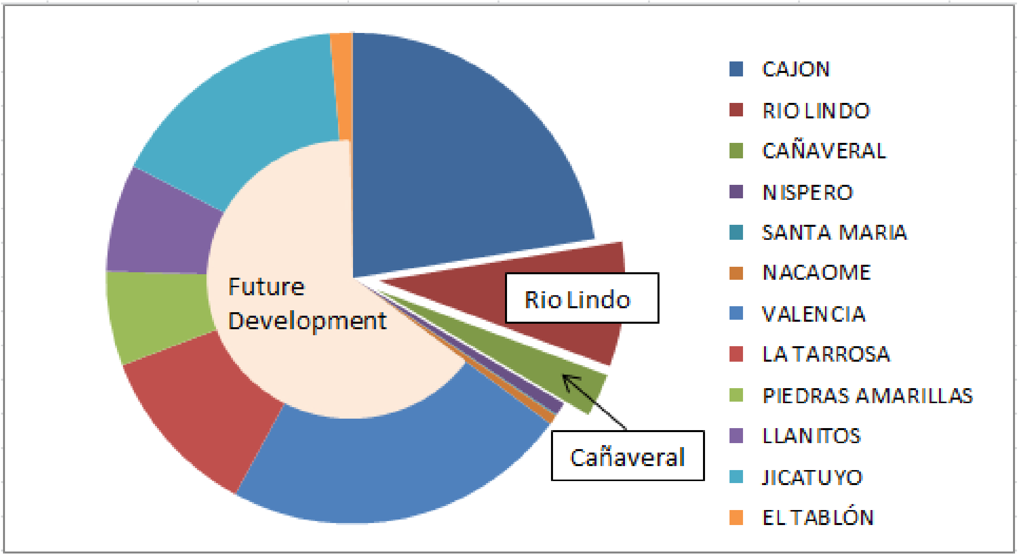


Figure 3.3-3 Scheduled Generation from ENEE's Hydroelectric Power Plants in 2025

To summarize the power development situation in Honduras, urgent generation expansion is required for accommodating rapid growth of electricity demand. Because of the governmental policy and poor financial conditions of ENEE, however, ENEE is relying on private development for not only thermal and renewable power but also large-scale hydropower projects. The project development of large-scale hydropower therefore may tend to be beyond the control of ENEE because joint development involves a complicated financing structure and legal documentations.

Under the circumstances above, electricity production from existing hydropower plants is very important in terms of providing cheap electricity to whole country. As shown in Figure 3.3-3, Cañaveral and Río Lindo HPPs are expected to generate around 11% of total ENEE's hydropower generation in 2025 (note that this projection assumes rehabilitation of Cañaveral and Río Lindo HPPs). ENEE put its personnel resources and budget to keep the hydropower running. Periodical maintenance work and major overhaul or rehabilitation is considered essential to sustainable economic growth of Honduras.

ENEE's projection of demand/supply and development plan will be discussed in Chapter 7.

CHAPTER 4 CAÑAVERAL AND RÍO LINDO HYDROELECTRIC POWER PLANTS

4.1 CAÑAVERAL - RÍO LINDO HYDROELECTRIC POWER COMPLEX

Cañaveral - Río Lindo Hydroelectric Power Complex (Centraesl Hydroelectricas Río Lindo - Cañaveral) consisting of Cañaveral and Río Lindo HPPs is located about 130km North West of Tegucigalpa city, in Cortés. Cortés is one of the 18 departments into which the Central American nation of Honduras is divided. The department covers a total surface area of 3,954 km² and, in 2005, had an estimated population of 1,365,497 people, making it the most populous department in Honduras. The Merendón Mountains rise in western Cortés, but the department is mostly tropical lowland, the Sula Valley, crossed by the Ulúa and Chamelecon rivers.

The Cañaveral - Río Lindo Hydroelectric Power Complex has a natural reservoir in Lake Yojoa, which is regulated annually, and the Cañaveral and Río Lindo HPPs belong to ENEE. These plants are cascaded, water is lead firstly turbines in Cañaveral HPP and then taken to the Río Lindo HPP, thus obtaining a greater yield from water resource. Because of this and other benefits, they are operated with greater efficiency and reliability as basic plants in the National Interconnected System.

Cañaveral HPP with installed capacity of 29,000kW has two Francis type hydraulic turbines and synchronous generators with their auxiliaries; each unit is connected to 138kV switchyard equipment via the step-up transformer. Cañaveral HPP is connected to 138kV National Interconnected System via Río Lindo switchyard and Piedras Azules substation.

Río Lindo HPP with installed capacity of 80,000kW has four Pelton type hydraulic turbines and synchronous generators with their auxiliaries; each unit is connected to 138kV switchyard equipment via the step-up transformer. Río Lindo HPP is connected to 138kV National Interconnected System via Cañaveral switchyard and Villanueva and El Progreso substations.

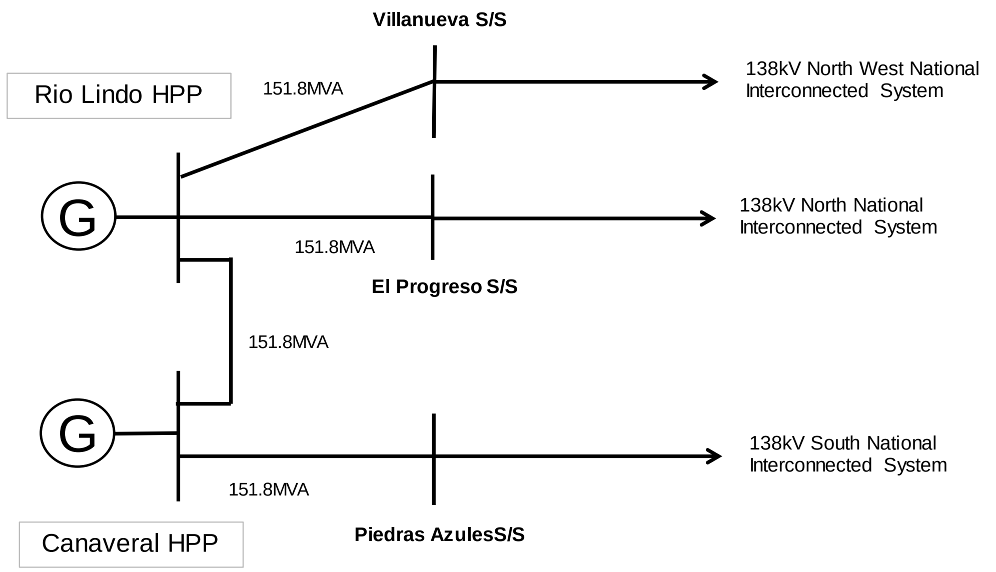


Figure 4.1-1 138kV Transmission Lines

Each 138kV transmission line connected to Cañaveral and Rio Lind HPPs has transmission capacity of 151.8MVA.

The basic features of the existing facilities and equipment for Cañaveral and Río Lindo HPPs are shown in Attachment-1 and Attachment-2, respectively. Photos of Cañaveral and Río Lindo HPPs are attached as Attachment-3 and Attachment-4.

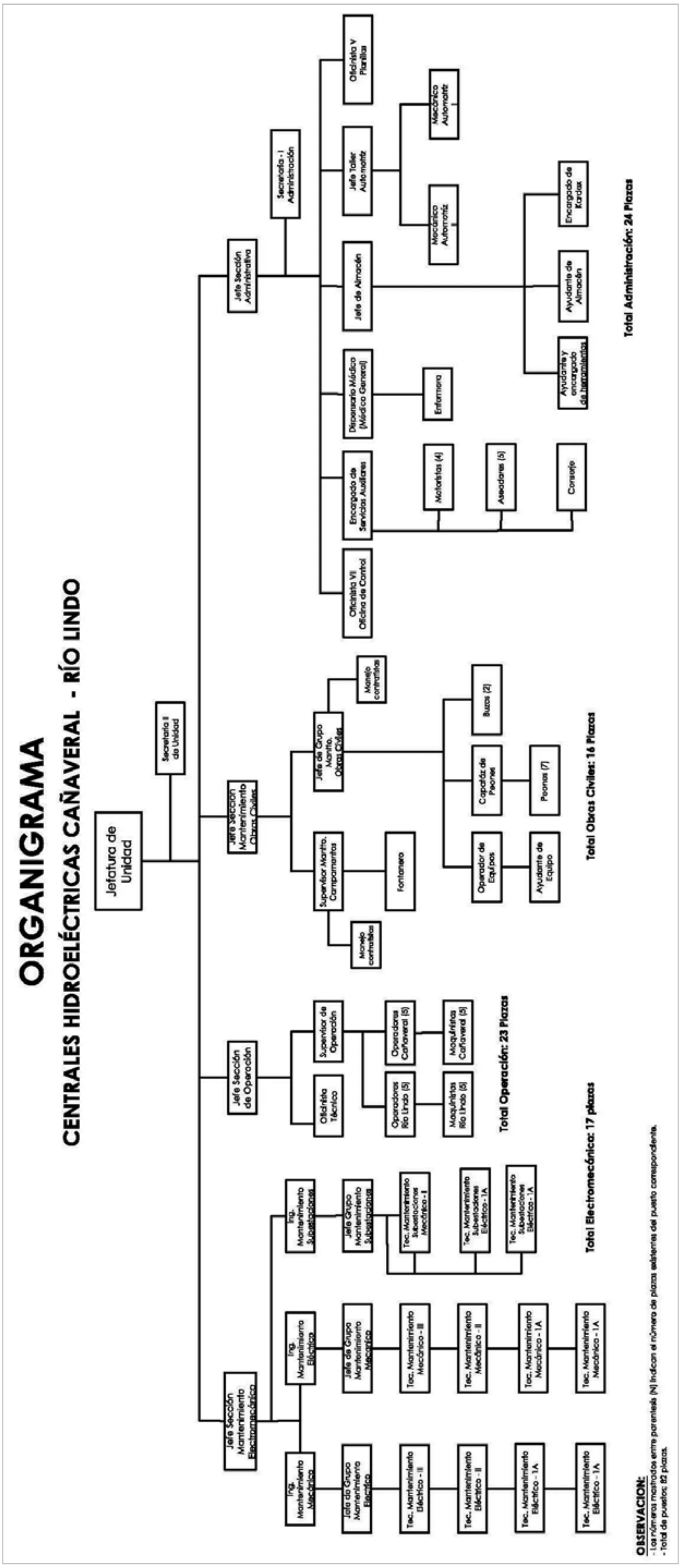
In order to continue maintaining operation indices after more than 20 years of continuous operation, major maintenance was performed in 1993. At present (2012), 18 years of continuous operation have elapsed, which have caused natural wear and tear, fatigue and operational deterioration through ageing in a lot of the parts of the turbine-generator group, thus making it necessary to carry out major maintenance in order to guarantee this clean and renewable generation of energy for another 30 years.

4.2 OPERATION AND MAINTENANCE STRUCTURES

(1) Organization

The Cañaveral - Río Lindo Hydroelectric Power Complex is under the south central transmission department of the transmission and production division. The Complex is responsible for the operation and the maintenance of the Cañaveral and Río Lindo HPPs.

The Cañaveral - Río Lindo Hydroelectric Power Complex has four (4) sections; electro-mechanical maintenance section, operation section, civil works maintenance section and administrative section. The electro-mechanical maintenance section has seventeen (17) crews, the operation section has twenty three (23) crews, the civil works maintenance section has sixteen (16) crews and the administrative section has twenty four (24) staff.



Source: ENEE

Figure 4.2-1 Organization of Cañaveral - Río Lindo Hydroelectric Power Complex

(2) Inspection and Maintenance of Facilities and Equipment

ENEE developed a preventive maintenance system (Método de Control y Mantenimiento Preparado, “MECEP”, refer to Attachment 9) which was prepared based on the maintenance standards of Électricité de France (EDF) and periodical inspection and monitoring are scheduled and conducted with written inspection report following MECEP. Inspection period is varied depending on facility’s characteristics and importance.

The fundamental objectives of MECEP are the followings:

(a) Maximize the availability of the installed equipment
(b) Avoid the un-useful disassembling of equipment
(c) Reduce the contingency failures of the equipment
(d) Control the weariness of the equipment and keep them efficient to extend their utility life
(e) Reduce equipment maintenance cost up to a reasonable possible point or maximize the production, operating reasonably

The MECEP processes in a plant are described below:

(a) **Forecast**. Watching the operation of the installed equipment and the on time detection of possible failures, as from a risk analysis for each of the installed equipment, all necessary resources must be provided to intervene the equipment on an appropriate date.

(b) **Decision**. According to a careful analysis of the condition of the installed equipment, of the consequences that a possible failure can have in the plant’s prediction or in the facility’s security, also as a function of the economic analysis, decisions must be taken to intervene the described equipment. To take decisions related to the installed equipment intervention, the followings are considered:

a. Security level of the parts of the equipment that is being checked out
b. Weariness level
c. Variation of the weariness of the components related to time
d. Increase of the equipment operation solicitations for several circumstances as time of the year, increase in the demand, etc.
e. Service quality that the evaluated machine must have
f. Risks for the operational staff and possible damages to third parties
g. Risks of material damages as the result of an accident
h. Economic operation
i. Standard obligations or contract obligations

(c) **Registry**. Once the intervention has been decided and its beginning date has been determined, it must be registered into an annual plan and into a special file whose characteristics will be discussed further on.

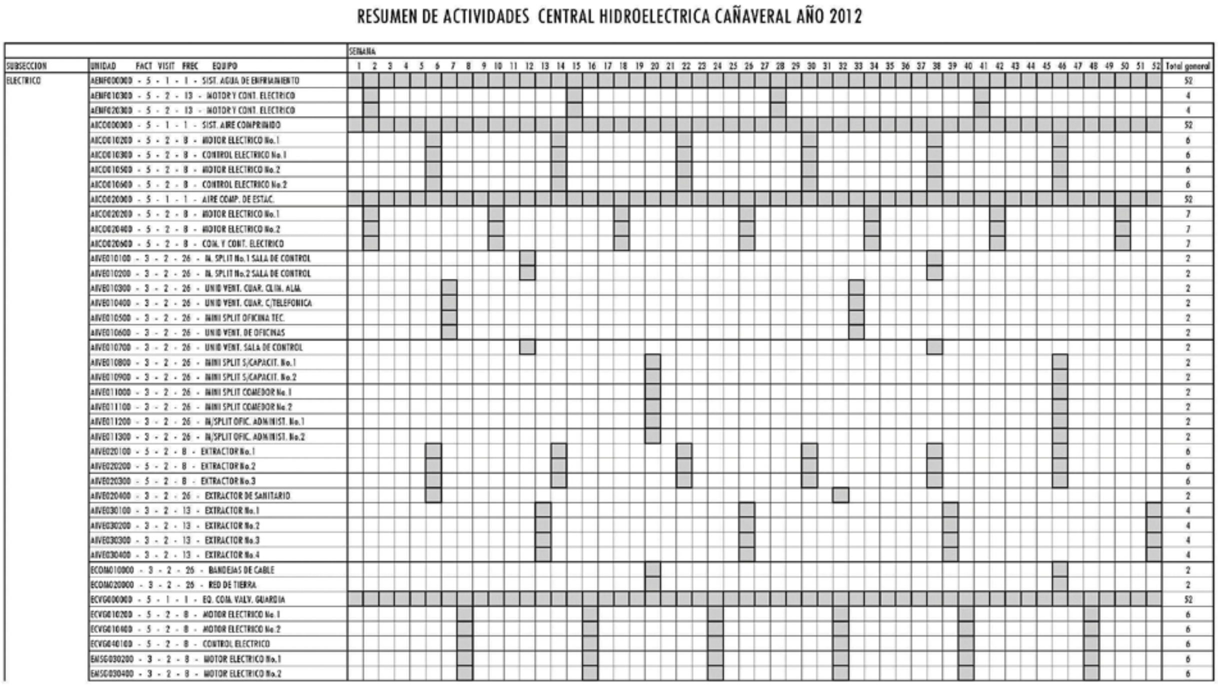
(d) **Work Preparation**. Each job to be developed, programmed or not programmed, must be planned and prepared up to minimal detail, with the purpose to decrease the outage periods.

(e) **Work Execution**. The work execution must follow the programmed plan. No work will be considered terminated without the corresponding report. The work execution includes the report formats.

(f) **Classification and Filing of Information**. Every intervention realized in the equipment has been prepared, planned, programmed and executed. The reports of such activities must be classified and filed correctly for its easy and quick localization as future references.

The maintenance section prepared the inspection and maintenance procedures and the inspection and maintenance schedules of equipment, apparatus and facilities as turbine, governor, generator, exciter, station service power supply equipment, switchgear as well as civil facilities for Cañaveral and Río Lindo HPPs based on MECEP. The inspection and maintenance of Cañaveral and Río Lindo HPPs are performed by the maintenance crews.

The maintenances are performed based on the maintenance activity lists. The maintenance activity lists are divided into four, the mechanical equipment and apparatuses, the electrical equipment, the civil facilities and the switchyard equipment. Figure 4.2-2 shows maintenance activity list for the mechanical equipment and apparatuses as example.



Source: ENEE

Figure 4.2-2 Maintenance Activity List

(3) Budget

The budgets in 2011 and 2012 of Canaveral - Río Lindo Hydroelectric Power Complex are shown in Table 4.2-1 Budgets in 2011 and 2012 of Canaveral and Río Lindo HPPs.

Table 4.2-1 Budgets in 2011 and 2012 of Cañaveral and Río Lindo HPPs

Cañaveral and Río Lindo HPPs	Budget	
	Done 2011	Approved 2012
O&M	43,179,576.50	78,824,031
Investment	14,865,458.13	22,000,000
Total (Lempiras)	58,045,034.63	100,824,031
Total (US$)	3,008,114.10	5,225,084.12

Source: ENEE

CHAPTER 5 REHABILITATION/EXPANSION PROJECT

5.1 MAJOR MAINTENANCE (OVERHAUL) EXPERIENCE

ENEE has carried out by himself the following major maintenances and overhauls of the power plants.

- ✓ Since 2006 major maintenance to four generating equipments of 75MVA each at Francisco Morazan HPP (or commonly known as El Cajón HPP) is being carried out.
- ✓ In 2001 major maintenance was carried out to a generating equipment of 22MVA located at El Nispero HPP.
- ✓ In 1994 a major maintenance of two diesel engines was carried out consisting of diesel engine generator sets of 16MVA.
- ✓ In 1993, a major maintenance of Cañaveral and Río Lindo HPPs was carried out consisting of the rehabilitation of two generating equipments of 14.5MVA each in Cañaveral HPP and of four generating equipments of 20MVA each in Río Lindo HPP.
- ✓ Major maintenance was carried out in several occasions to the four diesel/bunker engines of 6MVA each, located at La Ceiba.

(1) Francisco Morazan HPP (El Cajón Hydroelectric Power Plant)

The major maintenance to the following units of the generating equipment was completed.

Unit No. 4 in Year 2006
Unit No. 3 in Year 2008
Unit No. 2 in Year 2009

The major maintenance to Unit No. 1 of the generating equipment started in February 2009 and will be completed in May 2012. It includes planning, acquisition of parts, and the selection and training of staff involved in the repairs. In 2009, acquisition of special parts from different manufacturers began. In 2010 the budget was increased for staff recruitment, contracting services, procurement of equipment and local materials and execution of the repairs on the generator, turbine, governor and auxiliary systems of Unit No. 1.

The actual implementation schedule as of February 26, 2012 of Unit No.1 overhaul work of Francisco Morazan HPP is shown in Attachment-5, Overall Implementation Schedule of Unit No.1 of Francisco Morazan HPP.

This major maintenance is being implemented with ENEE permanent staff, temporary staff, and specialist personnel from the manufacturers to be hired for this work and the contracts for execution of work with local contractors.

The procurement, installation works and commissioning are carried out in the following lots with the employments of Labmac, Siemens, Hydro Vevey, Aέm and other contractors.

Lot-1 Disassembly and assembly of the generating equipment
(Procurement method: Bidding)

Lot-2 Procurement of special parts and guidance services for overhaul of the generator
(Procurement method: Direct Contract)

Lot-3 Procurement of special part and guidance services for overhaul of the turbine
(Procurement method: Direct Contract)

Lot-4 Painting of the generating equipment
(Procurement method: Bidding)

Lot-5 Repairing of civil facilities
(Procurement method: Bidding)

The overhaul of Unit No.1 consists of repair of the turbine, the generator, the governor and auxiliary equipment listed below. This includes the complete disassembly of all components, thus removing out all parts for renewal, replacement or modification, as appropriate.

(a) Hydraulic Turbines

a. Major overhaul and replacement of wiring and electric monitoring devices of the turbine

b. To inspect and assess the runner and replace it with the spare runner, if there is damage

c. To inspect, assess and repair damage in the upper and lower ends.

d. To inspect and repair corrosion damage in the turbine shaft.

e. To inspect, repair and replace parts to ensure the proper performance of the turbine seal, and to perform a new set-up of the seal and make changes, if necessary

f. To inspect the turbine bearing

g. To inspect the turbine guide bearing and its cooling accessories using ultrasonic, dye penetrant and / or magnetic particle techniques

h. To repairs in the pre distributor, the stay ring and inside the spiral case and the vent pipe

i. To perform an inspection in conjunction with an expert consultant on turbines and evaluate the guide vanes and make repairs in the event of damage.

j. Replacement of all packaging materials in the upper and lower bushings of the guide blades.

(b) Generators

a. Removal of the old stator frame and thorough cleaning of slots.

b. Installation of new frame in the stator

c. Varnishing the stator, including windings and stator iron
d. Disassembly of the 24 rotor poles and checking of the entire frame
e. Dismantling of the 24 poles to replace their insulation, coils and steel frames.
f. Renovation, cleaning and painting of the rotor poles
g. Renovation and replacement rotor interpolar connections
h. Changing of the connections of the rotor damper windings
i. To complete replacement of the slip rings, brushes and brush holders
j. To complete replacement of the oil vapor extraction system in the bearings
k. To complete replacement of the fiber and metal seals and of the upper guide bearing of the generator in order to prevent leakage of oil vapor into the slip rings
l. Major overhaul of the braking system
m. To complete replacement of the fiber seals of the generator’s combined bearing to prevent leakage of oil vapor into the enclosure of the generator
n. To repair of connections bars, general isolation of rods, and tinning of all terminations
o. Replacement of all protective caps of the joints between bars of the stator winding
p. Replacement of coil thermometers in poor condition
q. Centering of the stator
r. Measurement of “air gap”, measurement of "run out" and checking of shaft alignment
s. Testing of ventilation and heating of the generator
t. Adjustment of the fan blades for efficient operation of the generator
u. Inspection of the combined bearing and upper guide bearing and their cooling systems using ultrasonic, liquid penetrant and /or magnetic particle techniques
v. To set values for alarms and temperature probe shots for each bearing
w. Overall painting of generator

(c) Inlet Valves

a. Major overhaul, replacement of wiring and electric monitoring devices and controls for the inlet valve and its oil pumping system
b. To inspect valve bearings and replacing their packing
c. To inspect the lubrication system of the valve bearings and seals
d. To repair of valve actuators and replacement of packing

(d) Speed Governors

a. Major overhaul, replacement of wiring and electrical monitoring and control devices of the speed governor and its oil pumping systems.

b. To correct the oil cooling system in addition to the proper operation of all controls and hydraulic tank accessories and cask including protective devices

c. Replacement of devices needed in the hydraulic system

d. Tuning and adjustment of all hydraulic devices.

(e) Auxiliary Equipment

a. To change the generator's oil vapor extractor pump

b. To change the electrical control devices and the thrust bearing high pressure lubrication pump

c. To change electric control devices and inspect the rotor lifting pump

d. To correct anomalies in the compressed air system for brakes

The photographic record of the overhaul of No.1 Unit of Francisco Morazan HPP is shown in Attachment - 6, Overhaul of No.1 Unit of Francisco Morazan HPP.

The project cost is as follows:

Personnel Services:	Lempiras	28,399,400.00	($ 1,502,613.76)
Non-personnel Services:	Lempiras	21,746,979.10	($ 1,150,633.81)
Special Parts of Rehabilitation:	Lempiras	94,510,983.18	($ 5,000,581.12)
Material Supply:	Lempiras	1,874,000.00	($ 99,153.44)
Machinery and Equipment:	Lempiras	2,453,960.50	($ 129,839.18)
Total	Lempiras	148,985,322.78	($ 7,882,821.31)

(2) Cañaveral and Río Lindo Hydroelectric Power Plants in Year 1993

ENEE carried out the major maintenance of Cañaveral and Río Lindo HPPs from June 1991 to December 1993 as follows:

The special parts and the technical support services of the major maintenance of the generating equipment for Cañaveral and Río Lindo HPPs were supplied by Toshiba and Hitachi respectively under the direct contract.

The installation works and commissioning were carried out in the following lots with the employments of DIGILZA, and SEPAC, Mexican companies.

Lot-1 Installation of penstock valve of Río Lindo HPP

Lot-2 Disassembly and assembly of Unit No.1 generating equipment of Cañaveral HPP and Unit No.1 and Unit No.2 generating equipment of Río Lindo HPP

Lot-3 Disassembly and assembly of generating equipment of Unit No.2 of Cañaveral HPP and Unit No.3 and Unit No.4 of Río Lindo HPP

Lot-4 Replacement of control cables and installation of 2 units of power transformers of Cañaveral HPP

The major maintenance of Canaveral and Río Lindo HPPs consisted of:

a. Disassembly for checking, cleaning and changing of the excitation system,
b. Electrical testing of insulation and determination of parameters of the generator and auxiliaries,
c. Inspection for reviewing rotor poles, cleaning , insulation repairs and varnishing of the stator and the rotor of the generator,
d. Electrical testing of insulation and determination of parameters of the generator circuit bus bars, the transformers and the protection system,
e. Installation of the penstock valves,
f. Replacement of stator coils, rotor coils, bearings, the voltage regulator, turbine runners,
g. Replacement of 20MVA generator transformers of Canaveral HPP,
h. Replacement of the control and power cables in both power stations and switchyards,
i. Improving the voltage regulators,
j. General repairs and adjustments of all generating equipment of both HPPs,
k. General maintenance of the penstocks and the inlet valves of both HPPs,
l. Rehabilitation of structures and associated civil works at both HPPs,
m. Operation tests, and
n. Commissioning.

5.2 BACKGROUND OF REHABILITATION/EXPANSION PROJECT

Cañaveral and Río Lindo HPPs, together with Francisco Morazan HPP, is the backbone of the generating system of ENEE. Cañaveral HPP started commercial operation in March 1964, with two 15.2MVA units, then on May 20, 1971 the first stage of Río Lindo HPP came into commercial operation with two 21.05MVA units, and the second stage came into commercial operation on April 22, 1978 with two units of equal power, thus making a total capacity of 114.6 MVA for the complex.

In 1972 partial major maintenance was carried out on generating unit No. 1 at Cañaveral HPP and in 1978 partial major maintenance was carried out on generating units No. 1 and 2 of the first stage of Río Lindo HPP.

