Ex-Post Project Evaluation 2017:
Package IV-2 (India, Bhutan)

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JAPAN INTERNATIONAL COOPERATION AGENCY

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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.

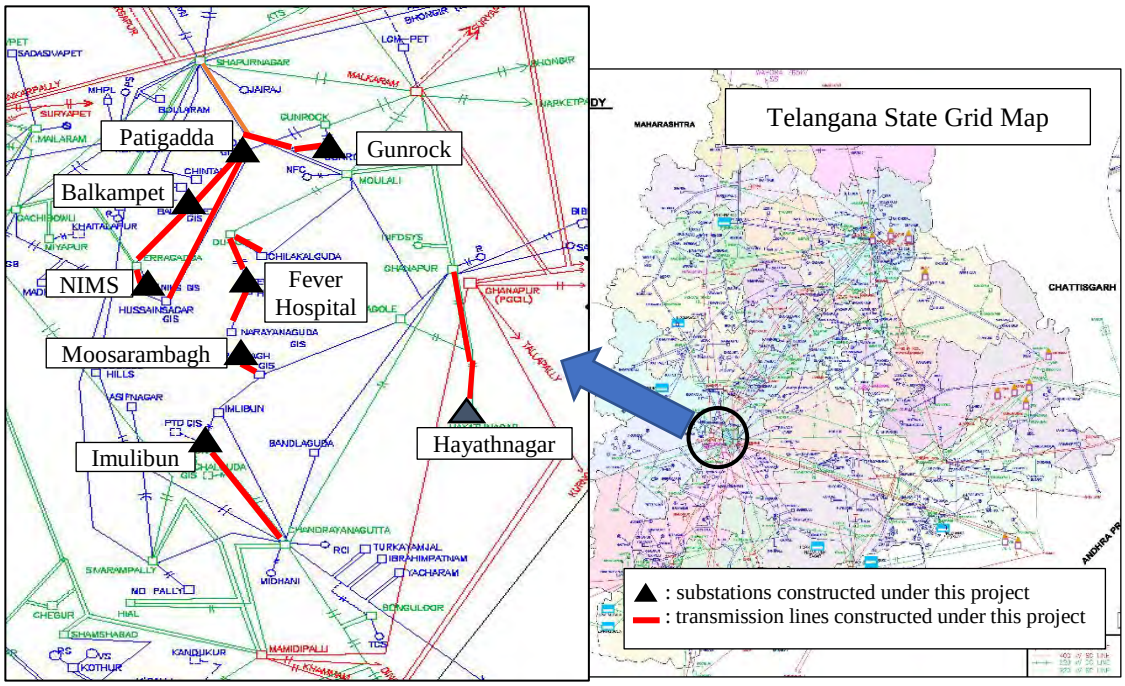
GIS unit
(Patigadda substation)

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.

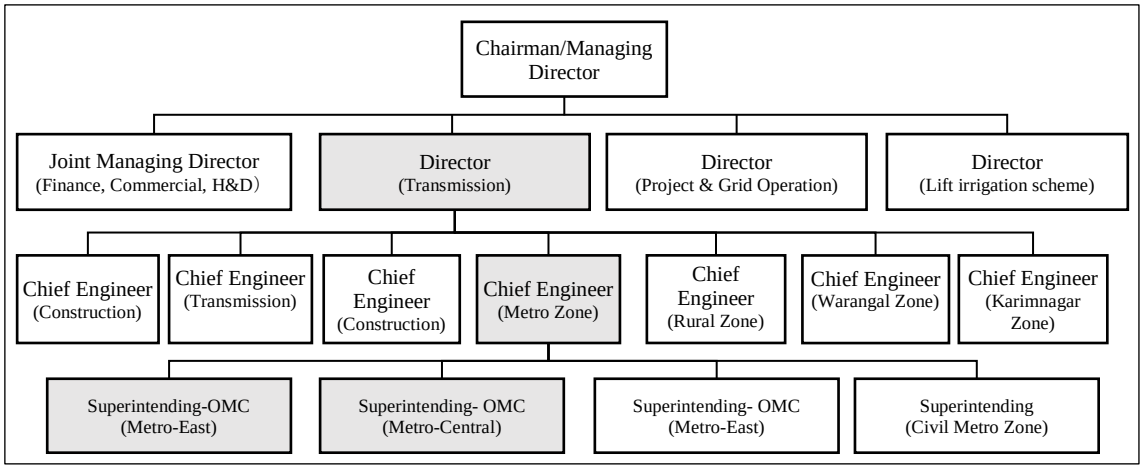
From the above, it can be seen than this project has largely achieved its objectives. Therefore, the effectiveness and impacts of the project are high.

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	

India

FY2017 Ex-Post Evaluation of Japanese ODA Loan Project

"Rajasthan Minor Irrigation Improvement Project"

External Evaluator: Nobuyuki Kobayashi, OPMAC Corporation

0. Summary

This project aimed at an increase in agricultural productivity in the project target area through the rehabilitation of existing minor irrigation dams and canal systems, and the promotion of water management and agricultural technology in Rajasthan, thereby contributing to improvements in the livelihoods and living conditions of the beneficiary farmers. This project was to make water accessible to wide range of farmers in Rajasthan where precipitation in the dry season is extremely low. As this purpose is consistent with India's developmental policy and development needs as well as Japan's ODA policy, the relevance of this project is high. The cost of the project fell within the plan, but the implementation period exceeded the plan due to the delay in project implementation caused by the delay of the consultancy contract. Therefore, the efficiency of the project is therefore fair. The beneficiary area of the project achieved the target, and two crops out of four crops achieved the expected values in the unit yield of major crops. However, targets for the production volume of the major crops was not set and no data was collected. Thus, it was difficult to sufficiently verify the incidence of project effects. By a comparison of before and after the project, it was confirmed that the income of beneficiary farmers had increased, they had a more balanced diet, and that there was increased expenditure on articles other than daily necessities. Based on the above, the effectiveness and the impact of the project are both evaluated as fair. For the project as a whole, the detailed situations such as whether water tariff is collected in accordance with the state regulation and whether Water Users Associations (WUA) face a constraint in budgets for their activities could not be confirmed. Of the 353 subprojects selected for this project, 189 were under the supervision of the panchayats, but the trend of their O&M budget was not clear. Out of the subprojects visited, most WUA were not collecting the water tariff and this was being a constraint in budgets for their activities. Although the O&M of this project does not have major issues in its institutional, technical aspects, and its status, there are some problems with finance. The sustainability of the effects realized as a result of this project is fair.

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

1. Project Description

Project location

The dam rehabilitated by the project

1.1 Background

Rajasthan is the state of India with the largest land area and is one of the leading granaries in the country. The unique meteorological characteristics of the state are that the average annual rainfall is small and that precipitation is concentrated in the rainy season. To use the limited water resources effectively, irrigation systems were developed in the state in 18th century. The rain water collected in dams and small reservoirs in the rainy season is thus used for agriculture in the dry season. By 1990s, however, deterioration of the irrigation systems themselves, and sediment and water leakage as a result of poor maintenance were making the irrigation systems less efficient. Many irrigation systems were no longer able to provide farmland with enough water. The state had promoted the use of groundwater to supplement surface water, but excess water pumping in response to increases in population and the growing number of domestic animals, as well as expansion of farmland, had caused concerns about the lowering of the groundwater level. To respond to these issues, the Irrigation Department[1] conducted a survey in the late 1990s in preparation for the rehabilitation of minor irrigation systems.

Against this background, the Japan International Cooperation Agency (JICA) conducted a Special Assistance for Project Formulation in 2004 to resolve the issues in the irrigation sector in Rajasthan, which led to the implementation of this project. This project aimed at the rehabilitation of minor irrigation dams and canal systems as well as capacity building for the operation and maintenance (O&M) of the irrigation systems.

1.2 Project Outline

The objective of this project was to increase agricultural production in the project area by the rehabilitation of existing small-scale irrigation facilities and through the dissemination of water management and agricultural techniques in Rajasthan, thereby contributing to the improvement

[1] The name at the time of the appraisal.

of livelihoods and the living conditions of beneficiary farmers.

Loan Approved Amount/ Disbursed Amount	11,555 million yen / 5,351 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	March 2005 / March 2005
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/Water Resources Department, State Government of Rajasthan[2]
Project Completion	June 2015
Main Contractor(s) (Over 1 billion yen)	—
Main Consultant(s) (Over 100 million yen)	GITEC CONSULT GMBH (Germany)/KIRLOSKAR CONSULTANTS LTD (India)/HAQ CONSULTANTS PVT.LTD (India)/ENV-DAS (INDIA)PVT.LTD (India)
Related Studies (Feasibility Studies, etc.)	"Special Assistance for Project Formulation for Rajasthan Minor Irrigation Improvement Project" (2004)
Related Projects	• Rajasthan Water Sector Livelihood Improvement Project (Phase I) (March 2017) • World Bank. "Rajasthan Water Sector Restructuring Project (RWSRP)" (2002-2013)

2. Outline of the Evaluation Study

2.1 External Evaluator

Nobuyuki Kobayashi, 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 28 – February 14, 2018, July 10 – July 23, 2018

2.3 Constraints during the Evaluation Study

While the executing agency of this project was the Water Resources Department (WRD), as at the time of this ex-post evaluation, some of subprojects were under the control of the Panchayats. On the sustainability of those subprojects under the jurisdiction of the panchayats[3], it was difficult

[2] At the time of the ex-post evaluation. At the time of appraisal, it was called the Irrigation Department.

[3] Panchayat is the local self-governing body in rural areas. There are three layers in the Panchayat system: District Panchayat, Block Panchayat, and Gram panchayat (Secretary and Planning department of the Minister, Ministry of Internal Affairs and Communications (2009) "Administration in India")

to collect and consolidate the information during the study period since many panchayats have the information on subprojects. The evaluation of sustainability depended, therefore, on the indirect and limited information obtained through the executing agency.

On the effectiveness and the impact, it was difficult to collect and consolidate all information on many subprojects during the study period. For this reason, the effects of the whole project was judged by using the limited number of indicators. In addition, monitoring was not implemented in accordance with the plan, and baseline, target, and actual data for the operation and effect indicators were insufficient. Furthermore, the end line survey used for unit yields by major crops just shows the project effect in a single year and, thus is affected by temporary factors (weather, etc.). From the above reasons, the judgement on the effectiveness / impact is made based on limited information.

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

3.1 Relevance (Rating: ③[5])

3.1.1 Consistency with the Development Plan of India

The 10th five-year National Development Plan (April 2002 – March 2007) was in place at the time of the appraisal. Its focus included an increase of public investment in irrigation facilities and water management, the development and promotion of agricultural techniques, and the diversification of agricultural products. The plan identified insufficient water as a factor hindering overall cropping intensity and placed importance on the expansion of public investment in irrigation facilities and water management as a countermeasure. *The National Water Policy 2002* that covers water resource management overall (formulated in 2002) mentioned on the irrigation sector: a) the maximization of beneficiaries by using all available sources of water, b) the equitable distribution of water and the obviation of the water allocation disparity between farms of different sizes, as well as between regions, c) the introduction of water saving techniques, and d) introduction of participatory water management including WUA. *The State Water Policy* (formulated in 1999) of the state government of Rajasthan resonated with sector policy at the national level, and aimed at the maximization of beneficiaries by usable water resource, fair water distribution in the irrigation sector, and the obviation of water allocation disparity among farms of different sizes and different regions using quantity management and rotational irrigation. The long-term water policy of Rajasthan, *Vision 2045* (formulated in 2000) laid out the maximum use of the water resource reserve, the optimization of water usage, the contribution by users, and the formation and promotion of WUA.

At the time of the ex-post evaluation, *the Three-year Action Agenda 2017/18 – 2019/20* formulated in 2017 by the National Institution for Transforming India Commission (NITI

[4] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[5] ③: High, ②: Fair, ①: Low

Aayog) stated that 45.7% of the labor population were involved in the agricultural sector and that one of the problems of the sector was the low productivity of the land and water resources in comparison with other countries. The document also pointed to poor access to water in the dry season as the cause of the country's low overall cropping intensity. *The National Water Policy 2012* (formulated in 2012), the national-level plan for the water resource sector at the time of the ex-post evaluation, refers to the fair distribution of water and project participation by a wide range of people including the WUA, aiming at the utilization of minor irrigation systems and water-saving technology. *The State Water Policy 2010* formulated in 2010 by the state of Rajasthan continued to place importance on the fair distribution of irrigation water. It referred to improvement of irrigation efficiency in the upper stream to reduce the disparity in distribution among farms of different sizes as well as between regions. *Vision 2045,* the long-term water policy of Rajasthan, can still be used as reference.

