India

FY2016 Ex-Post Evaluation of Japanese ODA Loan Project

"Maharashtra Transmission System Project"

External Evaluators: Akane Totani and Ryujiro Sasao, IC Net Limited

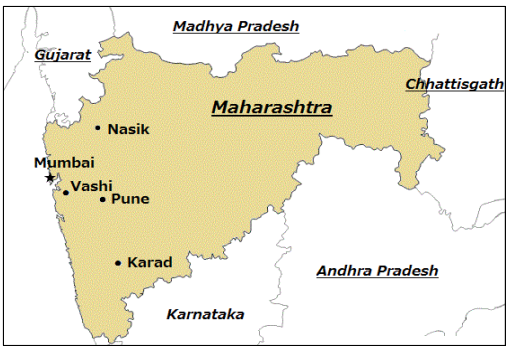
0. Summary

The project aims to ensure a stable power supply and meet the fast growing load demand by augmenting facilities at 110 substations and replacing old and deteriorated equipment at 95 substations in the State of Maharashtra.

Since the augmentation of transmission and transformation facilities corresponding to the rapid increase of power demand has been regarded as a priority at the time of both the project appraisal and the ex-post evaluation, this project has been highly relevant to the development plan and development needs of India. Also, Japan's Country Assistance Program for India at the time of the project appraisal mentions clearly that Japan would assist the development of power grid in order to create stable and efficient power supply. Thus, it can be said that this project is relevant to the Japan's ODA policy. As for the efficiency of the project, outputs of the project including the additional scope (replacement of equipment), which were approved during the project implementation period taking the necessity, urgency and the status of budget implementation into consideration, were achieved as planned. Although the project cost was within the budget, the project period exceeded the plan because of the delay in selecting consultants and suppliers (contractors) and the addition of the scope. Therefore, the efficiency of the project is fair. As for the effectiveness of the project, it was confirmed that the target operation and effect indicators such as availability factor of the transformers and transformer capacity, which were set at the time of the project appraisal, were met in 2014, which is two years after the project completion. As for the impacts of the project, although the contributions made by the project are still limited, it has been found that economic development has been enhanced, business activities of Japanese companies have expanded, and the living conditions in the State of Maharashtra have improved. Therefore, the effectiveness and impact of the project are high. No major problems have been observed in the institutional, technical, financial aspects and the status of the operation and maintenance system. Therefore, the sustainability of the project effects is high.

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

1. Project Description



Project Location

Substation Equipment Augmented
by the Project (Shirwal Substation, Karad Zone)

1.1 Background

Since the late 1990s, India has been suffering from a serious shortage of electric power supply, caused by the rapid economic growth. In spite of the government's intensive promotion of new power development, it witnessed a shortage of about 8% in the total requirement and 12% in the peak demand in 2005. Regional disparities in electric power supply and demand have also been exacerbated and the shortage was the most serious in the western and northern areas of India. Especially in the State of Maharashtra (whose capital is Mumbai), which is located in the western part of India and has the country's largest economy, electric power demand has increased remarkably and the annual average rate of increase of about 7% for 2001–2005 is expected to continue. To meet the current demand, as well as the future growth in demand, Maharashtra State Electricity Transmission Company Limited (MSETCL) prepared and implemented its investment plan to augment its transmission capacity; however, in many substations in the state, the power load had almost approached their maximum capacity.

1.2 Project Outline

The objective of this project is to ensure a stable power supply and to meet the fast-growing demand load by strengthening intra-state transmission systems in the State of Maharashtra which is a western state in India, thereby contributing to local economic development and improvement in the standard of living of the state's citizens.

Loan Approved Amount/ Disbursed Amount	16,749 million yen / 12,070 million yen	
Exchange of Notes Date/ Loan Agreement Signing Date	August 2007 / September 2007	
Terms and Conditions	Interest Rate	0.75% (Main portion) 0.01% (Consulting portion)
	Repayment Period (Grace Period	15 years 5 years)
	Conditions for Procurement	General untied
Borrower/ Executing Agency	The President of India / Maharashtra State Electricity Transmission Company Limited	
Project Completion	March 2015	
Main Contractors (Over 1 billion yen)	Vijay Electricals Limited (India), Bharat Bijlee Limited (India), Voltamp Transformers Limited (India), Transformer and Rectifiers Limited (India)	
Main Consultants (Over 100 million yen)	Nippon Koei Co., Ltd. (Japan)/ Tokyo Electric Power Company Holdings (Japan), Incorporated (Japan)/ Japan and Insight Development Consulting Group (IDCG) (India) (JV)	
Feasibility Studies, etc.	Feasibility study conducted by the Executing Agency (March 2007)	
Related Projects	【Technical Cooperation】Master plan study on pumped storage hydroelectric power development in Maharashtra State (1994–1998) 【Japanese ODA Loan】Rural Electrification Project (March 2006), Power System Improvement and Small Hydro Project (January 1991), Ghatgar Pumped Storage Project (December 1988), Ujjani Hydroelectric Project (November 1985), Paithan Hydroelectric Project (August 1978) 【Other Organizations】 ・ Asia Development Bank (ADB): Maharashtra Solar Park and Green Grid Development Investment Program (2012), Power Grid Transmission III (2004), Power Finance Corporation (1999) ・ World Bank: Organizational Transformation and Public Private Partnership: Maharashtra State Electricity Transmission Company Limited (2006–2010), Maharashtra Power Project 2 (1992–1998), Maharashtra Power Project (1989–1998) ・ KfW[1]: Shivajinagar Sakri Solar Power (2001)	

[1] Kreditanstalt für Wiederaufbau (a German government-owned development bank)

2. Outline of the Evaluation Study

2.1 External Evaluators

Akane Totani, IC Net Limited

Ryujiro Sasao, IC Net Limited

2.2 Duration of Evaluation Study

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

Duration of the Study: September 2016–October 2017

Duration of the Field Study: January 30–February 14, 2017, April 4–11, 2017

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

3.1 Relevance (Rating: ③[3])

3.1.1 Consistency with the Development Plan of India

At the time of the project appraisal, the Government of India, in the 10th Five-Year Plan (2002–2007), aimed to complete new power development of about 41,110 MW, as well as the augmentation of the nationwide high-voltage transmission networks. This would ensure efficient power transmission across the country from the northern, north-eastern and eastern parts of the country, where many sources of electric power are concentrated to the metropolitan areas in the west, north, and south of the country, and increase intra-state transmission by 30,000 MW by 2012. In the next plan, the 11th Five-Year Plan (2007–2012), further augmentation of inter-state and intra-state transmission system for more stable electric power supply, as well as new power development of 78,577 MW, was planned.