From 1979 until the entry into operation of the Francisco Morazan HPP in 1985, ENEE faced a critical period of generating capacity, both with regard to power and to energy and it became impossible to keep the generating units at Cañaveral and Río Lindo HPPs out of service in order to carryout major maintenance on them, despite the entry into operation of the Alsthom and Sulzer diesel power stations.

In 1993 it was possible to carry out major maintenance on the 6 generators of the Cañaveral and Río Lindo HPPs, leaving the units at Cañaveral HPP with a capacity of 15.2MVA.

In the major maintenance of 1993 the original technology of the equipment (1962 Cañaveral and 1971 Río Lindo), such as the turbines, speed governors, generators at Río Lindo HPP, control equipment and other auxiliary equipment, was kept. The complex was left with a capacity of 114.6MVA

Since then the generating units have been operating almost continuously until now (2012), with operation only being briefly interrupted to carry out preventive and corrective maintenance on them. As a result, some equipment has deteriorated through natural wear and tear and other has become obsolescent, which makes getting spares difficult.

5.3 NECESSITY OF REHABILITATION/EXPANSION PROJECT

(1) Cañaveral Hydroelectric Power Plant

Some components of equipment have been in operation for 47 years and some other for 18 years since the last major maintenance (1993) performed on the Cañaveral HPP. These components of equipment have been in continuous operation and are increasingly becoming faulty due to wear experienced by their parts, thus causing the hydroelectric plant to continuously lose efficiency and availability caused by failures and highly frequent corrective maintenance performed on electromechanical equipment. According to the operation records from 2007 to 2011, average planed outages of 133 hours in 2007, 85 hours in 2008, 73 hours in 2009, 72 hours in 2010 and 109 hours in 2011 were carried out for the maintenances of the generating equipment such as turbine, generator and their auxiliaries.

Among other pieces of equipment having the same operating hours as speed governors, the following ones can be mentioned: station control system; generator field poles; generator fire system; lock gate system and its control devices; inlet valve and its control system; pressure relief valve; power transformers; main circuit breakers for the 138kV units; air-oil system of drivers and inlet valve; and other ancillary equipment required to operate the station.

Due to the accumulated deterioration and wear and tear in the equipment because of its continuous use, this station is experiencing breakdowns more frequently and the trend is to be more serious. In addition, a lot of equipment has become obsolescent, spares cannot be found on the home market or abroad, and so there are more problems with the required maintenance.

Based on the manufacturers' experience and that of other companies in the hydroelectric power industry worldwide, the period to perform a major maintenance to the station ranges between 5 and 10 years, which can be shorter in other instances, depending on the operation the component of equipment is subject to in the station and the features of the area the station is located at.

(2) Río Lindo Hydroelectric Power Plant

After 18 years of operation since the last major maintenance, the equipment at Río Lindo HPP, which has been operating continuously for nearly 40 years, is having more breakdowns through wear and tear to its parts, and the hydroelectric complex is continuously losing efficiency and availability through breakdowns. According to statistics from June 2007 to June 2010, 10% of breakdowns are in the turbine, 43% in the generator and its auxiliary equipment, representing 29% and 40% of unavailability or time out of the total breakdowns in the units, were occurred respectively.

From the manufacturers' experience, the typical working life of a Pelton runner, under normal operating conditions, is 30 to 40 years on average. Excessive wear and tear can bring about fatigue fractures through use after the end of the working life has been reached.

Among other groups with the same number of hours of operation are the speed governors, the station control system, generator nuclei, generator coils and other auxiliary equipment necessary for operation.

Due to the accumulated deterioration and wear and tear in the equipment because of its continuous use, these stations are experiencing breakdowns more frequently and the trend is to be more serious. In addition, a lot of equipment has become obsolescent, spares cannot be found on the home market or abroad, and so there are more problems with the required maintenance.

(3) Civil Facilities of Cañaveral and Río Lindo Hydroelectric Power Plants

Civil facilities of Cañaveral HPP consists of open-channel waterway (8,000 m length) with stop log facility at the middle, intake pond, intake structure with an intake gate, a penstock (1,139m length, 3m diameter) and discharge channel (800m length). Water was taken from Lake Yojoa through open channel and penstock and flow is separated into two at the entrance of powerhouse. Open discharge channel lead discharged water directly to "control structure" of Río Lindo HPP. Maximum water discharge is 23.0 cubic meter per second (m^3/s) for 2 turbines.

Río Lindo HPP has two source of water, one is discharge water from Cañaveral HPP and the other is diverted water from Río Lindo (Lindo River). Maximum water discharge of Río Lindo HPP is $27m^3/s$ for 4 turbines, Excess amount of water to discharge from Cañaveral HPP is taken from Lindo River. At the control structure, two sources of water flow merge and led into upstream pipeline. There exists by-pass waterway from pondage of control structure to Lindo River for discharging excess water back to Lindo River. Overflow spillway of by-pass waterway has a radial gate. From control structure, an upstream pipeline (1,370m length, 3m diameter) and upstream tunnel (900m length, horseshoe shape with 4m diameter) convey water to Río Lindo HPP intake pond. Earth-fill embankment with inclined impervious zone (20m height, 500m length) forms intake pond which has 127,000 m^3 storage volume with 109,000 m^3 effective storage. Intake structure with a slide gate leads water to pressured tunnel (370m length, horseshoe shape with 3.3m diameter) then immediately downstream of the pressured tunnel, there is a bifurcation pipe to separate water flow into two pressured pipe lines (each 701m length, 3m diameter). Two butterfly valves are equipped just downstream of bifurcation pipe to each pressured pipeline. At the end of pressured pipe lines, two steel-made surge tanks exist for regulating inner pressure, then two penstocks (each 5,110m length, 2.4m diameter) with two bifurcation pipe at the end convey water flow to turbines. Water flow from Río Lindo HPP finally discharged to Lindo River through 1,500m length open channel.

Since Cañaveral and Río Lindo HPPs depend on water from Lake Yojoa, second stage development of Río Lindo HPP in 1978 included diversion works to compensate water to

Lake Yojoa. Río Yure, having its source at around 5 km east of Lake Yojoa and flowing to north east direction to El Cajón was diverted to Lake Yojoa at the upstream by constructing Yure dam (75m height center-core rock-fill dam, 200m length). The other diversion is at Río Varsovia, flowing from southern-east mountain of Lake Yojoa. It flows south around Lake Yojoa then flow to north joining Río Ulúa to Caribbean Sea. Varsovia dam, an earth-fill embankment (7m height, 20m length) with concrete spillway chute was constructed for diverting water from Varsovia River to Lake Yojoa. Another earth-fill embankment, La-Pita dam (7m height) was constructed for controlling water level of Lake Yojoa, When water level of Lake Yojoa exceed 637.5m amsl, water spills from La-Pita dam to Valsovia River. These facilities (Yure dam, Varsovia dam and La-Pita dam) are also civil facilities of Cañaveral and Río Lindo HPPs and operated/maintained by ENEE. Two diversion facilities take around $4m^3/s$ water flow to Lake Yojoa in average.

Civil facilities are well inspected and maintained in general following procedures of MECEP. Due to the lack of budget, however, some maintenance works are not conducted in spite of negative result of the periodical inspection. Followings are items that ENEE plan to repair/replace and validation of the Consultant.

1) Electrical equipment for hydraulic gates are almost exhausted and some of them are out of service. ENEE plans to replace electrical equipment, which is validated for maintaining normal and emergency operation of civil facilities.

2) Painting of waterway pipelines and penstocks has been peeled out at about 20 to 30% of the total length and corrosions are observed. Although ENEE has a periodical maintenance for leakage and bolt tightening at the expansion joints, there is no numerical record of painting deterioration and corrosion. Repair work is validated by internationally recognized maintenance procedure of steel pipe. It is recommended that the inspection record of paintings and corrosion be maintained. Touch-up work during periodical inspection is also recommended.

3) Intake screens for both Cañaveral and Río Lindo HPP have no trash rakes. Clearing debris at intake screen is done around once every 3 months by manual of divers. This maintenance procedure may deteriorate generation capability of both plants because debris at the intake screen create head loss. Should the trash rakes be installed, clearing work will be done more frequently, and then it can keep design effective head. In view of safety, screen clearing system is also required. Validation was made by observing operational record. (See next page)

4) Penstock valve of Río Lindo HPP has leakage according to inspection during dewatered overhaul.

5) Dam monitoring equipment has been out of service. There is no dam monitoring conducted after the malfunction of the equipment. The Consultant recommends installation of manual monitoring system and periodical inspection and dam stability evaluation procedure.

Validation of Intake Screen Trash Rake Installation

The operational records regarding head loss at the intake screen of Río Lind HPP were reviewed. Those data are hourly data of i) gross head, ii) discharge amount of Unit No. 3, observed by pressure meter and iii) output of Unit No.3. Duration of data is one month before screen clearing and 1 month after screen clearing. “Output Index” was calculated as a ratio of actual output to theoretical output, thus this index represents head loss at the intake screen. Figure 5.3-1 shows observed data while Figure 5.3-2 shows average Output Index eliminating some data because of accuracy of measuring discharge amount.

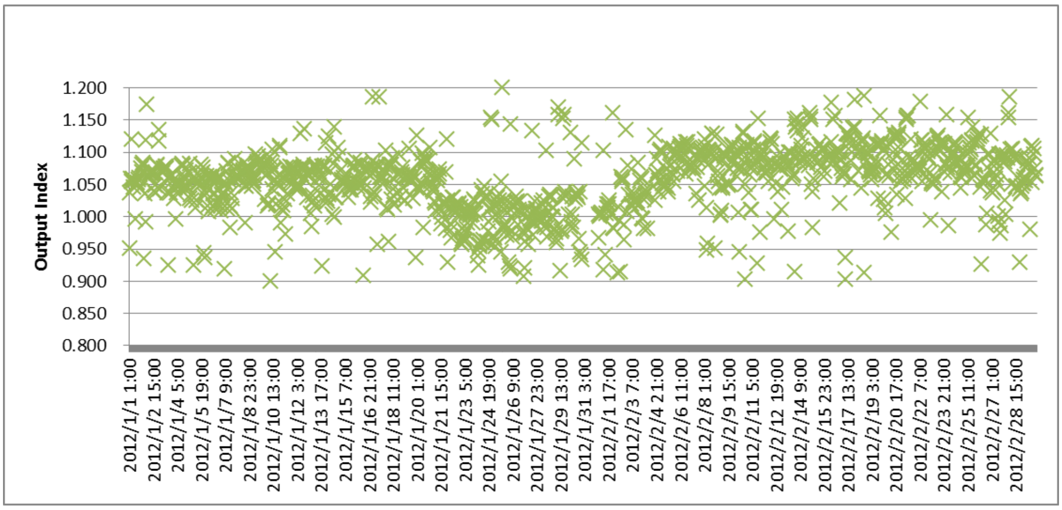


Figure 5.3-1 Output Index (all data)

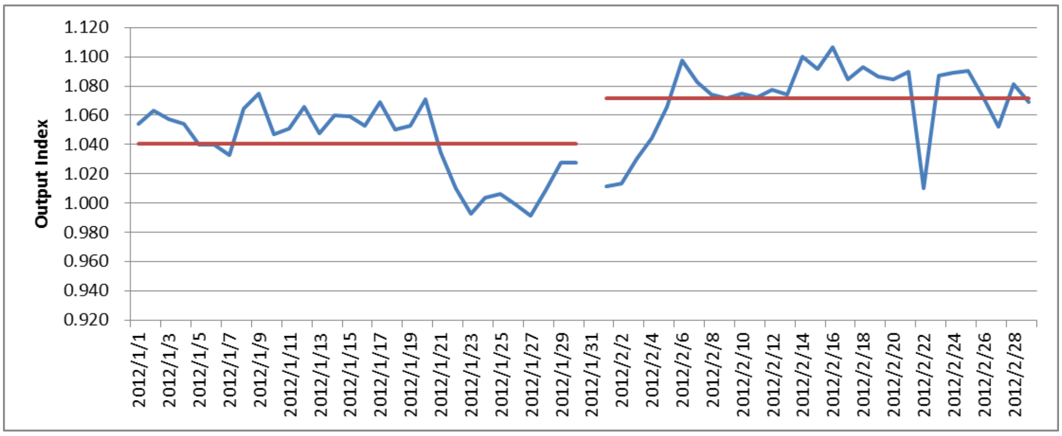


Figure 5.3-2 Average Output Index

Average Output Index implies around 3% of effective head was recovered by clearing intake screen. In conservative assumption, even assuming 0.3% effective head (equivalent around 1.2m) is lost by intake debris, the loss of revenue by this head loss is approximately 100,000 US$ per year (average generation of Río Lindo: 569Gwh, unit sales price; 0.152 US$/kWh in 2010). By installing the intake screen rake, screen clearing can be done more frequently, and then this loss of revenue will be eliminated.

5.4 REHABILITATION/EXPANSION PROJECT

This rehabilitation/expansion project was planned in order to avoid situation that Cañaveral and Rio Lindo HPPs are experiencing breakdowns more frequently and the trend is to be more serious due to the accumulated deterioration and wear and tear in the facilities and the equipment because of their continuous uses.

The decision to the rehabilitation/expansion plan such as repairing, replacing or improving the facilities and the equipment at Cañaveral and Río Lindo HPPs was made by ENEE technical personnel at Cañaveral - Río Lindo Hydroelectric Power Complex, with the support of the production and transmission division and was confirmed by engineering personnel of the manufacturers who visited the HPPs in March 2011 and September 2011 and by the Taiwan Power Company experts who visited them in March 2011. The generating equipment such as turbines, generators and their auxiliaries were diagnosed by the engineering personnel of the original manufacturers and the Taiwan Power Company experts.

The Consultant carried out technical review for hydro-electrical, hydro-mechanical and civil field to grasp the current status of both Cañaveral and Río Lindo HPPs by observation of facilities, review of the operational records (including historical maintenance record and accidental events) as well as the rehabilitation/expansion plan above prepared by ENEE and hearing with operators and maintenance crews. The reasonableness of the rehabilitation/ expansion then was reviewed and discussed with ENEE in terms of work scope and implementing budget.

(1) Rehabilitation of Generating Equipment

The existing generating equipment of Cañaveral and Rio Lindo HPPs were designed based on the technology and practice in the 1960's and in the 1970's, respectively. In the major maintenance of 1993 the original technology of the equipment (1962 Cañaveral HPP and 1971 Río Lindo HPP), such as the turbines, speed governors, generators at Río Lindo HPP, control equipment and other auxiliary equipment, was kept. Under such situation, some damage/deterioration can be possibly identified even if no severe problems have been observed so far. In addition, spare parts for the original equipment are difficult to find in the market.

According to "IEC[1] 62256 - Hydraulic Turbines, Storage Pumps and Pump-turbines - Rehabilitation and Performance Improvement", the opportune time for starting rehabilitation should be prior to the equipment experiencing frequent and severe problems with its major components such as for example: generator winding failures, major runner cracking, cavitation or particle erosion damage, bearing failures and/or equipment alignment problems due to foundation or substructure movement or distortion.

To avoid long term stoppage due to a severe problem and/or non-availability of spare parts for damaged components in the near future, rehabilitation of the generating equipment is recommended to restore the performance and reliability to maintain continuous long time

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operation. This can be achieved by adopting advanced and modern technology for the major components. Upon renovating the major components, each power plant could be to have an extended life of another more 30 years and each power plant performance is improved.

(2) Scope of Rehabilitation of Generating Equipment

As a scope of the rehabilitation of the generating equipment, partial or entire replacement of the components of the turbine and the generator is considerable, however, it is recommended to adopt a partial replacement because the partial replacement of the components of the generating equipment is able to restore the performance and reliability to maintain continuous long time operation of both Cañaveral and Rio Lindo HPPs, not necessary to adopt the entre replacement, according to the diagnosis results of both Cañaveral and Rio Lindo HPPs undertaken by ENEE and the Taiwan Power Company.

The scope of the rehabilitation of the generating equipment is as follows:

- Performance improvement
  The generating equipment performances of Cañaveral and Rio Lindo HPPs are improved by adopting advanced and modern technology for the major components.

- Procurement of main equipment
  Components and materials and the technical support services for the rehabilitation of turbines, generators and their auxiliaries of Cañaveral and Rio Lindo HPPs are procured.

5.4.1 Performance Improvement

(1) Cañaveral Hydroelectric Power Plant

(a) Turbine performance improvement

Designed turbine power will be increased to 16,500kW at effective head of 145m with approx. 2% increase of turbine efficiency and increase of discharge. However, operational turbine power caused by the limitation of the generator power is 16,100kW as shown in Table 5.4-1 Turbine Performance Improvement.

Table 5.4-1 Turbine Performance Improvement

No.	Item	Existing	After Rehabilitation
1	Turbine power	14,700kW	16,100kW
2	Discharge	11.5m^3/s	12.1m^3/s
3	Efficiency	-	+ Approx. 2%
4	Effective head	145m	
5	Speed	514rpm	

(b) Generator performance improvement

The maximum generator power will be of 17,000kVA as same as the existing one. However, by the turbine performance improvement (14,700kW to 16,500kW), the generator power under the operation will be increased to designed power (17,000kVA × 0.95 = 16.1MW)

Table 5.4-2 Generator Performance Improvement

No.	Item	Existing	After Rehabilitation
1	Generator power	17,000 kVA	17,000 kVA
		14,500kW	16,100kW
2	Number of units	2	2
3	Total power	34,000kVA (29,000kW)	34,000kVA (32,200kW)
4	Power factor	0.95	0.95

(2) Performance Improvement of Río Lindo Hydroelectric Power Plant

(a) Turbine performance improvement

Designed turbine power will be increased to 26,370kW at effective head of 405m (Design Head) with approx. 2% increase of turbine efficiency and increase of discharge as shown in Table 5.4-3 Turbine Performance Improvement.

Table 5.4-3 Turbine Performance Improvement

No.	Item	Existing	After Rehabilitation
1	Turbine power	24,420kW	26,370kW
2	Discharge	$6.75m^3/s$	$7.3m^3/s$
3	Efficiency	-	+ Approx. 2%
4	Effective head	405m	
5	Speed	450rpm	

(b) Generator performance improvement

Designed maximum generator power will be increased from 24,210kVA to 27,200kVA. This scheme will be the merits of both increasing power supply and long period of sound power supply. For the up-rating, the outer diameter of stator frame is a little enlarged.

Table 5.4-4 Generator Performance Improvement

No.	Item	Existing	After Rehabilitation
1	Generator power	24,210 kVA	27,200 kVA
		23,000kW	25,8000kW
2	Number of units	4	4
3	Total power	96,840 kVA (92,000kW)	108,880 kVA (103,200kW)
4	Power factor	0.95	0.95

(3) Actual Operation Condition of Río Lindo HPP

The effective head of 405m for the turbine of Río Lindo HPP mentioned above is designed effective head when 3 units of the generating equipment of Cañaveral HPP are operated after expansion of Cañaveral HPP. Present effective head and water discharge at Río Lindo HPP due to 2 units of the generating operation of Cañaveral HPP are 385m and 27.0m^3/s (6.75m^3/s × 4units).

The existing plant output of Río Lindo HPP is 80,000kW based on present effective head (385m). The plant output of Río Lindo HPP after the rehabilitation/expansion project would be 97,600kW (24,400kW × 4units) based on 385m and 29.2m^3/s.

5.4.2 Rehabilitation and Procurement

The following apparatuses, equipment, works will be procured for the rehabilitation/ expansion project.

(1) Cañaveral Hydroelectric Power Plant

(a) Procurement of Main Equipment

Components and materials and the technical support services for the rehabilitation of turbines, generators and their auxiliaries are procured. The digital type control and protection systems are complied with the requirement of transferring power plant information to the ENEE national dispatching center.

1) Turbine 2 units
Runner, guide vanes, discharge ring, facing plate, guide bearing, etc.

2) Governor 2 sets
Digital governing system and servomotors to be complied with the digital control system

3) Inlet Valve 2 sets
Sealing

4) Generator 2 sets
Thrust bearing, oil vapor seal

5)	Exciter and AVR Exciter with AVR to be complied with the digital control system	2 sets
6)	Control System (Generating Unit) Digital control system	1 lot
7)	Protection System (Generating Unit) Digital protection system	1 lot
8)	Technical Support Service	1 lot

(b) Procurement of Other Equipment

Since the following equipment and materials are used for 47years and the equipment have become obsolescent, spares cannot be found on the home market or abroad, and so there are more problems with the required maintenance, they will be procured and replaced.

1)	Protection System (Step-up Transformers)	2 sets
2)	Station Service Transformer	2 sets
3)	480Vac Low Voltage Distribution Board	1 set
4)	125Vdc MCB of DC Distribution Board	1 lot
5)	125V Battery	1 set
6)	Battery Charger	1 set
7)	Emergency Generator	1 set
8)	13.8/138kV Step-up Transformer	2 sets
9)	138kV Circuit Breaker	2 sets
10)	Control and Low Voltage Cables including Connectors and Other Apparatuses and Materials	1 lot
11)	Air Compressor	3 sets
12)	Fire Extinguishing System	1 set

The following equipment will be repaired.

1)	Repairing Components of Overhead Travelling Crane	1 lot

(c) Civil Facilities

The following facilities will be supplied, installed and repaired.

1)	Supply and Installation of Intake Gate Trash Rake (Intake Gate)	1 set
2)	Supply and Installation of Dam Monitoring System (Yure and Varsovia)	2 sets
3)	Repairing of Intake Gate Operating Mechanism	1 set
4)	Replacement of Vent Valve of Penstock	5 sets
6)	Painting of Penstock	1 lot
7)	Extension of Assembly Bay (Power House)	1 lot

(d) Installation Work

1)	for Main Equipment	1 lot

2)	for Other Equipment and Civil Facilities	1 lot
3)	ENEE's Work for Others	1 lot

(2) Río Lindo Hydroelectric Power Plant

(a) Procurement of Main Equipment

Components and materials and the technical support services for the rehabilitation of turbines, generators and their auxiliaries are procured. The digital type control and protection systems are complied with the requirement of transferring power plant information to the ENEE national dispatching center.

1)	Turbine Runner, nodule, needle, deflector, etc.	4 units
2)	Governor Digital governing system and servomotors to be complied with the digital control system	4 sets
3)	Generator Stator core, stator frame, stator coils, field coils, air coolers, repairing materials, etc.	4 sets
4)	Exciter and AVR Exciter with AVR to be complied with the generator output and the digital control system	4 sets
5)	Inlet Valve Sealing	4 sets
6)	Control System (Generating Unit) Digital control system	1 lot
7)	Protection System (Generating Unit) Digital protection system	1 lot
8)	Technical Support Service	1 lot

(b) Procurement of Other Equipment

Since the following equipment and materials are used for 40years and the equipment have become obsolescent, spares cannot be found on the home market or abroad, and so there are more problems with the required maintenance, they will be procured and replaced.

1)	Protection System (Step-up Transformers)	4 sets
2)	480Vac CB and MCB of Low Voltage Distribution Board	1 lot
3)	125Vdc MCB of DC Distribution Board	1 lot
4)	125V Battery	1 set
5)	Battery Charger	1 set
6)	13.8/138kV Step-up Transformer	2 sets
7)	138kV Circuit Breaker	4 sets

8)	Control and Low Voltage Cables including Connectors	1 lot
9)	Air Compressor	8 sets
10)	Air Vent Valve (Inlet Valve)	4 sets
11)	Oil Purification Pump	1 set
12)	Water Flow Meter	4 sets
13)	Cooling Water Flow Indicator	16 sets
14)	Water Cooling Filter	5 sets
15)	Emergency Generator	1 set
16)	Tailrace Crane	1 set
17)	Fire Extinguishing System for Transformer	1 lot
18)	Fire Extinguishing System for Generator	1 lot
19)	Fire Extinguishing System for Oil Purification Room	1 lot

The following equipment will be repaired.

1)	Repairing Components of Overhead Travelling Crane	1 lot

(c) Civil Facilities

The following facilities will be supplied, installed and repaired.

1)	Supply and Installation of Intake Gate Trash Rake (Intake Gate)	1 set
2)	Supply and Installation of Vent Valve of Penstock	5 sets
3)	Supply and Installation of Dam Monitoring System	2 sets
4)	Supply and Installation of Control Panel and Monitoring System (Pipeline Intake Gate)	1 set
5)	Supply and Installation of Power Intake Control Panel	1 set
6)	Repairing of Upstream Pipeline Intake Gate	1 set
7)	Repairing of Division Dam Spillway Gate	1 set
8)	Repairing of Penstock Valve including Hydraulic System	2 sets
9)	Painting of Penstock (Stage-1, Stage-2, Stage-3 and Stage-4)	1 lot
10)	Extension of Assembly Bay (Power House)	1 lot

(d) Installation Work and Administration

1)	for Main Equipment	1 lot
2)	for Other Equipment and Civil Facilities	1 lot
3)	ENEE’s Work for Others	1 lot

5.5 COST ESTIMATES

(1) Cost Estimates

Rehabilitation/expansion costs for Canaveral and Río Lindo HPPs were estimated based on quotations of original manufacturers of the turbines and generators, equipment manufacturers, companies, vendors as well as previous contract prices of the major maintenances for Canaveral and Río Lindo HPPs in 1993, El Nispero HPP and Francisco Morazan HPP.

The rehabilitation/expansion costs prepared by ENEE were reviewed and discussed with reference to the Consultant's data base as well as the producer price index industry data of the Bureau of Labor Statistics of USA.

Based on the review and discussion, ENEE concluded that estimated costs of the rehabilitation/expansion project; $139,030,092,90 for total cost, $41,275,516.69 for Cañaveral HPP, $91,196,069.72 for Río Lindo HPP and $6,558,506.49 for the Consulting Services as shown in Table 5.5-1 Cost Estimates of Rehabilitation/Expansion Project.