From the time of the appraisal through to the ex-post evaluation, the National Development Policy recognized access to water as a factor hindering the improvement of the overall cropping intensity, and considered infrastructure development in the irrigation sector as crucial for the resolution of this problem. The water sector policy throughout the project period aimed at the obviation of disparity between farms of different sizes as well as between regions. It also counted on the introduction of water-saving technology and the participation of WUA in irrigation projects. This project aimed at the rehabilitation of the irrigation infrastructure, agriculture extension, including water-saving technology, and the formation and capacity building of WUA, thereby enabling access to water by a wide range of farmers. This project, therefore, is considered to be consistent with the national development plan and with water sector policy in India.

3.1.2 Consistency with the Development Needs of India

At the time of the appraisal, Rajasthan ranked 5th in wheat production in India and 2nd in barley production of the country, which made the state the leading agricultural production area[6]. Agriculture played an important role in the state economy as the agricultural population occupied two thirds of its labor population. Agriculture also occupied 34% (based on the price in 1999/2000) of the state's GDP (2003/2004)[7]. In 2004, precipitation in Eastern and Western Rajasthan had been 629.7 mm/ year, and 386.7 mm / year, which was much less than the average in India (1323.5 mm / year; at 36 observation points)[8]. Western Rajasthan had especially little precipitation. The following three points were recognized as developmental problems in the irrigation sector: a) the slow construction of new irrigation systems due to strict financial

[6] Based on documents provided by JICA.
[7] Directorate of Economics & Statistics, Rajasthan (2010) "State Domestic Product of Rajasthan 2010"
[8] Ministry of Statistics and Program Implementation (2017) "Statistical Year Book India 2017"

constraints, b) dysfunction of the existing irrigation facilities due to leakage and sediment in the watercourses, and c) inefficient irrigation water usage caused by insufficient water resource management.

As of the ex-post evaluation, Rajasthan ranked 6th in wheat production in India and 2nd in barley production of the country (data from 2015/2016) [9]. The agricultural population was 15.6 million (2011) which consisted 66% of the labor population. Of the state GDP (2016/2017), agriculture occupied 26% (based on the price in 2011/2012) [10]. Precipitation in Eastern and Western Rajasthan (2015) had been 650.4 mm / year and 458.5 mm / year, which was again less than the average in India (1265.3 mm / year; at 36 observation points) [11]. Furthermore, rainfall in Rajasthan fluctuates greatly by season and 90% of the precipitation is concentrated in the three months between June 15th and September 15th [12]. There are approximately 3,900 irrigation systems (of which about 3,800 are small-scale irrigation) in Rajasthan state. Many of the small-scale irrigation have been built for more than 50 years, and the demand for maintenance is enormous. As actual maintenance activities cannot not satisfy the demand, maintenance works have been postponed. Even after the completion of this project, due to delayed maintenance work, the need for the rehabilitation of the irrigation dams and canal systems continues to be high. JICA is therefore supporting the rehabilitation of irrigation dams and canal systems through the "Rajasthan Water Sector Livelihood Improvement Project (Phase I)" (Loan Agreement signed; March 2017).

There was no major change in terms of the developmental needs before and after the project. Rajasthan is India's leading granary and the agricultural sector occupies a large proportion of both the labor population and GDP. While needs are high in the irrigation system due to the climatic conditions, development of the irrigation system is insufficient. As such, this project is evaluated to be consistent with the developmental needs of Rajasthan.

3.1.3 Consistency with Japan's ODA Policy

At the time of the appraisal, Japan's ODA policy for India emphasized poverty alleviation through economic growth, and the focus area for assistance included the poverty agenda[13]. As an approach to poverty alleviation, the direction was set to "promote the alleviation of poverty in rural areas by promoting rural development including that of irrigation systems, and transferring agricultural technology." JICA's *Medium-Term Strategy for Overseas Economic Cooperation Operations Policy* raised "rural development that is beneficial to the poor" as the

[9] Ministry of Statistics and Program Implementation (2017) "Statistical Year Book India 2017"
[10] Directorate of Economics & Statistics, Department of Planning, Rajasthan (2017) "State Domestic Product 2016/2017"
[11] Ministry of Statistics and Program Implementation (2017) "Statistical Year Book India 2017"
[12] Commissionerate of Agriculture, Rajasthan (2017) "Rajasthan Agricultural Statistics at Glance 2015-16"
[13] Ministry of Foreign Affairs. "Official Development Assistance (ODA) Data Book, 2004"

focus area for India. In JICA's *Country Assistance Strategy* for India (July 2002), "rural development from which poor people benefit" was a priority area.

The objective of this project was to increase agricultural productivity and agricultural income through the rehabilitation of irrigation systems and through technical support. This project objective was consistent with the approach to poverty alleviation stipulated in the ODA policy. JICA's *Medium-Term Strategy for Overseas Economic Cooperation Operations* mentioned rural development, focusing on the benefits to the poor. As this project aimed at the improvement of the livelihoods of farmers in Rajasthan through the improvement of agriculture productivity, it is consistent with *the Medium-Term Strategy for Overseas Economic Cooperation Operations* and *the Country Assistance Strategy*. Based on the above, this project is deemed to be consistent with Japan's ODA policy.

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

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The plan versus actual of the outputs of this project are shown in the following table.

Table 1: The Outputs of this Project (Plan and Actual)

Plan	Actual
• Rehabilitation of Minor Irrigation Facilities Number of Subprojects: 375 Civil Works:Rehabilitation of Dams, Water Intakes, Irrigation Canals, etc.	• Rehabilitation of Minor Irrigation Facilities Number of Subprojects:322 Civil Works:Rehabilitation of Dams, Water Intakes, Irrigation Canals, etc.
• Technical Assistance Scope of Assistance:Agriculture Extension, Malaria Prevention, Pro-poor Component, Formation and Capacity Building of WUA, Capacity Building of Government Officials, Strengthening of Project Management	• Technical Assistance Scope of Assistance:Agriculture Extension, Malaria Prevention, Pro-poor Component, Formation and Capacity Building of WUA, Capacity Building of Government Officials, Strengthening of Project Management
• Consulting Services Scope of Services:Engineering and Management, Evaluation and Monitoring Man-Months:International 110M/M, National 438M/M	• Consulting Services Scope of Services:Engineering and Management, Evaluation and Monitoring Man-Months:International 81.5M/M, National 659M/M

Source: Ex-ante evaluation, materials provided by JICA, materials provided by the executing agency.

For this project, 393 subprojects were proposed originally. The technical and environmental screening of candidate subprojects resulted in 353 subprojects proposed for rehabilitation and capacity building and 40 subprojects only for capacity building. In 322 subprojects, both rehabilitation and capacity building were completed by the end of the project. Civil work covered from the water source to the watercourse of the minor irrigation facilities. Based on the number

of the target subprojects, the rehabilitation of minor irrigation dams and canal systems reached 86% of the target. Out of the selected subprojects, 31 subprojects could not fully achieve their initial scope due to the reasons such as difficult construction works or incompletion during the project period[14].

The contents of the support was more or less in accordance with the plan. WRD was a main implementation body for the formation and capacity building of WUA, the Agriculture Department of Rajasthan was for agriculture extension, and the state health department was for malaria prevention. Meanwhile, the selected NGOs supported the implementation of agriculture extension, pro-poor component, and formation and capacity building of WUA. Agriculture extension focused on the technical aspects (introduction of new species, fertilization, pest control, water-saving technology). Workshops for field staff of the Agriculture Department in charge of agriculture extension as well as exhibitions of farming techniques at the subproject sites by government departments such as the Agriculture Department were carried out accordingly. The pro-poor component was carried out with 6 subprojects[15], but this was put on hold during project implementation. According to interviews with people involved in the project, this discontinuation was due to the fact that the NGO responsible for the component could not allocate appropriate personnel in the project target area and could not implement the income generation activities as planned. It was difficult to select a new NGOs and make the income generation activities back on truck during the rest of the project period (1 year and 2 months). Regarding the formation and capacity building of WUA, the WRD training institute (Irrigation Management and Training Institute: IMTI) provided training for the staff of the executing agency and officials of WUA on the formation and management of WUA. This project supported a large number of subprojects, and an agreement between the executing agency and a WUA was required for the implementation of each. For this reason, it was necessary to carry out training on the establishment and management of WUA on an unprecedented scale. Since the project supported 336 subprojects which covered the completed 322 subprojects, it is considered that a sufficient number of subprojects was assisted.

The contents of the consulting services were according to the plan. The contracts for “engineering and management” and “evaluation and monitoring” were signed respectively, and carried out. The increase in man-months on the part of domestic consultants was due to a) the extension of consulting services as a result of project delays, and b) supplementing some tasks assigned to international consultants[16].

[14] Out of 31 subprojects, 23 subprojects were partially completed (major part of rehabilitation and capacity building) and 8 subprojects were dropped out.
[15] 6 subprojects were in Karmadia, Shishod, Bhenta ka Naka, Bharai, Modia Mahadev, and Khodi.
[16] Due to the prolonged construction period, the cost of consulting service was increased by 160 m

3.2.2 Project Inputs

3.2.2.1 Project Cost

The actual project cost was 7,874 million yen against the planned cost of 14,695 million yen. Even against the adjusted planned cost (13,328 million yen) reflecting the reduction of the cost of civil work, price escalation, and physical contingency (reduction of 1,367 million yen) caused by modification of the outputs (the reduction of the number of subprojects from 375 to 322), the actual cost was less than the plan. The actual project cost was 54% of the plan (before adjustment) and 59% (after adjustment), which was well within the plan. The low actual cost against the plan is considered to be due to the weak Indian rupee, the competitive bidding process, and the reduction of interest during construction due to the reduction of the loan amount.

3.2.2.2 Project Period

The actual project period was 124 months (from March 2005 to June 2015) against the planned project period of 97 months (from March 2005 to March 2013) at the time of the appraisal (see the table below).

The actual project period was 128% of the planned period, which was longer than planned. The main reason for this prolonged project period was the delay of the consulting contracts. As of the appraisal, the onset of consultancy for engineering and project management was assumed to be January 2006. Due to a delay in the recruiting process however, the commencement of consultancy was delayed to April 2008. The delay of the selection process was due to the following: a) the time taken by the executing agency to follow the JICA guidelines, as this project was the first Japanese ODA loan, and b) in accordance with state regulations, the approval of the Rajasthan Financial Department was required when the consulting agreement exceeded a certain percentage (3%) of the project cost. The approval process required a longer period than expected.

Table 2: The Schedule of this Project (Plan and Actual)

	Plan	**Actual**
L/A Signing	Mach 2005	March 2005
Selection of Consultants	April 2005 - December 2005	June 2006 – March 2008
Consulting Services	January 2006 – March 2013	April 2008 - June 2015
Tendering of Rehabilitation Works	November 2006 – August 2007	April 2009 – January 2011
Rehabilitation Works	September 2007 – December 2011	February 2011－June 2015
Project Completion	March 2013	June 2015

Source: Documents provided by JICA

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

(1) Economic Internal Rate of Return (EIRR)

For this ex-post evaluation, the EIRR was recalculated for the 2 completed subprojects for which the EIRR had been computed at the appraisal (see the table below for the conditions of computation). The actual EIRR of the Jilmili subprojects was 10.9% against the planned 13.7%. The EIRR was decreased from that of the appraisal and the decrease of EIRR was due to the reduction of the planned irrigation area. The project cost actually decreased by 20% but the unit cost of operation and maintenance cost increased and the maintenance and maintenance (O & M) cost increased by 70% in real terms. The actual EIRR of the Panwar subproject, on the other hand, was 32.3% against the planned 23.0%. The reason for the latter was the major reduction of the project cost. The financial internal rate of return (FIRR), on the other hand, could not be computed as the executing agency did not gain any financial benefit from the project and there was no mention in the ex-ante evaluation sheet.

Table 3: Conditions for the Computing of EIRR at the Ex-post Evaluation

	Conditions for Calculation
Cost	Project Cost (excluding tax), O&M cost.
Benefit	Expansion of the irrigated area and the economic effect of agricultural products as a result of improved farming practices.
Project period	20 years after the loan agreement
Assumptions	• Regarding the cost, the conversion factor from the financial price to the economic price was recalculated to be 0.96 based on the trade data (actual) during the project period. Based on the GDP deflator, the nominal price was converted into the real price at the time of the ex-post evaluation (2017). • In terms of the benefits, the total benefit calculated at the time of the appraisal was recalculated by multiplying the ratio of irrigated area (actual / planned) and the price change (reflecting the price of agricultural product). The benefit was computed by using the price of agricultural products (wheat, barley, gram, mustard, and cumin) at the time of the ex-post evaluation (2017). The prices of agricultural products at the time of the ex-post evaluation increased by approximately 10-50% from the assumptions of the appraisal.

