Republic of the Philippines

FY 2020 Ex-Post Evaluation of Grant Aid Project

"Mini-Hydropower Development Project in the Province of Ifugao"

External Evaluator: Takako Haraguchi, i2i Communication, Ltd.

0. Summary

This project aimed to promote the use of domestically produced renewable energy by developing a mini-hydro electric power plant in Ifugao Province in northern Luzon Island, thereby contributing to the conservation of rice terraces as a regional tourism resource and to the reduction of greenhouse gas emissions. The relevance of the project is high because these objectives are consistent with the development plans and development needs in the Philippines and with Japan's aid policy. The power generation capacity of the Likud Mini-Hydro Power Plant (hereinafter referred to as "LMHPP") constructed under the project has been mostly maintained at the planned level. However, the plant has not been sufficiently operational due to the unapproved power supply agreement (hereinafter referred to as "PSA") and damage to civil engineering facilities such as the headrace. It is still out of commission at the time of the ex-post evaluation. Thus, no rice terrace conservation activities have been started using the income from electricity sales. Therefore, although there were some secondary effects, including the effects on agricultural aspects, the effectiveness and impact are judged to be low. The project outputs were mostly generated as planned, but the project cost and period exceeded the plan. Therefore, the efficiency is fair. The sustainability of the project effects is fair because the operation and maintenance of the project faced some problems due to the condition of some of the facilities.

In light of the above, this project is evaluated to be unsatisfactory.

1. Project Description

Project Location

Constructed Likud Mini-Hydro Power Plant

1.1 Background

Since the enactment of *the Renewable Energy Act of 2008*, the shift to renewable energy was actively pursued in the Philippines from the perspective of energy security and greenhouse gas emissions reduction. Although its impact on the overall energy balance would be small, the country hoped to actively develop small-scale hydropower generation because this type of power generation would be less challenging in terms of financing and environmental and social considerations than large-scale hydropower development. Ifugao Province, located in northern Luzon Island, has one of the highest potentials for small-scale hydropower generation in the country due to its abundant water resources and steep terrain. However, more than 90% of its annual electricity demand in 2011 relied on electricity supply from outside the province. The development of new power generation projects using small-scale hydropower was one of the important agendas.

In addition, there was a need to conserve the Ifugao Rice Terraces, which were registered as a World Heritage Site by the United Nations Educational, Scientific and Cultural Organization (UNESCO). Before this project, an initiative was underway to allocate part of the proceeds from the sale of electricity from the Ambangal Mini-Hydro Power Plant (hereinafter referred to as "AMHPP") (200 kW) installed in the province in 2010 with support from the Global Sustainable Electricity Partnership (hereinafter referred to as "GSEP," formerly known as e8; a framework for international support established by major power companies of the G8 countries, including Japan), for the conservation of rice terraces through the Rice Terraces Conservation Fund (hereinafter referred to as "RTCF"), which was established at the same time as the AMHPP. This project was also expected to expand this initiative.

1.2 Project Outline

The objective of this project is to promote the use of domestically produced renewable energy by developing a mini-hydro electric power plant (820 kW) in Ifugao Province in northern Luzon Island, thereby contributing to the conservation of rice terraces as a regional tourism resource and to the reduction of greenhouse gas emissions.

Grant Limit / Actual Grant Amount	893 million yen (original), 922 million yen (amended)[1] / 921 million yen
Exchange of Notes Date /Grant Agreement Date	March 2013 (original), March 2015 (amended) / April 2013 (original), May 2015 (amended)

[1] In this project, an amended Exchange of Notes and Grant Agreement were signed to increase the grant limit in order to accommodate the increase in project cost due to a change in scope after the start of the project (see "3.2 Efficiency").

Executing Agency	The Department of Energy (DOE)[2]
Project Completion	July 2015
Target Area	Barangay Haliap in Asipulo Municipality, Ifugao Province
Main Contractor	Iwata Chizaki Inc.
Main Consultant	Tokyo Electric Power Services Co., Ltd.
Basic Design/Preparatory Survey	July 2012 – March 2013
Related Projects	Development of the AMHPP by GSEP and Establishment of the RTCF (2010)

2. Outline of the Evaluation Study

2.1 External Evaluator

Takako Haraguchi, i2i Communication, Ltd.

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: December 2020 – January 2022

Duration of the Field Study: March 2021 (Remotely conducted from Japan due to the spread of the coronavirus[3])

3. Results of the Evaluation (Overall Rating: D[4])

3.1 Relevance (Rating: ③[5])

3.1.1 Consistency with the Development Plan of the Philippines

The development of renewable energy, including small-scale hydropower, has been promoted in the national and provincial development plans both at the time of the ex-ante and ex-post evaluations. Conservation of rice terraces has also been consistently pursued in the provincial development plans. Therefore, the consistency between this project and the development plan of the Philippines is high.

[2] In the ex-ante evaluation paper, the Provincial Government of Ifugao (hereinafter referred to as "PGI") was designated as the executing agency, and the DOE was designated as the supervising agency. This ex-post evaluation report aligns designations to the ones described in the grant agreement and official documents prepared during the project implementation.

[3] Under the direction of the ex-post evaluator, a local assistant residing in the suburbs of Manila conducted interviews with the executing agency and related organizations and made site visits. Some interviews were conducted online by the ex-post evaluator.

[4] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[5] ③: High, ②: Fair, ①: Low

At the time of the ex-ante evaluation, the promotion of the development and use of renewable energy, including hydropower, based on *the Renewable Energy Act of 2008,* is stated in *the Philippine Development Plan 2011–2016*, the national development plan, and *the National Renewable Energy Plan (2011–2030)*. In particular, these plans emphasize small-scale hydropower from the perspective of financing and environmental and social considerations. At the provincial level, Ifugao Province enacted *the Mini-Hydro Electric Power Development Program Ordinance No.2007-045* in 2007 to "increase the provincial development budget," "reduce electricity tariffs in the province," and "secure funds for rice terraces conservation," and encourages the development of small-scale hydropower in the province.

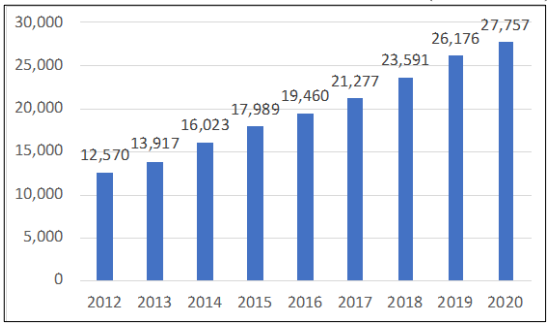
At the time of the ex-post evaluation, further promotion of renewable energy development and the promotion of the Electric Cooperative-owned Distributed Generation Facility Program are stated in the national development plan, *the Philippine Development Plan 2017–2022* (updated in February 2021). At the provincial level, *the Provincial Development and Physical Framework Plan 2017–2022* includes small-scale hydropower development as one of the infrastructure development goals. *The Mini-Hydro Electric Power Development Program Ordinance No.2007-045* stated above also remains effective.

