India

FY2017 Ex-Post Evaluation of Japanese ODA Loan Project
"Transmission System Modernization and Strengthening Project
in Hyderabad Metropolitan Area"

External Evaluator: Toshihisa Iida, OPMAC Corporation

0. Summary

The objective of this project was to improve the reliability and quality of the power supply by strengthening the transmission system in the Hyderabad Metropolitan Area, thereby contributing to local economic development and an improvement in the living standards of local residents in the area concerned. The project was sufficiently consistent with the development policy of India, its development needs, and with Japan's ODA policy, and thus its relevance is high. While the project cost was lower than planned, the project period was longer than planned due to delays in obtaining road cutting permissions for the laying of underground transmission lines, the effects of state bifurcation in 2014, location changes in the construction sites of substations, delays in obtaining land for substations, and delays related to procurement procedures. Thus, the efficiency of the project is fair. The stability, reliability and capacity of the power supply have been improved with declines in voltage fluctuation ratio, power outage times and transmission loss rate and increases in the amount of power supply. The substations constructed under this project are properly operated. Also, the project has positively contributed to economic development, business activities, job creation and an improvement in the living standards of local residents in the Hyderabad Metropolitan Area to some extent. Thus, its effectiveness and impact are high. Lastly, the operation and maintenance of the substations and transmission facilities constructed under this project is properly conducted, and the operation and maintenance of the project in terms of the institutional, technical, financial aspects and the current status is good. The sustainability of the project is high.

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

1. Project Description

Project Location

Moosarambagh Substation

1.1 Background

In India, with a rapidly growing demand for electricity driven by rapid economic development, the resolution of constitutive power shortages and a stable power supply has been a top priority in further economic development and poverty alleviation. Rapid economic development through industrial concentration such as that of IT industries in Hyderabad and its neighboring area resulted in a surge in the demand for power thanks to the increase in population, office buildings and factories. The power demand in Hyderabad and its neighboring area at peak hours increased on average at an annual rate of 7% for 4 years from 2001, and it was expected to increase by an average of 11% per year over the next 5 years from 2006. To meet this rapidly increasing power demand, it was planned that, in the state of Andhra Pradesh (at the time of project appraisal), where Hyderabad is located, the power supply at peak hours would be doubled by FY2011 from its FY2005 level through a proactive power development. To provide this surging power generation to consumers in a stable manner, it was urgent that the capacity of the transmission system be strengthened, especially in the Hyderabad Metropolitan Area where a high rate of growth in demand for electricity was expected.

1.2 Project Outline

The objective of this project was to improve the reliability and capacity of the power supply through strengthening of the transmission system in the Hyderabad Metropolitan Area, thereby contributing to local economic development and an improvement in the living standards of local residents in the areas concerned.

Loan Approved Amount/ Disbursed Amount	23,697 million yen /15,999 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	March 2007 /March 2007
Terms and Conditions	Interest Rate 1.3% Repayment Period 30 years (Grace Period 10 years) Conditions for Procurement General untied
Borrower / Executing Agency(ies)	The President of India/ Transmission Corporation of Telangana Limited (TSTRANSCO)[1]
Project Completion	May 2018[2]

[1] At the date of the loan agreement, the executing agency was Transmission Corporation of Andhra Pradesh Limited (APTRANSCO). In June 2014, the state of Telangana was formed as a result of a separation of Telangana Region including the project area from Andhra Pradesh state. Accordingly, TSTRANSCO was formed as a result of bifurcation of APTRANSCO, and became the executing agency of this project.

[2] This project was completed in May 2018 which was during this ex-post evaluation study.

Main Contractor(s) (Over 1 billion yen)	INDU PROJECTS LTD. (India), M/S ILJIN ELECTRIC COMPANY LTD. SEOUL (Republic of Korea), ILJIN ELECTRIC Co. LTD. NEW DELHI (India), LARSEN & TOUBRO LTD. (India)
Main Consultant(s) (Over 100 million yen)	NA
Related Studies (Feasibility Studies, etc.)	F/S by APTRANSCO in 2002
Related Projects	None

2. Outline of the Evaluation Study

2.1 External Evaluator

Toshihisa Iida, OPMAC Corporation

2.2 Duration of Evaluation Study

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

Duration of the Study: November, 2017 – January, 2019

Duration of the Field Study: January 22, 2018 – February 9, 2018,
June 24, 2018 – June 29, 2018

2.3 Constraints during the Evaluation Study

(1) The project was completed in May 2018 which was during this ex-post evaluation study. It is normal that a project impact should be identified as a mid-long term project effect. However, certain qualitative effects were observed at the transmission and substation facilities constructed in this project that were already completed and were being operated at the time of the ex-post evaluation. Therefore, these effects were considered as parts of the intended project impact. However, since most of the facilities under the project were commissioned from FY2016/17[3], it was difficult to measure quantitative impacts of the project at a macro level.

(2) Evaluation judgement had to be made based on limited information collected due to difficulties in obtaining some information necessary to conduct the ex-post evaluation for the following reasons:

- TSTRANSCO became the executing agency of this project after the bifurcation of APTRANSCO along with the creation of Telangana State in June 2014. Therefore, some information of pre-bifurcation could not be obtained at the time of ex-post evaluation.

[3] The fiscal year of TSTRANSCO is from April to March.

- There was a limit to the information obtained that supports the appropriateness of the changes in project scope, including substation sites and routes of transmission lines. This meant that the evaluation judgement in the ex-post evaluation had to rely on information based on the current operational conditions of the related substations.
- It was not possible to obtain detailed project cost information due to a lack of a mechanism enabling the executing agency to manage the actual total cost of the project in an integrated manner. In addition, as project completion was in May 2018, there were unfixed final payment amounts for some of the procurement packages to the contractors at the time of ex-post evaluation. Therefore, the actual project cost had to be based on a prediction of the final payments at the time of the ex-post evaluation.

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

3.1 Relevance (Rating: ③[5])

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 (April 2002 to March 2007)*, a development plan of India, focused on new development of power generation as well as development of the transmission and distribution network. Its intention was to add 41,110 MW of new power projects by the end of the Plan, in addition to augmentation of the nationwide high-voltage transmission network with the objective of ensuring efficient power transmission from the north, the north-east and the east where power resources were concentrated, to metropolitan area in the west, the north and the south which were the biggest power demand market. *The Common Minimum Programme*, issued in May 2004 by the central government of the time, regarded infrastructure development, including power, as a high priority area. Power sector reform in the state of Andhra Pradesh (at the time of project appraisal) was implemented with the aim of achieving a more efficient power supply system, including the reduction of transmission and distribution losses through strengthening of the power facilities.

At the time of the ex-post evaluation, in the *Three-year Action Agenda (2017/18 – 2019/20)*, which started from April 2017, power sector was regarded as one of the major engines driving economic development. Adding to the power generation capacity, as well as enhancing the transmission and distribution system, were listed in the Action Agenda for the said period[6]. Improvement of the power situation has been one of the top priorities of the current administration in the state of Telangana, where this project site is located, since the bifurcation of 2014. Telangana State, together with the central government, developed *24x7 Power for All*

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

[5] ③: High, ②: Fair, ①: Low

[6] The Government of India formulated a new framework, which consists of the *15-year Vision (2017/18–2031/32)*, the *7-year Strategy (2017/18–2023/24)* and the *3-year Action Agenda (2017/18–2019/20)*, after the end of the *12th Five-Year Plan (2012/13–2017/17)*. At the time of this ex-post evaluation, the *15-year Vision* and *7-year Strategy* were not yet finalized.

aiming at supplying electricity for 24 hours a day to all electricity consumers by FY2018/19 and achieving self-sufficiency in power generation by FY2020/21. It is expected that through this initiative, additions will be made to the power generation capacity and the transmission and distribution network will be strengthened to meet the expected growth in power demand from existing as well as future consumers. Thus, it can be said that the project maintained its relevancy to the development policy of the Indian Government at the time of project appraisal as well as at the time of the ex-post evaluation, and also to the power sector policy of the state of Telangana at the time of ex-post evaluation.

