Federal Democratic Republic of Nepal

FY2019 Ex-Post Evaluation of Japanese Grant Aid Project

"The Project for Micro-Hydropower Improvement in Western Area"

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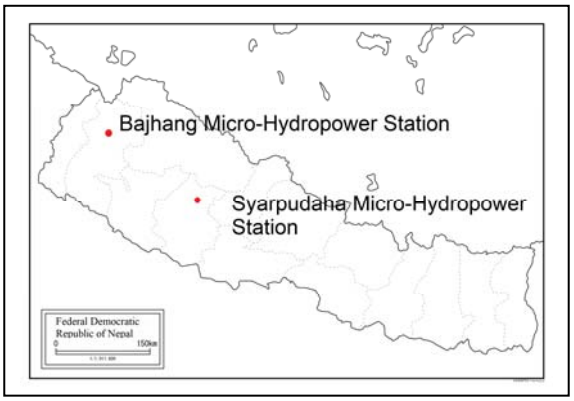
0. Summary

This project aims to respond to tight power supply-demand balance in the rural area by rehabilitating the existing aged micro-hydropower stations in the area (Bajhang District and West Rukum District) that are not connected to the main transmission/distribution system, thereby contributing to the enhancement of the regional economy and public welfare. As this objective was consistent with the development plan and development needs of Nepal as well as Japan's ODA policy, the project relevance is high. Although the project cost was within the plan, the project period exceeded the plan. Therefore, the efficiency of this project is fair. Regarding the three operational indicators set in this project, the target values for average power output (kW) and annual generated energy (kWh/year) were not achieved at the Bajhang and Syarpudaha Micro-Hydropower Stations, and that for the annual generated operation hours (h/year) was not achieved at the Bajhang Micro-Hydropower Station. Regarding the qualitative effects on the effectiveness and the impacts, certain effects were confirmed. Therefore, this project has achieved its objectives to some extent, and effectiveness and impacts of the project are fair. Some minor problems have been observed in terms of the project's technical and financial aspects and current status of operation and maintenance. Therefore, sustainability of the project's effects is also fair.

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

1. Project Description



Project Locations

Intake of Syarpudaha Micro-Hydropower Station

Bajhang Micro-Hydropower Station's Generator

1.1 Background

Nepal has abundant water resources, and at the time of planning, it was estimated to have a hydropower capacity of 83,000 MW and an economically effective hydropower capacity of 42,000 MW. Despite having such resources, the hydroelectric power generation capacity in 2012 was only about 758 MW, and it was suffering from chronic power shortages such as the inability to cover the peak power demand of 1,095 MW. Therefore, planned power outages of up to 16 hours a day was carried out. As a result, the annual electricity sales per capita were 115 kWh (2011)—the lowest level in the world. Furthermore, Nepal Electricity Authority (hereinafter referred to as "NEA"), which was the executing agency of this project, predicted that peak demand would grow at an annual rate of about 9%. The electrification rate in rural areas was as low as 61% (as of 2011), and especially that in the Mid-Western and Far-Western regions as low as 45%. In addition, even in the national transmission system, there were areas where unplanned power outages occurred frequently due to aging power generation facilities and insufficient capacity, which had seriously hindered the lives and economic activities of citizens, so a stable power supply was an urgent issue.[1]

The Government of Nepal had positioned economic infrastructure development, including electricity, as a priority area in the *Three Year Interim Plan* (FY 2013/2014 - 2015/2016), which

[1] Ex-ante evaluation paper, p. 1

was at the top of the national development strategy; implementing power development of 15,000 kW of small and micro hydropower over three years and supplying power to rural areas were also planned. In addition, the Government of Nepal formulated the *Renewable Energy Policy* in 2009, which positioned small and micro hydropower as necessary to supply electricity to rural areas that were not connected to the national transmission system.[2]

Under these circumstances, the Government of Nepal requested the Government of Japan to rehabilitate existing aged micro-hydropower stations in the target area that were not connected to the main transmission and distribution system.

1.2 Project Outline

The objective of this project was to respond to tight power supply-demand balance in the rural area by rehabilitating the existing aged micro-hydropower stations in the area that were not connected to the main transmission/distribution system, thereby contributing to the enhancement of the regional economy and public welfare.

Grant Limit/Actual Grant Amount	1,571 million yen/1,129 million yen
Exchange of Notes Date / Grant Agreement Date	April 2014/April 2014
Executing Agency	Nepal Electricity Authority
Project Completion	January 2017
Target Area	Bajhang District and West Rukum District[3]
Main Contractor	Marushin Shitaka Construction Co., Ltd.
Main Consultant	Nippon Koei Co., Ltd.
Procurement Agency	None
Preparatory Survey	July 2013 – March 2014

[2] Ex-ante evaluation paper, p. 1

[3] At the time of planning, the site was located in Rukum District; however, at the time of the ex-post evaluation, Rukum District was divided into two districts; thus, the site is currently located in West Rukum District.

Related Projects	ODA Loan: “Kali Gandaki ‘A’ Hydroelectric Project” (1996 – 2002, co-financing with Asian Development Bank), and “Tanahu Hydropower Project” (2013 – 2021, co-financing with Asian Development Bank) Technical Cooperation: “Project for the Nationwide Master Plan Study on Storage-Type Hydroelectric Power Development in Nepal” (2011 – 2013) Grant Aid: “The Project for Introduction of Clean Energy by Solar Electricity Generation System” (2010 – 2012)

2. Outline of the Evaluation Study

2.1 External Evaluator

Ruiko Hino, Foundation for International Development Organization

2.2 Duration of Evaluation Study

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

Duration of the Study: November 2019 – January 2021

Duration of the Field Study: February 23, 2020 – March 13, 2020

2.3 Constraints during the Evaluation Study

In response to the global pandemic of COVID-19, the evaluator did not visit the field for the second field survey scheduled for this evaluation; instead, the local assistant collected additional information, provided feedback on the content of the evaluation to the related organizations, and gathered comments. Through online meetings, the evaluator and local assistant shared information on the evaluation, including the evaluation framework and the survey method of the project, collected all the necessary information, and facilitated smooth communication with related organizations. By these measures, they tried to ensure the quality of the study.

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

3.1 Relevance (Rating: ③[5])

3.1.1 Consistency with the Development Plan of Nepal

In the *Thee Year Interim Plan* (FY 2013/2014-2015/2016), which was positioned at the top of Nepal's national development strategy at the time of the ex-ante evaluation, economic infrastructure development, including that on electricity, was a priority area, and it was indicated that the Government of Nepal would implement the power development by small and micro hydropower of 15,000 kW within those three years. In 2009, the Government of Nepal formulated the *Renewable Energy Policy*, which stated that small and micro hydropower would be required to supply electricity to rural areas that were not connected to the national transmission system.