3.1.2 Consistency with the Development Needs of the Philippines

Electricity demand and the need for small-scale hydropower development in Ifugao Province, as well as the need for rice terrace conservation through the sale of electricity, have been consistently high from the time of the ex-ante evaluation to the time of the ex-post evaluation.

As shown in Figure 1, electricity demand in Ifugao Province consistently increased from the time of the ex-ante evaluation to 2020. This is due to the progress in household electrification. The average annual growth rate of demand increased from 6.7% in 2001–2010 to 10.4% in 2012–2020. The peak demand shifted from 2.97 MW in 2013 to 6.97 MW in 2019, an increase of 135%. At the time of the ex-ante evaluation, the power was supplied by purchase from independent power producers (IPPs), with the exception of the AMHPP (200 kW) owned by the province. At the time of the ex-post evaluation, the LMHPP (820 kW) constructed under the project was added to this source. However, this did not change the situation that the province relied on purchases from IPPs for more than 90% of its electricity demand (see also "3.3.2 Impacts").

(Unit: MWh)



Source: Documents provided by the PGI

Figure 1: Electricity demand in Ifugao Province

According to the DOE, the executing agency of the project, and the Provincial Government of Ifugao (hereinafter referred to as "PGI"), which owns and operates the AMHPP and LMHPP, this project, namely the LMHPP, is critical in providing additional power to the regional grid and stabilizing voltage fluctuations. It was also pointed out that the plant is also an important facility as it would bring permanent and long-term jobs to the area and generate income, some of which the province can allocate to the conservation of the rice terraces.

Regarding the needs for rice terrace conservation, according to the PGI, as of the time of the ex-post evaluation, the support from the national and provincial governments for rice terrace conservation is on a one-time basis and limited in scale, and thus, considering the number of rice terraces that need to be rehabilitated (data not available), it is important to utilize the income from electricity sales from the provincial power plants.

3.1.3 Consistency with Japan's ODA Policy

For the reasons cited below, the consistency with Japan's ODA policy at the time of the ex-ante evaluation was high. *The Country Assistance Policy for the Republic of the Philippines (April 2012)* and *JICA Country Analysis Paper (March 2012)* state that Japan would support the diversification of power sources and improved energy self-sufficiency by promoting the development and use of renewable energy as part of "achieving sustainable economic growth through further promotion of investment" and "support for climate change countermeasures."

3.1.4 Appropriateness of the Project Plan and Approach

As explained below, the effectiveness and impact of the project were evaluated to be low, mainly due to the fact that the LMHPP constructed under the project was not in operation at the time of the ex-post evaluation. It was analyzed whether there were any problems in the project plan and approach (or whether they could have been avoided) based on existing documents and interviews with stakeholders concerning the major problems of the power plant: (1) damage to the facilities, such as cracks in the headrace and scouring of the settling basin, and (2) the fact that the power plant had to be shut down because the PSA has not been approved.

First, (1) regarding the damage to the facility, field investigations pointed out that they may have been caused by landslides due to the rise of groundwater level caused by heavy rains in 2016 and 2018. Moreover, after the heavy rains in 2020, the headrace was damaged again, including the repaired parts (see "3.3.1.1 Quantitative Effects" and "3.4.4 Status of Operation and Maintenance" for details on the condition of the facility). On the other hand, as a result of the investigation of the landslide topography at the time of the outline design (preparatory survey), it was concluded that the debris body was stable and debris slides would not recur. If the headrace crossed the topography in areas where surface land sliding had occurred in recent years, the headrace was designed with aqueduct bridge structures and retaining walls so that it

would accommodate such conditions, and no problems occurred. At that time, while the AMHPP in the adjacent municipality with similar topography had its headrace on a steeper slope, it did not experience similar problems. At the time of the ex-post evaluation, follow-up cooperation is provided by JICA, and it is planned to investigate and clarify whether the cracks in the headrace were caused by landslides or not. Thus, it cannot be concluded at the time of the ex-post evaluation that the outline design and detailed design underestimated the possibility of landslides.

Second, (2) regarding the pending approval for the PSA, it would have been difficult to foresee this issue, as similar problems had not occurred at the AMHPP, a similar power plant, at the time of the outline design of this project (see "3.2.1 Project Outputs" for details of the problem of the unapproved PSA).

Thus, the project plan and approach were considered to be generally appropriate given that it was beyond the project's control to foresee the problems that occurred after project completion.

In light of the above, 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 this project consisted of (1) construction of an 820-kW mini-hydro electric power plant (LMHPP), (2) consulting services (including a soft component), and (3) rehabilitation of existing irrigation facilities, which was not related to power generation but was added at the request of local residents. These outputs were mostly completed as planned, although there were some changes, as shown in the table below. All of the changes were made in response to situations that occurred after the start of the project, and no particular problems were identified. JICA also judged that the changes were appropriate. On the other hand, some of the approval procedures for the operation of the power plant, which were to be performed by the Philippine side, were not yet completed. While this did not affect the completion of the outputs, it caused the shutdown of the power plant and uncollected revenues from sales of electricity.