The importance of stable electric power supply in the country has not changed at the time of the ex-post evaluation of the project. In the 12th Five-Year Plan (2012–2017), new power generation for meeting the future electric power demand and augmentation of the existing transmission and distribution facilities have been given priority. The Draft National Electricity Plan, released in 2016, plans to invest for the new power generation and transmission projects such as expanding power generation capacity including re-examination of the composition of power sources, and strengthening inter-regional transmission links in response to the continuously increasing power demand. Considering that the project aims to realize stable electric power supply corresponding to the demand growth, it is fair to say that from the time of the project appraisal to its ex-post evaluation, the project has been consistent with the development plan of the Indian government.

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

[3] ③: High, ②: Fair, ①: Low

3.1.2 Consistency with the Development Needs of India

The State of Maharashtra is located in the western part of India. It has the country's largest economy and a high growth rate. According to the documents provided by the Japan International Cooperation Agency (JICA), the peak power demand increased from 12,535 MW in 2001 to 16,069 MW in 2005 and the annual average growth rate of about 7% is expected to continue. Although the length of the intra-state transmission grid was 35,626 km overall and the number of substations was 473 as of March 2007, according to the same document as above) it was found that in many substations and transmission lines in the transmission system, the power load had almost approached their maximum capacity. In Maharashtra, electric power is mainly consumed in the western coastal areas such as Mumbai which is the state capital, while the main supply sources are located in the eastern areas with some of the shortfall being met by import of electricity from other states. Therefore, augmentation of the transmission and distribution system in the western part of the state is an urgent requirement.

According to the Load Generation Balance Report for the years 2008 and 2016, prepared by the Central Electricity Authority (CEA), it was found that a peak demand of electric power in the State of Maharashtra has continuously increased from 18,441 MW in 2007 to 20,973 MW in 2015. It is worth noting that the increase happened even after the implementation of the project. On the other hand, power shortage was severe at the time of the project appraisal and the state had an electricity deficit of 18.3% in 2007. However, because of the increase in power supply brought about by the entry of new private companies into the power generation business beginning around 2010, and the progress in the augmentation of the transmission and distribution system, power shortage in the state has been alleviated. Maharashtra enjoyed an electricity surplus of 7.4% at the time of the ex-post evaluation of the project.

Thus, it is clear that electric power demand in the state has increased continuously, from the time of the project appraisal to the time of the ex-post evaluation of the project. Especially at the time of project appraisal, when the deficit was very large, it can be said that the priority for expansion of a transmission and distribution system such as this project was high. It was also found, in the ex-post evaluation, that the needs have been met to some degree owing to MSETCL's continuous efforts including their self-investment to augment electric substation equipment; however, the project is still important for stable power supply. Hence, it can be said that the project is consistent with the developmental needs of India.

3.1.3 Consistency with Japan's ODA Policy

In Japan's Country Assistance Program for India at the time of project appraisal (May 2006), assistance for the electric power sector was categorized as a priority area for promotion of economic growth. It was also clearly mentioned that Japan would assist in the development of the power grid in order to create a stable and efficient power supply, as well as development of power sources and human resource development. In Medium-Term Strategy for Overseas Economic Cooperation Operations (2005), assistance for poverty reduction and infrastructure development for sustainable growth were set as overall priority areas, and development of

economic infrastructure was prioritized, especially in the assistance earmarked for India. In Country Assistance Strategy for India (2006), electric power sector was regarded as a priority sector for providing Japanese ODA loan, and it was decided to provide necessary support for strengthening the transmission grid as stable power supply and distribution grid was important for economic revitalization and poverty reduction. Thus, it can be said that the project is consistent with Japan's ODA policy at the time of project appraisal.

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

3.2. Efficiency (Rating: ②)

3.2.1 Project Outputs

(1) Augmentation of substation facilities (transformers and peripheral equipment)

Under the project, substation facilities such as transformers and peripheral equipment were augmented at 110 substations in four zones (Vashi, Pune, Karad, and Nasik) in the western part of Maharashtra state. The number of targeted substations were the same as at the time of project appraisal. However, because MSETCL had already performed augmentation works to meet the large and urgent needs at 12 substations[4] prior to the project's start, these were replaced by other substations. The list of peripheral equipment provided during the project along with transformers, shown in Table 2, has also not changed since the time of the project appraisal. The images below show the transformer and the control panel (peripheral equipment) provided through the project.

Table 1: Number of Targeted Substations and Transformers Provided by the Project

Zone	No. of Substations	No. of Transformers
Vashi	19	27
Pune	28	48
Karad	20	50
Nasik	43	55
Total	110	180

Source: Document provided by the executing agency

Table 2: Contents of Substation Facilities Augmented by the Project

Transformers	220/33kV 50MVA、220/22kV 50MVA、132/33kV 50MVA、220/132kV 200MVA、220/132-110kV 200MVA、220/132-110kV 100MVA、220/132-100kV 200MVA、220/132-100kV 100MVA、220/132kV 100MVA、132-110/33kV 50MVA、132-110/22kV 50MVA
Peripheral Equipment	Current Transformer, Lightning Arrester, Isolator, Circuit Breaker, Control Panel, Power Control Cable, Fire-Fighting Equipment, etc.

Source: Document provided by JICA

[4] Three substations in Vashi, three in Pune, five in Karad, and one in Nasik

Transformer
(Lonawala Substation, Pune Zone)

Control Panel
(Kalwa Substation, Vashi Zone)

(2) Replacement of related equipment (additional scope)

After the approval on adding the project scope in March 2011, equipment that had deteriorated was replaced at the 95 substations in four zones (this includes 52 substations, which were also targeted by the original project scope). Selection of targeted substations and equipment to be replaced, as per the additional scope, was done according to the results of analysis in MSETCL's Life Extension Scheme.[5] As the need to replace peripheral equipment is as urgent as the need to augment substation facilities, it can be said that the judgment to include the replacement of equipment as an additional project scope is appropriate in terms of improving efficiency in not only target substations but also in the whole transmission system in the targeted zones. The list of equipment to be replaced, as per the additional scope, includes station transformer, circuit breaker, lighting arrestor, isolator, current transformer, potential transformer, control & relay panel, power & control cable, battery set, battery charger, and alternating current (AC) distribution box. The following images show a circuit breaker and isolator replaced by the project.