Table 5.5-1 Cost Estimates of Rehabilitation/Expansion Project

	Canaveral	Total (US$)		Rio Lindo	Total (US$)	Total CA + RL	JICA	Cofinance	ENEE
1	**REHABILITATION OF MAIN EQUIPMEMT**	26,962,337.66	**1**	**REHABILITATION OF MAIN EQUIPMENT**	60,958,039	87,920,377	87,920,376.62		
1.1	Turbine	7,053,247	1.1	Turbine	23,206,494	30,259,740			
1.2	Governor	3,762,338	1.2	Governor	6,590,922	10,353,260			
1.3	Generator	3,461,039	1.3	Generator	11,649,104	15,110,143			
1.4	Exciter and AVR	2,106,494	1.4	Exciter and AVR	3,554,623	5,661,117			
1.5	Control System	7,253,247	1.5	Control System	7,760,974	15,014,221			
1.6	Protection System (Generating Unit)		1.6	Protection System		0			
1.7	Inlet Valve Repairing	1,323,377	1.7	Inlet Valve Repairing	2,832,026	4,155,403			
1.8	Technical Support Service	2,002,597	1.8	Technical Support Service	5,363,896	7,366,494			
2	**PROCUREMENT OF EQUIPMENT AND MATERIALS**	2,703,852	**2**	**PROCUREMENT OF EQUIPMENT AND MATERIALS**	3,532,986	6,236,838		6,236,838.31	
2.1	Protection System (Step-up Transformers)	12,845	2.1	Protection System (Step-up Transformers)	64,227	77,073			
2.2	Station Service TR	70,699				70,699			
2.3	480V Low Voltage Distribution Board	8,505	2.2	480Vac CB and MCB of Low Voltage Distribution Board	68,041	76,546			
2.4	125Vdc MCB of DC Distribution Board	4,518	2.3	125Vdc Distribution Board	6,024	10,543			
2.5	Battery	40,399	2.4	Battery	40,399	80,798			
2.6	Battery Charger	6,379	2.5	Battery Charger	6,379	12,758			
			2.6	Overhead Travelling Crane Repairing	373,251	373,251			
2.7	Emergency Generator	79,735				79,735			
2.8	13.8/138 kV Step up TR	1,267,375	2.7	13.8/138 kV step up Transformer	1,520,850	2,788,225			
2.9	138kV CB	141,964	2.8	138 kV Circuit Breaker	39,911	181,875			
2.10	Apparatusses and Materials	650,234	2.9	Control and Low Voltage Cables including Connectors	650,234	1,300,467			
2.11	Repairing Components of Overhead Travelling Crane	373,251				373,251			
2.12	Air Compressor	39,868	2.10	Air Compressor	106,314	146,181			
			2.11	Air Vent Valves (Inlet Valve)	80,871	80,871			
			2.12	Oil Purification Pump	25,250	25,250			
			2.13	Water Flow Meter for Turbine	255,153	255,153			
			2.14	Cooling Water Flow Indicator	68,041	68,041			
			2.15	Water Cooling Filter	21,263	21,263			
			2.16	Emergency Generator	79,735	79,735			
			2.17	Tail Race Crane	10,100	10,100			
2.13	Fire Extinguishig System	8,080	2.18	Fire Extinguishig System for Transformer	53,157	61,237			
			2.19	Fire Extinguishig System for Generator	31,894	31,894			
			2.20	Fire Extingulishing System for Oil Purification Room	31,894	31,894			
3	**CIVIL FACILITIES:**	1,713,920	**3**	**CIVIL FACILITIES:**	4,384,734	6,098,654		6,098,654.05	
3.1	Supply and Installation of Trash Rake (Intake Gate)	949,063	3.1	Supply and Installation of Trash Rake (Intake Gate)	949,063	1,898,126			
3.2	Repairing of Intake Gate Operating Mechanism	18,180	3.2	Repairing of Upstream Pipeline Intake Gate	15,947	34,127			
3.3	Replacement of Vent Valve of Penstock	81,084	3.3	Repairing of Division Dam Spillway Gate	10,631	91,715			
			3.4	Replacement of Power Intake Control Panel	8,239	8,239			
			3.5	Penstock Valve Repairing including Hydraulic System	37,210	37,210			
			3.6	Vent Valve of Penstock	11,163	11,163			
3.4	Painting of Penstock	514,097	3.7	Painting of Penstock (Stage-1, Stage-2 and Stage-3)	3,213,103	3,727,200			
3.5	Extension of Assembly Bay (Powerhouse)	111,098	3.8	Extension of Assembly Bay (Powerhouse)	111,098	222,196			
3.6	Dam Monitoring System (Yure and Varsovia)	40,399	3.9	Dam Monitoring System	10,100	50,499			
			3.10	Control Panel and Monitoring System (Pipeline Intake Gate)	18,180	18,180			
4	**INSTALLATION WORK AND ADMINSTRATION**	9,895,407	**4**	**INSTALLATION WORK AND ADMINSTRATION**	22,320,311	32,215,717			
4.1a	Installation & commissioning rehabilitation main equipmemt	6,460,026.12	4.1a	Installation & commissioning (rehabilitation of main equipmemt)	16,772,696.44	23,232,723	23,232,722.56		
4.1b	Installation & commissioning rehabilitation procurement	1,323,137.88	4.1b	Installation & commissioning (procurement)	3,435,371.56	4,758,509		4,758,509.44	
4.1c	Others (ENEE)	1,508,773.89	4.1c	Others (ENEE)	1,508,774	3,017,548			3,017,547.78
4.2	Administrative Cost	603,468.82	4.1	Administrative Cost	603,469	1,206,938			1,206,937.65
5.0	Consultant		5.0	Consultant		6,558,506.49	6,558,506.49		
	TOTAL	41,275,516.69			91,196,069.72	139,030,092.90	117,711,605.68	17,094,001.80	4,224,485.43

Estimated cost of the consulting services is ¥505,006,000 ($6,558,506.49) as shown in Table 5.5-2 Cost Estimates of Consulting Services.

Table 5.5-2 Cost Estimates of Consulting Services

US $	= yen	77
Lp	= yen	4.07

	Unit	Qty.	Foreign Portion (Yen) Rate	Foreign Portion (Yen) Amount ('000)	Local Portion Lp Rate	Local Portion Lp Amount ('000)	Combined Total ('000) Yen
A Remuneration							
1 Professional (A)	M/M	81	2,591,000	209,871	0	0	209,871
2 Professional (B)	M/M	132	0	0	212,203	28,011	114,004
3 Supporting Staffs	M/M	0	0	0	0	0	0
Subtotal of A				*209,871*		*28,011*	*323,875*
B Direct Cost							
1 International Airfare		27	1,100,000	29,700	0	0	29,700
2 Domestic Airfare		0	0	0	0	0	0
3 Domestic Travel	Times	132		0	4,180	552	2,246
4 Accommodation Allowance (A)	Month	81	150,000	12,150	0	0	12,150
5 Accommodation Allowance (B)	Month	132	0	0	11,400	1,505	6,125
6 House Rental (A) (Long Stay)	Month	54	0	0	50,000	2,700	10,989
7 House Rental (A) (Short Stay)	Month	27	0	0	68,400	1,847	7,516
8 House Rental (B)	Month	132	0	0	17,100	2,257	9,187
9 Vehicle Rental	Month	132	0	0	85,500	11,286	45,934
10 Office Administrator	M/M	66	0	0	70,734	4,668	19,001
11 Office Rental	Month	66	0	0	75,000	4,950	20,147
12 International Communications	Month	66	40,000	2,640	16,000	1,056	6,938
13 Domestic Communications	Month	66	0	0	3,800	251	1,021
14 Office Supply	Month	66	30,000	1,980	10,000	660	4,666
15 Office Furniture and Equipment including PCs	Month	66	0	0	19,000	1,254	5,104
16 Report Preparation	Month	66	0	0	1,520	100	408
Subtotal of B				*46,470*		*33,086*	*181,131*
Total				**256,341**		**61,097**	**505,006**

(2) Import Tax and Value Added Tax

Import taxes of the equipment and materials to be imported into Honduras for the rehabilitation/expansion project will be exempted by applying to the Renewable Energy Law (Decree No. 70-2007).

Value added tax (VAT) of local contract for the rehabilitation/expansion project will be exempted by the Certification for VAT Exemption to be certified by the Secretary of Finance. This Certification for VAT Exemption will be applied by ENEE to the Bureau of Internal Revenue after each contract is occurred.

The exemptions of the import tax and VAT were applied by the same procedures above to the major maintenance to four generating equipment of 75MVA each at Francisco Morazan HPP.

(3) Source of Finance

ENEE expects Japanese ODA loan, co-finance loan and ENEE's own budget to be used for the rehabilitation/expansion project. It is planed that Japanese ODA loan is $117,711,000 for the rehabilitation of main equipment, the installation work of the rehabilitation and the consulting services, co-finance loan is $17,094,000 for the procurement of equipment and materials and for its installation work and ENEE's own budget is $4,225,000 for ENEE's work for others and the administration.

The Ministry of Finance will become the borrower of Japanese ODA loan and co-finance loan for the rehabilitation/expansion project.

ENEE will borrow the same amount of Japanese ODA loan and co-finance loan with the same terms and conditions from the Ministry of Finance and will repay the loans by ENEE's revenue.

5.6 PROJECT IMPLEMENTATION PLAN

(1) Overall Implementation Plan

For the implementation of the rehabilitation/expansion project, it is divided into three successive phases: preparation, procurement, pre-rehabilitation work and rehabilitation work and stages as shown below:

Phase	***Stage***	***Description***
Preparation	Stage I	Project programming and structuring
	Stage II	Revision, evaluation, diagnose and determination of the scope of required maintenance and repair of each equipment and facility
	Stage III	Determination of the scopes of the rehabilitation/ expansion, procurement of equipment and materials, civil facilities and installation works for Cañaveral and Río Lindo HPPs
Procurement	Stage IV	Biddings, contracts and manufacturing of the rehabilitation/expansion, procurement of equipment and materials, civil facilities and installation works for Cañaveral and Río Lindo HPPs
Pre-rehabilitation work	Stage V	Maintenance and repair of civil facilities
Rehabilitation work	Stage VI	Rehabilitation/expansion work and replacement of equipment and materials

The maintenance and repair of civil facilities such as the intake gate trash rake, the gates, assembly bay extensions, painting of the penstocks, etc. are implemented before the rehabilitation/expansion work and the replacement of the equipment and materials.

The repair of each penstock valve is implemented when each repaired inlet valve is reinstalled respectively during the rehabilitation/expansion work of Cañaveral HPP.

The replacement of the procurement of equipment and materials and the rehabilitation/ expansion work are implemented at the same time to take advantage of the outage period of the generating units.

After completion of one generating unit of the rehabilitation/expansion work next generating unit of the rehabilitation/expansion is undertaken sequentially from Units No.1 and No. 2 of Cañaveral HPP and then Units No. 1, No. 2, No. 3 and No. 4 of Río Lindo HPP taking account of increasing the country's load demand instead of three generating units at the same time; one in Cañaveral HPP and two in Río Lindo HPP.

The following conclusions are made taking account of minimizing outages of the generating unit and challenges and difficulties to avoid human error during the replacement of the control and protection systems one by one under the operation of other generating unit.

The period of the rehabilitation/expansion work for one generating unit is for 6 months taking account of challenges and difficulties to avoid human error during the replacement of unit control and protection system under the operation of other generating unit.

The inlet valves are repaired in Honduras by using large machine tools which they are used for the overhaul of Francisco Morazan HPP instead of in outside Honduras.

The rehabilitation/expansion project will be divided into the following lots for Cañaveral and Río Lindo HPPs.

- Lot-1 Rehabilitation/Expansion of Main Equipment
  Procurement of equipment and special parts for the generator and turbine, including the governors, voltage regulators, control system, repairing of the intake valve and technical services from the manufacturer

- Lot-2 Procurement of Equipment and Materials.
  Procurement of equipment and parts for power transformers, switchgear, auxiliaries, etc. including civil facilities

- Lot-3 Installation Work for Rehabilitation/Expansion

- Lot-4 Installation Work for Procurement of Equipment and Materials
  Repairing the civil facilities is included.

(2) Outage Plan

The following outage plans are considered to minimize outage duration and periods and generating unit of both HPPs.

- Outage of both Cañaveral and Río Lindo HPPs
  For dismantling and installation of the inlet valve, Cañaveral and Río Lindo HPPs will be shutdown totally for each 4 days and 6 days in the beginning and end of the rehabilitation/ expansion work for Units No. 1 and No. 2 of Cañaveral HPP.

- Outage of Units No. 1 and No.2 of Río Lindo HPP
  For dismantling and installation of Unit No. 1 inlet valve, Units No. 1 and No. 2 Río Lindo HPP will be shutdown for each 4 days and 6 days in the beginning and end of the rehabilitation/expansion work for Units No. 1 of Río Lindo HPP.

- Outage of Units No. 1 and No.2 of Río Lindo HPP
  For dismantling and installation of Unit No. 2 inlet valve, Units No. 1 and No. 2 Río Lindo HPP will be shutdown for each 4 days and 6 days in the beginning and end of the rehabilitation/expansion work for Units No. 2 of Río Lindo HPP.

- Outage of Units No. 3 and No. 4 of Río Lindo HPP
  For dismantling and installation of Unit No. 3 inlet valve, Units No. 3 and No. 4 Río Lindo HPP will be shutdown for each 4days and 6 days in the beginning and end of the rehabilitation/expansion work for Units No. 3 of Río Lindo HPP.

- Outage of Units No. 3 and No. 4 of Río Lindo HPP
  For dismantling and installation of Unit No. 4 inlet valve, Units No. 3 and No. 4 Río Lindo HPP will be shutdown for each 4 days and 6 days in the beginning and end of the rehabilitation/expansion work for Units No. 4 of Río Lindo HPP.

- Outage of Each generating Unit
  Each generating unit of Cañaveral and Río Lindo HPPs will be shutdown for 6 months during the rehabilitation/expansion work for the unit taking account of the replacement of the control and protection systems as well as the rehabilitation work.

5.7 PROJECT IMPLEMENTATION SCHEDULE

The preparation of the bidding document for selection of the consulting engineers for assistance with ENEE will be commenced in July 2012. Bidding of the consulting engineers will be commenced in October 2012 and the consulting engineers will be selected in April 2013.

Bidding documents and design reports for the procurements of the rehabilitation/expansion works will be prepared by ENEE. The consulting engineers will assist ENEE in these preparations.

The biddings and contracts for the procurements of the rehabilitation works will be commenced in August 2013. The contracts for the rehabilitation/expansion works will be occurred in the June 2014.

Planed duration of the rehabilitation work of each unit will be for 7 months (1 month for the preparation work and other 6 months for the rehabilitation work).

The sequence and duration of rehabilitation/expansion of each generating unit were considered taking account of outage availability of each generating unit.

The rehabilitation/expansion project for Cañaveral and Río Lindo HPPs will be commenced in July 2014 and will be completed in July of 2016 for Cañaveral HPP, and for Río Lindo HPP will be completed in December 2018.

The summary of the overall project implementation schedule is as shown in Figure 5.7-1 Overall Project Implementation Schedule.

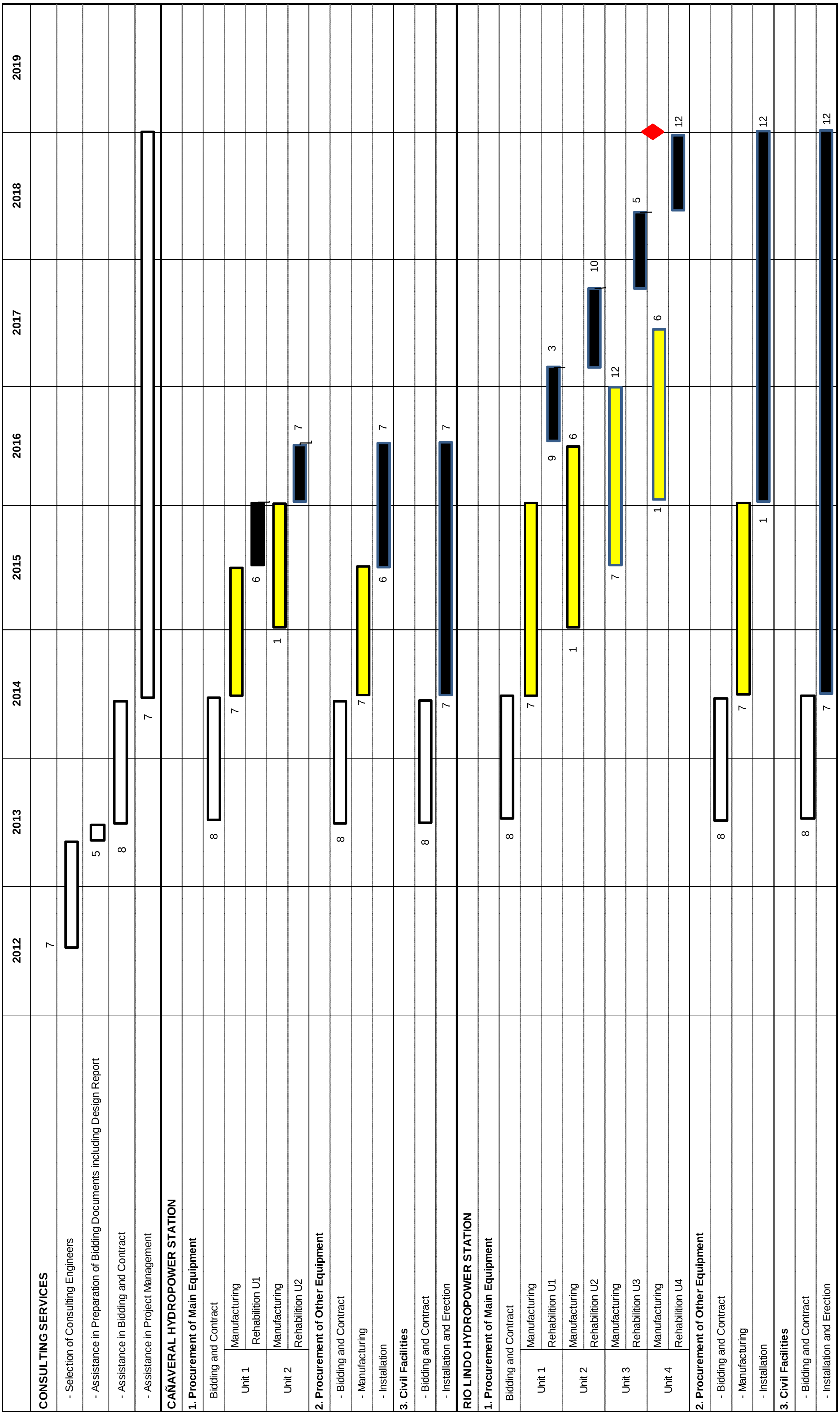


Figure 5.7-1 Overall Project Implementation Schedule

5.8 IMPLEMENTATION STRUCTURE

(1) Implementation Structure Plan

The development and implementation of the project is headed by a temporary executive unit consisting of experienced staff from the electrical maintenance and the mechanical maintenance at Cañaveral - Río Lindo Hydroelectric Power Complex, but this stage of the project only covers the procurement of equipment, special parts, assembly tools and some consulting services.

This involves the use of experienced local labor, thus reducing costs substantially, with foreign participation being limited to experts in turbines and generators to ensure the quality of the work and assist in implementation to optimize the operating point of the turbine, generator and control and protection systems.

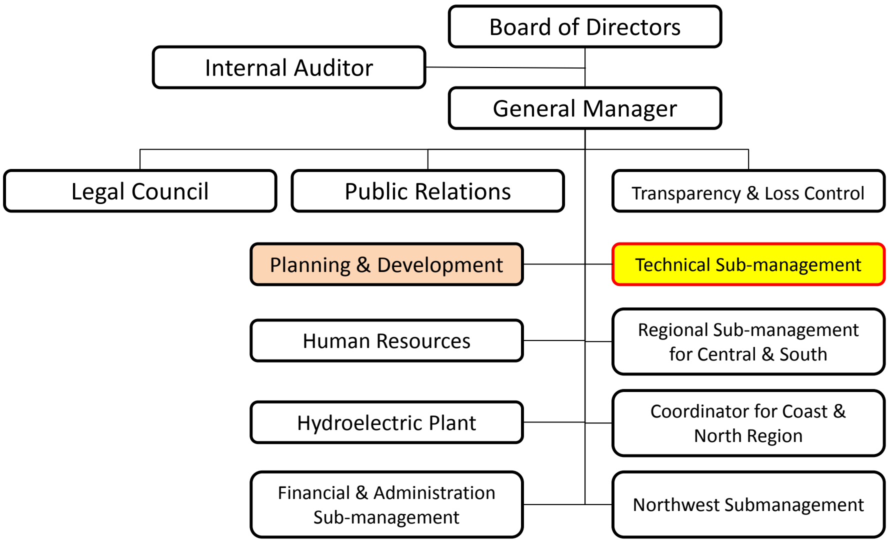
For project management, there will be staff with 18 years of experience specializing in high voltage equipment installed in the plant as well as experience in managing bids, contracts and working under pressure.

For the execution of mechanical works, there will be engineering and technical staffs with significant maintenance experience who also participated in the major maintenance in 1993 and at Francisco Morazan HPP. The management is supplemented by maintenance engineers in order to define the scope of the machining work, and to perform oversight of the work and commissioning.

For the execution of electrical works, there will be engineering staffs and other technicians with extensive experience in maintenance. The management of these electrical works is supplemented by maintenance engineers and specialists from the manufacturers for general guidelines and ensuring the installation of materials and special parts of the turbines, generators and control and protection systems.

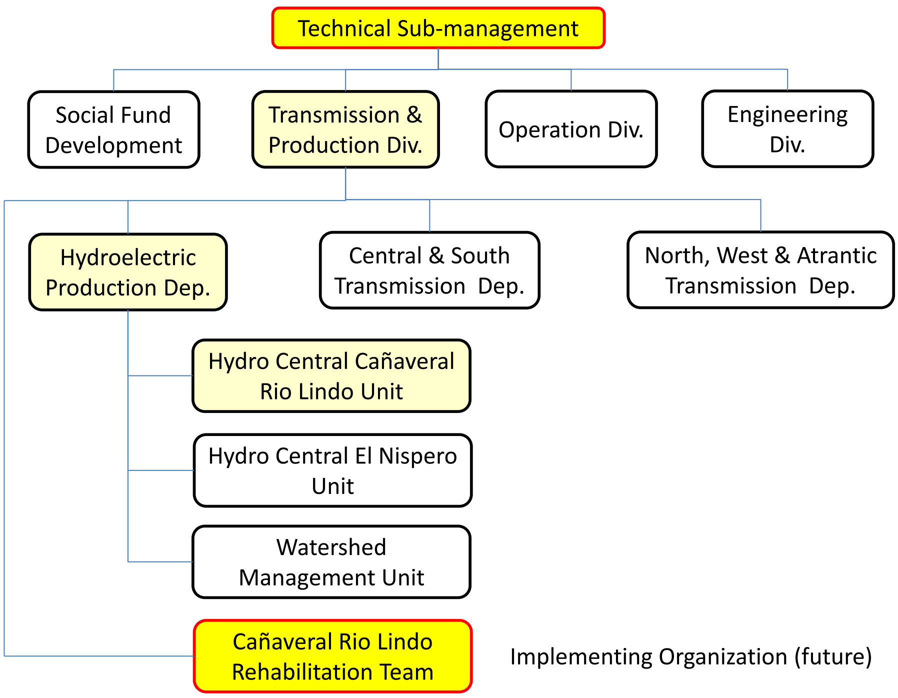
Project management personnel will be transferred in the beginning of July 2012 to begin programming, preparation of bidding documents for different services, preparation of bids, applications and specifications of materials, tools, equipment and parts, receipt, acceptance and review of parts, selection and training of personnel and of all activities prior to the rehabilitation/expansion project.

The transmission and production division will undertake responsibilities for this project.



Source: consultant

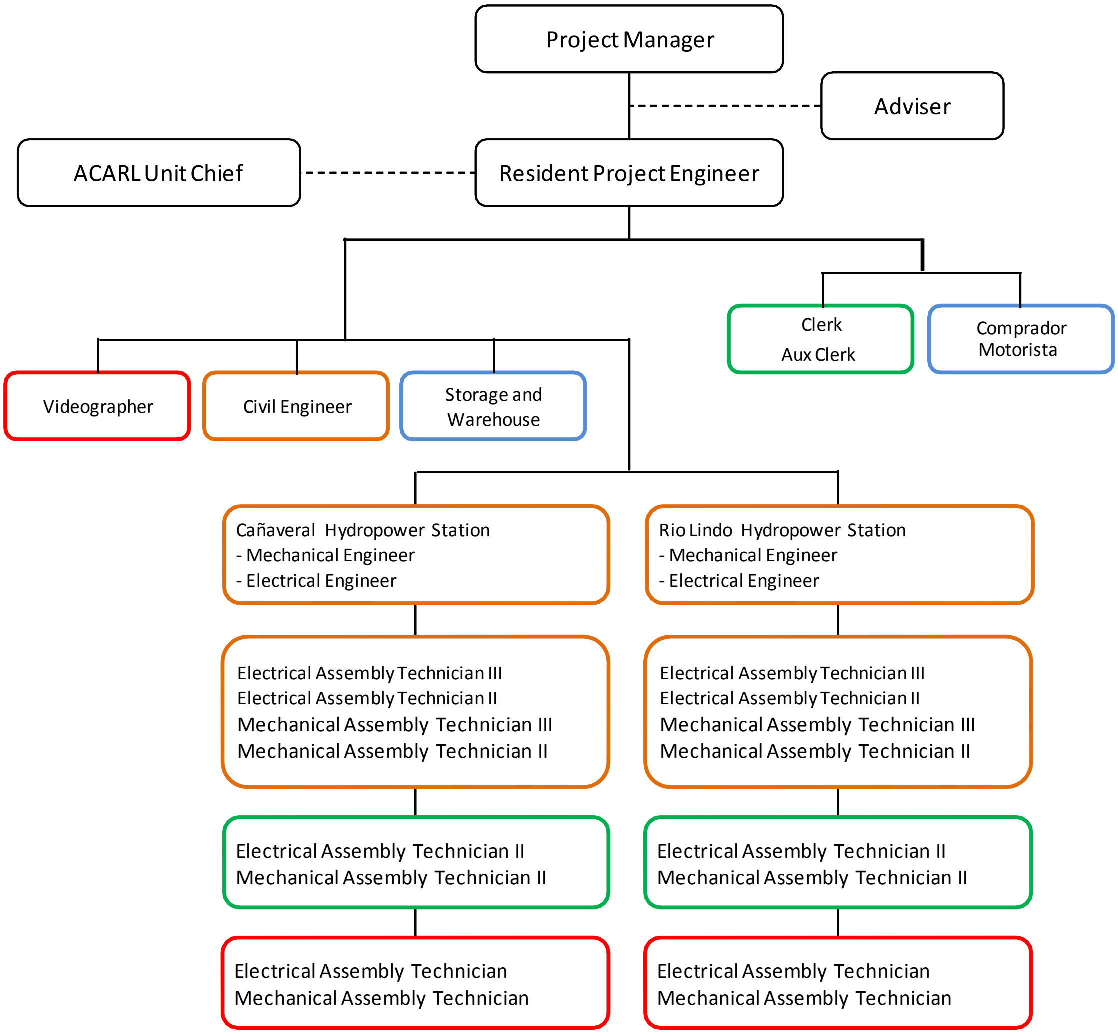
Figure 5.8-1 Organization of Overall Organization of ENEE



Source: consultant

Figure 5.8-2 Organization of Technical Sub-management

The following organization for the rehabilitation/expansion project will be established.



Source: ENEE

Figure 5.8-3 ENEE's Project Office Organization

As a reference, Figure 5.8-4 indicates an organization for overhaul of Francisco Morazan HPP.