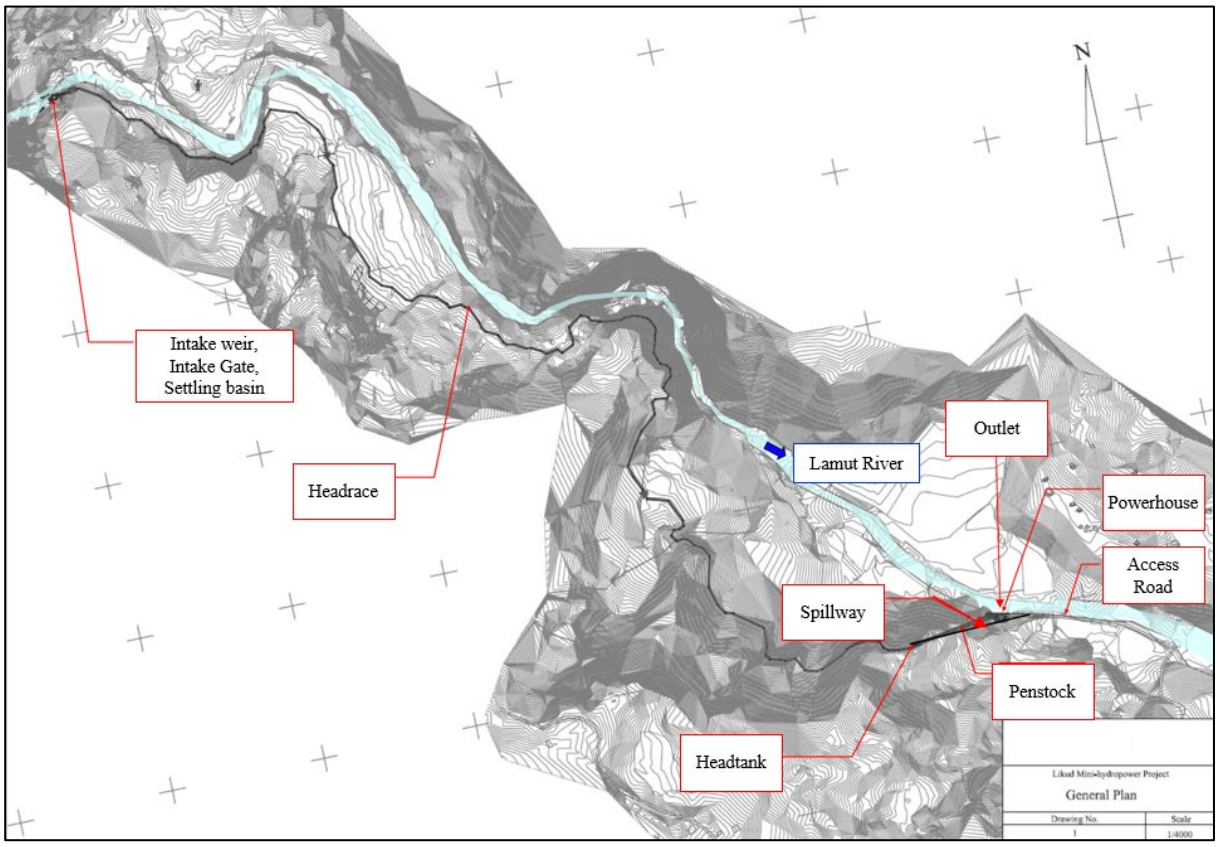
Table 1: Planned and actual outputs

Project Outputs	Plan at the Time of Ex-Ante Evaluation	Actual
(1) Construction of an 820-kW mini-hydro electric power plant	1) Equipment/Installation: Water turbine, generators, control device, switchgear, outdoor transformers, power distribution equipment 2) Civil structure: Intake weir, intake facilities, settling basin, headrace, penstock, head tank/spillway, powerhouse, access road	Mostly as planned with some scope changes. Major scope changes: • Changes in the shape of the headrace, changes in the shape and scope of the concrete retaining wall, and expansion of the scope of the masonry retaining wall construction for slope stability due to topographical changes caused by natural slope failures that seem to have occurred after the detailed design. • After excavation works began, cracks developed in the limestone more than expected, and it was found that the limestone was prone to collapse during excavation, which led to a change in the shape of the headrace from the slope of the steep cliff to a line crossing the ridge, and a partial change to a tunnel channel.
(2) Consulting services	1) Detailed design and construction supervision 2) Soft component: Developing the organization and human resources for the power plant, ensuring the proper operation of the RTCF	As planned. Specific contents of the soft component: • Developing the organization and human resources for the power plant (training for operator candidates (local residents) and a plant supervisor (provincial government worker)). • Ensuring the proper operation of the RTCF (revision of the existing RTCF guideline, assistance for revision of the Provincial Ordinance No. 2010-019 on the operation and maintenance of power plants and the RTCF, and revision of the operation manual of mini-hydro electric power plants. All approved at the Ifugao Provincial Assembly in July 2015.)
(3) Rehabilitation of existing irrigation facilities	Irrigation channel length: 700 m, irrigated area: 2.43 ha In conjunction with the construction of the power plant, repair of existing irrigation channels that were no longer functioning in the project area was added to the project components because local residents strongly requested it, its impact on the hydropower generation project was negligible, and the repair was relatively easy.	Irrigation channel length: 650 m. The irrigated area was mostly as planned according to the stakeholders, although the area was not surveyed accurately.

Source: Documents provided by JICA, documents provided by/interviews with the PGI, interviews with the consultants for construction supervision, site survey

Water Turbine and Generator

Headrace. The narrow canal on the valley side is the rehabilitated irrigation channel.



Source: Documents provided by the consultants for construction supervision

Figure 2: Project Layout

The Philippine side's obligations include (1) conclusion of a memorandum of agreement (MOA) between the DOE and the PGI regarding the division of responsibilities; (2) obtaining various approvals for the operation of the power plant by the PGI;[6] (3) establishment of an operation and maintenance setup by the PGI; (4) budgeting of operation and maintenance costs by the PGI; (5) operation of the RTCF by the PGI; and (6) tariff and tax exemption procedures by the DOE. As of September 2021, some aspects of (2) and (6) are uncompleted.

The following are the three incomplete items in (2) (various approvals for the operation of the power plant) above (the alphabetical symbols correspond to those in footnote 6).

[6] At the of the ex-ante evaluation, it was planned to (a) obtain Local Government Units (LGU) Endorsement (approval from provincial, municipal, and barangay assemblies) for the small-scale hydropower development, (b) acquire land for the project, (c) obtain the "Free and Prior Informed Consent (FPIC)" certificate from the National Commission on Indigenous Peoples (NCIP), (d) obtain an environment compliance certificate from the Department of Environment and Natural Resources (DENR), (e) obtain a water rights permit from the National Water Resources Board (NWRB), (f) obtain power plant operating permission (Renewable Energy Service/Operating Contract (RESC) and Certificate of Endorsement (COE) from the DOE, g) conclude a PSA between the PGI and Ifugao Electric Cooperative, Inc. (IFELCO), and (h) obtain the Certificate of Compliance (COC; certification of power plant operational capacity and the approval of power plant operation) from the Energy Regulatory Commission (ERC). The issue at the time of the ex-post evaluation is (i) the process of obtaining the approval of the PSA (item (g)) by the ERC. However, in the preparatory survey report, the PSA approval was not specifically mentioned separately from the conclusion of the PSA itself.