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

3.3 Effectiveness and Impacts[17] (Rating: ②)

3.3.1 Effectiveness

In this ex-post evaluation, the outcome of this project was defined as “increase in agricultural production in the project target area.” At the time of the appraisal, the outcome of this project was assumed to be the improvement in both agricultural productivity of the entire state, and agricultural income. However, considering that the project target area was less than 1% of the cropped area in the state, it was deemed more appropriate to limit the expected range of project

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

outcome to that of the project target area, and to set improvement in agricultural income as a project impact.

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

Among the operation and effect indicators set at the appraisal, 3 indicators were directly related to the outcome of this project, "increase of agricultural productivity in the project target area". These are beneficiary area, productivity of major crops, and unit yield of each major crop. There was not enough data to allow evaluation of the yield of major crops for the project. Neither was the target value determined. As the operation and effect indicators, therefore, the beneficiary area and the unit yield of each major crop were mainly examined.

The beneficiary area was defined in the appraisal as the irrigable command area (ICA) based on the volume of water reserved in dams, and the data was collected from all subprojects. As shown in the following table, the beneficiary area achieved the target value set at the appraisal. Of the 5 subprojects[18] where site surveys were conducted, four were discharging water in the dry seasons and have become an important water source. As one subproject (Dantli Bund) did not have sufficient rainfall, the supply of water was stopped to maintain the water level of wells[19]. The benefits of this subproject were therefore not readily accessible to those farmers who did not own wells. Based on the above, it should be noted that there were differences in the level of benefit even within the beneficiary area.

Table 4: Beneficiary Area of this Project

	Baseline	Target	Actual	
	2004	2015	2015/16	2016/17
		2 years after project completion	The year of project completion	A year after project completion
Beneficiary area (ha)*	89,754	101,938	116,000	118,300

Source: Documents provided by JICA. Documents provided by the executing agency.

The baseline was not set for the unit yield of major crops at the time of the appraisal. To create the baseline, in the 2010/2011 season, a sample survey was conducted with beneficiary farmers in 22 subprojects (Number of responding households: 2,297 households). In 2014, as the end line survey, a sample survey was conducted with beneficiary farmers in 20 [20]

[18] Site surveys were conducted at 5 subproject sites: (Para-I, Govta, Ronija, Dantli Bund, and Tokra) in this ex-post evaluation.

[19] According to the local hydrology engineers, it is thought that the dam water penetrates into the ground and the water level of the groundwater rises.

[20] Only 20 subprojects where civil work had progressed sufficiently for the emergence of the effect were surveyed. These subprojects were Needer, Ram Sagar Lumbahar, Reria Dam, Shodenpura, Tal Sarowar Arnia, Kana, Kiwandi Bankli, Meli, Seli Ki Nal, Khatka, Mogra, Ronija, Ankar Sol Ka Naka, Bandora, Biyapada Tank, Kala Bhata, Mandol, Modia Mahadev, Raithlias, and Unchakia.

subprojects (Number of responding households; 1,991 households)[21]. As the target values for the unit yield of the major crops were not defined during the project period, the estimation of the unit yield used for the computation of the EIRR during the appraisal (the expected unit yield of 6 target subprojects immediately after project completion) was used as a reference for evaluation of the achievement. Of four crops (wheat, mustard, gram, and barley)[22] for which the achievement level could be evaluated using the baseline, the end line, and conditions for the EIRR computation at the appraisal, two crops (wheat and barley) achieved the expected value (see the table below). While the annual rainfall (state average) at the time of the baseline survey was 436.6 mm (2009/10), that for the time of the end-line survey was 583.6 mm (2013/14). The amount of rainfall was relatively high for the time of the end-line survey. The improved water supply during the dry season as a result of this project and agriculture extension (such as the introduction of new varieties and their cultivation methods, mixed use of chemical fertilizer and compost) enabled the introduction of higher yield species of wheat, which, in turn, led to the achievement of a unit yield that exceeded the expected value. Barley also reached the target value of unit yield due to the increased water supply and the farming technology (introduction of high yield variety) promoted by this project. The unit yield of mustard and gram improved after the project, but did not reach the target.

Table 5: Unit Yield of Major Crops in the Project Target Area

Unit: 100kg/ha

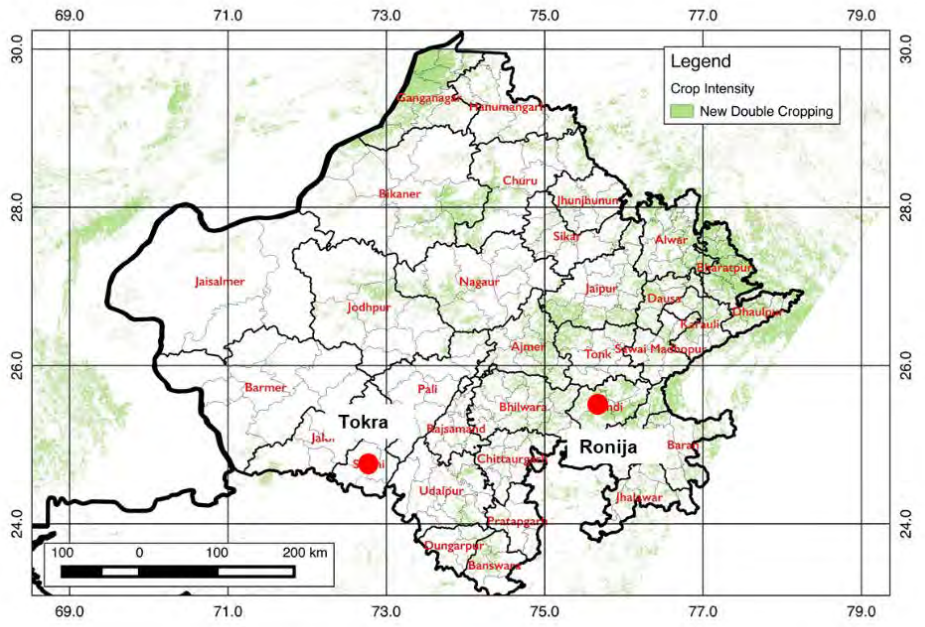
	Wheat	**Mustard**	**Chickpeas**	**Barley**
A: Baseline Survey* (2010-11)	23.73	11.17	9.41	20.39
B: End line Survey** (2014)	35.07	11.68	12.45	26.67
C: EIRR computing conditions (Unit Yield immediately after project completion)	30.00	14.00	14.00	25.00
B-A: Change of Unit Yield (Actual)	11.34	0.51	3.04	6.28
C-A: Change of Unit Yield (Target)	6.27	2.83	4.59	4.61
Achievement Rate ((B-A)/(C-A)	181%	18%	66%	136%

Source: Documents provided by JICA, Baseline survey, End line survey.
*The number of respondents in the baseline survey was 2,297 households. The respondents owned 2,170 ha in total.
**The number of respondents in the end-line survey was 1,991 households. The respondents owned 2,377 ha in total.

[21] As the samples were not randomly selected, statistical representativeness is not assured. Nonetheless, samples were selected as one-third from each of the head/middle/tail of canals and attention was paid in the sampling method to the reduction of bias.
[22] While wheat and barley are major grains with less price fluctuation due to seasons and varieties, mustard and chickpeas are cash crops with wide price fluctuations caused by seasons and quality.

[Column] Use of the Remote Sensing Data

To objectively analyze the effectiveness and impact of a project where the sites are dispersed, it is necessary to select sites for the site visits and data collection so that the evidence on the incidence of project effects is collected without a bias. When the subprojects are dispersed over a large area, as in this project, it is difficult to capture the whole picture on the incidence of project effects prior to the field survey. For this ex-post evaluation, remote sensing data provided by the Japan Aerospace Exploration Agency (JAXA) was used to select the subproject sites for the visits. This enabled the selection of sites from both districts where the number of harvests per year had increased from once (before the project) to twice (after the project: green parts on the map) and the districts where there was no change.



Interviews were conducted at each subproject with the beneficiary farmers and other people involved in the project (the staff of WRD and the agriculture department) regarding the changes before and after the project. Both situations are shown below.

Ronija subproject (Bundi district): Of the 3 farmers interviewed, one farmer had started cultivation in the dry season and introduced high yield wheat and vegetables after the project. An adjacent area has abundant water and large scale cultivation of vegetables and fruit was underway.

Tokra subproject (Sirohi district): Three farmers interviewed were cultivating during the dry season before the project, and none expanded the areas under cultivation after the project. The water supply in the dry season was increasing, however, high yield wheat which requires more water was being introduced. The Tokra subproject continued to supply water, but there were irrigation dams and canal systems that stopped the water supply in adjacent areas.

3.3.1.2 Qualitative Effects (Other Effects)

(1) Expansion of horticulture and cattle breeding

In the qualitative study[23], beneficiary farmers were interviewed about the qualitative changes in the agricultural sector brought by the irrigation dams and canal systems at six subprojects[24]. The results showed that the rehabilitation of the irrigation dams and canal systems had contributed to the expansion of horticulture and cattle breeding[25]. In terms of horticultural crops, in the area with good access to urban areas, there were farmers who cultivated vegetables (onions, cabbages, etc.) during the dry season. In areas without good access to urban areas, it was observed that the introduction of vegetable cultivation was introduced, and that the crops the produced were exchanged, sold in adjacent areas, or consumed at home. Vegetable cultivation requires more water than grain cultivation, and the increase of irrigation water led to this expansion. The interviews also revealed that farmers had begun to raise cattle, or had switched to a breed with a higher milk yield after the project. Farmers either sell the milk to dairy cooperatives, or manufacture dairy products for self-consumption. As a motivation for the expansion of cattle breeding, it was mentioned that the increase of irrigation water had made it easier to obtain fodder and water during the dry season.

(2) Use of water flow meters

This project placed water flow meters at 326 subprojects and provided the village water masters of the WUA with training on how to use them. As of the ex-post evaluation, to objectively measure water volume for the fair distribution of water among beneficiary farmers, water flow meters were being used by the executing agency staff and the farmers when discharging water in the dry season. Executing agency staff who were working in the O&M of the irrigation dams and canal systems pointed out that the introduction of the water meters lessened the number of complaints from farmers that water distribution to executing agency was arbitrary.

The water flow meter installed by this project

[23] For founding quantitative effects, interviews were conducted with beneficiary farmers (19 men and 5 women) at 6 subprojects (Para-I, Govta, Ronija, Talwas, Dantli Bund, and Tokra)of the project in the qualitative study.. For avoiding a bias in the upstream / midstream / downstream of the irrigation canal, 4-5 farmers (including 1 female) were selected for each sub-project except Tarwar. In Talwas, a beneficiary farmer (1 person) was interviewed on horticulture crops.

[24] In the state of Rajasthan , precipitation increases from the west to the east, so the subprojects to be surveyed were selected from the west (Tokra), the center (Para-I, Govta), and the east (Ronija, Tarlwas, Dantli Bund) respectively with attention to the prevention of bias.

[25] Interviews with staff of the executing agency and the Agricultural Agency show that horticulture (mainly vegetables) was introduced after the development of the irrigation systems in the whole project.

3.3.2 Impacts

For this ex-post evaluation, the impact of this project was set as "the improvement of livelihoods and living conditions among the beneficiary farmers." Although poverty reduction in the entire state was included in the impact when the project objective was set at the appraisal, the beneficiary land area was less than 1% of the total cropped area of the state (2014/15: 24.24 million ha)[26]. As the contribution of this project to poverty reduction in the entire state was very limited, the incidence of the project effects was analyzed mainly taking into account changes in the livelihoods of the beneficiary farmers in the project target area.

3.3.2.1 Intended Impacts

(1) Quantitative impacts

The end line survey, which mentioned in "3.3.1.1 Quantitative Effects (Operation and Effect Indicators)", gathered information on household income in the project target area, which revealed that agricultural income made up 50% of the entire household income. The end line survey referred to the increase of both agricultural income per unit and annual household total income when comparing the situation before and after the project. While the former marked a 77% increase (baseline survey: 17,853 India rupee/ha, end line survey: 31,624 India rupee/ha), the latter marked a 53% increase (baseline survey: 63,328 India rupee, end line survey: 96,819 India rupee). The rate of increase exceeded that of inflation in the same period (24.1% based on the GDP deflator between 2010 and 2014). Meanwhile the factors other than this project (the crop market situation, changes in income other than that from agriculture) also influenced agricultural income per unit area and the household income, and thus impacts cannot be credited solely to this project. The project, still, is assumed to have contributed to the increase in income that occurred during the project implementation period.

The rate of poverty decreased from 34% at the time of the baseline survey to 21% at the time of the end line survey. From the income data mentioned above, it can be presumed that the income increase partly brought by the project formed one of the factors that led to the reduction of the poverty rate.