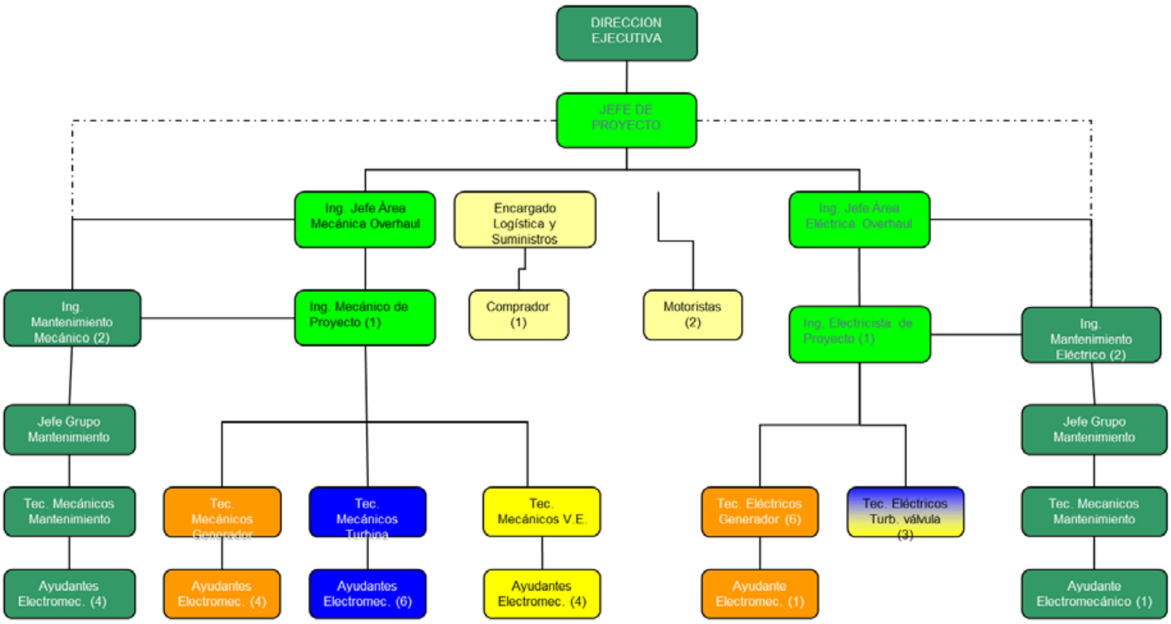


Figure 5.8-4 Francisco Morazan Overhaul Organization

(2) Basic Concept and Important Notice

The rehabilitation and the replacement works under the rehabilitation/expansion project will be made under the operation of Cañaveral and Río Lindo HPPs. The extent of the rehabilitation/expansion covers almost all their equipment. Prior to the commencement of the rehabilitation/expansion, optimum rehabilitation and replacement methods and work sequence will be studied for executing the rehabilitation/expansion smoothly and effectively without hindrance to generating operation of other units.

The basic concept and important notice for the implementation of the rehabilitation/expansion were discussed between the Consultant and ENEE and were confirmed as follows:

(a) ENEE

ENEE is in charge of the rehabilitation/expansion, operation and execution. For implementation of the rehabilitation/expansion, ENEE pays careful attention to the following item and to assign personnel in charge of the rehabilitation/expansion work for smooth execution including enough staffing to install all renovated equipment.

Good coordination and arrangements for unit shutdown during the rehabilitation work are essential for the rehabilitation/expansion works. In implementation of the rehabilitation/expansion, one group is requested to shutdown its operation for enough time period to avoid total blackout of the national grid to be caused by human error. The operation of the other units should be arranged so that the outage of the unit will not interfere the continuous electric power supply to the national grid.

(b) Consultant

ENEE will employ a consulting firm who assists ENEE in the preparation of bid document for procurement of equipment/parts and project management of the rehabilitation/expansion project. The major work items for the consultant to assist ENEE are listed below.

1) Pre-Construction Stage

a. Preparation of bid documents for procurement of equipment, parts, and services for rehabilitation works
b. Bidding and evaluation of bids
c. Contract negotiation

2) Construction Stage

a. Approval of drawing/documents
b. Witness of shop inspection before shipping
c. Issue of inspection certificate
d. Reporting and explanation to the parties concerned
a. Progress control of transportation, rehabilitation works, site inspections and tests, etc.
b. Coordination of work schedule among the contracts
c. Safety control at site
d. Witness of site inspections and tests
e. Evaluation of site test results
f. Preparation of monthly report regarding the transportation, rehabilitation works, site inspections and tests
g. Issue of payment certificates
h. Preparation of completion report on site works such as transportation, rehabilitation works, site inspections and tests
i. Final inspection for one year after taking over
j. Periodical reporting to the parties concerned

3) Assignment of Consultant

The following consulting engineers will be assigned for assistance with ENEE in activities mentioned above.

- Consultant Team Leader/Electromechanical Engineer (expatriate)
- Civil Engineer (expatriate)
- Electrical Engineer (Local)
- Mechanical Engineer (Local)

(c) Procurement of Main Equipment

The contractor for the procurement of main equipment is selected by international competitive bidding. The consultant assists ENEE in the following processes. The procurement process is as follows:

1) ENEE prepares the design documents without dismounting the generating equipment.
2) ENEE prepares the bid documents based on the design documents.
3) ENEE carries out bidding process including the bid evaluation and the contract negotiation based on the JICA's guideline.
4) The contract is occurred. The contract price is based on the bill of quantity with unit price.
5) The contractor designs, manufactures and derivers the components of the main equipment in accordance with the contract.
6) The contractor's specialists undertake the technical support service during the rehabilitation work. The rehabilitation work is carried out by ENEE under the technical support service of the contractor's specialists.

In the opinion of the Consultant, direct contract procedure for the selection of the contractor is also recommended in consideration of the following matters.

1) It is possibility that the equipment and parts for the rehabilitation/expansion cannot be designed without detailed data and information on the existing equipment such as design drawings, specifications, performances, materials and detailed dimensions.
2) It is possibility that these detailed data will not be disclosed or given to the third parties because they include the manufacturer's own technical know-how.
3) It is at risk for the investigation to be carried out by disassembling the turbines and generators, so it will require total shutdown of the units.
4) It is at risk for No manufacturer other than the original manufacturer who can make successful and reliable coordination for the desired performances with the existing parts to be re-used.

(d) Procurement of Other Equipment

The contractor for the procurement of other equipment is selected by international competitive bidding.

(e) Civil Facilities

The contractor for the civil facilities is selected by local competitive bidding. The procurement process is the same as the procurement process of main equipment.

(f) Installation Work

The contractors for the installation works for main equipment and other equipment and civil facilities are selected by local competitive biddings.

5.9 REHABILITATION/EXPANSION EFFECT INDICATORS

Baselines (average values from 2007 to 2011) and targets of the rehabilitation/expansion project for Cañaveral HPP and Río Lindo HPP based on the operation records from 2007 to 2011 are as follows:

(1) Cañaveral HPP

	Baseline	Target
Plant Output	29.0 MW	32.2 MW
Generated Energy	177 GWh/y	177 GWh/y
Plant Factor	70 %	70 %
Failure Outage	9 hours/unit/y	0 hour/unit/y

(2) Río Lindo HPP

	Baseline	Target
Plant Output	80.0 MW	97.6 MW
Generated Energy	544 GWh/y	544 GWh/y
Plant Factor	78 %	78 %
Failure Outage	25 hours/unit/y	0 hour/unit/y

ENEE intends to increase peak hour generation by taking more amount of water to Cañaveral and Río Lindo and instead, intends to reduce the off-peak hour generation for the purpose of keeping water balance in Lake Yojoa. By this operation plan, the targets of the generated energies are the same as the baselines.

Month-Year	Generated Energy (GWh)	Operation (Hours)		Reserve (Hours)		Availability (Hours)		Failure Outage (Hours)		Planed Outage (Hours)	
		Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2
Jan-07	13.1	744	658	0	6	744	663	0	13	0	68
Feb-07	11.4	665	656	0	2	665	658	2	0	5	14
Mar-07	12.3	714	548	17	166	731	713	0	16	13	15
Apr-07	15.2	716	601	0	101	716	702	0	3	4	15
May-07	18.9	735	731	1	3	736	734	0	0	8	10
Jun-07	15.6	693	705	20	15	714	720	0	0	6	0
Jul-07	14.6	731	737	10	0	741	737	0	0	3	7
Aug-07	14.6	724	715	9	3	733	718	0	5	11	21
Sep-07	13.3	716	696	1	20	716	715	0	1	4	4
Oct-07	13.2	731	541	8	197	739	738	0	6	5	0
Nov-07	11.5	617	504	58	208	675	712	0	0	45	8
Dec-07	11.1	741	382	3	362	744	744	0	0	0	0
Total	**164.8**	**8,527**	**7,472**	**128**	**1,082**	**8,655**	**8,554**	**2**	**43**	**103**	**163**

Month-Year	Generated Energy (GWh)	Operation (Hours)		Reserve (Hours)		Availability (Hours)		Failure Outage (Hours)		Planed Outage (Hours)	
		Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2
Jan-08	10.0	416	668	329	76	744	744	0	0	0	0
Feb-08	10.1	644	359	42	329	686	688	0	0	10	9
Mar-08	9.6	402	572	341	154	743	727	0	0	1	17
Apr-08	10.5	527	493	179	216	706	709	0	0	14	11
May-08	13.0	496	741	247	2	743	744	1	0	0	0
Jun-08	14.1	586	690	134	18	720	708	0	0	0	12
Jul-08	13.1	649	564	73	172	721	737	0	0	23	7
Aug-08	15.5	651	697	41	47	692	744	0	0	52	0
Sep-08	14.7	664	710	56	10	720	720	0	0	0	0
Oct-08	15.2	726	728	11	9	737	737	0	0	7	7
Nov-08	13.1	651	654	69	66	720	720	0	0	0	0
Dec-08	13.6	683	741	61	3	744	744	0	0	0	0
Total	**152.5**	**7,093**	**7,618**	**1,583**	**1,103**	**8,676**	**8,721**	**1**	**0**	**107**	**63**

Month-Year	Generated Energy (GWh)	Operation (Hours)		Reserve (Hours)		Availability (Hours)		Failure Outage (Hours)		Planed Outage (Hours)	
		Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2
Jan-09	14.1	714	722	21	10	735	732	0	0	10	12
Feb-09	11.3	563	672	109	0	672	672	0	0	0	0
Mar-09	15.7	696	728	39	8	735	736	0	0	9	8
Apr-09	17.8	715	710	5	10	720	720	0	0	0	0
May-09	18.8	740	728	4	4	744	732	0	0	0	12
Jun-09	17.1	700	701	4	0	704	701	8	2	8	17
Jul-09	16.6	731	733	9	10	740	743	0	0	4	1
Aug-09	16.2	723	721	21	19	744	740	0	4	0	0
Sep-09	16.5	690	705	19	4	710	708	0	0	10	12
Oct-09	14.7	644	726	96	17	739	744	0	0	5	0
Nov-09	16.7	696	709	12	0	708	709	0	0	12	11
Dec-09	17.2	724	735	12	0	736	735	0	0	8	9
Total	**192.7**	**8,336**	**8,591**	**350**	**82**	**8,686**	**8,673**	**9**	**6**	**65**	**81**

Month-Year	Generated Energy (GWh)	Operation (Hours)		Reserve (Hours)		Availability (Hours)		Failure Outage (Hours)		Planed Outage (Hours)	
		Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2
Jan-10	13.8	736	725	8	19	744	744	0	0	0	0
Feb-10	12.5	659	662	4	0	663	662	0	0	10	10
Mar-10	13.9	744	744	0	0	744	744	0	0	0	0
Apr-10	14.1	715	713	5	6	720	720	0	0	0	0
May-10	15.0	732	731	0	0	732	731	3	0	9	13
Jun-10	16.5	699	719	0	0	699	719	2	1	20	0
Jul-10	17.6	739	732	2	2	741	734	0	1	3	10
Aug-10	16.6	730	727	3	0	733	727	0	4	11	13
Sep-10	15.7	715	701	4	4	719	705	1	9	0	6
Oct-10	15.9	718	732	21	11	740	743	0	0	4	1
Nov-10	16.3	697	704	6	0	703	704	0	0	17	16
Dec-10	16.6	742	739	0	5	742	743	0	0	2	1
Total	**184.3**	**8,624**	**8,629**	**54**	**47**	**8,678**	**8,676**	**6**	**14**	**76**	**69**

Month-Year	Generated Energy (GWh)	Operation (Hours)		Reserve (Hours)		Availability (Hours)		Failure Outage (Hours)		Planed Outage (Hours)	
		Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2	Unit No. 1	Unit No. 2
Jan-11	14.7	710	710	31	34	741	744	0	0	3	0
Feb-11	13.1	651	654	0	0	651	654	0	0	21	18
Mar-11	15.1	470	734	4	4	744	738	0	1	0	5
Apr-11	15.2	701	710	18	8	719	718	1	1	1	1
May-11	15.6	714	724	9	5	723	729	1	1	20	14
Jun-11	16.8	718	719	0	0	718	719	0	1	2	0
Jul-11	17.2	701	680	7	2	708	682	0	1	36	61
Aug-11	18.0	735	738	8	5	743	743	1	1	0	0
Sep-11	17.4	735	738	8	5	743	743	1	1	0	0
Oct-11	15.9	713	713	10	13	722	726	3	0	18	17
Nov-11	14.5	694	705	25	15	719	720	0	0	2	0
Dec-11	16.0	744	741	0	3	744	744	0	0	0	0
Total	**189.4**	**8,286**	**8,565**	**119**	**95**	**8,675**	**8,660**	**8**	**6**	**101**	**117**

Source: ENEE

Figure 5.9-1 Operation Records of Cañaveral HPP (2007-2011)

Month-Year	Generated Energy (GWh)	Operation (Hours)				Reserve (Hours)				Availability (Hours)				Failure Outage (Hours)				Planed Outage (Hours)			
		Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4
Jan-07	47.0	744	744	734	734	0	0	0	0	744	744	734	734	0	0	0	0	0	0	10	10
Feb-07	40.6	668	665	666	664	2	5	3	5	670	669	669	669	0	0	0	0	2	3	3	3
Mar-07	42.7	699	699	688	705	33	25	44	36	732	724	732	741	0	2	0	0	12	18	12	3
Apr-07	47.5	662	631	694	682	25	29	25	21	687	660	720	703	31	0	1	0	1	60	0	17
May-07	55.0	742	737	741	740	2	3	3	4	744	739	744	744	0	5	0	0	0	0	0	0
Jun-07	45.8	696	701	698	701	15	6	11	6	710	707	709	707	0	0	0	0	10	13	11	13
Jul-07	43.6	723	740	726	744	15	0	0	0	738	740	726	744	0	0	16	0	6	4	2	0
Aug-07	43.8	731	740	734	662	8	4	5	4	739	744	739	666	0	0	0	0	5	0	5	78
Sep-07	42.5	640	697	688	702	15	12	21	6	709	709	709	708	0	0	0	0	11	11	11	12
Oct-07	38.6	515	632	641	614	81	113	103	130	596	744	744	744	0	0	0	0	148	0	0	0
Nov-07	37.4	565	562	569	557	144	150	151	163	709	712	720	720	0	0	0	0	11	8	0	0
Dec-07	37.3	626	646	600	621	114	98	134	114	740	744	734	735	0	0	0	0	4	0	10	9
Total	**521.9**	**8,010**	**8,191**	**8,178**	**8,126**	**454**	**444**	**501**	**489**	**8,518**	**8,635**	**8,678**	**8,615**	**31**	**7**	**17**	**0**	**211**	**118**	**65**	**145**

Month-Year	Generated Energy (GWh)	Operation (Hours)				Reserve (Hours)				Availability (Hours)				Failure Outage (Hours)				Planed Outage (Hours)			
		Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4
Jan-08	34.1	662	404	638	688	82	104	79	55	744	507	717	742	0	0	27	0	0	237	0	2
Feb-08	32.5	601	617	575	578	83	62	121	118	684	679	696	696	0	0	0	0	12	17	0	0
Mar-08	31.5	611	652	562	597	133	92	169	133	744	744	731	730	0	0	0	0	0	0	13	14
Apr-08	33.1	605	624	614	619	115	96	103	101	720	720	717	720	0	0	0	0	0	0	3	0
May-08	39.5	684	639	678	687	48	59	55	56	733	698	733	743	0	38	0	0	11	9	11	1
Jun-08	41.6	682	673	672	653	38	47	44	46	720	720	716	700	0	0	4	0	0	0	0	20
Jul-08	41.2	681	663	658	684	57	76	52	59	739	738	711	743	5	0	28	0	0	6	5	1
Aug-08	46.9	706	694	704	706	29	50	30	27	735	744	734	734	0	0	0	0	9	0	10	10
Sep-08	45.3	690	692	691	704	29	28	22	16	719	720	713	720	1	0	0	0	0	0	7	0
Oct-08	45.0	726	724	726	733	8	10	10	10	734	734	735	743	0	0	9	1	10	10	0	0
Nov-08	40.9	676	686	682	677	45	34	29	24	720	719	710	701	0	0	0	0	0	0	10	19
Dec-08	44.2	719	720	733	726	14	21	11	8	733	740	744	735	11	4	0	9	0	0	0	0
Total	**475.6**	**8,044**	**7,787**	**7,933**	**8,052**	**681**	**678**	**724**	**654**	**8,725**	**8,463**	**8,657**	**8,706**	**17**	**41**	**67**	**10**	**42**	**278**	**60**	**68**

Month-Year	Generated Energy (GWh)	Operation (Hours)				Reserve (Hours)				Availability (Hours)				Failure Outage (Hours)				Planed Outage (Hours)			
		Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4
Jan-09	45.4	727	723	722	733	5	13	11	11	732	736	733	744	0	0	0	0	12	8	11	0
Feb-09	37.1	672	663	693	299	0	4	0	0	672	667	593	299	0	5	0	0	0	0	79	373
Mar-09	48.5	720	723	728	530	6	12	12	0	726	735	741	530	0	4	4	8	18	5	0	206
Apr-09	52.0	695	703	707	699	6	7	5	8	701	710	712	707	7	0	0	3	12	10	8	11
May-09	54.4	738	723	737	732	5	5	6	7	744	729	743	739	0	15	1	5	0	0	1	0
Jun-09	50.5	719	715	713	718	0	0	4	0	719	715	717	718	1	5	3	2	0	0	0	0
Jul-09	50.3	683	723	728	721	10	10	4	8	693	733	732	730	0	0	0	4	51	11	12	10
Aug-09	49.3	727	701	731	729	15	19	13	15	742	720	744	744	2	24	0	0	0	0	0	0
Sep-09	50.6	686	711	716	716	7	8	4	4	693	719	720	720	11	1	0	0	16	0	0	0
Oct-09	47.5	732	723	374	651	9	6	6	6	740	729	380	657	4	0	0	2	0	15	364	86
Nov-09	53.2	719	720	702	708	0	0	0	0	719	720	702	708	1	0	0	1	0	0	18	11
Dec-09	54.1	720	719	738	738	5	5	6	6	725	724	744	744	8	11	0	0	11	9	0	0
Total	**592.9**	**8,538**	**8,546**	**8,288**	**7,974**	**68**	**90**	**71**	**64**	**8,606**	**8,637**	**8,260**	**8,039**	**35**	**66**	**7**	**24**	**120**	**58**	**493**	**697**

Month-Year	Generated Energy (GWh)	Operation (Hours)				Reserve (Hours)				Availability (Hours)				Failure Outage (Hours)				Planed Outage (Hours)			
		Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4
Jan-10	45.9	722	718	724	721	6	0	10	10	728	718	733	732	0	7	0	0	16	19	11	13
Feb-10	40.6	672	669	672	672	0	2	0	0	672	670	672	672	0	2	0	0	0	0	0	0
Mar-10	44.4	732	720	733	730	0	0	0	0	732	720	733	730	0	0	0	0	12	24	12	14
Apr-10	43.8	710	708	714	713	10	6	5	6	720	714	719	719	0	1	1	1	0	5	0	0
May-10	45.7	742	743	743	732	2	0	0	1	744	743	743	732	0	1	1	2	0	0	0	10
Jun-10	49.4	702	707	708	706	0	0	0	0	702	707	708	706	1	1	1	1	18	12	11	13
Jul-10	52.3	740	740	739	737	4	4	5	5	744	744	744	742	0	0	0	0	0	0	0	2
Aug-10	51.4	716	728	738	738	6	6	6	6	722	733	744	744	11	0	0	0	11	11	0	0
Sep-10	51.1	707	697	706	701	7	8	7	0	714	705	713	701	2	12	2	2	4	3	5	17
Oct-10	52.7	717	734	724	736	8	9	8	8	725	743	732	744	18	0	1	0	1	1	10	0
Nov-10	52.3	708	708	713	712	0	0	0	0	708	708	713	712	0	0	0	0	12	12	7	8
Dec-10	52.6	744	731	730	735	0	0	4	0	744	731	734	735	0	3	0	0	0	10	10	9
Total	**582.3**	**8,611**	**8,604**	**8,642**	**8,632**	**43**	**34**	**46**	**36**	**8,654**	**8,638**	**8,688**	**8,668**	**32**	**26**	**7**	**5**	**74**	**96**	**65**	**87**

Month-Year	Generated Energy (GWh)	Operation (Hours)				Reserve (Hours)				Availability (Hours)				Failure Outage (Hours)				Planed Outage (Hours)			
		Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4	Unit No.1	Unit No.2	Unit No.3	Unit No.4
Jan-11	46.6	720	704	698	721	24	40	43	23	744	744	741	744	0	0	0	0	0	0	3	0
Feb-11	42.5	651	655	672	671	3	0	0	0	654	655	672	671	0	4	0	1	18	13	0	0
Mar-11	47.1	727	734	726	728	3	4	0	0	730	738	726	728	0	0	5	7	14	6	13	9
Apr-11	15.2	701	710	0	0	18	8	0	0	719	718	0	0	1	1	0	0	1	1	0	0
May-11	45.7	724	725	709	735	7	7	0	9	732	732	709	744	0	0	24	0	12	12	12	0
Jun-11	47.5	662	631	719	711	0	0	0	0	662	631	719	711	1	1	1	1	57	88	0	8
Jul-11	49.8	733	728	734	736	11	8	10	8	744	736	744	744	0	0	0	0	0	8	0	0
Aug-11	52.0	729	730	730	726	4	4	5	0	733	734	734	726	0	0	0	9	11	10	10	9
Sep-11	51.5	720	720	709	707	0	0	0	0	720	720	709	707	0	0	0	0	0	0	10	13
Oct-11	51.0	728	722	739	743	4	0	4	0	732	722	743	743	1	11	1	1	11	11	0	0
Nov-11	47.5	697	693	687	695	9	4	4	6	705	697	691	701	15	23	0	0	0	0	29	19
Dec-11	51.8	744	744	744	744	0	0	0	0	744	744	744	744	0	0	0	0	0	0	0	0
Total	**548.2**	**8,536**	**8,495**	**7,866**	**7,918**	**83**	**77**	**66**	**46**	**8,619**	**8,572**	**7,933**	**7,964**	**17**	**40**	**31**	**18**	**124**	**148**	**76**	**58**

Source: ENEE

Figure 5.9-2 Operation Records of Río Lindo HPP (2007-2011)

CHAPTER 6 ENVIRONMENT AND SOCIAL CONSIDERATION

6.1 LEGAL FRAMEWORK

(1) Law and Legislation regarding Environmental and Social Consideration

Laws and legislations for implementation of the project with regard to environmental and social consideration are shown below.

(a) Environmental General Law

Environmental General Law was enacted on May 27th 1993. It regulates that an environmental impact assessment ("EIA") has to be carried out whenever the project have possibility to impact on environment, natural resources, and cultural and historical heritage.

(b) Regulations of the National Evaluation System of Environmental Impact ("SINEIA")

SINEIA was established on March 5th 1994, which was revised in 2003, and its new reforms were enacted on December 31th 2009.

Project is classified to 4 categories in view of the magnitude of impacts on the environment.

Table 6.1-1 Environmental Category for EIA

Category	Impact Level
Category 1	Low environmental impact
Category 2	Moderate environmental impact
Category 3	High environmental impact
Category 4	Mega environmental impact (e.g., hydroelectric energy generation project, exploitation of metallic mines, oil production, great infrastructure project)

Development projects that have a potential environmental impact are required consultation with SERNA. SERNA, with its capacity of an environmental management agency, determine categorization. Projects which are categorized to Category 4 are obliged to conduct investigation and study regarding environmental impact and submit environmental impact assessment document to SERNA. Category 1 projects should submit Form F-O1 (environmental impact assessment form) and Category 2 or 3 projects should submit Form F-O2 to SERNA. SERNA reviews the project with site inspection (environmental audit) and issue environmental license for implementation of the projects. EIA of Category 4 projects will be disclosed to public for public opinion.

The part of the Environmental Category Table in relation to hydroelectric power is shown below.

Table 6.1-2 Environmental Category Table

Category	Division	Name of Activity	Description	Categories of Impact / Environmental and Health Risk			
				1	2	3	4
E. Basic Service Sector	Electricity, gas and water	Generating electricity from hydraulic sources	Hydropower	to 3MW	>3-15MW	>15-30MW	>30MW

Source: Compendio de Legislacion Ambiental de Honduras 2011

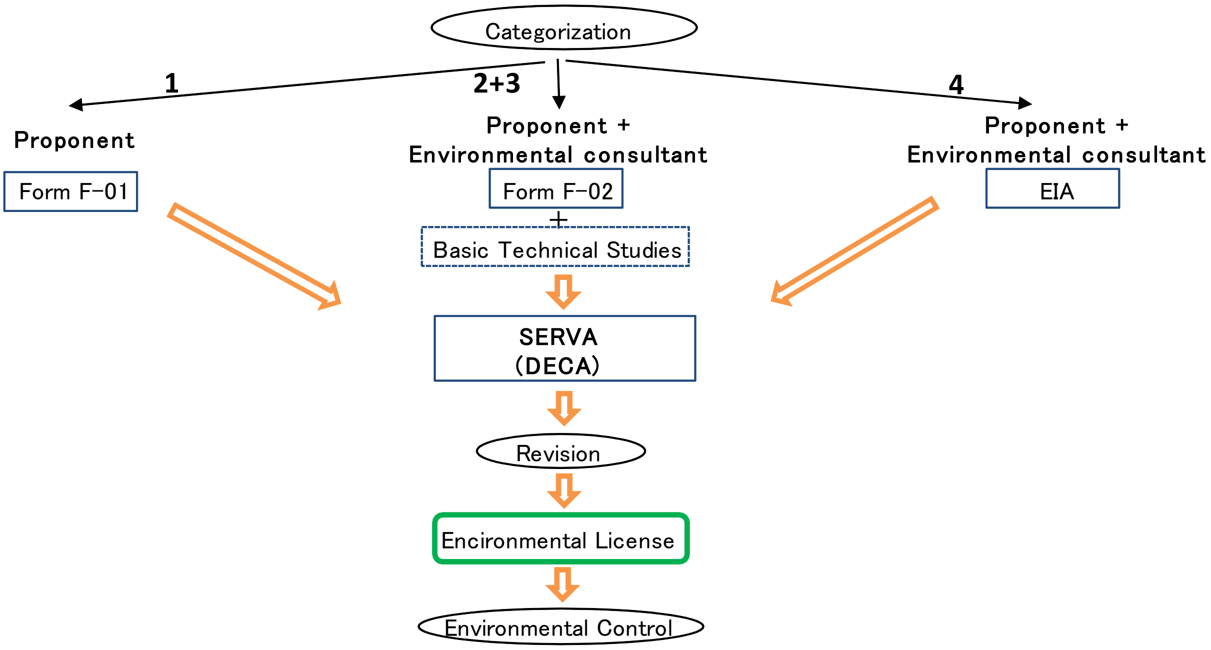


Figure 6.1-1 EIA Procedure

(c) Environmental Standards

Environmental Standards have been established for drinking water and wastewater. It is referenced international environmental standards such as United States Environmental Protection Agency (EPA) for noise, vibration, exhaust gas, and dust. Environmental standards for wastewater is shown below.