Circuit Breaker
(Takali Substation, Nasik Zone)

Isolator
(Lonawala Substation, Pune Zone)

[5] One of the schemes in MSETCL's investment plan to replace deteriorated substation facilities and transmission lines in order to avoid failure and electric outage

(3) Consulting services

In the project, compared to the 48 M/M (24 M/M for Japanese consultants and 24 M/M for local consultants) planned in the project appraisal, 35 man-months (M/M) were actually provided for consulting services. The breakdown of the M/M is as shown in Table 3. Because time was required for procurement, the period for which the consulting service was actually provided was March 2009 to March 2011, although the original plan had scheduled it from August 2008 to September 2010.

Table 3: Consulting Services (Unit: Man-Month)

Items of Works	Planned	Actual
Introduction of Total Quality Management (TQM)	8.0	9.5
Plan and Coordination of Training Program in Japan[6]	4.0	1.5
Project Supervision	12.0	12.0
Project Supervision (Local Consultant)	17.0	6.0
Capacity Building Support (Local Consultant)	7.0	6.0

Source: Documents provided by the executing agency and JICA

Japanese consultants were assigned as nearly planned; however, it was found that M/M for the local consultant on project supervision was far less than planned. It occurred because the frequency of travels of the Japanese consultants from Japan had been less than planned, and this led to the revision of the assigned M/M for the local consultants. In addition, it was already agreed at the time of the project appraisal to exclude the review of detailed design and assistance for tendering in the terms of reference (TOR) for consultant services, because it was found that the executing agency was capable enough and had the relevant knowhow and experience.

[6] In the project, a two-week training course was conducted three times in Japan for MSETCL technicians of the head office and the zone offices.

3.2.2 Project Inputs

3.2.2.1 Project Cost

Table 4 shows the comparison between the planned and actual project costs. It is found that the total project cost, including additional scope, was 65% of the planned amount and that the Japanese ODA loan component was 72% of the planned amount. It can be said that the project cost was within the budget. As indicated in 3.2.1, the project outputs including additional scope were appropriate, and it is fair to say that the project cost matches the project outputs. The main reason for the imbalance between planned and actual project costs is the appreciation of the Japanese yen. Compared with the exchange rate at the time of project appraisal and the average IMF rate during the project period, it was found that the exchange rate of Japanese yen against Indian rupee appreciated by 32%. The fact that the actual bid amount for procuring transformers and peripheral equipment was lower than the planned amount estimated at the time of the project appraisal was another reason for the actual project cost falling below the estimated amount.

Table 4: Planned and Actual Project Cost

	Planned	Actual	Planned/Actual
Total Project Cost	20,712 million yen	13,393 million yen	64.7%
Japanese ODA Loan	16,749 million yen	12,070 million yen	72.1%

Source: Documents provided by the executing agency and JICA

3.2.2.2 Project Period

The project period exceeded the plan. While the planned period at the time of the project appraisal was 3 years and a month (37 months), starting from September 2007 (signing of Loan Agreement (L/A)) and ending in September 2010[7], the actual period including additional scope approved in March 2011 was 6 years and a month (73 months), starting from September 2007 (signing of L/A) and ending in September 2013. For comparing the planned and actual project periods, the planned period was revised taking into account necessary period for additional scope. The actual project period, including the additional scope, was 91 months (September 2007–March 2015) and exceeds the planned period (73 months) by 125%. The main reasons for the actual project period exceeding the planned period were as follows:

1) The executing agency did not have enough experience in procuring consultants, so it required much time to prepare the documents for inviting proposals from consultants. In addition, following the usual procurement process in India, it took a certain amount of time to prepare the shortlist. As a result, 7 months of delay occurred at the “procuring consultants” stage.
2) Because the bidding took longer owing to the large number of bid packages, 2 months of delay[8] occurred at the stage of preparation for bidding.

[7] The project completion was defined as commissioning of all the substations, completion of all the activities for human resource development are implemented, and completion of consulting services.

[8] While the planed period was 15 months from October 2007 to December 2008, the actual one was 17 months from February 2008 to June 2009.

3) Because the transformers and equipment were delivered and installed during the monsoon period and the erection works were delayed owing to outage problems, installation works at some substations could not be completed as per the original schedule.
4) In March 2011, consent to replace the related equipment as an additional scope of the project was obtained from JICA. Although the planned period for the additional scope was 30 months, from April 2011 to September 2013, the actual period was 49 months because of the delay in the preparation for bidding.

Table 5: Comparison of Original and Actual Schedule

Process	Original	Actual
Selection of Consultant	Oct. 2007–Jul. 2008	Jan. 2008–Feb. 2009
Consulting Services	Aug. 2008–Sep. 2010	Mar. 2009–Mar. 2011
Selection of Supplier (Contractor)	Oct. 2007–Dec. 2008	Feb. 2008–Jun. 2009
(Additional Scope)	Apr. 2011–	Nov. 2011–Jun. 2012
Delivery of Equipment	Jan. 2009–Mar. 2010	Apr. 2009–Jan. 2011
(Additional Scope)	–Mar. 2013	Feb. 2012–Nov. 2013
Erection / Installation of Equipment	Jan. 2009–Mar. 2010	Sep. 2009–Mar. 2011
(Additional Scope)	–Mar. 2013	Mar. 2012–Mar. 2014
Commissioning	Mar. 2010	Feb. 2012
(Additional Scope)	Mar. 2013	Sep. 2014
Project Completion	Sep. 2010	Mar. 2012
(Additional Scope)	Sep. 2013	Mar. 2015

Source: Document provided by JICA
Note: In the document provided by JICA, it is assumed that all the construction works of the additional scope are done by March 2013. However, similar to the original scope, project completion is regarded as September 2013 which is six months after the completion of the installation.

3.2.3 Results of Calculations for Internal Rates of Return (Reference only)

3.2.3.1 Financial Internal Rate of Return (FIRR)

It was concluded that, at the time of the project appraisal, a calculation for the FIRR was not possible because no immediate benefit from the project can be expected in the transmission sector.

3.2.3.2 Economic Internal Rate of Return (EIRR)

In the project appraisal, the EIRR was calculated based on economic costs which consist of the project cost excluding cost escalation, taxes and duties, connection cost to the distribution network, operation and maintenance (O&M) cost (which is equivalent to 3% of the initial investment cost), cost of power purchase, and economic benefit is brought by the increased power supply including consumer surplus. In the recalculation of the EIRR in the ex-post evaluation of the project, the same figures are taken for the initial investment cost for installation of distribution network, connection cost and power purchase cost. As the electric outage rarely happens except during inspection and maintenance in the target zones, the consumer surplus accrued by switching to electricity utilization from other energy sources during the power outage is excluded from the economic benefit.