At the time of the ex-post evaluation, electric power development remained one of the main goals of the *15th National Development Plan* (FY 2019/2020-2023/2024), which was Nepal's national development strategy. However, under this policy, small and micro hydropower was positioned as an alternative energy, and its position seemed to be changed. Furthermore, for the areas connected to the national transmission system, the policy was shown to connect (synchronize) alternative energies, such as small and micro hydropower, solar and wind power generation, and bioenergy, to the national transmission system.

In this way, electric power development has been one of the priority areas in the country's national development, from the time of planning to the ex-post evaluation. Although the position of small and micro hydropower was changed to an alternative energy source at the time of the ex-post evaluation, the project, which aimed to respond to the tight power-demand balance in the rural area by rehabilitating the existing aged micro-hydropower stations in the project area, is highly consistent with the development policy of Nepal.

3.1.2 Consistency with the Development Needs of Nepal

At the time of the ex-ante evaluation, the electrification rate in the rural area of Nepal was as low as 61% (2011), and it was even lower at 45% in the Midwestern region where Bajhang District is located and the Far Western region where West Rukum District is located.[6]

At the time of the ex-post evaluation, since the national transmission system was connected to both areas, the power supply area of the micro-hydropower stations rehabilitated in this project was smaller than that expected at the time of planning. However, when the power supply from the national transmission system is interrupted for a long period of time, power is transferred from the micro-hydropower stations to the power supply area of the national

[4] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory.
[5] ③: High, ②: Fair, ①: Low.
[6] Ex-ante evaluation paper, p. 1.

transmission system in the districts, and so the micro-hydropower stations function as a backup power source for the national transmission system.[7]

From the above, it is confirmed that the consistency with the development needs of this project in Nepal and the target area is high.

3.1.3 Consistency with Japan's ODA Policy

The *Country Assistance Policy for the Federal Democratic Republic of Nepal* (2012) stipulated "improvement of social infrastructure and institutions for economic growth" as one of the priority areas and asserted that the urban environment on such things as power shortages—which were becoming more serious year by year—would have a serious impact on the lives of citizens. In addition, the Rolling Plan attached to the *Country Assistance Policy* in Priority Area 3, "Social environment and infrastructure development for sustainable and balanced economic growth," pointed out the following: Nepal relied on hydropower for 99% of its electricity supply; the electricity demand had grown rapidly in recent years (8% annually), significantly exceeding the supply and forcing planned power outages of up to 16 hours a day; and the electricity shortages hindered the country's commercial and industrial activities as well as its economic and industrial development, posing a serious obstacle to its activities and directly affecting the living standards of the people in various areas such as emergency medical care and security concerns.

In this light, it can be said that this project was in line with Japan's aid policy at the time of planning of the project.

3.1.4 Appropriateness of the Project Plan and Approach

(1) Change the scope

The project included the Bajura Micro-Hydropower Station in Bajura District at the time of planning; however, the power station was excluded from the scope of the project due to the floods that occurred in the Bajura District in August 2014. After the construction/machinery procurement was postponed, the consultant carried out a reinvestigation and additional design and consequently revealed that it was difficult to carry out the construction and equipment procurement of the Bajura Micro-Hydropower Station within the exchange of notes (E/N) grant limit. Therefore, the scope of the project was changed to exclude the Bajura Micro-Hydropower Station from the plan. Regarding the change of scope, the minutes of the discussion (M/D) were signed by NEA, the Ministry of Finance of Nepal, and Japan International Cooperation Agency (hereinafter referred to as "JICA") after consultations with the executing agency and the Ministry of Finance of Nepal in July 2016. From the above, it can be said that the scope change

[7] Questionnaire responses from the executing agency and interview survey results from the executing agency.

was carried out through the appropriate process.

(2) Setting the target values of the operational indicators

The target values of the operational indicator “average power output (kW)” in this project were set without consideration of the point that both of the micro-hydropower stations in Bajhang and Rukum were not operating at 100% of their installed capacity (200 kW) because they were normally operated as single systems.[8] In single systems of micro-hydropower stations, it is necessary to adjust demand so that it does not exceed supply and to supply power that falls below the installed capacity. In addition, even though the maximum demand during peak hours at night was about 180 kW, the power demand during off-peak hours of the daytime decreased significantly, so it was impossible to operate constantly with the installed capacity. Thus, the target values were overestimated. Furthermore, since the target values for “average power output” were excessive, the target values for the operational indicator “annual generated energy” were also excessive. This point will be described again in section 3.3, on effectiveness and impacts.

As described above, it can be said that appropriate procedures were taken according to the proper process for changing the scope of this project. In regards to setting the target values of the operational indicators, the conditions under which the targeted micro-hydropower stations would be operated may not have been sufficiently examined at the time of planning. This is considered to be the factor that caused the setting of excessive target values for the indicators.

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

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

This project implemented the construction and equipment procurement of the micro-hydropower generation facilities as well as the soft component (capacity building program by the consultant) of the facilities’ operation and maintenance for the personnel involved in. As shown in Tables 1 and 2 below, the planned outputs were implemented almost as planned, but as stated in Section 3.1.4 (1), the scope of this project has changed since the time of planning, so the changed scope shall be considered as the planned values.

[8] Both micro-hydropower stations were physically connected to the national transmission system but not synchronized. They normally supplied power by an independent distribution network as single systems. On the other hand, when the power supply from the national transmission system was stopped for a long period of time, they were connected to the main transmission system and served as backup power sources for it.