- (c) Obtaining the "Free and Prior Informed Consent" (hereinafter referred to as "FPIC") certificate from the National Commission on Indigenous People (hereinafter referred to as "NCIP"): Since the project site is located in an area inhabited by the Ifugao People, an indigenous people under Philippine domestic law, the development project had to disclose the project contents and information to the indigenous community in advance to obtain the FPIC in accordance with *The Indigenous Peoples' Rights Act of 1997*. The PGI had obtained the FPIC from the three directly affected barangays in 2014 during the construction stage. However, the NCIP headquarters additionally instructed that the FPIC from all relevant municipalities needs to be obtained. The PGI and the local NCIP are currently working on this request. According to the PGI, it is taking a long time for the NCIP provincial office to prepare necessary documents. Based on the "Revised Guidelines on Free and Prior Informed Consent (FPIC) and Related Processes of 2012," a project implementer is required to obtain a certificate from the NCIP indicating that the FPIC has been granted. However, the certificate for this project has not been issued yet due to the above-mentioned situation. Moreover, according to the PGI, the failure to obtain the certificate may affect the water rights (e) and the approval of the PSA (i) as explained below. The PGI is proceeding with the PSA approval process with the submission of a notification document indicating that the FPIC certification process is underway.

- (e) Obtaining a water rights permit from the National Water Resources Board (hereinafter referred to as "NWRB"): During the project implementation, the PGI responded to the NWRB's requests for additional documents after the submission of the application. However, the permit has not been obtained yet at the time of the ex-post evaluation. According to the PGI, it has requested the cost for expert service fees in the FY2021 supplementary budget to prepare an additional document, the "Ecological Sustainability Plan." Moreover, according to the PGI, although a water rights permit is one of the requirements for applying for approval of the PSA (i), the PSA approval process is proceeding with the submission of a notification document explaining that the process of obtaining a water rights permit is underway, and even if it is not obtained, the power plant can be operated based on the notification document.

- (i) Approval of the PSA by the Energy Regulatory Commission (hereinafter referred to as "ERC"): The PSA was executed in October 2014 between the PGI and the Ifugao Electric Cooperative, Inc. (hereinafter referred to as "IFELCO," the power distributor in the province), and the PGI and IFELCO submitted application documents for approval to the ERC in March 2015. However, incomplete application documents and

subsequent changes in requirements[7] have caused delays and interruptions in the process, resulting in uncollected revenues from sales of electricity and the shutdown of the power plant. In April 2021, the PGI and IFELCO submitted application documents again, which were accepted by the ERC. As of September 2021, the ERC, the PGI, and IFELCO are in the process of conducting hearings and other activities. The DOE and JICA (the Philippine Office and the follow-up cooperation mentioned above (being implemented at the time of the ex-post evaluation) are also supporting the process. It should be noted that during the delay in this procedure, the certification of power plant operational capacity and the approval of power plant operation called the Certificate of Compliance (hereinafter referred to as "COC") has expired. The COC, listed as item (h) in footnote 6, is a requirement for the PSA approval and was valid from August 18, 2016, to August 17, 2021. The PGI is in the process of applying to the ERC for renewal of the COC, but the fact that the FPIC certificate (item (c), not yet obtained as mentioned above) is a requirement for COC renewal is affecting the process. The PGI lodged a petition to the court claiming that the progress being made concerning FPIC should justify its COC renewal procedure. The court accepted the petition, and the PGI is awaiting the ERC's reply regarding the COC renewal.

Regarding (6) tariff and tax exemption procedures by the DOE, the Value Added Tax (VAT) had not been refunded as of July 2021, and the contractor was in the process of requesting the refund with the support of JICA and the Japanese Embassy. According to the DOE, the process is taking a long time due to the strict compliance with the Philippine government's auditing and accounting procedures.

3.2.2 Project Inputs

3.2.2.1 Project Cost

The planned amount for the total project cost was 966 million yen (the Japanese side: grant limit 922 million yen based on the amended Exchange of Notes; the Philippine side: 44 million yen). The actual cost was 972 million yen (the Japanese side: 921 million yen; the Philippine side: 51 million yen), which exceeded the plan (101% against the plan).[8] While the project

[7] The application documents were not accepted because the format used was the one used at the time of the application for the AMHPP (2010) and the documents did not include information for items that have been required since then. In addition, the ERC has mandated a Competitive Selection Process (hereinafter referred to as "CSP") for PSAs since April 30, 2016, and it took time to consider how to ensure that the LMHPP would not be subject to this requirement (On September 5, 2018, the DOE informed IFELCO that the project is not subject to CSP). Although the preparation of the application was subsequently resumed, the ERC pointed out that the date of the attached documents was old, and some documents were missing, which necessitated further documentation.

[8] Figures are rounded down to the nearest million yen. The project cost on the Japanese side exceeded the planned amount mainly due to exchange rate fluctuations. The actual project cost on the Philippine side is 17,962,270 pesos for the DOE and 2,985,198 pesos for the PGI. The actual amount of the DOE does not include the unrefunded VAT (10,276,000 pesos). The exchange rate used for the yen conversion is (Plan) 1 peso = 2.03 yen (used in the preparatory survey) and (Actual) 1 peso = 2.45 yen (average during the project implementation).

cost on the Philippine side does not include the amount of the unrefunded VAT mentioned in the previous section, if the VAT refund is completed, the actual project cost on the Philippine side would be 61 million yen, making the total project cost 982 million yen (102% against the plan).

3.2.2.2 Project Period

The planned period between the signing of the grant agreement for this project and the start of operation of the power plant was 23 months, starting in April 2013 and ending in February 2015, according to the ex-ante evaluation. The actual project period was 28 months, starting in April 2013 and ending in July 2015, exceeding the plan (122% against the plan).[9] The reason for the extra time was the scope change mentioned above, as well as delays in some construction work due to delays in pre-construction procedures and the contractor's inability to secure some labor (planned construction period: 16 months, actual construction period: 21 months).

In light of the above, both the project cost and the project period exceeded the plan. Therefore, the efficiency of this project is fair.

3.3 Effectiveness and Impacts[10] (Rating: ①)

3.3.1 Effectiveness

While the power generation capacity of the LMHPP constructed under the project has been mostly maintained, the plant has not been sufficiently operational, and thus the amount of generated electrical energy at the generating end, which indicates the quantitative effects, has been far below the target value during the period from the target year to the year in which this ex-post evaluation is conducted. While the effect of the soft component was confirmed as a qualitative effect, the achievement of the project objective, "the use of domestically produced renewable energy," was judged to be limited based on the results of the quantitative effects and the fact that the power plant was not in operation at the time of the ex-post evaluation.

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

In this project, two indicators were set for quantitative effects: "generated electrical energy at the generating end" and "contribution to CO_2 emissions reduction." Since the project objective of the effectiveness level is "the use of domestically produced renewable energy," the indicator

[9] In line with the principle of JICA ex-post evaluation, the starting point of the project period was the signing of the grant agreement, and the end point was the start of operation. When comparing the planned and actual project periods, we used the date of signing of the initial grant agreement as the starting point of the project period, because the amended exchange of notes and grant agreement were signed after the start of the project.

[10] Sub-rating for Effectiveness is to be put with consideration of Impacts.