3.1.2 Consistency with Development Needs

At the time of project appraisal, peak power demand in the Hyderabad Metropolitan Area had been rapidly growing with an annual average growth of about 7% from 2001 to 2005. This was due to increases in population (from 5.5 million in 2001 to 6.3 million in 2003) and in office buildings and factories associated with vigorous economic activities including those of a high concentration of high-technology industries. Furthermore, peak power demand was expected to increase by average of 11% per year over the five years from 2006. To meet this surging power demand, ex-Andhra Pradesh State planned to double its peak supply of power with the rigorous power resource development by FY2011 in comparison with FY2005. To provide this surging power generation to consumers in a stable manner, the capacity of the transmission system had to be enhanced especially in the Hyderabad Metropolitan Area where a rapid growth of power demand was expected.

At the time of the ex-post evaluation, with the state government's active investment incentives and an improving infrastructure, including power supply situation[7], economic activity in the Hyderabad Metropolitan Area was vigorous with the new entry of companies such as construction of industrial parks, the IT industry and manufacturing, resulting in a population growth from 6.4 million in 2005 to 8.9 million in 2015 [8]. The peak power demand in the same area has grown at annual average rate of 7.4% since FY2014/15 (Table 1). To meet the increasing power demand, the transmission network system has been significantly enhanced (Table 2). The population in the area is estimated to be about 9.4 million in 2018 [9]. A continuous enhancement

[7] At the time of state bifurcation in 2014, there was about a 26 % power demand/supply gap in the state of Telangana. There were planned power outages including power cuts for 2 days a week for industries, 9 hours a day in rural areas and 6 hours a day in urban areas. Interviews with the Department of Energy in Telangana State revealed that since state bifurcation, improvement of the power situation has been given one of the highest priorities in the State. Through the implementation of a) full coordination among generation, transmission and distribution companies, b) systematic enhancement of generation, transmission and distribution capacity along with power demand prediction, c) long-term power purchase agreements with neighboring states, and d) purchasing power from state-owned companies as short-term measures, in FY2015/16, power supply for 24 hours a day in Hyderabad was achieved and the power demand/supply gap was eliminated. Power supply 24 hours a day in rural areas was started in January 2018. Thus, the power situation in Telangana state has been substantially improved.

[8] Source: http://worldpopulationreview.com/world-cities/hyderabad-population. Access: April 30, 2018

[9] Source: http://population .city/india/hyderabad/. Access: August 13, 2018

of the transmission network systemin the area is needed to achieve a continuously stable and reliable power supply.

Table 1: Peak Power Demand/Supply Gap in the Hyderabad Metropolitan Area

FY	2014/15	2015/16	2016/17	2017/18
Peak Power Demand (MW)	2,261	2,497	2,586	2,796
Peak Power Supply (MW)	2,261	2,497	2,586	2,796
Demand/Supply Gap (%)	0	0	0	0

Sources: Documents provided by the executing agency

Table 2: Transmission and Substation Facilities in the Hyderabad Metropolitan Area

FY	2014/15	2015/16	2016/17	2017/18
Total Length of Transmission Lines (ckm[10])	632	985	1,314	1,396
Total Capacity of Transformers in Substations for Transmission (MVA)	1,696	2,436	3,236	3,336

Source: Documents provided by the executing agency

From the above, it can be seen that due to the high level of power demand and the high necessity for a continuous enhancement of the transmission network to maintain a stable electricity supply in the Hyderabad Metropolitan Area, the necessity for this project remained at the time of the ex-post evaluation.

3.1.3 Consistency with Japan's ODA Policy

At the time of project appraisal, *Japan's Country Assistance Program for India*, formulated in May 2006, listed the promotion of economic growth as one of the priority targets, and put special emphasis on assistance for infrastructure development contributing to private-oriented economic growth through improvement of India's investment climate. Specifically, it placed a priority on assistance for the electric power and transport sectors. The program stated the following as areas for Japanese assistance for the electric power sector: (i) development of power resources to increase the electric power supply, (ii) development of the power grid to create a stable and efficient power supply, and (iii) organization reform to improve project effectiveness in the electric power sector as well as enhancement of capacity building such as human resource development. In *Medium-Term Strategy for Overseas Economic Cooperation Operations by JICA (former JBIC's) (April 2005-September 2008)*, assistance for poverty reduction and infrastructure development for sustainable growth were set as overall priority areas, and the development of economic infrastructure was prioritized as the priority area in assistance to India. In JICA's (former JBIC's) *Country Assistance Strategy for India (FY2006)*, the electric power sector was regarded as a priority sector, and assistance was planned for (i) the development of

[10] Circuit Kilometer (circuit length (km))

new power resources to increase the power supply and the enhancement of the transmission and distribution system to provide a stable power supply, and (ii) strengthening of the distribution grid and rural electrification for economic revitalization and poverty reduction by providing a stable power supply.

As seen above, the project objective was to strengthen the transmission system required to enhance capacity in the Hyderabad Metropolitan Area and to promote economic growth through development of the economic infrastructure. This was consistent with Japanese ODA policy at the time of project appraisal.

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

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The planned and actual project output are shown in the Table 3 below. The differences between the planned and actual output are as follows:

(i) The number of sub-stations constructed: no difference between the planned and actual output (8 substations in both the planned and actual output);

(ii) Location of substations constructed: changes in 2 substation sites;

(iii) The capacity of transformers installed in substations: the capacities of transformers installed in 7 substations were changed from the plan and the actual total capacity of transformers installed was 1,540MVA compared to 1,000MVA in the original plan (an increase by 154%);

(iv) The routes of transmission lines: 2 routes were cancelled, 3 routes were newly added, and the origination and/or termination of 6 transmission lines were changed. The total length of transmission lines was 131.177ckm against 130ckm in the original plan (an increase by 101%);

(v) Bay-extension of existing substations: 4 bay-extension as planned (though bay-extensions were constructed at substations which were different from the original plan had);

(vi) Consulting services: cancelled

Table 3: Planned and Actual Output

Items	Plan	Actual
Construction of Sub-Stations	• 220/132kVsubstation: 2 • 220/33kV substation: 1 • 132/33kVsubstation: 5 • Total Capacity of Transformers: 1,000MVA	• As planned • As planned • As planned (2 substation sites were changed) • Total capacity of Transformers: 1,540MVA
Installment of Transmission Lines[11]	• 220kV Transmission line: 3routes • 132kV Transmission line: 7 routes • Total length of transmission line: 130ckm	• 220kV Transmission line: 3 routes (changes in the origination/termination of transmission lines for 2 routes) • 132kV Transmission line: 8 routes (cancelled for 2 routes, added for 3 routes, changes in the origination/termination of transmission lines for 4 routes) • Total length of transmission lines: 131.177ckm
Bay-extension of existing sub-stations	4 substations	As planned
Consulting Services	• Overseas training for O&M of the GIS unit[12] • Pilot-based introduction of Total Quality Management (TQM)	Cancelled

Source: Documents provided by the executing agency

Some of the major changes and the reasons for them are as follows[13].

- The reasons for the changes in the two 132/33kV substation sites were: (i) as land allocated for a sub-station at Miralam Filter Bed area could not be used due to security reasons, the site was shifted to another area where the power demand was increasing, and (ii) as the construction of the Osmania University substation in the original plan was funded by other financial sources, a new substation site for the JICA project was added in the neighboring area where the power demand was increasing.

- The increases in the capacities of transformers in 7 substations out of 8 substations under this project were caused by an increase in the rated capacity of transformers of 220/132kV and 132/33kV substations in the Hyderabad area to 160MVA and 80MVA respectively during the project implementation period in order to meet the increasing power demand in the Hyderabad area.

- 2 routes of transmission lines were canceled due to the changes in the locations of substations to which the transmission lines were originally going to be connected mentioned above. The changes in the origination and/or termination of 6 transmission lines as well as the addition of 3 new transmission line routes were made in order to establish a reliable and efficient transmission system network in the project area where enhancement

[11] Most of the transmission lines installed by this project were underground cables that were laid along existing roads, since the project area was located in a metropolitan area with a dense population.
[12] Gas insulated switchgears (GIS) encapsulate components such as circuit-breakers and disconnectors in a sub-station using a compact metal container insulated by gas. They can save installation space for switchgear compared to that in a convention substation.
[13] From interviews with the executing agency

of the network of substations and transmission lines was being implemented in addition to this project. This was in response to changes in the power demand situation in the project area during the project implementation period, as well as to changes in the substation sites mentioned above.

