

Republic of Guatemala

FY2015 Ex-Post Evaluation of Japanese Grant Aid Project

“Project for the Promotion of Productive Activities with the Use of Clean Energy in the Northern Villages of the Republic of Guatemala”

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**0. Summary**

The Project for the Promotion of Productive Activities with Use of Clean Energy in the Northern Villages of the Republic of Guatemala (hereinafter referred to as “the Project”) was implemented with the aim of improving the access of local residents to electricity by constructing micro hydroelectric power plants and distribution facilities in three sites located in the poorest area of Alta Verapaz Department in Guatemala where electrification by extension of the electricity grid was difficult, as well as by providing technical assistance for the operation and maintenance of these facilities and to promote productive activities using electricity, thereby contributing to the promotion of productive activities and the improvement of livelihood.

The Project has been relevant to Guatemala’s development policies of proceeding with electrification by independent systems utilizing renewable energies in areas to which extension of the electricity grid is difficult; to Guatemala’s development needs in terms of a strongly required electrification in Alta Verapaz Department because the electrification rate of this department has been the lowest in the country; and to Japan’s ODA policy of assisting developing countries to promote reduction of CO<sub>2</sub> emissions and other measures to combat climate change. Therefore, the relevance of the Project is high.

Although the project cost was exactly as planned, the project period exceeded the plan. Therefore, the efficiency of the Project is fair.

Both power generation and power consumption have been steadily increasing. The targets in terms of number of electrified households and electrified persons have been achieved and the target in terms of household electrification rate has largely been achieved. Although the peak load has not reached the target, it is expected to increase in the coming years due to the increasing demand for electricity. The intended impacts have been realized in regard to improvement of the educational and healthcare environments and improvement of living conditions. In addition, the Project has contributed to improve the quality of living through electrification and to the empowerment of women through productive activities using electricity. Therefore, the effectiveness and impact of the Project are high.

The conditions of both the power generation and distribution facilities are generally good although some require repair or the replenishment of spare parts. The Development Associations are in charge of the electric enterprise as well as the operation and maintenance of the facilities in their

respective villages. One of them has no problems at all, another one has some problems with the financial aspects and remaining one has some problems with the institutional, technical and financial aspects of operation and maintenance. It is necessary for the Ministry of Energy and Mines which is the implementing agency, to provide active assistance for the Development Associations of these three villages. Therefore, the sustainability of the Project is fair.

In light of the above, this Project is evaluated to be satisfactory.

## 1. Project Description



Project Location



Power Generation Facility (Seasir)

The penstock entering the facility can be seen in the front

### 1.1 Background

Since 2004, the Government of Guatemala has been promoting sustainable development, including the creation of employment through the use of renewable energies and poverty reduction. The national electrification rate in 2008 when the Project was planned was 83%. In contrast, the electrification of poor areas in the Northern Region has been extremely slow due to the difficulty of extending the power grid to those mountainous areas dotted with small villages. The electrification rate of Alta Verapaz Department where the three sites of the Project are located was 41% which was the lowest in the country. Even though the National Institute for Energy Development (*Instituto Nacional de Desarrollo Energético*; hereinafter referred to as “INDE”) who is in charge of electrification in rural areas was proceeding with the rural electrification through the construction of distribution lines, it was expected that electrification through the extension of distribution lines could only cover up to 90% of the national land area of Guatemala, making independent electricity supply systems essential for the electrification of the remaining 10%. In Alta Verapaz Department, since 2004, other donors<sup>1</sup> had been implementing various projects for the selection of priority sites for

<sup>1</sup> In 2004, the United States Agency for International Development (USAID) conducted the “*Social Study on 74 Villages in Poverty Areas of the Northern Region*”. The number of target villages was reduced from 74 to 50 villages in 2005 by the “*Renewable Energy Programme under the Global Village Energy Partnership for Guatemala*” of the United National Development Programme (UNDP). This was followed by the formulation of the “*Productive Uses of Renewable Energy (PURE)*” in 2007. In 2008, the “*Energy Project for Poverty Reduction in Rural Areas of Guatemala*” of the Inter-American Development Bank (IDB)” selected 10 target villages for electrification from among these 50 villages and the Feasibility Study for three priority sites (Las

rural electrification and suitable projects through the Solar Foundation<sup>2</sup>, a local NGO. The plan of the Project was based on the findings of the “*Feasibility Study on Micro-Hydropower Plants in Las Conchas, Seasir and Jolom Ijix sites in Alta Verapaz Department*” which was conducted by the Inter-American Development Bank (hereinafter referred to as “IDB”) in 2008 at the three target sites of the Project. Even though electrification using renewable energies as solar, wind power and hydropower was thought to be effective to facilitate rural electrification, especially electrification using independent systems, the high cost of these alternatives posed a major financial challenge for the government. The Project was implemented as a response by the Government of Japan to a request for a grant aid made by the Government of Guatemala for the construction of micro hydroelectric power plants and distribution network in three unelectrified villages located in the poor areas of the Northern Region and to provide assistance for productive activities using electricity, thereby contributing to the livelihood improvement of local residents.

## 1.2 Project Outline

The objective of this Project is to improve the access of local residents to electricity in three sites (Las Conchas in the city of Chahal, Seasir in the city of Cahabón and Jolom Ijix in the city of Panzós) located in the poorest area of Alta Verapaz Department in Guatemala, where electrification through connection to the electricity grid was difficult by constructing micro hydroelectric power plants and distribution facilities, as well as by providing technical assistance for the operation and maintenance of these facilities and the promotion of productive activities using electricity, thereby contributing to the promotion of productive activities and improvement of the livelihood in the target villages.

E/N Grant Limit or G/A Grant Amount/Actual Grant Amount		1,003 million yen/1,003 million yen
Exchange of Notes Date		January, 2010
Grant Agreement Date		January, 2010
Implementing Agency		Ministry of Energy and Mines (Ministerio de Energía y Minas, MEM)
Project Completion Date		March, 2014 <sup>3</sup>
Project Implementation	Main Contractors	Calsa S.A. & Silva Equipos de Construcción S.A Joint Venture

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Conchas, Seasir and Jolom Ijix) which are the target villages of the Project was carried out in the same year.

<sup>2</sup> The Solar Foundation is a local NGO in Guatemala which is implementing renewable energy and environmental conservation projects in the country. It is active nationwide with the assistance of such international organizations as the UNDP, the Organization of American States, and private enterprises, etc.

<sup>3</sup> The Project completion date is considered to be March 2014, when the technical assistance was completed. The starting of operations of the power generation and distribution facilities was July 2012.

System <sup>4</sup>	Main Consultant <sup>5</sup>	NEWJEC Inc. (*Including technical assistance)
	Procurement Agent	Japan International Cooperation System
Basic Design		November, 2009
Detailed Design		August, 2010
Related Projects		[Other Organizations] USAID: “Social Study on 74 Villages in Poverty Areas of the Northern Region” (2004) UNDP: “Productive Uses of Renewable Energy (PURE) in Guatemala” (2007) IDB: “Feasibility Study on the Micro-Hydropower Plants in Las Conchas, Seasir and Jolom Ijix Sites in Alta Verapaz Department” (2008)

## 2. Outline of the Evaluation Study

### 2.1 External Evaluator

Hiroimi Suzuki S, Global Group 21 Japan Inc.<sup>6</sup>

### 2.2 Duration of Evaluation Study

The ex-post evaluation study for the Project was conducted over the following period.

Duration of the Study: October 2015 to February 2017

Duration of the Field Study: February 28 to March 19, 2016 and June 20 to 27, 2016

## 3. Results of Evaluation (Overall Rating: B<sup>7</sup>)

### 3.1 Relevance (Rating: ③<sup>8</sup>)

#### 3.1.1 Relevance to the Development Plan of Guatemala

The “*National Development Plan 2007-2013*” of Guatemala at the time of the planning of the Project (2009) emphasized the promotion of social development based on the needs of indigenous people as well as the poor with the aim of achieving a nation building through dialogue. The basic policies of the Plan included reduction of poverty and economic gap, and improvement of social infrastructure. The Ministry of Energy and Mines (hereinafter referred to as “MEM”) who was the implementing agency of the Project, prepared the “*Energy Policy 2008-2015*” based on this Plan, adopting such targets as enhanced production, employment creation and poverty reduction in local

<sup>4</sup> The Project was implemented under the procurement agent system of JICA’s Program Grant Aid for Environment and Climate Change. Under this system, a non-profit corporation with professional knowledge and know-how of international procurement who can act as a neutral third party plays the role of the “procurement agent” for the government of the recipient country based on a contract with the said government to manage and supervise a series of procurement processes concerning the selection and procurement of equipment and services along with fund management. The main contractor is a local corporation.

<sup>5</sup> The local consultants (*Alvarado & Monzón Ingeniería Civil, S.A.* (hereinafter referred to as AIMS) and Solar Foundation) worked under a contract with the Japanese main consultant.

<sup>6</sup> Suzuki is affiliated to IC Net Limited. In this ex-post evaluation she participated as a reinforcement of Global Group 21 Inc.

<sup>7</sup> A: Highly satisfactory; B: Satisfactory; C: Partially satisfactory; D: Unsatisfactory.

<sup>8</sup> ①: Low; ②: Fair; ③: High.

areas through the use of energy. The concrete activities envisaged included electrification with renewable energy. For mountainous areas where the extension of distribution lines was difficult, the Global Village Energy Partnership Board<sup>9</sup> of the UNDP and the World Bank took the initiative in the planning of independent electrification using renewable energies, including micro hydroelectric power generation. In addition, in 1998, the “*Rural Electrification Program*” was prepared as a program devoted to rural electrification. The target of this plan was to achieve a national electrification rate of 90% by 2005 through the realization of electrification for 1.5 million new beneficiaries with the INDE heading the electrification drive in those rural areas where investment by a private enterprise was difficult. Therefore, the relevance of the Project to the development plans and policies of Guatemala is high.