Table 6: EIRR (Project Appraisal/Ex-Post Evaluation)

	Project Appraisal (2007)	Ex-Post Evaluation (2017)
EIRR (%)	23.0	27.9
Project Life	30 years from the project completion	
Cost	Investment cost, connection cost, operation & maintenance (O&M) cost, power purchase cost	
Benefit	Economic benefit brought by increased power sales and savings (including consumer surplus)	Economic benefit brought by increased power sales (excluding consumer surplus)

Source: Documents provided by JICA for project appraisal; calculated by the external evaluators based on the information provided by the executing agency for the ex-post evaluation

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

3.3. Effectiveness[9] (Rating: ③)

3.3.1 Quantitative Effects (Operation and Effect Indicators)

In the evaluation of effectiveness, much emphasis is put on the operation and effect indicators that were set at the time of the project appraisal such as the "availability factor of the transformers" (in percentage) and "transformer capacity" (in MVA). For the comparison between target and actual, the figures relating to 2014[10], that is, two years after project completion, were treated as the actual effect.

The actual availability factor of the transformers almost coincides with the target value. It shows that the substation facilities augmented by the project have been properly brought into use. The actual figures on transformer capacity exceeded the target as a whole, although the target capacities for 132 kV and 100 kV transformers were not met. This is because some target substations were replaced, as mentioned in 3.2.1, and transformers with 132 kV and 100 kV capacity were replaced by the transformers with the other kV classes.

Table 7: Operation and Effect Indicators

	Baseline	Target	Actual	
	2006	2012	2012	2014
	Baseline Year	2 Years after Completion	Completion Year	2 Years after Completion
Availability Factor of the Transformers (%)	81.9	62.0	56.8	61.0
Transformer Capacity (MVA)				
220 kV	4,566	7,970	8,153	8,153
132 kV	2,279	4,700	4,502	4,502
110 kV	300	600	714	714
100 kV	400	950	908.5	908.5

Source: Documents provided by the executing agency and JICA

Note: The availability factor of the transformers is calculated as "maximal load (MW) / (rating capacity (MVA)× power factor". It shows whether the transformer is appropriately operated at around the target availability factor that is set leaving room for margin. The transformer capacity indicates the capacity according to the voltage class.

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

[10] The operation and effect indicators were not revised at the time of adding the scope. Since the additional scope aims to exchange the old and deteriorated relevant equipment, it can be said that there are no effects on the indicators which were originally set at first. Thus, comparison of target and actual figures of indicators is done regarding 2012, when the augmentation of transformers in the original scope was completed, as completion year.

For reference, the availability rate of the transformers based on operating time was 98.82% in 2006 and 99.73% in 2014 (two years after project completion). It also shows that the substation facilities augmented by the project are being operated to the fullest extent.

Table 8: Availability Rate of the Transformers

	2006	2012	2014
Availability Rate of the Transformers (%)	98.82	99.71	99.73

Source: Document provided by the executing agency
Note: The availability rate of the transformers indicates the proportion of actual operating hours of transformers out of 24 hours and 365 days.

Thus, it can be judged that the target operation and effect indicators, which were set at the time of the project appraisal, were achieved, and that the project could elicit the expected effects.

3.3.2 Qualitative Effects (Other Effects)

The stability of electric power supply, as a result of the augmentation of substation facilities and capacity building of the relevant people in the executing agency and developed through the consulting services in the project, were analyzed as the qualitative effects of the project. Investment promotion and improvement of living conditions in the State of Maharashtra, which were also seen as qualitative effects of the project at the time of the project appraisal, were regarded as impacts of the project.

(1) Outline of the beneficiary survey

In the ex-post evaluation, manifestations of qualitative effects (situation of power supply) and impact (improvement in living conditions) were examined through a beneficiary survey of residents living in the vicinity of the target substations, private companies, and public institutions, which received power supply directly from the target substations or even from any distribution companies in the substation area, conducted at seven substations (two substations each were selected from Nasik, Pune, and Karad; one from Vashi). At each substation area, three surveyors were assigned to conduct a questionnaire survey in the different target areas, which were already trisected, and 113 residents, 22 private companies, and 10 public institutions were randomly selected according to the equidistant spacing method. Finally, valid responses could be collected from 101 residents, 22 private companies, and 10 public institutions that have been living, working, and/or running a business in the area before the project was implemented.[11]

[11] The 101 residents include 74 men and 27 women. With regard to their age, 5 are in their 20s, 32 in 30s, 34 in 40s, 17 in 50s, and 12 in 60s or above, and 1 unknown. The breakdown by zone is as follows.

	Residents	Private Company	Public Institution
Vashi Zone	16	7	0
Nasik Zone	25	7	0
Pune Zone	32	3	2
Karad Zone	28	5	8
Total	101	22	10

Note: 2 substations each from Nasik, Pune and Karad zones and 1 substations from Vashi zone

(2) Improvement in electric power supply

The beneficiary survey asked the respondents a question on the degree of satisfaction regarding the electric power supply after project completion, with four scales: "very satisfied," "satisfied," "somewhat satisfied," and "not satisfied." Among the respondents, 24% of the residents and 16% of the private companies and public institutions chose the "very satisfied" and 76% of the residents and 84% of private companies and public institutions chose "satisfied" (none chose "somewhat satisfied" or "not satisfied"). Decreases in the frequency of outage and voltage stability were given as reasons for their satisfaction.

