India

Ex-Post Evaluation of Japanese ODA Loan

"Umiam Stage II Hydro Power Renovation & Modernization Project"

External Evaluator: Keishi Miyazaki, OPMAC Corporation

0. Summary

The objective of this project was to meet the growing demand for electricity in the State of Meghalaya by the renovation of the Umiam Stage II Hydro Power Station (18 MW) which is located in the river basin of the Umiam River. The project matched India's national development policy and development needs at both the appraisal (2004) and the time of the ex-post evaluation as well as Japan's ODA policy at the time of the appraisal, therefore its relevance is high. For the project outputs, there was no major changes except for the expansion of installed capacity from 18 MW to 20 MW. This augmentation corresponded with the project objective to take measures against power shortage. However, the project period significantly exceeded the plan; therefore the efficiency of the project is fair. For the operation and effect indicators, the planned outage hours and the maximum output reached the target values, however, the forced outage hours, the plant load factor and the net electric energy production did not reach the target values. The main factors for the failure to attain the target value of the plant load factor and net electric energy production were considered to be the water shortage for power generation due to changes in the amount and pattern of rainfall. However there is the possibility that the setting of the target values at the appraisal was overrated. There was a certain level of achievement in the improvement of the operation and management capacity of the executing agency by capacity building. On the other hand, the Umiam Stage II Hydro Power Station generats approximately 2-2.5% of the annual electric power generated in Meghalaya State and contributed to a stable power supply as the state's base load power generation[1]. However, the state has not solved the issue of power shortage completely, and it was difficult to confirm the impacts of the project on industrial development and improvements in the living standards of the local residents in Meghalaya. No negative impact of the project on the natural environment was observed and there was no land acquisition or resettlement. Therefore, the effectiveness and impacts of this project are fair. As for the sustainability of the project effect, some minor problems have been observed in terms of the financial aspects and therefore sustainability of the project effect is fair.

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

[1] The base load power generation means that the power generation which can provide stable power with low cost regardless of season, weather or time of day.

1. Project Description

Project Location

The Generator of the Umiam Stage II Hydro Power Station

1.1 Background

Meghalaya State, located in the northeastern part of India, has had a growing demand for electric power due to the industrialization policy established by the state government in 1997; on the other hand, it experienced severe power shortages in 2002 when its shortage was 530 GWh (46.9%) against a power demand of 1,130 GWh, as well as a supply shortage of 51 MW (21.7%) during peak hours against a power demand of 235 MW. The Umiam Stage II Hydro Power Station, the target facility of this project, was built with a grant aid from the United States Agency for International Development (USAID) in 1970. However the power generation facility has notably deteriorated, and its power generation efficiency has decreased. For this reason, the power station was in need of renovation.

1.2 Project Outline

The objective of this project was to meet the growing demand for electricity in the State of Meghalaya by the renovation of the Umiam Stage II Hydro Power Station (18 MW) located in the river basin of the Umiam River, thereby contributing to the promotion of industrial development and to improvement in the living standards of local residents in the state.

Loan Approved Amount / Disbursed Amount	1,964 million yen / 1,825 million yen	
Exchange of Notes Date / Loan Agreement Signing Date	March 2004 / March 2004	
Terms and Conditions	Interest Rate:	1.3%
	Repayment Period:	30 years
	(Grace Period:	10 years)
	Conditions for Procurement:	General untied

Borrower / Executing Agency	The President of India / Meghalaya State Electricity Board (current Meghalaya Energy Corporation Limited: MeECL)
Final Disbursement Date	June 2012
Main Contractor (Over 1 billion yen)	-
Main Consultant (Over 100 million yen)	Joint venture of TEPCO (Japan) and TEPSCO (Japan)
Feasibility Studies, etc.	1. Feasibility Study (F/S) (November 1994) 2. The Special Assistance for Project Formation (SAPROF) for the Umiam Stage II Hydro Power Renovation & Modernization Project (September 2003)
Related Project	-

2. Outline of the Evaluation Study

2.1 External Evaluator

Keishi Miyazaki, OPMAC Corporation

2.2 Duration of Evaluation Study

Duration of the Study: August 2014 - September 2015

Duration of the Field Study: November 29 - December 27, 2014, March 8 - 21, 2015

2.3 Constraints during the Evaluation Study

It was difficult to obtain the financial statements of the executing agency for the latest three fiscal years of 2012/13, 2013/14 and 2014/15 from the executing agency as they had not been audited and officially authorized at the time of ex-post evaluation of this project. Therefore, it was necessary that the evaluation judgement on the financial sustainability of the project was made based on the available secondary information as mentioned in "3.5.3 Financial Aspects of Operation and Maintenance".

3. Results of the Evaluation (Overall Rating: C[2])

3.1 Relevance (Rating:③[3])

3.1.1 Relevance to the Development Plan of India

At the project appraisal (2004), one of the most important tasks of the Tenth Five-Year

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

[3] ③: High ②: Fair, ① Low

Plan (2002-2007) was stated as the need to make new power resource development to meet the increased demand for electricity in the future. Power resource development of 46,939 MW (of which 17,311 MW would be hydropower) nationwide by 2007 was planned.

The Meghalaya state government had been promoting alloy iron, steel and cement industries based on an industrial policy established in 1997. However, the state experienced severe power shortages caused by the growing demand of these industries which took up almost half of the electricity consumption. The Meghalaya State Electricity Board (at that time) planned to increase the installed capacity of generation to a total of 242 MW by 2012 through the renovation of the existing hydropower station as well as the construction of new power stations such as the Umngot Stage I & II Hydro Power Stations and the Myntdu Leshka Hydro Power Station, in order to cope with the power shortage.

The objective of this project was to cope with the power shortage in the state of Meghalaya by renovation of the existing hydropower station; therefore it was relevant to the mentioned Tenth Five-Year Plan and to the state's power sector plan.

At the time of the ex-post evaluation, under the national development plan of the Twelfth Five-Year Plan (2012-2017) which acknowledged the need for a stable power supply for all economic activities and inclusive growth, new power development of 88,000 MW was planned for the same period.

Furthermore, the Twelfth Five-Year Plan (2012-2017) of Meghalaya State had three priority areas: (i) Use of natural resources for development and living, (ii) Infrastructure development, and (iii) Human resource development. As for (ii) Infrastructure development, the need for new power resource development to include hydro power and thermal power was stated as being necessary to meet the state's severe power shortage. Umngot Stage I & II Hydro Power Stations are in a preparatory phase, and Stage I of the Myntdu Leshka Hydro Power Station was completed in 2013 with Stage II in a preparatory phase. In Meghalaya, another 64 MW of generation capacity will be added, with the target that this is expanded to 378 MW by 2017.

Improvement in the power supply capacity continues to be a priority in India's national and Meghlaya state's development plans, and it was relevant to the objective of this project at the time of the ex-post evaluation.