The relevant development plan of Guatemala at the time of ex-post evaluation is the “*National Development Plan 2014-2032*”. The relevance of the Project to this plan is high as the plan calls for (i) the reduction of economic gap and rectification of poverty and extreme poverty, (ii) comprehensive rural development (promotion of improvement of the necessary infrastructure for productive activities in rural areas) and (iii) sustainable economic development (response to climate change and promotion of renewable energies, including micro hydroelectric power, wind power and biomass). The “*Energy Policy 2013-2027*” as the strategy for the energy sector adopts sustainable development as its objective and lists five pillars of development, ranging from energy saving and the effective use of energy to reduction of wood as fuel to improve the national electrification rate from 85.6% to 95%.<sup>10</sup> Moreover, the “*Rural Electrification Program 2012-2016*” calls for the electrification of 28,000 households to improve the living conditions of poor households in rural areas. The actual measures envisaged is facilitation of the connection of rural areas to the existing electric power system, and proceeding with the development of independent power supply systems utilizing micro hydroelectric power generation and other renewable energy sources.

As described above, the Project was consistent with such targets as sustainable development, elimination of poverty and diversification of energy sources through the use of renewable energy called for by the National Development Plan, Energy Policy and Rural Electrification Program at the time of both ex-ante evaluation and ex-post evaluation. Therefore, the relevance of the Project to the development policies is high.

### **3.1.2 Relevance to the Development Needs of Guatemala<sup>11</sup>**

While the national electrification rate of Guatemala in 2008 was 83%, the electrification of mountainous areas with scattered villages as well as poor areas in the Northern Region which were

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<sup>9</sup> The Global Village Energy Partnership is a 10 year program established in 2002 by the UNDP and the World Bank. It was composed of 70 member countries; and it aimed to promote the provision of modern energy services to those areas with low access to energy services.

<sup>10</sup> Based on MEM’s “*Energy Policy 2013-2027*”.

<sup>11</sup> The sources are reference materials provided by JICA for the relevance at the time of project planning, and MEM’s 2015 Annual Report for the relevance at the time of ex-post evaluation.

difficult to reach by the extension of the power grid lagged behind. The electrification rate of Alta Verapaz Department, the target area of the Project inhabited by many indigenous people, was the lowest among all departments at 41%. Similarly, the poverty ratio of Alta Verapaz Department in 2008 was very high at 80% compared to the national poverty ratio<sup>12</sup> of 51%. In these poor areas of the Northern Region, the introduction of independent electricity sources using such renewable energies as solar power, wind power and hydroelectric power was necessary to facilitate electrification. Because of shortage of funds, however, the prospect was that approximately 10% of households in these areas would remain unelectrified even after the implementation of the “*Rural Electrification Program*”. Therefore, there was a strong need for the Project.

At the moment of the ex-post evaluation, it was found the national electrification rate had improved to 90% in 2014. The electrification rate in Alta Verapaz Department had slightly improved to 44% however it remains as the region with the lowest electrification rate in the country due to the geographical conditions of this department which make electrification through extension of the power grid difficult.

As can be seen, the electrification rate of Alta Verapaz Department was the lowest in the country at the time of both ex-ante and ex-post evaluation. Moreover, because of the geographical conditions, etc., there is a strong local need for electrification through independent systems using renewable energy. Therefore, the relevance of the Project to Guatemala’s development needs is high.

### **3.1.3 Relevance to Japan’s ODA Policy<sup>13</sup>**

At the time of planning, the priority areas for Japan’s ODA for Guatemala were rural development, sustainable economic development and establishment of democracy with the objective of alleviating the gap between indigenous and non-indigenous people and between urban and rural areas. The Project has been particularly relevant to rural development and sustainable economic development while also contributing to decrease the gap between indigenous and non-indigenous people.

In addition, since 2008, as part of its overall efforts to combat climate change, Japan has been providing assistance to developing countries engaged in the reduction of emissions and other measures to combat climate change, as well as to those developing countries which are vulnerable to the adverse impacts of climate change. In fact, in 2008, Japan announced the establishment of the Program Grant Aid for Environment and Climate Change as a form of Grant Aid, in order to support

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<sup>12</sup> Ratio of population with equivalent disposable income below the poverty line (6,574 quetzal, approximately 78,000 yen at the time of planning, and 10,218, quetzal, approximately 165,000 yen, at the time of ex-post evaluation) determined as the annual cost of basic food consumption (Guatemala National Statistics Institute). Exchange rates at the moment of planning was 1 quetzal=11.89 yen (according to Preliminary Study Report, June 2009), and 1 quetzal=16.110 yen at the moment of the ex-post evaluation (according to JICA exchange rates as of December 2015, JICA website).

<sup>13</sup> Based on the results of the ODA Policy Consultation Meeting held in June, 2008 between the ODA Task Force for Guatemala of the Ministry of Foreign Affairs, Japan and the Government of Guatemala (Source: ODA Data Book for Guatemala, 2009).

these efforts. This Project was implemented under this new scheme, from where it is possible to see that the Project which aimed at promoting the use of renewable energy was in conformity with Japan's ODA policies.

This project has been highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore its relevance is high.

### **3.2 Efficiency (Rating: ②)**

#### **3.2.1 Project Outputs**

The outputs of the Project were the development of micro hydroelectric power plants and distribution facilities; technical assistance for the operation and maintenance of these facilities, and also for the promotion of productive activities using electricity.

##### Micro hydroelectric power plants and distribution facilities

Table 1 shows the planned and actual output of the micro hydroelectric power plants and distribution facilities.

The current generating capacity (power output) is as planned at each site even though some changes took place, including a change in the location of the power generation facilities at Las Conchas site and minor changes of the headrace, penstock and length of the distribution line at each site (Table 1). All the changes were relevant from the technical point of view and were finalized through due procedure based on the E/N and G/A.

As for the change in location of the power generation facilities at Las Conchas site, because part of the originally planned facilities was located inside a national park, the location of these facilities was moved approximately 50m upstream in order to minimize noise and any adverse impacts on the scenery of the national park.

##### Technical assistance

As part of the Project, four technical assistance activities shown in Table 2 were implemented as planned for the purpose of establishing a proper operation and maintenance system for the power plants, distribution facilities and electricity business; securing the financial as well as technical capacity to manage these facilities, and creating organizations to conduct productive activities using electricity to improve livelihood.<sup>14</sup>

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<sup>14</sup> For the technical assistance, the Solar Foundation, a local NGO which had been working continuously since 2004 in the Project sites, acted as the local consultant (see "1.1 Background").

Table 1 Micro Hydroelectric Power Plants and Distribution Facilities (Plan and Actual)

	Las Conchas	Seasir	Jolom Ijix
Water intake weir	NA	No1: Height 1.3m, Length 5.5m No 2: Height 0.4m, Length 2.4m No. 3: Height 0.4m, Length 1.2m	Height 1.05m, Length 13.8m
Intake	Width 2.0m, Height 1.4m	NA	NA
Headrace	Box culvert Length 684m, Width 2m, Height 1.4m (Length after change 906m)	No 1: PVC pipe Length 626m, Inner diameter 30cm (Length after change 590m) No 2: PVC pipe Length 498m, Inner diameter 30cm No 3: PVC pipe Length 765m, Inner diameter 30cm	PVC pipe Length 761m Inner diameter 46cm
Open Channel	Length 534m Width 2m Height 1.4m	NA	NA
Head tank	Width 2.56m Height 2.7m Length 13.6m	Width 2.5m Height 1.4m Length 5.8m	Width 5.0m Height 3.0m Length 20.0m
Penstock	Steel pipe: Diameter 1,350mm Length 6.8m (Length after change 3.3m)	PCV pipe: Diameter 200mm Length 1,120m Steel pipe: Diameter 200mm Length 151m (Length after change 269m)	PCV pipe: Diameter 250mm Length 148m (Length after change 184.5m) Steel pipe: Diameter 250mm Length 158m (Length after change 80.7m)
Power house	Total floor space: 58.7m <sup>2</sup>	Total floor space: 30m <sup>2</sup>	Total floor space: 36m <sup>2</sup>
Water Turbine Generator	Propeller turbine (Kaplan turbine) 1 unit	Pelton turbine 1 unit	Pelton turbine 1 unit
Power Output	94kW	59kW	98kW
Tailrace	Length 15.5m Basin: Width 3.0m, Length 4.0m Height 3.15m	Length 7.2m	Length 8.8m
Power distribution installations	High-voltage electric wire system 13.8/7.97kV Length 21.0km Low-voltage electric wire system 240/120V Length 13.40km (Length after change 10.45km)	High-voltage electric wire system 13.8/7.97kV Length 7.37km (Length after change 5.95km) Low-voltage electric wire system 240/120V Length 6.0km (Length after change 3.70km)	High-voltage electric wire system 13.8/7.97kV Length 12.88km (Length after change 11.50km) Low-voltage electric wire system 240/120V Length 9.78km (Length after change 8.59km)

Source: Reference materials provided by JICA and findings of the interview with and materials provided by the MEM. With the exception of those parts indicated with "length after change" the actual output was as planned.



Table 2 Planned Technical Assistance and Actual Results

Plan	Actual
<p><u>Activity 1: Establishment and strengthening of a proper operation and maintenance system for the power plants and distribution installations</u>                      Establishment and strengthening of an operation and maintenance system; establishment of operation and maintenance systems for civil engineering facilities, hydroelectric power generation and distribution installations; periodic review of operation and maintenance methods</p>	As planned
<p><u>Activity 2: Establishment and strengthening of a proper management organization for the electricity business</u>                      Establishment of a business management systems and methods; electricity demand forecast and electricity supply management; formulation of plans to increase electricity demand and effective use of electricity; development of a capable organization and strengthening of organizational functions</p>	As planned
<p><u>Activity 3: Strengthening and establishment of the capacity improvement of activities related to the improvement of livelihood</u>                      Appointment of a leader and members of a livelihood improvement group; convening of workshops on participatory development; convening of seminars on improvement of knowledge of basic living and livelihood; environmental conservation and management activities of the basin; planning and convening of livelihood improvement workshops; implementation and evaluation of livelihood improvement mini-projects</p>	As planned
<p><u>Activity 4: Strengthening, establishment and capacity improvement of organizations for productive activities aiming to improve livelihood using electricity</u>                      Appointment of a leader and members of a production group; analysis of the present situation of local resources; examination of viable concrete productive activities; capacity improvement in preparation for corporatization; formulation of a productive activities plan and preparation for its implementation</p>	As planned

Source: Documents provided by JICA, Solar Foundation, and interviews conducted to consultants.