Table 6: Transition of the Poverty Rate

	Above the poverty line	Below the poverty line*	Unknown	Total
Baseline survey (2010)	61%	34%	5%	100%
End line survey (2014)	77%	21%	2%	100%

Source: End line survey report

Note: "Below the poverty line" is defined as the households that own the ration card issued to those below the poverty line set by the Indian government (Minimum needs basket method).

[26] Commission of Agriculture (2017) "Rajasthan Agricultural Statistics at a Glance 2015-16"

(2) Qualitative Impacts

In the qualitative survey, beneficiary farmers were interviewed about changes in diet and household expenditure as qualitative impacts.


Vegetable cultivation in the project area

The results of the interviews revealed that the farmers' diets had become more balanced after the project. In terms of food consumption, both men and women said that they consumed more dairy (yogurt, butter and cheese), vegetables and fruit after the project. The interviews with the beneficiary farmers confirmed the increase in the consumption of food items other than the staples of the project target area (wheat and barley). As mentioned in the section "effectiveness," "3.3.1.2 Qualitative Effects (other effects)," the increase in farmers who cultivate vegetables and produce dairy products for home consumption led to changes in the patterns of food consumption. Fruit, on the other hand, was often being purchased. The increase in fruit consumption therefore is assumed to have been the result of increased income.

As items for which expenditure had increased after the project, men who were interviewed mentioned farming equipment, motor cycle, house repairs, social affairs (weddings, religious rituals) and so on. The interviews with women revealed increases in the purchase of clothes and jewelry. It is considered that decisions about expenditure made by women are increasing. It is surmised that the increase of income is enabling a tendency to allow both men and women to purchase relatively costly goods, and to spend more on goods that are beyond the necessities of life. In terms of expenditure on education, it was difficult to spot a clear trend after the project as this expense depends also on the age of the children in each family and was affected by factors other than income.

3.3.2.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

JBIC Guidelines for the Confirmation of Environmental and Social Considerations (2002) were applied to this project, the category being FI[27]. Based on the agreement at the time of the appraisal, the engineering and management consultant reviewed the probable impact of the subprojects on the natural environment during project implementation. As a result of the review, those subprojects that could have a large impact on the environment were deemed noneligible for the project. The questionnaire response from the executing agency did not point out any

[27] This category is applied when confirmation of environmental and social considerations is not possible at a loan agreement due to the unestablished scope of a project at the appraisal.

negative impact on the natural environment during project implementation. There was no negative impact on the natural environment observed either during the site surveys at the time of the ex-post evaluation.

(2) Resettlement and Land Acquisition

According the questionnaire response from the executing agency, there was no resettlement or land acquisition. The interview with the executing agency confirmed that the project did not require land acquisition as it was to rehabilitate existing minor irrigation dams and canal systems.

(3) New Initiatives of This Project

The project was the first large-scale irrigation rehabilitation project since the formulation of the WUA operational provision in Rajasthan in October 2002. The project introduced partnerships with NGOs to provide a variety of assistance to WUA in an extended area. Six NGOs[28] were selected and each NGO was engaged in the support of WUA in the assigned area (2-7 districts). Through this project, many executing agency staff received training on the operation of WUA at IMTI, were able to familiarize themselves with assistance to WUA, and then to experience cooperation with NGOs. Furthermore, for this project, the executing agency established a corpus fund worth 200,000 India rupees for each subproject to strengthen the financial base of WUA. The fund was managed in bank accounts jointly opened by the executing agency and WUA, and interest is spent on the O&M of the irrigation facilities. The ODA loan project that follows this project, "Rajasthan Water Sector Livelihood Improvement Project (Phase I)," has a plan to continue the above mentioned cooperation with NGOs as well as the establishment of the fund.

WUA have a major role in enhancing and sustaining the project effects of irrigation projects. As stated above, this new approach was introduced in this project to build the capacity of WUA. This initiative is incorporated in the subsequent project.

Among the indictors to show the outcomes of this project, that of beneficiary area of the project reached the target, and as for the unit yield of major crops, two crops out of four achieved the expected values. Thus, its achievement level of outcome is moderate. On the other hand, monitoring of the production volume of major crops was not carried out in accordance with the plan. The targets for the production volume of major crops was not set and no data was collected. Thus, it was difficult to verify the achievement of project targets. Through a before-after comparison of the project, though it does not necessarily show the pure effect of the project, the increase in farmers' income leading to a more balanced diet, and the increase in expenditure on

[28] The NGOs were not those which implemented the pro-poor component.

articles other than daily necessities were confirmed. In view of this above, the project has achieved its objectives to some extent, thus effectiveness/impacts of the project is fair.

3.4 Sustainability (Rating: ②)

3.4.1 Institutional / Organizational Aspect of Operation and Maintenance

According to the plan about O&M of each subproject after the completion of the civil work, at the time of the appraisal, it was arranged that WRD would oversee the O&M of the subprojects where the culturable command area (CCA) was over 300ha, while panchayats would oversee those with less than 300ha. As of this ex-post evaluation, the O&M work followed this initial structure. Of the selected 353 subprojects, 189 were under the supervision of the panchayats. Each subproject formed more than one WUA, each of which selects its officers by election every 5 years.

Interviews with people related to the project, at the time of ex-post evaluation, revealed that WRD or panchayats were carrying out the O&M work for the dams and related facilities as well as for the irrigation canals other than watercourses, while WUA were taking responsibility for the O&M of the watercourses. Within WRD, it was found that the division office was taking responsibility for the formation of O&M plans and budget management while the sub-division office was in charge of the actual O&M work of the individual irrigation dams and canal systems (management of the civil work contracts and progress as well as the monitoring of the quality of the civil work). Within panchayats, the duties were divided in the manner that the district panchayat supervises the overall O&M, the block panchayat formulated the plan for O&M, and the gram panchayat implements[29] the O&M work.

There was no increase in the number of engineers at WRD over the past few years: 1,403 in April 2015, 1,218 in April 2016 and 1,317 in April 2017. According to questionnaire responses and the interview with the executing agency, the rehabilitation work was supposed to be commissioned to contractors in principle and there was no shortage of engineers. Within the panchayats, engineers were allocated to district panchayats and block panchayats and the district panchayats were seconded by WRD staff.

It is considered that there are no organizational issues that negatively affect sustainability as the management structure of O&M is clearly established for the rehabilitated irrigation dams and canal systems of this project, and as the number of engineers is stable.

3.4.2 Technical Aspect of Operation and Maintenance

During the project, training was conducted for WRD staff and WUA officers on participatory irrigation management, water canal operation and maintenance, establishment and operation of WUA, etc at IMTI. A total of 212 training sessions were organized during the project

[29] Gram panchayats are responsible for the O&M work for not only the irrigation, but also for the agricultural roads.

implementation, and the number of participants amounted to 6,203. In addition, IMTI conducted the training of WUA village water masters on the formulation of water distribution plans, the control of water flow, and the management of water tariffs. IMTI was a permanent training institute, and as such, at the time of the ex-post evaluation, it continued training for WRD staff and WUA officers as well on subjects such as participatory irrigation management and canal maintenance and the formation and management of WUA. In addition to IMTI, other public training institutes and universities provide technical training for WRD staff (on the use of PC, irrigation services, GIS, etc.). From the interviews with the division and the subdivision offices of the executing agency, it was understood that executing agency staff received training once a year or so.

Questionnaire responses from the executing agency stated that manuals were being in place for the O&M of irrigation dams and canal systems, and for the operation of WUA. They also stated that these manuals were being used at the WRD sub-division offices though they were not assumed to be used by WUA.

The situation of the technical level at the time of the ex-post evaluation is as follows.

WRD: Rehabilitation work of this project was carried out by local contractors. Though highly advanced technology was not utilized, the O&M could be implemented at the same technical level as that for the existing irrigation dams and canal systems. In view of the above, s WRD seems to have the capacity to carry out the O&M of the facilities rehabilitated in this project as it also was involved in the O&M often irrigation facilities for many years.

Panchayats: As mentioned in the previous section, the O&M of the facilities rehabilitated in this project did not require sophisticated technology. Furthermore, executing agency staff were seconded to the panchayat in order to provide support for the technical aspects of the irrigation sector. The O&M of the facilities rehabilitated in this project, therefore, can be judged to be technically possible.

WUA: The majority of the watercourses where WUA were carrying out O&M were minor earth canals, and beneficiary farmers had the technical capacity to attend to the O&M needs. Interviews with beneficiary farmers revealed that they had the support of the WRD sub-division offices for O&M (repair and canal operation).

Training was provided to WRD staff and the WUA officers during project implementation. At the time of the ex-post evaluation, too, there was an environment that enabled the sustainability of the technical level among executing agency staff through training. The project is concerned with the rehabilitation of existing irrigation dams and canal systems, and the executing agency

staff, the panchayat staff and the WUA staff all have a technical level that assures O&M activities. Based on the above, it is presumed that there are no technical issues that have detrimental effect on sustainability.

3.4.3 Financial Aspect of Operation and Maintenance

The annual expenditure of the executing agency during the past three years shows the trend of increase (see the table below). However, there was a decrease in O&M expenditure in the fiscal year 2016/17 because there was an increase in the expenditure for the rehabilitation of the existing facilities within the construction budget. Comparing the annual expenditure at the time of the appraisal (FY2003/04: 7,224 million India rupees) and at the time of the ex-post evaluation (FY2016/17: 18,648 million India rupees), it can be seen that there is a nominal 2.58-fold increase, while in real terms the increase was 1.35-fold (based on the GDP deflator). It should be noted, however, that there was no provision of maintenance budget by the executing agency for subprojects where the CCA was below 300ha and that were under the supervision of the panchayats. As of the ex-post evaluation, the trend of the O&M budget for these subprojects is unclear as the executing agency does not monitor the subprojects under the supervision of the panchayats.

Table 7: Annual Expenditure of the Implementing Agency

Unit: million India rupees

	2014/15	2015/16	2016/17
Total expenditure	11.529	12,873	18,648
Civil work	3,595	4,805	12,606
O&M	3,241	3,490	2,512

Source: Provided by the executing agency

In this project, the executing agency provided each subproject with a corpus fund worth 200,000 India rupees. WUA were entitled to withdraw the interest (about 10,000 – 20,000 yen a year) for O&M activities. For other irrigation facilities outside this project where the executing agency supervised O&M, no corpus fund available for WUA was established. Interviews with the beneficiary farmers showed that the interest from the fund was being used to purchase necessary materials (cement, etc.) for maintenance or to pay for labor. It can be presumed that the interest of the fund was covering the minor O&M needs of the watercourses to a certain extent.

According to the state regulations, WUA were responsible for collecting water tariffs, a part of which WUA could expense. At the majority of the subprojects where site surveys were conducted, however, collection was carried out by the Rajasthan Revenue Department[30]. In

[30] Of the 5 subprojects where site surveys were conducted in this ex-post evaluation, the WUA of 4 subprojects were not collecting the water tariff.

interviews, executing agency staff explained that it was normal practice that the revenue department collected the water tariffs. However, there is the information that WUA have started to collect water tariff recently. On the collection of water tariff, the detailed situation is not clear. Water tariff could not be directly used for maintenance of the irrigation facilities as the tariff went to the state revenue and was expensed as a recurrent budget. Insufficient budget restricted the activities of WUA, having made activities other than minor repair difficult. Individuals related to the project pointed out that there was not much incentive for WUA to collect the water tariff as they could not use it for their own activities. According to the site survey, one subproject Govta introduced a system where the WUA collects the water tariff and its activity budget for its own use. With the support of NGOs, some subprojects collected funds other than the water tariff for their activities, and conducted income generating activities (such as sales of fodders) for the budget of WUA activities[31].

The annual expenditure of the executing agency was on the increase, and the allocation for O&M was stable. It was difficult, however, to have an accurate grasp of the situation in the subprojects that were not supervised by the executing agency. The trend of the O&M budget in this respect was not clear. For watercourses where WUA were taking responsibility for O&M, it was possible for minor O&M needs to be covered with interest from the fund. For the project as a whole, however, the detailed situations such as whether water tariff is collected in accordance with the state regulation and whether Water Users Associations (WUA) face a constraint in budgets for their activities could not be confirmed.

3.4.4 Status of Operation and Maintenance

As far as it could be observed in the site surveys of 4 subprojects, there was no serious damage (structure collapsing, etc.) in the rehabilitated facilities. At the Tokra subproject, however, the head area of the main canal (not part of the project area) was damaged in the rainy season of 2017. It was planned that the damage would be repaired by the dry season of the same year. In the subprojects where the executing agency took care of the O&M, dirt was cleaned out before the dry season. Weeding was also conducted (once a year). In addition to the O&M carried out by the executing agency, other O&M activities for the waterways were achieved through the

Cleaned canal
(section improved by this Project)

[31] JICA(2017) “The Preparatory Survey on Rajasthan Water Sector Livelihood Improvement Project: Final Report”

national government's rural job creation program[32]. Regarding the O&M of the watercourses, WUA discussed measures, although the frequency of discussions differed from one subproject to another. In the subprojects that provided irrigation water, the farmers themselves were participating in the cleaning of dirt and the weeding of the watercourses on average once a year (before the dry season). As mentioned in the previous section, Dantli Bund subproject did not supply water and the irrigation water canal was not in use. Therefore, the cleaning of the waterway did not take place often enough, and the canal was clogged with mud and overgrown with weeds.