3.1.2 Relevance to the Development Needs of India

In 2002, Meghalaya State experienced severe power shortages where its supply shortage was 530 GWh (46.9%) against a power demand of 1,130 GWh as well as a supply shortage of 51 MW (21.7%) during peak hours against a power demand of 235MW. The Umiam Stage II Hydro Power Station, the target facility of this project, was built with a grant aid by the United States Agency for International Development (USAID) in 1970. However the power station facility had notably deteriorated, and its power generation efficiency had

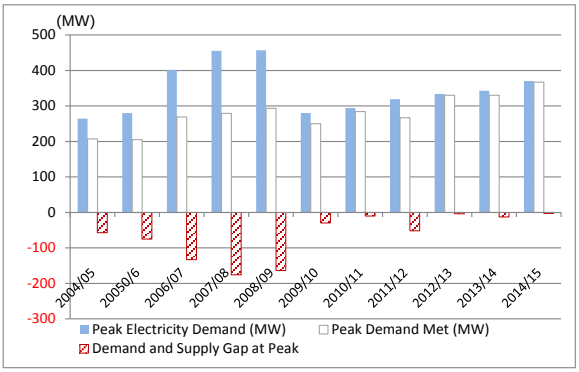
decreased due to frequent breakdowns as seen in an incident in 2002 when it was forced to experience a long-term power outage. On the other hand, the construction of a new power station to replace it would take considerable time and investment, therefore it was necessary to meet the state's severe power shortage by renovation of the existing power station.

At the time of the ex-post evaluation, the total installed capacity of power stations under the management of Meghalaya Energy Corporation Limited (MeECL) had increased to 314.7 MW (Table 1). As a result, the power shortage at peak hours was eased to 13 MW (3.8%) in 2013/14 (Figure 1). Similarly, there was a power shortage of 190 GWh (10.6%) against the required power supply volume of 1,794 GWh in 2013/14, which indicates the improvement in power supply in Meghalaya State[4].

Table 1: The Installed Capacity of Existing Hydro Power Stations under the Management of MeECL (As of 2014)

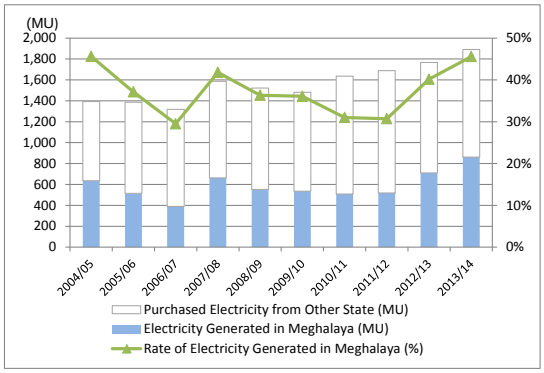
No	Power Station	Total Capacity
1	Umiam Stage I Hydro Power Station	36 MW (9 MW x 4 units)
2	Umiam Stage II Hydro Power Station	20 MW (10 MW x 2 units)
3	Umiam Stage III Hydro Power Station	60 MW (30 MW x 2 units)
4	Umiam Stage IV Hydro Power Station	60 MW (30 MW x 2 units)
5	Umtru Hydro Power Station	11.2 MW (2.8 MW x 4 units)
6	Sonapani Hydro Power Station	1.5 MW (1.5 MW x 1 unit)
7	Leshka Hydro Power Station	126 MW (42 MW x 3 units)
	Total	314.7 MW

Source: Meghalaya Energy Corporation Limited (MeECL).



Source: Central Electricity Authority (CEA), Ministry of Power, Government of India.
Note: At the time of the ex-post evaluation in 2013/14, the peak power supply was 330 MW against a peak power demand of 343 MW. The above 330 MW includes generation from the power stations of private companies and central government in addition to that of MeECL.

Figure 1: The Power Demand and Supply Gap at Peak Hours in Meghalaya



Source: Meghalaya Power Generation Cooperation Limited (MePGCL).
Note: 1 MU (Mega Unit) is equivalent to 1,000,000 KWh.

Figure 2: Annual Power Supply Volume in Meghalaya

[4] Load Generation Balance Report 2014-2015, Central Electricity Authority (CEA), Government of India.

For this reason, Meghalaya purchases electricity from the power stations[5] of neighboring states through India's northeastern power grid. Of Meghalaya's total power generation of 1,891 GWh in 2013/14, 862 GWh, which is the equivalent of 46%, was generated within the state. The remaining 1,029 GWh, which is the equivalent of 54%, was purchased from out of state (Figure 2). The Umiam Stage II Hydro Power Station shares 6% of the total installed capacity in Meghalaya, and 5% of the annual power supply volume as its base load power source. However, this figure drops to 2-2.5% if the power purchased from out of state is included in the state's overall annual power supply volume. As seen here, although the power supply gap of Meghalaya during peak hours has somehow been improved since the time of appraisal, it had yet to be completely closed at the time of the ex-post evaluation. For this reason, there is a continuing need for improved generation capacity to meet the power shortage.

3.1.3 Relevance to Japan's ODA Policy

At the project appraisal, Japan's Country Assistance Plan for India (established in May 2006) had not yet been established. However, Japan's ODA policy for India in 2004 included the following priority sectors: (i) Economic infrastructure, (ii) Poverty alleviation, and (iii) Environment protection. For (i) Economic infrastructure, it was stated that the economic infrastructure would be promoted mainly in power and transportation. This project was implemented along the lines of (i) of the above mentioned priority sectors.

Furthermore, in JICA's County Assistance Strategy for India (September 2003), the "development of economic infrastructure with a focus on power" was stated as a priority area, and it was planned that support would be provided for the development of power sources, the development of distribution lines for a stable and efficient power supply and for efforts to reform the central and state government sectors. From the above, it is clear that this project was relevant to Japan's ODA policy.

3.1.4 Appropriateness of Target Values of the Operation and Effect Indicator

The Umiam Stage II Hydro Power Station (18 MW at the time of planning) generates power by recycling 100% of the water used in the Umiam Stage I Hydro Power Station (36 MW) that is located upstream and therefore the operation of the Umiam Stage II depends on the operation status of the Umiam Stage I. At the project appraisal, the target value for the plant load factor (3 years after completion) that was one of the application effect indexes was set to be 45%. This was established based on the results of the Special Assistance for Project Formation (SAPROF) for the Umiam Stage II Hydro Power Renovation & Modernization

[5] Meghalaya State has signed long-term power purchase agreements with the North Eastern Electric Power Corporation (NEEPCO), the National Hydroelectric Power Corporation (NHPC), the National Thermal Power Corporation (NTPC), and power generation companies under the Oil and Natural Gas Corporation (ONGC), and receives power supply from them.

Project (September 2003). According to the above study report, there was the precondition of an expected annual power generation volume of 70.4 GWh from the Umiam Stage II, recycling the water used for power generation in the Umiam Stage I, which was calculated based on the actual power generation volume of 129.4 GWh in 2002. The target value of 45% in the plant load factor was set based on this precondition[6].

However, the actual plant load factor of the Umiam Stage II, which is the target facility of this project, after the project completion, was less than 30%, remaining at an approximate 60% achievement of the target value (45%). The reasons for the actual value being less than 30% in the plant load factor are considered to be the decreased amount of water available for power generation caused by changes in the amount and pattern of rainfall. The actual volume of power generation in Umiam Stage I in 2002, which was the precondition for the establishment of the target value, was, in fact, a result attained with relatively good conditions of available water for power generation. If the target value had been calculated based on the average rainfall for the past 5-10 years, or the future rainfall forecast using this trend, it is possible that the target value could have been lower than 45%. Therefore, the target value of 45% in the plant load factor may have been overestimated to some extent.

