India

Umiam Hydro Power Station Renovation Project

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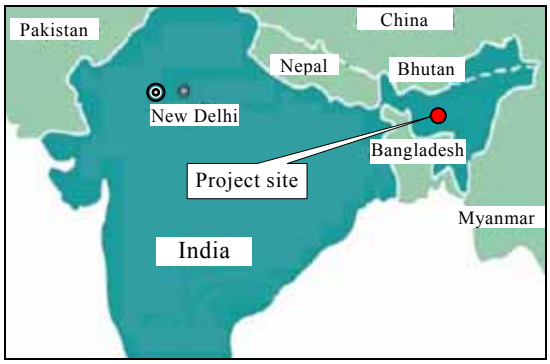
Field Survey: October 2006 / February 2007

1. Project Profile and Japan's ODA Loan



Map of project area

Umiam Hydro Power Station

1.1 Background

The state of Meghalaya, located in the northeastern part of India, was established in January 21, 1972, when it split off from the state of Assam. Meghalaya, with a total area of about 22,429 km^2, is situated in the Shillong Plateau at an altitude of more than 1,000 m. Meghalaya is famous for its hilly country with about 38% of the area covered with forests. In addition, monsoon impacts this region directly, making Meghalaya the wettest state in India (average annual rainfall: 1,200 cm), and rich in water power resources. To the north lies the state of Assam; to the south is the border with Bangladesh. Meghalaya has a population of about 2,320,000. In FY2004, its gross state domestic product per capita income in real terms was 11,278 rupees, ranking it 20th out of a total of 32 states/union territories of India[1]. Thus, in terms of economic development, Meghalaya lags behind other states of India[2].

In 1994, Meghalaya was the only state in India that was self-sufficient in electric power. However, it was predicted that the demand for electric power would increase accompanying economic growth not only in the state itself but also in the entire northeastern part of India, thereby bringing into focus the development of a new power supply and renovation of existing power generation facilities as an important issue. In 1997, the state government of Meghalaya adopted the Industrialization Policy that

[1] India is now comprised of 28 States and 7 Union Territories.
[2] Ministry of Statistics and Programme Implementation (FY1993=100)
(http://mospi.nic.in/mospi_nad_main/htm)

resulted in an increase in the demand for electric power, which in turn triggered a shortage in electric power after FY2001, turning Meghalaya into a recipient of electricity quota from the Northeastern grid.

1.2 Objective

The objectives of this project are to increase power and energy production as well as to improve power generation efficiency in the state of Meghalaya, through the renovation and modernization of Umiam Power Station Stage I (9 MW × 4 units, operation launched in 1965), in order to contribute to its further economic growth and to improvement of living conditions.

1.3 Borrower/Executing Agency

President of India/Meghalaya State Electricity Board (MeSEB)

1.4 Outline of Loan Agreement

Loan Amount / Loan disbursed Amount	1,700 million yen / 1,693 million yen
Exchange of Notes/Loan Agreement	January 1997 / February 1997
Terms and Conditions -Interest Rate -Repayment Period (Grace Period) -Procurement	 2.3% 30 years (10 years) Generally untied
Final Disbursement Date	June 2004
Main Contractors	Mitsui & Co., Ltd.
Consulting Services	—
Feasibility Study (F/S), etc.	1994 Japan Consulting Institute

2. Evaluation Result (Rating: B)

2.1 Relevance (Rating: a)

In the 8th Five-Year Plan (1992–97), when the project was accepted, and in the 10th Five-Year Plan (2002–2007) of the government of India, when the existing project was evaluated, the electric power sector was given the highest share of the budget in the public sector investment plan (18.3% and 26.4%, respectively). Thus it is evident that the electric power sector continues to be one of the most important areas of the national policy of India.

The Central Electricity Authority (CEA), having recognized the comparative advantages of existing hydro power stations in India's policy for electric sector, drafted

the National Perspective Plan in 2000. One of the objectives of this Plan was to fill the power shortage by rehabilitating and modernizing the existing hydro power stations by the 11th Five-Year Plan (2007–2012). After that, the National Electricity Policy (2006), which was established on the basis of the Electricity Act adopted in April 2003, indicated that electricity was an important infrastructure for the social economic development of the nation. In particular, hydro power was emphasized as a clean and renewable source of energy. In addition, the "50,000 MW Hydro Power Initiative" was launched in May 2003 with a view to developing hydro power generation by FY2017.[3] As the above description clearly shows, hydro power continues to be important for India's electric power sector.