### 3.2.2 Project Inputs

#### 3.2.2.1 Project Cost

The Project was implemented using the procurement agent method. As the grant limit agreed in the E/N and G/A was fully disbursed to Guatemala, no funds had to be reimbursed to the Japanese side on completion of the Project<sup>15</sup>. Because of this, both the planned and actual project costs for the Japanese side were the same as the grant limit of 1,003 million yen. From the project cost for the Japanese side, 194.63 million yen (actual) was spent for the technical assistance.

The project cost for the Guatemala side was 957 million quetzal<sup>16</sup> (approximately 111 million yen) at the time of planning. The Guatemala side was mainly responsible for the payment of value added tax and other taxes, installation work for the low voltage distribution lines and improvement

<sup>15</sup> The fund that remained was distributed to the Electricity Administration Unit of the Development Association at each site to be used as part of the budget for the procurement of spare parts.

<sup>16</sup> 1 quetzal=11.89 yen (June 2009, Preliminary Study Report).

of the access road to each site. The actual amount was not available; however the scope of work remained the same.

### **3.2.2.2 Project Period**

The planned project period was from January 2010 to May 2013 (41 months) but the actual project period was stretched from January 2010 to March 2014 (50 months, 122% of the planned period), longer than planned.

The actual length of the delays or extensions and the reasons by project stage are described below.

- Up to the signing of the contractor agreement: After signing of the G/A, the plan was to immediately sign the contracts with the procurement agency and the consultant. However, it actually took over 6 months to sign the contract with the consultant. In addition, the period from the tender to the signing of the contractor agreement was seven months instead of the planned five months, with the contractor agreement being signed in March 2011.
- Civil engineering and construction work, procurement and installation of equipment and distribution line installation<sup>17</sup>: The actual period to complete this work was 16 months compared to the originally planned 13.5 months. Construction and installation of the generation and distribution facilities at each site were completed in July 2012, starting operations at the same time. The main reasons for the extension of this process were (i) a long time was required for the transportation and installation of the equipment at the Seasir and Jolom Ijix sites as these two sites have difficult access, and (ii) a long time was required to complete customs clearance for the generators imported from Germany and Austria.
- Technical assistance: Because of the delay in signing the contractor agreement, starting of technical assistance had to be delayed until April 2011. However, the actual period of the technical assistance itself was 36 months as originally planned and it ended in March 2014.

Based on the above, it is safe to conclude that the generating capacity (power output) at each site is as planned despite some changes regarding the length of the headrace, penstock and/or distribution line at each site.

Although the project cost was exactly as planned, the project period exceeded the plan. Therefore, the efficiency of the Project is fair.

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<sup>17</sup> At the time of planning, starting time of each process differed from one site to another. However, everything was actually implemented in parallel.

Table 3 Planned and Actual Values of the Operation and Effect Indicators

		Target	Actual			
		2016 Target to be achieved (3 years after project completion)	2012 Starting operations	2013 1 year after starting operations	2014 2 year after starting operations	2015 3 year after starting operations (target achievement rate)
<b>MAIN INDICATORS</b>						
1 Total number of electrified households		1,017 households	945	984	977	1,155 (114%)
Total number of electrified person		Approx. 6,200	4,862	5,671	6,279	7,173 (116%)
Breakdown	Las Conchas	416 households 2,500 persons	397 1,985	411 2,466	424 2,968	433 3,031
	Seasir	204 households 1,300 persons	209 1,250	218 1,430	217 1,430	362 2,200
	Jolom Ijix	397 households 2,400 persons	339 1,627	355 1,775	336 1,881	360 1,942
2 Household electrification rate		100%	81%	89%	91%	90 %
Breakdown	Las Conchas	100%	100%	100%	100%	100%
	Seasir	100%	96%	100%	100%	92%
	Jolom Ijix	100%	61%	75%	77%	78%
3 Peak Load (kW)		251 kW	81kW	93kW	106kW	125kW
Breakdown	Las Conchas	94 kW	28kW	32kW	45kW	50kW
	Ratio to planned peak load					(53%)
	Seasir	59 kW	28kW	32kW	32kW	40kW
	Ratio to planned peak load					(68%)
Jolom Ijix	98 kW	25kW	29kW	29kW	35kW	
	Ratio to planned peak load					(36%)
<b>AUXILIARY INDICATORS</b>						
4 Plant utilization rate (%)						
Las Conchas			-	41%	49%	52%
Seasir			37%	44%	56%	68%
Jolom Ijix			26%	67%	NA	NA
5 Operating hours (hrs/year)						
Las Conchas			-	7,560	8,420	8,385
Seasir			-	8,734	8,704	8,739
Jolom Ijix			3,906	8,435	7,979	8,704
6 Unplanned plant outage by cause (hrs/year)						
Las Conchas	a. Equipment failure		-	1,104	55	25
	b. Human error		-	9	41	30
	c. Other causes (natural disaster, etc.)		-	72	68	148
Seasir	a. Equipment failure		-	0	26	0
	b. Human error		-			
	c. Other causes (natural disaster, etc.)		-			
Jolom Ijix	a. Equipment failure		508	168	625	5
	b. Human error		0	23	19	13
7 Planned plant outage for maintenance (hrs/year)						
Breakdown	Las Conchas		-	15	80	172
	Seasir		-	26	30	21
	Jolom Ijix		6	24	24	24
8 Annual power generation (kWh/year)						
Breakdown	Las Conchas		-	336,813	406,502	429,335
	Seasir		190,150	226,512	291,128	353,046
	Jolom Ijix		221,105	572,485	NA	NA
9 Annual power consumption amount (kWh/year)						
Breakdown	Las Conchas		-	43,759	66,574	83,105
	Seasir		6,988	18,752	51,465	65,264
	Jolom Ijix		18,356	47,741	41,141	47,304
10 Annual Power consumption per household (kWh/household)						
Breakdown	Las Conchas		-	106	157	192
	Seasir		33	86	237	180
	Jolom Ijix		54	135	123	131

Source: Questionnaire survey and interviews to each of the Electricity Administration Units.

2: Household electrification rate = (number of electrified households ÷ number of households enrolled with the Development Association) x 100

4: Plant utilization rate = annual power generation (kWh) ÷ rated output (kW) x annual operating hours (hrs) x 100

\* On the ex-ante evaluation document, May 2013 was set as the project completion date (completion of technical assistance) and the timing of ex-post evaluation was set for 2016, three years after project completion. In this ex-post evaluation, the level of achievement of the project effect indicators was judged based on the actual values in 2015 which was three years after completion and starting of operations of power generation facilities in 2012. In setting the targets for 2016 of the number of households and population for the electrified households and electrified persons indicators respectively, these are the same as the values set in 2006.

\*\* The years in this table are calendar years (i.e. from January to December).

### 3.3 Effectiveness<sup>18</sup> (Rating: ③)

#### 3.3.1 Quantitative Effects (Operation and Effect Indicators)

The assumed effect of the implementation of the Project was “improved residents’ access to electricity”. To quantitatively assess this effect, three main indicators were established at the time of ex-ante evaluation. These are “number of electrified households and number of persons”, “household electrification rate” and “peak load”. In addition to these, several auxiliary indicators used as reference data relating to the operation of facilities were introduced (see Table 3).

#### Achievement level of the main indicators

1. Number of electrified households and persons: At the time of planning, one target value was set for the sum of the three sites, with 1,017 households and approximately 6,200 persons for 2016. The actual values three years after the starting operations in 2015 were 1,155 households and 7,173 persons, exceeding the planned values by 14% and 16% respectively. At Las Conchas, 12 villages were electrified under the Project as planned.<sup>19</sup> At Seasir, the number of electrified villages was three as planned until 2014, but one village was added in 2015, bringing the number of electrified villages to four at the time of the ex-post evaluation. At Jolom Ijix site, electrification commenced at nine villages and two further villages were electrified in June 2015, resulting in a total number of 11.
2. Household electrification rate<sup>20</sup>: The household electrification rate at Las Conchas and Seasir in 2015, three years after project completion, was as high as 100% and 92% respectively, mostly achieving the target. On the other hand, the rate at Jolom Ijix was much lower at 78%, partly because of a large number of non-payers and partly because of the non-completion of service connection to some households in two newly joined villages. The average rate for the three sites of 90% means that the target was basically achieved. According to interviews with municipal

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<sup>18</sup> The effectiveness is rated in consideration of not only the effects but also the impacts.

<sup>19</sup> At the time of planning, the number of villages to be electrified was set at 11 but one village has since split into two, resulting in a total number of electrified villages of 12, although there are no changes in the target households. At the Las Conchas site, a private mobile phone service provider has installed a mobile phone tower and has become a new business user of the locally generated electricity.

<sup>20</sup> The household electrification rate is usually the proportion of electrified households in the total number of households. In case of this Project however, the target households for electrification were those which have paid the membership fee to the Development Association of each village. As such, the household electrification rate in the Project was defined at the time of planning as the electrification rate of the households that became members of the Development Associations. To be more precise, the total number of households functioning as the denominator is the number of member households of each Development Association, excluding non-member households and/or those households which dropped out during the project period from the scope of calculation. Meanwhile, the electrification rate record includes those households to which electricity supply has been suspended due to non-payment of the electricity bill for more than three months. Therefore, any percentage short of 100% represents non-paying households plus households waiting service connection in a newly joined village. According to the findings of the interview survey with the Electricity Administration Unit of the Development Association for each site, the number of non-member households or households dropping out from the Association is extremely limited and there have been many cases of households which were not interested in joining the Association at the beginning of the Project but have later joined after the Project started.

officials, the electrification rate of those municipalities to which the target villages of the Project belong in 2015 was 20% for Chahal (Las Conchas), 44% for Panzós (Jolom Ijix) and approximately 35% for Cahabón (Seasir). As the electrification rate at each target site of the Project is higher than the electrification rate of the corresponding municipality, the Project has contributed to improvement of the electrification rate in these sites.