Table 6.1-3 Environmental Standard of Waste Water in Honduras

parameter		National Standard
pH		6-9
SS (Suspended Solid)		100mg/L
BOD		50mg/L
COD		200mg/L
T-N		30mg/L
T-P		5mg/L
Heavy Metals	Cu	0.5mg/L
	Zn	2mg/L
	Cd	0.05mg/L
Hydrocarbons		0.5mg/L
Phenols		0.5mg/L
Cyanide		0.5mg/L
Temperature		<25°C

Souce: Compendio de Legislacion Ambiental ABRIL-2011 (SERNA)

(d) Protected Area

The following types of protected areas that require consideration for the environment, activities are limited. Ramsar Convention is left to discretion of governments for management of international important wetland.

In Honduras, environmental fragile areas are defined to supplement, in part, the absence of land use planning that takes environmental issues into account. It also aims to establish special areas of country, which is considered environmentally sensitive by their nature or their special administrative status. Some development activities are regulated or prohibited within its area.

Table 6.1-4 Environmental Fragile Areas List

No.	Type of Geographic Area	Degree of limiting and restrictive pattern
1	National Parks	Limiting high until prohibitive.
2	Forest Reserves	Limiting high.
3	Protected Zones	Limiting high and restrictive for many productive actions.
4	Biological Reserves	Limiting high.
5	National Wildlife Refuges	Limiting high and restrictive for many types of productive activities.
6	Wetlands	Limiting high until prohibitive.
7	Natural Heritage	Limiting high and restrictive for many productive actions.
8	Bodies and natural watercourses	Limiting high and restrictive for many productive actions.
9	Protection areas and natural water courses and springs or permanent springs	Limiting high and restrictive for many productive actions.
10	Marine area - land or sea or lake shoreline as defined in current legislation	High to moderate limitation and restrictive for some productive actions.
11	Areas with natural forest cover	Limiting high and restrictive for many productive actions.
12	Aquifer recharge areas of strategic value formally defined by the authorities in maps	Limiting high and restrictive for many productive actions.
13	Areas where resources are archaeological, architectural, scientific or cultural heritage considered by the legislation formally defined and established by the appropriate authorities	High to moderate limitation and restrictive for some productive actions.
14	Areas of Indian Reservations	High to moderate limitation and restrictive for some productive actions.
15	Condition of areas considered high to very high susceptibility to natural hazards formally established by the appropriate authorities	Limiting high and restrictive for many productive actions.
16	Areas with slopes greater than 60%	High to moderate limitation and restrictive for some productive actions involving infrastructure development.
17	Environmentally fragile areas defined as within the regulatory plans or regional planning studies that are unofficial.	High to moderate limitation and restrictive for some productive actions.

Souce: Compendio de Legislacion Ambiental ABRIL-2011 (SERNA)

Table 6.1-5 Characteristics and Use Objectives of Categories of Management Areas

Characteristics and objectives	National Park	Nature Reserve	National Monument	Multiple Use Area	National Forest
Size	More than 5,000ha	Any size	Less than 5,000ha	Any size	Any size
Importance	National or International	National or International	National	Local	National
Integrity of a representative example of an ecosystem	Yes	Yes	Facultative	Facultative in designed areas	Facultative in designed areas
Unique landscapes or geological formations	Yes	Facultative	Yes	Facultative in designed areas	Facultative in designed areas
Research	Yes	Yes	Facultative	Facultative	Facultative
Environmental Education	Yes	Facultative	Yes	Facultative	Facultative
Visitation and Recreation	Yes	Facultative	Yes	Yes	Yes
Usage of natural water	Yes	Yes	Yes	Yes	Yes
Production of wood and non-wood products	No	No	No	Yes	Yes
In designed areas only	In designated parts of the buffer zones only	In designated parts of the buffer zones only	In designated parts of the buffer zones only	Yes	Yes
Habitation	In designated areas in buffer zones	In designated areas in buffer zones	In designated areas in buffer zones	In designed areas only	In designed areas only

Source: Rationalization of the protected areas system of Honduras (WICE, 2002)

(e) Lake Yojoa Protection Law

Lake Yojoa has unique ecosystem of economic, social, and environment in Honduras, but in the past, resources of the basin had been utilized immoderately, which caused significant damage to environment. This law was established to maintain biodiversity and sustainable use and it limits some activities in Lake Yojoa. There are two organizations for management of Lake Yojoa, that are HONDULAGO and AMUPROLAGO. HONDULAGO is the governmental organization in charge of legal issues related to Lake Yojoa. AMUPROLAGO is a local government institution consists of three coastal departments (Comayagua, Santa Bárbara and Cortés Department) which discuss and determine the management of Lake Yojoa. It is stipulated to consult with these relevant organizations in Lake Yojoa Protection Law when anyone plan to implement some activities on the lake.

(2) Organization regarding Environmental and Social Consideration

The main responsible organization of the Honduran government is SERNA. The section that governs EIA in SERNA is Direction of Environmental Evaluation and Control (“DECA”).

(3) ENEE organizes an environmental department under a director of planning, which has a responsibility for managing environmental and social issues. The organization chart of the environmental section of ENEE is shown below.

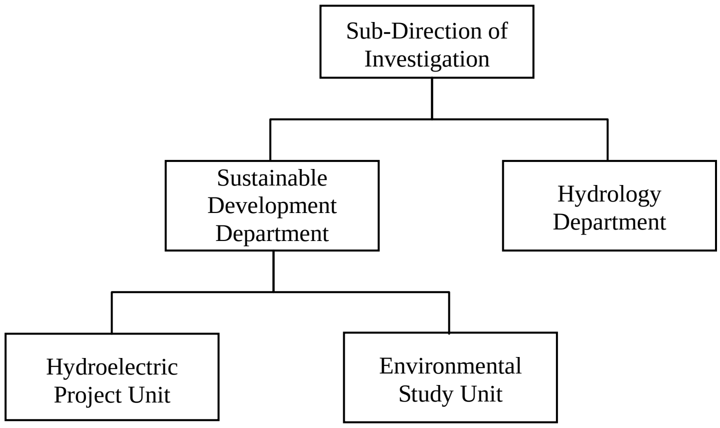


Figure 6.1-2 ENEE's Environmental Organization

6.2 ENVIRONMENTAL/SOCIAL CONSIDERATIONS OF THE PROJECT

(1) Project Location

Both Cañaveral and Río Lindo Hydropower Plants are located in Santa Cruz de Yojoa Municipality, Cortés Department. Cañaveral HPP belongs to Peña Blanca Village while Río Lindo HPP belongs to Río Lindo Village.

Population and area of each local government unit is shown in Table 6.2-1, located is shown in Figure 6.2-1.

Table 6.2-1 Local Government Unit

	Population	Area (km^2)
Santa Cruz de Yojoa M.	58,930	725.6
Peña Balanca V.	10,800	10.56
Río Lindo V.	17,281	30.71

Source: National Census 2001

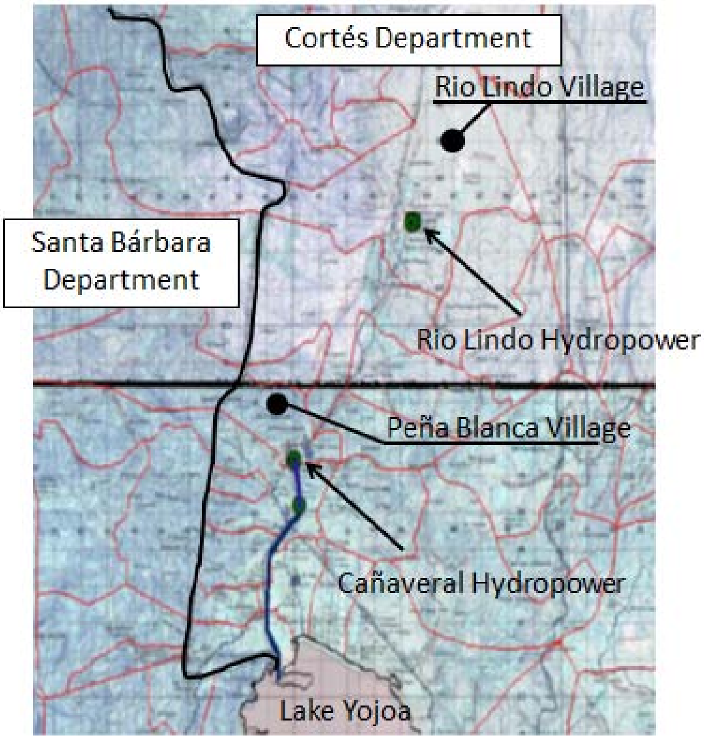


Figure 6.2-1 Location of the Plants

(2) Environmental Situation

Cañaveral - Río Lindo Hydroelectric complex have a natural reservoir of Lake Yojoa whose regulation is annual. The hydroelectric complex pulls the water of the lake into open channel and the water flows to Cañaveral and Río Lindo hydro turbines then discharge water goes to Lindo River (Río Lindo). See Chapter 5.3 (3).

(a) Land Use

Area around the project site has 2,800mm annual precipitation (Figure 6.2-2).

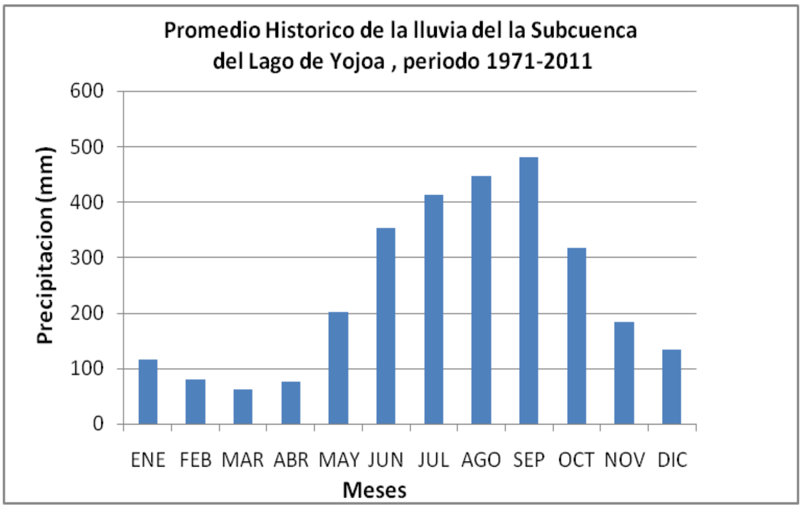


Figure 6.2-2 Annual Precipitation at Lake Yojoa

It is almost covered with the broad-leaved forest around the hydroelectric complex and Lake Yojoa. Then it is confirmed the microbroad-leaved deciduous shrub land, the broad-leaved evergreen rainforest in sub-mountain, and mixed forest. They are dominated by pine, mahogany, and white cedar (*Cupressus lusitanica*) etc. Moreover there is agricultural system such as animal husbandry and farmland.

Forest

Animal husbandry

Poultry Farm

Situation of Roadside near the Project Site

Photo 6.2-1 Land Use

(b) Protected Area

There are some protected areas and national parks around Lake Yojoa, which are Santa Barbara National Park, Cerro Azul Meambar National Park, and Lake Yojoa sub-basin Ramsar site (Figure 6.2-3). These protected areas are located in range of about 2.5km – 38.0km from Cañaveral hydro-power plant.

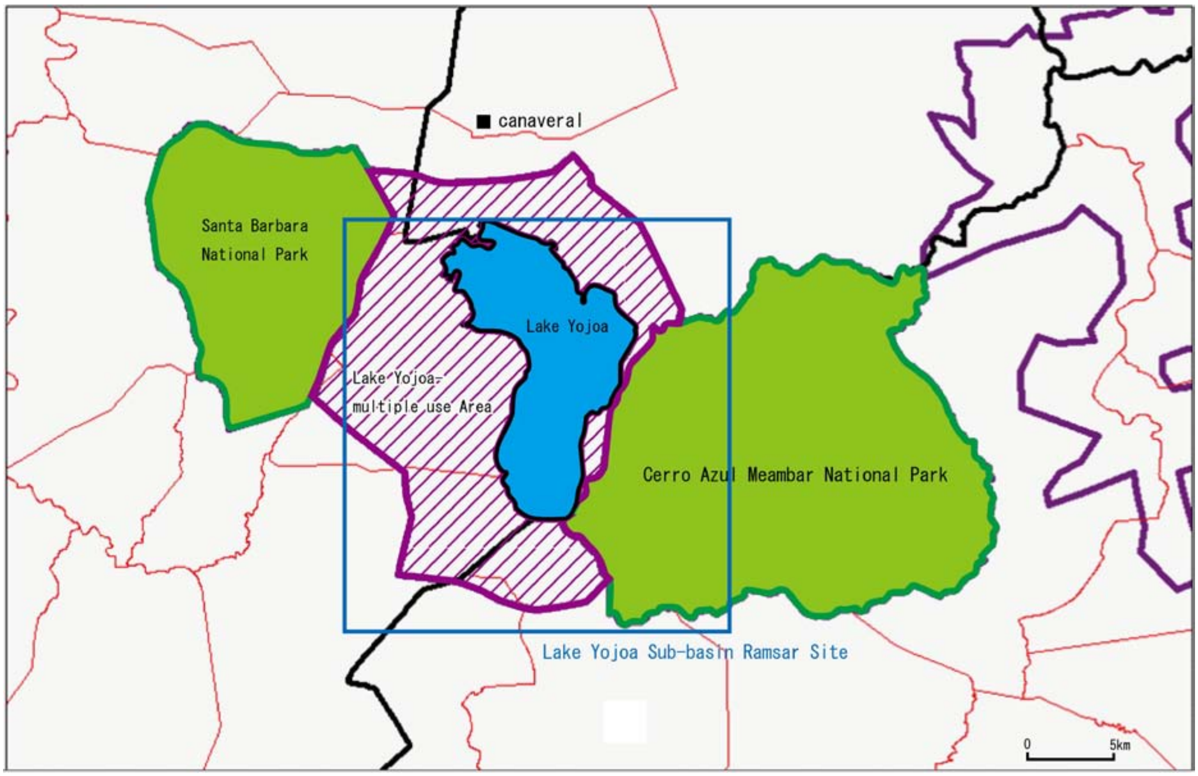


Figure 6.2-3 Protected Area around Project Site

Table 6.2-2 Protected Area

Name	Area	Date of establishment	Limitations
Santa Barbara Mountain National Park	13,201.55ha		In development
Cerro Azul Meambar National Park	17,871.74ha		farming, building
Lake Yojoa multiple use area	14,544.95ha		mining
Lake Yojoa sub-basin Ramsar site	43,640.00ha	July 5th 2005	farming, building

A Lake and surrounding area containing a total 3 wetland types and unique ecosystems for Honduras, such as evergreen low mountain forest and the highest karst mountain in Central America. The site hosts 169 fern species (24.7% national total); 71 aquatic and emergent plants (86.5% national total); 29 freshwater fish species (32.9% national total). It is the only site where all kingfishers have been recorded. Endemic fish species have decreased due to the introduction of exotic species, such as Tilapia and Black bass. Additionally the most notable endemic species of fauna are shown below.

Table 6.2-3 Important Species in Lake Yojoa Sub-basin Ramsar Site

Scientific name	English name	IUCN	CITES	Remarks
Dendrotriton sanctibarbarus	Salamander			
Nototriton barbouri	Salamander			
Myrmecophaga tridactula	Giant anteater		II	
Ixobrychus exilus	Least bittern			
Pandion haliaetus	Osprey	LC	II	Only site in Honduras
Rostrhamus sociabilis	Snail kite	LC	II	Only site in Honduras

Source: http://www.ramsar.org

(c) Lake Yojoa

Lake Yojoa is the largest natural lake in Honduras whose surface area, average depth and surface elevation are 90 km^2, 15m, 700m respectively. It lies in a depression formed by volcanoes. Lake Yojoa is a popular fishing destination (leisure fishing) and important for drinking water and irrigation of fruits, grains, and vegetables as well. The surrounding area has a rich biodiversity--almost 400 species of birds and 800 plant species have been identified in the region. However, it also is threatened by deforestation, cattle ranching, and development.

Its water quality has been deteriorated because of mining, fish farming of Tilapia, animal husbandry and wastewater from restaurants located on the shore of the lake. Therefore ENEE is trying water quality purification in cooperation with International Atomic Energy Agency from 2007.

Lake Yojoa

Restaurant lining the shore of the lake Fish farm on the lake

Photo 6.2-2 Situation of Lake Yojoa

Around Lake Yojoa, there are 3 dams with the purpose of mainly hydroelectric power operation. (See Chapter 5.3 (3)). Consequently Lake Yojoa has unique water use system. Its water balance is shown below (Figure 6.2-4).

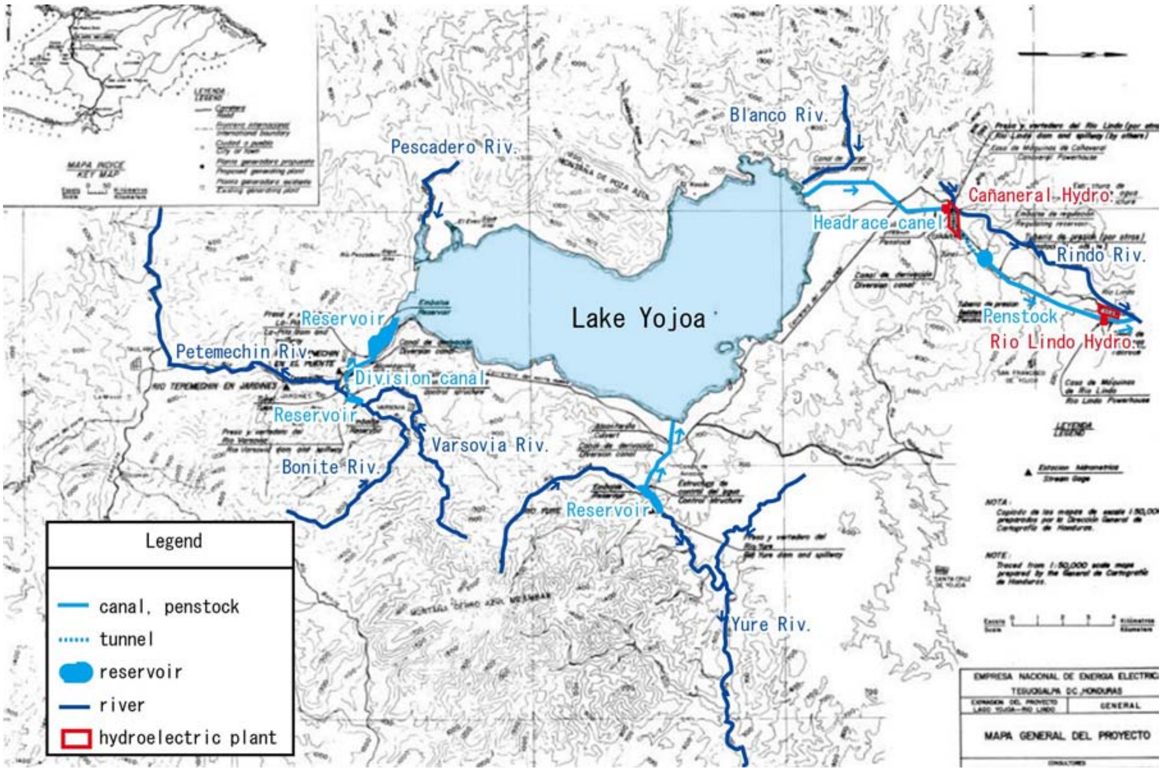


Figure 6.2-4 Water System of Lake Yojoa

Two natural rivers flowing to the Lake are Pescadero River and Blanco River, but there is no natural river flowing from Lake Yojoa. Maximum capacity of the canal to Cañaveral and Río Lindo hydroelectric complex is 23.0m^3/s. Annual average discharge for generation of the last five years is from 14.7 m^3/s to 18.2 m^3/s in Cañaveral and from 18.0 m^3/s to 22.4 m^3/s in Río Lindo (Table 6.2-4). Discharge of Río Lindo is slightly more than Cañaveral because the water of Lindo River is added to the canal to use for power generation in Río Lindo HPP just below Cañaveral. Yure dam and Varsovia dam divert water to the lake from Yure River and Varsovia River for the compensation of water usage for HPPs. The water level is carefully maintained from 631.5m to 637.5m for preserving environmental condition in Lake Yojoa (Figure 6.2-5). ENEE takes a roll of monitoring agency of Lake Yojoa's water balance.

Table 6.2-4 Annual Average Discharge for Generation

(Unit: m^3/s)

	2007	2008	2009	2010	2011
Cañaveral	15.8	14.7	18.5	17.7	18.2
Río Lindo	19.7	18.0	22.4	22.0	21.6

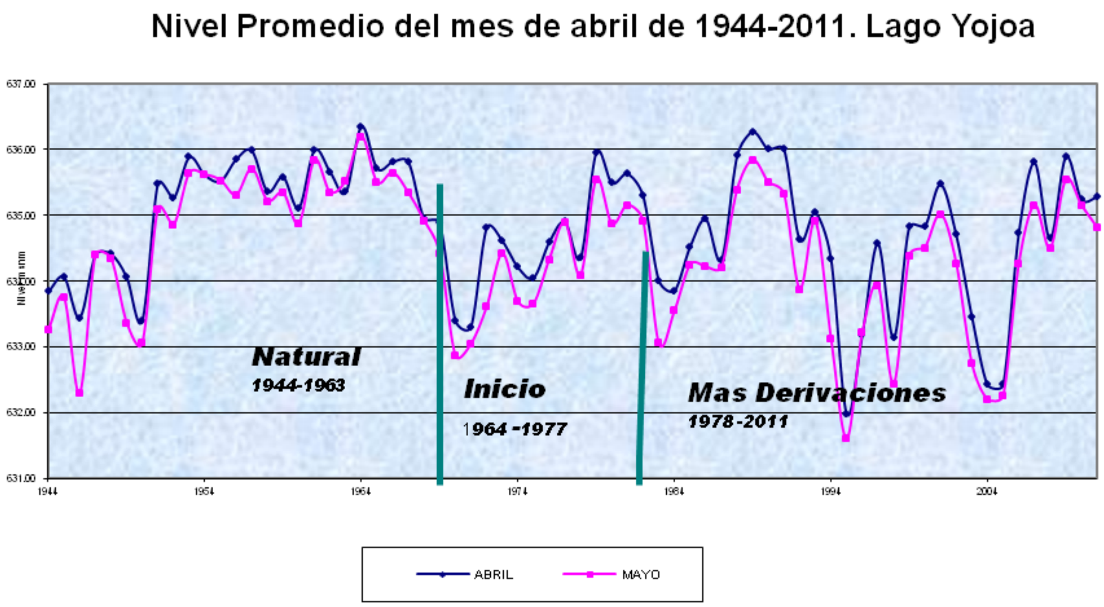


Figure 6.2-5 High Water Level of Lake Yojoa in April and May

Headrace Canal

Reservoir of Yure Dam

Spillway from Yure Dam

Division Cannel of Varsovia River

Photo 6.2-3 Water System of Lake Yojoa

As an environmental protection the water gate of Lindo River is opened in the dry season (approximately from January to August) in order to maintain the minimum limit water ($2m^3$) determined 10% of average water. Average, minimum and maximum flow of

Lindo River is 22 m^3/s, 12 m^3/s and 36 m^3/s, respectively.

(d) Downstream of Hydroelectric Complex

The discharge water from Río Lindo Plant passes through the channel and joins with River Lindo. There are some houses along the discharge canal and a fish farm on the channel which have not been used. There is Pulhapanzak Waterfall on the tributary of Río Lindo, which is one of attractions in Honduras.

Water Gate of Río Lindo

Photo 6.2-4 Situation of Río Lindo

Fish Farm downstream of Río Lindo HPP Pulhapanzak Waterfall

Photo 6.2-5 Downstream of Hydroelectric Complex

(e) Archaeology

There are two world heritages in Honduras, such as Maya site of Copán and Río Plátano Biosphere (Table 6.2-5, Figure 6.2-6).

Los Naranjos is one of the Maya archaeological sites located on the north shore of Lake Yojoa to around 600m near Peña Blanca Village. Inhabited at least 3,000 years ago by pre-Columbian cultures, it has a few small pyramids (earth and rock embankment, see Photo 6.2-6) and some ceramics remain. Initially the site was developed by ENEE during the construction stage of Cañaveral Hydroelectric Power Plant and later it has been transferred to managing institution. Currently it has become an eco-archaeological park with a natural beauty. Los Naranjos eco-archaeological park has 2.4 km^2 area.

Table 6.2-5 World Heritages in Honduras

Name	Category	Date of inscription
Maya Site of Copán	Cultural site	1980
Río Plátano Biosphere Reserve	Natural site	1982

Source: http://whc.unesco.org

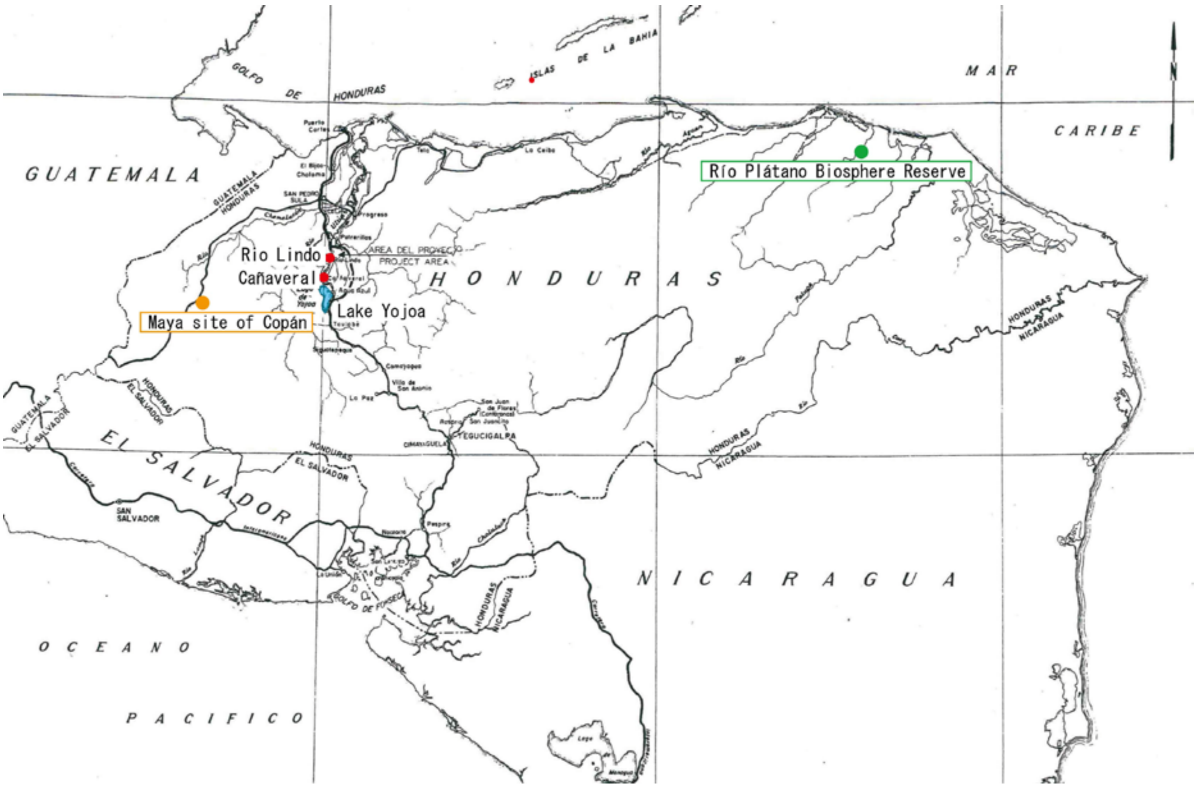


Figure 6.2-6 Location of World Heritages

Photo 6.2-6 Pyramid in Los Naranjos Eco-archaeological Park

(f) Species

According to SERNA and ENEE, there is no information of important species around the project site.