As noted earlier, given that Meghalaya is rich in potential water power resources, hydro power has played an important role in the state's energy policy. As of FY1994, in Meghalaya, the annual electric power production was 584 GWh against the annual consumption of 249 GWh. The surplus was sold to the rest of northeastern region. As of 1991, it was predicted that the per capita power demand would increase in the northeast, suggesting the growing importance of development of electric power resources. In this context, Umiam Power Station Stage I and Stage II constituted important power stations in Meghalaya accounting for 26% of the state's entire electric power production. However, given that 30 years had already elapsed since the two power stations went into operation and due to the aging of the facilities, the need for this project which involved thorough renovation and modernization of Umiam Power Station Stage I was very high.[4]

On the other hand, in the state of Meghalaya itself, electricity consumption increased by about 10 fold from FY1997 to FY2005 as a result of the adoption of the Industrialization Policy by the government of India in FY1997. Consequently, Meghalaya, which had been beset by power shortages since FY2001, saw its rate of peak demand power shortage increase to 37.8% after a five-month hiatus in FY2006 (April – August), and rehabilitation of existing electrical power facilities and development of electric power resources continued to be regarded as important issues. This shows that the relevance of the project has still been maintained.

[3] This Initiative consists of a total of 162 hydro power projects to be implemented in 16 states, including 11 projects (total generation capacity of 931 MW) in Meghalaya.

4 The project was included in the 8th Five-Year Plan of the state of Meghalaya as "Renovation and Upgrading of Existing Hydro Power Station" and in the 9th Five-Year Plan (1992–2002) and 10th Five-Year Plan (2002–2007) as "Renovation and Modernization of Umiam-Power Station."

Table 1: Electric Power Supply and Demand Situation in Meghalaya

FY	01	02	03	04	05	06 (April – Aug.)
Power generation facility capacity [MW]	185.2	185.2	185.2	185.2	185.2	185.2
Peak demand electric power ［MW］	165	189	246	264	280	291
Peak supply electric power [MW]	160	189	195	207	205	181
Difference [MW]	**-5**	**0**	**-51**	**-57**	**-75**	**-110**
(%)	**-3**	**0**	**-20.7**	**-21.6**	**-26.8**	**-37.8**
Annual demand [GWh]	700	949	1,151	1,374	1,382	574
Annual Supply [GWh]	705	947	1,076	1,228	1,144	454
Difference [MW]	**5**	**-2**	**-75**	**-146**	**-238**	**-120**
(%)	**0.7**	**-0.2**	**-6.5**	**-10.6**	**-17.2**	**-20.9**

Source: Meghalaya State Electricity Board, North Eastern Development Finance Corporation Ltd

2.2 Efficiency (Rating: b)

2.2.1 Outputs

The project comprised of replacing the turbine components, the generator components, the 11 kV metal-closed switchgear, the main control panel, and the consulting services (29 M/M). But in actuality, the following changes were made:

Regarding the major components of the turbines, replacement of guide bearings of all four units was added to the original plan, as was the replacement of guide bearing pad spares for Units 3 and 4. In addition, the planned repair of the main inlet valves (MIV) and that of the servomotors of Units 1 and 2 were changed to replacement. Also, the replacement of bypass and pressure relief valves were added to the original plan. Moreover, of these turbine components, replacement of components of all four units was considered unnecessary when the Loan Agreement was signed. However, an overhauling of the four units revealed that the components had become so deformed that they had to be replaced. The MIVs had also become deformed, but because of budgetary restraints, only the MIVs of Units 1 and 2 were replaced.

With regard to the major components of generators, the number of rotor fans in all four units was halved from the original plan due to the introduction of new model components. Additionally, replacement of air coolers for Unit 1 was cancelled. Regarding the control panel, replacement of recorder panels for Unit 1 was canceled due to budgetary restraints.

2.2.2 Project period

The project period was supposed to be from February 1997 to November 2001 (57 months), but was extended by 14 months, from February 1997 to January 2003 (71 months). The main reasons for this extension were: (i) that the selection of the consultant took more time than planned; (ii) that the procurement method was changed from international competitive bidding to direct contract; and (iii) that negotiations and approval between the executing agency, consultant, and JBIC in regard to modifications in output extended the project period by a total of about 9 months. As a secondary reason, it can be pointed out that transportation and customs procedures of machineries and components (especially, the guide bearing) extended the project period another 5 months or so[5].

2.2.3 Project cost

At the time of appraisal, the project cost was to be 2,047 million yen, and the actual project cost was 2,090 million yen, a mere 2.1% increase. Increase in the cost of material and machinery due to inflation resulted in the slight increase of the project cost over the planned cost.