- Consulting services which included (i) overseas training in O&M for GIS units and (ii) pilot-based introduction for TQM were not implemented. According to the executing agency, the reason for the cancellation of the consulting services were as follows:
  - For overseas training in O&M for GIS units: the suppliers of the GIS units provided the overseas training as a part of the procurement contracts[14].
  - For the pilot-based introduction of TQM: while it was difficult to confirm any clear reasons for the cancelation of the introduction of TQM, judging from interviews with staff of the executing agency and JICA, it seems that the cancelation was mainly due to the fact that the executing agency did not feel the necessity for the consulting service for the introduction of TQM as the executing agency thought that it could implement TQM by itself. The executing agency claimed that it had sufficient institutional capacity and institutional arrangements to conduct business with an expansion of the quality control section (Quality Control Wing[15]) and development of planning for enhancement of the transmission system based on past actual data, including power demand data.

This project was implemented in parallel with the overall enhancement of the transmission system in the project area in order to meet changes in power demand. Accordingly, changes in the scope of works were carried out with consideration of the establishment of a reliable and efficient transmission system meeting changes in the power demand situation in the project area. Changes were also made due to specific factors of the project such as difficulties in obtaining land for the construction of substations. Therefore, it can be said that the changes in the scope of work were appropriate. No issues in the operation of the substations or in the power supply in the project area have been identified and, as mentioned in the section, "Effectiveness and Impacts" below, a reliable power supply in terms of quality and quantity has been provided in the project area.

[14] 8 engineers and 4 engineers from the executing agency participated in training in the O&M for GIS units in South Korea and France for 8 days and about 2 week respectively. The engineers received desk trainings and field training including training on examination methods of GIS units, O&M methods and emergency responses.

[15] This section conducts random checks in the conditions of materials procured and the progress of construction works, and investigates material suppliers. The results of investigations by this section are directly reported to the Joint Managing Director of TSTRANSCO. When issues in the investigation results are identified, these issues are fed back to the section concerned to improve their operations.

GIS unit
(Patigadda substation)

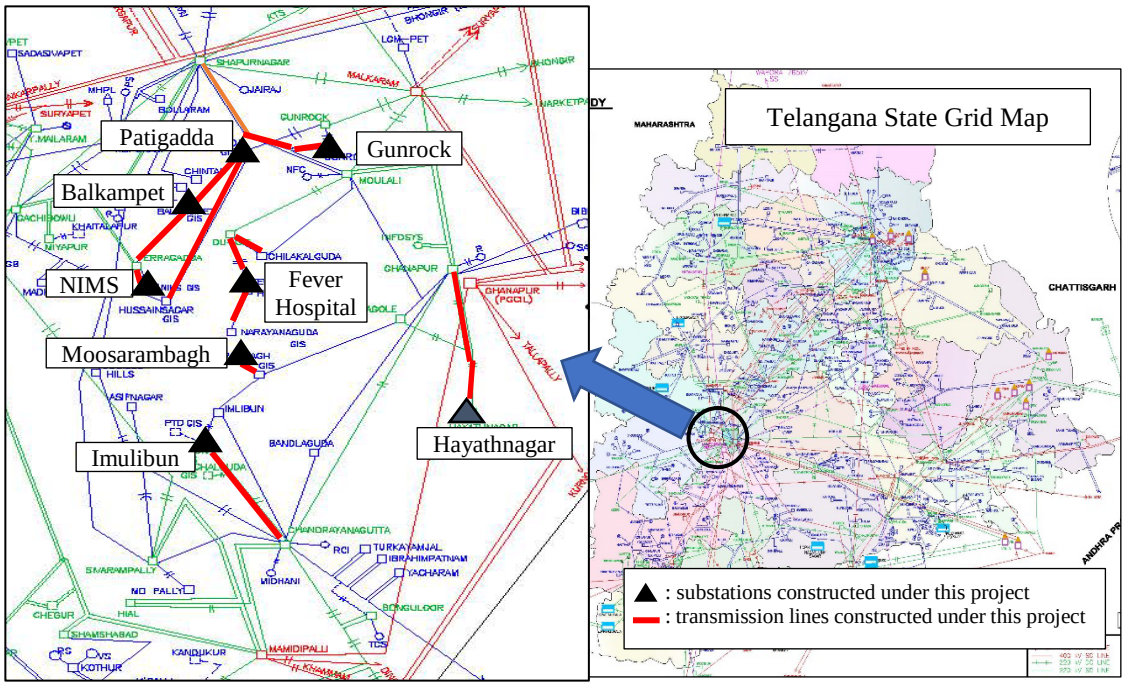
Control panel
(Balkampet substation)

220kVtransmission line
(between Hayathnagar substation and Ghanapur substation)

As for the cancelation of the planned consulting services from the scope of work, in regard to overseas training in O&M for GIS units, the GIS unit suppliers provided training to the staff of the executing agency as a part of the procurement contracts. No problems have been identified in the O&M activities of GIS units. Thus, it can be said that the cancel was appropriate. On the other hand, as for the pilot-based introduction of TQM[16], though no specific reason for the cancelation of this item has been identified, as mentioned above, it cannot be said that the executing agency has fully established organization management whereby its business operations are conducted based on objective facts and results required for an efficient organization management and where operations function across the institution as a whole with recognition of the importance of effective communication between staff across different divisions, since it was difficult to obtain project related data such as detailed project costs and data which was supposed to be regularly monitored and analyzed as part of project monitoring by the executing agency. The cancelation of the consulting services related to TQM does not have a negative impact on the expression of the project effects, impacts and sustainability. However, it is necessary that business operations are strengthened based on results and objective facts and propulsion of communication among staff of all divisions in order to strengthen organizational operation and management onward. The executing agency has introduced a SAP[17] program related to planning, O&M, building, finance and quality control to enhance business operations based on objective facts and results since FY2017/18.

[16] The objective of the pilot-based introduction of TQM which was initially expected in this project was further institutional strengthening of the executing agency through the building up of the organizational capacity to set business targets within each division or unit, while voluntarily improving performance by achieving the target.

[17] SAP is an enterprise resource planning package that redesigns the concept of the business process produced by a German based company, SAP.



Source: Documents provided by the executing agency

Figure 1: Locations of Substations and Transmission Lines Constructed under This Project

3.2.2 Project Inputs

3.2.2.1 Project Cost

The total actual cost amounted to 23,922 million yen (including the 15,999 million yen of the Japanese ODA loan), which was lower than the total planned cost of 30,123 million yen (including the 23,697 million yen of the Japanese ODA loan) (79% of the planned cost)[18]. In a comparison of the total project cost excluding the cost for the consulting services which were not implemented, the actual project cost was 23,922 million yen against the 30,074 million yen of the planned cost, which was 80% of the planned cost. The main factors behind this lower total were: (i) the actual procurement costs for the GIS units were lower than the planned costs as the result of bidding and (ii) changes in the foreign exchange rate[19]. The actual disbursement amount of the Japanese ODA loan was 68% of the planned amount, due to the fact that the executing agency paid for some of the project costs eligible for the Japanese ODA loan, including the costs for laying transmission lines, after the arrival of the expiration of the Japanese ODA loan in December 2015. This was in addition to the reduction of the total project cost mentioned above.

[18] Due to project completion being in May 2018, the total actual project costs had not been finalized at the time of the ex-post evaluation. Thus, the total actual project costs were based on an estimation.

[19] While 1 INR was equaled to 2.52 yen at the time of project appraisal, 1 INR equaled 2.02 yen on average during the project period (from March 2007 to May 2018). 1 INR equaled 2.18 Japanese yen on average from the signing date of the Loan Agreement (L/A) to the expiration date of the Japanese ODA loan(December 2015).

Project related data needed for project monitoring as well as for the ex-post evaluation such as the project cost data and the operation and effect indicators, was supposed to be collected by the executing agency under an agreement made at the time of the project appraisal between JICA and the executing agency. However, the executing agency did not establish a mechanism enabling it to manage the project cost, including the payment portions by the executing agency, in an integrated manner. This resulted in difficulties collecting detailed project cost data at the ex-post evaluation. While JICA asked the executing agency to create a mechanism to collect the necessary data as a part of JICA's project monitoring activities, the executing agency did not do so. Furthermore, when the executing agency was bifurcated in 2014, though JICA urged that items agreed between the executing agency and JICA at the time of project appraisal were appropriately handed over, some staff working for the project were also replaced and the handover of jobs was not appropriately carried out. This could be an additional factor in the failure to collect necessary data.