"generated electrical energy at the generating end" is verified in this section because this indicator, due to its nature, can be used as both an operation indicator and an effect indicator for the effectiveness level. On the other hand, "contribution to CO_2 emissions reduction" will be verified later in "3.3.2.1 Intended Impacts" as an impact level indicator because it measures the project objective of the impact level "the reduction of greenhouse gas emissions."

As shown in Table 2, the actual value of generated electrical energy at the generating end in the target year (2018) was 1,315 MWh/year, which was far below the target value of 4,451 MWh/year (30% achievement). In 2017, when the power plant operated stably, the performance was above the target. However, the average of power generation from 2016 to 2020, for which the annual average can be calculated, was 1,856 MWh/year, equaling to 42% of the target.

Table 2: Generated electrical energy at the generating end in the LMHPP

(Operation and Effect Indicator)

(Unit: MWh/year)

	Baseline	Target	Actual					
	2012	2018	2015	2016	2017	2018	2019	2020
		3 Years After Completion	Completion Year	1 Year After Completion	2 Years After Completion	3 Years After Completion	4 Years After Completion	5 Years After Completion
Generated electrical energy at the generating end	0	4,451[a]	545	2,095	4,447	1,315	961	462
(Reference) Generated electrical energy at the transmission end	0	-	532	2,042	4,360	1,303	961	462

Source: Documents provided by JICA, documents provided by the PGI

[a] The planned amount of generated electrical energy at the generating end differed depending on where it was reported; 3,657 MWh in the ex-ante evaluation paper, and 5,585.5 MWh or 4,451 MWh in the preparatory survey report. Since JICA stated that 4,451 MWh was the correct amount, this figure was adopted in this report.

The reason why the amount of electricity generated fell below the target was the shutdown of the power plant due to various problems. The details are summarized in Table 3. The facility problems included damage to the headrace and water leakage from the water turbines. While the PGI has been repairing the headrace every time it is damaged, the damage caused by the typhoon in November 2020 is scheduled to be repaired pending the results of the investigation in the follow-up cooperation conducted during the ex-post evaluation. As for the water leakage from the water turbines, investigation of the cause (worn labyrinth seals supporting the shaft) and emergency measures such as replacing the drainage hose have been carried out. However, the biggest impediment is the fact that the PSA has not been approved as mentioned above,

causing the power plant to stop operating and most of the past electricity sales revenue to remain uncollected as accounts receivable. The operation of the power plant and the sale of electricity in the past were done as a temporary measure by the PGI to perform the PSA between the PGI and IFELCO. However, the ERC recommended IFELCO and the PGI, and IFELCO and the PGI accepted, to stop the operation of the power plant while the agreement remained unapproved by the ERC. The operation of the power plant was suspended in August 2020.

Given the good performance in 2017, when the facility was trouble-free, and the fact that the maximum output of the power plant has generally remained at the planned level (Table 4), it is likely that the project effects will materialize as expected once the PSA is approved and the damaged headrace is repaired.

Table 3: Periods when power generation was lower than planned and its reasons (Excerpts)

Period	Reasons
July–November 2015	The operation was 12 hours a day to build a shed next to the head tank.
September–October 2015	The operation was stopped for 40 days due to a blown fuse (overcurrent in the power plant switchboard).
January–April 2016	The operation was stopped for 4 months due to transformer troubles.
October–November 2016	The operation was stopped for 23 days due to damage to the headrace caused by a typhoon (repaired).
October 2016–August 2017	The plant was operated intermittently for 10 months due to damage to the settling basin caused by a typhoon (repaired).
February–July 2018	Only one generator was operated until IFELCO completed reconfiguration due to a current imbalance caused by an error in the power distribution setting on the IFELCO side.
August–October 2018	The operation was stopped for 3 months due to cracks in the headrace caused by heavy rains (repaired).
March 2019	The operation was stopped for one month due to a dry season drought.
November 2019–May 2020	The operation was stopped for 7 months due to water leakage from the water turbines (emergency measures (replacement of drainage hose, etc.) have been taken, but the labyrinth seals supporting the shaft need to be replaced).
August 2020–present (as of September 2021)	The operation was stopped due to the unapproved PSA by the ERC. One part of the headrace was damaged by the typhoon in November 2020, and the repaired cracks nearby were damaged again. The PGI will repair it pending the results of the investigation in the follow-up cooperation.

Source: Documents provided by the PGI

Table 4: Other data of the LMHPP and reference data of the AMHPP

	2015	2016	2017	2018	2019	2020
Maximum output (kW)	815	820	820	812	802	764
Plant load factor (%)[a]	7.69	29.53	62.68	18.53	13.54	6.51
Number of months in operation (month)	6	8	12	9	9	3
Unplanned outage hours (hour) [b]	2,557	1,425	867	1,117	1,659	65
Amount of electricity sold (MWh) [c]	532	2,042	4,360	1,303	961	462
Gross electricity sales (thousand pesos) [d]	1,926	7,394	15,784	4,716	3,478	1,673
Net electricity sales (thousand pesos) [e]	1,830	7,327	15,701	4,601	3,889	1,640
Of which collected	1,830	480	0	0	3,389	801
Reference: AMHPP						
Amount of electricity sold (MWh)	910	0	220	424	442	630
Electricity sales (thousand pesos)	3,294	0	796	1,535	1,600	2,281

Source: Documents provided by the PGI
[a] The planned plant load factor is 62.73% (from 2016 onward).
[b] Figures are only for months when the power plant was in operation.
[c] Figures include sales revenue not yet collected.
[d] Since the approval of the PSA has not been obtained from the ERC, the PGI used the unit price of the AMHPP (3.62 pesos/kWh) to calculate the amount.
[e] The amount after deducting the amount for electricity purchased from IFELCO (for internal consumption) when power generation is suspended.

3.3.1.2 Qualitative Effects (Other Effects)

As qualitative effects[11] for the effectiveness, the effects of the soft component, namely the development of the organization and human resources at the power plant and the optimization of RTCF operations, were realized as planned. According to the PGI, all the personnel of the power plant trained under the project[12] engage in the operation and maintenance of the plant, with no issues with their basic skills. As for the RTCF operation, all the trained personnel have left the jobs at the time of ex-post evaluation because they were job orders (temporary) employees. However, new personnel is also operating the RTCF using the guidelines developed by the soft component (see also "3.4.2 Technical Aspect of Operation and Maintenance").

3.3.2 Impacts

3.3.2.1 Intended Impacts

This study considers that the manifestation of one of the intended impacts of this project, which was anticipated in the ex-ante evaluation paper, "the conservation of rice terraces as a regional tourism resource," has been limited. However, the other impact, "the reduction of greenhouse gas emissions," has been partially attained, although this is only theoretically so.