2.2.4 Conclusion

Some changes were added to the project outputs, period and costs. However, since some of the reasons for the changes were unavoidable, the implementation of this project was judged to be fully efficient.

2.3 Effectiveness (Rating: a)

2.3.1 Operational indicators

[5] In addition to the aforementioned reasons, the following reason was also cited: Due to worsening security conditions in the northeastern part of India caused by the attack on the Indian army post in Kashmir by Pakistani forces in May 2002, part of the team of Japanese engineers were temporarily withdrawn, following official advice for evacuation by the government of Japan. Since the warning was removed in June 2002, its impact was limited.

The completion of the rehabilitation of Umiam Hydro Power Station Stage I and the start of operation are as follows:

Unit 1	February 25, 2002
Unit 2	September 11, 2002
Unit 3	October 21 2002
Unit 4	January 17, 2003

Figure 1: Umiam Hydro Power Station Stage I

(1) Maximum output

The maximum output was 9 MW × 4 units, total 36 MW, or a 100% achievement ratio.

(2) Net electric energy production

Based on the annual precipitation of 86.6 inches, the planned net electric energy production in the F/S was set at 143 GWh. This target never achieved fully in any year after the rehabilitation, albeit in FY2003 and FY2004, the achievement ratio exceeded 80%. The low achievement ratio of FY2005 was due to the breakdown of the electric transformer of Unit 3, which had to be replaced, thus lowering electric energy production to 16.6 GWh.

The main reason that the target value was not achieved fully was the reduction in rainfall in recent years. FY2004 was the only year when the rainfall was at the same level of or exceeded the assumed rainfall of the F/S. From FY2000 to FY2005, there used to be a trend that a year with a lot of rainfall would always be followed by a year with little rainfall. However, in FY2006, this trend was interrupted when the amount of rainfall decreased further from the level recorded in the previous fiscal year. As per January 2007, accumulated rainfall for the fiscal year was 48.9 inches, which was only about 50% of the amount considered in the F/S.

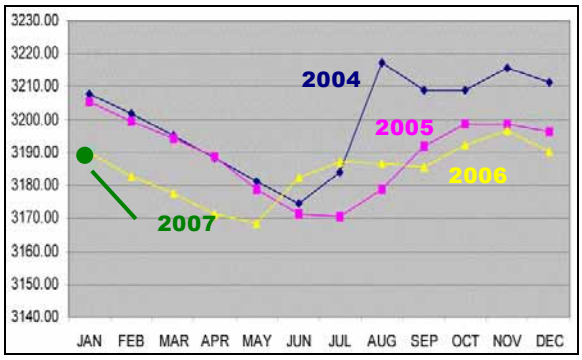
Table 2: Achievement Ratio of Net Electric Energy Production Target Value

(Unit: GWh)

Target value: 143 GWh	Before rehabilitation (average 98/99–00/01)	After rehabilitation		
		03/04	04/05	05/06
Unit 1	16.4	25.3	31.1	22.1
Unit 2	21.9	30.6	37.8	30.1
Unit 3	24.4	23.1	30.8	16.6
Unit 4	47.3	37.3	39.6	30.1
Total	110.1	116.4	139.3	98.9
Target value		143 GWh		
% achievement of target value	—	**81.4%**	**97.2%**	**69.2%**

Figure 2: Water Level at the Umiam Reservoir

Rainfall at Umiam Reservoir (unit: inch)



Water Level at Umiam Reservoir (as of October 2006)

Source: Meghalaya State Electricity Board website
Note1: For 2007, only January data available.

(3) Plant load factor[6]

The plant load factor target value of 45.3% as per F/S was never achieved. A main reason for this is the decrease in the net electricity energy production due to the aforementioned reduction in rainfall at the Umiam Reservoir. Still more than 80% of the target was achieved in FY2003 and in FY2004 when there was high rainfall.[7] In addition, the low level of achievement recorded in FY2005 is due to the aforementioned breakdown of the transformer of Unit 3.