In the site survey, no subproject was found where the damage to the rehabilitated facilities was hindering the emergence of the project effects. At subprojects where the irrigation waterways are not in use, however, the cleaning was insufficient.

Some minor problems have been observed in terms of the financial aspect. Therefore sustainability of the project effects is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project aimed at an increase in agricultural productivity in the project target area through the rehabilitation of existing minor irrigation dams and canal systems, and the promotion of water management and agricultural technology in Rajasthan, thereby contributing to improvements in the livelihoods and living conditions of the beneficiary farmers. This project was to make water accessible to wide range of farmers in Rajasthan where precipitation in the dry season is extremely low. As this purpose is consistent with India's developmental policy and development needs as well as Japan's ODA policy, the relevance of this project is high. The cost of the project fell within the plan, but the implementation period exceeded the plan due to the overall delay in project implementation caused by the delay of the consultancy contract. Therefore, the efficiency of the project is therefore fair. The beneficiary area of the project achieved the target, and two crops out of four crops achieved the expected values in the unit yield of major crops. However, targets for the production volume of the major crops was not set and no data was collected. Thus, it was difficult to sufficiently verify the incidence of project effects. By a comparison of before and after the project, it was confirmed that the income of beneficiary farmers had increased, they had a more balanced diet, and that there was increased expenditure on articles other than daily necessities. Based on the above, the effectiveness and the impact of the project are both evaluated as fair. For the project as a whole, the detailed situations such as whether water tariff is collected in accordance with the state regulation and whether Water Users Associations (WUA) face a

[32] Called the MGNREGA program as it is conducted based on the Mahatma Gandhi National Rural Employment Guarantee Act.

constraint in budgets for their activities could not be confirmed. Of the 353 subprojects selected for this project, 189 were under the supervision of the panchayats, but the trend of their O&M budget was not clear. Out of the subprojects visited, most WUA were not collecting the water tariff and this was being a constraint in budgets for their activities. Although the O&M aspect of this project does not have major issues in its institutional structure, technical aspects, and its status, there are some problems with finance. The sustainability of the effects realized as a result of this project is fair.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

At the subproject sites of this project, the tariff paid by the beneficiary farmers could not be used directly for O&M activities of WUA. Therefore, WUA faced a constraint in an operational budget at many subprojects. During the project implementation, however, the WUA in some subprojects collected additional funds on top of the water tariff. WUA started income-generating activities and used income as their operational budget. For revitalizing the activities of WUA in the future, it is desirable that the WRD analyze the situation at each subproject, consider the introduction of similar schemes, and gradually expand the coverage of the schemes.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

<u>Setting the Operation and Effect Indicators</u>

This Project did not make a final selection of subprojects at the appraisal and it was planned to select appropriate subprojects through a detailed survey after project commencement. Thus, the targets were not set for some of the effect indicators at the time of the appraisal and it was planned that appropriate targets would be set for the selected subprojects after commencement of the project. However, no target was set during the project implementation and the executing agency and JICA did not make an agreement on targets. In the case where subprojects are selected after the commencement of a multisite project, it is recommended that operation and effect indicators are reviewed in consideration of project scope, that JICA agrees with the executing agency for data collection in a timely manner, and that monitoring is implemented in accordance with the agreement. Moreover, it is desirable to assess types of crops to measure production volume and unit yield in operation and effect indicators, reflecting characteristics of subprojects area and types of crops. The executing agency can also provide guidance to farmers for the achievement of

project targets based on the latest state of operation and effect indicators such as the latest production volume of crops and the unit yield in the target area through monitoring.

The criteria for NGO selection

There was a pro-poor component in this project, but it was halted during project implementation. The reason for the discontinuation was that the NGO responsible for this component could not allocate appropriate staff in the project target area, which hindered the implementation according to plan of the livelihood improvement activities. In view of the above, where livelihood improvement activities are carried out through cooperation with NGOs, it is critical that there are personnel who are well informed of the target area, and who also have the necessary knowledge about the livelihood improvement activities concerned. It is therefore suggested that the selection criteria of NGO is carefully set, in order to obtain a sufficient number of personnel with the required capacity in the project target area. It is also desirable that NGO issues are grasped at an early stage through monitoring, and that countermeasures are considered.

The establishment of a monitoring system where the executing agency does not supervise the O&M

During the appraisal, it was assumed that, after the completion of civil work in subprojects, the O&M of some of the subprojects would be supervised by the panchayats rather than by the executing agency. However, there was no system envisaged to enhance the monitoring of those subprojects supervised by the panchayats. This situation made it difficult to collect some of the operational indicators set in the appraisal for the purpose of the ex-post evaluation. Information concerning sustainability was also limited. In cases where it is already evident during the appraisal that the executing agency would not supervise the O&M, it is desirable that the related organizations responsible for the O&M be officially incorporated into the monitoring system and that agreements be signed with these organizations regarding the provision of information after project completion.

End

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs Rehabilitation of Minor Irrigation Facilities	• 375 subprojects	• 322 subprojects
Technical Assistance	• Agriculture Extension • Malaria Prevention • Pro-poor Component • Formation and Capacity Building of WUA • Capacity Building of Government Officials • Strengthening of Project Management	• Agriculture Extension • Malaria Prevention • Pro-poor Component • Formation and Capacity Building of WUA • Capacity Building of Government Officials • Strengthening of Project Management
Consulting Services	• International: 110M/M • National: 438M/M	• International: 81.5M/M • National: 659M/M
2. Project Period	March 2005 – March 2013 (97 months)	March 2005 – June 2015 (124 months)
3. Project Cost Amount Paid in Foreign Currency Amount Paid in Local Currency Total ODA Loan Portion Exchange Rate	 935 million yen 13,760 million yen (5,733 million INR) 14,695 million yen 11,555 million yen 1INR = 2.4 yen (As of August 2004)	 348 million yen 7,526 million yen (3,653 million INR) 7,874 million yen 5,351 million yen 1INR = 2.06 yen (Average between 2005 and 2015)
4. Final Disbursement	July 2015	

India

FY2017 Ex-Post Evaluation of Japanese ODA Loan Project

"Haryana Transmission System Project"

External Evaluator: Keishi Miyazaki, OPMAC Corporation

0. Summary

The objective of this project was to ensure a stable power supply to meet rapidly growing power demand by developing an intra-state transmission and substation system in India's northern state of Haryana, thereby contributing to economic growth and improvement of living conditions in the region. The relevance of the project is high, as the objective was consistent with India's development policies and development needs as well as with Japanese ODA policies. The efficiency of this project is fair, as although the project cost was within the plan, the project period significantly exceeded the plan.

Regarding the operation and effect indicators of this project, such as the capacity operation rate of transmission lines and transformers and system availability, system availability mostly achieved its target values in 2017 (the project completion year). On the other hand, data could not be obtained by the executing agency for the capacity operation rate of transmission lines and transformers and therefore it was difficult to verify the level of achievement. However, the average capacity operation rate in 19 substations of the project was 72% in 2017 (the project completion year), which was verified to be lower than the target value of 75%. This means that the project substations were operated within their installed capacity and with enough remaining capacity. After the implemenation of this project, improvements such as increase in power supply time, stabiliztion of voltage fluctuation, and reduction in power outage hours and frequency were observed in the project target areas. For this reason, it was judged that the project objective of ensuring a stable power supply had been achieved. Also, this project had a certain positive impact on regional economic development through the reduction of operation and maintenance costs for backup power generators as well an increase in productivity and services for bulk electricity users in Gurgaon. Furthermore, there was an improvement of living standards in villages of the central part of Haryana state. No negative impact on the natural environment was observed, and land acquisition was appropriately executed in accordance with the related domestic laws and regulations of India. No resident resettlement was executed. Therefore, the effectiveness and impact of this project are high. Meanwhile, no major problem has been observed in the institutional, technical, financial aspects and current status of the operation and maintenance system. Therefore, the sustainability of the project effects is high.

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

1. Project Description

Project Location

Sector 20 Substation (Gurgaon)

1.1 Background

The northern Indian state of Haryana includes Gurgaon, a neighbouring city of the capital Delhi, where an industrial cluster has rapidly developed. Many foreign companies, including those from Japan, already conduct their operations in the region. The economic growth rate of this region reached 12.6% in the fiscal year of 2005. As a result of this rapid growth, the power demand for the entire state rose on average at a rate of 11.8% per annum, from 3,465 MW in FY2003 to 4,837 MW in FY2006, and it was expected to continue to increase at about the same rate in the coming few years. To meet this demand, the state of Haryana planned to purchase electric power from other states as well as to develop new power sources. Meanwhile, the capacities of transmission lines and substations became tight with many facilities in the state's transmission grid due to the new construction of transmission lines and substations corresponding to the development of new power plants as well as the increase in power supply volumes. Therefore, there was an urgent need to expand the existing transmission and substation networks. As of February 2007, 57 Japanese companies had already moved into the state, and it had become a target area for the Delhi-Mumbai Industrial Corridor Project[1], meaning that the region could be expected to have more Japanese companies in the future. For this reason, the securing of a stable power supply through the implementation of this project would expect to have positive effects for these Japanese companies.

1.2 Project Outline

The objective of this project was to ensure a stable power supply to meet the rapidly growing power demand by developing an intra-state transmission and substation system in India's northern

[1] A regional development project agreed between the Japanese and Indian governments in 2006. This project aimed at developing one of the world's largest industrial zones between Delhi and Mumbai through the construction of an approximately 1,500km railway for cargo and the development of industrial estates and logistical hubs alongside the railway by using private funds.

state of Haryana, thereby contributing to economic growth and an improvement of living conditions in the region.

Loan Approved Amount/ Disbursed Amount	20,902 million yen / 11,809 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	March 2008 / March 2008
Terms and Conditions	Interest Rate 0.65% Repayment Period 15 years (Grace Period) (5 years) Conditions for Procurement General Untied
Borrower / Executing Agency	Rural Electrification Corporation Limited (REC) / REC (Guarantee by the President of Republic of India) and Haryana Vidyut Prasaran Nigam Limited (HVPN)
Project Completion	February 2017
Main Contractors (Over 1 billion yen)	• K. Ramachandra Rao Transmission & Projects PVT. Ltd. (India)/SEW Infrastructure Ltd. (India) (JV) • Shreem Electric Ltd. (India) • K. Ramachandra Rao Transmission & Projects PVT. Ltd. (India)/Deepack Cables (India) Ltd. (India) (JV) • Cobra Instalaciones y Servicios S.A.(Spain)
Main Consultant (Over 100 million yen)	N.A.
Related Studies (Feasibility Studies, etc.)	Feasibility Study by REC and HVPN (March 2007)
Related Projects	• JICA, "Haryana Distribution System Upgradation Project" (March 2014) (Japanese ODA loan) • World Bank, "Haryana Power System Improvement Project" (2009-2017)

2. Outline of the Evaluation Study

2.1 External Evaluator

Keishi Miyazaki (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: February 11 – 28, 2018, June 17 – 23, 2018

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 appraisal, the Government of India had placed emphasis on new power supply development and strengthening of the transmission network in *the 10th Five-Year Plan* (April 2002 - March 2007), followed by *the 11th Five-Year Plan* (April 2007 - March 2012). A new power supply of 78,000 MW was planned together with the strengthening of the high voltage transmission network nationwide in order to supply power efficiently from the northern, north eastern and eastern regions where the power supply were centered, to other areas. The plan targeted a decrease in power transmission and distribution losses, which exceeded 30% in 2007, to 15% by 2012 through developing the transmission network. In addition, since 2001, the Government of India had executed *the Accelerated Power Development and Reform Program (APDRP)*, in order to decrease the high rate of transmission loss, and to promote efficiency in terms of facilities and finance for the power distribution sector. Furthermore, the Government of India established *Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY)* in April 2005 for the promotion of rural electrification, which targeted secure power access for all households nationwide by 2009.

At the time of the ex-post evaluation, the Government of India stated in *the Three-Year Action Agenda* (FY2017/18-FY2019-20) starting from April 2017 that the energy sector was one of the important engines for economic growth and development, and listed the strengthening of power generation capacity as well as development of the transmission and distribution system as part of its action agenda for the period. In addition, *the Draft National Energy Policy*, which is currently under development, has the goal of providing power 24 hours a day for all households by 2022. A solid transmission and distribution infrastructure, an efficient power market and the improvement of the financial situation of the power distribution companies are listed as policies for the transmission and distribution sector.