Table 1 Comparison of the Planned and Actual Scope of the Project

(Facilities and Main Equipment)

<table>
<tr><th>Item</th><th>Planned</th><th>Actual (differences)</th></tr>
<tr><td>Water intake</td><td>Construction of two intake weirs for micro-hydropower stations (Bajhang and Syarpudaha)</td><td>As planned.
However, the type of sand drainage gates at both micro-hydropower stations[9] and the construction method for the left bank of the intake weir of the Syarpudaha Micro-Hydropower Station[10] were changed.</td></tr>
<tr><td>Headrace</td><td>Rehabilitations of the existing headraces and powerhouses, partial rehabilitations of water tanks and penstocks of the two micro-hydropower stations.</td><td>As planned</td></tr>
<tr><td>Power generation equipment</td><td>Update of water turbines/generators (2 units each), control devices, input valves, main transformers, etc. at the two micro-hydropower stations.
<table>
<tr><td></td><td>Bajhang Micro-Hydropower Station</td><td>Syarpudaha Micro-Hydropower Station</td></tr>
<tr><td>Installed capacity[11]</td><td>200 kW[12]</td><td>200 kW</td></tr>
<tr><td>Power generation method</td><td>Run-of-river type</td><td>Run-of-river type</td></tr>
<tr><td colspan="3">Water wheel</td></tr>
<tr><td>Type</td><td>Cross flow</td><td>Belton</td></tr>
<tr><td>Effective head</td><td>37.043 m</td><td>265.6 m</td></tr>
</table></td><td>As planned</td></tr>
</table>

Source: Documents provided by JICA and interviews with the consultant

[9] The type (rack) assumed at the time of planning was changed to the general (spindle) type because there was no production record in Nepal and it was assumed that maintenance after implementation would be difficult.

[10] When the excavation was carried out on the back of the retaining wall on the left bank of the intake weir after the start of the project, it became clear that it would be difficult to perform excavation with the construction method chosen at the time of planning, and so the construction method was changed.

[11] The installed capacity of the existing micro-hydropower station was 200 kW in both Bajhang and Syarpudaha.

[12] Water turbine output (for one) was 115 kW at Bajhang and 120 kW at Syarupudaha. Generator-end output (for one) was 100 kW (125 kVA (standard capacity) × 0.8 (power factor)) at both Bajhang and Syarupudaha. Therefore, the installed capacity was 200 kW.

Table 2 Comparison of the Planned and Actual Scope of the Project

(Soft Component)

Planned	Actual (differences)
Guidance on operation and maintenance Operation and maintenance of electrical machinery equipment Operation and maintenance of civil engineering equipment	As planned
Guidance on financial statement preparation	As planned

Source: Documents provided by JICA

3.2.2 Project Inputs

3.2.2.1 Project Cost

The cost of this project was the grant limit of the E/N (1,571 million yen); however, as mentioned above, the scope of this project was changed, and the project cost excluding the Bajura Micro-Hydropower Station at the time of planning was 1,136 million yen. This amount shall be the planned project cost. The total project cost on the Japanese side of this project was 1,129 million yen (99% of the plan). Regarding the amount borne by the Nepalese side, the planned and actual costs were 2.3 million Nepalese rupees (equivalent to about 2.3 million yen,[13] 100% of the plan). Regarding the obligations to be implemented by the Nepalese side, there was a delay in tax exemption measures, customs clearance work, and advice on authorization to pay (A/P), but others were implemented as planned.[14]

From the above, the project cost was within the plan.

3.2.2.2 Project Period

The planned project period after the scope change was from April 2014 to May 2016 (26 months), but the actual project period was from April 2014 to July 2016 (28 months), slightly exceeding what was planned (108% of the planned period). One factor behind the difference was the delay in the main construction and the installation work; the delay in the main construction owed to the impact of the two-month border blockade with India, which was caused by the security concerns in October 2015, and water leakage that occurred outside the scope of work during the test period and the restoration work for the damaged area. In addition to the blockade of the Indian border, the delay in the installation work was caused by the suspension of shipping due to a significant delay in the conclusion of bank arrangements (B/A) and the issuance of authorization to pay (A/P), which were obligations on the Nepalese side.

Although the project cost was within the plan, the project period exceeded the plan. Therefore, the efficiency of the project is fair.

[13] 1 Nepalese rupee = 1.082 yen (as of August 2013)

[14] Questionnaire responses from the executing agency.

3.3 Effectiveness and Impacts[15] (Rating: ②)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

Regarding the three operational indicators set in this project, both micro-hydropower stations failed to achieve Indicator 1, "average power output," and Indicator 2, "annual generated energy." Indicator 3, "annual generated operation hours," was achieved only at the Syarpudaha Micro-Hydropower Station.

Table 3 Baseline Values, Target Values, and Actual Values of Operation and Effect Indicators

	Baseline	Target	Actual		
	2012	2019	2017	2018	2019
		2 Years After Completion	Completion Year	1 Year After Completion	2 Years After Completion
Indicator 1 Average power output (kW)					
Bajhang Micro-Hydropower Station	100	200	130	127	33(*1)
Syarpudaha Micro-Hydropower Station	100	200	65	70	76
Indicator 2 Annual power generation (kWh/year)					
Bajhang Micro-Hydropower Station	810,000	1,704,000	759,200	603,010	276,705(*2)
Syarpudaha Micro-Hydropower Station	780,000	1,704,000	560,000	603,120	659,986
Indicator 3 Annual generated operation hours (h/year)					
Bajhang Micro-Hydropower Station	810,000	1,704,000	759,200	603,010	276,705(*2)
Syarpudaha Micro-Hydropower Station	780,000	1,704,000	560,000	603,120	659,986

Source: Documents provided by the executing agency

Note: At both micro-hydropower stations, the operating hours and power generation output were not aggregated monthly or yearly, so it is necessary to make a certain reservation for the reliability of the data. The average power output and annual generated energy include the power generation amount when both power stations generated power as the backup power source for the national transmission system.

(*1) The electricity demand in the Bajhang Micro-Hydropower Station supply area in 2019 was 10 kW to 20 kW and based on this information, the average power output is calculated to be 12 kW (24-hour average of the demand per day ((20 kW x 3 hours) + (10 kW x 17 hours) + (15 kW x 4 hours))).

(*2) According to the chief of NEA Bajhang Distribution Center, the figures were read from the generator panel. Therefore, the value was the amount of power generated by the generator, not the amount of power transmitted. Calculated using the above estimation of power demand, the value is 100,620 kWh.

(*3) At the time of planning, for both micro-hydropower stations, the target values of the annual operating hours were set under the following assumptions: (1) they were operated as single systems, (2) their demand exceeded the installed capacity (200 kW), and (3) the power generation flow rate was sufficient to generate 200 kW, which was the maximum installed capacity. Under these assumptions, the annual maintenance period of the generators was expected to be 10 days; thus, the target value of the annual operating hours was set (355 days x 24 hours = 8,520 hours).

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

The reasons why the three abovementioned operational indicators were not achieved are as follows.

(1) Indicator 1: Average power output (kW)

There were two main reasons why the actual values did not reach the target values of 2019, two years after completion. At the Bajhang Micro-Hydropower Station, the first factor shown below had a significant effect, and at the Syarpudaha Micro-Hydropower Station, the second factor provided the impact significantly.