3.2.2.2 Project Period

The planned project period at the time of project appraisal was 46 months, starting from March 2007 (signing of the Loan Agreement (L/A)) and ending in December 2010 (completion of construction work). However, the actual project period was 135 months, starting from March 2007 (signing of the L/A) and ending in May 2018, which was significantly longer than planned (293% of the planned period). Looking at the period of each process, the planned period for bidding/contracts was 27 months while the actual period was 96 months, a delay of 69 months. The planned period for construction work was 31 months while the actual period was 100 months, a delay of 69 months (Table 4).

Table 4: Comparison of Planned and Actual Schedule

Process	Planned	Actual
L/A Signing	March 2007	March 2007
Bidding/Contract	April 2007 - June 2009 (27 months)	April 2007 - March 2015 (96 months)
Construction of substations and transmission lines	June 2008 - December 2010 (31 months)	February 2010 - May 2018 (100 months)

Source: Documents provided by JICA and the executing agency

From interviews with the executing agency and JICA, the reasons for the project delay were identified as follows:

(1) Retendering of contractors for the constructions of substations

Due to slow progress of the construction of 5 substations by 3 contractors, their contracts were terminated, and new tenders were called for the selection of new contractors to complete the works. This caused about a 3-year delay in the constructions of these substations.

(2) Delay in obtaining road cutting permission for the laying of underground transmission lines

Obtaining permission for road cutting from the agencies concerned was required to lay underground transmission lines. In the original plan, the work period for the constructions of underground transmission lines was 1 year for the construction of all lines. However, there is a ban on road cutting during the monsoon season (from June to October), and during festivals and other important functions. When construction periods overlapped with these periods, the construction of transmission lines was delayed due to the wait for permissions. Furthermore, obtaining permission could take longer depending on the conditions of roads and the area surrounding the construction of the transmission lines. In addition, changes in the construction sites of substations and the routes of transmission lines during project implementation meant reapplication for road cutting permission, which caused further project delay.

(3) Effects of state bifurcation in 2014

Due to the state bifurcation and the consequent bifurcation of state agencies in 2014, the period from 2012 to 2015 was a kind of transition period. During this period, the concerned agencies including the executing agency put most priority on the administration of transition works, including changes in organization structures, incurred by the state bifurcation. This meant that there were fewer major decisions made in the executing agency as well as longer processing times required to obtain road cutting permission from the agencies concerned.

(4) Location changes in the construction sites of substations and delays in obtaining land for substations

The use of the allocated construction site for a substation in Miralam Filter Bed area was canceled due to security reasons after the contract for the construction of the substation was awarded. Subsequently, the substation site was moved to NIMS area where the power demand was high. This meant retendering for a contractor for construction of the substation, resulting in a delay in the completion of the substation of more than 1 year. Furthermore, the site initially allotted for the construction of the Moosarambagh substation could not be obtained due to certain constraints of the land owner and therefore an adjacent site was allotted. This caused about a 2-year delay in the completion of the substation.

(5) Delay related to procurement procedures

The actual period for the bidding and contracts was much longer than the planned period. In addition to the reasons for delay mentioned in (1) to (4) above, that is, retendering of contractors for the construction of substations, delays in obtaining road cutting permission, the effects of state bifurcation in 2014 and delays in obtaining land for the construction of substations, frequent changes in the project scope and personnel changes in the executing agency also caused more time than was expected for internal process for the procurement in the executing agency, as well as JICA's review and concurrence process. JICA provided the executing agency with the necessary support for Japanese ODA loan procedures, including seminars and training, in order to improve their knowledge about procurement procedures for Japanese ODA loans in order that their procurement procedures could be smoothly implemented. However, due to the reasons mentioned above, delays related to procurement procedures nevertheless occurred.

It can be said that it was difficult for the executing agency to avoid most of the factors in the project delays. However, as for the delay in obtaining road cutting permission, the project planning was unrealistic in that the construction period for laying transmission lines was set equally for all lines. In fact, as it could have been assumed in advance, the construction work for road cuttings for the laying of transmission lines could not be conducted in the rainy seasons, and the periods required for obtaining road cutting permission from the agencies concerned tended to be longer depending on the condition of the roads and areas surrounding the construction work for the laying transmission lines. Thus, it is thought that the planned periods needed to obtain road cutting permission and the construction periods needed for the laying of transmission lines should have been more realistic at the planning stage taking into consideration the condition of the roads to be cut and the situation of the surrounding areas.

3.2.3 Results of the Calculations for Internal Rates of Return (Reference only)[20]

(1) Financial Internal Rate of Return

The original FIRR was 2.8% at the time of the project appraisal. The results of the recalculation of the FIRR for this project at the time of the ex-post evaluation was 4.5%, which was higher than the original FIRR. This is because the project benefit, that is the incremental transmission revenue, was included from the year that the substations under this project started their operations, in accordance with the actual results in the recalculation of FIRR at the time of the

[20] In the recalculation of the internal rate of return, the following points had to be assumed: (i) since the total project cost was not fixed at the time of the ex-post evaluation, the unfixed parts of the project costs were included in the payment of FY2018/19; (ii) since project cost data by year, item and currency was not available, the amounts of items for which payment years were not identified were allocated to each year based on the amounts of items for which payment years were identified; (iii) due to the bifurcation of the executing agency in 2014, related data before bifurcation was separated based on the power allocation ratio @53.89% which is used in *AAR and Determination of Transmission Charges for the Balance Period for 3rd Control Period FY2017-18 and FY2018-19*, which determines the transmission charges for TSTRANSCO by the Telangana State Electricity Regulatory Commission.

ex-post evaluation. Meanwhile in the FIRR calculation at the time of the project appraisal, the financial benefits of this project were included from the year following project completion. Revenues for reduction in transmission loss as an incentive from distribution companies were included in the calculation of the original FIRR. However, according to the executing agency as well as Telangana State Electricity Regulatory Commission, it seems that this incentive does not currently exist. Thus, the revenues from incentives for reduction in transmission loss were not included in the recalculation of the FIRR at the time of the ex-post evaluation. The pre-conditions of the FIRR calculation at the appraisal and the ex-post evaluation are shown in Table 5 below.

Table 5: Precondition of the FIRR calculation

	At the project appraisal	At the ex-post evaluation
Costs	Capital cost, Operation and Maintenance cost	As the project appraisal
Benefits	Incremental transmission revenue, Transmission loss reduction incentives	Incremental transmission revenue[21]
Project Life	30years after the L/A	As the project appraisal

Source: Documents provided by JICA

(2) Economic Internal Rate of Return

The original EIRR was 6.0% at the time of the project appraisal. The results of the recalculation of the EIRR for this project at the time of the ex-post evaluation was 8.5%, which was higher than the original EIRR. This is because the project benefits, that is incremental transmission revenue and reductions in transmission losses, were included from the year that the substations under this project started their operations, in accordance with the actual results in the recalculation of EIRR at the time of the ex-post evaluation. Meanwhile, in the EIRR calculation at the time of the project appraisal, the financial benefits of this project were included from the year following project completion. The EIRR calculations at the appraisal and the ex-post evaluation were based upon the pre-conditions below:

- Cost: project cost (excluding taxes and duties), operation and maintenance cost
- Benefit: reduction in transmission losses, increase in transmission revenue[22]
- Project life: 30 years after the L/A

Although the actual project cost was lower than the planned, the actual project period was significantly longer than the planned. Therefore, the efficiency of the project is fair.

[21] In the calculation of FIRR at the time of the project appraisal, an incremental transmission revenue as a project benefit was calculated by setting a transmission charge which could recover the project's capital costs. However, it was impossible to obtain the incremental transmission charges and transmission revenues attributed to this project from the information obtained in the ex-post evaluation since the actual transmission charge was set based on many factors other than those connected with this project. Therefore, the FIRR at the time of the ex-post evaluation was recalculated by setting certain recovered amounts of the project's capital cost as the project benefit.