In the light of the above, this project has been highly relevant to India'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

The outputs of this project are shown below (Table 2).

Table 2: Project Outputs (Plan/Actual)

Item	Plan	Actual
(1) Installed Capacity	• 18 MW (9 MW x 2)	• 20 MW (10 MW x 2)
(2) Mechanical Equipment	• Turbine (runner, inlet valve, guide vane control system, main shaft water sealing device, etc.) • Governor and Turbine Control System • Air Compressed Supply System • Dewatering & Drainage System • Others	• As planned
(3) Electrical Equipment	• Generator and its Auxiliary (Fixed Coils, Fixed Core, etc.) • Excitation System • Main Control Boards • 11KV Metal-Enclosed Cubicles • Generator Transformer and Station Transformer • Others	• As planned

[6] The installed capacity of the Umiam Stage II Hydro Power Station at the initial plan was 18 MW, and the target value or 45% was set based on this precondition. This project has augmented the installed capacity from 18 MW to 20 MW.

Item	Plan	Actual
(4) Consulting Services (a) Assistance for Renovation Work	• Assistance in Procurement, Implementation of Renovation and Modernization Work, Operation and Maintenance Instruction, Project Reporting • Input: 45 M/M	• The service contents were as planned • Input: 58.39 M/M
(b) Capacity Building	• Capacity Building of the Meghalaya State Electricity Board ➢ Improvement of financial issues, improvement of the organization management, Improvement of problem solving skills by introducing QC circles • Survey on Upgrading of the Human Development Center ➢ Recommendations for improvements in the human resource development system, facilities and equipment, utilization of the North-Eastern Regional Centre of the National Power Training Institute • Input: 48 M/M	• The service contents were as planned • One month of Total Quality Management (TQM) training for 10 staff members of Meghalaya State Electricity Board was conducted in Japan. • Input: 80.5 M/M

Source: Data from JICA and responses from questionnaires.
Note: QC is an abbreviation for Quality Control. In the QC circle activities, a small group of volunteers in the office work on quality control, the improvement of products and services, and also on reducing defective products and on safety measures.

There was no significant change in the components of the mechanical and electrical equipment except for the change in the installed capacity from 18 MW (9 MW x 2 units) to 20 MW(10 MW x 2 units). As for the change in the installed capacity, the Central Electricity Authority (CEA) of the Ministry of Power recommended to the executing agency that augmentation was possible considering turbine capability. This recommendation was studied by the executing agency who concluded that a 2 MW of augmentation was possible within the project cost. Design change was then implemented. This augmentation corresponded with the project objective to take measures against power shortage.

Furthermore, the input of consulting services increased. The work volume of consulting services regarding assistance for renovation works increased by 13.39 M/M (approximately 30%) due to some additional work for design changes and retendering of the main contract. The work volume of capacity building increased by 32.5 M/M (approximately 68%) due to some additional work caused by the extended project period.

For procurement, the generator transformer, the station transformer and the water supply facility were procured as a package through Local Competitive Bidding (LCB) and the other main electrical devices were procured as a package through International Competitive Bidding (ICB).


Generator (Unit 1, Unit 2)


Substation


Controller


11KV Switch Gear Panel


Umiam Lake (Umian Reservoir)


Channel (Out of Project Scope)

3.2.2 Project Inputs

3.2.2.1 Project Cost

The actual project cost amounted to 2,147 million yen (Japan's ODA loan: 1,825 million yen) against the planned cost of,2,343 million yen (Japan's ODA loan: 1,964 million yen) and this was within the plan (equivalent to 92% of the original plan) (Table 3).

In this project, the machinery cost exceeded the estimation by 257 million yen due to some additional outputs (the augmentation of installed capacity). However, other costs such as electrical equipment, transportation, installation, administration and physical contingency were below the plan, therefore the actual project cost was within the plan. In addition, although the actual work volume of the consulting services increased, the actual cost was below the plan. It is thought that the reason for this was that it was possible to contract with consulting services at a lower unit cost of man-month (M/M) than the unit cost of M/M estimated at the time of appraisal as a result of competitive bidding.

Table 3: Project Cost (Plan/Actual)

Unit: Million yen

Item	Plan			Actual		
	ODA loan	Indian government	Total	ODA loan	Indian government	Total
1. Mechanical equipment	365	0	365	622	0	622
2. Electrical equipment	589	0	589	582	0	582
3. Transportation cost	112	0	112	21	0	21
4. Installation cost	200	0	200	122	0	122
5. Price escalation	81	28	109	0	0	0

Item	Plan			Actual		
	ODA loan	Indian government	Total	ODA loan	Indian government	Total
6. Physical contingency	135	34	169	56	28	84
7. Consulting service	415	0	415	356	0	356
8. Administration cost	0	142	142		8	8
9. Tax and duties	0	175	175		285	285
10. Interest during construction (IDC)	67	0	67	67	0	67
Total	1,964	379	2,343	1,826	321	2,147

Source: Data from JICA.

3.2.2.2 Project Period

The planned project period was 55 months, or from March 2004 (signing of loan agreement) to September 2008 (start of a test run of the power station). The actual project period was 95 months, or from March 2004 to January 2012, which significantly exceeded the plan (equivalent to 172% of the original plan) (Table 4). The main reason for the delay was that the Central Electricity Authority (CEA) of the Ministry of Power did not agree on the contents of the terms of reference and the tender price for the main contract making retendering necessary. This resulted in a delay of 3 years. On the other hand, the actual project period between the announcement of the result of retendering and the start of the commissioning of the unit 2 generator was 25 months as planned.

Table 4: Project Period (Plan/Actual)

Item	Plan	Actual
Signing of loan agreement	March 2004	March 2004
Start of tender for main contract	April 2005	July 2008 (retendering)
Announcement of tender	June 2005	August 2008 (retendering)
Tender evaluation by MeECL	January 2006	September 2009 (retendering)
JICA concurrence for the award of contract	July 2006	November 2009 (retendering)
Award of contract	August 2006	December 2009 (retendering)
Commissioning of Unit 1	June 2008	January 2012
Commissioning of Unit 2	August 2008	December 2011
Project Period	March 2004-September 2008 (55 months)	March 2004-January 2012 (95 months)

Source: Data from JICA.
Note: MeECL: Meghalaya Energy Corporation Limited.

3.2.3 Results of Calculations of Internal Rates of Return

At the appraisal, the Financial Internal Rate of Return (FIRR) of the project was 18.8%, and the Economic Internal Rate of Return (EIRR) was 20.5%. The results of recalculation of the FIRR and EIRR at the time of the ex-post evaluation were FIRR=7.9% and EIRR=7.9%. The preconditions at the time of project planning were as follows:

	Financial Internal Rate of Return (FIRR)	Economic Internal Rate of Return (EIRR)
Cost	Investment cost, operation and maintenance cost	Investment cost, operation and maintenance cost (tax and duties excluded)
Benefits	Power sales revenue	Power sales revenue (tax and duties excluded)
Project life	30 years after commercial operation	30 years after commercial operation

In the light of the above, the project cost was within the plan but the project period significantly exceeded the plan; therefore the efficiency of the project is fair.

