Internal Ex-Post Evaluation for Grant Aid Project

conducted by Honduras Office: October 2020

Country Name	Micro-Hydroelectric Power Generation Project in the Metropolitan area of Tegucigalpa
Republic of Honduras	

I. Project Outline

Background	In Honduras, there have been issues in the power sector, such as 1) high dependence on thermal power generation (57%), 2) high transmission and distribution losses (over 20%), and 3) power tariffs system without reflection of generation costs. In particular, the high dependence on thermal power generation resulted from the intensive development of small scale thermal power generation plants in the late 1990s. This led to the increasing import of fossil fuels and their soaring prices as well as the pressure on the fiscal balance due to the increasing expenditures for power subsidy.			
Objectives of the Project	To promote renewable energy use and improve the operation of the two target water treatment plants in Tegucigalpa Metropolitan Area (Concepción and Picacho) (through reduction of buying electricity), by installations of small-scale hydroelectric power generation facilities at the target water treatment plants, thereby contributing to socio-economic development and reduction of emissions of greenhouse gases.			
Contents of the Project	1. Project Site: Concepción Water Treatment Plant and Picacho Water Treatment Plant in Tegucigalpa City 2. Japanese side: Construction works, procurement of equipment (hydraulic turbines, generators, turbine/generator control system, etc.), technical training (water distribution from the water treatment plants and water required for power generation, operation of the water distribution plan, maintenance management). 3. Honduran Side: Land acquisition, land clearance, provision of waste disposal sites, maintenance of access roads, etc.			
Project Period	E/N Date	March 18, 2013	Completion Date	December 15, 2015
	G/A Date	March 18, 2013		
Project Cost	E/N Grant Limit: 952 million yen		Actual Grant Amount: 952 million yen	
Implementing Agency	National Autonomous Service of Aqueducts and Sewerage (SANAA)			
Contracted Agencies	Main Contractor: Hazama Ando Corporation. Main Consultants: NEWJEC Inc., Nihon Techno Co. Ltd.			

II. Result of the Evaluation

<Special Perspectives Considered in the Ex-Post Evaluation>

・ In the ex-ante evaluation, one of the quantitative measures of effectiveness was the reduction of CO2 emissions, which was a result of promoting the use of renewable energy (outcome). In the ex-post evaluation, this was verified as one of the expected positive impacts.

<Constraints of Evaluation>

・ Because of the outbreak of COVID-19, information was collected through a questionnaire survey and phone interviews to make evaluation judgment in the ex-post evaluation. Site visits were not conducted.

1 Relevance

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

The Government of Honduras announced a policy to actively promote the introduction of renewable energy from the viewpoints of energy security and diversification of primary energy sources, curbing greenhouse gas emissions, and so on, in the “National Vision 2010-2038” and the “National Plan 2010-2022.” Thus, the project was consistent with the development policy of Honduras at the time of ex-ante evaluation.

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

In Honduras, the high dependence on thermal power was an issue to be tackled. This resulted in the expanding current account deficit associated with the increase in fossil fuel imports and the rise in fossil fuel prices as well as the larger pressure on the fiscal balance by the increase in electricity subsidy spending. The project, which aimed to promote the use of renewable energy and the efficient operation of the existing water treatment plants, was consistent with the development needs of Honduras at the time of ex-ante evaluation.

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

In the “Country Assistance Policy for Honduras” (2012), "disaster prevention measures" was identified as a priority area, and the project, which aimed to mitigate the impact of climate change in the country through the promotion of the use of renewable energy, was positioned in line with this priority area. Thus, it was consistent with Japan's ODA policy at the time of ex-ante evaluation.