3. Peak load: The target achievement rate is low at all of the sites (57% at Las Conchas with an actual peak load of 50 kW compared to a target of 94 kW; 68% at Seasir with an actual peak load of 40 kW compared to a target of 59 kW; 36% at Jolom Ijix with an actual peak load of 35 kW compared to a target of 98 kW). In the feasibility study, the peak demand was determined based on the assumption that the consumption by each household would increase along with the development of local industries using electricity. In reality, however, even though the number of electrified households and persons increased, the power consumption level at each household was less than planned. Support to business start-ups and attraction of businesses to the project sites was not enough, resulting in a failure to create medium to large-scale electricity users. Consequently, the target peak load was not achieved. Especially at Jolom Ijix where the maximum output is low, the original assumption was that a maize mill, cardamom and coffee drying plants and a chocolate plant would be created as production facilities using electricity.<sup>21</sup> Of these, only a small maize mill and cardamom drying plant had been established at the time of the ex-post evaluation.

#### Actual results of the auxiliary indicators

4. Plant utilization rate in 2015: The plant utilization rate in 2015 was 52% in Las Conchas and 68% in Seasir. The rate has steadily increased and is expected to continue to increase based on the prediction that there will be more service connections to villages and an increase of the consumption per household. In the case of Jolom Ijix, a total reshuffle of members of the Board of Directors and the coordinator of the Electricity Administration Unit of the Development Association had taken place as described later (see “3.5.1 Institutional Aspect of Operation and Maintenance” for details), thus, there was no accurate data for the annual power generation. Consequently, plant utilization data for 2014 and 2015 could not be obtained.
5. Operating hours, unplanned outages and planned maintenance and repair: Las Conchas site experienced a number of outages, including mechanical breakdown, immediately after the plant started operating due to malfunctioning of the turbine propeller and breaker of the control panel.<sup>22</sup> By 2015, however, the number of outage hours had fallen to 25 hours a year.

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<sup>21</sup> “Feasibility Study on Micro-Hydropower Plants at Las Conchas, Seasir and Jolom Ijix Sites in Alta Verapaz Department” (IDB, 2008).

<sup>22</sup> As these breakdowns occurred during the warranty period, the repair work for replacement of the parts concerned

Meanwhile, because a water leakage from the valve that connects to the generator turbine had started since 2014, the number of planned outage hours increased to 80 in 2014 and further to 172 in 2015. As this worsening situation required an urgent solution, the Las Conchas Development Association in charge of the operation and maintenance requested for a quotation for repair work to the supplier. At Seasir, unplanned outages occurred only in 2014 for a total of 26 hours and planned outages were put into place as indicated by the manual. At Jolom Ijix, while planned outages were put into place each year in accordance with the manual, considerable unplanned outages due to equipment failure occurred in 2014, totalling 625 hours. This was because a lengthy time was required to repair the breakdown of the alarm on the control panel, burning out of the power unit and deformation of the penstock connectors. As these problems were solved in due course, the unplanned outage hours fell to five hours in 2015.

6. Annual power consumption and annual power consumption per household: These show an upward trend in general. When a community that had originally no access to electricity is for the first time supplied with it, the residents are often initially reluctant to use electricity. In the case of the Project, it appears that the residents of the target villages have been steadily incorporated electricity into their lives.

As seen above, the targets for the “number of electrified households and persons” were achieved as the figures steadily increased from 2012 to 2015. The “household electrification rate” mostly achieved its target as well. In contrast, the “peak load” has not achieved its target, primarily because of failure to foster productive activities using electricity contrary to the initial assumption. Nevertheless, the peak load is expected to increase in the coming years due to an increase of the number of electrified persons as a result of new connections to hitherto unelectrified villages; increase of power consumption per household, and increase of the power demand by new productive activities. Both the annual power generation and annual power consumption have been steadily increasing and other auxiliary indicators offer a similar conclusion to that described above. Therefore, the project objective of “improved access to electricity of residents” is judged to have been mainly achieved.

### **3.4 Impacts**

#### **3.4.1 Intended Impacts**

The expected impacts of the Project were the promotion of productive activities and contribution to the improvement of livelihood. To be more precise, five concrete impacts which are discussed below were assumed. These have been analysed through a beneficiary survey<sup>23</sup> and focus

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was conducted by an engineer of the manufacturer who was dispatched from Austria.

<sup>23</sup> The beneficiary survey was conducted during February 2<sup>nd</sup> and 20<sup>th</sup>, 2016. Sample size was 48 persons at Las Conchas (nine villages), 51 persons at Seasir (four villages) and 51 persons at Jolom Ijix (five villages), totalling 150 persons (54% female and 46% male). Sampling was conducted selecting villages by population distribution

group discussions. The state of realization of the impacts of the Project is described here. The beneficiary survey found a high level of satisfaction with the Project as 96% and 4% of the respondents stated that the Project was “highly satisfactory” and “satisfactory” respectively.

1. Improvement of the educational environment, such as enabling of residents to study at night using electric lighting<sup>24</sup> both at home and at evening schools: The expected impact has fully been realized.

The beneficiary survey found that 67% of the respondents believe that the educational environment has improved. In the focus group discussions held at each site, there were some common comments, including “prior to the Project, the time to do school homework was limited but this can now be done in the evening” and “prior to the Project, the use of candles or a kerosene lamp to study at home was a health concern regarding eyesight, respiratory system, etc. but the use of electric lamps since the Project has eradicated such concern”. However, none of the sites yet have an evening school for literacy. By site, students at the Las Conchas site used to pay 20 quetzal (about 322 yen)<sup>25</sup> before the Project for a return trip to Chahal where the computer school is located in order to learn computing. Since the Project, personal computers have been introduced at three secondary schools, enabling students to learn computing at their own schools. This is one example of general improvement of the educational environment resulting from the Project. At Seasir, an American NGO opened a vocational training school in 2015 and a total of 85 trainees have acquired certification for woodworking, plastering and cooking. A residential electrical engineer<sup>26</sup> course was added in March, 2016 with a trainer dispatched from the Technical Training and Productivity Institute (*Instituto Técnico de Capacitación y Productividad*, INTECAP). It is hoped that this school will contribute to the training of engineers required to ensure the sustainability of the Project which is described later in “3.5.2 Technical Aspect of Operation and Maintenance”. At



A primary school in Jolom Ijix:  
with the introduction of a  
computer, new educational material  
can now be used

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and accessibility. As a result, nine villages were selected from among 12 villages in Las Conchas, five villages from 11 villages in Jolom Ijix and all four villages in Seasir. In the case of those villages with difficult access, focus group discussions and interview surveys were separately conducted from the questionnaire survey. The information obtained from these activities suggests that the level of satisfaction of the residents with the Project do not differ significantly from that of the residents who participated in the beneficiary survey. As such, there should be no bias originating from the non-inclusion of certain villages in the beneficiaries survey.

<sup>24</sup> In the beneficiary survey, 97% of the respondents replied that lighting was the main use of electricity. The top five household electrical appliances used are mobile phones (61%), televisions (45%), refrigerators (31%), satellite antenna (31%) and radios (14%). The field survey found that electric fans and radios are also used.

<sup>25</sup> 1 quetzal=16.110 yen (December 2015, JICA exchange rates (JICA website)).

<sup>26</sup> A trainee completing the residential electrical engineer course acquires an INTECAP certificate which is acknowledged throughout the country. INTECAP is in charge of vocational training in Guatemala and offers 75 vocational training courses at 29 training centres (as of 2015). The training implemented under the technical assistance of the Project was also carried out by INTECAP.

Jolom Ijix, one personal computer has been introduced at a primary school, enabling the use of new teaching media, such as CD-ROM and DVD. It is said that these new media have enhanced the interest of students for learning.<sup>27</sup>

2. Improvement of the medical environment, such as the refrigeration of vaccines, etc.: The expected impact has been partially realized.

At Seasir, the previously mentioned American NGO and a local company have jointly established and operate a health clinic in 2015 with one full-time doctor and two full-time nurses, examining an average of 100 to 120 patients per month. In addition to these full-time staff members, a medical mission consisting of volunteers is regularly sent from the United States to this hospital. These missions have examined a total of 1,200 patients as of October, 2015. These facts indicate that the Project has greatly contributed to improvement of the medical environment at this site.<sup>28</sup> However, at the time of ex-post evaluation, the clinics at the Las Conchas and Jolom Ijix sites were closed due to shortage of doctors, nurses, medicines and medical equipment. Therefore, the expected effect of the Project of improving the medical environment at the project sites has not yet been fully realized.

3. The activities for livelihood improvement using micro hydroelectric power generation contribute as a model case for other regions: The expected impact has not been realized.

Up to the time of ex-post evaluation, no livelihood improvement activities have been conducted in other regions using the Project as a model. Also the implementing agency has not promoted the Project as a model case. However, at Las Conchas the number of requests by other local public bodies and universities to conduct visits to the micro hydroelectric power plant has been increasing every year.

4. Contribute to household income increase: The expected impact has been partially realized.

The ex-post evaluation has found that while the living conditions have generally improved at the target sites, the level of income increase varies from one household to another.<sup>29</sup> The income of those households which have procured a refrigerator, freezer, copying machine and/or personal computer to establish a new business has increased, however, income of other households has not

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<sup>27</sup> Prior to the implementation of the Project, audio equipment such as radios and CD players were used to assist teaching (battery operated as there was no generator).

<sup>28</sup> At the time of the field survey, about 20 dentists dispatched from the US were treating patients. The availability of infrastructure for electricity supply was cited as a decisive factor for the opening of a clinic at Seasir. The operation of the hospital has been steady as electricity with stable quality is supplied using a transformer procured and installed by the Electricity Administration Unit of Seasir's Development Association.