3.3 Effectiveness[7] (Rating: ②)

3.3.1 Quantitative Effects (Operation and Effect Indicators)

At the project appraisal, the forced outage hours, planned outage hours and plant load factor were set as the operation indicators, and the maximum output and net electric energy production as the effect indicators (Table 5).

Table 5: Operation and Effect Indicators

Index	Baseline	Target	Actual		
	2002	2011	2012/13	2013/14	2014/15
	Prior to appraisal	3 years after completion	Completion year	1 year after completion	2 years after completion
<Operation Indicator>					
Forced Outage Hours (hours/year)					
(1) By Mechanical Trouble	530	88	0	0	0
(2) By Human Error	0	0	0	0	0
(3) Other	0	0	Unit 1: 44h46 Unit 2: 937h46 Total: 982h32	Unit 1: 103h25 Unit 2: 69h45 Total: 173h10	Unit 1: 127h07 Unit 2: 19h31 Total: 146h38
Planned Outage Hours by Periodical Inspection (hours/year)	3,787	88	Unit 1: 154h24 Unit 2: 100h49 Total: 255h13	Unit 1: 22h45 Unit 2: 28h45 Total: 51h30	Unit 1: 73h00 Unit 2: 10h30 Total: 83h30
Plant load factor (%)	36	45	28.8	23.6	26.1
<Effect Indicators>					
Maximum output (MW)	18	18	20	20	20
Net electric energy production (MWh/year)	56,470	70,000	50,408	41,322	41,327

Source: Data from JICA and response to questionnaires.
Note 1: Actual values are the data based on the Indian fiscal year (April-March).
Note 2: The actual value for 2014/15 is based on data for 11 months between April 2014 and February 2015.

The forced outage hours due to mechanical trouble was 0 hour/year during 2012/13-2014/15 against the target value of 88 hours/year, therefore the target value was achieved. The forced outage hours by human error was 0 hour/year during 2012/13-2014/15, therefore the target value was achieved. On the other hand, however, the forced outage hours by other causes was 982 hours/year in 2012/13, 173 hours/year in 2013/14 and 146

[7] Sub-rating for Effectiveness is to be put with consideration of Impact.

hours/year in 2014/15, which meant that the target of 0 hour/ year was not achieved. This was because at the Umiam Stage II, there were frequent occurrences of rapid voltage increase during power supply, and the operation of generators was temporarily suspended in order to avoid any damage to the machinery. Such cases were more frequent in 2012/13. According to the executing agency, another distribution line should be developed in order to avoid rapid voltage increase. However, this would cost a lot of time and money and therefore the temporary suspension of the operation of generators to prevent damage was the only available countermeasure.

Although the planned outage hours was 255 hours/year in 2012/13, the total was 51 hours/year in 2013/14 and 83 hours/year in 2014/15 which meant that the target value of 88 hours had been achieved.

For the maximum output, the installed capacity was originally 18 MW, changed to 20 MW, therefore the target value of 18 MW was achieved. The net electric energy production and plant load factor were below the 2002 baseline before renovation in both 2012/13 and 2014/15, and the target values were not achieved. According to the executing agency, this was considered to be due to changes in the amount and pattern of rainfall which led to a decrease in the water volume available for power generation. In addition, there is the possibility that the change of installed capacity from 18 MW to 20 MW affected decrease in the plant load factor. Meanwhile, as mentioned earlier, the target value for the plant load factor of 45% was set based on good preconditions and there is the possibility that it was overestimated to some extent.

The water drawn from the Umiam lake (Umiam reservoir) is used to generate power at the Umiam Stage I, carried to the Umiam Stage II through a channel[8], then reused to generate power at the Umium Stage II (Figure 3). For this reason, the operation of the Umiam Stage II highly depends on the operation status of the Umiam Stage I. When looking at the past 13 years of annual rainfall and the power generation volume of the Stage I and Stage II during 2001/02-2013/14, the power generation volume of these two stations

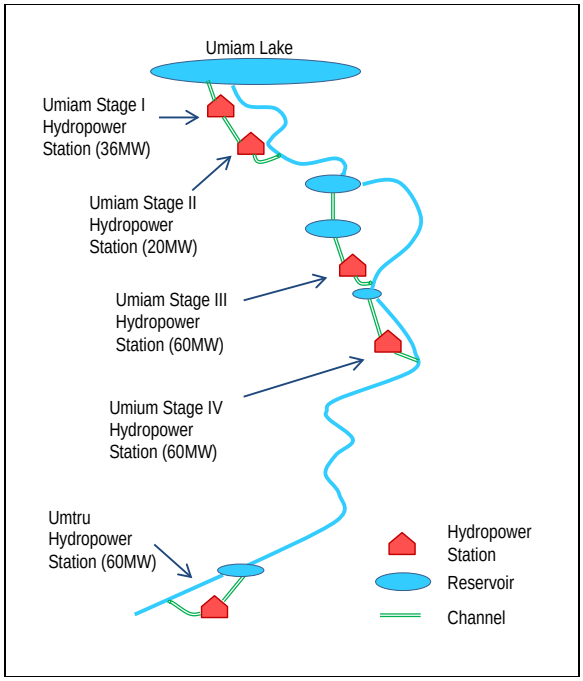
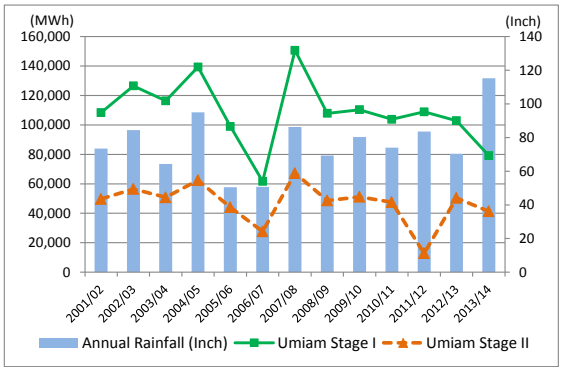


Figure 3: Map of Project Site

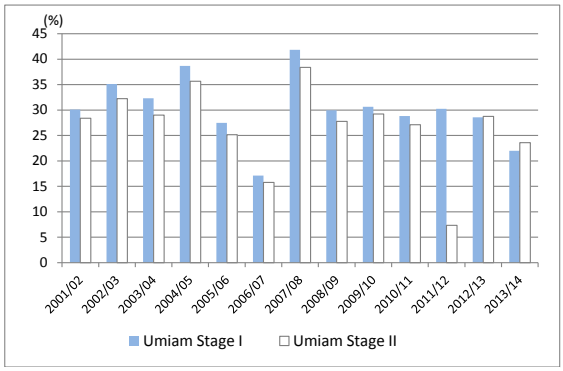
[8] Total extension of the channel is 3,411 m (open channel: 1,188 m, tunnel: 2,226 m).

changes in almost the same pattern, except for 2011/12 when there were more planned outage hours (Figure 4). Furthermore, there were only two times (in 2004/05 and 2007/08) when the plant load factor of the two stations went above 35% during the past 13 years. For other years, it fluctuated around approximately 25%-30% (Figure 5). Considering this, a realistic target value for the plant load factor of the Umiam Stage II would have been an average of 30%-35%, and 40% at the most.