The Haryana Five-Year Plan (2012-2017) stated the following as targets for the power sector: (1) enhancement of the power generation capacity, (2) enhancement, modernization and augmentation of the transmission and distribution network, (3) reduction of transmission and distribution loss to 15% by FY2019/20, and (4) enhancement of the financial capacity of the power distribution sector. The specific goal for the power distribution sector was to add a distribution capacity of 5,650 MVA at a 220kV level during the Five-Year Plan (investment amount of 307.6 million rupees).

As mentioned above, the importance of the development of the transmission and distribution system was often stated in the national development plan, energy policy and the Haryana State

[2] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[3] ③: High, ②: Fair, ①: Low

Development Plan at the time of the appraisal as well as the ex-post evaluation, therefore it is considered to be relevant to this project.

3.1.2 Consistency with the Development Needs

At the time of the appraisal, Haryana state was experiencing rapid industrialization of Gurgaon, in the south, a neighbouring city of the national capital Delhi, and the increase in electricity demand which accompanied this economic growth was remarkable (as mentioned in *1.1 Background*)**.** It was expected that the power demand would continue to increase and the state attempted to enhance its power supply capacity by the development of new power supply as well as the purchase of power from out of state. There was an urgent need to expand the state's power transmission network in order to respond to the increasing power supply volume.

As for power supply in Haryana at the time of the ex-post evaluation, there had been a power shortage until FY2014/15. However the situation had improved since FY2015/16 as Independent Power Producers (IPPs) had led power supply development (Table 1). On the other hand, however, power supply shortages had been constant for peak power demand and supply, except for the FY2013/14 through FY2016/17, and this was expected to continue in the future (Table 2). Although approximately 50% of the electricity in Haryana state was generated by the public power corporation of the state, the rest was dependent on power purchase from the national power company, the National Thermal Power Corporation (NTPC) and IPPs.

Table 1: Power Supply-Demand in Haryana

Unit: MU

Fiscal Year	Energy Requirement	Energy Availability	Energy Deficit/Surplus
2009/10	33,441	32,023	-1,418 (-4.2%)
2010/11	34,552	32,626	-1,926 (-5.6%)
2011/12	36,874	35,541	-1,333 (-3.6%)
2012/13	41,407	38,209	-3,198 (-7.7%)
2013/14	43,463	43,213	-250 (-0.6%)
2014/15	46,615	46,432	-183 (-0.4%)
2015/16	51,901	70,543	18,642 (+35.9%)
2016/17	56,350	72,426	16,076 (+28.5%)
2017/18	61,380	73,872	12,492 (+20.4%)
2018/19	66,821	75,102	8,281 (+12.4%)

Source: HVPN
Note 1: Estimation for FY 2015/16-2018/19.
Note 2: 1 MU (Mega Unit) = 1 GWh = 1,000 MWh

Table 2: Peak Power Supply-Demand in Haryana

Unit: MW

Fiscal Year	Energy Requirement (At Peak Hours)	Energy Availability (At Peak Hours)	Energy Deficit/Surplus (At Peak Hours)
2009/10	6,133	5,678	-455 (-7.4%)
2010/11	6,142	5,554	-588 (-9.6%)
2011/12	6,767	6,443	-324 (-4.8%)
2012/13	8,086	6,725	-1,361 (-16.8%)
2013/14	8,114	8,114	0 (0%)
2014/15	9,152	9,152	0 (0%)
2015/16	9,113	9,113	0 (0%)
2016/17	9,262	9,262	0 (0%)
2017/18	11,126	9,773	-1,353 (-12.1%)
2018/19	12,112	9,967	-2,145 (-17.7%)

Source: HVPN
Note: Estimation for FY2015/16-2018/19.

Haryana state attempted to expand its power transmission and distribution facilities along with further development of power generation in order to respond to the vigorous power demand, mostly in the southern part of the state, which includes the Gurgaon region. As of the end of August 2017, the number of substations managed by HVPN was 418, and the total extension of power transmission lines was approximately 15,000 km. According to the HVPN *Capacity Addition Program* (2016-2022), the development of 75 new substations, the augmentation of 328 substation, and the installation of 1,560 km of power transmission lines were planned. This includes the construction of 17 new substations, the augmentation of 45 existing substations and the installation of 191 km power transmission lines in the Gurgaon.

As mentioned above, the lessening of power shortages at peak hours in Haryana state remained a priority at the time of both the appraisal and the ex-post evaluation, therefore the development needs for this project was high.

3.1.3 Consistency with Japan's ODA Policy

At the appraisal, the *Country Assistance Policy for India* (established in May 2006) listed the promotion of economic growth as a priority target, and emphasized support for infrastructure development contributing to economic growth led by private investment through an improvement in the investment environment in India. Emphasis was particularly placed on support for the electric power and transportation sectors. The policy included (1) the development of power generation to increase the power supply, (2) the development of the power transmission and distribution network for a stable and efficient power supply, and (3) organizational reform targeting the improvement of project effectiveness in the electric power sector as well as enhancement of capacity building such as human resource development.

JICA's (former JBIC's) *Medium-Term Strategy for Overseas Economic Cooperation Operations* (April 2005-September 2008) listed support for poverty reduction and fundamental

development for sustainable growth as its overall priority area, and development of the economic infrastructure as its priority area for India. Also, the electricity was positioned as the main sector for support in India in JICA's (former JBIC's) *Country Assistance Strategy for India in FY2006*. Support was planned for (1) the development of new power generation to increase the power supply volume and power transmission and distribution network to stabilize the power supply, and (2) the development of power distribution network and rural electrification in order to vitalize the economy and reduce poverty through a stable power supply.

As seen above, the objective of this project is to provide a stable power supply in order to respond to a rapidly increasing power demand through the development of the transmission network in Haryana state, which was relevant to Japan's ODA policy at the time of appraisal.

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

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The project outputs were the installation of 492 km of power transmission lines (including the construction of a transmission tower) and the construction and augmentation of 220 kV substations in 14 locations. However, the actual outputs were the installation of 582.7 km of power transmission lines and the construction and augmentation of 220 kV substations in 13 locations, as well as 132 kV substations in 6 locations (a total of 19 substations) which exceeded the project outputs (Table 3). The details of the actual inputs are shown in Table 1. Although there were some changes such as the cancellation of or additions to parts of the subproject, these changes were made in order to respond to demand predictions, changes in the needs for power needs and problems of land acquisition in the target areas, therefore they were considered to be appropriate when compared to the project objective (Table 4).

Table 3: Project Outputs (Plan/Actual)

Items	Plan	Actual
(1) Procurement and installation of the power transmission lines, transmission tower, and related equipment	Total length of transmission lines: 492 km	Total length of transmission lines: 582.7 km
(2) Procurement and installation of transformer, substation related equipment (circuit breakers, switching, current transformers, arresters, insulators, etc.)	220kV substations: 14 locations	220kV substations: 13 locations 132kV substations: 6 locations

Source: Documents provided by JICA and HVPN
Note: There were some changes in the length of transmission lines for some subprojects in the original project scope. However, Table 3 does not indicate the details of the changes in length of transmission lines in each subproject.

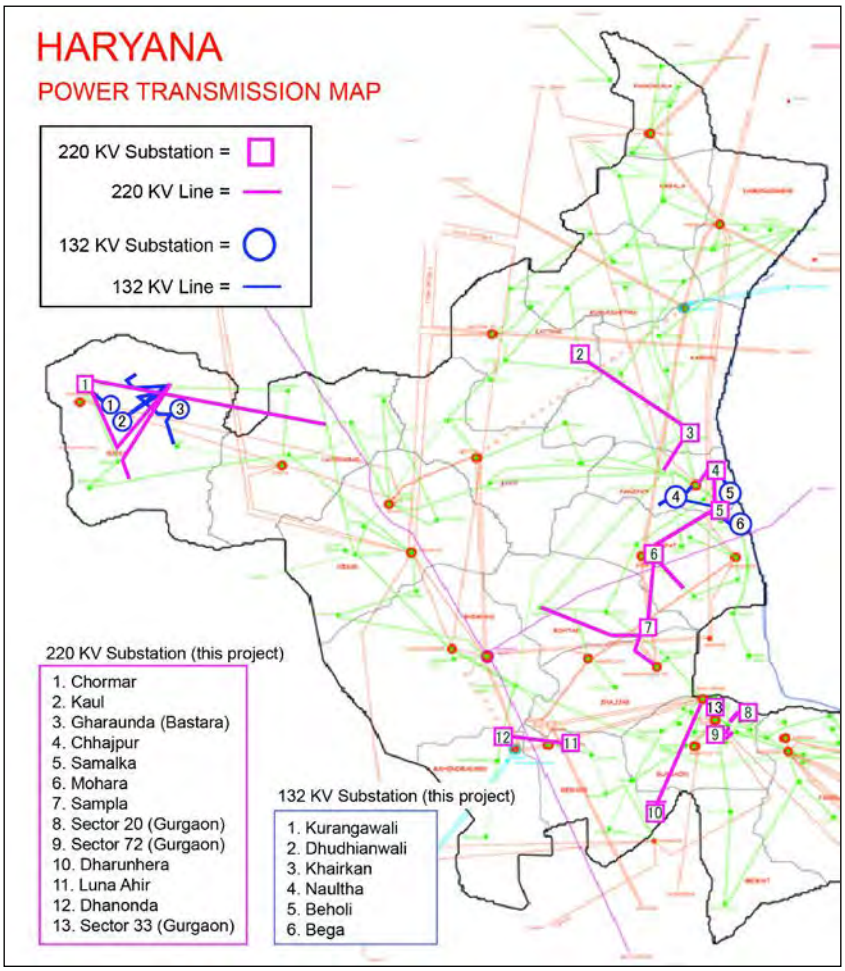
Table 4: Changes in Project Outputs

Items	Changes	Details
Cancelled subprojects	5 subprojects	220kV substations: 2 locations (2 subprojects) 220kV transmission lines: 82 km (3 subprojects)
Additional subprojects	2 subprojects	220kV substation: 1 location (1 subproject) 132kV substations: 6 locations (6 subprojects) 220kV power lines: 1.7 km (2 subprojects) 132kV power lines: 119.3 km (9 subprojects) 66kV power lines: 7.4 km (2 subprojects)

Source: Documents provided by HVPN

The procurement of contractors for transmission lines and substation equipment was planned to be undertaken by 10 procurement packages through international competitive bidding. However, in the end, the number of packages increased to 14 (if the sub-packages spilt from the existing package are included, the total number of packages was 18). No consultant supporting the project implementation was employed for this project.

As for the structure of project implementation, the project steering committee, consisting of the related departments from REC and HVPN, was held every 6 months in order to implement the project smoothly, and project monitoring, decision making and coordination between related departments was carried out. The REC Haryana office in Panchkula took charge of daily monitoring of the project. The REC then reviewed the monthly progress reports submitted by HVPN, and if any problem arose, discussion between REC and HVPN took place. In addition, staff of the JICA India office visited the project sites every six months or one year, regular meetings were held with HVPN, and monitoring was carried out to confirm progress.



Source: HVPN

Figure 1: Project Sites

As already mentioned, this project has newly constructed or expanded substations in 19 locations and constructed 582.7km of power transmission lines. These are equivalent to 4.5% of HVPN's overall substation facilities and 5.6% of the total power transmission lines (there were 418 substations and a total of approximately 15,000km power transmission lines in total in HVPN as of the end of August 2017).

3.2.2 Project Inputs

3.2.2.1 Project Cost

The actual project cost was 18,532 million yen against the planned cost of 26,364 million yen (ratio against the plan: 70%). This was within the plan (Table 5).

Table 5: Project Cost (Plan/Actual)

Items	Plan			Actual		
	Foreign Currency (Mill. Yen)	Domestic Currency (Mill. Yen)	Total (Mill. Yen)	Foreign Currency (Mill. Yen)	Domestic Currency (Mill. Yen)	Total (Mill. Yen)
Substations	9,925	0	9,925	0	7,537	7,537
Transmission Lines	9,018	0	9,018	0	7,384	7,384
Price Escalation	964	0	964	0	0	0
Contingency	995	0	995	0	0	0
Subtotal	**20,902**	**0**	**20,902**	**0**	**14,921**	**14,921**
Administration Cost	0	1,045	1,045	0	664	664
Tax (VAT and Duties)	0	2,508	2,508	0	1,593	1,593
Land Acquisition Cost	0	1,524	1,524	0	968	968
Interest during Construction	260	0	260	260	0	260
Commitment Charge	125	0	125	125	0	125
Total	**21,287**	**5,077**	**26,364**	**385**	**18,147**	**18,532**

Source: Documents provided by JICA and HVPN

Although there were additional outputs, the actual project cost was within the plan. This was mostly because of the 36% change in the exchange rate that was used to calculate the actual project cost (the yen appreciated 36% more against the rupee). For reference, if the actual project cost is calculated using the exchange rate from the time of appraisal (1 rupee = 2.85 yen), the result it 28,959 million yen, which is 109.8% against the plan. In addition, when the project cost is compared with rupees, the actual project cost was 10,723 million rupees (1 rupee = 1.81 yen) (average for 2008-2016) against the planned cost of 9,251 million rupees (1 rupee = 2.85 yen), which is 116% against the plan.