<sup>29</sup> The beneficiary survey found a change of lifestyle in addition to changes in education and medical care due to the introduction of electricity. Compared to before the Project, the time used for farming, housework and sleeping has decreased with watching television taking up a lot of time after the Project. Especially it was found that watching television appears to be the principal reason for the reduction of sleeping time.



changed so much since before the Project. In addition, the level of living has improved at Las Conchas where a local industry (tourism) exists and where access to the site is relatively easy compared to that of the other two sites, which lack a notable local industry as well. Many women's groups which received technical assistance for livelihood improvement and productive activities has reinvested all of the profits gained through the Project in their businesses or have loaned them to other members. As they have learned through the technical assistance, majority of the groups mainly re-invest all their profits to expand their businesses instead of distributing part of it among members. Apart from the group which loan its profits to the members, productive activities have not yet directly increased the household income (see "Column: Empowerment of Women through Productive Activities Using Electricity" for details).

5. Reduction of CO<sub>2</sub> emissions due to less use of firewood and kerosene: The CO<sub>2</sub> emission reduction has been limited.

Because the use of kerosene lamps has decreased, the emission of CO<sub>2</sub> should have fallen proportionally. However, as firewood is still the main fuel for cooking, the overall CO<sub>2</sub> emission reduction is likely to have been limited.

The educational environment is an area where the expected impact has been sufficiently realized while improvement of the medical environment and increase of the household income have been realized at some sites but not at all sites. The impact on the emission of CO<sub>2</sub> has been limited and the impact as a model for livelihood improvement using electricity has not been realized. In short, of the five expected impacts, three have been partially or sufficiently realized and the quality of living has definitely been improved due to the use of electrical appliances, such as electric lamps, televisions and refrigerators, among others.



A group of housewives preparing an evening meal under an electric lamp (Las Conchas)

### **3.4.2 Other Impacts**

#### Impacts on the natural environment

At the time of planning, there was concern in regard to impacts on the natural environment during the construction work such as air pollution by vehicles, turbidity of rivers due to work in the river channels, land pollution due to oil and/or grease spillage, construction waste, noise, bad odour and others, urging the adoption of appropriate work procedures and other measures. For these possible adverse impacts, appropriate measures were implemented in accordance with the check list of the

monitoring plan<sup>30</sup> which in turn was in line with the relevant JICA guidelines.<sup>31</sup> The beneficiary survey found that 95% of 150 respondents replied that there were either “no problems at all” or “hardly any problems” for every category of possible adverse impact, confirming the very limited nature of impacts on the natural environment.<sup>32</sup> The field survey as part of the ex-post evaluation found no adverse impacts on the natural environment in terms of the restoration of pastoral land, reforestation and noise, etc.

#### Resettlement and land acquisition

No resettlement of residents was necessary at Las Conchas and Seasir sites. At Jolom Ijix, however, one family (three members) residing at the planned construction site of the head tank required relocation. Through negotiations with the Development Association and land owner, the family was relocated with the cooperation of the local residents to a new house constructed on different land within the village. After relocation the family continued working as farmers and there were no negative impacts in regard to reduction of income and living conditions. On the other hand, in regard to land acquisition, there had been an understanding that land acquisition meant the acquisition of permanent land use rights from the time of project planning. Letters of approval of permanent land use rights were prepared between representatives of the Development Associations and land owners with the assistance of MEM. These letters had been exchanged between all stakeholders as official documents in all the sites by 2008 and MEM considered that the exchange of these official documents implied the completion of land acquisition. The process of securing land for the Project was actually completed without any significant problems and the evaluator confirmed the existence of these official documents concerning permanent land use rights. However, as long as the land ownership is not transferred to MEM, the facilities and equipment of the Project which are owned by MEM cannot be registered as state assets. This means that if any large-scale breakdown or accident occurs due to an unexpected natural disaster (flooding or lightning, etc.), MEM cannot provide the assistance required for their repair.<sup>33</sup>

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<sup>30</sup> As part of the project site (the Las Conchas Municipal Natural Recreation Park) is located in the Las Minas Mountains Biosphere Protection Buffer Zone, an EIA (Environmental Impact Assessment) was required under the environmental law of Guatemala. However, because of the small scale of development, it was decided that the submission of an IEE (Initial Environmental Evaluation) report and a monitoring plan would be approved as an EIA. The IEE report was prepared on July 31, 2009 and was approved on October 15, 2009. As this report covers most of the subject items for assessment listed in JICA’s Guidelines for Environmental and Social Considerations, its relevance is high. Due to the insufficient content regarding a monitoring plan in this report, the MEM prepared a monitoring plan (check list and monitoring form) in line with JICA’s Guidelines and monitoring was conducted on the basis of this plan.

<sup>31</sup> Concerns in regard to impacts on the natural environment during the construction work which were addressed at the moment of project planning were (1) exhaust gas and dust, (2) turbidity of rivers and land pollution due to civil works, (3) construction waste and bad odour among others. The measures taken were: for (1) water was sprinkled periodically in the construction area and trucks received a periodical maintenance. For (2) measures such as putting portable toilets were taken in order to minimize the impact to the environment. For (3) construction waste were collected and treated in specific places indicated by the Municipal government.

<sup>32</sup> The remaining 5% of the respondents did not answer the question.

<sup>33</sup> In regard to land use rights, MEM was expected to submit a schedule for the concrete procedure of registering state assets to JICA in October, 2014 according to the review conducted in August, 2014 at the time of the

### Other impacts

- Promotion of poverty reduction: A questionnaire survey was conducted with the Development Association at each site, asking them to grade the effect of the Project on poverty reduction on a scale from 1 to 5. Las Conchas and Jolom Ijix sites answered that “the effect was slightly low” while Seasir answered “an effect can be recognize to some extent”. These results were lower than the comparable results of the beneficiary survey. During the focus group discussions, their opinion was that even though the quality of living had improved due to electricity supply, the situation did not lead to a tangible income increase and livelihood improvement. The “quality” of life has improved but an increase in income is yet to be seen. In addition, some households have been able to start their own businesses using electricity while other households have not done so. Income of the former had increased but not so for the latter, who even responded that the increase in expenses was greater than the income increase. In general, there was no clear impact of the Project in terms of promoting poverty reduction.
- Empowerment of women<sup>34</sup> (see Column for details): The Project had an impact on reduction of women’s workload in household chores as the use of electric appliances such as refrigerators and fans, as well as light can be used. In addition to this, as part of the technical assistance, support was offered under the Project for the productive activities of women’s groups. These groups decided their preferred productive activities themselves and learned the necessary knowledge and know-how to implement the selected activities. Each group collectively determined such matters as how to manage their businesses. As 13 groups (approximately 80 women) are still in operation at the time of ex-post evaluation, it is fair to say that the Project has contributed to the empowerment of women.<sup>35</sup>

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completion of JICA’s technical assistance. However, no progress has been made up to the time of ex-post evaluation although MEM stated that the registration of lands as state assets should be completed by August, 2016. Land ownership and land use rights in Guatemala are often not clearly distinguished and the question of land ownership is extremely complicated because of its historical background. Obtaining an official document concerning land use rights is customarily regarded as constituting the completion of land acquisition. The Government of Guatemala has established a body responsible to solve the issue of land ownership. It should be noted that MEM, as a policy making institution, cannot provide financial assistance directly to the Development Associations, however it would arrange assistance from other institutions.

<sup>34</sup> Apart from productive activities, the participation of women in plant operation and maintenance has been quite limited as only one woman works as a book-keeper in the Las Conchas Electricity Administration Unit. However, the rules of the Development Association state that residents can only become members of the Association if both a man, as the head of the household, and a woman, as the spouse, apply for membership. Both men and women have voting rights to decide various issues of the Association. This means that the activities of the Association indirectly reflect women’s opinions to some extent.

<sup>35</sup> Each Development Association is expected to follow up the activities of women’s groups after the completion of the Project but such follow-up is only observed at Las Conchas at the time of ex-post evaluation.

### Column: Empowerment of Women Through Productive Activities Using Electricity

The technical assistance under the Project introduced two activities targeting women. Activity 1 was “assistance for the construction of organizations to conduct activities related to livelihood improvement and strengthening of the capacity for improvement”. Activity 2 was “assistance for the construction of organizations for productive activities using electricity and strengthening of the capacity for improvement, aiming at livelihood improvement”.

In Activity 1, various efforts for livelihood improvement at the community level in post-war Japan were introduced in a workshop. This was followed by the search for local resources in each community and three types of improvement were taught, i.e. “improvement not requiring money”, “improvement requiring money” and “improvement generating money”. Each woman’s group then planned, implemented and evaluated a mini-project for “improvement not requiring money”. The number of groups at one point was many as 48, from which 12 groups were selected based on their attitude while working on the mini-projects, the results, as well as their continuous participation in the workshops. Activity 2 was then conducted on these 12 selected groups. As part of Activity 2, workshops were held on the planning, implementation and book-keeping of productive activities using electricity. To launch the productive activity of each group, 3,000 quetzal (about 48,000 yen) was provided for each group as a start-up fund. At the time of project completion, as some groups decided to split there were 14 groups (five in Las Conchas, seven in Seasir, and two in Jolom Ijix) operating in chicken farming, pig farming, bread-making, maize cultivation and flour milling. All important group decisions, such as change in activity and business management policies, are discussed and decided among all the members. Although some groups have split or ceased activity, 13 groups are active at the time of ex-post evaluation, involving chicken farming, pig farming, maize cultivation and flour milling.<sup>36</sup>



Livelihood improvement: maize flour milling (Las Conchas)

The background for the continuous activities of the 13 groups despite a change of activity on the part of some groups is that the group members acquired the basic knowledge required for their productive activities through the technical assistance. Moreover, these women have gained confidence as human beings and now have the willpower and capacity to devise and implement different activities instead of simply giving up when hitting a wall as was the case before the assistance. These are significant outcomes of the technical assistance, illustrating the positive contribution of the technical assistance of the Project to the raising of awareness and empowerment of women. During the focus group discussions, many opinions were expressed to illustrate these positive outcomes. Some examples are: (1) knowing about livelihood improvement in post-war Japan made me believe that, as members of a community, we can achieve something if we work together, boosting our confidence; (2) before attending the workshop, I never thought that improvement would be possible without money because I believed that money was necessary for everything. Japan’s technical assistance broadened my vision and imagination; (3) the acquisition of know-how on chicken and pig farming led to earning of real money, boosting my own confidence and showing the community that women can butcher pigs, and (4) learning book-keeping has enabled me to understand the flow of money not only in a group activity but also in my own household, making me more careful about how I spend money. Most men in these communities appear to understand why women involve themselves in productive activities and are supportive. Even though the status of women is rather low in Mayan society, JICA’s technical assistance has boosted the confidence as well as capacity of women and facilitated the understanding of the importance of women’s involvement in productive activities among men, thereby contributing to the improved status and empowerment of women.

