

Country Name	Project for Introduction of Clean Energy by Solar Electricity Generation System (el Proyecto para Introducción de Energía Limpia por Sistema de Generación de Electricidad Solar)
Plurinational State of Bolivia	

I. Project Outline

Background	In Bolivia, over 59% of the electric power output was generated by thermal power and 39% by hydropower in 2013. The rest of the power output (2%) was generated by biomass. In the same year, the total power generation capacity reached 1,682.3 MW in the national interconnected system and independent systems: thermal power accounted for 1,188.5 MW and hydropower accounted for 493.8 MW. The Government of Bolivia considered the promotion of research work and the introduction of renewable energies in order to enhance national independence in energy for which it requested assistance to the Government of Japan.						
Objectives of the Project	To increase power generation capacity, diversify power sources, and raise awareness of people of Bolivia for utilization of renewable energy by procurement of photovoltaic (PV) system and related equipment in the Viru Viru International Airport and the Major University of San Andrés (Universidad Mayor de San Andrés: UMSA) as well as technical assistance for capacity building of technical personnel, and thereby contributing to the demonstration of Japan's initiatives for promoting collaborative efforts by both developed and developing countries against climate change.						
Contents of the Project	<ol style="list-style-type: none"> Project Site: La Paz City and Santa Cruz City Japanese side <ol style="list-style-type: none"> PV generation systems (UMSA: 50kW, Viru Viru International Airport: 315kW) (PV modules, power conditioner, transformer, data recording devices, power display board, and others) and PV system spare parts and maintenance tools Technical assistance (soft component): Training on basic knowledge, technical characteristics, preventive inspection, operation, and maintenance (O&M) including the emergency response of grid-connected PV system Bolivian side: Land acquisition and preparation, other expenses related to the procurement of equipment and contracted agent which was not covered by grant aid and its interests 						
Project Period	E/N Date	March 19, 2010		Completion Date (ex-ante)	February 2015	Completion Date (actual)	July 21, 2017
	G/A Date	August 31, 2010 March 20, 2012 (Amendment 1) January 9, 2013 (Amendment 2) November 8, 2013 (Amendment 3)					
Project Cost	E/N Grant Limit / G/A Grant Limit: 440 million yen			Actual Grant Amount: 440 million yen			
Implementing Agency	Major University of San Andrés (UMSA), Administration of Airports and Auxiliary Services to the Air Navigation (AASANA) ¹						
Contracted Agencies	Main Contractor: Marubeni Protechs Corporation Main Consultant: Nippon Koei Co., Ltd. Agent: Crown Agents Ltd.						

II. Result of the Evaluation

<Special Perspectives Considered in the Ex-Post Evaluation>

- The project was extended for two years and completed in 2017. For verification of qualitative effects, target figures were set as objectives three years after completion in the ex-ante evaluation. Therefore, the actual achievement in 2020 was compared for with these target figures in the ex-post evaluation.

1 Relevance

<Consistency with the Development Policy of Bolivia at the Time of Ex-Ante Evaluation>

In the "National Development Plan" (2006-2011), one of the main policies was to introduce renewable energy, including solar energy, and to conduct research and development in order to establish energy independence as a nation. In addition, one of the medium-term goals (2011-2015) was to increase the supply of electricity through the development of renewable energy. Bolivia ratified the 3rd Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP3) and Kyoto Protocol. Thus, the project was consistent with the development policy of Bolivia at the time of ex-ante evaluation.

<Consistency with the Development Needs of Bolivia at the Time of Ex-Ante Evaluation>

At the time of ex-ante evaluation, the power outputs were generated by thermal power, hydropower, and biomass in Bolivia, and there was a need for the introduction of renewable energy including solar power in order to enhance the national independence in energy.