Source: Meghalaya Power Generation Corporation Limited (MePGCL).
Note: 1 inch is equivalent to 25.4 mm.

Figure 4: Annual Rainfall and Power Generation



Source: Meghalaya Power Generation Corporation Limited (MePGCL).

Figure 5: Plant Load Factor

3.3.2 Qualitative Effects

(1) Improvement in the operation and maintenance capacity of the executing agency

In this project, capacity building of the executing agency was implemented in addition to procurement assistance, the supervision of renovation works and operation and maintenance instruction as part of the consulting services. In particular, there were the improvement of financial issues, the improvement of organization management, the improvement in problem solving skills by introducing QC circles, recommendations for the improvements of human resource development systems, facilities and equipment, and a survey on the upgrading of the human resource development center to include examination of the usage of the North-Eastern Regional Center. At the ex-post evaluation interviews with current and former cadres of the human resource development department of the executing agency, accounting personnel and the head of the Umiam Stage II Hydro Power Station were conducted, and the following qualitative effects were confirmed.

<u>Strengthening the organizational capabilities by introducing QC circles</u>

At the executing agency, a TQM secretariat was established under the department of human resource development, and this secretariat supported the spread of TQM in the areas of human resource development, accounting, sales and corporate management. Furthermore, a circular was made on TQM promotion, and activities were conducted to disseminate QC

circles in each section and department of the power generation and transmission sectors. As the result, the power generation company started to conduct OJT on transformer repair as a part of quality management as well as holding regular meetings in order to standardize the work within each QC circle. In addition, the concept of OJT was newly introduced.

QC circles were also introduced in the Stage II Hydro Power Station, and this has shown certain effects. Prior to this, for example, when there was a breakdown, the staff of the power station opened the machine for repair, instead of following specific procedures. However, when a breakdown occurs today, they (i) refer to the manual and follow the procedures ➔ (ii) discuss countermeasures among themselves ➔ (iii) and conduct the repairs, as instructed in the procedures. This has led to the improvement of their maintenance and management skills.

According to the officer responsible in the department of human resource development, the importance of problem solving through QC circle activities has been widely acknowledged among employees. However, the person in charge of human resource development who played an important role in the TQM secretariat was transferred to a different department in 2013. Since then, the activities of the TQM secretariat have been discontinued and the QC circle activities have not been as active as before.

Strengthening training capacity

This project studied the upgrade of the human resource development center, which is an in-house training center of the executing agency, and based on the survey results, the executing agency improved their training programs, contents and methods at the human resource development center as well as conducting employee training using a new training program. Each training program requires a subject on TQM (See 3.4.2 Technological Aspects of Operation and Maintenance for the current training system).

Strengthening financial and accounting capacities

An accountant who received training on financial management in Japan was able to conduct accounting works based on expenditure plans, and this helped optimize financial management. In addition, there are several sections within the finance and accounting department, and now staff members hold regular meetings to share information on their duties, leading to improvement in their business.

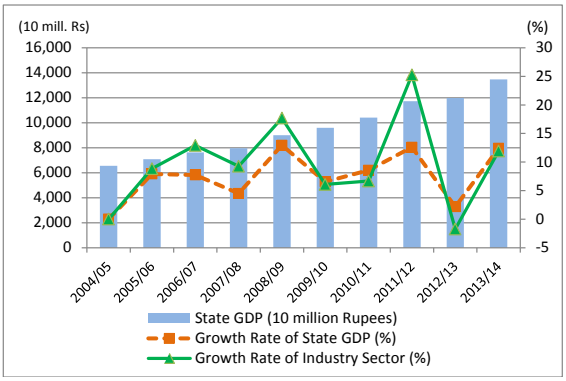
As seen above, this project had positive effects on the improvement of the operation and maintenance capabilities of the executing agency to some extent.

3.4 Impacts

3.4.1 Intended Impacts

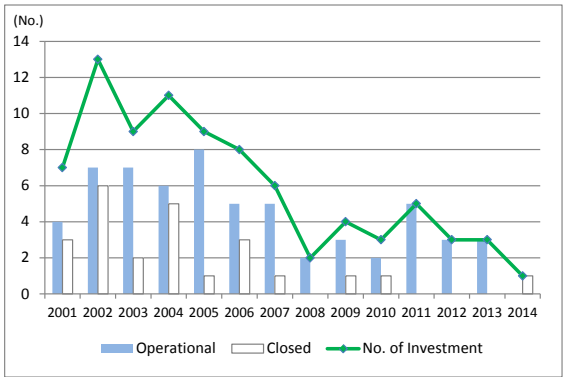
(1) Industrial development of Meghalaya State

The Umiam Stage II Hydro Power Station generates 6% of the installed capacity of Meghalaya State and 5% of the annual electricity generated as its base load power source. Its annual power generation volume accounts for approximately 2-2.5% of that of the entire Meghalaya State including electricity purchased from out of state, and this contributes to the state's power supply source to some extent. The main industries of Meghalaya are technical industries including alloy, steel and cement. For the past 10 years since 2004/05-2013/14, Meghalaya's state GDP and its growth rate have been improving steadily. The growth rate of the industrial sector, has shown positive growth except for 2012/13 (Figure 6). On the other hand, the number of investments (more than 1 billion rupees) has been decreasing to around 3 annually, with a peak in 2003-2004 (Figure 7). According to an interview with the Directorate of Commerce and Industry of the Meghalaya state government, the problem of the state's power shortages has had a negative effect on investments.



Source: Planning Commission, the Government of India.
Note: Industry sector includes mining, manufacture and energy such as electricity and gas.

Figure 6: Major Macro Economic Data of Meghalaya State



Source: Directorate of Commercial and Industrial, the Meghalaya state government.
Note: The investments were in factory plants, facilities and equipment.

Figure 7: Number of Investments in Meghalaya State (more than 1 billion rupees)

According to interviews with bulk users of electricity[9] such as those in the alloy, steel and cement industries, the power system has been steady and electricity has been provided stably most of the time since the renovation of the Umiam Stage II power station through securing the generation capacity of 20 MW. This has contributed to the issue of power shortage.

[9] Interviews were conducted with three companies in the fields of alloy iron manufacturing, manganese alloy manufacturing and cement manufacturing. The companies were members of the Byrnihat Industries Association (BIA). BIA is an organization with 30 manufacturing companies doing business in the Export Promotion Industrial Park (EPIP) in Brynihat, Meghalaya State. Most of the BIA members are in alloy iron, cement or beer manufacturing and their sales contacts are in the domestic market.

However, most manufacturers have installed their own captive power plants in order to overcome problems such as power shortage and seasonal drops in voltage. The cost for captive power plants is a financial burden for business enterprises. These enterprises had the intention of expanding existing facilities as well as building new facilities in Meghalaya, if the state could resolve the problem of power shortage or increase the power supply volume.