[11] While in the ex-ante evaluation paper, "conservation of tourism resources (conservation of rice terraces) through electricity sales revenue" was stated as a qualitative effect, this was regarded as an impact-level effect due to its nature. As for the qualitative effect at the Effectiveness level, the effect of the soft component was confirmed.
[12] Excluding one person who passed away.

In addition, while not specified in the ex-ante evaluation paper, this evaluation also examined potential impacts of the project, such as "contribution to the stable supply of electricity to Ifugao Province" and "increased interest in renewable energy and increased use of small-scale hydropower," and found that they have materialized to some extent.

(1) Conservation of rice terraces as a regional tourism resource

There is no impact yet on the conservation of rice terraces from the electricity sales of this project. The RTCF is mainly used for repairs of small-scale irrigation systems in rice terraces, and three to eight projects are implemented every year, all of which have so far been funded by the AMHPP. The contribution from the LMHPP is limited. This is because the LMHPP has not collected a large portion of the revenue from electricity sales because the PSA has not been approved. As of March 2021, the amount transferred to the RTCF from the LMHPP was 450,000 pesos, which was transferred in FY2020 to cover the cost of three small-scale irrigation repair projects in the rice terraces. However, there has been no actual expenditure yet. According to the budget document of the PGI, these projects will be implemented in FY2021.

Table 5: The RTCF data of Ifugao Province (as of March 2021)

Unit: pesos

		FY2016–FY2020
Transfer from electricity sales revenue	LMHPP	450,000
	AMHPP	4,200,000
	Total	4,650,000
Expenditure for rice terrace conservation	LMHPPa	0
	AMHPP	1,757,756
	Total	1,757,756
Balance	LMHPP	450,000
	AMHPP	2,442,244
	Total	2,892,244

Source: Documents provided by the PGI

[a.] Expenditures are planned for FY2021.

(2) Reduction of greenhouse gas emissions

The impact of the project on the reduction of greenhouse gas emissions was estimated by calculating the CO_2 emission reduction as a theoretical value based on the amount of electricity generated (as shown in the table below). Although Ifugao Province had been using hydropower as its power source before the project, if we look at the Philippines as a whole, CO_2 emissions have been reduced to the extent that the LMHPP has been put into operation.

Table 6: Contribution to the CO_2 emission reduction by the LMHPP (theoretical value)

(Effect Indicator)

Unit: tCO_2/year

	Baseline	Target	Actual					
	2012	2018	2015	2016	2017	2018	2019	2020
		3 Years After Completion	Completion Year	1 Year After Completion	2 Years After Completion	3 Years After Completion	4 Years After Completion	5 Years After Completion
Contribution to the CO_2 emission reduction (at the generating end) [a]	0	2,167[a]	266	1,020	2,166	640	468	225

Source: Documents provided by JICA, documents provided by the PGI

[a.] While the target reads 1,780 tCO_2/year in the ex-ante evaluation paper, 2,167 tCO_2/year as stated in the preparatory survey report was used according to the instruction of JICA. Both target and actual values are calculated as Annual Power Generation x Emission Factor (0.487 tCO_2/MWh).

(3) Contribution to the stable supply of electricity to Ifugao Province

In Ifugao Province, electricity from the LMHPP and AMHPP is regarded as the baseload power source for the province, and the province expected to receive a stable power supply from these sources. The share of purchases from IPPs to electricity demand was 91% on average between 2015 and 2020, remaining unchanged from the time of the ex-ante evaluation. This was due to increased electricity demand and frequent shutdowns of the LMHPP. In 2017, when the plant operated relatively smoothly, the amount purchased from IPPs dropped to 79%, but due to subsequent problems, the percentage, which had once decreased, has increased again. Thus, we can say that this impact occurred during the period when the power plant was in operation. According to the PGI's Rate Impact Analysis (2021), if the LMHPP operates as planned and purchases from IPPs decrease, the generation cost would increase slightly, but the transmission cost would decrease, resulting in an overall cost reduction.[13] The AMHPP has been operating mostly stably except in 2016.

(4) Increased interest in renewable energy and increased use of small-scale hydropower

The impact of the project on the increased interest in renewable energy and increased use of small-scale hydropower can be seen in the fact that the project, together with the AMHPP, has become an example of small-scale hydropower in the region and has contributed to subsequent small-scale hydropower development. In other words, the two power plants have raised awareness and demand for small-scale hydropower in regions, and the DOE has issued 11 Hydropower Service Contracts in Ifugao Province with a total capacity of 450 MW. As of

[13] This analysis is based on IPP prices as of 2020, but since these prices fluctuate, the impact on power generation costs may also change.

March 2021, one of them was under construction, and ten were under feasibility study or detailed design.

3.3.2.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment[14]

No negative impacts on the natural environments were observed.

Under the Philippine environmental laws, this project is exempted from the application of the Environmental Impact Assessment (EIA) due to its small output. The project was required to obtain the Certificate of Non-Coverage (hereinafter referred to as "CNC") certifying the exemption from the Department of Environment and Natural Resources (hereinafter referred to as "DENR"), and the PGI obtained the CNC in April 2013 and October 2014 (for the design change).

The construction works under this project were to minimize the impact of air pollution and noise caused by operating construction machinery and transporting materials and equipment, as most of the work was done by hand, and simple cableways (non-powered) were used to transport materials and equipment. Regarding the operation stage, the project selected oil-less equipment so that water pollution (caused by oil spills, etc.) would be prevented in the event of an accident caused by abnormal floods, etc. Although there were no houses in the vicinity of the power plant, and the plant was unlikely to generate noise and other problems, it was decided to prevent noise from leaking outside by making the powerhouse a reinforced concrete structure. In this way, the impact of the project on the natural environment was minor. Even so, in order to mitigate any negative impacts of the project, the DOE and the PGI decided to implement an environmental management plan. This plan included water quality conservation measures (drainage through settling basins in both construction and operation stages) and ecosystem conservation measures (keeping a flow rate of 0.136 m^3/s in a water reduction section of 1.8 km in the operation stage). These measures were implemented as designed and did not encounter any problems.

After the project completion, the PGI has been submitting an environmental monitoring report to the DENR once every six months. The report contains the results of monitoring in accordance with the environmental management plan.

(2) Resettlement and Land Acquisition

In addition to the planned acquisition of approximately 1.5 hectares of land, the project required the acquisition of the land above the tunnel (a 5-meter-wide area directly above the tunnel) due to design changes. The DOE and the PGI reported that the land was acquired in

[14] The environmental and social consideration guidelines applied to this project is the "JICA Guidelines for Environmental and Social Considerations" (2010). The environmental category was "B".

accordance with Philippine domestic procedures and JICA guidelines, and the acquisition and payment of compensation were completed without any problems. No resettlement occurred.