[22] Please see Note 21 above

3.3 Effectiveness and Impacts[23] (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

Table 6 shows the baseline, target and actual data of the operation and effect indicators in this project. As mentioned in 2.3 Constraints during the Evaluation Study, while the target data of the operation and effect indicators was set as that for 2 years after project completion, since the project was completed in May 2018 which was during the ex-post evaluation and 7 substations out of 8 substations under this project were commissioned by FY2017/18, the ex-post evaluation confirmed the quantitative effect by utilizing the actual data for 3 fiscal years from 7substations that had already been commissioned before project completion[24].

Table 6: Achievement Status of Operation and Effect Indicators

		Baseline	Target	Actual		
		FY2006/07	FY2012/13	FY2015/16	FY2016/17	FY2017/18
			2 Years After Completion	3 Years Before Completion	2 Years Before Completion	1 Year Before Completion
Voltage Fluctuation Ratio (% from target level)		±6.87	±4.09	+3% to -1.5%	+3% to -1.5%	+3% to -1.5%
Operation Ratio (%) (Note 1)	220kV	53.26	69.94	70.0	65.0	64.8
	132kV	59.92	56.10	45.5	41.0	44.9
Outage Times (no./year)		71	20	2	5	3
Transmission Loss Rate (%) (Note 2)		4.35	4.0	3.13	3.37	3.25
Electricity Supply in the project area (GWh)		8,860	16,329	15,644	15,819	17,250

Source: Documents provided by JICA and the executing agency
Note 1: The average operation ratio of the transformers installed in the 7 substations commissioned by FY2017/18 under this project at peak time out of 8 substations constructed under this project.
Note 2: The figures for transmission loss in the State were utilized due to the difficulty in obtaining the transmission loss data for the project area. Other data refers to the project area.

(1) Voltage Fluctuation Ratio

The voltage fluctuation ratio of electricity transmitted from the substations constructed under the project has hovered between +3% and -1.5% since FY2015/16. This improved significantly with the achievement of the target number, ± 4.09%, compared to the ratio at the time of the project appraisal, of ± 6.87%. Thus, it can be said that the power supply has been stable. This

[23] Sub-rating for Effectiveness is to be put with consideration of Impacts.
[24] At the end of FY2017/18, the construction work for a part of laying transmission lines between the Erragadda substation and the NIMS substation was ongoing due to the wait for obtaining road cutting permission from agencies concerned to lay the lines. At this point the NIMS substation (under this project) to which the transmission lines would be connected was not yet commissioned. The substation started its full scale operations in September 2018 subsequent to performance tests following the completion of the construction work for laying the transmission lines in May 2018.

also meets the standard criteria for voltage fluctuation ratio of less than or equal to ±10%, set by Telangana state and the executing agency[25].

(2) Average operation ratio of transformers

Average peak time operation ratios of the transformers installed in the substations constructed under this project were 64.8% (for 220kV) and 44.9% (for 132kV) in FY2017/18, slightly lower than the target values of 69.94% (for 220kV) and 56.10% (for 132kV). This is mainly caused by the fact that TSTRANSCO installed transformers with a higher capacity to avoid overloading in a few years, taking into account rapid increases in power demand in the project area. 7 substations that were working at the time of the ex-post evaluation supply stable electricity[26].

(3) Power Outage Times

The reliability of the power supply in the project area has improved as shown in the significant improvement in the number of annual power outages in the project area. This was 2 times in FY2015/16, 5 times in FY2016/17 and 3 times in FY2017/18, compared with 71 times at the time of project appraisal. The number of power outages caused by problems in the transmission system was 2 times in FY2015/16, 3 times in FY2016/17 and 1 time in FY2017/18 [27]. It is only the one time, in FY2017/18, that a power outage caused by problems in the transmission facilities constructed under this project occurred in the last 4 years[28]. The annual power outage hours were 2 hours in FY2015/16, 4 hours in FY2016/17 and 6 hours in FY2017/18 [29]. For reference, while planned power outages were implemented for 6 hours a day till FY2014/15 in the project area, there have been no planned power outages since FY2015/16.

(4) Transmission Loss Rate

Due to the difficulty in obtaining data for transmission loss rate in the project area, this ex-post evaluation used the data for transmission losses in the whole state. The transmission loss rate in FY2017/18, at 3.25%, were significantly lower than the target transmission losses, at 4.0%. This was mainly due to the large expansion of the transmission network system after

[25] The standard criteria of the voltage fluctuation ratio in the Telangana State Electricity Regulatory Commission are as follows: (i) 400kV: between +5% and -10% (420kV-360kV), (ii) 220kV (between +11.4% and -10% (245kV-200kV), (iii) 132kV: between +9.8% and -9.1% (145kV-120kV), (iv) 33kV: between +6.2% and -10% (35kV-30kV).

[26] According to Central Electricity Authority planning guidelines for transmission systems, when the operation ratio of a transformer is more than 60% at normal time and more than 80% at peak time, measures to supply stable electricity, such as expansion of the capacity of transformers or construction of new substation, should be considered.

[27] According to the executing agency, main factors of power outages caused by troubles in the transmission system are: defect in the connection parts of transmission lines and cutoff of underground transmission lines during the construction of other infrastructures.

[28] A short-term power outage was occurred at the time that one transformer installed in Imulibun substation was broken due to internal defect in July 2017.

[29] According to the executing agency, since substations in TSTRANSCO basically receive and send powers through 2 routes, long-hour power outages do not occur when one route shuts down due to troubles.

bifurcation and this project could only be a part of the contributing factors in the reduction of transmission loss rate.

(5) Electricity Supply in the project area

The amount of the electricity supply in the project area in FY2017/18 was 17,250 GWh, which exceeded the target level of 16,329 GWh. It can be said that the capability to supply electricity has been improved.

As mentioned previously, at the end of FY2017/18, only 7 substations out of 8 substations constructed under this project were being operated due to the ongoing construction works for the laying of transmission lines. Nevertheless, all operation and effect indictors met the target values a year before project completion. Thus, it can be said that the project has contributed to improvements in the reliability and quality of the power supply. According to the executing agency, no negative impacts on the reliability, stability and quantity of power supply in the project area were caused by the fact that one substation was not yet operating.

3.3.1.2 Qualitative Effects (Other Effects)

In order to identify the qualitative effects of the project regarding improvement of power supply ability and stabilization of the power supply in the ex-post evaluation, a comparison of the situation before and after the operation of the substations under this project was used, instead of a comparison of the situation before the project and after project completion. The following 2 points were taken into consideration:

- Due to the significant improvement in electricity supply in the entire state, including the project area since state bifurcation in 2014 [30], the impact of external effects on the electricity supply in the project area is considerable.
- Most of the substations constructed under the project started their operations from FY2016.

Interviews were carried out in the ex-post evaluation[31] with 8 bulk electricity users (a tobacco manufacturer, a pharmaceutical company, a packaging company, a printing company, a data center, a hospital, a railway station and a sewage treatment plant), which were prospected beneficiaries of the project and 3 substations of the Southern Power Distribution Company of Telangana Ltd., which has received electricity directly from substations constructed under the project. Their responses to the current power supply situation, compared with the power supply situation before substations in the project were operated, were as follows:

[30] Please see Note 7

[31] TSTRANSCO has sent all electricity to distribution companies, and does not directly sell electricity to bulk electricity users. Thus, the bulk electricity users who were interviewed in this ex-post evaluation receive electricity from the distribution companies.

- No or fewer power outages and short-interruptions[32] have been observed at present, while previously power outages lasting from 30 minutes to 1 hour occurred 2-5 times per month and there were frequent short-interruptions.
- There are no or fewer voltage fluctuations[33] at present. Previously these occurred from multiple times in a month to once in 2 months.
- The current electricity supply is largely satisfactory since a sufficient amount of power supply has been provided.

According to the Southern Power Distribution Company of Telangana Ltd., the enhancement of the transmission system in the Hyderabad area, including through this project, has strengthened the power supply capacity in the transmission system network, resulting in none or fewer of the voltage fluctuations that previously frequently occurred due to overload, thereby increasing the reliability and stability of the power supply. The effects brought only by this project alone, however, could not be explained. The perception is also that there is a stable power supply with a stable and proper load factor of substations and that there has been an improvement in the reliability of the power supply with declines in voltage fluctuation ratio.