<Appropriateness of Project Design/Approach>

In the project, the target values of the amount of power generation volume at the power generating end had been set within a certain range of the level of dam water and the amount of water pumped. However, climate change reduced the number of days of rainfall needed to maintain dam levels, and the demand for civilian water supply increased as the urban population grew. Therefore, at the time of ex-post evaluation, the operation level of the small hydroelectric power generation facilities was not attaining to the level initially expected. Although the approach itself to generate electricity using renewable energy through the construction and procurement of equipment for the small hydroelectric power generation and to improve the operation of the water treatment plants by reducing the electricity purchase amount was appropriate, it appears that the analysis of possible changes in external conditions and also target values were not sufficient at the preparatory survey and ex-ante evaluation.

<Evaluation Result>

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

2 Effectiveness/Impact

<Effectiveness>

The project objectives, namely promotion of renewable energy use and efficient operation of the water treatment plants, have been limitedly achieved. At both power generation plants of Concepción and Picacho, the power generation volume at the power generating end has not reached the target values of 2018 (1,650 MWh/year and 520 MWh/year, respectively) (Indicator 1). The reason for this is that the Concepcion Water Treatment Plant was continuously improved and expanded to meet the growing demand for water supply in the municipality, because the development of new water sources by the Government of Honduras was delayed, and this resulted in an increase in water delivery from the dam and then an increase in the friction loss in the conduits[1]. Accordingly, the effective drop was reduced. Also lowered dam levels due to reduced rainfall caused by climate changes also interfered with an effective drop that could generate electricity. Furthermore, as SANAA (implementing agency) has put the first priority on water supply, it has needed to attend the increasing demand for water supply due to the increasing population. Therefore, the power generation by the plant of Concepción has been suspended since February 2017. At the power generation facility of Picacho, the target amount of generated energy at the power generating end for 2018 was set based on water supply hours of about three to four days a week before the implementation of the project. However, at the time of ex-post evaluation, the water supply was limited to only one day a week caused by the water supply restrictions due to insufficient rainfalls, the generator's operating hours were limited. In addition, the flow rate during the water supply did not reach the generation flow rate. As a result, the power generation volume remained at only 75.2 MWh/year (126.9 MWh/year in 2019). Thus, power generation facilities of both plants have generated less electricity than planned, and the electricity cost reduction has not reached the target value (Indicator 2). It should be noted that it was not confirmed the actual performance of procured equipment in accordance with the original specifications at the ex-post evaluation.

As a qualitative effect, the operation and maintenance system of water distribution and power generation facilities by SANAAhas been strengthened. The first reason for this is that the power generation facility of Concepción was in operation until February 2017 and that of Picacho has been operated as of the time of ex-post evaluation, and those facilities have been maintained. Therefore, it can be said that the engineers for both power facilities obtained the basic knowledge of hydropower generation technology, power generation and distribution, and water distribution system operation, through the training provided in this project. Secondly, in order to strengthen the operation system for the power generation facilities, the small hydropower team was formed to be in charge of the operation and maintenance of the power generation facilities, and the following manuals and formats were developed (operation manual for the electricity business, ledgers of equipment, spare parts and fixtures, monitoring forms, operation manual of power generation equipment, inspection, and maintenance manual of power generation and distribution equipment, water distribution plan, operation manual of water distribution equipment, inspection, and maintenance manual of water distribution equipment).

<Impact>

The use of renewable energy promoted by the project was expected to reduce CO2 emissions. However, as mentioned earlier, both water treatment plants have limited energy generation, and accordingly, he CO2 emission reductions have not reached the expected level (Table 1).

Table 1: CO2 Emission Reduction

	Target 2018	Actual 2016	Actual 2017	Actual 2018	Actual 2019
Concepción	645	79.84	6.18	0	0
Picacho	203	11.61	19.59	29.40	49.62

Source: SANAA.

Note: A reduction coefficient of 391g/kWh was used to calculate CO2 emission reduction.