Photo 6.2-7 Iguana Living around Río Lindo HPP

6.3 IMPACT ON ENVIRONMENT

(1) Impact on Hydrology

ENEE plans to increase output of both HPPs by 20.8MW. Output is increased by efficiency upgrade and increased discharge water by 2.2 m^3/s. Major objectives of this expansion is to supply electricity at the peak demand duration (around 4 hours of the day) to reduce generation from fossil power plants (mainly diesel generator). ENEE intends to increase peak hour generation by taking more amount of water to Cañaveral and Río Lindo and instead, intends to reduce the off-peak hour generation for the purpose of keeping water balance in Lake Yojoa. Environmental impact from this expansion is therefore very limited.

Maximum discharge amount from Río Lindo HPP will be increased from 27.0m^3/s to 29.2m^3/s. Since the Lindo River at the confluence of Río Lindo discharge channel has enough capacity to safely flow increased amount of water, environmental impact is also very limited. Photo 6.3-1 shows water flow situation at the confluence point of Lindo River and Río Lindo discharge channel.

Confluence Point

Downstream of Confluence

Photo 6.3-1 River Flow Situation at Lindo River

The cross section of Lindo River at the immediate downstream of the confluence is around 30m wide and the river bank height is around 5m, in which water flows at 1 to 1.5 meter depth. The flow amount is assumed to be natural flow of Lindo River (average 22 m^3/s) plus discharge amount of 27 m^3/s. The width of the river is widened to around 100m at 300m downstream of the confluence point. In ENEE's operation procedure, start-up operation takes 40 minutes until full operation (discharge 27 m^3/s). This operation rule is considered enough to keep safety at the discharged river, preventing accident caused by rapid water level increase.

According to ENEE, there is no water usage downstream of the confluence point. Drinking water is taken from mountainous area and delivered to nearby communities. Fishing activities are not commonly observed.

(2) Waste Material Treatment

Asbestos is used for insulation material at the generators of Río Lindo. Although ENEE has no experience to handle asbestos, SERNA has a regulation for asbestos disposal and experience. According to SERNA, asbestos will be separated from general waste and be contained in a concrete confinement. No other toxic materials exist.

(3) Powerhouse Expansion

Powerhouse buildings for Cañaveral and Río Lindo are to be expanded for rehabilitation/ expansion works. Impact of expansion of power house is assumed very small because all expansion works will be within ENEE's property (Figure 6.3-1).


Cañaveral HPP

Río Lindo HPP

Figure 6.3-1 Range of Expansion Power Plant

(4) Impact during Construction

While it is assumed that noise, vibration, dust, and exhaust gases from vehicles cause adverse environmental impacts during construction, this project does not include a transport of heavy equipment over size of the transformer. Therefore these impacts on nearby residents are limited by, for example, the following mitigation measures; limit of traffic time, traffic speed limits, and traffic induction.

There are residential areas to a distance of about 400m from Cañaveral HPP and to a distance of about 200m from Río Lindo HPP. Since the construction period is short and there is no significant earth moving work, impact of noise and vibration during powerhouse expansion construction is limited.

Oil leakage of lubricating oil of the generator and insulation oil for transformer and circuit breaker and wastes after replacement of equipment are also considered causes of environmental impact. This impact is limited and will be able to mitigate by implementation of appropriate measures such as oil fence.

ENEE claimed that there are no PCB utilized in any equipment.

Carñaveral HPP

Río Lindo HPP

Souce: google map

Figure 6.3-2 Distance between Residential Area and Power Plant

(5) Mitigation and Monitoring

ENEE is currently undertaking water quality monitoring in Yojoa Lake. Monitoring items are temperature, pH, conductivity, Na^+, K^+, Ca^{2+}, Mg^{2+}, Total Hardness, Cl^-, SO_4^{2-} ,HCO_3^-, N-NH_3, N-NO_2, N-NO_3, PO_4^{3-}, Transparency Secchi, Total Coliform and Fecal, Organochlorine Pesticides, Heavy Metals and DO.

As this project doesn't include alternation of land, large change in water use or use of heavy vehicles, environmental impact is limited. Additionally the project site is not in the protected areas or habitats of important species. Therefore, it is considered that no additional environmental monitoring is required. However, in order to mitigate the environmental impact during construction period, following mitigation measures are recommended and the appropriate action of mitigation measures are to be monitored.

Table 6.3-1 Proposed Mitigation Measures

Impact			Mitigation
	During construction	During operation	
Waste	・Asbestos for insulation material at the generators of Río Lindo	-	・Appropriate asbestos disposal following regulation. (Asbestos will be separated from general waste and be contained in a concrete confinement.)
Noise and Vibration etc.	・Noise, vibration, dust, and exhaust gases from vehicles ・Noise, vibration during powerhouse expansion construction	-	・Traffic speed limits, Traffic priority of residents ・Limit of working time Temporary enclosure,
Oil leakage	・Oil leakage of lubricating oil of the generator and insulation oil for transformer and circuit breaker	-	・Oil fence etc.

As a step of environmental approval process of SERNA, SERNA may issue mitigation measures and monitoring plan to ENEE after its examination of the project, if necessary. ENEE will implement mitigation and monitoring according to SERNA'S instruction.

6.4 CURRENT STATUS OF ENVIRONMENTAL LICENSE PROCEDURE

ENEE and SERNA had a meeting on February 28, 2012. ENEE informed the outline of the project. SERNA, after reviewing the information, issued an official letter to ENEE on March 1, 2012, in which SERNA requested ENEE to submit some basic information about the project together with Form F-O2. A joint site inspection (environmental audit) is conducted from March 20, 2012 lasting about 7 days.

According to SERNA, the rehabilitation and expansion project of Cañaveral and Río Lindo Hydroelectric Power Plants is classified in either Category 2 or 3, therefore, the project is not required to procure EIA. After the environmental audit and submission of Form F-O2, SERNA schedules to issue an environmental license to ENEE within 30 days should there be no environmental/social concerns.

CHAPTER 7 ECONOMIC EVALUATION

7.1 ENEE'S FINANCIAL STATUS

7.1.1 Current Status

Information listed below are collected and reviewed during the 2nd mission

1) Financial Statement from 2007 to 2011
2) Budget from 2011 to 2012
3) Cash flow projection in 2012
4) Debt repayment schedule
5) Tariff schedule
6) Generation of and payment record to independent power producers (IPPs)
7) Capital investment plan 2011 to 2016
8) Demand projection 2010 to 2030
9) Demand/Supply balance projection 2012 to 2026
10) Generation Expansion Plan 2011 to 2025
11) Plan Estratégico Empresa Nacional de Energia Eléctrica 2011-2014 dated January 2012 (ENEE Strategic Plan 2011 -2014)

Tables 7.1-1 and 7.1-2 show ENEE's historical financial statement from 2007 to 2011.

Table 7.1-1 Balance Sheet of ENEE

(Figures in Lempiras)

	2007	2008	2009	2010	2011
1. Asset					
11 Fixed assets of public service					
111 In service	28,134,445,673	27,522,737,148	26,473,409,463	26,055,727,705	25,636,837,249
112 In construction	723,948,376	993,419,483	1,097,767,074	867,466,958	2,648,020,535
113 Fixed asset acquired	40,239,207	10,356,812	0	0	0
Total Fixed Asset	**28,526,513,444**	**28,898,633,256**	**27,571,176,537**	**26,913,194,663**	**28,284,857,784**
12 Asset					
Short term asset (current)					
121 Availability	94,518,229	138,913,213	45,772,633	821,170,650	341,673,954
123 Accounts and notes receivable	2,047,511,911	1,606,414,742	1,408,491,018	716,899,579	1,877,837,420
125 Payments anticipated	14,077,102	8,655,593	0	0	
Totol Short Term Asset	**2,156,107,242**	**1,753,983,547**	**1,454,263,651**	**1,538,070,229**	**2,219,511,373**
Long term asset					
123 Accounts and notes receivable	215,808,129	120,820,119	120,372,122	122,916,205	115,802,333
124 Materials and supplies	864,966,887	716,141,515	527,444,473	665,772,652	400,319,584
126 Investments	94,475,500	94,475,500	106,284,938	910,483,375	635,451,000
Total Long Term Asset	1,175,250,516	931,437,133	754,101,533	1,699,172,232	1,151,572,917
Total Short and Long Term Asset	**3,331,357,758**	**2,685,420,681**	**2,208,365,184**	**3,237,242,461**	**3,371,084,291**
13 Deferred asset					
131 Deferred charges	140,643,234	125,852,971	97,577,267	84,326,856	345,995,442
132 Forwar contract	129,819	0	0	0	53,363
Total Deferred Asset	**140,773,052**	**125,852,971**	**97,577,267**	**84,326,856**	**346,048,804**
Total Asset	32,370,764,067	31,337,787,096	29,877,188,989	30,234,763,979	32,001,990,880
2 Liability					
21 Heritage					
211 Equity	2,061,204,666	1,721,121,047	1,721,121,047	1,721,121,047	1,721,121,047
212 Accumulated result	-12,003,585,702	-11,979,871,873	-13,031,938,685	-10,022,983,761	-8,335,829,882
212 Current year exercise result	-2,669,251,137	-3,078,437,579	-489,165,759	50,557,491	-3,042,421,206
213 Capital transferes received	2,739,965,168	5,781,438,985	6,044,138,756	6,294,921,041	7,509,648,528
214 Revaluation of assets	24,312,986,430	21,720,327,296	19,264,295,219	17,983,074,381	17,958,334,938
216 Debt Condonaci'on	1,072,414,438	1,077,380,566	1,077,380,566	1,401,037,473	1,536,846,990
217 International contribution	21,347,611	23,117,068	23,117,068	23,117,068	23,117,068
Total Equity	**15,535,081,474**	**15,265,075,510**	**14,608,948,214**	**17,450,844,740**	**17,370,817,484**
Liability					
Short term liability					
222 External and internal debt	261,415,738	217,201,334	202,908,844	2,110,996,679	230,484,725
223 Delinquent debt	203,445,665	361,319,757	518,418,533	2,127,958,712	2,425,625,630
224 External and internal debt interest	65,985,869	63,741,797	59,888,074	58,526,776	75,061,972
225 Delinquent debt interest	138,148,345	184,159,668	231,529,226	578,343,164	1,010,955,692
241 Account payable	2,612,155,757	2,012,371,701	1,469,696,336	1,468,033,347	2,694,109,625
242 Payment to employees	8,498,501	604	1,265,896	0	1,357,163
243 Retaining employees	11,801,531	15,695,310	6,614,288	13,058,848	7,586,002
245 Notes payable	1,086,598,050	32,867,332	45,641,186	33,508,124	33,702,706
247 Interim deposits	1,213,562	5,618,995	13,746,731	16,006,950	0
Total Short Term Liability	**4,389,263,018**	**2,892,976,497**	**2,549,709,114**	**6,406,432,601**	**6,478,883,515**
Long term liability					
221 External and internal debt	11,796,906,137	12,310,018,802	11,737,309,409	4,645,343,540	6,237,356,336
241 Accout payable	8,045,734	16,162,032	2,906,816	2,933,038	0
244 Deposit paid	20,317,728	110,563,921	209,436,163	278,998,619	393,217,946
249 Interest payable	134,809,984	231,607,886	37,485,504	292,737,769	146,745,157
Total Long Term Liability	**11,960,079,583**	**12,668,352,641**	**11,987,137,891**	**5,220,012,966**	**6,777,319,439**
Total Short and Long Term Liability	**16,349,342,601**	**15,561,329,138**	**14,536,847,005**	**11,626,445,566**	**13,256,202,954**
Deferred liabilities					
251 Deferred credits	486,339,993	219,602,448	225,243,769	651,393,673	727,070,441
252 Employee liabilities	0	291,780,000	506,080,000	506,080,000	647,900,000
Total Deferred Liabilities	**486,339,993**	**511,382,448**	**731,323,769**	**1,157,473,673**	1,374,970,441
Total Liabilities and Equity	**32,370,764,067**	**31,337,787,096**	**29,877,118,988**	**30,234,763,980**	**32,001,990,880**

Table 7.1-2 Profit and Loss Statement of ENEE

(Figures in Lempiras)

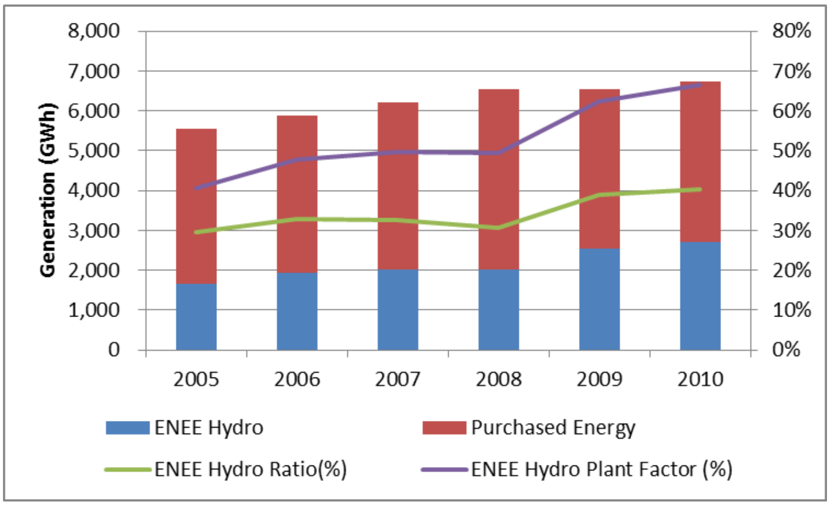
	2007	2008	2009	2010	2011
4 Reveneu Result					
41 Revenue					
411 Operating Income	10,033,224,400	13,700,850,026	13,611,374,756	15,247,567,097	18,223,761,805
413 Non Operating Income	22,979,831	24,363,123	17,776,079	432,087,898	96,476,431
Total Revenue	**10,056,204,231**	**13,725,213,149**	**13,629,150,835**	**15,679,654,995**	**18,320,238,237**
5 Expenses & Cost Result					
51 Public Service Expense					
511 Operation and Maintenance	11,806,277,800	15,325,555,349	12,382,282,502	14,212,159,179	19,668,997,552
511-11 Purchase of Electricity	(8,899,566,118)	(12,314,979,724)	(8,665,125,921)	(10,393,020,153)	(14,665,614,915)
512 General Expense	171,885,350	218,500,609	1,228,679,125	218,992,559	620,102,868
513 Financial Expense	418,306,896	381,098,121	233,551,268	1,118,359,266	968,064,352
519 Non-operational expense	28,194,221	155,866,883	62,940,029	77,537,336	105,223,856
Sub-Total Public Service Expense	**12,424,664,268**	**16,081,020,963**	**13,907,456,924**	**15,627,048,340**	**21,362,388,628**
51 Condonation and Discount					
521 Condonation	2,785,814	578,217	140,308	0	270,814
522 Discount	54,131	5,313	242,394,424	0	
Total Condonation and Discount	**2,839,945**	**583,530**	**242,534,733**	**0**	**270,814**
Total Expense and Cost	**12,427,504,213**	**16,081,604,493**	**14,149,991,656**	**15,627,048,340**	**21,362,388,628**
Net Profit/Loss	**-2,371,299,982**	**-2,356,391,343**	**-520,840,821**	**52,606,655**	**-3,042,421,206**
Currency Exchange					
413-04 Profit from Currency Exchange	210,726,661	436,869,149	765,418,745	-	-
513-05 Loss from Currency Exchange	508,677,816	1,158,915,384	733,743,683	-	-
Profit and/or Loss from Currency Exchange	**-297,951,155**	**-722,046,236**	**31,675,062**	-	-
611 Tax					
611-01 Tax Payable				2,049,164	0
Total Tax				**2,049,164**	**0**
Total Profit/Loss of the Period	**-2,669,251,137**	**-3,078,437,579**	**-489,165,759**	**50,557,491**	**-3,042,421,206**

Until 2009, ENEE marked negative profit. According to Power Sector Update and Revision Study reported on March 22, 2010 prepared for JICA, there are mainly three (3) reasons of this unsustainable financial status. Those are,

i) Technical and non-technical loss
ii) High dependency on imported fuel
iii) Tariff structure being unable to directly reflect fuel price

In this chapter, above three factors are discussed. The cost of each generation source and long term debt of ENEE is also introduced.

Note that positive profit in 2010 was mainly result of increased hydropower generation and lowered fuel cost. ENEE's hydropower marked historically highest generation of 2,707GWh and plant factor (ratio of actual generation to theoretical maximum generation) of 66.6%. This highest plant factor implies good hydrological condition and minimum outage of the plants. See Figure 7.1-1.



Source: ENEE

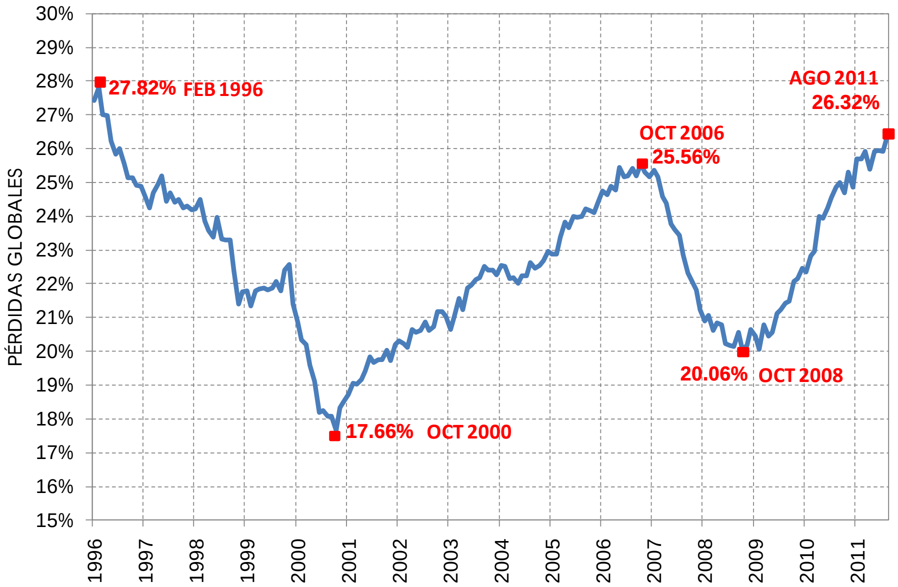
Figure 7.1-1 ENEE Hydropower Performance

Technical and non-technical loss

The historical change of the rate of energy losses which is moving average for the last twelve months is shown in Figure 7.1-2. The loss rate has been varied between 18% and 28%. Therefore, this energy loss is a significant impact on electricity sales revenue of ENEE. Since this value is considerably large compared with the theoretical (technical) loss rate of the power system, the majority of this loss is the non-technical loss in distribution system. In order to improve the income of ENEE, it is important to reduce the non-technical loss.

In the 1990s, considerable effort has been made. As a result, the loss rate was improved to about 18% in 2000. However, the loss rate has risen again to about 25% in 2007 since the loss management has not been implemented. From 2006 to 2009, ENEE implemented an extensive program to install automatic meter reading (AMR) and wholesales meter, which resulted in improvement of loss to 20% in 2009. The effect of the program, however, is not sustained because of the political crisis and the loss rate has turned to increase again.

These facts show that continuous implementation of loss management with the immediate spread of AMR is required in order to decrease certainly the non-technical losses.



Source: GENERACIÓN AUTÓNOMA Y USO RACIONAL DE LA ENERGÍA ELÉCTRICA, Tegucigalpa, M.D.C, Sept. 2011)

Figure 7.1-2 Total Electricity Losses (12month moving average)

High Dependency on imported fuel and tariff structure

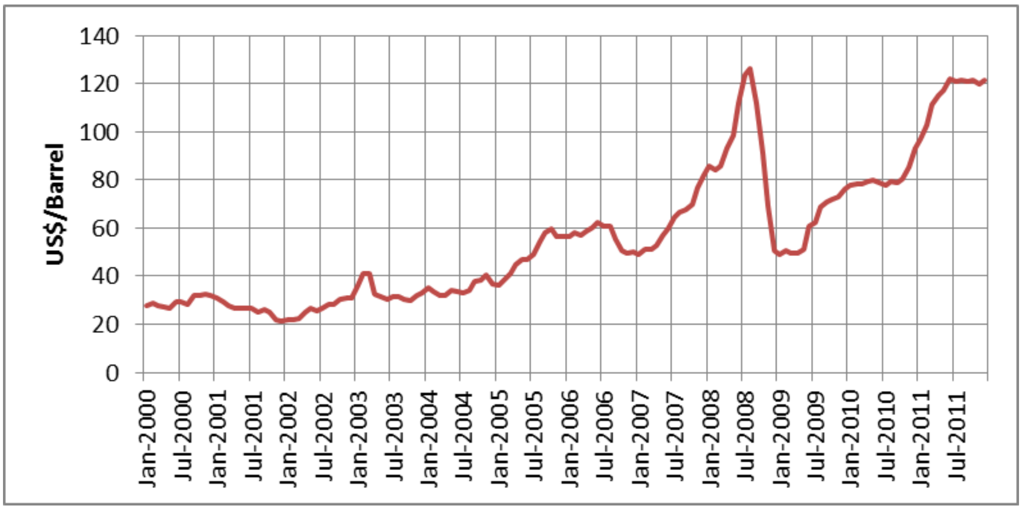
As discussed in Chapter 3, thermal power plant is mostly operated by private companies (IPPs). Power purchase agreements (PPAs) between IPPs and ENEE generally defines i) ENEE makes a dispatch instruction to IPP, ii) IPP should make its plant available preparing for ENEE's dispatch instruction under a certain condition then IPP can receive fixed payment regardless actual generation, iii) ENEE pays energy payment including fuel cost indexed with bunker C oil price according to actual generation. The imbalance is that ENEE pays actual fuel cost to IPPs but the reflection to tariff is limited and delayed.

ENEE's expenses to IPPs (including renewable IPPs) are summarized in Table 7.1-3.

Table 7.1-3 ENEE Total Expense and Electricity Purchase

	2007	2008	2009	2010	2011
Total Expense (Mil. Lps)	12,425	16,081	13,907	15,627	21,362
Electricity Purchase (Mil. Lps)	8,900	12,315	8,665	10,393	14,666
Ratio	72%	77%	62%	67%	69%

In 2008, oil price marked historically highest until world-wide credit crisis in September. The oil price is recently again gradually increasing. Fuel oil price ("bunker C" or "residual fuel oil") has almost reached to the historical highest level. Honduran Government and ENEE need to take immediate action for recovering financial deficit in the short term.



Source: US DOE

Figure 7.1-3 Residual Oil Price (Low Sulfur Oil)

Tariff Structure

ENEE has a difficulty to incur all relative cost of generation, transmission and distribution. Especially that is significant for purchasing cost of energy form private IPPs. PPA with private generators are much beneficial for generators. There are mainly two systems that hinder ENEE from recovering financial unsustainability.

PPA generally has time of use tariff structure. Electricity generated during peak hours of the day are purchased at higher price. ENEE, however, does not have time of use sales tariff, resulted in back spread situation.

ENEE's sales tariff schedule includes price adjustment formula for fuel price fluctuation. It considers oil price of USA, exchange rate and actual heat rate of particular fossil power plants. This adjustment is applied every month, namely, ENEE researches relevant data of previous month, submit result of adjustment formula to the government for approval and reflect the adjustment factor on to the next month's electricity bill. Ideally, if this "pass-through" structure is completely implemented, financial impact by imported oil price fluctuation should be minimalized. The problem is that the governmental approval are hardly obtained as proposed because of political reasons. The uncollected adjustment factor is about 1.4 MUS$ per month. See Table 7.1-4.

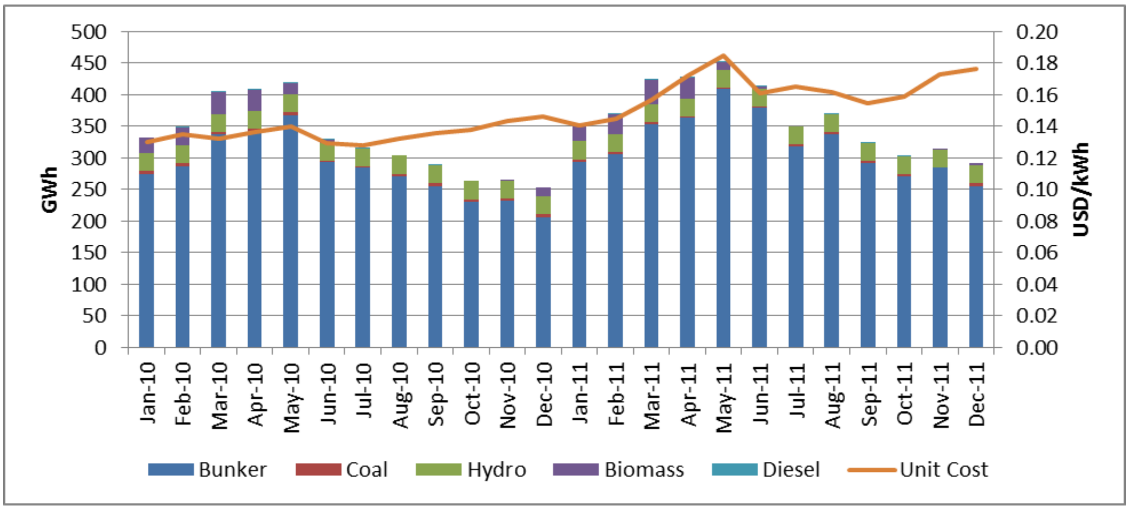
Table 7.1-4 Fuel Price Adjustment Record

Month	Adjustment Factor by Formula (%)	Approved Adjustment Factor (%)	Oil Price (US$/bbl)	Expected Adjustment (M Lps)	Actual Adjustment (M Lps)	Difference
Jan-11	13.53	12.00	74.99	134.60	119.38	-15.22
Feb-11	15.63	12.00	77.99	176.05	135.16	-40.89
Mar-11	20.42	12.00	85.07	220.03	129.30	-90.73
Apr-11	28.26	20.26	96.62	329.14	235.97	-93.18
May-11	32.33	28.26	102.61	390.31	341.17	-49.14
Jun-11	29.45	27.40	98.37	381.83	355.25	-26.58
Jul-11	31.66	29.53	101.74	388.34	362.21	-26.13
Aug-11	30.62	28.44	100.19	369.71	343.39	-26.32
Sep-11	29.36	29.00	98.89	356.18	351.81	-4.37
Oct-11	30.08	30.08	99.37	353.96	353.96	0.00
Nov-11	29.19	29.19	97.56	322.02	322.02	0.00
Dec-11	32.01	32.01	101.31	341.58	341.58	0.00
Jan-12	28.81	28.81	96.74	304.25	304.25	0.00
Feb-12	31.87	31.87	100.64	362.19	362.19	0.00
Mar-12	36.44	31.87	106.74			
Average Uncollected Adjustment Money per Month						-26.61

Source: ENEE

Generation Cost

Generation cost for each generation source (bunker oil, coal, diesel, private-owned hydro power, biomass) was analyzed from actual payment from ENEE to each IPP. Figure 7.1-4 and Table 7.1-5 shows generation volume and generation cost (purchase cost) received and paid in 2010 and 2011.