Firstly, the power supply areas at both micro-hydropower stations were reduced due to the connection of NEA's main transmission system.[16] As a result, the electricity demands were lower than expected at the time of planning. In particular, the decrease in the electricity demand at the Bajhang Micro-Hydropower Station was remarkable. Table 4 shows the changes in the number of contractors for both micro-hydropower stations and in the electricity demand during peak hours between the time of planning and the time of the ex-post evaluation.

Table 4 Number of Contractors and Electricity Demand during Peak Hours for the Micro-Hydropower Stations

	Number of contractors		Peak electricity demand (kW)	
	At the time of planning (2013)	At the time of the ex-post evaluation (2020)	At the time of planning (2013)	At the time of the ex-post evaluation (2020)
Bajhang Micro-Hydropower Station	1,821	Approximately 150	Approximately 400	Approximately 20
Syarpudaha Micro-Hydropower Station	3,948	Approximately 2,500	Approximately 500	Approximately 180

Source: Preparatory survey report, interview with the executing agency

As mentioned in Relevance, small and micro hydropower was positioned as an alternative energy source in Nepal at the time of the ex-post evaluation, and small- and micro-hydropower stations were said to supply power to areas where the national transmission system was not connected. According to NEA, the policy of promoting local electrification by expanding the national transmission system has been strongly promoted since FY 2017/2018, and it can be said that the connection of the national transmission system to both districts was a part of this policy. Therefore, it can be said that it was difficult to assume at the time of planning the connection of

[16] The NEA main transmission system was connected to the capital of the Bajhang District, Chainpur, where the Bajhang Micro-Hydropower Station was located, around November 2018, and to the capital of the West Rukum District, Musikot, where the Syarupudaha Micro-Hydropower Station was located, in October 2016.

the national transmission system to both areas.

Secondly, as mentioned above, the target values were overestimated. Although the two micro-hydropower stations constructed in this project were operated as independent systems, the target values (200 kW) were set without consideration that they would not be operated at 100% of the installed capacity (200 kW). When a micro-hydropower station is operated as a single system, power demand must be adjusted so that it does not exceed the power that can be supplied. It is necessary to provide a certain amount of buffer, and even if there is a peak power demand of 200 kW, actual operations shall be performed below 200 kW. In addition, the peak and off-peak power demands of both micro-hydropower stations differed substantially, but the target values were set without consideration of this point.[17]

In addition, before the target year (2019), the national transmission system was not connected to Bajhang District, and there was no major change in the power supply area of the Bajhang Micro-Hydropower Station compared to the time of planning. However, the actual values for 2017 and 2018 have not reached the target values. This is because there were several issues with water intake, besides the second factor mentioned above (the target values were excessive). It was confirmed that the micro-hydropower station did not have sufficient water during the dry season. In addition, during the period excluding the dry season, sufficient amount of water could not be obtained because of the bar screen's clogging and because of the simple water conveyance due to the damage of the headrace caused by the landslide in 2018, which has not yet been solved at the time of ex-post evaluation. These points were also considered as the factors.[18]The three factors that caused the water intake problem are described in detail below, but it is probable that it was difficult to assume any of the factors at the time of planning.

Analysis of water volume during the dry season: At the Bajhang Micro-Hydropower Station, verification of whether sufficient water volume could be obtained during the dry season was carried out through the examination of expansion potential in the preparatory survey. In the examination, the water flow observations were carried out, and the measurement results included data that indicated that the Bajhang Micro-Hydropower station could not operate at the maximum output (200 kW). As a result of analyzing rainfall data for 30 years that was available at that time and interviewing local residents, the consultant comprehensively judged that the period of measurement of the flow rate (late October 2013 to early February 2014) was a dry

[17] The peak power demand at the ex-post evaluation of the Bajhang Micro-Hydropower station was 20 kW, while the off-peak (daytime) power demand was 15 kW and the demand of the lowest time was around 10 kw. The demand for 20 kW was 3 hours/day, the demand for 15 kW was 4 hours/day, and the demand for 10 kW was 17 hours/day. At the time of the ex-post evaluation, the peak (night) power demand was about 180 kW, the off-peak (daytime) power demand was 80 kW, and the midnight/early morning power demand was about 40 kW at the Syarpudaha Micro-Hydropower Station. In addition, the demand for 180 kW was 2 hours/day, the demand for 80 kW was 15 hours/day, and the demand for 40 kW was 7 hours/day (interview with the executing agency).

[18] The bar screen is made by fixing circular or square rods or plates to the outer frame at regular parallel intervals and has the function of removing dust and foreign matter.

year. There was no flow data before the time of the planning in the target area, and the hydrological data were extremely limited. It was very difficult to verify whether the measurement period was a dry year and whether the existing micro-hydropower station sufficiently operated at the maximum output. As described above, the consultant conducted the analysis to the extent possible at that time, but it was difficult to conduct precise analysis on the amount of water during the dry season due to the large restrictions on the available data.

Bar screen clogging: The water intake design adopted in this project is based on the technology researched and established in Japan; however, bar screen clogging is an unavoidable problem in terms of function and structure, and bar screen cleaning is done manually even in Japan.

At the Bajhang Micro-Hydropower Station, cleaning to remove gravel was carried out once every one or two months during the dry season and two or three times a day during the rainy season, as confirmed at the time of the ex-post evaluation. In addition, the bar screen was still clogged, which was a factor in reducing water intake efficiency.[19] To estimate the scale of clogging that occurred at the Bajhang Micro-Hydropower Station at the time of planning, it was necessary to conduct a survey to measure the amount of sediment contained in river water during the rainy season, measure the sizes of particle and concentration of sediment in the river water, and then conduct further experiments to confirm the status of screen clogging, which necessitated a span of multiple years. Therefore, it was difficult to assume the situation of bar screen clogging at the Bajhang Micro-Hydropower Station at the time of planning.

Landslide damage to the headrace: At the Bajhang Micro-Hydropower Station, the landslide in 2018 damaged part of the headrace (60 m). At the time of the ex-post evaluation, a simple repair was carried out on this part, and since water was taken in that situation, the water intake efficiency was poor and a sufficient amount of water could not be obtained.

(2) Indicator 2: Annual power generation (kWh/year)

Since indicators 1 and 3 have not been achieved, the target values have not been achieved at either micro-hydropower station.