(3) Consideration for indigenous people

The area around the project site is inhabited by the Ifugao People with a unique culture in the Philippines. The area also has rice terraces designated as a World Heritage Site. For this reason, it was pointed out during the ex-ante evaluation that construction management would need to take into account the local conditions and customs. According to the DOE, the PGI, and the consultants for construction supervision, discussions were held regularly and on an as-needed basis to address the impact on local customs and traditions, and no problems were reported.[15]

(4) Others

The following positive secondary effects were observed among the target population.

- Agricultural production: The rehabilitation of the irrigation facilities (concrete lining) enabled two cropping seasons for rice, which was not possible before the project due to damage to the facilities.[16] In addition, additional water intake was made possible by installing pipes and holes in the spillway, and water intake from the headrace to vegetable fields was made possible by using small diameter hoses when there is surplus water or when the power plant is not in operation. All of these use surplus water and have no negative impact on hydropower generation. It was also observed that the concrete cover of the headrace was used for drying rice paddy.
- Aquaculture: Several areas adjacent to the headrace where water was stagnant have been developed by the PGI as small-scale tilapia (edible freshwater fish) aquaculture ponds for local consumption.
- Employment of local residents: In addition to the large number of residents employed as construction workers, ten people were hired to operate the completed power plant.
- Road: The access road was paved with concrete for the construction works under this project, which made it easier for local residents to transport their agricultural products to the market. Concrete roads are also used for drying rice.

[15] As explained above, the FPIC from the NCIP was obtained from the directly-affected barangays in 2014, and the fact that the certificate for the FPIC has not been obtained (see "3.2 Efficiency") does not mean that there is a negative impact on the social environment.

[16] Yield data was not available.

In addition, as part of the utilization of products and technologies developed by Japanese small and medium-sized enterprises (SME), water turbines and generators from SMEs in Fukushima Prefecture were used, which were highly evaluated by the DOE. However, the impact on the Japanese side could not be confirmed.

No negative impact of this project was observed.

In light of the above, while some positive impacts were observed, this project has achieved its objectives at a limited level. Therefore, effectiveness and impacts of the project are low.

Beneficiary areas for the rehabilitation of the irrigation facilities along the headrace

Drying rice paddy in the concrete area above the headrace

3.4 Sustainability (Rating: ②)

3.4.1 Institutional/Organizational Aspect of Operation and Maintenance

The operation and maintenance system of this project is mostly as it was expected at the time of the ex-ante evaluation. The PGI is responsible for operation and maintenance of the project facilities, under which the head of the Provincial Planning and Development Office (hereinafter referred to as "PPDO") serves as the plant manager and oversees the LMHPP (this project), the AMHPP, and the Ifugao Cultural Heritage Office (hereinafter referred to as "ICHO") that manages the RTCF. The Steering Committee consisting of relevant agencies from across the province oversees the plant manager. The personnel of the LMHPP includes one plant manager (the head of the PPDO), one electrical engineer, six plant operators, and three water guards.

At the time of the defect inspection (August 2016), the consultant recommended that the maintenance of the distribution lines be outsourced to IFELCO, which is licensed by the PGI for distribution line maintenance. This recommendation, based on the necessity of periodic maintenance such as clearing of vegetation under the distribution lines, was carried out by the time of the ex-post evaluation. On the other hand, the project has not carried out the recommendations made by the soft component consultant, namely (1) to make the temporary organization, ICHO, a permanent office of the province to accumulate know-how on rice terrace conservation activities and (2) to assign a full-time staff member to supervise both the mini-

hydropower plants and RTCF operations. Regarding (1), according to the PGI, the head of the ICHO (contract staff) and ten job orders staff are assigned, and the PGI plans to establish the ICHO as a permanent office in its organizational reform plan. Regarding (2), while there is no concrete prospect, the PGI recognizes that the assignment of a full-time supervisor is desirable. At the time of the ex-post evaluation, the current operation and maintenance system has not encountered any problems regarding either of (1) and (2), as there are a small number of conservation activities by the RTCF.

Thus, the system and structure for operation and maintenance are generally established.

3.4.2 Technical Aspect of Operation and Maintenance

Although there are no professional hydropower engineers in the PGI for the operation and maintenance of the LMHPP, the plant manager of the PPDO has been supervising the LMHPP and AMHPP since the project completion and has sufficient basic knowledge. Based on the interviews with the PGI and the site visit during the ex-post evaluation, it seems that the personnel at the LMHPP have the necessary skills of power plant operation, the basic skills of power plant maintenance, and the knowledge on flood risks and countermeasures. The "Likud Mini-hydropower Plant Operation & Maintenance Manual" prepared during the soft component of the project has also been used. However, the PGI demands the assignment of experts and further training in troubleshooting techniques for mechanical and electrical equipment. While no new training is planned by the PGI, the current status of the technical level and future requirements will be identified in the follow-up cooperation conducted during the ex-post evaluation.

As for RTCF management, according to the PGI, the ICHO staff have the capacity to manage fund allocations. The "RTCF Guideline" prepared during the soft component of the project has also been used.

Thus, although room for further improvement has been pointed out, the operation and maintenance techniques are generally established.

3.4.3 Financial Aspect of Operation and Maintenance

The operation and maintenance expenditure of the power plant is secured by the revenue from electricity sales and supplementary funds from the PGI. According to the PGI, there is no shortage in the budget for operation and maintenance costs, and the PGI plans to pay the cost of measures (repairs, etc.) in response to the recommendations to be made in the follow-up cooperation.

As explained above, while the contribution from the LMHPP to the RTCF is still limited, the contribution mechanism has been established, and thus it is expected that the contribution will be made as planned once the PGI is able to recover the uncollected revenue from electricity sales.

Table 7: Budget allocation from the PGI to the LMHPP

Unit: pesos

	FY2019	FY2020	FY2021
Operation and maintenance cost	808,979	2,148,147	1,657,572
Of which, remuneration for power plant staff	600,000	1,201,626	500,000
Remuneration for external electrician	0	179,388	239,184
Repair and maintenance	129,979	570,633	532,888
Others	79,000	196,500	385,500
Honorarium	0	60,000	60,000
Capital investment	0	140,000	100,000
RTCF contribution	0	450,000	0
Total	1,617,958	4,946,295	3,475,144

Source: Documents provided by the PGI

Thus, it can be said that the finances for operation and maintenance have been secured.