<Consistency with Japan's ODA Policy at the Time of Ex-Ante Evaluation>

One of the priority areas was productivity improvement through regional development. Promotion of infrastructure development was emphasized for the country's sustainable economic growth, especially electricity and roads². In addition, the project was implemented under a scheme of "Program Grant Aid for Environment and Climate Change", which the government of Japan newly introduced in 2008 in order to support developing countries with the willingness to contribute to the mitigation of climate change but with lack of capacity and fund to balance between their economic growth and greenhouse gas reduction." Thus, it was consistent with Japan's ODA policy at the time of ex-ante evaluation.

¹ Se anunció en diciembre de 2021 que AASANA sería desmantelada dentro de dos años por la decisión del gobierno (Decreto Supremo 4630) y que su propiedad sería asumida por una nueva entidad.

² Ministry of Foreign Affairs, "ODA Databook" (2013).

<Evaluation Result>

In light of the above, the relevance of the project is high.

2 Effectiveness/Impact

<Effectiveness>

The project objectives, namely increase in power generation capacity and reduction of CO₂ emission at UMSA and AASANA have been partially achieved. As quantitative effects, power generation at the transmission end mostly reached the target value at only UMSA three years after the project completion (Indicator 1). In 2018, the PV systems of both plants were disconnected for five months, due to pending requirements between the regulatory authority and distribution companies. Since 2019, power generation has been mostly as planned at UMSA. AASANA has outsourced the O&M work of the PV plant to the electric power company named ENDE Guaracachi since 2019. In 2020, unforeseen disconnection occurred during the period of the COVID-19 pandemic, as there were restrictions on access to the facility at AASANA. Furthermore, since there has been no economic benefit from connecting to the grid of the Rural Cooperative of Electrification (Cooperativa Rural de Electrificación: CRE), it has been difficult for ENDE Guaracachi to sustain has not had enough motivation for the operation of the PV plant. ENDE Guaracachi has requested to utilize more space near the PV plant to expand the facility and increase power generation capacity to 5 MWp³. The estimated reduction of CO₂ emission achieved the target value at only UMSA (Indicator 2). As supplemental information, power generation has contributed to the reduction in electricity consumption by 18% compared to before the project at UMSA. On the other hand, the PV system of AASANA has not been connected to any airport facility but just to the air-conditioning equipment of the PV plant not for sales, and thus AASANA has recognized only little benefit of the PV system for them.

As qualitative effects, firstly, UMSA has operated and maintained the PV system as expected. UMSA cleaned the system and evaluated its functions in 2018 and 2019, and prepared the maintenance plan and some technical documents for 2020 and afterward. Also, the Institute of Investigation on Electric Engineering (IIIE) has carried out monthly activities to report to the Electric Engineering Department of regarding the power generation. ENDE Guaracachi has performed periodic inspections of the PV plant to verify its operation, cleaning of panels, maintenance of air conditioning equipment and green areas. ENDE Guaracachi has kept a monthly record of power consumption and production. Secondly, UMSA conducted various activities to explain to the public about the effectiveness of the PV plant and its contribution to the environment, such as i) training on PV power with the grid connection system for technicians of the electric power sector, university and institutions in 2017 in collaboration with the Vice Ministry of Electricity and Alternative Energies (Viceministerio de Electricidad y Energías Alternativas: VMEEA) and the German Corporation for International Cooperation (GIZ), ii) seminars for students of various courses of the Electric Engineering Department in 2020 and 2021, and iii) seminars for teachers and students of Virgen de Copacabana School (secondary school) in 2021. Also, AASANA conducted training on PV energy with the grid connection system for technicians of the electric sector in 2017 in collaboration with VMEEA and GIZ and received students of two high schools (Doming Savio and Isabel Saavedra) and two other organizations to explain the PV system and its advantages in 2018. However, such explanatory sessions have not been carried out to the public at AASANA, because it is not included in the agreement with ENDE Guaracachi

<Impact>

In 2017, the Partners' Group in the energy sector was created to promote coordination, communication, and exchange between the Government of Bolivia and international donors on issues related to the renewable energy and electricity policy. JICA has assumed the leadership of this group since February 2020. Thus, it can be said that Japan's initiative for promoting measures against climate change has been demonstrated through the implementation of the project.