Bajhang Micro-Hydropower Station
Landslide location

(3) Indicator 3: Annual generated operation hours (h/year)

The main reason for the Bajhang Micro-Hydropower Station's failure to reach the target values in the target year of 2019 was the problem of water intake. In the Bajhang

[19] During the rainy season in 2016, a large amount of gravel blocked the entire surface of the bar screen, causing the water intake function to stop, and one bar was then removed from the bar screen around February to March 2017. Since then, clogging has not occurred to such an extent that the water intake function has stopped.

Micro-Hydropower Station, as described above, insufficient water was obtained during the dry season. Furthermore, the water intake efficiency was reduced due to the clogging of the bar screen and the simple water conveyance. Therefore, it was sometimes necessary to restore the water level in the water tank in order to generate electricity that met the power demand. Each time, the operation was stopped for about 45 minutes on average and then restarted. Also, in 2018, a landslide damaged headrace, and power could not be generated for about 45 days. This incident was also a factor in lowering the actual value for the year. In addition, compared with the actual values of the annual generated operation hours in 2017 and 2018, an improvement was shown in 2019. This is due to several factors: the fact that the national transmission system was connected to the Bajhang District around November 2018, then the electricity demand of the micro-hydropower station decreased significantly in 2019. As a result, the required water level has dropped and the frequency of shutdowns to restore water levels has decreased.

3.3.1.2 Qualitative Effects (Other Effects)

In the ex-ante evaluation paper, three points were observed as the outcomes of this project: stable power supply, stable night lighting, and stable voltage and frequency of the power supply.

(1) Stable power supply

As mentioned earlier, upon completion of this project, the national transmission system was connected to the capitals of Bajhang District and West Rukum District, where the micro-hydropower stations are located, and the power supply areas of both micro-hydropower stations were reduced. Therefore, the power demand in the power supply areas of both facilities at the time of the ex-post evaluation was within the range of the installed capacity of the power generation, and it was not necessary to limit the power load. In fact, the Bajhang Micro-Hydropower Station produces electricity on average 18 hours a day, during which no load restrictions (power outages) are applied. At the Syarpudaha Micro-Hydropower Station, power outages occur 5 to 10 times a month on average due to problems such as the maintenance of the distribution network, but these only last about 2 hours in total. In addition, from the results of interviews with the residents (hereinafter referred to as “informants”) who used the electricity of the micro-hydropower stations constructed in this project, it was clear that long-term load restrictions were not implemented at the time of the ex-post evaluation. Therefore, it can be said that power was supplied stably to a certain extent in the power supply areas of both micro-hydropower stations at the time of the ex-post evaluation.

(2) Stable night lighting

In the field survey, 11 informants in Bajhang District and 8 in West Rukum District were interviewed. In both districts, all informants answered that power outages were reduced

compared to before completion of the project and that power was stably supplied at night at the time of the ex-post evaluation. Although it is the result of hearing from a limited number of informants, night lighting is being used stably.

(3) Stable voltage and power supply frequency

In the field survey, when the evaluator visually confirmed with the instruments of the power stations, no significant fluctuations in voltage or frequency were confirmed. Specifically, the voltage fluctuation range at the Bajhang Micro-Hydropower Station was 400 V to 420 V, and the frequency was almost unchanged. The voltage fluctuation range at the Syarpudaha Micro-Hydropower Station was 400 V to 410 V, and the frequency fluctuation status was 50 Hz to 52 Hz.

Therefore, it was confirmed that the voltage and frequency were stable.

3.3.2 Impacts

3.3.2.1 Intended Impacts

At the time of the ex-ante evaluation, the qualitative effects "improvement of public services by stable power supply to public facilities," "promotion of community activities by stable night lighting," and "reduction of motor failures by stable voltage and frequency of power supply" were expected.[20] In addition, the purpose of the project was to "contribute to enhancement of the regional economy and public welfare." Based on these expected impacts, the following three points were verified as the qualitative impacts in this evaluation.

(1) Is there a stable power supply in the public facilities (health facilities, schools)?
As a result, have the learning environment and health services been improved?

In the field survey, we visited one health post (clinic) and one public school each in Bajhang District and West Rukum District, and conducted the interviews. The results of the interviews are shown in Table 5.

[20] ex-ante evaluation paper, pp. 2-4

Table 5: Results of Interviews with the Public Facilities

	Bajhang District (one each)	West Rukum District (one each)
Health post (clinic)	Because the facility was established in 2019,[21] it was not possible to compare with the situation before the implementation of the project; however, the electricity was stably supplied and the medical services could be provided without any problems.	The power supply has been stable since it was connected to the system of the Syarpudaha Micro-Hydropower Station. The new medical service that uses electricity has been preparing to provide.
Public primary and secondary schools	Since the national transmission system was connected to the district capital, the power supply has been stable and the computers have been used stably, mainly by teachers. There was no lighting equipment in the school classrooms.	Power outages have decreased compared to before, and the power supply situation has improved. As a result, the school principal felt that the learning and teaching environment has improved and children's motivation and interest in learning have increased. He also felt that it was safer in terms of security because the electricity was stably supplied and lighting could be used. In addition, the neighboring villagers have also started new businesses, and the principal said that it has led to increases in income.

As mentioned above, although based on limited information,[22] the teaching and learning environments were improved through the stable supply of electricity in the public primary and secondary schools. In addition, although improvement in the health services was not confirmed, there were signs of it.

(2) Are power outages reduced and is stable lighting available at night in the community? Are nighttime activities (children's learning, community activities, etc.) thereby promoted?

In the field survey, 11 informants in Bajhang District and eight in West Rukum District were interviewed. The results of the interviews are shown in Table 6.

[21] In Bajhang District, there was only one health post, which was established in 2019, as a contractor of the micro-hydropower station, so it was not possible to confirm the situation before the project.

[22] In Bajhang District, the number of public facilities supplied by the Bajhang Micro-Hydropower Station was extremely limited, and the number of public facilities that could be visited in the field survey in both districts was also limited. As a result, the number of facilities visited was small.