3.3.2 Impacts

3.3.2.1 Intended Impacts

(1) Contribution to local economic development

At the time of the project appraisal, (i) real gross regional domestic product and (ii) amount of foreign direct investment were set as quantitative impact indicators. However, data for the regional gross domestic product was only available until FY2015/16, and data for foreign direct investment in the project area was not available. On the other hand, the project was completed in May 2018 and only 2 substations out of 8 substations constructed under the project had been commissioned by FY2015/16. Thus, it was difficult to confirm the quantitative impact of the project at the time of the ex-post evaluation.

The transmission facilities constructed under this project accounted for about 46% of the total transmission facilities in the project area in terms of the capacity of transformers installed as of end FY2017/18 (the total transformer capacity of substations in the project area was 3,336MVA, while the transformer capacity of substations installed under this project was 1,540MVA). This indicates that the project has had a significant role in power supply in the project area. Interviews with a local chamber of commerce conducted in this ex-post evaluation revealed that the local economy in the Hyderabad Metropolitan Area has been active with the new entry of domestic and foreign companies in areas such as the IT industry including soft-ware

[32] In this interviews, short-interruptions are defined as blackouts for a few seconds.
[33] When voltage fluctuation happens, excessive voltage may damage electronic devices.

companies, shopping centers, hotels, and the garment and pharmaceutical industry, all of which have created new job opportunities. It was also revealed that, though it is difficult to identify how much this project has contributed to this local economic development, it can be said that there has been at least a partial support for local economic growth by improvement of the reliability and stability of the power supply in the project area through the strengthening of the transmission system by this project, taking into account the significant role of the project in power supply in the area.

Interviews with bulk electricity users revealed that the construction of new substations under this project has resulted in a significant improvement in the power supply situation in terms of power outages, short-interruptions and voltage fluctuations as mentioned in 3.3.1.2 Qualitative Effects. This improvement has brought about positive impacts on business activities such as improvements in productivity, improvement in the quality of services and products, and a reduction of fuel costs. This in turn has led to positive impacts on local economic development such as increases in job opportunities, the expansion of production capacity, and expansion of customer base. Specific impacts identified through the interviews on local business activities and public institutions were as follows:

- Improvement in productivity through reductions in losses of raw materials in the manufacturing process caused by stoppages of production lines and by reductions in the idling and restarting time of production lines, caused by power outages and short-term interruptions.
- Improvement of the quality of services and products including on-time delivery and a reduction in the incidence of defective products caused by power outages, short-term interruptions and voltage fluctuations during the manufacturing process.
- Reduction of fuel costs thanks to less use of private power generators.
- Increase in production volumes, expansion of sales channels and customer base, and increases in job opportunities caused by expansion of the production line through the positive impact on business activities mentioned above.
- In cases of public institutions such as the railway station and the sewage treatment plant, improvements in the quality of public services and preservation of the environment have been noted. Trains are operated on time as scheduled[34] and there have been reductions in the discharge of untreated sewage[35], both of which were previously caused by power outages and short-term interruptions.

[34] According to staff at the railway station, a railroad truck has to be washed in water every time a train passes a railway station. When power outages happened, the cleaning could not be taken place due to stoppage of the water pump. This in turn caused a delay to the train that had to wait for the cleaning before reaching the train station..

[35] According to staff at the sewage treatment plant, when power outages happened, the waste water inflow to the sewage treatment system was automatically stopped and the waste water was discharged into a nearby river without treatment, becoming a source of river pollution.

As seen above, it can be said that this project, aiming at improvement in the reliability and stability of the power supply, has partly contributed to the development of local business activities and the local economy, although other factors have also contributed to this development.

(2) Improvement in the living standards of local residents

According to interviews with related agencies and bulk electricity users conducted in the ex-post evaluation, the disappearance of planned power outages resulting from a stable power supply has significantly contributed to an improvement in the living environment of local residents. When planned power outages occurred every day, people were under pressure to complete all the tasks necessary in their houses, including housework and study, during the period that electricity was available. Many people said in the interviews that a daily 24 hours available for domestic activities resulting from no planned power outages had enabled local residents to easily plan their daily lives, thereby improving their living environment. Although many other factors have contributed to the end of planned power outages, the enhancement of the transmission system under this project has been one factor contributing to the achievement of a stable power supply in the project area.

Some bulk electricity users interviewed in the ex-post evaluation own dormitories for their employees near their factories, which have received the same stable and reliable power supply as their factories after this project. Interviews revealed that their employees have started to purchase expensive electronic devices, such as big-screen TVs, with less concern about damage caused by voltage fluctuations, thereby improving their living standards. Furthermore, as mentioned previously, with a more reliable and stable electricity supply, some of the bulk electricity users have been able to create new jobs and increase earning opportunities for local residents as their production capacities have been expanded. This has also contributed to the improvement of living standards for local residents.

As seen above, although some other factors have also contributed to improvements in living standards, it can be said that the project has contributed to an improvement in the living standard of local residents to some extent by improving the reliability and stability of the power supply through strengthening the transmission system.

3.3.2.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

This project was categorized as Category B under the “JBIC Guidelines for Confirmation of Environmental and Social Considerations (April 2002).” According to the executing agency, their staff frequently visited project sites and monitored any negative impact on the

environment arising from works for road-cutting to construct underground transmission lines during the project implementation, such as noise, vibration, and sediment discharge. According to the executing agency, no negative impact on the environment was observed during the implementation of this project. In addition, according to the executive agency and Greater Hyderabad Municipal Corporation (GHMC), no complaints were received during construction. Thus, it can be said that there was no negative impact on the natural environment.

(2) Resettlement and Land Acquisition

In this project, a total of 2.4 ha of land for the construction of substations was acquired from GHMC and a power distribution company with no costs incurred. There was no resettlement caused by implementation of the project.

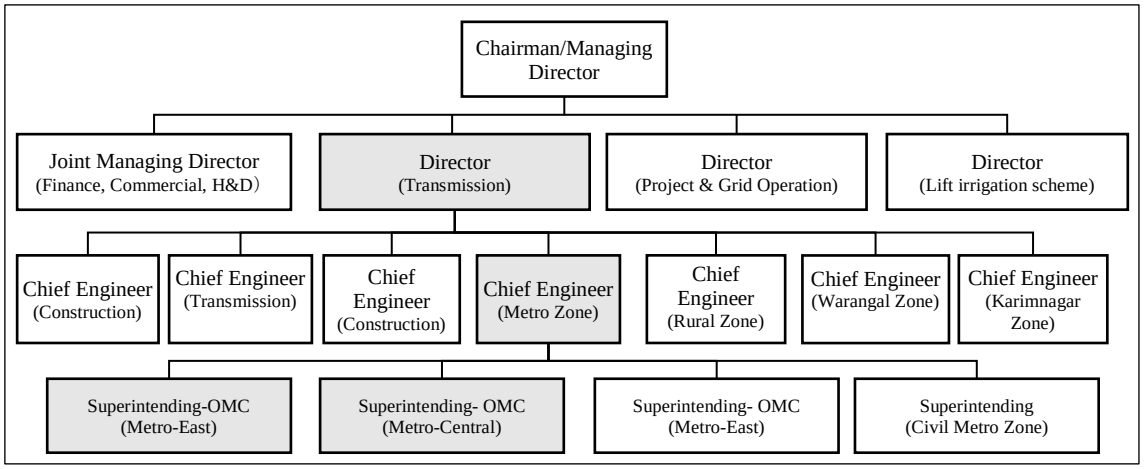
From the above, it can be seen than this project has largely achieved its objectives. Therefore, the effectiveness and impacts of the project are high.

3.4 Sustainability (Rating: ③)

3.4.1 Institutional / Organizational Aspect of Operation and Maintenance

TSTRANSCO is responsible for the operation and maintenance (O&M) of the project facilities constructed under this project[36]. The Metro-East and Metro Central Zone of Operation, Maintenance and Construction (OMC) have carried out the O&M activities for the facilities under the project. The daily O&M activities for substations and transmission lines are conducted by staff in each substation, where 1 assistant engineer, 4 engineering diploma holders and 2-3 graduates of Industrial Training Institutes are allocated. In the Metro-East and Metro Central Zone of OMC, there are special maintenance teams in each zone, called the Special Maintenance Gangs, consisting of 1 assistant divisional engineer as team head and 4-6 engineers. Each team conducts monthly, quarterly, semiannual and annual preventative maintenance activities other than daily maintenance activities in 2-3 substations. Similarly, routine inspection and preventative maintenance activities for transmission lines other than daily inspections are conducted by a transmission line maintenance team, called the Central Break Down Gangs, which consists of 10-12 maintenance engineers in each Metro-East and Metro Central Zone of OMC. According to the executing agency, a sufficient number of staff for the O&M of substations and transmission lines installed by the project has been provided and no issues affecting O&M activities caused by a lack of staff have been observed.