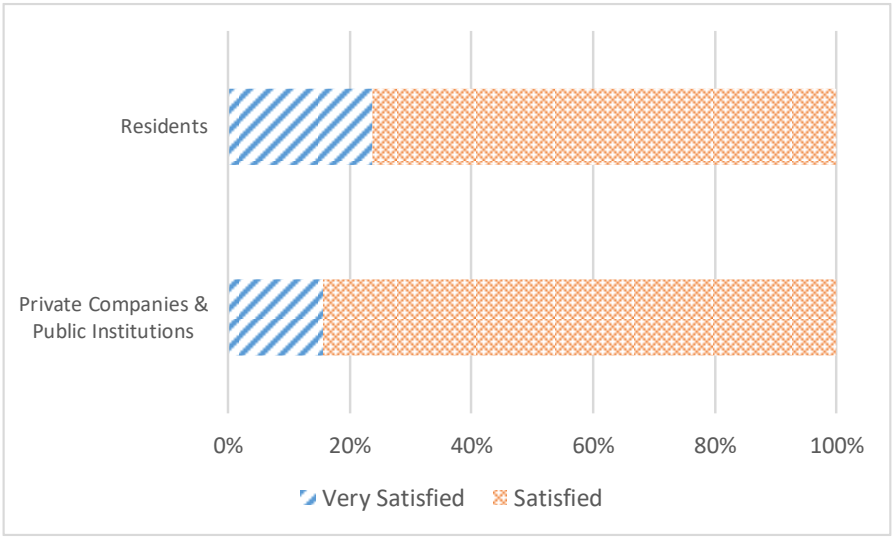


Figure 1: Degree of Satisfaction on the Electric Power Supply (Beneficiary Survey)

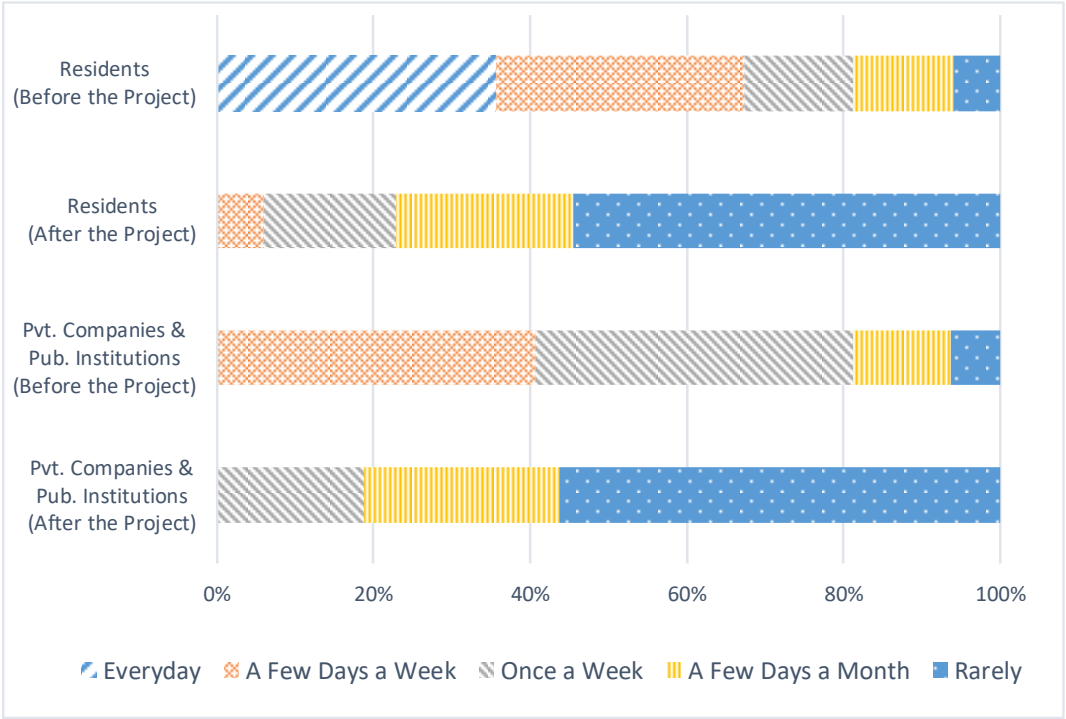


Figure 2: Frequency of Outage (Beneficiary Survey)

The survey also asked a question on the frequency of outage before and after project completion with five scales: “every day,” “a few days a week,” “once a week,” “a few days a month,” and “rarely.” As shown in Figure 2, it was found that the frequency of outage was drastically reduced after project completion, although the situation before the project for residents and private companies as well as public institutions was quite different. The augmentation of substation facilities by the project makes it possible to provide constant power supply by operating other transformers at the time of regular inspection and maintenance, or when the transformer malfunctions.

(3) Capacity building of the concerned personnel of the executing agency

In the project, based on the assessment of the operation and maintenance (O&M) system and capacity of the executing agency, training plan and curriculum, according to the needs and capacity-building plan, were prepared and implemented through the consulting services. Initially, in-country training on the basic concepts of total quality management (TQM) and practical introduction to the plan-do-check-act (PDCA) cycle was conducted for middle-level managers. A two-week overseas training session was also held three times in Japan during the project period and the trainees visited such facilities as a central load dispatching control center, substations, and construction site of the distribution grid, learning about the practical aspects of introducing TQM in Japan and the latest technology in transmission and distribution systems.

According to the personnel at the head and zonal offices who participated in the training in Japan, the TQM concept itself was not introduced by the project because it was already used in the work of the executing agency. However, in reality, the TQM concept was not being properly practiced in the organization. Hence, through the workshops conducted by the project, the trainees understood better the objectives and practice methods of TQM. It was also reportedly meaningful to observe the TQM concept being intensively put into practice at the substations in Japan. By contrast, it was found that, because most of the people who participated in the workshops and training in Japan were transferred to other departments, the management know-how obtained through the project was not actively used at the executing agency, at the time of the ex-post evaluation.

3.4. Impacts

3.4.1 Intended Impacts

As intended impacts, the number of indirect beneficiaries in the four target zones, economic situation of the State of Maharashtra, expansion of business activities of Japanese companies in the target areas, and improvement in living conditions in the target area are examined.

3.4.1.1 Number of indirect beneficiaries

In the project appraisal, it was reported that, although it was difficult to confirm the exact

number of direct beneficiaries of the project,[12] 61.64 million people in the four target areas could benefit from the indirect impacts of the project. In the ex-post evaluation, it was found that the population of the four target areas (indirect beneficiaries) was estimated as 85.48 million, based on the results of the census in 2011. Thus, the number of indirect beneficiaries of the project has increased by 39%, compared with the number finalized during the project appraisal, which shows the magnitude of the indirect impacts of the project.

Table 9: Estimated Population in the Four Target Areas in 2014

Vashi Zone	32,018,607
Pune Zone	16,840,867
Karad Zone	13,863,755
Nasik Zone	22,760,586
Total	85,483,815

Source: Document provided by the executing agency

3.4.1.2 Economic situation of the State of Maharashtra

The table below shows the economic situation in the State of Maharashtra, the target area of the project.