<sup>36</sup> As of 2014, many groups were involved in chicken farming. At the time of ex-post evaluation, however, many of these groups have opted for pig farming. The background for this change is that many women who were not selected for group activities have independently learned how to raise chickens through visits to group activities and have started to raise their own chickens, creating strong competition. Because women not selected for “assistance for the strengthening, establishment and capacity improvement of organizations for productive activities aimed at improving livelihood using electricity” have obtained new knowledge and know-how, it is safe to say that JICA’s technical assistance has achieved indirect effects.

The effectiveness and impact of the Project were to “improve access of residents to electricity” and “promote productive activities and contribute to the improvement of livelihood”. In regard to effectiveness, “total number of electrified households” and “total number of electrified persons” have achieved their respective targets. Although the “peak load” did not achieve the target, both the annual power generation and annual power consumption have steadily increased. A further increase of the number of electrified persons and annual power consumption per household is expected through new connection to hitherto unelectrified villages, and it is safe to conclude that the quantitative effects have been achieved. In regard to impacts, expected impacts have been recognized in terms of improvement of the educational environment, improvement of the medical environment and improvement of livelihood. The Project has also significantly contributed to the empowerment of women. In contrast, the actual impact is limited in terms of poverty reduction or income increase as the income level varies from one household to another. There have been no negative impacts on the environment or in terms of resident resettlement.

This Project has largely achieved its objectives. Therefore effectiveness and impact of the Project are high.

### **3.5 Sustainability (Rating: ②)**

At the time of Project planning, with respect to operation and maintenance, it was pointed out that “routine inspection and simple maintenance would be conducted by operation and maintenance workers, however, if even minor problems are not properly dealt with, it can be expected that this could result in serious problems”. Thus in order to secure the sustainability of the Project, as the implementing agency, MEM was to sign an agreement with INDE who is in charge of rural electrification, so that INDE could provide technical support to the Development Associations. In addition, the necessity to establish and strengthen a comprehensive support system for operation and maintenance involving MEM, INDE and municipal authorities<sup>37</sup> was recommended in the midterm and project completion review reports<sup>38</sup> of the technical assistance. Moreover, another recommendation was made during the defect inspection conducted in July, 2014 regarding the necessity to promote cooperation between MEM and municipal authorities (in order to secure necessary budget; establish a cooperation system with electrical work companies, universities and NGOs that are active in the Project site; and monitor the Project, etc.) At the time of ex-post evaluation, however, there was no formal cooperation system between MEM, INDE and municipal authorities. There has been a commitment from INDE to provide technical assistance (which

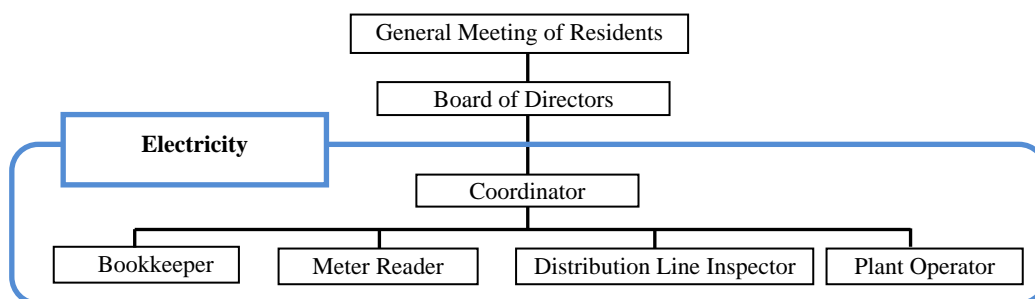
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<sup>37</sup> MEM is the administrative organization for the electricity sector and is responsible for the development of the legal framework and formulation of policies and electrification plans. Direct operation and management, as well as technical matters of electricity business are not among their functions.

<sup>38</sup> In this Project, with respect to the technical assistance conducted by the consultant, JICA conducted a midterm review (June 2012) and a review at the moment of project completion (March 2014).

excludes purchasing of spare parts) to MEM but it has not yet been a formalized cooperation system, due to difficulties in MEM’s internal coordination. In addition, not all municipal authorities were aware of the existence of the Project. There was a comment from one municipal authority that the municipality does not engage in electricity business thus it could not provide technical assistance and that financial assistance would also be difficult due to the limited municipal budget.<sup>39</sup>

In short, the involvement in operation and maintenance of MEM and municipal authorities has been very limited. Therefore, this ex-post evaluation focused on the institutional, technical and financial aspects of the Electricity Administration Unit of each Development Association which is actually responsible for the power plant operation and maintenance, in order to evaluate the operation and maintenance of the Project.



Source: Information provided by Development Associations.

Fig.1 Organizational Chart of the Development Association and Electricity Administration Unit

### 3.5.1 Institutional Aspects of Operation and Maintenance

A Development Association<sup>40</sup> consisting of local residents as members was established at each site for the purpose of the operation and maintenance of the facilities constructed under the Project, and an Electricity Administration Unit to run the electricity business was created under the General Meeting of Residents and the Board of Directors (Fig. 1). Concrete rules for the electricity business

<sup>39</sup> The midterm review (June 2012) and project completion review (March 2014) of the technical assistance of the Project recommended that municipal assistance should be obtained. However, this recommendation has not been realized, partly because of the frequent change of municipal officials. Although each Development Association compiles a monthly report recording the state of operation, electricity demand, income and expenditure, main repair works carried out, breakdowns and periodic/extraordinary inspections so that MEM and municipalities can conduct monitoring, only the Development Association in Las Conchas submits this report to the municipal authority (municipal authorities have not made it a requirement either). Residents have a strong sense of distrust in municipal authorities, citing the following reasons for the non-submission of the monthly report: “submission of information to the municipal authority does not lead to any actual assistance” and “we do not want to reveal our income and expenditure as we do not trust the municipal authority”. Unless this fundamental sense of distrust is solved, municipal assistance for the Project cannot be expected. The Chahal municipal authority of which the jurisdiction covers Las Conchas mentioned that “although financial assistance by this municipal authority is impossible, it is possible to provide assistance such as bring in an engineer if necessary.”

<sup>40</sup> The members of the Development Association consist of male household heads and their female spouses and each member has a voting right. The directors are selected through voting at a General Meeting of Residents.

(selection method of directors, operational rules of the electricity business, electricity tariff, obligation of residents to pay the electricity bill and other relevant matters) were created through the technical assistance of the Project.

Operation and maintenance systems for each of the power plants and chain of command are in place at each site. Although the number of persons assigned to monitor the distribution network is less than originally planned (four persons), no problems have been reported as the residents take turns to act as monitors as well. At Las Conchas and Seasir sites, the operation and maintenance system at the time of ex-post evaluation is judged to be mostly adequate and stable. In addition, residents conduct the cleaning of the distribution line, and water intake in turns, helping to ensure a stable electricity supply. At Jolom Ijix, all members of the Board of Directors had been replaced just before this ex-post evaluation. There were no changes in the staff of the Electricity Administration Unit, but one operator was being trained to fill the gap created by the departure of one operator<sup>41</sup>, and thus operation and maintenance is conducted with the minimum manpower.

Table 4 Number of personnel at each Development Association's Electricity Administration Units

(unit: persons)

Site Name Name of Development Associations*	Coordinator (Management)	Book- keeper	Meter Reader	Distribution line Inspector	Plant Operator	Total
Las Conchas ASOCALCO	1**	1	1	1	3 (3 shifts)	6
Seasir ADECORK	1	1	1 (Also works as a distribution line inspector)		2 (2 shifts)	5
Jolom Ijix ADESMI	1	1	1	2 (2 shifts)		5
Assumed Appropriate Manpower Strength at Time of Planning	1	2		4	2 to 3	9 to 10

Source: Information provided by Development Associations as of May, 2016.

\* ASOCALCO: Asociación para el Desarrollo Las Conchas; ADECORK: Asociación para el Desarrollo Comunitario Rax K'liche; ADESMI: Asociación para el Desarrollo Sierra de las Minas.

\*\*Also works as a plant operator.

From the above, the institutional aspect of operation and maintenance is mostly fine at Las Conchas and Seasir but there are concerns at Jolom Ijix.

<sup>41</sup> In regard to personnel turnover at the Electricity Administration Units, at Las Conchas and Seasir, two operators and one book-keeper were either dismissed or left their posts in 2014, two years after commencement of operation, due to inappropriate work performance, change of job, or family reasons. However, no one has left since then. It is worth mentioning that there is a rule that any vacant posts created by the departure of an employee must be filled by a person trained in the Project and all personnel matters are approved after examination by the Board of Directors.

### 3.5.2 Technical Aspects of Operation and Maintenance

At the moment of the ex-post evaluation, all personnel in charge of operation and maintenance in each Electricity Administration Unit had received technical guidance under the Project. To be more precise, five persons were selected as plant operators and distribution line inspectors from each site and underwent through a training organized by the INTECAP, followed by OJT and other trainings, organized as part of the technical assistance under the



Routine inspection (Jolom Ijix)

Project to learn the basic skills for the routine inspection of the civil engineering facilities as well as power generation and distribution facilities (see Table 2 for more details of the technical assistance). However, no continuous training or training to foster new technical personnel has taken place after this initial training.