3.4.4 Status of Operation and Maintenance

It is commendable that the operation and maintenance of the LMHPP are carried out in accordance with the "Likud Mini-hydropower Plant Operation & Maintenance Manual," and that problems have been handled every time. The condition of the power generation facility is as described in "3.3.1.1 Quantitative Effects," and the problems that need to be solved at the time of the ex-post evaluation are water leakage from the water turbines (worn labyrinth seals need to be replaced)[17] and the damage to the headrace. Regarding the first issue, according to the PGI, while a quotation for new labyrinth seals has already been obtained from the Japanese manufacturer, it plans to place the order after collecting the accounts receivable from IFELCO (subject to the approval of the PSA).

A damaged part of the headrace.
A part that was repaired in the past was damaged again.

Regarding the second issue, while damage to the headrace has been repaired every time, the repair of the damage caused in November 2020 is pending the survey results of the follow-up cooperation. During the site visit in March 2021, it was observed that there was a lot of sediment inflow into the settling basin and the headrace. According to the PGI, this is because during floods, the stop log[18] of the intake either did not work due to floating or the water was not

[17] There was a possibility that the wear of the labyrinth seals was caused by sediment and dust being drawn into the water turbine, but at the time of the site visit in March 2021, there was no sediment in the head tank and no damage to the dust prevention screen in the penstock. According to the operator, the turbine runner and guide vanes were also undamaged, and the labyrinth seals were considered to be worn out due to friction.

[18] A square piece that is dropped into vertical grooves on both sides of the sluice gate to stop water flow.

stopped when the water level exceeded the upper limit, and slope failure occurred in the open-type headrace section (where slope failure was not expected). Moreover, the areas where slope failures had occurred were covered with wood, but the wood corroded and fell into the headrace in some places (the PGI is considering replacing the wood cover with concrete material). The accumulated sediment is removed by hand, and the power plant operation is sometimes suspended for this purpose. On the other hand, the head tank was in good condition.

Thus, some issues were present in the status of operation and maintenance.

In light of the above, some minor problems have been observed in terms of the current status. Therefore, sustainability of the project effects is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project aimed to promote the use of domestically produced renewable energy by developing a mini-hydro electric power plant in Ifugao Province in northern Luzon Island, thereby contributing to the conservation of rice terraces as a regional tourism resource and to the reduction of greenhouse gas emissions. The relevance of the project is high because these objectives are consistent with the development plans and development needs in the Philippines and with Japan's aid policy. The power generation capacity of the Likud Mini-Hydro Power Plant (LMHPP) constructed under the project has been mostly maintained at the planned level. However, the plant has not been sufficiently operational due to the unapproved power supply agreement (PSA) and damage to civil engineering facilities such as the headrace. It is still out of commission at the time of the ex-post evaluation. Thus, no rice terrace conservation activities have been started using the income from electricity sales. Therefore, although there were some secondary effects, including the effects on agricultural aspects, the effectiveness and impact are judged to be low. The project outputs were mostly generated as planned, but the project cost and period exceeded the plan. Therefore, the efficiency is fair. The sustainability of the project effects is fair because the operation and maintenance of the project faced some problems due to the condition of some of the facilities.

In light of the above, this project is evaluated to be unsatisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

(1) The power plant operation has been suspended because the PSA has not been approved. The PGI is recommended to take full advantage of the JICA follow-up cooperation conducted at the time of the ex-post evaluation to obtain necessary approvals as soon as

possible, including the approval of the PSA, so that the power plant can be restarted promptly. The DOE is also recommended to continue to cooperate fully with the PGI.

(2) While it is necessary to purchase labyrinth seals to stop water leakage from the water turbines, the procurement is planned using the accounts receivable (revenues from the sale of electricity so far) that will be collected from IFELCO after the approval of the PSA. If it is expected that the approval of the PSA will take more time, the PGI is recommended to use the provincial budget to procure the labyrinth seals without waiting for the collection of accounts receivable so that the water leakage from the turbines can be fixed as soon as possible and the plant will not be shut down again due to this problem after it is restarted.

(3) The PGI is recommended to promptly repair the damaged headrace and restart the power plant as soon as possible, based on the findings of the follow-up cooperation.

(4) The PGI is recommended to take measures against the inflow of sediment into the settling basins and headrace during heavy rains, including measures to prevent the floating of the stop log (a proposal based on the site observation is to replace the worn stop logs with high-density and durable ones, but it has to be confirmed that this is technically valid) and covering the headrace sections where sediment has flowed in due to slope failure. It is also desirable to proceed with the plan to replace the corroded wood that is currently used as a cover. It is necessary to ensure safety by restricting people's passage and stay in those places. In addition, preparations against floods should be made beforehand so that when the water level in the river starts to rise above the design discharge level of the facility, steps can be taken to shut down the power plant to prevent sediment from entering the head tank.

(5) The DOE is recommended to look for training opportunities for plant personnel to improve their mechanical and electrical troubleshooting skills and refer the PGI to training institutions. Even when outsourcing mechanical and electrical maintenance to specialized companies, the PGI requires that the staff have knowledge of the functions of each facility and component and skills to perform simple repairs.

4.2.2 Recommendations to JICA

JICA is recommended to continue to monitor the outstanding issues at the time of the ex-post evaluation and provide indirect support through the follow-up cooperation to the PGI's efforts to obtain the approval of the PSA and to improve the skills of the plant personnel.

4.3 Lessons Learned

Sufficient consideration for obtaining approvals for a mini-hydro electric power plant

In this project, the ERC approval of the PSA has not yet been obtained, causing uncollected revenues from sales of electricity (the portion operated temporarily without approval) and

shutdowns of the power plant. Although the preparatory survey report (outline design) listed the necessary permits and approvals and described the required time frame, there was no analysis of the risks in case of delays in different procedures. In particular, regarding the PSA, the report mainly covers the period up to the execution of the agreement between the PGI and IFELCO, and there is no clear assumption about the subsequent approval by the ERC, which is the main problem this project encountered.

Although the delay in obtaining the approval was due in part to external factors such as changes in the process during the application process, it was also affected by the fact that the PGI was not able to prepare the required documents promptly at the beginning of the application process. This, in turn, resulted in an increase in the number of required procedures over time, causing further delays. This suggests that the PGI was asked to take actions beyond its capacity. In addition, in the Philippines, each agency has strong authority. The efforts of the DOE (headquarters) and JICA in providing monitoring and advice did not lead to approval.

Local governments are expected to be the main actors in obtaining approvals for mini-hydro electric power plants. Thus, it is important, at the planning stage, to adequately estimate the realistic amount of time required for each procedure and risks in light of the capacity of the implementing entities. At the implementation stage, the relevant national government and JICA need to provide timely monitoring and advice by taking into account risk factors. Realistic planning is particularly important in cases where each agency has strong authority, as in the Philippines, because we can expect that attempting to intervene with the implementing entity would be difficult. It may be possible to consider incorporating support for obtaining permits and approvals into the work of consultants.