Meanwhile, as the Stage III power station is located downstream of the Stage II and generates power using recycled water from the Stage II, according to the executing agency, if the renovation of the Stage II power station stops, or shuts down due to deterioration, a significant negative influence can be expected on the operation of the Stage III power station[10]. Furthermore, if the operation of the Stage II is stopped, it becomes necessary to purchase power from out of state to replace power generated in the Stage II. At this point some additional financial burdens are expected.

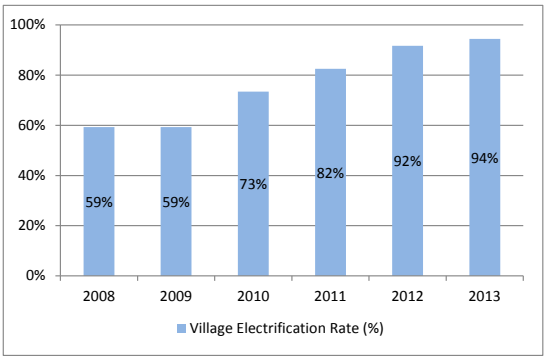
As seen above, this project contributed to the stable power supply of Meghalaya State to some extent by the renovation of the Umiam Stage II Hydro Power Station. However the state has not solved power shortage issues completely, and the positive impacts of the project on Meghalaya's industrial development have not been sufficiently confirmed. On the other hand, the implementation of this project has made it possible to avoid future risks such as a decreased power generation capability of the Stage II and Stage III, as well as that of an additional financial burden caused by substitutional power purchase from out of state. It can therefore be said that there has been a positive impact on the state's power sector.

(2) Improvement in the living standards in Meghalaya State

The rural electrification rate[11] of Meghalaya has been improving over the years, rising to 94% in 2013 from 59% in 2008 (Figure 8). The number of subscribers has increased from 200,000 in 2004/05 to 350,000 in 2013/14 (Figure 9).The average growth rate of Meghalaya's GDP in the past 10 years (2004/05-2013/14) is as high as 8.4% (Figure 6).

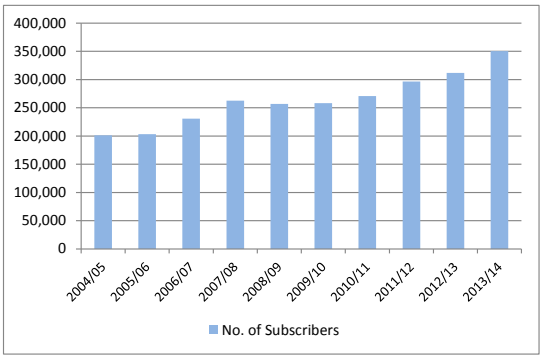
[10] It is necessary to construct a detoured water channel in order to deliver water from the Stage I to the Stage III without going through the Stage II. However, this is not a realistic option due to the significant costs involved.

[11] According to the definition revised in February 2004, village electrification is defined as: (i) basic infrastructure such as distribution transformers and distribution lines provided in the inhabited locality as well as in the Dalit Basti/ hamlet where they already exist, (ii) electricity is provided to public places such as schools, the Panchayat office, health centers, dispensaries, community centers etc. and (iii) the number of households electrified should be at least 10% of the total number of households in the village (Source: Ministry of Power, vide letter No. 42/1/2001-D (RE) dated on February 5, 2004).



Source: Meghalaya Power Generation Corporation Limited (MePGCL).

Figure 8: Village Electrification in Meghalaya State



Source: Meghalaya Power Generation Corporation Limited (MePGCL).

Figure 9: Number of Subscribers in Meghalaya State

However, the objective of this project was a renovation of the existing hydro power station, and although the contribution of the Umiam Stage II Hydro Power Station was recognized to some extent in the state's base load power source, it was still difficult to collect data that proved the causality between the project and the impact in the improvement of the living standards in Meghalaya. Therefore, in the end, it was impossible to validate the impact.

3.4.2 Other Impacts

(1) Impacts on the Natural Environment

This project was categorized as type C in the Japan Bank for International Cooperation (JBIC) Guidelines for the Confirmation of Environmental and Social Considerations (established in April 2002) since the project did not correspond to a sector or area that was likely to be influenced. The Environmental Impact Assessment (EIA) report for this project was established in May 1996, and the environmental clearance by the Ministry of Environment and Forests was obtained in August of the same year.

The environmental monitoring of this project was controlled by the Maintenance and Small Hydro Department of Meghalaya Power Generation Corporation Limited (MePGCL). The executing agency has submitted an environment compliance report in every 6 months (twice a year) on the Umiam Stage II Hydro Power Station to the Meghalaya State Department of Forest and Environment during and after completion of the project. The reports have not mentioned any particular negative impact on the environment. In addition, all water from the Umiam lake (Umiam reservoir) is supposed to be used for power generation, and the executing agency controls the water level of the lake within the required standard rage of 3,220-3,155 feet (about 981-961 meter).

As seen above, there was no specific negative impact on the natural environment through implementation of this project.

(2) Land Acquisition and Resettlement

The objective of this project was to replace a power generator in the existing facility; therefore there was no land acquisition or resettlement.

In the light of the above, this project has to some extent achieved its objectives. Therefore effectiveness and impact of the project are fair.

3.5 Sustainability (Rating: ②)

3.5.1 Institutional Aspects of Operation and Maintenance

In March 2010, the Meghalaya State Electricity Board was reorganized into the Meghalaya Energy Corporation Limited (MeECL) which supervised all areas of power generation, transmission and distribution. MeECL was then divided into three corporations in 2013/14: Meghalaya Power Generation Corporation Limited (MePGCL), Meghalaya Power Transmission Corporation Limited (MePTCL) and Meghalaya Power Distribution Corporation Limited (MePDCL). The administration of these three corporations, such as the Department of Finance and the Department of Corporate Affairs that includes the human resource development department, remained in MeECL. Currently, MeECL is in the position of a holding company for the power generation (MePGCL), transmission (MePTCL) and distribution corporations (MePDCL). Therefore, the operation and maintenance (O&M) agency of the project is MePGCL in the narrow sense. However, MeECL is included in a wider sense. The number of staff in the above four corporations, and the organization chart of the executing agency are shown in Table 6 and Figure 10 respectively.

The Umiam Stage II Hydro Power Station which is under the Generation Department of MePGCL has taken charge of the direct O&M of the project facility. The staff of the power station consists of 28 full-time employees (10 engineers, 17 technicians, 1 administration staff) and 11 contracted employees (part-time employees), totaling 39 staff members. They are divided into 4 groups, and there are 3 shifts in 24 hours. The power station is short of entry level technicians and young full-time employees, so for the time being they hire contractors to compensate for the shortage in order to avoid any impediment in business.

From the above, it is clear that there is no issue in the institutional aspects of operation and maintenance.

Table 6: Number of Staff in the Four Meghalaya State Power Corporations

(As of November 1, 2014)

Unit: person

	Category I	Category II	Category III	Category IV	Total
Meghalaya Energy Corporation Limited (MeECL)	47	62	173	104	386
Meghalaya Power Generation Corporation Limited (MePGCL)	58	259	180	292	789
Meghalaya Power Transmission Corporation Limited (MePTCL)	19	110	100	99	328
Meghalaya Power Distribution Corporation Limited (MePDCL)	51	208	727	595	1,581
Total	175	639	1,180	1,090	3,084

Source: MePGCL.