Table 3: Plant Load Factor

	Before rehabilitation 98/99–00/01average	After rehabilitation		
		03/04	04/05	05/06
Umiam Power Station Stage I	34.9%	36.8%	44.2%	31.4%
% Achievement of Target Value	**—**	**81.1%**	**97.4%**	**69.2%**

(4) Unplanned outage hours/planned outage hours

The target value of unplanned outage hours were originally set to be zero. However, when there was a case of unplanned outage, the executing agency divided the reasons for the unplanned outage hours into two categories: (A) breakdown of machine and turbine; and (B) other reasons (breakdown of transformer, electric circuits, etc.). It was found that

6 $\text{Plant load factor} = \frac{\text{Net electricity energy production}}{\text{Maximum output} \times 8760\ \text{Hrs}} \times 100$

7 Apart from the target value at the time of appraisal, MeSEB sets its own target value of plant load factor in the "MeSEB Annual Plan." Based on these targets, more than 100% of the target was achieved in FY2004.

there was a case of unplanned outage for both reasons.[8]

The duration of outage hours "due to other reasons" was long at Unit 2 in FY2003 and at Unit 3 in FY2003 and FY2005. In the case of Unit 2, a failure in the automatic voltage regulator (AVR) was the reason for the long outage hours. In the case of Unit 3, the reson was a failure in the transformer. For both units, the problem was solved through the replacement of the part in question with a new one purchased from the manufacturer.

One problem was found also in the record keeping of the "Planned outage hours"(the time spent on planned maintenance). It is natural that the planned outage hours would not be zero as long as maintenance is properly conducted because the complete stoppage of the power plant is required for maintenance. However, as regard to this project, the duration of planned outage hours was recorded as zero, and outages of less than 4 hours were not recorded. Judging from the condition mentioned above, for a proper maintenance, it can be said that the way of record keeping needs to be improved.

2.3.2 Economic analysis (IRR)

FIRR increased as compared to that at the time of appraisal. A reason for this is that the unit selling price of electric power at the time of appraisal was revised from 1.478 million yen/GWh to the market price of 3.5 million yen/GWh. Meanwhile, EIRR slightly decreased for the reason that the local currency portion was included as part of the project cost.

	Time of appraisal		Time of ex-post evaluation	
IRR	FIRR: 6.97%	EIRR: 19.12%	FIRR: 16%	EIRR: 17%
Cost	Investment in plant and equipment, and operation and maintenance expenses. However, only the foreign currency portion was considered for investment in plant and equipment.	Exemption of customs that were included in the project cost; adoption of exchange conversion factor, exemption of VAT (12.5%).	Calculated by including the local currency portion as the total project cost.	
Benefit	Net income from selling electric power (the difference between the case that the project is implemented and the case that it is not).	The construction and maintenance cost per 1 kWh (0.035 USD /kWh) of the coal power plant is counted as unit selling price of electric power.	Net profit from selling electrical power (the difference between the case that the project is implemented and the case that it is not).	
Project Life	25 years			

Note: Since the EIRR was not calculated at the time of appraisal, conditions regarding cost and benefit were established and estimated.

8 In the case of the MeSEB, outages of 4 hours or less were not recorded before FY2004. The outage hours that were not recorded ranged from 15 to 30 hours for each unit.

2.3.3 Conclusion

Due to a marked reduction in precipitation, the water level in the Umiam Reservoir has dropped continuously over the previous three years. As a result, neither the annual output nor the plant load factor achieved 100% of the target. However, the maximum output target of 100% was achieved, and since the annual output and the plant load factor both achieved around 80% of the target, this plant is deemed to have a certain level of effectiveness.

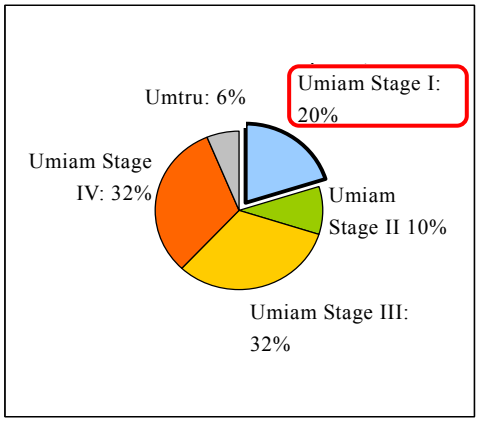
2.4 Impact

(1) Economic growth

Umiam Power Station Stage I accounts for 20% of the total electricity generation capacity of the Meghalaya State Electricity Board, and it serves as a third important power station in the state of Meghalaya after Umiam Power Station Stage III and Stage IV (see Table 4). Thus it can be said that the project is valuable in a sense that it ensured the stable production of 36 MW of electricity through the renovation of a power plant that was about to go out of commission due to aging.

Table 4: Umiam Power Station Stage I share in the Meghalaya State Electricity Board total generation capacity
(as of 2007)

Power Station	Capacity
Umiam Stage I	**36 MW**
Umiam Stage II	18 MW
Umiam Stage III	60 MW
Umiam Stage IV	60 MW
Umtru	11.2 MW
Total	185.2 MW



In addition, considering the economic development plan based on the Industrialization Policy in 1997 and the subsequent increase in the demand for power, the impact of the project on the industrialization and modernization of the state of Meghalaya is significant. For reference, increase in the demand for power is evident from Table 5; per capita consumption of electricity increased about 1.5 fold. Increase in the sale of electricity to industry sector is remarkable; it increased by 638%, from 76.9 MKWh in FY1998 to 490.8 MKWh in FY2004, which is assumed to be as a result of the Industrialization

Policy.