Table 10: Economic Situation of the State of Maharashtra

	2010	2011	2012	2013	2014	2015
Population (in thousands)	111,645	113,179	114,697			
Gross State Domestic Product (GSDP, million rupee)						
(at Constant (2011-2012) Prices)	-	-	-	14,418,430	15,248,460	16,470,450
(at Current Prices)	10,683,270	11,995,480	13,237,680	15,101,320	17,921,220	19,691,840
Annual Growth Rates of Real GSDP	-	-	6.6%	6.2%	5.8%	8.0%
Sectoral (Agriculture)	-	-	-1.9%	12.6%	-16.0%	-2.7%
Sectoral (Industry)	-	-	5.4%	1.2%	6.8%	5.9%
Sectoral (Services)	-	-	8.2%	7.0%	10.0%	10.8%
Net State Domestic Product (State Income, NSDP, million rupee)	9,824,520	10,827,510	11,967,540	14,500,030	15,720,370	-
State Income per Capita (rupee)	87,686	95,339	103,991	125,146	134,081	-
No. of Companies in Industrial Sector	27,892	28,215	28,949	29,123	-	-
(Percentage to Whole India)	13.2%	13.0%	13.0%	13.0%	-	-
Labor Force in Industrial Sector (in 100 thousands)	12.03	13.21	12.33	13.12	-	-
(Percentage to Whole India)	12.2%	12.7%	12.3%	12.6%	-	-
Profit in Industrial Sector (million rupee)	918,680	784,880	1,016,400	1,195,370	-	-
(Percentage to Whole India)	23.6%	17.4%	22.9%	26.3%	-	-

Source: Economic Survey of Maharashtra 2011–12, 2012–13, 2013–14, 2014–15, 2015–16

As shown in Table 10, it was found that the gross state domestic product (GSDP) and the GSDP growth rates of the service sectors and industry, in addition to the state income per capita, increased after the completion of the project in 2012, and that the economic development in the State of Maharashtra was led by the service sectors and industry. In general, it is reasonable to say that the increase of electric power supply and its use are the contributing factors for the regional economic development. However, because the project scope focuses only on the

[12] This is because the executing agency of the project simply supplies electric power to the distribution companies, which directly distribute electric power to the customers (beneficiaries).

augmentation of substation facilities—a component of the entire electric system—and the direct beneficiaries of the project are part of the indirect beneficiaries shown in 3.4.1.1, the impact of the project on the economic development in the State of Maharashtra is limited. By contrast, as the rapid economic development of the state continues, as described above, the significance of the project—which contributed toward securing a stable electric power supply in the western coastal areas of the state with their rapidly growing power demand—for the state's development is quite high.

3.4.1.3 Expansion of business activities of Japanese companies in the target area

At the time of the project appraisal, 67 Japanese companies already had business activities in the State of Maharashtra (project target area) (as of June 2006). Thus, it was expected that they would also benefit from the project's objective of ensuring stable electric power supply. According to the list of Japanese companies operating in India (2016), at the time of the ex-post evaluation (as of 2016), the number of Japanese companies operating in Maharashtra was 205, which is almost three times as many as the number at the time of project appraisal. Table 11 indicates that the number of hubs of Japanese companies in India increased fourfold in the eight years since 2008. However, it was also found that both the number of hubs in 2016 and the growth rate since 2008 in the western region, including the State of Maharashtra, was lower than what it was in the northern, north-eastern, and southern regions. According to the interview with the concerned people, this is because the high electricity tariff in the State of Maharashtra is an obstacle for the promotion of investments in the state. On the other hand, it was confirmed that the stability of electric power supply in the state, compared with that of other states, could be a promoting factor for the Japanese companies to make investment decisions. According to the list of Japanese companies operating in India (2017), as of October 2016, the number of Japanese companies located in the target areas of the project is as follows: 5 companies, with 5 hubs in Vashi; 158 companies, with 192 hubs in Pune; 1 company, with 1 hub in Karad; and 14 companies, with 17 hubs in Nasik. It is fair to say that the stable power supply realized by the project indirectly contributes to the business expansion of the Japanese companies.

Table 11: List of Hubs of Japanese Companies by Region in India[13] (2008–2016)

	2008	2009	2010	2011	2012	2013	2014	2015	2016
North/North-East	305	369	410	474	613	707	1,246	1,490	1,585
East	39	65	93	95	109	144	336	369	385
West	208	268	246	265	365	519	994	1,128	1,163
Maharashtra	174	219	198	218	277	395	625	712	709
South	286	347	487	588	717	1,133	1,305	1,430	1,457
Total (Hubs)	838	1,049	1,236	1,422	1,804	2,503	3,881	4,417	4,590

Source: Embassy of Japan in India and JETRO, *The List of Japanese Companies Operating in India* (2017)

[13] The hubs were of the following types: 1) representative office and branch office of the Japanese company, which is not locally incorporated; 2) locally incorporated head office, central branch, production plant, branch office, business office, local office, etc., of the Japanese company (fully affiliated company or a joint venture) ; and 3) companies set up by Japanese nationals in India.

3.4.1.4 Improvement of Living Conditions in the target area

In the ex-post evaluation, the beneficiary survey[14] was conducted to compare the living conditions in the target areas of the project before and after the project implementation. On a whole, living conditions in the target areas were improved in several aspects after the project implementation. However, it cannot be said that the changes indicated in Figure 3 have been brought about only by the stable electric power supply resulting from this project. The changes could also be influenced by the economic conditions of the respondents' households or of the target areas. According to Figure 3, most of the respondents chose "very improved" or "improved" in availability of lighting, TV and radio, convenience with the use of home electric appliances (because of fewer outages), and frequency of breakdown of home electric appliances (because of stable electric voltage). As for the burden of housework and time management, compared to the above-mentioned items, more respondents chose "very improved", while a certain number of the respondents chose "not changed". Notably, more than half of the respondents choose "very improved" in securing a block of time and fixing working time (because reduction and/or change in working hours is resolved due to the stability of the power supply).