Note: Category I includes higher level executives such as chief engineers, additional chief engineers, or accountants, Category II includes mid-level executives such as assistant engineers or assistant accountants, Category III includes intermediate or entry level engineers or technicians, and Category IV includes technicians, electricians, drivers or telephone operators.

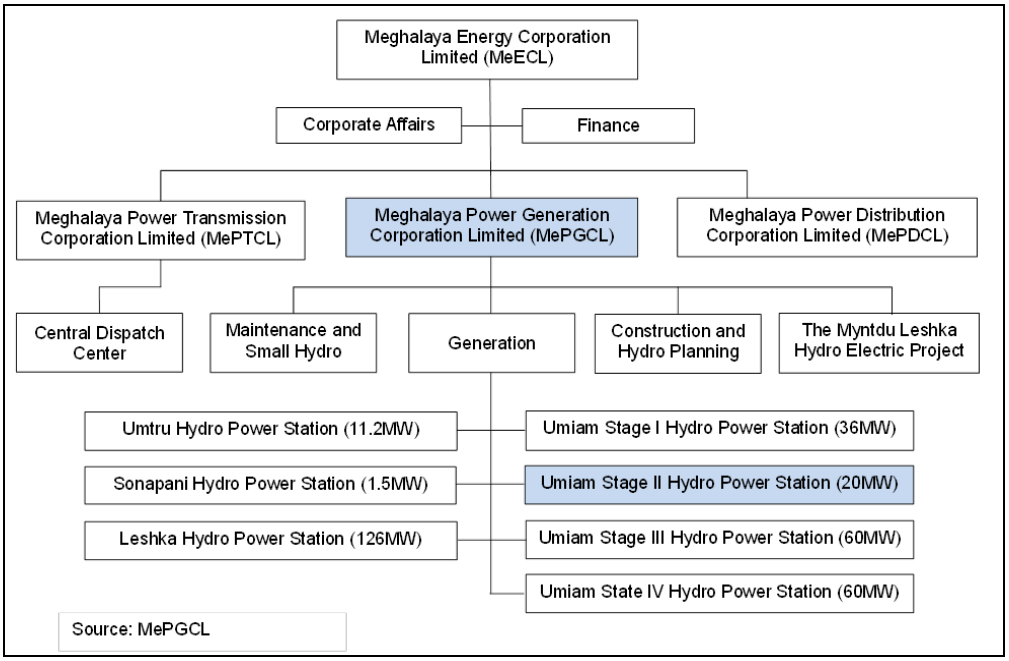


Figure 10: Organization Chart of the Executing Agency

3.5.2 Technical Aspects of Operation and Maintenance

The staff of MePGCL working at the Umiam Stage II possess degrees or certificates in electrical or mechanical engineering, and they have a certain level of technical skills in the O&M of a power generation facility. The contracted staff also hold diplomas from the Industrial Training Institute (ITI) of the state. The executing agency has an evaluation system for employees and evaluates their staff annually. Furthermore, MeECL owns its own Human Resource Development Center (located in Umiam), an in-house training center equipped

with a training room that can accommodate 35-40 people as well as training equipment such as audio equipment. Here, training is conducted for the staff members of the three power companies under MeECL. The training system is divided into three schemes: (i) in-house training organized by MeECL employees, (ii) on-site training/sponsored training at the partner training institutes, and (iii) training at MeECL with lecturers invited from the partner training institutes. There are four levels, A, B, C, D (levels according to duty positions or job title). For (i), the target is young employees at level C & D, and the training usually incorporates a combination of lectures and OJT. The content is electrical security, disaster management, power distribution management systems and also injuries associated with work. For (ii), the target is managers and veteran staff at the level A & B. They are sent to the reputable training institutes[12] in India using the Indian government's training schemes. In the Human Resource Development Center of MeECL, five training programmes[13] were planned and conducted in 2014/15. One of these was in-house training, and the remaining four were conducted at the partner training institutes. The executing agency is currently planning to augment the facilities of the human resource development center, such as expanding its accommodation by increasing the number of training rooms or introducing new training equipment.

The Umiam Stage II Hydro Power Station is equipped with an O&M manual prepared by the manufacturer and this is referred to and used for routine O&M works. As shown in the operation and effect indicators, there was no incident of forced outage hours through mechanical trouble or human error after project completion, and this shows the high O&M ability of the power station staff.

From the above, it is clear that there were no issues in the technical aspect of operation and management.

3.5.3 Financial Aspects of Operation and Maintenance

Table 7 indicates the operation and maintenance budget of the Umiam Stage II Hydro Power Station after project completion. According to the head of the Umiam State II Hydro Power Station and the Director of the Financial Department of MeECL, the budget necessary for the operation and maintenance of the project had been secured every year.

[12] Such as the National Power Training Institute (NPTI), the Central Institute of Rural Electrification (CIRE) of Rural Electrification Corporation (REC) or the training center of the Aditya Birla Group.

[13] They are: (i) Design and O&M of Hydro Generating Station, (ii) Root Cause Analysis of failures of electricity, (iii) Power System Operation, (iv) Life Assessment of Transformers & Generators, and (v) Personality Development & Behavioral Science. The training programs of (i)-(iv) are organized by the partner training institutes, and (v) is conducted through in-house training.

Table 7: O&M Budget of the Umiam Stage II Hydro Power Station

Unit: thousand rupee

Item	2011/2012		2012/13		2013/14	
	Plan	Actual	Plan	Actual	Plan	Actual
O&M cost	6,172	1,389	6,323	2,720	2,785	3,139
Employment cost	9,710	10,034	10,678	11,407	11,173	10,917
Administration cost	268	38	278	29	163	51
Total	16,150	11,461	17,279	14,156	14,121	14,107

Source: Responses to questionnaires.

Since the establishment of the four public corporations after 2013/14, each of the power generation, transmission and distribution corporations had individual financial statements. However, as the financial statements for the most recent three years of 2012/13, 2013/14 and 2014/15 had not been audited or officially approved at the time of the ex-post evaluation, it was difficult to obtain them from the executing agency. According to the available information[14], MeECL showed a loss for three years from 2007/08-2009/10, marking a loss amount of approximately 1.04 billion rupees in 2010/11. The cost recovery rate in 2010/11 was 81% (national average: 76%) if revenue included the subsidy. However, the loss increased to 2.09 billion rupees in 2011/12 and the cost recovery rate was 71% (national average: 72.5%) if the revenue included the subsidy. It should be noted that the above figures were better than for the other states in the North East Region.

In March 2013, the Ministry of Power announced the performance ratings[15] of the transmission and distribution companies nationwide, mainly their financial capacity. According to the ratings, MeECL was rated "Grade C^+"[16], and its operation as well as financial capabilities were evaluated to be low (however, this rating was carried out before MeECL was divided into three corporations to include power generation, transmission and distribution). On the other hand, according to a petition[17] regarding electricity bill revision for 2014/15, submitted to the Meghalaya State Electricity Regulatory Commission by the MeECL, MePGCL's rate of return on equity for 2014/15 was expected at 14%, which is a high profitability for a single corporation.