Table 5: Sales of Electricity by Type of Consumer

(unit: kWh)

	98/99	99/00	00/01	01/02	03/04	04/05
Household	122.9	151.6	144.2	182.3	159.0	171.6
Commerce	34.2	37.9	47.3	52.6	31.2	35.5
Industry	76.9	77.4	120.7	182.9	455.9	490.8
Public services	23.0	23.3	29.8	41.9	28.3	27.0
Other (within the state)	85.6	88.3	95.7	140.2	122.6	127.9
Outside the state	175.8	183.5	168.9	77.0	7.7	7.4
Total	518.2	561.9	606.6	677.1	804.7	860.2
Per capita consumption	192.8	213.2	246.6	259.7	343.7	367.7

Source: MeSEB. Data not available for 02/03.

(2) Improvement of living conditions[9]

The impact that a power generation project has on the living conditions of the people depends also on the condition in which the generated power is transmitted and delivered. Consequently, it is impossible to accurately determine the impact this project had on people's living conditions as the scope of this project is limited to the renovation of power plants. However, judging from the fact that a community with a market, a school, and a medical facility had developed around Umiam Power Station 1, and that the executing agency and local residents stated that their living conditions improved, it can be said that the project made a significant contribution in that area, albeit indirectly.

(3) Environmental impact

The Environmental Clearance of August 21, 1996 requires the executing agency to submit a progress report every six months to the Ministry of Environment and Forests. However, since the executing agency, had not complied with this obligation until May 31, 2005, it was difficult to study the environmental impact of this project. Subsequently, the executing agency, having realized the importance of complying with related rules and laws of the Ministry of Environment and Forests, appointed an officer in July 2006 specifically to look after this matter. Since then, the said office has taken charge of all matters related to the environment including the submission of the progress reports as

9 The "household electrification ratio" used as an indicator of improvement in living conditions is tabulated and announced only in years when the population census is taken. Significant improvements were made up to the 2001 census ("household electrification ratio" increased from 17% in 1981 to 43% in 2001), but comparable data for subsequent years were not available. Additionally, in states like Meghalaya where the proportion of the rural population is high, the "rural electrification ratio" is taken as an indicator of an improvement in living conditions. However, when asked to provide a definition of "rural electrification," the executing agency replied: "Any village where an 11 KV transformer has been installed is considered to have been electrified, even when electricity does not actually reach the households." Thus, this indicator was not used in this evaluation, as it cannot be said to be the real indicator of improvement in living conditions and it is related more to transmission and distribution problems than to generation.

required by the Clearance. Thus a clear improvement can be seen in the executing agency's response to environmental matters.[10]

The Umiam Reservoir which was constructed as a part of the project to construct Umiam Power Station Stage I is today playing an important role as the Umiam Lake, a tourist spot of the state of Meghalaya. However, in recent years, the problem including reservoir sedimentation due to accumulation of silt as well as increase in solid waste and water pollution has become serious issues. Because the polluted water flows first into Umiam Power Station Stage I, and the serious damage to the machinery is suspected, the executing agency has been dealing with the problem by clearing the solid waste. However as a burden on the executing agency is huge, it is strongly desired that an immediate measure to solve this problem will be taken by Meghalaya State Pollution Control Bureau (MSPCB).

(4) Conclusion

It is impossible to determine accurately the impact this project had on economic development and people's living conditions as the scope of this project is limited to the renovation of power plant. However, through the renovation of a power station that was highly likely to be put out of commission due to aging, the effective handling of the growing demand for power, and the positive impact of this project that had on the living conditions of the local people are evident, therefore the project can be considered to be significant to a large extent.

【Column】Satisfaction Survey of Large Consumers and Domestic Consumers in the Vicinity of the Umiam Power Plant

In this ex-post evaluation, a satisfaction survey was conducted on large-scale consumers (industry) and domestic consumers (who are assumed to make up part of the project's beneficiaries) in the vicinity of the area where this project was implemented. Although the survey sample was not large enough statistically, nor was it able to clearly specify the degree of direct contribution of this project, the survey provided an opportunity to get to know the voices of some users.

[Objective]

- Clarify the improvements needed to ensure adequate power supplies for areas affected by this project by ascertaining the power condition in those areas.