Operation and maintenance manuals for the civil engineering facilities and power generation and distribution facilities, as well as forms for daily operation records and routine inspection records were prepared under the technical assistance.<sup>42</sup> These documents are properly used and stored at the Electricity Administration Unit and power plant at each site. Routine maintenance conducted in accordance with the manuals at the time of ex-post evaluation includes the application of grease, cleaning of ventilation filter for the control panel, cleaning of the air inlet and outlet of the generator and cleaning as well as grease application of the intake. In addition, the removal of deposits at the weir and pruning of tree branches along the distribution lines are conducted with the help of residents. In addition, the manuals list the contact information of engineers, suppliers, etc. When a repair or replacement of electrical equipment is required, it is necessary to contact the manufacturer, possibly leading to the import of parts<sup>43</sup> which can become a financial burden. Repair of the distribution facilities is to be conducted by a local company.<sup>44</sup>

From the above, it can be seen that the technical capacity to conduct the minimum routine inspection and maintenance is secured to a certain extent at the time of ex-post evaluation, but concern remains regarding the training of new personnel from the viewpoint of preserving the project effects in a sustained manner from here on.

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<sup>42</sup> As some people working at the Electricity Administration Unit had completed only up to primary education, these manuals and forms were prepared with due consideration of the educational background of the persons involved.

<sup>43</sup> In regard to the procurement of parts to deal with equipment breakdowns, at the time of the ex-post evaluation all the Electricity Administration Units had the understanding that the only available option was to import these parts from the Germany of Austrian manufacturer. According to the local consultant (AIMSA) who worked in the Project, it is possible to import these parts or to call an engineer from a neighbouring country, such as Mexico or Costa Rica.

<sup>44</sup> Based on materials provided by JICA, findings of the questionnaire survey to the Electricity Administration Units, as well as interview surveys conducted during the field work.



### 3.5.3 Financial Aspects of Operation and Maintenance

The routine maintenance cost of the facilities and equipment installed under the Project is covered by electricity fee collected by each Electricity Administration Unit and it is assumed that MEM is responsible for the provision of financial assistance in the case of operational failure due to an unexpected accident. However, in order for MEM to secure the necessary budget for this purpose, there is a precondition that the ownership of the land where the facilities and equipment installed by the Project must be transferred to MEM, so that these can be registered as state assets. At the time of ex-post evaluation, they were still not registered as state assets and MEM is not in a position to secure any budget<sup>45</sup> (see “3.4.2 Other Impacts: Resettlement and Land Acquisition” for more details of land acquisition at the time of planning). Consequently, each Electricity Administration Unit must finance all project-related operation and maintenance costs, including the repair cost necessary in case of a breakdown, from the collected electricity charges. It is, therefore, essential to lower the delinquency rate as much as possible and, if necessary, revise the tariff in order to build up the reserve to meet the cost of such consumables as grease and the cost of parts scheduled for replacement in due course.

Under the technical assistance of the Project, all Development Associations were advised to save 2,000 quetzal (about 32,000 yen) a month as the minimum amount.<sup>46</sup> If done accordingly, 72,000 quetzal (about 1.16 million yen) should have already been set aside by December 2015. However, only the Development Association in Las Conchas has built up this reserve (Table 5). The financial situation in each site is as follows.

- Las Conchas: Apart from contracts with residents, there is a contract with a large user, which is a mobile phone service provider. Through strict enforcement of the “culture of proper payment”, the delinquency rate is low at 18%, making the electricity supply business very healthy with an annual surplus.
- Seasir: The annual balance is in the black, partly due to income from such large users as the health clinic and vocational training school. However, the delinquency rate is very high at 63%, and the reserve as of May 2016 is slightly lower than the required level. It is necessary to improve these aspects.
- Jolom Ijix: Unlike the other two sites, there is no large user and the delinquency ratio is extremely high at 72%. A “culture of proper payment” has not been established, partly because

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<sup>45</sup> The project completion review report (March 2014) for the technical assistance states that “in this Project, the latest technologies have been introduced which can operate for at least 20 years without a major maintenance work as long as the minimum routine operation and maintenance work is conducted by the personnel from the Electricity Administration Units that received training through the technical assistance. Regardless of such advantages, it has been pointed out from the time of project planning that these are sensitive equipment, and that it was necessary to make clear and to agree upon a support system, involving MEM, INDE and municipal authorities regarding concrete counter-measures (in terms of system, budget, securing components and spare parts etc.), including the precondition of the registry of the facilities as national assets, to guarantee ways to secure personnel that can conduct the repairs, as well as measures to be taken should a large-scale breakdown occur.

<sup>46</sup> Based on the interview survey conducted to a local consultant (Solar Foundation) who worked in the Project.

of the fact that electricity supply has so far not been suspended for non-payment. Also, residents generally lack awareness that the electricity supply service is reliant on the payment of a fee by the residents and the lack of any awareness campaign has aggravated the situation. Moreover, when two villages were added to the network, the National Rural Electric Cooperation Association (NRECA)<sup>47</sup> which was assisting the electricity supply business in rural areas advanced a loan of 50,000 quetzal (about 810 thousand yen) to the Development Association. This loan has not yet been repaid. Furthermore 10,000 quetzal (about 160 thousand yen) has been invested in the opening of a computer class but the recovery of this investment is nowhere in sight because of management problems, and there are other loans which have not been recovered. The accumulated reserve as of May 2016 is the lowest of the three sites. Routine operation and maintenance costs are being covered barely, but there are no funds to deal with a breakdown that would require amounts that surpass the reserve. Due to these problems, the entire members of the Board of Directors have been replaced, and a new chairman and coordinator of the Electricity Administration Unit are making efforts to improve this situation.<sup>48</sup>

Table 5 Financial Status of each Electricity Administration Unit

(Unit Quetzal)

Item	Las Conchas			Seasir				Jolom Ijix		
	2013	2014	2015	2012 (Aug-Dec)	2013	2014	2015	2013	2014	2015
Total income (A)	167,221	230,714	288,825	50,202	129,509	169,959	144,131	149,133	149,161	196,204
·Charge collection	103,964	165,277	226,146	38,781	97,695	64,816	72,441	94,538	49,057	45,126
·Collection of delinquent charges	22,448	39,743	45,811	289	26,906	103,369	71,690	54,595	100,104	151,078
·New membership fee and installation charge, etc.	40,809	25,694	16,868	11,132	4,908	1,774	0	NA	NA	NA
Expenditure (B)	128,485	178,369	207,903	42,463	115,456	142,549	132,579	118,160	155,760	136,014
·Personnel cost	96,000	102,600	110,350	32,380	83,633	80,740	79,800	92,400	92,400	92,400
·Office expenses	32,485	54,059	73,038	2,287	11,746	13,195	2,671	25,760	33,360	33,614
·Other (repair, etc.)	0	21,710	24,515	7,796	20,077	48,614	50,108	0	30,000	10,000
(A) - (B)	38,736	52,345	80,922	7,739	14,053	27,410	11,552	30,973	▲ 6,599	60,190
Reserve for facility renewal, etc.	175,928 (As of January 2016)			62,700 (As of December 2015)				12,000 (As of May 2016)		

Source: Documents provided by the Electricity Administration Units of ASOCALCO, ADECORK and ADESMI. Exchange rates as indicated in the footnote.<sup>49</sup>

<sup>47</sup> The NRECA is a national association of electric companies of the United States. In addition to rural electrification in the U.S., its mission includes rural electrification in other countries. It has conducted rural electrification projects in 43 countries since its establishment in 1962.

<sup>48</sup> Specifically, electricity supply to 26 households with the longest delinquency periods has been suspended and they have been given the option of paying the arrears in instalments with the accrued interest being waived. To reduce personnel costs, negotiations were made and an agreement has been reached with the meter-readers, who will be paid based on 10 days' work which is the number of days required for meter-reading, instead of a monthly payment as full-time employees. In the case of Jolom Ijix, the Rafael Landivar University has been providing small-scale technical assistance for operation and maintenance. OJT by a university engineer was scheduled in June 2016 and this university intends to provide assistance to improve the financial situation in the coming years.

<sup>49</sup> 1 quetzal=13.208 yen in December 2013, 1 quetzal= 15.786 yen in December 2014, 1 quetzal=16.110 yen in December 2015 (JICA rates (JICA website)).

The electricity tariff is determined in accordance with the rules of each Development Association and can be revised at the General Meeting of Residents. So far, the tariff has been revised twice since the time of starting operation to the time of ex-post evaluation. The basic charge at the time of ex-post evaluation is 17 quetzal (about 274 yen)/month for general users (110 V) plus a metered rate of 2 quetzal (about 32 yen) per kW of consumption. For commercial and industrial users (220 V), the basic charge is 20 quetzal (about 322 yen)/month plus a metered rate of 4 quetzal (about 64 yen) per kW of consumption. An installed transformer cost 20,000 quetzal (about 322 thousand yen).<sup>50</sup> Some Electricity Administration Units say that the tariff is rather low when the financial sustainability of the service is taken into consideration. While the financial situation may improve with further revision of the tariff, it appears difficult to increase the tariff for general users in the immediate future, when taking into consideration Seasir and Jolom Ijix high delinquency rates, as well as poverty and household income levels in these sites. Although the lack of a thorough “culture of proper payment” is a factor for the high delinquency rate, there are many households which fail to pay the electricity charge out of necessity due to insufficient income. In regard to the tariff for industrial and commercial users, it may be feasible to replace the existing uniform metered rate with a variable tariff based on the scale of business and actual power consumption amount in such businesses as game arcade, copying services and general stores as well as restaurants using refrigerators. However, there is no plan for this kind of differentiation of electricity users at the time of the ex-post evaluation.

For all the sites, their current financial situation makes it difficult for them to properly deal with a situation requiring large funding, including a large-scale accident or an unexpected breakdown. As neither MEM nor the municipal authorities can secure the necessary budget, it is important for the Electricity Administration Units to build up a reserve. However, the reality is that only Las Conchas has successfully built up such a reserve. At Seasir and Jolom Ijix, the delinquency rate is high due to the low level of income of the residents and lack of “a culture of proper payment”, causing concern regarding the financial health of the electricity supply situation.