Table 6 Results of the interviews with the informants

	Bajhang District (11 people)	West Rukum District (8 people)
Reduction of power outages	All informants answered that power outages were reduced compared to before the completion of this project and that power was stably supplied at night at the time of the ex-post evaluation.	
Increase in children's learning time	Nine out of nine valid respondents said their children's learning time increased.	Three of the seven valid respondents said their children's learning time increased. In addition, four respondents answered that their children were learning at night, although it was not possible to compare with the situation before the implementation of this project.
Increase in community activities	In both districts, four respondents each answered that activities within the communities such as parties and weddings increased, which made it easier to prepare for a party. They also answered that in the past it was necessary to hold a party in another place because there was no electricity, but at the time of the ex-post evaluation, it was said that it could be held in or near the house.	
Easiness of daily life	Seven respondents in each district answered that the stable power supply had made their daily lives easier. Specifically, it was easier to clean and cook because lighting could be used stably at night and sufficient brightness could be obtained. It was easier to cook because rice cookers, electric water heaters, electric stoves, etc. could be used. There was also a comment that the time spent on required tasks had shortened and that leisure time, such as for watching TV, reading, or writing, had increased.	
Others (increase in income)	Four respondents said that their income had increased due to the stable power supply. Informants who processed wood using electric planes were able to work for a long time, including at night, and their income had increased. In addition, it was said that stores could be opened at night and that new products could be sold (ice cream for refrigerators, etc.), which led to an increase in income.	One respondent said that the stable supply of electricity improved his income.

From the above, it was confirmed that power outages decreased in both Bajhang District and West Rukum District County compared to before the implementation of the project and that power was stably supplied at night at the time of the ex-post evaluation. It was said that children's learning time has increased compared to before the project was implemented. Regarding community activities, it was confirmed that opportunities such as parties and weddings have increased, and it was also confirmed that the use of electrical appliances has increased, daily life has become easier, and leisure time has increased. In addition, although the number of cases was limited, an increase in income was confirmed.

(3) Did voltage and frequency stabilize compared to before the project was implemented, and as a result, did the number of motor failures decrease?

In the field survey, one company in Bajhang District and two in West Rukum District that used motors were interviewed.[23]

The furniture supplier, the only contractor of the micro-hydropower station in Bajhang District, opened up for business just five months ago, and although it was not possible to confirm the situation before the project was implemented, the business opened near the micro-hydropower station. The supplier pointed out two reasons for this: availability of customers and obtaining stable power. He stated that the power was being supplied in a stable manner, and it was confirmed that there were no failures in the equipment used.

A furniture company in West Rukum District replied that the power supply was stable and there was no breakdown of the electrical equipment used. In addition, the metalworking company, which opened up for business one year ago, replied that electricity was being supplied in a stable manner, was more reliable than the main transmission system, and has had no negative impact on machinery.

As shown in the section on effectiveness, the voltage and frequency of the power supply areas of both micro-hydropower stations were stable. As mentioned above, from the scope of this survey, no reduction in the failure of electrical equipment, including among electric motors, was confirmed, but equipment failures due to fluctuations in the voltage and frequency of the supplied electricity were similarly not confirmed.

3.3.2.2 Other Positive and Negative Impacts

(1) Impact on the natural environment

At the time of the ex-ante evaluation, it was assumed that the project target area did not correspond to vulnerable areas such as national parks or their surroundings and that undesired impacts on the natural environment were minimal.[24] At the time of the ex-post evaluation, we confirmed that environmental monitoring was carried out by NEA, and no negative impact on the natural environment was confirmed.[25]

[23] In Bajhang District, there was only one contractor for the micro-hydropower station, so we could not confirm the situation before the start of this project.
[24] Ex-ante evaluation paper, p. 2
[25] Interviews with executing agency and informants.

(2) Resettlement and land acquisition

In this project, there was no relocation of residents, but there was a possibility that land acquisition would be required in Bajhang.[26] In February 2014, NEA formulated the *Land Acquisition and Compensation Plan*.[27]

In the field survey, it was confirmed two land acquisitions at the Bajhang Micro-Hydropower Station and no land acquisition at the Syarpudaha Micro-Hydropower Station. Compensation for land[28] was paid by the executing agency for land acquisition at the Bajhang Micro-Hydropower Station.[29] Also, through interviews with the two former landowners, it was confirmed that both of them received compensation.

(3) Benefits to the residents

At the time of planning, "improvement of living environment through stable power supply in poor areas" was expected as the impact on the promotion of poverty reduction. At the time of the ex-post evaluation, as mentioned above, signs of increases in income through the improvement of daily life and the activation of small-scale businesses were confirmed in the target areas of the project, although limited. Therefore, a certain degree of improvement in the living environment was confirmed.

(4) Other

As mentioned earlier, both Bajhang District and West Rukum District were connected to the main national transmission system at the time of the ex-post evaluation, and the areas where the micro-hydropower stations supplied power were limited. In both districts, the power supply from the national transmission systems sometimes interrupted for a long period of time, and the micro-hydropower stations constructed in this project serve as backup power sources for the main transmission system.[30] In addition, at the Bajhang Micro-Hydropower Station, maintenance was underway to expand the power supply area at the time of the ex-post evaluation. As of July 2020, the installation of four transformers has being implemented. Once these installations are complete, it will be possible to supply electricity to 500 new households.[31]

This project has achieved its objectives to some extent. Therefore, effectiveness and impacts of the project are fair.

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[26] Preparatory Survey Report, pp. 2-56
[27] Preparatory Survey Report Appendix 6.
[28] Based on the land re-acquisition price shown in the land acquisition and compensation plan. It also included compensation for living support.
[29] Questionnaire responses from the executing agency.
[30] Interview with the executing agency.
[31] Installation of three has already been completed.

3.4 Sustainability　(Rating: ②)

3.4.1 Institutional/Organizational Aspect of Operation and Maintenance

At the time of planning, the facilities of the Bajhang Micro-Hydropower Station were leased to the electric operating company, and the facilities of the Syarpudaha Micro-Hydropower Station were leased to the electric cooperatives; it was supposed that these organizations could continue to operate and maintain the facilities.

At the time of the ex-post evaluation, NEA Bajhang Distribution Center (hereinafter referred to as "NEA Bajhang DC") operated and managed the Bajhang Micro-Hydropower Station because it was connected to the national transmission system. NEA Bajhang DC has one chief, 15 technicians, and 12 temporary staff. Four staff members were engaged in the operation and maintenance of the Bajhang Micro-Hydropower Station, including the maintenance of transmission lines, distribution, customer service, and the operation of the generators. In the interviews with the staff who worked on the operation and maintenance, they did not confirm any shortage of personnel for the daily operation and maintenance, but there were comments regarding the shortage of personnel for cleaning the water tank during the rainy season.[32]

NEA Rukum West Distribution Centre (hereinafter referred to as "NEA Rukum West DC") operated and maintained the Syarpudaha Micro-Hydropower Station. The Rukum West DC has 15 permanent staff, including the chief and two supervisors, and 38 temporary staff. Seven full-time personnel were involved in the operation and maintenance of the micro-hydropower station, and four other personnel (mainly transmission line management) performed additional duties. According to the chief of NEA Rukum West DC, the number of personnel who maintain the micro-hydropower station's operation was sufficient at the time of the ex-post evaluation. There was a shortage of personnel who maintain the distribution network, including the national transmission system.