10 As a condition for obtaining environmental clearance, giving sufficient consideration for the treatment of waste oil and other contaminants during renovation was cited. Thus waste oil generated during the renovation process was filtrated and reused in other power stations.

[Outline of Survey, etc.]

	Industry	Domestic
Period of survey	October 23, 2006, to November 3 2006	
Place	Export Promotion Industrial Park (EPIP), Byrnihat	Umtreu and Ladryngud (refer to Village A and Village B in this report)
Sample size sample method	25 companies Randomly selected	30 households（15 households for Village A, Village B each） Randomly selected
Main industry	Steel, iron, cement, ferro alloy	Agriculture
Valid response rate	40%（12 companies）	100%

[Results]

- With regard to the supply situation of electricity, all the targeted companies said they were "not at all satisfied." Meanwhile, 67% of domestic consumers said they were "satisfied or somewhat satisfied." And all said, "We do not feel inconvenient particularly by the outages." The reasons given are as follows:

(1) Quality of electricity: Voltage fluctuation was frequent.

(2) Frequency of interruption and outages: [Industry]: Occurs 5–6 times a day with the total duration of 1 to 1.5 hours a day. As a result, the production line stopped on average 1-2 hours a day. [Domestic consumer] In village A, outages occurred 5–6 times a day (each outage lasting 3–4 hours) in winter; in summer, 8–9 times (each outage lasting 6–7 hours). In the case of village B, outages occurred 5–6 times a day (each outage lasting 6–7 hours) in winter; in summer, 8–9 times (each outage lasting 12 hours). In the rainy season, outages may last for 2–3 days. In either village, members of all households lived with alternatives such as oil lamps or coal.

(3) Costs incurred per year due to outages: [industry] Most of the companies incurred the cost up to 1 million rupees (about 2.7 million yen), including the cost of raw materials, equipment failure, and contract cancellation.

(4) Potential areas for improvement: (i) construction of new power plants; (ii) renovation of existing power plants; (ii) training employees; (iv) institutional reform of the power sector; (v) improving customer services; (vi) introduction of an efficient billing system, etc. (According to the large consumers, the state government promised it would ensure the provision of infrastructure including electricity in its effort to attract companies to invest in the state of Meghalaya however, this has not yet be materialized.)

2.5 Sustainability (Rating: b)

2.5.1 Executing agency

2.5.1.1 Technical capacity

In the executing agency, it was observed that the technical level was sustained mainly through on-the-job training (OJT). Other types of training target only engineers, so most

of the training was conducted by external training facilities.[11] On the other hand, having recognized the importance of human resource development from both technical and managerial standpoints, the executing agency reinforced the Human Resource Development Center (HRDC) in 2004. HRDC commenced operation as a full-fledged training center with the financial support of the state government. There are a total of 67 trainees (as of September 2006), and preparation was being made to provide training for engineers. As of February 2007, the executing agency began making a curriculum with its aim to increase the number of trainees and to invite external experts to the center. This effort was planning to be continuously strengthened in future.

However, at the time of the field survey, as the effort was just started, needs assessment, setting up criteria for selecting trainees, and updating of training content had not been tackled. Additionally, it was observed that the emphasis continued to be placed mainly on technical training of engineers while training courses related to management had also been increased. Furthermore, front line technicians, who actually worked on the machines had not received any training except OJT. Consequently, technicians at the site were not being trained in any of the updated technologies and integration of company-wide technical capabilities was not being made.

Figure 4 Human Resource Development Center

Meanwhile, routine maintenance was not necessarily being conducted

11 External training facilities here refer to the National Power Training Institute (NPTI) and the Power Systems Training Institute (PST). Training conducted at both of these agencies provides an opportunity to come into contact with state-of-the-art technologies. And yet, in many cases the training has not come up to the technical level of the executing agency and many complaints were heard that the training provided at these facilities was not very useful. In a survey that the Energy and Resources Institute (TERI) conducted in 2003, there was a proposal that it was necessary for the Meghalaya State Electricity Board to develop human resources concerning the improvement of operation and management system, as well as the reinforcement of the financial and technical management capability. Additionally, in February 2006, as part of the consulting service provided in Phase 2 of the project, Tokyo Electric Power Company and Tokyo Electric Power Services Co., Ltd, conducted training for supervisory personnel of the Meghalaya State Electricity Board in, among other things, “financial and investment plan,” “operation and maintenance,” ”financial analyses and forecasts,” and “implementation of quality control circles.” Through these training programs, the consulting firms clearly demonstrated just how important human resource development is for power companies, and made recommendations for establishing a training system in the Meghalaya State Electricity Board.