3.2.2.2 Project Period

The actual project period was 108 months (from March 2008 to February 2017) against a planned project period of 30 months (from March 2008 to August 2010) (ratio against the plan: 360%), therefore the actual exceeded the planned.

The project consisted of 14 procurement packages (total of 18 packages to include the splits in existing packages), and packages 1, 3, 11, 12, 13 and 14 exhibited significant delays of more than 4 years. For package 1, despite prior approval, there was a subway construction within part of the target section of the power transmission lines which made it difficult to secure Right-of-Way, meaning that a change in the route of the target section had to be made. For package 3, although one of the three target substations was almost completed, installment of the control room was delayed due to a delay in land acquisition. For package 11, although the construction of two 220 kV substations was originally planned in Sector 20 and Sector 57 of Gurgaon, the forecast for power demand in the target area was lower than expected. Therefore, the Sector 57 construction was excluded from the target scope, and bidding was carried out again. The delay was also due to the fact that it required some time to conduct contract negotiation among

suppliers for the selection of equipment for substations. Further delay was taken place in civil works caused by a change in the method of foundation construction because of soft ground. Packages 12, 13, 14 were additional scopes, and therefore, the bidding for each package started at the beginning of 2013. This caused the main construction works to drag on after 2013. Because of these delays, the loan expiry date was extended from September 2014 to March 2016.

The common causes of delays for other packages are as follows, listed in order of frequency: (1) delay accompanying land acquisition, (2) delay accompanying the acquirement of Right-of-Way and (3) performance of contractors. Most of the land acquired for this project was public property owned by so called Panchayat, traditional rural autonomous organizations in India. According to HVPN, conventionally, when Panchayat land was acquired for a project, there were many cases where the community understood the necessity for land acquisition and provided the land for free. They also received many benefits from the newly constructed substations. However, because there was a change in the procedure for land acquisition as well as changes in the awareness of people, in recent years it became necessary to provide financial compensation for Panchayat land which also meant that more time was required for the compensation procedure.

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

(1) Financial Internal Rate of Return (FIRR)

The Financial Internal Rate of Return (FIRR) of this project was 5.6% at the appraisal. The preconditions for the FIRR calculation are shown in Table 6. The recalculation of the FIRR was made at the time of the ex-post evaluation by applying the same precondition at the appraisal, which turned out to be 6.0%, exceeding the original FIRR value. This was because the actual project cost was lower than the planned project cost. Also, if the FIRR were to be recalculated assuming that the project life starts from the signing of the loan agreement, the FIRR would be 5.2% at the appraisal and 4.9% at the ex-post evaluation. It is because the period after project completion would be shorter in the project life and the benefits scaled down due to the prolonged project implementation period.

Table 6: The Financial Internal Rate of Return (FIRR) at the Project Appraisal

Items	
Financial Internal Rate of Return (FIRR)	5.6%
Costs	Project cost, Maintenance cost
Benefits	Increase of revenue from transmission tariffs, increase of revenue from reduction of transmission loss
Project Life	30 years after project completion

Source: Documents provided by JICA

(2) Economic Internal Rate of Return (EIRR)

The Economic Internal Rate of Return (EIRR) of this project was 33.2% at the appraisal. The preconditions for the FIRR calculation are shown in Table 7. The recalculation of the EIRR was made at the time of the ex-post evaluation by applying the same precondition as at the appraisal, which turned out to be 24.6%, falling below the original EIRR value. This was because the timing of the production of the benefits was delayed due to the prolonged project implementation period. Also, if the EIRR were to be recalculated assuming that the project life starts from the signing of the loan agreement, the EIRR would be 33.2% at the appraisal and 24.5% at the ex-post evaluation. This is because the period after the project completion would be shorter in the project life and the benefits would be scaled down due to the prolonged project implementation period.

Table 7: The Economic Internal Rate of Return (EIRR) at the Project Appraisal

Items	
Economic Internal Rate of Return (EIRR)	33.2%
Costs	Project cost (excluding tax), Maintenance cost
Benefits	Effect on incremental power transmission volume, effect on the reduction of transmission loss, effect on saving costs for alternative power generation
Project Life	30 years after project completion

Source: Documents provided by JICA

In light of the above, although the project cost was within the plan, the project period exceeded the plan significantly. Therefore, the efficiency of this project is fair.

Substations and Transmission Facilities built by the Project

Bastara Substation

Shamalhka Substation

Power Line (Samalhka Substation)）

Sector 20 Substation (Gurgaon)
Gas Insulated Switchgear (GIS)

Sector 72 Substation (Gurgaon)

Transmission Lines (Gurgaon)

3.3 Effectiveness and Impacts[4] (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

For the operation and effect indicators for this project, the capacity operation rate of the transmission lines and transformers and the system availability were established, each with a target value of two years after project completion. Meanwhile, because this project was completed in February 2017 when the construction of the Sector 20 Substation in Gurgaon was completed, this was set as the year of project completion at the time of the ex-post evaluation in 2017. Therefore the two years post project completion for which the target value was set is 2019. Thus, the actual value for each indicator was analyzed as of 2017 at the ex-post evaluation while referring to the target value for two years after project completion (2019). The actual value for each indicator is shown in Table 8.

Table 8: Operation and Effect Indicators

Unit: %

Indicator	Baseline	Target	Actual	
	2007	2012	2016	2017
		2 years after project completion		Year of project completion
Capacity Operation Rate				
Transmission Lines	60	60	N.A.	N.A.
Transformers	83	75	N.A.	N.A.
System Availability	99.6	98.0	99.04	98.7

Sources: Documents provided by JICA and HVPN

Note 1: The above indicator is the value for the entire Haryana state. The target values are those with estimated increase in power generation volume.

Note 2: The capacity operation rate of the transmission lines is the percentage of the peak load against the designed capacity of the transmission lines. That of the transformers is a percentage of the peak demand against the installed capacity of the substations.

Note 3: The actual value of the system availability in 2016 shows the data for 12 months from April 2016 to March 2017 and the actual value in 2017 shows the data for 4 months from April 2017 to July 2017 (The fiscal year in India is from April to March).

As for the capacity operation rate of the transmission lines and transformers for which the value for the entire Haryana state was assigned, actual data from HVPN could not be obtained as it was not possible for HVPN to formulate this indicator with the same definition. Instead, data for the capacity operation rate was obtained from 19 substations of the project. Although there were some differences in operational conditions depending on the circumstances of each substation, the average capacity operation rate in these 19 locations was 72% in 2017 (the year of project completion) (Table 9). This is lower than the target value of 75% established by the operation and effect indicator for the two years post project completion (2019). This means that these 19 substations were operating within their installed capacity with enough remaining

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

capacity. The capacity operation rate at Sampla substation from 2013-2015 exceeded 100%. In this case, normally, nearby substations provide backup for such overloaded substations by taking a detour to other substations temporarily in order to prevent overload of a specific substation.

Table 9: Capacity Operation Rate of the Project Substations

Unit: %

Substation	2011	2012	2013	2014	2015	2016	2017	Completion
220 kV Substation								
Chormar	N.A.	67.04	72.18	70.90	60.95	73.90	67.61	Sep. 2011
Kaul	37.00	44.00	49.00	94.00	96.00	81.00	79.00	May 2016
Gharaunda (Bastara)	92.0	90.00	90.00	90.00	92.00	92.00	96.00	May 2016
Chhajpur	98.00	90.00	84.00	92.00	98.00	96.00	95.00	May 2016
Samalka	73.60	93.60	69.00	85.50	71.20	87.10	90.00	Mar. 2011
Mohana	52.00	68.00	84.00	55.50	81.20	95.60	96.00	Mar. 2011
Sampla	45.56	93.73	107.16	105.38	103.10	63.21	72.96	Mar. 2011
Dharunhera (Mau)	83.94	57.79	91.43	95.15	93.17	82.73	78.65	Oct. 2011
Luna Ahir	N.A.	N.A.	53.62	73.28	63.74	73.28	71.95	Nov. 2011
Dhanonda		N.A.	26.20	52.29	55.53	56.10	62.40	Nov. 2011
Sector 20 (Gurgaon)	―	―	―	―	―	―	37.30	Feb. 2017
Sector 33 (Gurgaon)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	48.00	Oct. 2011
Sector 72 (Gurgaon)	25.90	28.60	31.00	40.00	45.80	61.00	67.30	Nov. 2011
132 kV Substation								
Kurangawali	N.A.	33.82	55.76	39.00	47.84	43.57	39.61	July 2011
Dhudhianwali	N.A.	96.88	97.80	90.50	88.22	82.28	81.36	July 2011
Khairkan	N.A.	53.48	57.14	57.14	44.08	49.97	62.16	July 2011
Naultha	57.70	57.70	66.80	74.80	80.10	74.80	74.80	Oct. 2010
Baholi	75.00	75.00	37.00	80.00	80.00	91.00	93.00	Oct. 2010
Bega	57.60	60.00	57.00	67.00	53.00	51.00	58.40	Oct. 2010

Source: HVPN

For system availability, the actual value in 2017 was 98.7%, almost achieving the target value of 98% set for the two years after project completion (2019). The system availability of 98% means that there was hardly any power shortage, and that the operational status was good. Meanwhile, the Haryana Electricity Regularity Commission (HERC) established its annual target value for system availability of the transmission system (Table 10). In comparison with this, the actual system availability of HVPN mostly achieved the target value of HERC for each year. In addition, although power transmission loss in 2008 (at appraisal) was 2.57% (already sufficiently low), it is further improved to 2.31% in 2016 and 2.20% in 2017.

Table 10: Comparison with System Availability and Target Value set by the HERC

Unit: %

Year	System Availability		Transmission Loss (HVPN Actual Value)
	HERC Target Value	HVPN Actual Value	
2008	N.A.	99.57	2.57
2009	N.A.	99.39	2.68
2010	N.A.	99.59	2.63
2011	N.A.	99.56	2.76
2012	N.A.	99.67	2.49
2013	98.5	99.72	2.73
2014	98.8	99.13	2.61
2015	99.0	98.29	2.69
2016	99.2	99.04	2.31
2017	98.8	98.71	2.23

Source: HVPN
Note 1: HERC: Haryana Electricity Regularity Commission
Note 2: The HVPN Actual Value in 2017 shows 4 months of data from April to July 2017.
Note 3: N.A. means that the target value was not set.

3.3.1.2 Qualitative Effects (Other Effects)

(1) To Ensure Stable Power Supply

<Distribution Corporation>

According to key informant interviews with the Haryana Northern Power Distribution Company (UHBVN) and the Haryana Southern Power Distribution Company (DHBVN)[5], the stability of the power supply as well as voltage from HVPN had improved in the project target areas after project implementation.

<Bulk Electricity Users in Gurgaon>

Key informant interviews were carried out with six bulk electricity users which received a direct power supply through 66 kV and 11 kV feeder lines from the 220 kV substations of Sector 20 in Gurgaon. Of the six companies, two were manufacturers (steel and iron processing), and the others were a soft drink bottling factory, a hotel, a large-scale shopping mall, and a rental office building company. The following were seen in all six bulk users: (1) an increase in the power supply time (increased from 20-23 hours/day to 23.5-24 hours/day), (2) stable voltage fluctuation, and (3) a decrease in power outage hours and frequency (decreased from 1-5 hours/day to 0-0.5 hours/day). For these companies, because there was a distance from the nearest substations to their business facilities, the feeders between them were 2.5-8.0 km long with many branch points. It was for this reason that there were issues such as transmission loss, voltage fluctuation and accident blackouts. However, after the project constructed a 220kV substation at Sector 20, the feeder distances from the substation to each business facility decreased to 0.5-1.0 km, making a more stable power supply in terms of

[5] An ODA loan "Haryana Power Distribution Facility Improvement Project" (March 2014) is being implemented in Haryana, with UHBVN and DHBVN as executing agencies.

quality and quantity possible. The six bulk electricity users were generally satisfied with the current power services.