### **3.5.4 Current Status of Operation and Maintenance**

At the time of ex-post evaluation, the condition of facilities and equipment is generally good in each site and no damage or failure has occurred with the civil engineering facilities, power plants or distribution facilities. However, some repairs and replenishment of some spare parts are necessary as shown in Table 6. When routine maintenance in accordance with the manuals and equipment maintenance by specialists are conducted, the minimum service life is 20 years. However, generally

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<sup>50</sup> At the Las Conchas site, an independent contract has been signed with a private mobile phone service provider and the agreed payment consists of 15,000 quetzal (about 24,000 yen) for connection with a basic charge of 250 quetzal (about 4,000 yen) /month and a metered rate of 5 quetzal (about 81 yen) /kW. Similar independent contracts have been signed at Seasir with a health clinic and a vocational training school run by a NGO.

in Guatemala, a lack of routine maintenance, or a lack of timely repair by a specialist in case of a breakdown can reduce the service life to about 10 years.

Table 6 Pending Issues and Necessary Measures Regarding Operation and Maintenance  
(as of May, 2016)

<p>[Las Conchas]</p> <ul style="list-style-type: none"> <li>• There is a water leakage from the inlet valve of the turbine and an oil leakage from the generator. As the water leakage has been worsening, urgent repair by an electrical engineer is necessary (the Electricity Administration Unit has already contacted the manufacturer).</li> </ul> <p>[Seasir]</p> <ul style="list-style-type: none"> <li>• The progressive erosion of the water intake weir suggests a need for thorough maintenance work.</li> <li>• As the control panel indicates error signals from the sensors for the bus bar (metallic bar conducting electricity to the control panel) and the location of the injector of the waterwheel, the checking of these by an electrical engineer is necessary.</li> <li>• Power plant operation has been halted several times a year due to increasing water levels, deterioration of the water quality and/or rubbish caused by extraordinary rainfall. The strict enforcement of a regime of preventive routine maintenance is necessary to eliminate problems in advance, including more frequent cleaning of the intake during the rainy season.</li> <li>• As there is no stock of spare parts (governor for the control panel, generator bearings, etc.), an urgent replenishment of these spare parts is necessary.</li> </ul> <p>[Jolom Ijix]</p> <ul style="list-style-type: none"> <li>• The prominent rusting of metal components, such as the intake gate, that are in contact with water is observed, indicating a need for thorough maintenance work.</li> <li>• As the water gauge of the head tank is not functioning, no water level data is indicated on the control panel. This situation must be rectified by a specialist.</li> <li>• As there is no stock of spare parts (governor for the control panel and generator bearings, etc.), an urgent replenishment of these spare parts is necessary.</li> </ul>
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As described above, the operation and maintenance conditions of the facilities and equipment installed with the Project are generally good at the time of the ex-post evaluation. However, some repair and the replenishment of spare parts are necessary at some sites.

The Development Association of Las Conchas which conducts the actual operation and maintenance has no institutional, technical or financial problems. However, the Development Association of Seasir requires significant improvement in terms of its financial status. The Development Association of Jolom Ijix has concerns in all aspects, that is, institutional, technical and financial aspects thus, MEM must assess this situation and should urgently provide the necessary assistance as described in “4.2 Recommendations”.

Some minor problems have been observed in terms of the institutional, technical and financial aspects of operation and maintenance. Therefore, sustainability of the project effects is fair.

## **4 Conclusions, Lessons Learned and Recommendations**

### **4.1 Conclusion**

The Project for the Promotion of Productive Activities with Use of Clean Energy in the Northern Villages of the Republic of Guatemala was implemented with the aim of improving the access of local residents to electricity by constructing micro hydroelectric power plants and distribution facilities in three sites located in the poorest area of Alta Verapaz Department in Guatemala where electrification by extension of the electricity grid was difficult, as well as by providing technical assistance for the operation and maintenance of these facilities and to promote productive activities using electricity, thereby contributing to the promotion of productive activities and the improvement of livelihood.

The Project has been relevant to Guatemala's development policies of proceeding with electrification by independent systems utilizing renewable energies in areas to which extension of the electricity grid is difficult; to Guatemala's development needs in terms of a strongly required electrification in Alta Verapaz Department because the electrification rate of this department has been the lowest in the country; and to Japan's ODA policy of assisting developing countries to promote reduction of CO<sub>2</sub> emissions and other measures to combat climate change. Therefore, the relevance of the Project is high.

Although the project cost was exactly as planned, the project period exceeded the plan. Therefore, the efficiency of the Project is fair.

Both power generation and power consumption have been steadily increasing. The targets in terms of number of electrified households and electrified persons have been achieved and the target in terms of household electrification rate has largely been achieved. Although the peak load has not reached the target, it is expected to increase in the coming years due to the increasing demand for electricity. The intended impacts have been realized in regard to improvement of the educational and healthcare environments and improvement of living conditions. In addition, the Project has contributed to improve the quality of living through electrification and to the empowerment of women through productive activities using electricity. Therefore, the effectiveness and impact of the Project are high.

The conditions of both the power generation and distribution facilities are generally good although some require repair or the replenishment of spare parts. The Development Associations are in charge of the electric enterprise as well as the operation and maintenance of the facilities in their respective villages. One of them has no problems at all, another one has some problems with the financial aspects and remaining one has some problems with the institutional, technical and financial aspects of operation and maintenance. It is necessary for the Ministry of Energy and Mines which is the implementing agency, to provide active assistance for the Development Associations of these three villages. Therefore, the sustainability of the Project is fair.

In light of the above, this Project is evaluated to be satisfactory.

## 4.2 Recommendations

### 4.2.1 Recommendations to the Implementing Agency (MEM)

- Arrangement with INTECAP regarding human resources development for the three Development Associations

At the time of ex-post evaluation, the number of staff members which had received technical assistance under the Project is five at each site. The development of additional human resources to follow in the steps of these five is necessary in order to ensure the sustainability of the project effects. While it is possible in Seasir to receive training on electrical engineering by a lecturer from INTECAP at the vocational training school established by the American NGO, there is concern for the succession of technical competence in Las Conchas and Jolom Ijix. In regard to this issue, MEM has expressed its view that although they cannot provide financial assistance, they can arrange training and technical assistance through coordination with INTECAP or other human resources development organizations. It is required that MEM identify the capability (not only technical but also business management and book-keeping) to be strengthened at the Electricity Administration Unit of each Development Association and arrange the participation of personnel of these sections in training programs sponsored by INTECAP or another human resources development organization.

- Arrangement of technical cooperation by the INDE

Regarding a support system in case of large-scale accidents or breakdowns due to natural disasters, INDE has expressed that it is possible for them to provide technical cooperation and assistance. They have commented that they can dispatch its technical personnel to assess the technical level of the power plants in order to clarify the scope of technical assistance they can provide and then possibly propose a concrete assistance system and an agreement on technical assistance to MEM. MEM should urgently make the necessary arrangements with INDE.

- Registration of facilities and equipment as state assets

The procedures to register facilities and equipment as state assets which were scheduled to be completed by August 2016 are required to continue. If this registration procedure is found to be time-consuming, discussions should be held involving legal experts, the municipal authorities and Development Associations to facilitate the necessary work.

- Support for the Jolom Ijix Development Association

Among the three targeted sites of the Project, Jolom Ijix in particular has problems with all aspects of operation and maintenance, that is, institutional, technical and financial aspects. MEM should maintain close communication with the Electricity Administration Unit of the Development Association in Jolom Ijix and conduct regular monitoring to prevent operating

accidents, etc. If necessary, MEM should consider collaborating with INDE and the Rafael Landívar University which has been providing assistance for Jolom Ijix.

#### **4.2.2 Recommendations to JICA**

JICA should continue to check the progress of MEM regarding the recommendations made in “4.2.1 Recommendations to the Implementing Agency”, and if necessary, encourage MEM in order to urge the implementation of these recommendations.

### **4.3 Lessons Learned**

- Ensuring sustainability through the combination of an infrastructure development project and technical assistance

In addition to the development of infrastructure, the Project also emphasised the technical assistance which was necessary to ensure the sustainability of the Project by putting in a fair amount of technical assistance compared to other ordinary grant aid projects. This was a special characteristic of the Project and it is what led to the success of the Project. The timing of the commencement of the technical assistance was appropriate, as training started prior to the completion of the power generation facilities. Once the facilities started operating, OJT on the actual operation and maintenance was jointly conducted with the Japanese and local consultants at the same time. This way it became possible to foster personnel capable of properly conducting basic operation and maintenance of the facilities. The introduction of manuals and data recording methods matching the technical level of operators was the key to successfully ensure the technical sustainability up to a certain level. This Project constitutes a very good precedence for similar projects in the future.

- Importance of establishing a relationship of trust with local residents, collaboration and practical use of local NGOs

The Alta Verapaz Department where the three sites of the Project are located had been receiving assistance related to rural electrification using renewable energy from other donors through the Solar Foundation, a local NGO, since 2004 (see footnote 2 for details). As such, at the time of the planning of the Project, there was already a relationship of strong trust between this NGO and the local residents. Through the activities of this NGO, the necessity for the empowerment of women was already well understood by male residents. In Guatemala, when any project is implemented in a rural non-Spanish speaking area with difficult access and with a high poverty rate, building a relationship of trust between the donor and the beneficiaries is extremely important for the success of the project. In this Project, employing a trusted local NGO as a local consultant to conduct technical assistance enabled the good use of the above mentioned relationship of trust.

- Registration of infrastructure development projects as state assets in Guatemala

Land ownership in Guatemala is a very complicated issue due to the country's historical background. Many small-scale projects have been implemented based on an officially registered document approving land use rights between a land owner and user in accordance with customary law. However, if the assets of a project are not registered as state assets, the budget required to deal with a large-scale accident or breakdown may not be secured as has been the case of this Project. For similar infrastructure projects in the future, careful consideration should be given in the stage of project formulation and planning, in order to secure both the transfer of land ownership and registration as state assets.