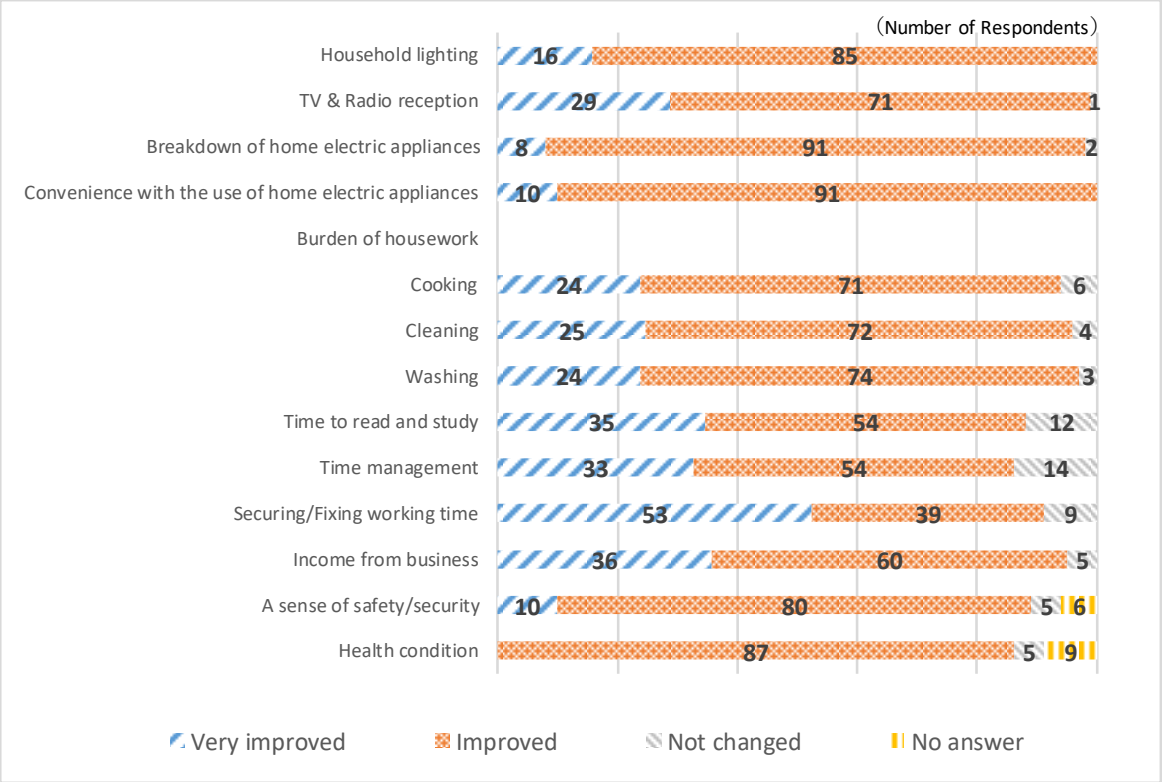


Figure 3: Changes in the Living Conditions in the Target Areas (Beneficiary Survey)

[14] Same as the survey described in 3.3.2

3.4.2 Other Positive and Negative Impacts

3.4.2.1 Impacts on the Natural Environment

In the project appraisal, it was expected that there would be minimum negative impacts on the natural environment. In the ex-post evaluation, according to the interviews with the concerned personnel of the executing agency and technical officers at the target substations, as well as the beneficiary survey[15], it was confirmed that there were no impacts on the natural environment because of the projects' augmentation of substation facilities and replacement of related equipment.

3.4.2.2 Land Acquisition and Resettlement

In the ex-post evaluation, through the interviews on the occurrence of land acquisition and resettlement t with the concerned personnel of the executing agency and residents living in the areas surrounding the target substations, it was confirmed that no land expansion or displacement of the existing sub-stations occurred. Thus, there was no land acquisition and resettlement caused by the implementation of the project.

This project has largely achieved its objectives. Therefore, the effectiveness and impact of the project are high.

3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspects of Operation and Maintenance

MSETCL consists of the head office in Mumbai and seven zone offices that are engaged in the installation of transmission and substation facilities and their operation and maintenance (O&M). In the ex-post evaluation, it was confirmed that the O&M of the substation equipment augmented or replaced by the project has been done by EHV Construction with O&M Zone Offices (O&M Zone Offices) in Vashi, Pune, Karad, and Nasik, as planned in the project appraisal without any changes of posts in charge of O&M. Each O&M Zone office is responsible for supervising the O&M activities at the substation level, while operators and technicians are actually engaged in the regular O&M activities at the substation under the supervision of the chief engineer. The O&M division in each zone, which is in charge of 20 substations, can provide technical support to the substations as needed.

Meanwhile, MSETCL faces a chronic shortage of technical human resources at all levels, including the O&M division and substations. Because efficiency in staff assignment has been improved by combining the separate duties of the operation of substation facilities and O&M into one, the number of vacant technical positions was reduced from 5,880 out of 14,182 technical posts (as of December 2016) to 3,301 (as of April 2017) out of 12,286 technical posts. Although staff shortages still exist, it was confirmed that the substation facilities have been properly operated and maintained with the requisite minimum number of personnel at the substation levels, so it is not currently such a serious problem.

[15] Same as the survey described in 3.3.2

Thus, it was found that the O&M has been appropriately performed at the substations with clear demarcation of responsibilities and roles among the concerned departments, as well as in the system of command and communication. Therefore, it can be said that a proper O&M system has been established. However, it is still necessary to take immediate and necessary measures for filling the vacant technical posts.

3.5.2 Technical Aspects of Operation and Maintenance

As of December 2016, MSETCL had 10,143 employees, including 8,528 technical staff members. The technical levels of the departments and staff in charge of O&M are kept at the proper level: a bachelor's degree or higher in electronic engineering is an eligibility requirement for the technical staff, and necessary knowledge and techniques are updated through training for newly appointed personnel and a series of regular technical training courses[16] provided by the head office and zone offices.

At each substation, a manual for the O&M of the substation equipment is prepared and regular inspection and maintenance are properly conducted according to the common rules established by the head office. The records are also appropriately kept at the substations. However, in the ex-post evaluation, it was found that the contents and quality of the operation manuals are not standardized but vary from one zone and substation to another. The substations that can get more input from the O&M division possess and use a more practical and detailed manual, while the manual that the other substations possess does not provide any concrete procedures. However, interviews revealed that even the substations with a simple operations manual conduct regular inspection and maintenance as well as the other substations do, and no failures of transformers and related equipment or accidents happened.

Thus, it can be judged that the technical level of personnel at the zone and substation levels are high enough to operate and maintain properly the substation facilities introduced by the project.

3.5.3 Financial Aspects of Operation and Maintenance

Table 12 shows the financial status of MSETCL in the last three years. Because MSETCL is a public corporation for transmission, its source of revenue is not the fare collection from the customers but the commission charges from the State Transmission Utility (STU). As shown in the table below, in the last three years, the total income exceeded the total expenditure, and the net profit was stable with around 17,000 million rupee before the fiscal year (FY) 2015 when adjustment of depreciation was posted. It is fair to say that the sustainability of revenues and the financial status of MSETCL are secured. The recording of depreciation in FY2015, which made the net profit negative, was temporary and not expected to occur in the subsequent years.