Among other impacts, the project was the first pilot small hydro project in Honduras to use renewable energy by utilization of unused energy produced by the water purification process. Although the technology has not yet been applied by other water treatment plants, it has been introduced to the public through newspapers and tours of the facilities for university and high school students. Besides, at the Concepción Water Treatment Plant, the additional conduits constructed by the project to reduce friction losses contributed to the increase in water pumped volume to meet the recent increasing water demand. Also, the conduits facilitated the decrease in the operating hours of booster pumps, which resulted in the reduction of power consumption for water purification through

For the construction of power generation facilities, there was an acquisition of vacant land adjacent to the existing aeration system at Concepción and vacant land on a slope along the existing water distribution channel at Picacho. Both properties were privately owned, and SANAA negotiated with the landowners following the regulations and no negative impact has occurred. There has been no negative impact on the natural exvronment.

<Evaluation Result>

In light of the above, the project objectives have not been achieved. Therefore, the effectiveness/impact of the project is low.

Quantitative Effects

Indicator		Baseline 2012	Target 2018 3 years after project completion	Actual 2016 1 year after project completion	Actual 2017 2 years after project completion	Actual 2018 3 years after project completion	Actual 2019 4 years after project completion
Power generation volume at the power generating end (MWh/year)	Concepción	-	1,650	204.2	15.8	0	0
	Picacho	-	520	29.7	50.1	75.2	126.9
Electricity cost reduction (US$/year)	Concepción	-	225,967	15,823	1,227	0	0
	Picacho	-	71,214	2,301	3,882	5,827	9,833

Source: SANAA.

3 Efficiency

The project cost was as planned (ratio against the plan: 100%). On the other hand, the project period exceeded the plan (ratio against

[1] At the Concepción site, small-scale hydroelectric power generation uses the difference in elevation between the water level of the storage dame ad the water level of the aeration system to generate electricity. In the project, additional conduits were installed in the waterway from the dam to reduce friction losses in the conduits, thereby increasing the effective drop.

the plan: 142%). The reason was that at the Picacho Power Treatment Plant, a pipe connection failure occurred during the trial period, and the equipment broke down due to a water leak. It took time to get the replacement parts from the manufacturer and then test drive them. Therefore, the efficiency of the project is fair.

4 Sustainability

<Institutional Aspect>

At the time of ex-post evaluation, the waterworks were being prepared for transfer from SANAA to the Municipality of Tegucigalpa, and the water treatment plants of Concepción and Picacho remained under the control of SANAA. The power generation facility of Concepción has been stopped as mentioned above and has not been staffed. The organizational structure has not been sustained. As for the prospect of resuming operations, technical alternatives have been considered, and a trial run has been considered after an overhaul of the facility, if the power generation conditions are met. At Picacho, there have been five operators and three personnel in charge of maintenance (as well as security), with shifts that have allowed 24-hour operation.

<Technical Aspect>

The operation and maintenance of the power generation facilities require knowledge of hydropower generation technology and the function and structure of power generation, distribution, and drainage facilities. For the power generation facility at Concepción, the relevant manuals and formats have not been used, as the facility has been closed. It can be judged that the staff assigned to the power generation facility at Picacho has sustained the necessary knowledge as it has been operated and maintained. The manuals for operation and maintenance of the power generation and distribution facilities, as well as water distribution facilities prepared by the project have been utilized. The ledgers were revised into a single form and have been utilized. Periodic monitoring formats have been also utilized. On the other hand, the manual and formats for the operation of the electricity business have not been used because no electricity has been sold. To maintain the technical level of the personnel, training was provided for new personnel, and daily operations have been provided through On the Job Training (OJT). Technical support has been available from ENEE if needed.

<Financial Aspect>

For SANAA's waterworks for the metropolitan area, expenditures have exceeded revenues until 2019. However, according to SANAA, payments for maintenance of facilities and equipment, including personnel costs for operating the power generation facility at Picacho, have been made appropriately. On the other hand, because of the limited power generation volume at the power generating end, the operation and maintenance expenditures have exceeded revenues that would have been generated from the sale of electricity. Both the revenues and expenses have been down in 2019 due to the preparation period for the transfer of water services to the municipality.