From the above, NEA's DC operated and maintained both of the micro-hydropower stations at the time of the ex-post evaluation. At the time of the ex-post evaluation, no major shortage of personnel for maintenance of the micro-hydropower station was confirmed.

Therefore, it can be said that the institutional and organizational aspect of the operation and maintenance of the micro-hydropower station rehabilitated in this project are secured to a certain extent.

[32] Interview with the executing agency.

3.4.2 Technical Aspect of Operation and Maintenance

At the time of planning, the electric operating company and the electric cooperatives had experience in the operation of power supply, and it was thought that the operation after the project's completion could be carried out. However, regarding the maintenance capacity, it was pointed out that the records of the inspections and repairs were not managed and maintained, that NEA regional offices that controlled the areas lacked leadership in the maintenance technics, and that the procurement plan related to the parts was insufficient from a financial perspective. Against such a background, the implementation of soft components was planned for the purpose of improving the operation and maintenance capabilities of NEA staff and the staff of the electric operating companies and electric cooperatives.[33]

At the time of the ex-post evaluation, the operation records were managed at both of the micro-hydropower stations, but the inspection records, maintenance records, and accident records were not managed. The ledger of replacement parts and spare parts was managed at the Syarpudaha Micro-Hydropower Station but not at the Bajhang Micro-Hydropower Station. In addition, the manuals provided by the soft component were not kept and used at both micro-hydropower stations, and the financial statements were not prepared. At both micro-hydropower stations, the water volumes, issues such as clogging, maintenance status, and so on were described on the operation log, and the records were referred to as necessary. Regarding the operation and maintenance of micro-hydropower stations, there were no technical issues at the time of the ex-post evaluation.[34]

Behind the fact that the inspection records were not managed and the manuals were not kept and used, the executing agency for the operation and maintenance changed from the electric operating company and the electric cooperatives to NEA by connecting the national transmission system. Due to such change, the deliverables and knowledge of the soft components were not inherited. Therefore, at the time of the ex-post evaluation, staff at both DCs were unaware of the existence of the formats of inspection records, maintenance records, and accident records. In addition, it was confirmed that there were no major problems in the operation and maintenance at both micro-hydropower stations and that there was no need to record accidents. Both DCs commented that they would like to obtain the formats and manuals of each inspection records again and use them.

In summary, regarding the technical aspect of operation and maintenance, the inspection records, maintenance records, accident records, and financial statements for which technical support was provided through the soft components have not been implemented, and the provided manuals have not been utilized. In this respect, it can be said that there were some

[33] Preparatory survey report, pp. 2-7, 3-25-3-26
[34] Interview with the executing agency.

problems.

3.4.3 Financial Aspect of Operation and Maintenance

At the time of the ex-ante evaluation, NEA was in the red for more than 10 years. Electricity charges were increased in September 2012, but in FY 2012/13, the deficit was 4,515.48 million Nepalese rupees. It was said that this was largely due to the rise in the price of power purchase agreements with India, in addition to the increase in import volume due to the increase in domestic demand. In NEA income statement, the operation and maintenance costs of "other expenses," including general and administrative expenses, were on the rise, and that budget item included the budget allocated to the Distribution and Customer Service Bureau, which was in charge of facilities maintenance after this project's completion. Therefore, the operation and maintenance costs of distribution facilities were on the rise, and it was expected that the maintenance costs after this project's completion would be secured within the same budget.

At the time of this project's completion, it was pointed out that the maintenance of power generation facility other than the power generation equipment at the power stations may not be practiced due to the cost issues rather than their technics.[35]

At the time of the ex-post evaluation, according to NEA's profit and loss statement confirmed for three years (FY 2016/2017, 2017/2018, and 2018/2019), the surplus was 1,502 million Nepalese rupees (about 1.4 billion Japanese yen) in FY 2016/2017, 2,897 million Nepalese rupees (about 3.2 billion Japanese yen) in FY 2017/2018, and 7,204 million Nepalese rupees (about 7.3 billion Japanese yen) in FY 2018/2019.[36] This indicates that their business situation is sound. In addition, "other costs," including the operation and maintenance costs of the distribution facilities, continue to increase.[37]

Table 6 shows the annual budget for the operation and maintenance of the Bajhang Micro-Hydropower Station, and a sufficient budget for daily operation and maintenance was allocated.

Table 6 Operation and Maintenance Budget Required for Bajhang Micro-Hydropower Station

Routine maintenance cost	2,000
Periodic maintenance costs	3,000
Repair costs	50,000
total	55,000

(Unit: Nepalese rupee)

[35] Documents provided by JICA.
[36] For exchange rate, JICA's monthly exchange rate is used.
[37] Questionnaire responses from the executing agency.

However, as shown later in 3.4.4, Status of Operation and Maintenance, a part of the headrace was damaged, and at the time of the ex-post evaluation, water was conveyed using the high-density polyethylene pipes, and the repair budget was insufficient. NEA Bajhang DC applied for the budget (4 million Nepalese rupees) required for this repair to NEA Regional Office, which is a superior organization, but the budget was not allocated at the time of the ex-post evaluation.

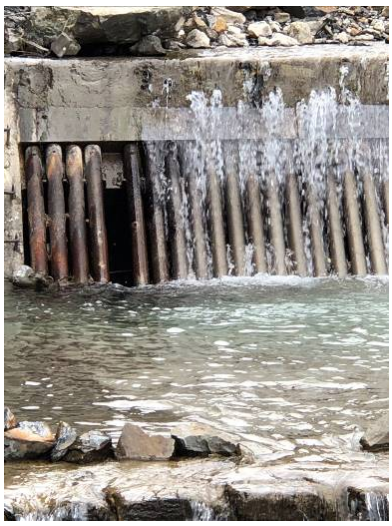
At the Syarpudaha Micro-Hydropower Station, it was not possible to obtain the information on the allocation status of the operation and maintenance budget, but it was said that the cost for daily operation and maintenance was sufficient.[38] However, as with the Bajhang Micro-Hydropower Station, when the headrace was damaged in the past, it was not possible to make a repair budget within NEA, and repairs were carried out with the support of the local government. When large-scale repairs/renovations are required , the budget may be insufficient.