Several other positive impacts have been reported by UMSA. Firstly, thanks to the UMSA and AASANA's PV plants which have worked as Pilot Plants of the solar electricity generation system, the Government of Bolivia enacted Supreme Decree No. 4477 in 2021 on distributed generation to encourage electricity generation for self-consumption through grid-connected renewable sources especially PV energy. The enactment of the decree, as well as a decrease in the price of the PV panels and accessories, has motivated more and more individuals and companies to install the PV system and distribute power generation. This has resulted in the need for training for individuals, companies, and academic institutions. IIIE of UMSA has been working on the development of a diploma course on PV system engineering, and it has been planned that the case of O&M of UMSA's grid-connected PV system would be included in the course modules. Secondly, taking advantage of the installation of the PV plant, UMSA has worked on projects so that undergraduate students of the Electrical Engineering Program could graduate as electrical engineers. Thirdly, as the PV plant has been established on the campus, more female students have come to get interested in alternative energies, especially photovoltaic solar energy than before.

There have been no negative impacts by the project including those on the natural environment.

<Evaluation Result>

In light of the above, the project objectives have been partially achieved. Therefore, the effectiveness/impact of the project is fair.

Quantitative Effects

		Baseline (2013) Baseline Year	Target (2018) 3 year after Completion	Actual (2018) 1 year after Completion	Actual (2019) 2 year after Completion	Actual (2020) 3 year after Completion	Source
1. Power generation volume at transmission end (MWh/year)	AASANA	0	374	158	275	162	AASANA
	UMSA	0	80	52	77	78	UMSA
	Total	0	454	210	352	240	
2. Estimated reduction of CO ₂ emission (ton/year)*1	AASANA	0	228	96	168	99	AASANA
	UMSA	0	48	31	47	48	UMSA
	Total	0	277	127	215	146	

*1: The estimated reduction of CO₂ emission at AASANA and UMSA was calculated by multiplying the generation output by the emission reduction unit. The unit used in the ex-ante evaluation was 0.61. The same unit was used in the ex-pot evaluation.

3 Efficiency

³ According to the agreement exchanged between AASANA and ENDE, AASANA will provide ENDE with 15 hectares of land for 30 years as a free deposit under the Supreme Court decision, and then ENDE will transfer the land to ENDE Guaracachi, which will build and operate a power plant to supply the population of Santa Cruz and the country.

Although the project cost was as planned (ratio against the plan: 100%), the project period exceeded the plan (ratio against the plan: 211%). This is because much time was needed for the bidding process and customs clearance which required many documents. Also, there was a change of authority and counterpart personnel during the project implementation period, and thus it took time to explain them about the project and get approval for activity implementation. On the other hand, the outputs were produced as planned. Therefore, the efficiency of the project is fair.

4 Sustainability

<Institutional/Organizational Aspect>

UMSA has sustained the organizational structure for O&M of the PV system. It has appointed the personnel responsible for the operation, maintenance, and materials and maintenance tools, supervised by the director of IIIE. The personnel in charge of O&M of the PV plant have been a research professor and a research assistant. They have monthly used 64 hours for O&M work in 2020 and 2021, which has been hindering their research work. For the PV system at AASANA, ENDE Guaracachi has assigned a manager and an electrical engineer, and they have considered that the number of personnel has been sufficient for O&M of the PV plant. However, as explained earlier, ENDE Guaracachi has not been enough motivated for operating a small plant without financial return, and there has not been a certainty to continue the agreement, according to ENDE Guaracachi and AASANA.

<Technical Aspect>

At UMSA there was training for the personnel for O&M of the PV system in 2018, but since 2019 no training has been conducted. However, the assigned personnel have known electric engineering and thus been capable of O&M of the PV system. Also, the manual developed by the project has been referred to for preparing the maintenance plan and developing the undergraduate Electrical Engineering Program. UMSA has planned to utilize the data and information that they have collected for future training. ENDE Guaracachi has trained its personnel with the information provided by AASANA. Besides, ENDE Guaracachi has a training system per its policy and procedure. As ENDE Guaracachi has operated bigger power plants, there has been no problem for their O&M of the PV system at AASANA.