[14] MeECL Annual Reports of 2007/08-2010/11, and the Performance of State Power Utilities for the Year 2010-11 to 2012-13, Power Finance Corporation (PFC), 2003.

[15] "State Distribution Utilities First Annual Integrated Rating" Ministry of Power (March 2013). The Ministry of Power implemented the performance rating of transmission and distribution companies nationwide in order to understand their financial status and specify their needs for future financing. The actual evaluation was conducted by India's Power Finance Corporation Ltd. and the rating was conducted by Investment Information and Credit Rating Agency of India Limited and Credit Analysis and Research Ltd.

[16] The definition of each grade is as follows: Grade A: Very high operational and financial performance capability (Score distribution: 80-100), Grade B+: Moderate operational and financial performance capability (Score distribution:50-65), Grade B: Below average operational and financial performance capability (Score distribution:35-50). Grade C^+: Low operational and financial performance capability (Score distribution: 20-35), and Grade C: Very low operational and financial performance capability (Score distribution: 0-20).

[17] Petition for Annual Revenue Requirement and Generation Tariff for FY2014/15, Meghalaya Power Generation Corporation Ltd.

From the above, there are some concerns about the financial aspects of operation and maintenance.

3.5.4 Current Status of Operation and Maintenance

The project facility of the Umiam Stage II has been kept in a good condition. The operation and maintenance of the facility has been appropriately conducted according to the maintenance plan, the O&M manual and the standard operation procedures (SOP), and, during the site visit, an hourly operation record for each piece of equipment was made with each check point of the logbook. In the case of problems that could not be handled by employees at the power station, the headquarters of manufacturers were contacted and repairs conducted with instructions from the manufacturer's representative office in Delhi. As for the procurement of spare parts, Since genuine products for the power generator were procured through the manufacturer's representative office in Delhi, there were no issues noted. The Umiam Stage I and II use the same type of power generators from the same manufacturer, therefore they can share spare parts in cases of emergency.

From the above, it is clear there were no issues in the current status of operation and management of the project facility.

In the light of the above, some minor problems were observed in terms of the financial aspects of operation and maintenance of this project. Therefore the sustainability of the project effects is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The objective of this project was to meet the growing demand for electricity in the State of Meghalaya by the renovation of the Umiam Stage II Hydro Power Station (18 MW) which is located in the river basin of the Umiam River. The project matched India’s national development policy and development needs at both the appraisal (2004) and the time of the ex-post evaluation as well as Japan’s ODA policy at the time of the appraisal, therefore its relevance is high. For the project outputs, there was no major changes except for the expansion of installed capacity from 18 MW to 20 MW. This augmentation corresponded with the project objective to take measures against power shortage. However, the project period significantly exceeded the plan; therefore the efficiency of the project is fair. For the operation and effect indicators, the planned outage hours and the maximum output reached the target values, however, the forced outage hours, the plant load factor and the net electric energy production did not reach to the target values. The main factors for the failure to attain the target value of the plant load factor and net electric energy production were considered to be the water shortage for power generation due to changes in the amount and pattern of rainfall. However there is the

possibility that the setting of the target values at the appraisal was overrated. There was a certain level of achievement in the improvement of the operation and management capacity of the executing agency by capacity building. On the other hand, the Umiam Stage II Hydro Power Station generated approximately 2-2.5% of the annual electric power generated in Meghalaya State and contributed to a stable power supply as the state's base load power generation. However, the state has not solved the issue of power shortage completely, and it was difficult to confirm the impacts of the project on industrial development and improvements in the living standards of the local residents in Meghalaya. No negative impact of the project on the natural environment was observed and there was no land acquisition or resettlement. Therefore, the effectiveness and impacts of this project are fair. As for the sustainability of the project effect, some minor problems have been observed in terms of the financial aspects and therefore sustainability of the project effect is fair.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

(1) Continuing Use of the TQM Secretariat

The improved problem solving skills and strengthened organizational capacity introduced by QC circles as part of the consulting service of this project have taken root in the companies and it is acknowledged that there has been a certain effect in some work places. It is recommended that the TQM secretariat, which is currently in a dormant state, be reactivated and used as a promoter of TQM in order to continue to disseminate this effect in the organization.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

(1) The necessity to factor in the operation status of other facilities that work as an integral part of the entire system including the project facilities.

The Umiam Stage II Hydro Power Station generates power by recycling 100% of the water used in the Umial Stage I Hydro Power Station which is located upstream. Thus the operation of the Umiam Stage II depends on the operation status of the Umiam Stage I. This means that both Umiam Stage I & II operate as an integral part of the entire system. In a case like this, where the project target facility operates together with another non-project target facility operated by the executing agency, it is desirable that operation and effect indicators and target values are also set for the non-target facility at the time of planning in order to keep track of its operation status after project completion. It is also necessary that the water

level of the reservoir and future rainfall amount are predicted as they can significantly influence the operation of the facility. These should be examined in as much detail as possible and the results of this should be reflected in the plan.

Comparison of Original and Actual Scope

Items	Plan	Actual
(1) Project Outputs (i) Installed capacity	• 18 MW (9 MW x 2)	• 20 MW (10 MW x 2)
(ii) Mechanical Equipment	• Turbine (runner, inlet valve, guide vane control system, main shaft water sealing device, etc.) • Governor and Turbine Control System • Air Compressed Supply System • Dewatering& Drainage System • Others	• As planned
(iii) Electrical Equipment	• Generator and its Auxiliary (Fixed Coils, Fixed Core, etc.) • Excitation System • Main Control Boards • 11KV Metal-Enclosed Cubicles • Generator Transformer and Station Transformer • Others	• As planned
(iv) Consulting Services (a) Assistance for Renovation Works	• Assistance in Procurement, Implementation of Renovation and Modernization Work, Operation and Maintenance Instruction, Project Reporting	• The service contents were as planned
	• Input: 45 M/M	• Input: 58.39 M/M
(b) Capacity Building	• Capacity Building of the Meghalaya State Electricity Board ➢ Improvement of financial issues, improvement of the organization management, Improvement of problem solving skills by introducing QC circles • Survey on Upgrading of the Human Development Center ➢ Recommendations for improvements in the human resource development system, facilities and equipment, utilization of the North-Eastern Regional Centre of the National Power Training Institute	• The service contents were as planned • One month of Total Quality Management (TQM) training for 10 staff members of the Meghalaya State Electricity Board was conducted in Japan.
	• Input: 48 M/M	• Input: 80.5 M/M
(2) Project Period	March 2004-September 2008 (55 months)	March 2004-January 2012 (95 months)
(3) Project Cost Amount Paid in Foreign Currency	1,700 million yen	unknown
Amount Paid in Local Currency	643 million yen (248 million rupee)	unknown
Total	2,343 million yen	2,147 million yen
Japanese ODA Loan Portion	1,964 million yen	1,825 million yen
Exchange Rate	1 rupee = 0.386 yen (As of August 2003)	unknown