Table 2: Revenue and expenditure of SANAA

	2017	2018	2019
Revenue	776,268,631	1,122,304,152	794,343,663
Expenditure	1,036,798,931	1,185,049,045	924,460,166

Source: SANAA.

<Current Status of Operation and Maintenance>

At both Concepcion and Picacho, the power generation facilities and main equipment (power plant buildings, water turbines, generators, divider valves, electric water intake valves, transformers and lightning rods, and so on) have been in good conditions. However, as mentioned above, the power generation facility at Concepcion has been closed and not maintained. At the Picacho power generation facility, pressure and vibration over time have caused cracks in the fasteners of the water pipes. Besides, there has been noise from the bearings on the generator shaft since the beginning, which the contractor tried to adjust but did not resolve. However, these issues have not affected operations.

In terms of maintenance of the Picacho power generation facility, the Energy Efficient Utilization Unit has conducted daily tours of the facility. The Maintenance Department has planned degradation overhauls inspections every five and 10 years, respectively. Consumables and spare parts have been prepared without problems. The daily operation record has been kept in the ledger.

<Evaluation Result>

There have been slight issues in the institutional and financial aspects and current status of operation and maintenance. Therefore, the sustainability of the project effect is fair.

5 Summary of the Evaluation

The achievement of the project objectives, namely promotion of the use of renewable energy and the efficient operation of the water treatment plants, have been limited. This was because the conditions under which power could be generated, such as the dam water level and the pomped water volume, were not met. Regarding sustainability, one of the power generation equipment has not been operating, and accordingly, less staff has been assigned. As to efficiency, although the project cost was as planned the project period exceeded the plan.

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

III. Recommendations & Lessons Learned

Recommendations to Implementing Agency:

- It is recommended that SANAA conduct a trial run of the Concepcion power generation equipment that has not been in operation for more than two years, by adjusting the delivered water volume when the dam water level satisfies the required condition for power generation in the rainy season, in order to confirm whether or not the equipment be ready for use (e.g., whether or not it be defective or deteriorated). The condition of the equipment would be an important piece of information for SANAA and JICA to consider feasible measures. For preparation of the trial, overhauling may pose a risk of electrical leakage. If the manufacturer needs to be present during the overhaul, it is advisable to consult JICA Honduras Office.

Lessons Learned for JICA:

- Although one of the intended quantitative effects of the project was an increase in the power generation volume at the power generation end, it was much lower than the target. This is since the conditions to be able to generate electricity, such as the dam water level and the amount of water pumped, have not been met, leading to a decrease in the number of days that power can be generated and to the suspension of operations. Therefore, in projects which introduce small-scale hydropower generation using unused energy produced at water treatment plants, it is necessary to project the increase or decrease in rainfall, the expansion of water supply demand due to the future increase in urban population, and the partner government’s plan for water source development, including undesirable cases, in the preparatory survey and set the power generation conditions that could respond to long-term changes and develop the water supply

plan. In relation to this, it is desirable to consider the specifications of the equipment for small hydropower generation to meet these conditions. Even small hydropower projects should be studied and examined in the same way as regular hydropower projects to a possible extent.

- In the case of renewable energy use in water treatment facilities, the public water supply corporation puts a priority on the water supply to citizens, so it cannot optimize the conditions that sacrifice water supply for power generation, which could be a secondary service. For projects which support secondary services for the implementing agency, it is necessary to confirm the possible influence caused by the trends of the primary servies (water supply service in the case of this project). Therefore, it is advisable to consider several scenarios in the preparatory survey on targets for the number of days available for electricity generation and the power generation volume at the power generation end and cost-effectiveness including maintenance costs, from the viewpoint of the operation of the power generation facility, which is based on realistic water supply plans and is positioned as an adjunct to the water supply facilities.

Inside the building of Concepción power generation plant

Inside the bulding of Picacho power generation plant