Source: ENEE

Figure 7.1-4 Purchased Generation and Average Purchase Cost

Table 7.1-5 Generation Cost of Each Generation Source

(in US$)

	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Average
Bunker	0.138	0.144	0.138	0.143	0.145	0.135	0.134	0.140	0.144	0.147	0.150	0.157	0.142
Coal	0.118	0.127	0.125	0.127	0.132	0.123	0.122	0.120	0.124	0.124	0.120	0.130	0.125
Hydro	0.067	0.067	0.067	0.071	0.076	0.075	0.076	0.075	0.075	0.072	0.069	0.067	0.072
Biomass	0.083	0.061	0.083	0.086	0.086	0.084	0.000	0.000	0.000	0.000	0.067	0.093	0.081
Diesel	–	1.668	3.387	0.880	0.797	1.005	2.148	–	5.554	–	–	–	1.928
Weighted Average	0.130	0.135	0.132	0.137	0.140	0.129	0.128	0.132	0.135	0.138	0.143	0.146	0.135

	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Average
Bunker	0.151	0.156	0.166	0.182	0.191	0.166	0.175	0.170	0.164	0.172	0.179	0.183	0.172
Coal	0.129	0.140	0.152	0.162	0.173	0.175	0.179	0.182	0.176	0.171	0.000	0.178	0.165
Hydro	0.069	0.068	0.080	0.072	0.073	0.077	0.076	0.074	0.079	0.076	0.068	0.069	0.074
Biomass	0.085	0.082	0.084	0.088	0.055	0.063	0.000	0.000	0.000	0.000	0.072	0.068	0.081
Diesel	–	2.866	1.868	0.712	0.556	0.517	–	1.061	3.118	18.671	–	–	1.182
Weighted Average	0.140	0.145	0.156	0.172	0.185	0.161	0.165	0.162	0.154	0.159	0.173	0.177	0.163

Source: ENEE

Pricing formula is defined in each PPA. Generation from bunker oil increased from 0.142 US$/kWh in 2010 to 0.172 US$/kWh in 2011 reflecting bunker oil price increase. Diesel power plant operates for supplying only peaking hours and the pricing formula determine relatively high pricing (note that average generation cost includes fixed payment regardless dispatch instruction).

Private-owned hydropower and biomass are classified in renewable energy. Pricing formula therefore is based on Renewable Energy Law in 2007, which regulate; i) pricing is based on short term marginal cost at the contract year, which is publicly announced every year, ii) 10% incentive are given to the less-than-50MW project on to short term marginal cost until 10 years from the commercial operation year and iii) price escalation is considered annually indexed with US-CPI but limited to 1.5% per year. Since almost renewable power were contracted in 2007, the pricing is relatively low (hydropower 0.074 US$/kWh, biomass 0.081 US$/kWh in 2011).

It is noted, however, the recent short term marginal cost has been increased to 0.12445 US$/kWh (Official Gazette No.0298-2012) reflecting recent higher cost of thermal generation. Future development of renewable energy still has an advantage compared with fossil power, but the level of advantage in terms of purchasing cost has been reduced. Large scale hydropower development or rehabilitation/expansion project of ENEE have higher advantage for long term financial stability of ENEE.

According to ENEE’s calculation by separating annual expenses of hydropower operation and maintenance cost from those of transmission line and distribution line, average generation cost of ENEE’s hydropower plants is 0.0318 US$/kWh.

Long Term Debt

Total outstanding debt as of March 2012 is US$133.7 million in which external debt is US$2.3 mil, and internal debt is US$131.4 mil. Early 2012, ENEE repaid US$ 2.6 mil debt to

IDB. Outstanding external debt is borrowed from Paris Club for the use of specific projects. Internal debt consists of two parts, one is a loan from Honduran government, which was previously borrowed from IDB and was forgiven. Another one is a bond issued in 2011 with 5 years redemption period and 5.5% interest rate. Current arrangement of new loan is not clear, but ENEE consider project oriented loan, for example, loan from Chinese EXIM bank for Piedras Amarillas or Patuca 3 project.

Table 7.1-6 Long Term Debt

Creditor	Loan No.	Currency		Total	Repayment
External					
Crub de Paris					
Swiss Bank	CP V	USD	Principal	164,596	2027
			Interest	10,811	
Swiss Bank	CP VI	USD	Principal	2,159,962	2033
			Interest	1,478,588	
External Principal Total		USD		2,324,557	
Internal					
GOH IDB Account	2016/BL-HO	USD	Principal	7,193,527	2039
			Interest	3,880,708	
			Commission	112,144	
			Principal	8,565,000	2019
			Interest	154,294	
	1584/SF-HO	USD	Principal	15,612,257	2044
			Interest	2,819,538	
			Commission	15,866	
Central Bank	RBCP-2011	USD	Principal	100,000,000	2016
			Interest	24,750,000	
			Commission	4,083,333	
Internal Principal Total		USD		131,370,784	

7.1.2 Strategic Plan for Financial Recovery

ENEE developed Strategic Plan 2011-2014 (Plan Estratégico Empresa Nacional de Energia Eléctrica 2011-2014) in January 2012. It focuses on;

1) reducing losses
2) corrective maintenance of distribution network
3) implementation of prioritized investment plan including large-scale hydropower projects
4) improving administrative efficiency
5) encouragement of renewable energy development

Following measures are to be implemented during 2011 to 2014 period.

1. Implementation of the Loss Reduction Program
2. Preparation for smart meter system installation (SEMEH, meter reading, collection, cutting service)
3. Implementation of arrears reduction program
4. Purchasing emergency supplies and equipment for the distribution network.

5. Promoting the adoption by Congress of the Law of the crime of illegal use of electricity.
6. Implementation of the corrective maintenance of distribution networks in areas of high incidence of failure.
7. Designing a communication strategy.
8. Implementation of emergency investments in processing and transmission.
9. Promoting the adoption of a new tariff schedule with hourly rates that improve system load factor.
10. Starting construction of the headquarters of the ENEE.
11. Starting construction of the Piedras Amarillas (or Patuca 3) hydropower project.
12. Starting Jicatuyo hydropower and Los Llanitos hydropower projects.
13. Starting construction of the Aguan Energy Complex Project.
14. Introduction of power generation project with liquefied natural gas (LNG).

Medium term measures consist of;

1. Finalizing implementation of Energy Sector Efficiency Improvement Project (PROMEF) funded by the World Bank, one of its components provides for the creation of strategic business units for generation, transmission and distribution and accounting separation thereof.
2. Reinforcing the structure of the regional distribution network.
3. Installation of SCADA system for the city of San Pedro Sula
4. Introduction of procurement development programs, including distribution and transmission works through Built and Transfer (BT) contract.
5. Developing pre-investment projects of La Tarrosa, Valencia, El Tablón hydropower.

ENEE simulates financial impact of implementing Strategic Plan 2012-2014 and concluded that ENEE can achieve positive net profit from 2013. Simulation result is shown in Table 7.1-7.

Table 7.1-7 ENEE Strategic Plan Simulation Result

(in million Lps)

Result with Minimum Actions	2011	2012	2013	2014	2015
Net Profit	-2,408	-5,417	-3,351	-2,300	-678
Annual Cash Flow	-1,338	-1,338	-1,338	-1,338	-1,338
Cumulative Cash Flow	-1,338	-5,847	-7,923	-8,683	-7,862
Loss Percentage	27.75%	27.15%	26.55%	25.95%	25.35%
Total Investment	2,404	4,536	2,661	703	257
Result with All Actions	**2,011**	**2,012**	**2,013**	**2,014**	**2,015**
Net Profit	-2,408	-1,283	349	-381	1,536
Annual Cash Flow	-1,338	-54	2,279	1,163	1,959
Cumulative Cash Flow	-1,338	-1,393	886	2,049	4,008
Loss Percentage	27.75%	21.75%	15.75%	14.75%	13.75%
Total Investment	2,404	13,083	6,409	1,413	561

Source: Plan Estratégico Empresa Nacional de Energia Eléctrica 2011-2014

Assumption in the simulation is summarized in Table 7.1-8.

Table 7.1-8 Assumption of Strategic Plan

	Minimum Action	All Action
Loss	2011: 27.75% 2012 onward: 21.75%	2011: 27.75% 2012: 21.75% 2013:15.75% 2015: 12.17%
Recovery of arrears	None	1.344 mil. Lps in 3 years
Average tariff	2012 onward: 3.67Lps/kWh	Adjusting fuel adjustment factor
Investment	Low level to transmission and distribution network	Adequate level
Bunker price	US$103.79/BBL	US$103.79/BBL
Diesel price	US$125.28/BBL	US$125.28/BBL
Average purchase price	3.03Lps/kWh	3.03Lps/kWh

Source: Plan Estratégico Empresa Nacional de Energia Eléctrica 2011-2014

Although the Consultant does not review details of the simulation above, it is easily understood that the most contributable factor to financial recovery is loss reduction. ENEE will allocate US$ 235 mil. (including PROMOF funding of US$ 6 mil. from IDB-WB) from 2012 to 2014 for loss reduction.

ENEE's strategic plan proposes loss reduction program. The major activities to be implemented in the program and their costs are shown in Table 7.1-9.

The above program aims to reduce non-technical losses nationwide and its target is to reduce 6% of losses in the first two years and 1% from the third year. The target will be achieved by measures consisting of a measurement system which quantifies the amount of losses, a control system and some political measures.

The reduction of the loss rate of about 5% from 2006 to 2009 is the effect by the installation of remote reading meter, etc. From this, the following concrete measures among the plans shown in Table 7.1-9 can be expected the remarkable effect of loss reduction, since they are direct measures installed in distribution system.

- Implementation of remote reading to prevent fraudulent meter readings
- Use of anti-theft connection box and cable to prevent stealing connections
- Adoption of prepaid meter to prevent continuing non-payment

Table 7.1-9 Activities of LOSS REDUCTION PROJECT

(in Million US $)

No.	Description of actions	Content	Cost
1	Management system of measurement Data	Implementation of system administration and flexible data management through the system of information management and remote reading meter ,which is a management tool of anomalies of electrical parameters of the service, in order to efficiently solve the evolution of consumption control of large customers	4.0
2	Managerial Organization of Loss Control	Establishment of the management organization that addresses the issue across the board in all areas of distribution	3.0
3	Strengthening of Technical Staff	Reinforcement of the regional sub directorates in existing branch offices in order to carry out all technical activities including loss reduction	10.7
4	Legalization of illegally connected premises	To convert the customers who are not billed because of no metering into legal status by installing individual meters and macro meters	27.0
5	Operational plans for reducing losses	Performing loss reduction operation	6.7
6	Energy balances of transformers	Acquisition of AMR meters (remote meter reading) for measurement for energy balances of distribution transformers in particular areas of high consumption.	0.9
7	Re- implementation of anti-fraud network	Acquisition of network equipment which should be installed in the districts with high recidivism rate of energy theft in order to prevent fraud	3.0
8	Act of Energy Theft	Promoting the adoption by Congress of the law of illegal use of electricity	---
9	Iimplementation of Prepaid system	Installation of the pilot system of prepaid meter (with 5000 meters) in order to cancel supply for repeat customers in the illicit use of energy (power theft) and recidivism in arrears	1.0

7.2 ECONOMIC EVALUATION OF THE PROJECT

7.2.1 Review of ENEE's Economic Evaluation

ENEE evaluated economic advantage of the Rehabilitation/Expansion project of Canaveral and Río Lindo HPP. There are two approaches for economic evaluation. One is evaluating increased generation with the project assuming there would be increased downtime because of natural wear and tear without the project. The other is to evaluate value of peaking power. By implementing the project, the total output of these plants was assumed to be increased by 18MW (final figure is 20.8MW). This approach is based on the idea that the incremental output will be utilized during the peaking hours when the electricity purchasing price is higher than off-peak period.

Economic Evaluation by Increased Generation

ENEE assumed availability factor and plant factor for 3 cases, namely, no- investment (without-project), usual overhaul and rehabilitation/expansion (with-project) for 15 years then simulated future revenue. Operation and maintenance cost for each case were also considered.

Discount rate for calculating Net Present Value ("NPV") is 8%. Result of the simulation is as follows;

Table 7.2-1 ENEE's Economic Evaluation

Rio Lindo Economic Evaluation (ENEE)			
	No Investment	**Overhaul**	**Rehab/Expan**
Investment	0	69.0 MUS$	79.28 MUS$
Average AF	0.783	0.949	0.967
Average PF	0.637	0.757	0.764
Unit Revenue	0.04 $/kWh		
NPV	99.5 MUS$	-50.4 MUS$	42.9 MUS$
IRR	- (no investment)	-5.6%	15.50%
Cañaveral Economic Evaluation (ENEE)			
	No Investment	**Overhaul**	**Rehab/Expan**
Investment	0	36.6 MUS$	42.3 MUS$
Average AF	0.715	0.963	0.963
Average PF	0.531	0.755	0.755
Unit Revenue	0.04 $/kWh		
NPV	30.0 MUS$	-17.5 MUS$	-6.1MUS$
IRR	- (no investment)	0.0%	5.80%

Source: ENEE, Technical and Financial Profile, Sep 2011

In this analysis, ENEE considers availability factor reduction and plant factor reduction. "Average AF" in table 7.2-1 means average availability factor for 15 years and "Average PF" means average plant factor. ENEE assumes availability factor declines from 97% (2012) to 60% (2021 onward) at Cañaveral HPP and from 97% (2012) to 70% (2019 onward) at Río Lindo HPP. As for plant factor, Canaveral HPP is assumed to be 74% (2012) to 40% (2021) and Rio Lindo is 75% (2012) to 60% (2020). Supporting data for these assumption is difficult to find because hydropower plants are usually given periodical overhaul and/or rehabilitation in internationally recognized utility practice. Actual availability factor in recent 5 years is calculated from actual operation record (Figure 5.9-1 and Figure 5.9-2). Cañaveral has 98.8% availability in average and Río Lindo has 98.0%. As described in Chapter 5.3, however, some component of equipment has been in operation since the commissioning and spares are not available in the market. Considering the current situation, periodical maintenance and repair work will need more time duration and system downtime caused by failure may be increasing dramatically. ENEE's assumption for availability factor and plant factor deterioration is therefore regarded reasonable as a conservative scenario.

The result of cash flow analysis shows the best scenario in terms of the economics of investment is no-investment case. ENEE concluded, however, that the "no action" scenario is the worst case because it deteriorates effective use of natural resources for power generation.

In this analysis, there are some conservative assumptions;

1) Unit price for evaluating value of increased generation is estimated as 0.04 US$/kWh. This is a generation cost of ENEE's hydro. The substitute pricing (purchase price from private thermal power) is around 0.14 US$/kWh. The unit price of sales is 0.177

US$/kWh in 2011 (total operational revenue divided by generation).

2) Operation and maintenance cost is estimated relating to annual generation, 0.5% of annual generation (US$/kWh). This cause unreasonable result of future O&M cost because ENEE estimated larger amount of O&M cost in rehabilitation case than no-investment case in spite of installation of up-to-date facilities. Without rehabilitation, O&M cost should be heighted up exponentially.

3) Financing cost is assumed based on 8% interest with 15 years tenor.

The Consultant considers at least first 2 factors should be studied in addition to ENEE's evaluation as a reference information. Assuming the unit price for evaluation be 0.14 US$/kWh and O&M cost without rehabilitation be the same amount through 15 years (conservative assumption), the result is as follows.

Table 7.2-2 Project Economics Evaluation (Modified)

Rio Lindo Economic Evaluation (ENEE; Modified)			
	No Investment	Overhaul	Rehab/Expan
Investment	0	69.0 MUS$	79.28 MUS$
Average AF	0.783	0.949	0.967
Average PF	0.637	0.757	0.764
Unit Revenue	0.14 $/kWh		
NPV	376 MUS$	383 MUS$	503 MUS$
Cañaveral Economic Evaluation (ENEE; Modified)			
	No Investment	Overhaul	Rehab/Expan
Investment	0	36.6 MUS$	42.3 MUS$
Average AF	0.715	0.963	0.963
Average PF	0.531	0.755	0.755
Unit Revenue	0.04 $/kWh		
NPV	128 MUS$	142 MUS$	156 MUS$

Source: Consultant

Note that IRR value has no meanings since the return to the investment should be evaluated by future revenue created by only such investment.

Economic Evaluation by Increased Peaking Supply

ENEE also evaluated economic value for supplying peaking power to the grid since the additional capacity (20.8MW) will be utilized to supply electricity during peaking period. For considering environmental impact to Lake Yojoa, ENEE will operate additional output by increasing discharge amount from Lake Yojoa and in turn, ENEE decrease output during off-peak period so that the daily discharge amount for power generation would not be changed. Peaking hours are two (2) hours in the morning and another two hours in the evening, when residential customers put on lights.

During the peaking hours, ENEE needs to purchase high-cost electricity from fossil power generators with 0.28 US$/kWh compared with off-peak purchase price of 0.14 US$/kWh. Assuming 15% of the investment cost being utilized to output expansion by 18.4MW (note;

final figure of additional capacity is 20.8MW), and additional output being replaced to high-cost generation purchase, ENEE concluded that net present value is 44.9 MUS$ (under 8% discount rate). The Consultant considers that taking characteristics as a peaking facility into account is reasonable approach.

7.2.2 Economic Evaluation on National Benefit

Economic evaluation was analyzed in view of national benefit. Cost and benefit were compared by adapting discounted cash flow model. The evaluation is based on NPV, Benefit/Cost ratio (B/C) and Economic Internal Rate of Return (EIRR).

EIRR is defined by following formula.

$$\sum_{t=0}^{n} C_t /(1+r)^t - \sum_{t=0}^{n} B_t /(1+r)^t = 0$$

Where, Ct : Cost at time t
Bt : Benefit at time t
t : year
n : Project period (year)
r : Discount rate (= EIRR)

The investment criteria is
NPV > 0
EIRR > Expected return for this kind of investment; 10%
B/C > 1

As an alternative option to compensate the energy which will be added by the project, thermal power generation was selected because of the actual demand/supply balance of national grid.

Total project cost is assumed as US$ 144,365,071 and investment schedule follows the construction schedule as described in Table 7.2-3.

Table 7.2-3 Project Cost Distribution Schedule

(in US$)

	JICA Loan (with interest)	Co-finance, ENEE Loan	Total Project Cost
Total	**122,277,215**	**22,087,856**	**144,365,071**
2012	0	0	
2013	419,026	75,692	
2014	18,205,484	3,288,594	
2015	68,715,008	12,412,510	
2016	16,069,304	2,902,720	
2017	9,440,374	1,705,286	
2018	9,348,260	1,688,647	
2019	79,760	14,408	

Assumptions are as follows;

1) Project period is 40 years considering standard tenor of Japanese ODA loan (10 years grace period, 30 years repayment period)
2) Discount rate is 10%
3) Availability factor is assumed to be 98.0% in 2012 (current average value) and to be reduced 1% per year. In without-project case, availability factor is assumed to go down to 70% after 30 years of the last rehabilitation (1993) considering the fact that actual availability factor before the last rehabilitation recorded 70%. In with-project case, the availability factor is back to 98% after rehabilitation.
4) As an alternative case, fossil power compensate the deficit energy in without-project case. Projected fuel price for this alternative case was adopted referring ENEE's projection. This will be discussed separately.
5) Peak generation value is separately simulated. For this simulation, peak hour unit price and off-peak hour unit price are 0.28 US$/kWh and 0.14 US$/kWh, respectively (the same assumption in Chapter 7.2.1)
6) Since investment is made for rehabilitation and expansion project, benefit was calculated as a difference between "with-project" and " without-project".

Fuel Pricing Assumption

As discussed in Chapter 7.1.1, current supply of electricity relies largely on private fossil power plant that use imported fuel (bunker oil, coal and diesel), which cost reflect to ENEE's purchasing cost. The purchase price of ENEE from private fossil power generators is divided into two parts, one is fixed payment and the other is variable payment. Fixed payment is a payment for pre-determined availability and the payment amount is almost fixed per month regardless actual power dispatch. Variable payment is mostly relating fuel compensation. Figure 7.2-1 is a breakdown of actual payment to fossil IPPs (oil-fueled generators). Average unit payment price for variable payment is almost linked with oil price (Figure 7.2-2).

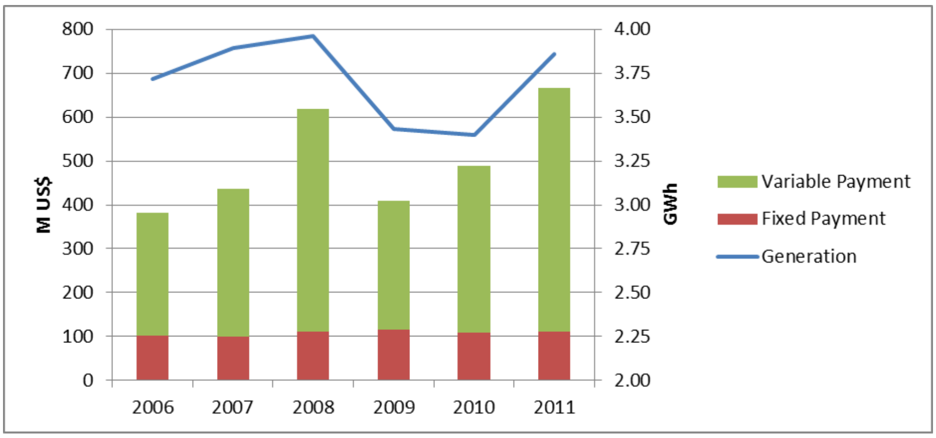


Figure 7.2-1 Payment for Fossil Power Generators

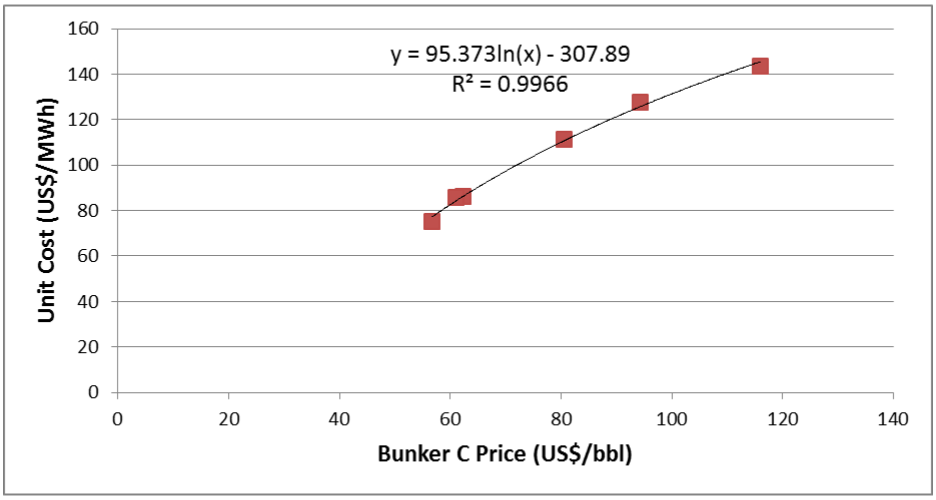


Figure 7.2-2 Correlation between Variable Payment and Oil Price

ENEE projects future demand and supply balance by dispatch simulation for each fossil power plant, hydropower plant and other renewable power plants. ENEE's simulation also include payment to each IPP considering future fuel price (See Figures 3.3-1 and 3.3-2). As a result of the simulation, however, the purchasing price from fossil power generators is highly fluctuating (detail is not clear). For the purpose of averaging the analysis, the future price of fossil power is assumed;

1) Fixed payment is based on installed output and follows ENEE's generation expansion plan. Fixed payment is assumed 125.3 M US$/MW (average actual payment from 2006 to 2011)
2) Bunker C oil price is assumed 105 US$/bbl
3) Overall escalation (to both fixed payment and variable payment) is assumed as 5% p.a.
4) ENEE's projection of annual generation plan (2012 to 2026) was adopted.

Chart below shows the result of the assumption. It shows also ENEE's projection.

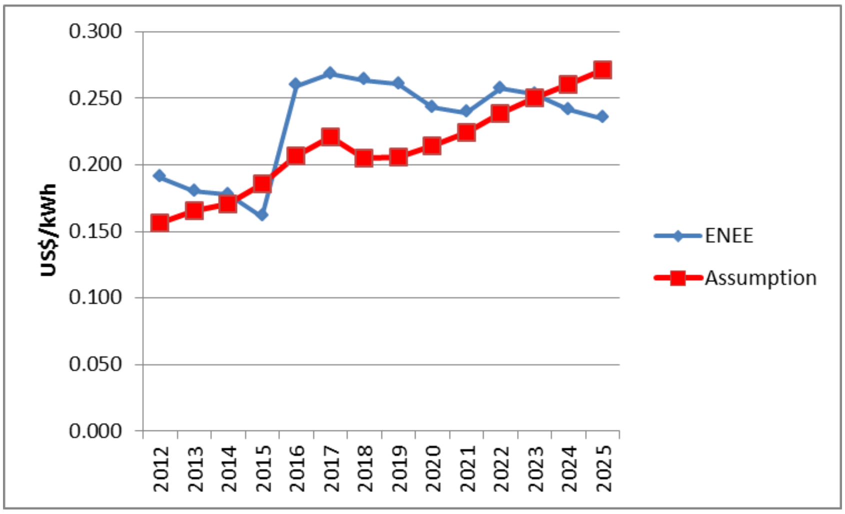


Figure 7.2-3 Assumption of Purchase Cost for Fossil Power

In the assumption, purchase price drops in 2018. This is because ENEE plan to decommission some fossil power plants (see Table 3.3-1, "retired power").

Simulation Result

Together with the base case simulation, some sensitivity studies were conducted. Those cases are:

1) Availability Deterioration for "without project" case: Average availability factor without the project is assumed as 76.3% as a base case. This case assumed availability factor loss is 50% of the base case .
2) Thermal Unit Price: Purchasing price from private thermal plants has a big impact for evaluating "lost" energy. This case assumes purchasing price as 70% of base case.
3) Discount rate: 8% and 12% was simulated.