[36] The total number of TSTRANSCO's staff including engineers, accountants and administrative officer is about 1,900 in FY2017/18.



Source: the website of TSTRANSCO (https://www.tstransco.in)

Figure 2: Organization Chart of TSTRANSCO

It was found that the organization framework for the O&M of the transmission and substation facilities constructed by this project as well as the demarcation of responsibilities and roles among the concerned sections are clear. Also, no issues were found in the number of staff who are responsible for the O&M activities of the facilities installed by the project. Therefore, no particular problem has been observed in the institutional aspect of the O&M activities.

3.4.2 Technical Aspect of Operation and Maintenance

In TSTRANSCO, its staff in substations are engaged in the O&M activities of the transmission and substation facilities in accordance with the TSTRANSCO O&M manual. The O&M manual for GIS units, which was provided by the GIS unit suppliers, has been used as it is. While there have been no problems so far with the manual provided by the GIS unit suppliers, it does not include necessary actions to be taken in case of accidents. Therefore, considering the accumulated experience of TSTRANSCO in the O&M of GIS units, it is desirable that they create their own O&M manual for GIS units based on their own experience.

At-desk training as well as on-site training for the O&M of the GIS units installed in this project were provided by the equipment suppliers in South Korea and France and a total of 12 engineers from TSTRANSCO participated in the training. TSTRANSCO continually provides its staff with a variety of training programs in its Central Training Institution. As for the O&M activities in transmission and substation facilities, the following is provided: (i) induction training in which all substation operators receive 45-days training for preventive maintenance activities of transmission and substation facilities including desk training as well as on-site training and (ii) in-service training where all substation operators receive 2-3 days training to update their knowledge of the O&M of transmission and substation facilities every 5 years. This training is conducted continuously throughout the year, and 25-30 substation operators per session

participate in the training. Training for the O&M of GIS units is provided by the staff who received training from the suppliers mentioned above.

TSTRANSCO organizes a “safety week” once a year in which all operational staff in substations get together to raise their awareness of safety and share appropriate responses in case of accidents. In meetings during “safety week,” senior engineers provide classroom lectures about the methods of handling equipment, points to note in preventive maintenance activities and action to be taken in the case of accidents, using actual accident cases. Interviews with staff at the head-quarters and substations revealed that the staff at the headquarters are satisfied with the technical skills of the O&M staff in substations, and that the staff in substations engage in O&M activities with confidence in their technical skills.

It can be said that there are no particular problems in the technical aspects of TSTRANSCO since the TSTRANSCO O&M manual is put in place and O&M activities are conducted in accordance with the manual, regular training programs to improve the technical skills of staff are provided, and the staff in substations engage in O&M activities with confidence in their technical skills.

3.4.3 Financial Aspect of Operation and Maintenance

The O&M budget of TSTRANSCO for O&M of the transmission and substation facilities is based on the length of transmission lines and the number of substation bays. The total O&M budget is allocated for transmission lines and substations in the ratio of 30:70. Table 7 shows the O&M budget and actual expenses for TSTRANSCO for last 4 years. While there is a fiscal year in which the actual O&M expenses exceeded the O&M budget, according to the executing agency, when this happens, additional budget is allocated for the O&M expenses from other budgets, and the O&M budget is sufficiently secured to cover the actual costs.

Table 7: O & M budget and actual expenses for TSTRANSCO

Unit: 10 million INR

FY	2014/15	2015/16	2016/17	2017/18
Budget	294.7	385.3	420.1	564.5
Actual	293.1	386.7	415.2	524.3

Source: Documents provided by the executing agency

The major financial indicators of TSTRANSCO for the 3 years from FY2014/15 are shown in Table 8. Due to increasing loans to finance transmission system expansion over the last 3 years, the debt to equity ratio and the capital to asset ratio deteriorated from 3.41 times and 22.7% in FY2014/15 to 5.08 times and 16.4 % in FY2016/17 respectively. On the other hand, since the

interest-coverage ratio[37] was 1.74 times in FY2016/17, there is little concern about the capability of paying the loan interest. The profitability, which can be measured by the return on assets and the return on equity, both of which were improved from 0.93% and 4.1% in FY2014/15 to 2.13% and 12.82% in FY2016/17 respectively, has been secured.

The transmission tariff in the state of Telangana is basically reviewed every 5 years by the Telangana State Electricity Regulatory Commission. Since the structure of the transmission tariff is determined based on the operating expenses and the amount of electricity sent to distribution companies, TSTRANSCO can maintain a certain level of profit. The current structure of the transmission tariff was determined in May 2017 to reflect the situation after the bifurcation of state, while the transmission tariff structure from FY2014/15 to FY2018/19 was determined in 2014 before the state bifurcation. The next review of the transmission tariff structure is planned in FY2019/20. From the above, it can be seen that there is no serious problem in the financial aspect of O&M.

Table 8: Major Financial Indicators of TSTRANSCO

Unit: 10 million INR

FY	2014/15	2015/16	2016/17
Current ratio (times)	0.74	0.68	0.70
Debt to Equity ratio (times)	3.41	4.15	5.08
Capital to asset ratio (%)	22.7	19.4	16.4
Interest coverage ratio (times)	1.46	1.59	1.74
Return on assets (%)	0.93	1.45	2.13
Return on equity (%)	4.1	7.61	12.82
Transmission revenue	655.25	928.61	1,416.79
Interest and finance charges	152.28	234.97	353.59
Profit before taxes	69.57	139.27	261.32

Source: created by the ex-post evaluator from TSTRANSCO Financial Statements (FY 2014/15 – FY2016/17)
Note 1: Financial Statement (FY2014/15) covered only from May 29, 2014 to March 31, 2015 after the establishment of TSTRANSCO.
Note 2: While data for FY2014/15 & FY2015/16 was from the audited Financial Statement, the data for FY2016/17 was from a provisional annual account (unaudited).

3.4.4 Status of Operation and Maintenance

The facilities constructed by this project have been well maintained. Although one of the 2 newly installed transformers in Imulibun substation broke down due to an internal defect, the other transformer in the substation has been properly operated at about 45% of operation ratio. The transformer, with which the suppliers replaced the broken transformer free of charge, was installed in a different substation in which an upgrade of transformer was needed to meet increasing power demand, and TSTRANSCO plans to install a new transformer in Imulibun substation at a later date. It can be said that installing the replaced transformer in a substation

[37] The interest-coverage ratio is the ratio of finance charges to operating profit. This ratio is mainly used in financial analyses to measure the capability of paying loan interests.

that urgently required expansion of its transformer capacity in order to prioritize a stable supply of electricity to the transmission system as a whole, as well as establishing an efficient transmission system, was an appropriate response.

The maintenance activities for the substation facilities constructed by this project has been conducted daily, weekly, monthly, quarterly, semiannually and annually. The daily and weekly maintenance activities in substations are conducted by substation operators, while the monthly, quarterly, semiannual and annual maintenance activities are conducted by the Special Maintenance Gangs. Similarly, the monthly maintenance activities for transmission lines are conducted by the Central Break Down Gang. The context of regular maintenance for the substations and transmission lines is shown in Table 9.