15 However, as mentioned above, prior to FY2004, the reasons and the details on power outage for less than 4 hours were not recorded.

according to the manuals provided by the manufacturer. Consequently, maintenance was more corrective than preventive. Daily maintenance was conducted every other day and the record of each maintenance day was being kept.[15] In regard to overhauling, it is considered that the best option in India is to outsource in small-scale power stations with limited human resources like the one involved in the project. Judging from the aforementioned condition, it can be said that although there is still room for improvement as a whole, there are no major problems the technical capacity of the executing agency.

2.5.1.2 Operation and maintenance system

There were chief engineers who lead each section of electricity distribution, its generation and transmission, and rural electrification in executing agency which was headed by a chairman. No major problems with the operation of Umiam Power Station Stage I was observed. However, the ideal number of engineers and technicians in operation and maintenance, which was considered to be eleven, was not met, and as of February 2007, the post of assistant engineer was vacant, and only 4 to 6 technicians were appointed to this team. As a consequence of this, the maintenance was currently being conducted with the minimum available number of people.

The operation team was being obligated to keep at 100%, but when there was a vacancy it had to be filled with a person from the maintenance team. Thus the maintenance activities were often put on the back burner.

The above problem can be traced to the ambiguity in the personnel policy of the executing agency. The agency suffers from a dearth of engineers and technicians, but has a surplus of administrative personnel. Since there are no specific plans for the transfer of personnel, engineers are often transferred unpredictably after short periods of tenure. Consequently, the maintenance system becomes quite uncertain, resulting in merely "maintaining the status quo." In addition, transfers between departments (i.e., generation, distribution and transmission) are frequent, adversely affecting specialization.

2.5.1.3 Financial status

As far as the trend in pre-tax profit is concerned, the executing agency's financial status improved in FY2004. In addition, even after subsidies from the state (108 million rupees) were subtracted, it was in the black. On the other hand, since profit for the same year was only 2 million rupees and the executing agency had to rely on other states to procure electric power, the agency's finances did not improve enough to gain profits commensurate to earnings. This suggests that the executing agency's financial soundness has not exactly been secured. However, state subsidies have been allocated for income compensation as well as for investment in plant and equipment, and under the assumption

that these subsidies will continue to be provided, it can be said that financial sustainability is secured.[16]

Table 8: MeSEB's Financial Status

(unit: million rupees)

FY	Income		Purchase of Power	Other expenses	Profit before tax	Outstanding balance of borrowings
		subsidies				
00/01	1,172	103	-101	-1,272	-201.	4,837.9
01/02	1,299	110	-253	-1,295	-249	5,164.0
02/03	1,733	109	-567	-1,412	-246	6,360.3
03/04	2,075	104	-976	-1,282	-183	5,481.2
04/05	2,591	108	-1,324	-1,157	110	5,824.8

2.5.2 Operation and maintenance status[17]

At Umiam Power Station Stage I, at present, the MIV of Unit 4 is becoming old for work. The underlying reason for this is that executing agency suspended the replacement of MIV of unit 3 and 4 (and replaced only the ones of unit 1 and 2) in order to minimize the cost despite the advice of the consultants who suggested, at the time of appraisal, that in all the units the replacement of MIV was necessary. Although abnormal sound and water leakage were detected right after rehabilitation of Unit 4 was completed (July 2003),[18]even four years after that (at the time of evaluation) the leakage problem were not completely resolved. This shows that raising awareness of the importance of maintenance is necessary. In addition, problems related to spare parts occurred one after another. For example, the recurrence of water leakage in the guide bearing cooler of Unit 3 was largely due to the low quality of the parts procured locally.[19]

While the importance of the aforementioned problems cannot be ignored, the situation of operation and maintenance (particularly, the cleanup situation, etc.) at the Umiam Power Station Stage I is better than the average of the situation at all power stations in India. Thus it has received high praise from technical evaluators.

16 The Ministry of Power conducts an evaluation of the performances in the electricity sector reforms of each state based on 7 criteria. As of March 2005, the Meghalaya State Electricity Board had 26.72 points out of 100, coming in 18th place among 29 states. Regarding "Financial Risk," the fact that income from fares was not enough to cover expenses was raised as one of the serious issues to tackle.

17 Improvements need to be made concerning employee awareness of the importance of always wearing a helmet while at work. In addition, the cleanliness of the power stations is above average by Indian standards.

18 The proposal for renewing MIVs was prepared in February 2007. This was approved by the MeSEB board of directors.

19 The main problems related to spare parts are: (1) spare parts are difficult to supply because the specifications are outdated; and (2) since the specifications are those of Japan, procuring spare parts from OEM is costly. Although its significance may be secondary, the time required to go through customs cannot be ignored.