The simulation result with sensitivity analysis are shown in Table 7.2-4.

Table 7.2-4 Economic Evaluation Sensitivity Study

		NPV (MUS$)		EIRR		B/C	
		Case A	Case B	Case A	Case B	Case A	Case B
Base Case		113	130	17.0%	18.1%	2.18	2.36
Availability Deterioration	Base x 1/2	2	19	10.2%	11.5%	1.02	1.20
Thermal Unit Price	Base x 0.7	50	68	13.5%	14.7%	1.53	1.71
Discount Rate	12%	62	75	17.0%	18.1%	1.70	1.85
	10% (Base)	113	130	17.0%	18.1%	2.18	2.36
	8%	192	215	17.0%	18.1%	2.86	3.08

Source: Team

Note: Case A considers only generation volume difference between without-project and with-project cases. Case B takes peak generation value into account.

Sensitivity analysis result shows that the assumption of availability deterioration is the most sensitive factor for economic value of the project. In all cases, this project clears investment criteria. The economic value of this project was validated.

7.2.3 Evaluation of ENEE's Repayment Capability

Although the Japan ODA Loan is generally contracted between governments, the implementing agency (in this case, ENEE) has a responsibility for repayment. In this chapter, ENEE's repayment capability is discussed and simulated.

As discussed in Chapter 7.1.1, ENEE's financial sustainability is fragile. It is heavily depending imported fuel, and strategic improvement is expected to i) loss reduction, ii) tariff increase (or pass-through mechanism) and iii) renewable energy development.

These strategic actions need additional investment and funding. For detailed evaluation on determining ENEE's future financials, these investment cash flows should be considered as well as commercial cash flow and financial cash flow in the simulation model. However, since those factors are difficult to predict with same level of accuracy and Japanese ODA Loan has generally 40 years life, which makes future prediction more difficult, the Consultant assumed as follows;

1) New investment should have its own economic benefit for ENEE. ENEE should arrange funding for each investment so as for ENEE to repay from its cash flow generated by such new investment without considering other income.
2) As such, the rehabilitation project of Cañaveral and Río Lindo should have enough positive cash flow to repay the loan. The cash flow generated by the investment should be an only source of repayment.

This study therefore defines that the repayment will be made from the cash flow generated by the project. Cash generation comes from increased generation (the difference between with-project and without-project). ENEE’s overall financial stability will be discussed in Chapter 7.2.4.
The analysis was made based on the same assumption of economic benefit analysis described in Chapter 7.2.2. The base case scenario in Chapter 7.2.2 is simulated.

Repayment capability is commonly judged by debt service coverage ratio (DSCR) which is an index calculated from amount of debt service reserve account (DSRA) divided by repayment due. Since there would be no DSRA, accumulated profit created by the project is considered as DSRA. Available profit is only amount of money that is created by the project, namely, sourced by the revenue from generation increase.

Some assumptions were made onto the assumption described in Chapter 7.2.2.

1) Japanese ODA Loan condition;
   Tenor : 30 years repayment schedule with 10 years grace period
   Interest Rate: 0.5%
2) Other Loan condition (Co-finance and ENEE)
   Tenor: 10 years
   Interest Rate: 5%
3) Unit revenue: 0.14 US$/kWh (average sales price from 2006 to 2011)

Result of the cash flow simulation shows that there will be enough cash generated from this project. Net profit turns to positive in 2019. When the repayment start in 2023 (assuming loan agreement is done in 2012 and 10 years grace period), accumulated profit is around 52 M US$ and increasing onward (repayment due is maximum 4.4 M US$). Simulation result is shown in Figures 7.2-4 and 7.2-5.

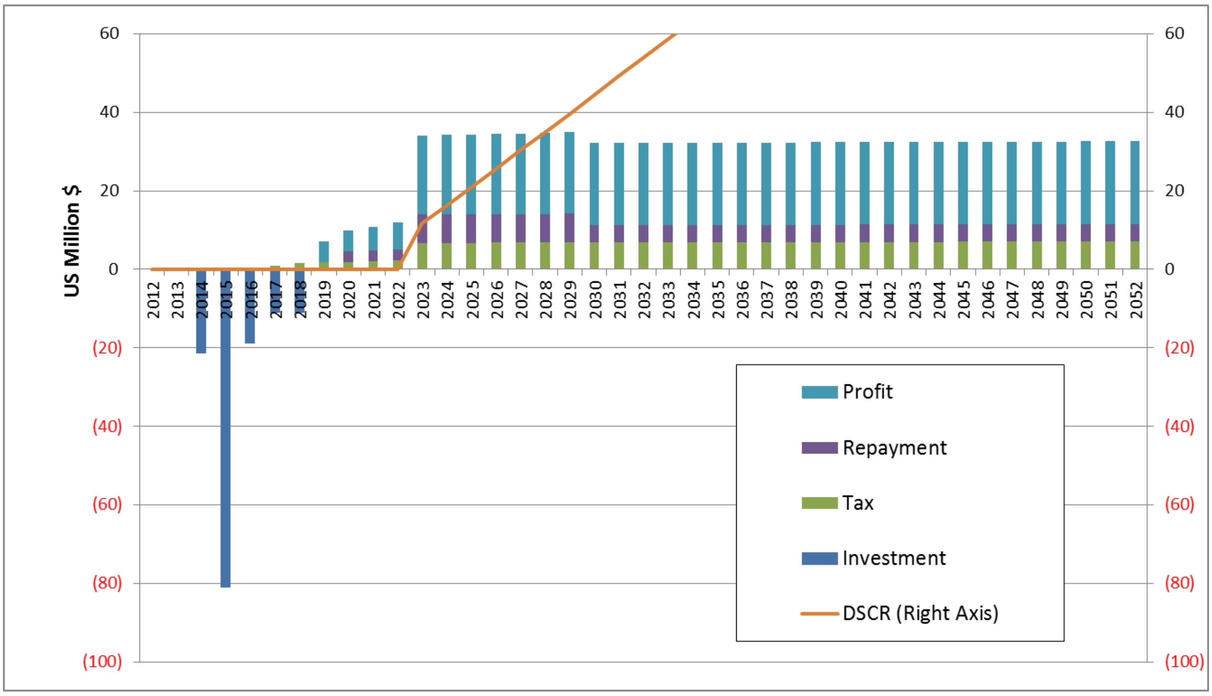
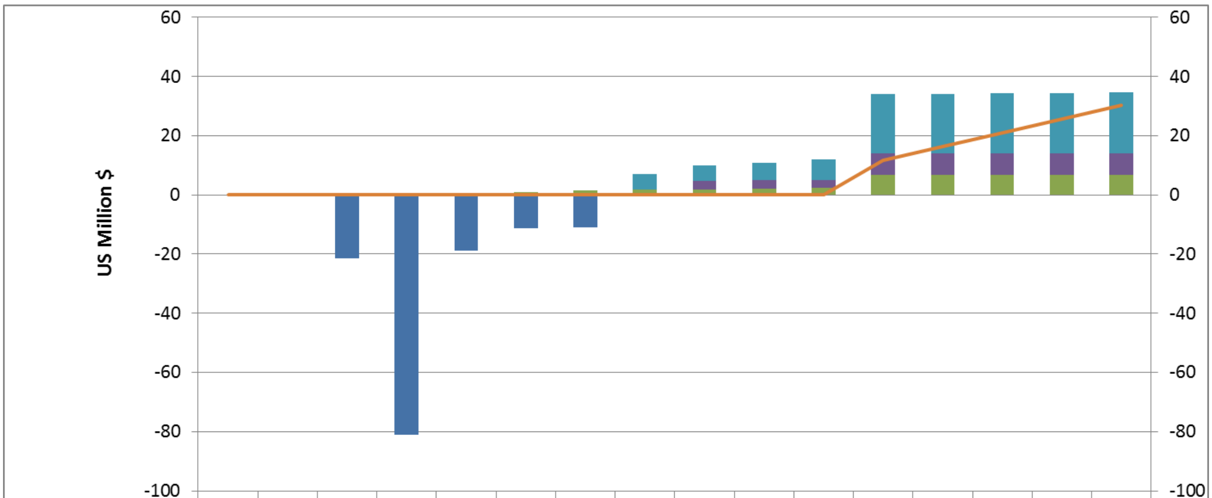


Figure 7.2-4 Cash Flow from 2012 to 2052



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Profit	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	5.2	6.1	6.9	20.1	20.2	20.3	20.4	20.5
Repayment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	2.9	2.9	7.3	7.3	7.3	7.3	7.3
Tax	0.0	0.0	0.0	0.0	0.3	0.9	1.5	1.8	1.7	2.0	2.3	6.7	6.7	6.8	6.8	6.8
Investment	0.0	-0.5	-21.5	-81.1	-19.0	-11.1	-11.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DSCR (Right Axis)												12	16	21	26	30

Figure 7.2-5 Cash Flow from 2012 to 2027

7.2.4 Evaluation of Impact Factors for ENEE's Financial Condition

ENEE's future cash flow has a lot of uncertainty. It depends on demand/supply projection, imported fuel price, PPA contracts (including future PPA), power development schedule, new capital project (including transmission, distribution system), new loans or bonds, tariff structure, hydrology and the loss rate. In this chapter, by using a preliminary cash flow model, the extent of financial impact caused by each factor is studied with following conditions and assumptions.

1) New capital investment, new loan (or bond) are not considered in the model, assuming capital projects may have its own funding resources.
2) Adopting demand/supply projection and supply cost (including energy purchase cost) of ENEE. According to ENEE, it includes fuel price projection.
3) In its demand/supply projection, ENEE has a short-term target of loss rate reduction. It is adopted as a base case, then sensitivity studies are done.
4) Average tariff (operational income divided by sales volume) is adopted.

Following factors are considered in sensitivity studies.

(1) Loss Rate

ENEE Strategic Plan 2010-2014 set the target loss rate. On the other hand, ENEE projected loss rate in its supply demand balance projection. In the simulation, loss rate projection in ENEE Strategic Plan was adopted as a base case. Loss rate in demand supply forecast is studied as a sensitivity study. For worst case scenario, no loss rate reduction case is studied. (24.82% is continuing) Figure 7.2-6 is a comparison of loss rate projection.

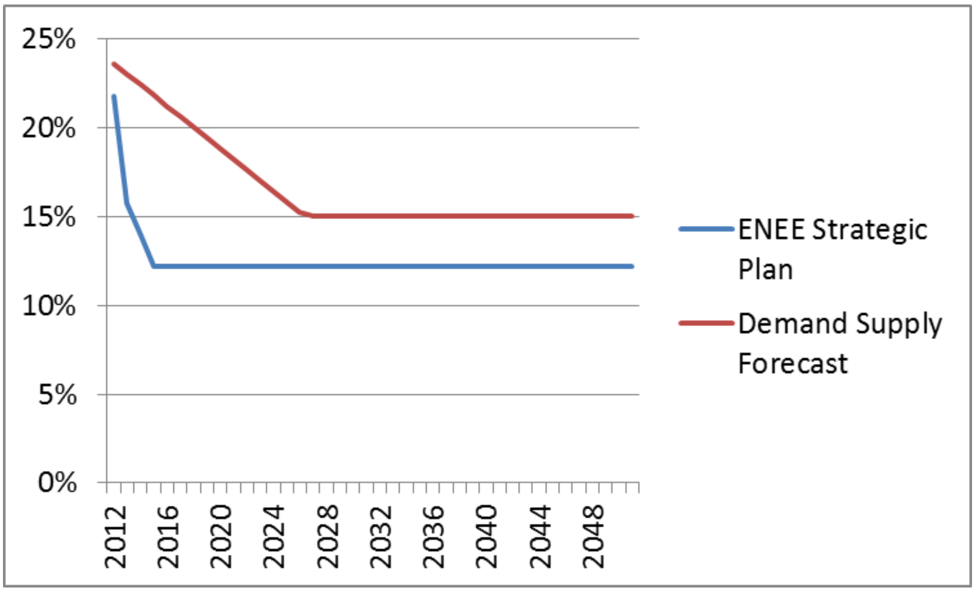


Figure 7.2-6 Projected Loss Rate (Base Case)

(2) Average Tariff Increase

Though the average tariff (operational revenue/sales) is fluctuating by fuel price, actual generation condition, hydrology and other things, actual record of average tariff show steady increase from 2007 to 2011.

Increase rate of 2.0% p.a. is adopted and 3.0%, 1.0% and 0% cases are studied as sensitivity.

Table 7.2-5 Average Tariff

		2007	2008	2009	2010	2011	Average
Sales	Gwh	4931.5	5179.7	5081.7	5112.8	5424.6	5146.1
Operational Income	M Lps	10,033	13,701	13,611	15,248	18,224	14,163
	M US$	528.1	721.1	716.4	802.5	959.1	745.4
Unit Sales Price	Lps/kWh	2.035	2.645	2.679	2.982	3.359	2.740
	US$/kWh	0.107	0.139	0.141	0.157	0.177	0.144
Increase Rate			30.0%	1.3%	11.3%	12.6%	13.8%

Source: Financial Statement, Website Data

(3) Renewable Ratio

Renewable ratio was adopted in power development plan, 66.9% in 2026. Thereafter, 80% is set in 2038 as it is a target rate in Country Vision 2010 to 2038.

As a sensitivity analysis, 75% of ENEE's target development and 67% case are studied.

Table 7.2-6 Generation Projection

(in GWh)

	2012	2013	2014	2015	2016	2017	2018
ENEE Hydro	1,857.9	2,137.0	2,250.0	2,337.2	3,524.9	4,051.7	3,463.8
ENEE Thermal	148.0	122.4	124.2	42.9	0.0	0.0	0.0
Private Hydro	391.6	470.6	1,008.6	1,428.0	2,138.9	2,373.5	3,184.5
Private Renewable	500.0	636.0	695.0	1,034.0	959.5	950.8	988.1
Private Thermal	5,171.6	5,119.5	4,823.5	4,556.1	3,271.5	2,996.4	3,232.8
TOTAL	8,069.1	8,485.6	8,901.4	9,398.2	9,894.9	10,372.4	10,869.2
Renewable Ratio	34.1%	38.2%	44.4%	51.1%	66.9%	71.1%	70.3%
(Margin vs Demand)	6.0%	6.2%	6.1%	6.7%	6.9%	6.8%	6.7%
	2020	2021	2022	2023	2024	2025	2026
ENEE Hydro	3682.2	3792.8	5216.6	5685.8	5713.6	5820.4	6057.1
ENEE Thermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Private Hydro	3114.2	3283.2	3265.6	3271.7	3294.8	3299.4	3320.8
Private Renewable	1063.8	1086.3	1024.2	1040.1	1070.6	1042.3	1040.2
Private Thermal	4077.5	4343.4	3587.9	3706.0	4253.0	4823.6	5159.5
TOTAL	11937.6	12505.7	13094.4	13703.5	14332.0	14985.7	15577.5
Renewable Ratio	65.8%	65.3%	72.6%	73.0%	70.3%	67.8%	66.9%
(Margin vs Demand)	6.1%	5.9%	5.8%	5.7%	5.6%	5.6%	5.8%

Source: ENEE Plantification Department "Projection Purchasing and Generation for ENEE March 2010"

Those assumptions and study cases are summarized in Table 7.2-7 below.

Table 7.2-7 Study Case

	Loss Rate	Average Tariff Increase	Renewable Ratio
Base	Strategic Plan	2.00%	ENEE Plan
Case Loss Rate1	Demand/Supply	2.00%	ENEE Plan
Case Loss Rate2	No improvement	2.00%	ENEE Plan
Case Average Tariff 1	Strategic Plan	3.00%	ENEE Plan
Case Average Tariff 2	Strategic Plan	1.00%	ENEE Plan
Case Average Tariff 3	Strategic Plan	0.00%	ENEE Plan
Case Renewable Ratio1	Strategic Plan	2.00%	3/4 of ENEE Plan
Case Renuwable Ratio2	Strategic Plan	2.00%	2/3 of ENEE Plan

(4) Study Result

The study results for each case are compared by earnings before interest, tax, depreciation and amortization (EBITDA). Table 7.2-8 and Figures 7.2-6 to 7.2-9 show the study result of EBITDA. Since ENEE's projection is done up to 2026, later assumption are not reliable.

Table 7.2-8 EBITDA

(in US M$)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Base	-161	-84	-33	-9	129	191	220	249	236	243	414	460	432	398	593
LR1	-186	-180	-148	-149	-6	60	94	125	111	120	300	351	327	299	512
LR2	-186	-188	-167	-179	-47	6	28	42	7	-6	155	180	123	56	254
AT1	-161	-72	-9	30	185	268	319	375	392	433	643	732	753	773	1027
AT2	-161	-95	-56	-47	74	118	125	131	90	67	205	213	144	64	212
AT3	-161	-106	-80	-85	21	47	35	19	-46	-95	13	-10	-114	-232	-123
RR1	-201	-131	-91	-89	-6	17	64	89	59	41	155	162	108	46	308
RR2	-215	-147	-110	-116	-51	-41	12	35	1	-26	68	63	1	-72	214

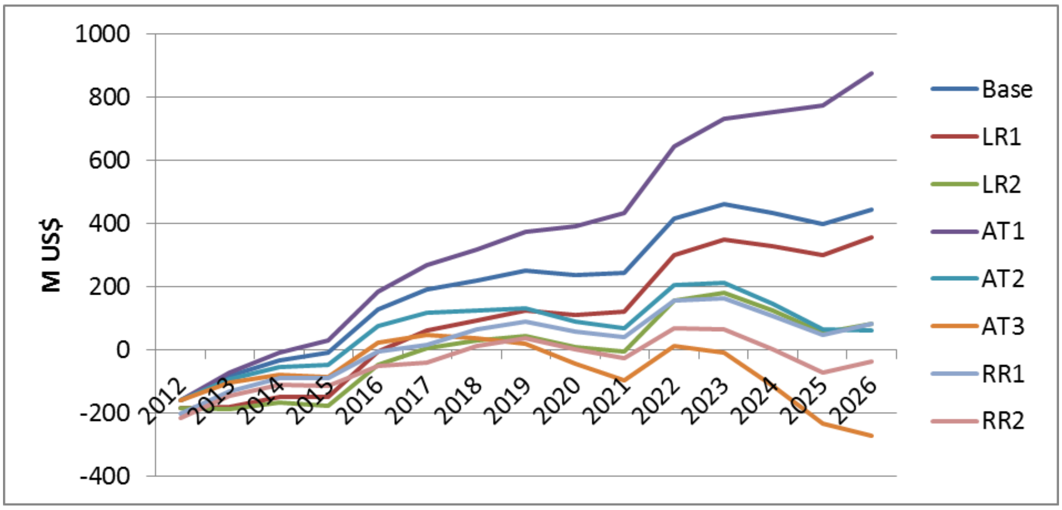


Figure 7.2-7 Study Result, EBITDA (all cases)

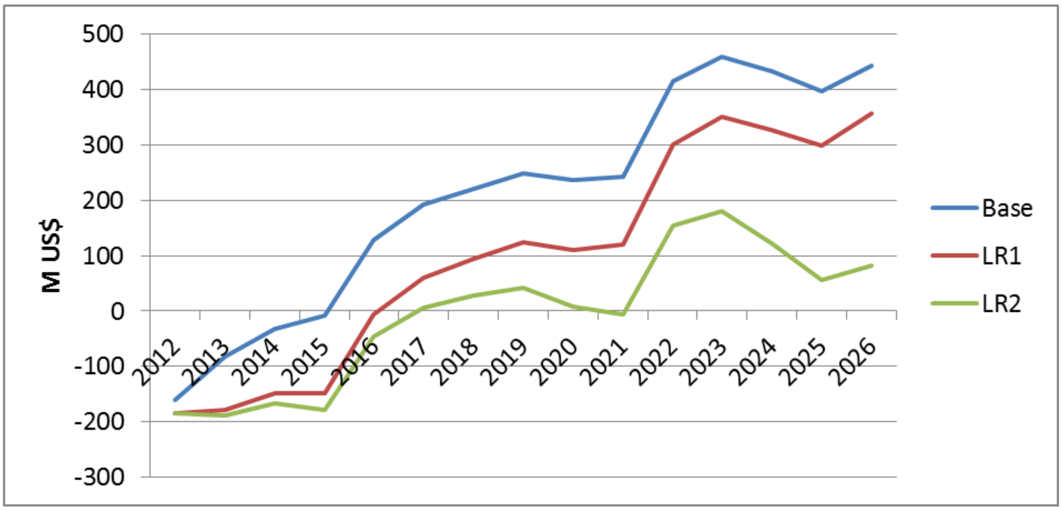


Figure 7.2-8 Study Result, EBITDA (Loss Reduction Impact)

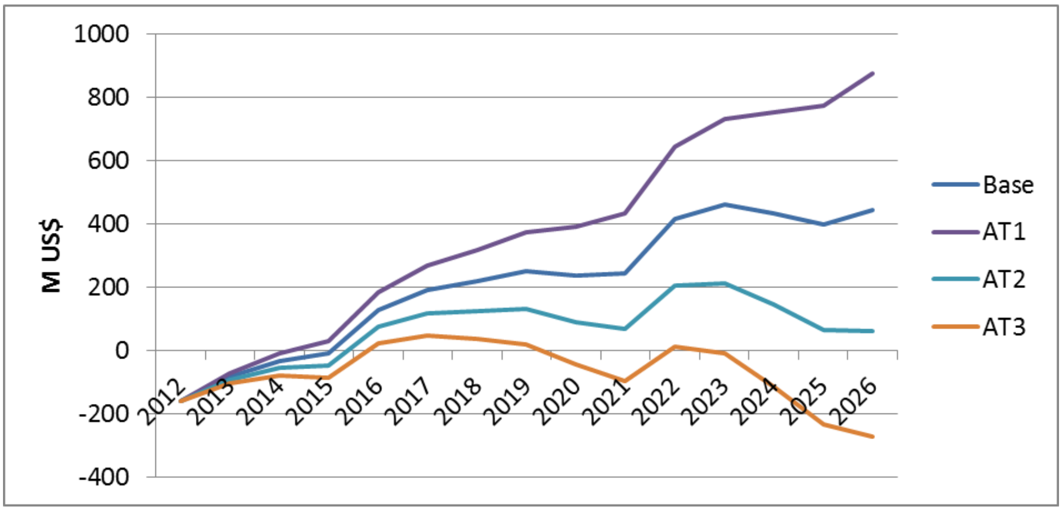


Figure 7.2-9 Study Result, EBITDA (Average Tariff Impact)

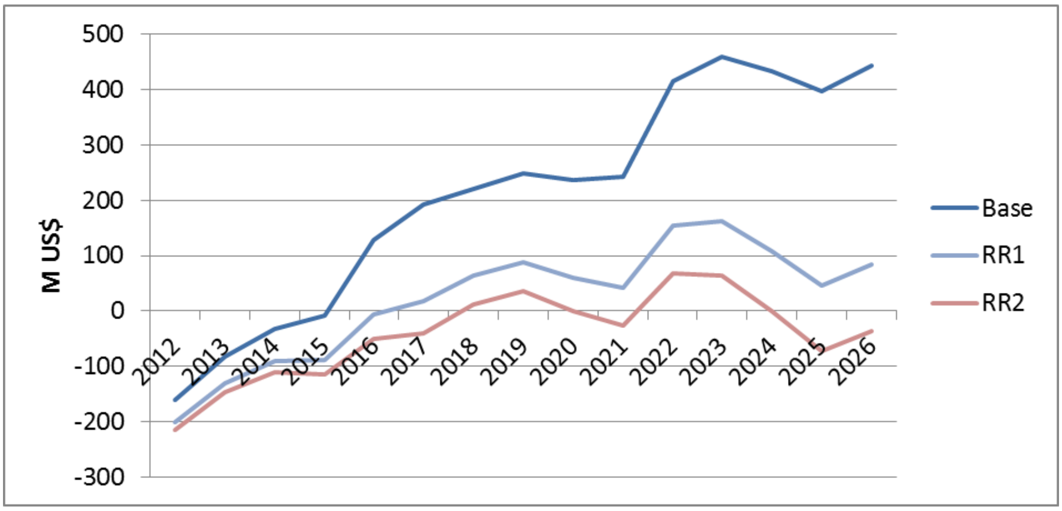


Figure 7.2-10 Study Result, EBITDA (Renewable Ratio Impact)

Though the model and assumptions is preliminary, it can be observed that;

- ✓ Base Case shows the EBITDA turns into positive in 2015 and remain increasing thereafter.
- ✓ Without the loss rate reduction, EBITDA remains almost negative until 2021.
- ✓ Tariff should be increased at least 2% annually (base case). Without increasing tariff, EBITDA remains negative during this period.
- ✓ Renewable development has a big impact on ENEE's financial condition. If ENEE can develop only 67 % of the target development plan, EBITDA remains almost negative during this period. The improvement on 2022 (in all cases) is because La Tarrosa (Patuka 2A; 150MW) and Velencia (Patuca 2; 270MW) are planned to start generation on that year. Both are considered ENEE's hydropower.

It is highly recommended that ENEE will materialize its own strategy (loss reduction, renewable development). In addition, imbalance tariff should be resolved.

7.2.5 Evaluation of GHG Reduction

The Project enhances hydropower generation compared with without-project case and thus reduction effect of greenhouse gas (GHG) is expected .

Since the Project is replacement of existing facilities, the effect of the amount of power generation is calculated as the difference between with-project and without-project cases. Therefore, the same value as being applied in the economic evaluation (Chapter 7.2.2) is used for the electric generation energy corresponding to CO_2 reduction. Table 7.2-9 shows annual average of generation from 2012 to 2051 (40 years).

Table 7.2-9 Annual Average Generation

(in GWh)

	With-Project	Without-Project	Difference
Cañaveral	187.70	146.41	41.29
Río Lindo	517.00	403.89	113.11
Total	704.70	550.30	154.40

The emission factor for the electric system of Honduras is shown in Table 7.2-10 in recent year.

Table 7.2-10 CO_2 Emissions per kWh from Electricity and Heat Generation

(grammes CO_2 / kilowatt hour)

Description	2007	2008	2009	average of 3 years
Average of all fuels	418	409	344	391
From oil	670	661	627	653

(Source: CO_2 EMISSIONS FROM FUEL COMBUSTION-Highlight, 2011 Edition, IEA)

In the upper line of the table, the CO_2 emissions include emissions from fossil fuels, industrial waste and non-renewable municipal waste that are consumed for electricity and heat generation in transformation and output includes electricity and heat generated from fossil fuels, nuclear, hydro (excluding pumped storage), geothermal, solar, bio-fuels, etc. As a result, the emissions per kWh can vary from year to year depending on the generation mix. In the lower line of the table, the same one is from oils including oil products.

Since the above-mentioned electric energy is considered that the alternative generation without project should be power generation by fossil fuel, the emission factor for the evaluation in CO_2 reduction is applied the value used oil. It is 653 (grammes CO_2/kWh) which is average of from 2007 to 2009 in Table 7.2-9.

From the above condition, the amount of CO_2 reduction is calculated by multiplying the emission factor 653g/kWh and the electric energy 154,400,000 kWh corresponding to alternative energy from oils. 100,800 CO_2-t per year will be reduced during the evaluation period.