Table 9: Periodical Maintenance Activities

Facilities	Frequency	Activities
Transmission Lines	Monthly	Visual inspection of the road condition above underground transmission lines
	Quarterly	Visual inspection of overhead transmission lines, cleaning of transmission towers, inspection of transmission lines by heat sensing camera
Substations	Daily	Visual inspection of equipment, collection of operation data
	Weekly	Checking silica gel level in transformers, checking of voltage transformers, cleaning of circuit breakers
	Monthly	Cleaning of isolators/circuit breakers, CT, Hydraulic pressure check of transformers
	Quarterly	Testing of isolators and circuit breakers
	Semi-annually	Oil sampling test of transformers
	Annually	Oil changes of transformers, relay testing, transformer capacity testing

Source: Documents provided by the executing agency

No major problems were 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.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The objective of this project was to improve the reliability and quality of the power supply by strengthening the transmission system in the Hyderabad Metropolitan Area, thereby contributing to local economic development and an improvement in the living standards of local residents in the area concerned. The project was sufficiently consistent with the development policy of India, its development needs, and with Japan's ODA policy, and thus its relevance is high. While the project cost was lower than planned, the project period was longer than planned due to delays in obtaining road cutting permissions for the laying of underground transmission lines, the effects of state bifurcation in 2014, location changes in the construction sites of substations, delays in obtaining land for substations, and delays related to procurement procedures. Thus, the efficiency of the project is fair. The stability, reliability and capacity of the power supply have been improved

with declines in voltage fluctuation ratio, power outage times and transmission loss rate and increases in the amount of power supply. The substations constructed under this project are properly operated. Also, the project has positively contributed to economic development, business activities, job creation and an improvement in the living standards of local residents in the Hyderabad Metropolitan Area to some extent. Thus, its effectiveness and impact are high. Lastly, the operation and maintenance of the substations and transmission facilities constructed under this project is properly conducted, and the operation and maintenance of the project in terms of the institutional, technical, financial aspects and the current status is good. The sustainability of the project 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

(1) O&M manual for GIS substations

The O&M of GIS units in substations has been conducted according to the O&M manual provided by the suppliers of the GIS units. TSTRANSCO has accumulated experience of the O&M of GIS units for some years since TSTRANSCO introduced GIS units in its substations. Therefore, it is desirable that TSTRANSCO develop its own O&M manual for GIS units based on its experience and including actual examples of defects.

(2) Further strengthening of institutional capacity

While consulting services for the pilot-based introduction of TQM was included in the original scope of work in this project, it was later deleted from the scope. When conducting the ex-post evaluation, it was difficult to obtain project related data such as detailed project costs and data related to the project effect which were supposed to be regularly monitored and analyzed as project monitoring. This may indicate that business operations based on effective communication among divisions and on objective facts and results, necessary for more efficient management of the organization, were not fully recognized by staff, and that an organizational arrangement to achieve the effective business operations have not been fully established. Since FY2017/18, TSTRANSCO has introduced a SAP program for planning, O&M, building, finance and quality control in order to enhance its business operations based on objective facts and results. It is desirable that TSTRANSCO proactively utilize this program to enhance its business operations.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

Setting a realistic implementation schedule for infrastructure projects in urban areas

The actual project period was significantly longer than the planned project period, at 293% of the planned period. One of the main reasons for the delay was the delay in obtaining road cutting permission from agencies concerned for the laying of underground transmission lines. Although monthly consultative meetings were held in which infrastructure related agencies in the Hyderabad area discussed and coordinated their infrastructure development activities in the area, and although sufficient information sharing took place among the agencies concerned in the meetings, there were still significant delays in some cases in the obtaining of road cutting permissions for the project.

It is highly likely that coordination among, and the obtaining of permissions from, multiple other related agencies are required for infrastructure development projects in urban areas. However, there are cases where this coordination and the obtaining of permissions takes more time than expected, resulting in project delays. Therefore, it is desirable that an examination of possible measures to mitigate the risk of project delays be made at the project design stage. These should include the setting of a realistic implementation schedule as well as the promotion of information sharing among concerned agencies, with thoughtful consideration of the complexity and practicality of coordination among concerned agencies as well as the condition of the areas surrounding the planned construction sites.

Project monitoring after changes of executing agency

The executing agency of this project was bifurcated in line with the bifurcation of state in 2014. The executing agency did not fully develop a system to collect and monitor project related data such as actual project cost and operation and effect indicators even prior to bifurcation, and the succession of the work to new staff who are working with this project after bifurcation was insufficient. These caused difficulties in the obtaining of some data and information necessary for the ex-post evaluation.

The succession of the terms of agreement between JICA and an executing agency when the executing agency changes has been primarily left to the executing agency. However, there are cases, as in this project, when succession to new staff is not sufficiently conducted following personnel changes of those in charge. Therefore, when an executing agency is changed/bifurcated, it is desirable that JICA: (i) confirm the situation of the succession of the agreement between JICA and the ex-executing agency from an early stage, including the method and system of collecting the project related data and operation and effect indicators needed for project monitoring, and (ii) prompt the establishment of a method and system to collect the project related data needed for project monitoring and the implementation of regular monitoring of the project related data. This would enable JICA to conduct proper project monitoring activities as well as

enabling the ex-post evaluator to conduct the ex-post evaluation smoothly.

End

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs		
a) 220/132kV Substations		
• Imulibun substation (GIS)	• 100MVA×2	• 160MVA×2
• Gunrock substation	• 100MVA×2	• 160MVA×2
b) 220/33kV Substations		
• Hayathnagar substation	• 50MVA×2	• As planned
c) 132/33kV Substations		
• Osmania University substation (GIS)	• 50MVA×2	• Canceled
• Balkampet substation (GIS)	• 50MVA×2	• 80MVA×2
• Moosarambagh substation (GIS)	• 50MVA×2	• 80MVA×2
• Miralam Filter Bed substation (GIS)	• 50MVA×2	• Canceled
• Patigadda substation (GIS)	• 50MVA×2	• 80MVA×2
• Fever Hospital substation (GIS)	• —	• 80MVA×2 (added scope)
• NIMS substation (GIS)	• —	• 80MVA×2 (added scope)
d) 220kV Transmission Lines		
• Malkaram substation – Gunrock substation – Shapurnagar substation	• 34ckm, 2 line	• Gunrock substation – Shapurnagar substation, 32.2ckm, 2 lines
• Chandrayanagutta substation – Imulibun substation	• 23ckm, 2 line	• 19.2ckm, 2 lines
• Chandranagagutta substation – Hayathnagar substation	• 19ckm, 2 lines	• Hayathnagar substation – Ghanapur substation, 16.878ckm (overhead line) +7.2ckm (underground line), 2 lines (changes in the connected substation of transmission lines from Hayathnagar substation)
e) 132kV Transmission Lines		
• Osmania University substation LILO	• 2ckm, 2 lines	• Osmania University substation – Chilakalguda substation, 4.25ckm, 1 line (changes in the connected substation of transmission lines from Osmania substation)
• Erragadda substation – Balkampet substation – Patigadda substation	• 13ckm, 1 line	• 8.98ckm, 1 line
• Hussainsagar substation – Chilakalguda substation	• 7ckm, 1 line	• Hussainsagar substation – Patigadda substation, 5.63ckm, 1 line (changes in the connected substation of transmission lines from Hussainsagar substation)
• Chandrayanagutta substation – Moosarambagh substation	• 10ckm, 1 line	• Moosarambagh substation, LILO, 0.9ckm, 2lines (changes in the connected substation of transmission lines from Moosarambagh substation)
• Sivarampally substation - Miralam Filter Bed substation	• 5ckm, 1 line	• Canceled

Item	Plan	Actual
• Sivarampally substation – Imulibun substation	• 12ckm, 1 line	• Canceled
• Patigadda substation – Chilakalguda substation	• 5ckm, 1 line	• Patigadda substation – Gunrock substation, 12.544ckm, 2 lines (changes in the connected substation of transmission lines from Patigadda substation)
• NIMS substation – Erragadda substation	• —	• 11.21ckm, 2 lines (added scope)
• Osmania University substation - Fever Hospital substation	• —	• 10.4ckm, 2 lines (added scope)
• Fever Hospital substation – Narayanaguda substation	• —	• 1.785ckm, 1 line (added scope)
f) Bay-extension in existing substations	4 substations	4 substations
g) Consulting Services	• Oversea trainings for the O&M of GIS units • Introduction of Total Quality Management	• Canceled • Canceled
2. Project Period	March 2007– December 2010 (46 months)	March 2007 – May 2018 (135 months)
3. Project Cost		
Amount Paid in Foreign Currency	19,552 million yen	5,189 million yen
Amount Paid in Local Currency	10,571 million yen (4,195 million INR)	18,733 million yen (9,274 million INR)
Total	30,123 million yen	23,922 million yen
ODA Loan Portion	23,697 million yen	15,999 million yen
Exchange Rate	1INR = 2.52 yen (As of September 2006)	1INR = 2.02 yen (Average between March 2007 and May 2018（Source: IMF, International Financial Statistics）)
4. Final Disbursement	December 2015	