[16] According to an interview, technical training courses are held several times a year at the head office and the zone offices of MSETCL in addition to on-the job training at the substation provided by the zone offices.

Table 12: Financing Status of MSETCL (FY2013–FY2015) (Unit: Million Rupee)

Item	FY2013	FY2014	FY2015
Total Income	54,957	54,320	35,700
Total Expenditure	29,424	27,920	29,020
Profit before Tax	25,532	26,400	6,670
Depreciation due to FRP	-	-	46,540
Net Profit (after Tax)	17,031	17,640	-42,560

Source: Documents provided by the executing agency
Note: Depreciation due to Financial Restructuring Plan (FRP) in FY2015 is the difference in the depreciation between FY2005 and FY2015, which was caused by the increased value of asset of MSETCL according to the FRP scheme of the Maharashtra State Government in 2016.

Table 13: Balance Sheet of MSETCL (Unit: Million Rupee)

Item	FY2014	FY2015
Asset	197,227	209,170
Current Asset	31,668	37,294
Non-Current Asset	165,559	171,876
Accounting Capital	67,228	84,866
Debt	129,999	124,304
Current Debt	25,329	23,415
Non-Current Debt	104,670	100,889

Source: Documents provided by the executing agency

Table 13 shows the balance sheet of MSETCL in the last two years. According to the figures in FY2015, it was confirmed that MSETCL had current ratio of 159%[17]. The capital adequacy ratio of 41%[18] also meets the generally desirable level.

As for the budget for O&M, 2,922 million rupee in FY2016 and 3,128 million rupee in FY2015 were secured in the four target zones. The O&M budget is allocated not to the substation levels but the O&M division that supervises the substations based on the plan and request submitted by each substation. Interviews with the concerned personnel confirmed that the annual O&M budget per substation is around 2–3 million rupee and an emergency budget is separately allocated to the O&M division in each zone. According to the personnel at the O&M division and substations, a sufficient O&M budget is allocated for proper operation and maintenance of substation facilities.

3.5.4 Current Status of Operation and Maintenance

The site survey of the ex-post evaluation has confirmed that the substation facilities introduced by the project have been appropriately operated and maintained. Specifications of the equipment are based on MSETCL's standards, and the availability of spare parts is secured.

The frequency of regular maintenance at the substation is annual, semiannual, quarterly, monthly, or daily, depending on the type of equipment. Especially for the transformers and the peripheral equipment, the engineers of the inspection division perform a routine operation check once a week; the schedule depends on the zone. So far, no serious failure has been reported. In

[17] Current ratio is calculated by dividing current asset by current debt.
[18] Capital adequacy ratio is calculated by dividing accounting capital by total asset.

case of trouble, the maintenance team of the O&M division in each zone is responsible for addressing the issues and, if necessary, the neighboring substations can provide technical support.

Thus, it has been confirmed that the equipment introduced by the project are properly operated and maintained through regular inspection. By the time of the ex-post evaluation, no failure and fixing of equipment have been reported. An emergency response procedure is also clearly set. It is fair to say that a proper O&M system has been established.

No major problems have been observed in the institutional, technical, financial aspects and status of the operation and maintenance system. Therefore, sustainability of the project effects is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The project aims to ensure a stable power supply and meet the fast growing load demand by augmenting facilities at 110 substations and replacing old and deteriorated equipment at 95 substations in the State of Maharashtra.

Since the augmentation of transmission and transformation facilities corresponding to the rapid increase of power demand has been regarded as a priority at the time of both the project appraisal and the ex-post evaluation, this project has been highly relevant to the development plan and development needs of India. Also, Japan's Country Assistance Program for India at the time of the project appraisal mentions clearly that Japan would assist the development of power grid in order to create stable and efficient power supply. Thus, it can be said that this project is relevant to the Japan's ODA policy. As for the efficiency of the project, outputs of the project including the additional scope (replacement of equipment), which were approved during the project implementation period taking the necessity, urgency and the status of budget implementation into consideration, were achieved as planned. Although the project cost was within the budget, the project period exceeded the plan because of the delay in selecting consultants and suppliers (contractors) and the addition of the scope. Therefore, the efficiency of the project is fair. As for the effectiveness of the project, it was confirmed that the target operation and effect indicators such as availability factor of the transformers and transformer capacity, which were set at the time of the project appraisal, were met in 2014, which is two years after the project completion. As for the impacts of the project, although the contributions made by the project are still limited, it has been found that economic development has been enhanced, business activities of Japanese companies have expanded, and the living conditions in the State of Maharashtra have improved. Therefore, the effectiveness and impact of the project are high. No major problems have been observed in the institutional, technical, financial aspects and the status of the operation and maintenance system. Therefore, the sustainability of the project effects is high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

To actively use the management method such as TQM and PDCA cycle acquired through the project, it is desirable to establish the information sharing and implementing mechanism for the concerned departments to play central roles to share and instill the outputs of management method within the organization, even in case that most of the personnel who participated in the workshops under the consulting services of this project and training in Japan were transferred to the other departments.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

None

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs	Augmentation of substation facilities (110 substations) - 180 transformers - Current Transformer, Lightning Arrester, Isolator, Circuit Breaker, Control Panel, Power Control Cable, Fire-Fighting Equipment (including erection works) Consulting services	As planned As planned
		(Additional scope) Replacement of related equipment (95 substations) station transformer, circuit breaker, lighting arrestor, isolator, current transformer, potential transformer, control & relay panel, power & control cable, battery set, battery charger, alternating current (AC) distribution box (including erection works)
2. Project Period	Sep. 2007–Sep. 2010 (37 months)	Sep. 2007–Mar. 2015 (91 months)
3. Project Cost Amount Paid in Foreign Currency Amount Paid in Local Currency Total ODA Loan Portion Exchange Rate	 13,975 million yen 6,737 million yen (2,504 million Rupee) 20,712 million yen 16,749 million yen 1 Rupee＝2.69 yen (As of May 2007)	 12,070 million yen 1,323 million yen (723 million Rupee) 13,393 million yen 12,070 million yen 1 Rupee＝1.83 yen (Average of IMF Rate between 2008 and 2014)
4. Final Disbursement	November 2014	