2.5.3 Conclusion

In conclusion, while some areas for improvement regarding the executive agency's technical capacity, institutional system and operation and maintenance were observed at the time of evaluation, the staff at the executing agency themselves had recognized the need for such improvements. The agency had already begun attempting to take measures for some of these areas by strengthening its human resource development system, keeping thorough record keeping of operation and maintenance, and so forth. Therefore, it would be certain that some aspects which were judged to remain at "the status quo" at the time of evaluation would begin to turn for the better. Moreover, since financial sustainability, which is crucial for improving the situation, is secured to some extent, overall, it is judged that there is no major problem in sustainability.

3. Feedback

3.1 Lessons Learned

The current problem of water leakage at Unit 4 occurred partly due to the fact that the replacement of parts was waived for the cost saving upon the request by the executing agency. As the result, the actual cost that the executing agency incurred at the end was higher than the original replacement cost. For similar projects in the future, advice should be given to the executing agency from the earliest stage of the project on a timely basis, especially for main machinery and replacement of parts.

3.2 Recommendations

3.2.1 Recommendations to the executing agency

(1) On maintenance

Since it is desirable that overhauling be conducted every 5 years, it is recommended that it should be conducted during FY2007. The executing agency should ask the manufacturer to conduct a technical assessment as soon as possible so that they can budget for the appropriate expenses. In addition, recording of all data on maintenance is required. At the same time, all outages, including those of less than a 4-hour duration, should be recorded.

(2) On human resources development and awareness for improvement

It is recommended that the coordination between the Human Resource Development Center and the Personnel Affairs Department be strengthened. In addition, for the purpose of securing knowledge and know-how in the power station for a medium- or long-term,

and an appropriate system of human resource development, it is also recommended that an upper and lower limit be established in the duration of engineers and technicians posted in the power station. Furthermore, in order to create a specialist in the real sense of the word, transfers between generation, distribution and transmission departments should be kept at a minimum.

Regarding human resource development, the Human Resource Development Center should be strengthened through training needs assessment, constant updating of post-training evaluation and monitoring, clear articulation of the criteria for selecting trainees, and increase of courses related to business and management along with technical courses. In addition, a training program for front-line technicians should be introduced as soon as possible.

Security and safety measures should be adopted in compliance with the Indian law. It is recommended that helmets be procured and supplied to the personnel at the power station as soon as possible. In addition, all the personnel stationed at the power station should be reminded on a daily basis to thoroughly implement these measures.

3.2.2 Recommendations to the government of India

(1) Changes in the precipitation patterns of the Umiam Reservoir should be reviewed. The government of India should confer with the Shillong office of the Ministry of Environment and Forests and municipal authorities of Shillong about the measure to be taken when burden sharing is required or any problems arise. In addition, they should immediately request Meghalaya State Pollution Control Bureau to come up with a concrete proposal for solving the water pollution issue of the reservoir.

(2) Problems related to spare parts are not specific to this project. In order to solve these problems, it is recommended that the government of India build up its capacity to procure the required machinery or spare parts by taking appropriate measures including ensuring adequate budgetary support.

Comparison of Actual and Original Scope

Item	Plan	Actual
(1) Outputs	1) Replacement of following components: ・ Turbine components ・ Generator components ・ 11 kV metal-closed switchgear ・ Main control panel 2) Consulting services (29 M/M)	1) Changes in the following components: ・ Turbines: replacement of guide bearings of all four units was added. Replacement of guide bearing pad spares for Units 3 and 4 were added. The planned repair of the MIV and servomotors of Units 1 and 2 were changed to replacement. Replacement of bypass and pressure relief valves of all four units were added. ・ Generators: the number of rotor fans in all four units was halved. Replacement of air cooler for Unit 1 was cancelled. ・ 11 kV metal-closed switchgear: as planned ・ Main control panel: replacement of recorder panel for Unit 1 was cancelled. 2) Consulting services: as planned
(2) Project Period	Feb. 1997–Nov. 2001 (57 months)	Feb. 1997–Jan.2003 (71 months)
(3) Project Cost Foreign currency Local currency Total ODA loan portion Exchange rate	 1,602 million yen 445 million yen (142 million rupees) 2,047 million yen 1,700 million yen 1 rupee = 3.14 yen (As of May 1996)	 1,693 million yen 397 million yen (153 million rupees) 2,090 million yen 1,693 million yen 1 rupee = 2.59 yen (As of February 1997)