<Financial Aspect>

Although UMSA has secured more budgets than planned, they have not been sufficient. Most of the budgets have been for remuneration of O&M for the researcher and research assistant and salary of the security guard which had not been expected at the preparatory survey. UMSA has desired to include the budget after 2022 for hiring exclusive personnel for O&M. AASANA did not assign any budget for O&M of the PV plan because they do not have mandate for the operation of PV plant. However, since the agreement with AASANA, ENDE Guaracachi has annually budgeted an amount dedicated to the plant O&M. Besides, it has insured all the components of the plant for a value of 300,000 US dollars.

Budget for O&M of the PV system at UMSA (USD)

	2018	2019	2020	2021
Equipment maintenance	0	0	0	0
Employment	772	784	1,313	1,313
Management and others	459	459	459	459
Total	1,231	1,243	1,772	1,772

Source: UMSA.

Budget for O&M of the PV system at ENDE Guaracachi (US\$)

	2018	2019	2020	2021
Equipment maintenance	NA	NA	30,000	30,000

Source: ENDE Guaracachi

<Current Status of Operation and Maintenance>

All of the equipment and spare parts procured by the project have been in a good condition and functioning at UMSA. All the devices have been readjusted every quarter to check if any of them needs to be replaced. Spare parts and consumables can be purchased in Bolivia but normally it takes at least one month. At AASANA, three PV modules and air-conditioning equipment were stolen in 2018. After this incident, AASANA assigned a guard until ENDE Guaracachi started the operation. Spare parts, measurement and adjustment devices have been stored at AASANA's warehouse and not been transferred to ENDE Guaracachi yet.

<Evaluation Result>

Some minor problems have been observed in terms of the institutional/organizational aspect, financial aspect, and current status of operation and maintenance. Therefore, sustainability of the project effects is fair.

5 Summary of the Evaluation

The project objectives have been partially achieved. In other words, power generation capacity and reduction of CO₂ emission have reached the target at one plant but not the other. Regarding sustainability, there have been issues related to the assignment of the personnel exclusively dedicated personnel at one plant and also the agreement for outsourcing O&M of the PV system at the other plant. As to efficiency, the project cost was as planned but the project period exceeded the plan.

Considering all of the above points, this project is evaluated to be partially satisfactory.

III. Recommendations & Lessons Learned

Recommendations to Executing Agency:

- It is recommended to UMSA to secure a budget and assign personnel exclusively responsible for O&M of the PV system, by adding them in the annual operational plan and/or collecting some fee from the seminars for private sector on PV energy with the grid connection system,
- It is recommended to AASANA to clarify its O&M strategy of the plant, and permit ENDE Guaracachi to use the maintenance spare parts and data measurement and adjustment devices procured by the project.
- In order to make higher effectiveness of the PV plant and to raise awareness of the public on the use of renewable energies, it is recommended to AASANA to fix the power generation monitor which has been installed in the VIRU VIRU airport and device the monitor location and display methods for further awareness raising.

Lessons Learned for JICA:

- In the project, power generation at the transmission end has been far below the target at AASANA. Although the sales of the generated power was not included in the project objectives, AASANA and the current O&M company for operation of the PV plant have not been much motivated by the little economic benefit from connecting to the grid due to the small capacity of the PV systems.. If the sales of the generated power is expected after the project completion, necessary conditions are the registration required for the grid-connection and contract of O&M and sales. In projects for electricity generation in which the implementing agency does not have the mandate of electricity generation and sales, it is necessary to confirm that the implementing agency has a strong initiative for the project especially in terms of budget security and that there is a legal framework which allows the electricity generation, distribution

and selling. These should be conditions before the project commencement, not external conditions for the operation of the constructed facility. If there are concerns about these conditions, they should be identified as risks at the project formulation stage and have common understanding with the implementing agency and continue discussion for solution.



Solar panel installed at UMSA.



Solar panel installed at AASANA.