According to the Community & Rural Electrification Department, Distribution & Consumer Services Directorate, which is in charge of this project, when large-scale repairs are required, the branch office makes a request to the regional office. Then, in response to the application from the regional office to the headquarters, the headquarters would decide to allocate the budget.

From the above, although the daily operation and maintenance costs were sufficient, there was a budget shortage when large-scale repairs were required, and it was confirmed that there were some problems in the financial aspect of operation and maintenance.

[38] Interview with the executing agency.

3.4.4 Status of Operation and Maintenance



Bajhang Micro-Hydropower Station bar screen in which one bar was removed

At the time of the ex-ante evaluation, the electric cooperatives and electric operating company carried out the small-scale partial repairs of the equipment. However, the overhaul inspection and maintenance of the water turbines and generators and renewals or repairs of the important equipment were not carried out. In the event of failures, the existing equipment was put into operation by repeating the partial repairs as symptomatic treatments. Under these circumstances, the power generation facilities and equipment were aging and continued to operate in a state of failure or damage.[39]

At the time of the ex-post evaluation, the generators were functioning without problems at the Bajhang Micro-Hydropower Station. As for the intake, clogging caused by gravel accumulation during the rainy season continued to occur. In response to the indication during the defect inspection, one bar was removed from the bar screen from February to March 2017 to secure the amount of water, which then alleviated clogging of the bar screen. On the other hand, the amount of stones and gravel that invaded the headrace and water tank increased. Under these circumstances, NEA Bajhang DC cleaned the bar screen to remove gravel once every one or two months during the dry season and two or three times a day during the rainy season, and it regularly cleaned the headrace and water tank. The method of cleaning the bar screen is to go behind the screen and removing gravel, which is highly dangerous during the rainy season when the amount of water increases. In addition, in order to prevent the invasion of gravel as much as possible during the rainy season, measures are taken to change the water intake destination to a tributary. As for the headrace, as mentioned above, a part of the headrace (60 m) was damaged by the landslide that occurred from June to August 2018. At the time of the ex-post evaluation, a high-density polyethylene pipe was temporarily used for the water conveyance, and there were situations where a sufficient amount of water could not be obtained.

At the Syarpudaha Micro-Hydropower Station, the two generators were operating without problems and there were no problems with the intake, which allows for generating electricity for almost 24 hours. A part of the headrace (25 m) was damaged by the landslide that occurred in October 2019, but it had been repaired by the time of the ex-post evaluation, and there was no problem with the headrace function. There is a water leak in a part of the penstock pipe, but it

[39] Preparatory survey report, pp. 1-4

does not affect the power generation capacity. There are no problems with other facilities.

From the above, it was confirmed that there are some issues in the status of operation and maintenance.

Based on the above, some minor problems have been observed in terms of the technical aspect, the financial aspect, and the current status. Therefore, sustainability of the project effects is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project aims to respond to tight power supply-demand balance in the rural area by rehabilitating the existing aged micro-hydropower stations in the area (Bajhang District and West Rukum District) that are not connected to the main transmission/distribution system, thereby contributing to the enhancement of the regional economy and public welfare. As this objective was consistent with the development plan and development needs of Nepal as well as Japan's ODA policy, the project relevance is high. Although the project cost was within the plan, the project period exceeded the plan. Therefore, the efficiency of this project is fair. Regarding the three operational indicators set in this project, the target values for average power output (kW) and annual generated energy (kWh/year) were not achieved at the Bajhang and Syarpudaha Micro-Hydropower Stations, and that for the annual generated operation hours (h/year) was not achieved at the Bajhang Micro-Hydropower Station. Regarding the qualitative effects on the effectiveness and the impacts, certain effects were confirmed. Therefore, this project has achieved its objectives to some extent, and effectiveness and impacts of the project are fair. Some minor problems have been observed in terms of the project's technical and financial aspects and current status of operation and maintenance. Therefore, sustainability of the project's effects is also fair.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

(1) Renovation of the headrace of the Bajhang Micro-Hydropower Station

As shown in sections of Effectiveness and Sustainability, the headrace damaged by the landslide at the Bajhang Micro-Hydropower Station was simply repaired, so the water supply capacity and thus the flow rate required for power generation were not sufficient. Immediate repair of the headrace is required to secure the power generation capacity. NEA Bajhang DC needs to coordinate with its superior organization, NEA Regional Office, to ensure that the budget required for the repair is secured within NEA. If it is difficult to secure a budget

within NEA, another effective method is to work with local governments to secure the budget, as was done at the Syarpudaha Small Hydropower Station.

(2) Examination of connectivity to the main transmission system of the Micro-Hydropower Stations

As shown in the relevance section, at the time of the ex-post evaluation, Nepal has indicated a policy of connecting (synchronizing) small and micro hydropower stations to the main transmission system. In addition, both micro-hydropower stations are in a situation where their original power generation capacity is not fully utilized because the area to be supplied with electricity has been reduced from the time of planning. Therefore, it is proposed to consider the technical connectivity and then connect to the main transmission system if possible, in order to maximize the power generation capacity of the micro-hydropower stations rehabilitated in this project. In that case, one must pay sufficient attention not to impair the backup functions of the micro-hydropower stations to the main transmission system. It is also important to review the synchronous cases that NEA has implemented with the similar small and micro hydropower stations, and utilize the lessons learned from those experiences. If it is technically impossible, it is proposed to consider alternatives, such as the expansion of the power supply area being implemented by the Bajhang Micro-Hydropower Station at the time of the ex-post evaluation. In addition, in consideration of the decentralization system in Nepal and the remoteness of the sites, it is desirable that the Regional Offices, which are the superior organizations of the DCs, take the lead in conducting these studies.

4.2.2 Recommendations to JICA

As for the recommendation to the executing agency shown in 4.2.1(2) above "examination of the possibility of connecting the Micro-Hydropower Stations to the national transmission system," it is proposed that JICA support the smooth implementation of the above examination by collecting and providing the necessary information to the executing agency in response to the request from them. In that case, it will be more effective if specialized advice is provided while appropriately communicating with the generator manufacturer and consultants.

4.3 Lessons Learned

Setting the target values of the operational indicators reflecting on the actual situation

The target values of the operational indicators set in this project were excessive. The two aspects; (1) the micro-hydropower stations are operated as single systems, so they cannot be operated at all times with 100% power generation capacity, and (2) the power demand in the target area differs greatly between nighttime and daytime, were not taken into consideration. When setting the target values of the operational indicators at the time of planning, it is

important to properly understand the conditions under which the target project will be operated, to extract and analyze the factors that affect the indicator, and then to reflect the results of that analysis in the target value.