<Villages in Central Haryana >

Key informant interviews were carried out with representatives of seven villages in the target regions of four 220 kV substations (Sampla substation, Mohana substation, Samalka substation and Chhajpur substation) constructed by the project in Central Haryana. The seven villages[6] had already been electrified before project implementation and their household electrification rates were at a fairly high level. The key informant interviews revealed the following: (1) increases in power supply time (increased from 6-12 hours/day to 12-18 hours/day) (one village had been receiving power supply for 24 hours/day), (2) stable voltage fluctuation, and (3) decreases in malfunctions from overload and low voltage. A 220 kV substation was constructed close to the villages and thus the reliability of the power distribution system for the 132 kV substations and the rest increased. This resulted in an improved stable power supply in terms of quality and quantity. The seven villages were satisfied with the current power services.

<Local Industrial Organizations>

A key informant interview was carried out with the Chamber of Industry of Udyog Vihar, a local industrial organization in Gurgaon. The Chamber of Industry has 400 member companies (manufacturers, IT, rental office business, etc.) that operate in the Udyog Vihar area (Phase 1-5[7] in Gurgaon where the Udyog Vihar industrial complex is located). The 220kV substation completed by this project at Sector 20 distributes power to the Phase 1-3 areas in Gurgaon, where 25% of the industrial clusters belonging to the Chamber of Industry are concentrated. There are 45-50 member companies located in Sector 20.

According to the Chamber of Industry, after the construction of the 220 kV substation in Sector 20 as well as the transmission facilities between Sector 20 substation and Sector 23 substation, power status in Sector 20 and Sector 23 improved, with significant improvement in the 11 kV distribution lines in Sector 20. However, during the summer months from May to July when the power demand was at its peak, the power supply to general households had a higher priority, therefore the power supply for industries was limited to 7-8 hours a day. For this reason, the issue of responding to peak demand remains a challenge in the power sector of Haryana state.

[6] The target villages are (i) Chulkana Dham, (ii) Chhajpur, (iii) Garhi Sampla, (iv) Garhi Hakikat, (v) Jaji, (vi) Naina Tatarpur, and (vii) Maachhri.

[7] In Gurgaon, the largest unit of a lot is called a “Phase”, and then there is a “Sector” which is a subordinate unit of a Phase.

3.3.2 Impacts

3.3.2.1 Intended Impacts

(a) Regional Economic Development

According to the key informant interviews with six bulk electricity users who receive direct power supply from the 220 kV substation at Sector 20 in Gurgaon, the bulk users had to use their in-house power generators (diesel powered generation) on a daily basis due to the regulation of power supply time and frequent accident blackouts. The operation and maintenance costs of this were burden to them. However, after the construction of the 220 kV substation at Sector 20, in-house power generators were no longer needed thanks to the stable power supply. Therefore, the costs of in-house generators were cut. The range of cost savings vary depending on the customer's power usage, but for example, a large-scale shopping mall could save 12,500,000 rupees/month (approximately 20 million yen/month). In addition, the repair costs for the feeder cables from the substation to each business facility was borne by the customers, but as cable malfunction was almost eliminated after project implementation, these expenses have decreased, meaning a reduction in the customers' financial burden. The customers' administrative burden for the maintenance of in-house power generators has also been reduced.

Also, a large-scale shopping mall and a rental office building company charged the electricity bill to their tenant companies which included additional cost for their in-house power generators. After the reduction of the above additional cost, the financial burden of the tenant companies relating to the electricity bill was reduced.

Because a more stable power supply has been attained, there have been positive impacts on the productivity and improved service of corporate customers. There has been an increase of 5% in sales and production in the iron manufacturing industry. At a hotel, in-house power generation automatically switches on in the case of a power outage, although there has been a time lag of tens of seconds to a few minutes. Although this has caused complaints from customers coming from developed countries, such complaints have decreased.

(b) Improvements in Living Standards

According to the key informant interviews with representatives of seven villages in the target region of four 220 kV substations (same seven villages referred in "3.3.1.2 Qualitative Effects"), positive impacts have been seen in all of the villages as a result of an increased power supply period and stable voltage fluctuation. These have included (1) improved access to information through TV, radio, mobile phones or the internet, (2) improvement in educational opportunities as the result of students being able to study at home at night, (3) a reduction in domestic work hours as the result of the use of home electrical appliances, and (4) improved safety at night.

However, the above impacts may have come not only from the project but also from improvements in the related power distribution facilities.

3.3.2.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

This project fell under category B in *the Guidelines for Confirmation of Environmental and Social Considerations* (established in April 2002) as it was considered that the project was not likely to have significant adverse impact on the environment due to the fact that the project sector and project characteristics were not likely to exert impact and the project was not located in a sensitive area. Therefore, potential adverse environmental impacts of the project were not likely to be severe. An Environmental Impact Assessment (EIA) for this project was not required by Indian domestic law.

During project implementation, the contractor took the necessary mitigation measures in order to reduce negative impacts on air, noise, water quality and soil erosion. Monitoring of the environment impact of the noise during the construction period was also carried out by HVPN. Meanwhile, environmental monitoring after the project completion has not been carried out by HVPN as it is not required by law. The purpose of this project was to develop substations and power transmission lines, and no air pollution, noise, deterioration of water quality or soil erosion is expected through the operation of project facilities. No negative impact on the natural environment is expected in the future. According to HVPN, no negative impact on the natural environment has been reported nor have there been any particular complaints from nearby residents caused by project implementation.

Therefore, no negative impact on the natural environment has been observed.

(2) Land Acquisition and Resettlement

Although land acquisition of 97.5 ha was planned at the appraisal, the actual land acquisition area was 106.29 ha (Table 11). The reason for the 8.79 ha increase in the land acquisition area was the increase in the number of substations as the result of the additional scope. Most of the acquired land was a public property owned by the Panchayat, traditional rural autonomous organizations, with only 4 ha of land acquisition from private property. In addition, compensation for agricultural products was provided for the acquisition of the Right-of-Way for the power transmission lines. The above land acquisition was undertaken appropriately in accordance with the related laws and regulations of Haryana state. There was no resettlement of residents related to this project.

Table11: Actual Value for the Land Acquisition Areas

Substation		Land Acquisition Areas (Actual Value) Hectare	Note
220 kV Substation	Chormar	8.26	Panchayat
	Kaul	6.07	Panchayat
	Gharaunda (Bastara)	6.47	Panchayat
	Chhajpur	5.07	Panchayat
	Samalka	6.07	Panchayat
	Mohana	10.12	Panchayat
	Sampla	3.24	Panchayat
	Dharunhera (Mau)	9.06	Panchayat
	Luna Ahir	9.64	Panchayat
	Dhanonda	17.60	Panchayat: 13.6 ha, Public Property: 4 ha
	Sector 20 (Gurgaon)	3.89	Panchayat
	Sector 33 (Gurgaon)	0.97	Panchayat
	Sector 72 (Gurgaon)	4.62	Panchayat
132 kV Substation	Kurangawali	2.75	Panchayat
	Dhudhianwali	2.33	Panchayat
	Khairkan	2.79	Panchayat
	Naultha	2.83	Panchayat
	Baholi	2.89	Panchayat
	Bega	1.62	Panchayat
Total		**106.29**	

Source: HVPN

Regarding the operation and effect indicators, system availability mostly met its target value and the average capacity operation rate for 19 substations of the project also achieved the target value. There were improvements such as an increase in the power supply time, stable voltage fluctuation, and a decrease in power outage hours and frequency in the project target area following project implementation. Therefore, it is judged that the project objective of securing a stable power supply was achieved. This project also had a certain positive impact on regional economic development through the reduction of operation and maintenance costs for backup power generators as well as the increasing productivity and services for bulk electricity users in Gurgaon. Furthermore, there was an improvement in living standards for villages in the central part of Haryana state.

In light of the above, this project largely achieved its objectives. Therefore, the effectiveness and impacts of this project are high.

3.4 Sustainability (Rating: ③)

3.4.1 Institutional / Organizational Aspect of Operation and Maintenance

HVPN is the operation and maintenance institution of this project, and its technical department is responsible for the operation and maintenance of the project facilities. There were 3,740 staff

in HVPN as of the end of May 2018. Although the current number of HVPN staff does not fulfil the authorized number of positions of 10,480, HVPN outsources approximately 3,000 external staff to execute its duties. The HVPN organizational chart is shown in Figure 2.

There are approximately 10-20 staff allocated at each 220 kV and 132 kV substation depending on its scale. There, the persons in charge of substations (junior engineers) possess diplomas (polytechnic), the operators, maintenance staff, and the linemen have graduated from Industrial Training Institutes, and assistant workers possess a high school diploma. On the other hand, the Chief Engineer, Superintending Engineer, Divisional Engineer and Assistant Engineer who manage and supervise the entire operation and maintenance of the substations and power transmission facilities possess a bachelor's degree. When accidents happen at a project facility (substations and power transmission facilities), it is mainly the field staff at each substation who respond to them. However, there is a system whereby technical staff from nearby substation, regional offices or the headquarters can be sent for support as needed.

As described above, although the number of HVPN staff does not fulfill the authorized number of positions, the shortfall is supplemented by the hiring of outsourced staff. HVPN requests approximately 1,400 new staff from the state government and continuously works on increasing the number of its staff members. Staff who possess a certain level of technical qualification are allocated to each substation, and there have been no obstacles in their work so far.

Therefore, no major issues have been observed in terms of the institutional aspects of operation and maintenance.

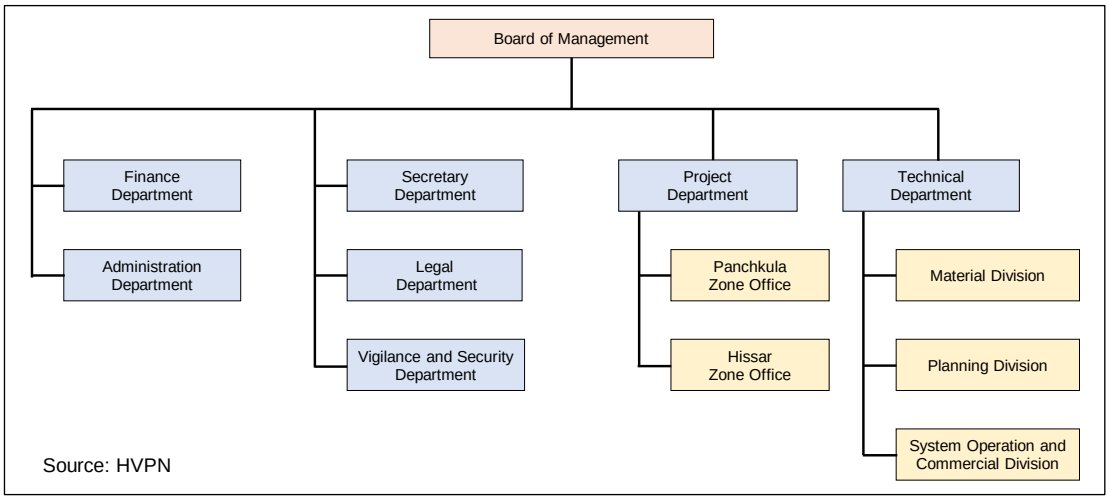


Figure 2: HVPN Organogram

3.4.2 Technical Aspect of Operation and Maintenance

HVPN has introduced a performance management system[8] in order to evaluate the technical skills of the operation and management staff. It has an inhouse training institution, the "HVPN Power Training Institute", and it carries out training programs in various fields every year, including operation and maintenance training for substation and power transmission facilities, safety management and disaster prevention training, financial management training, computer and IT skills training, freshman training, and management training. The staff to be trained include technical staff as well as officials in administrative departments such as accounting/auditing, human resource development and legal affairs. Table 12 shows the training record for the past five years.

Table 12: The Training Record of HVPN in the Past Five Years

Fiscal Year	Number of Training Days	Number of Participants (Total Number of Persons)
2013/14	177	592
2014/15	175	826
2015/16	243	1,180
2016/17	107	591
2017/18	177	990

Source: HVPN
Note: For FY 2017/18, the data period is from April 2017 to February 2018 (11 months).

The operation and maintenance of the substations and power transmission facilities is implemented based on the operation and maintenance manual. Each substation and power transmission facility has its own inspection manual, which defines the inspection items and schedule in detail according to facility and equipment type. Checkups and inspections are carried out according to the manual. This project has introduced gas insulated switchgear (GIS) in the Sector 20 substation and the Sector 33 substation in Gurgaon. HVPN has had experience in the operation and maintenance of GIS for over seven years in other substations and therefore there is no issue in this regard.

Therefore, no major issues have been observed in terms of the technical aspects of operation and maintenance.

3.4.3 Financial Aspect of Operation and Maintenance

According to the head of the HVPN finance department, income and expenditure was in deficit until FY2014. However, as the result of the approval of a new power transmission tariff with price increases by the Haryana Electricity Regulatory Commission (HERC) following the general election of the state assembly in October 2014, the balance has been in profit since

[8] An management method to promote the sustainable growth of enterprises and individuals by aiming at achieving business goals and promoting motivation and the capacity of employees.

FY2015. Table 13 shows a comparison of the income and expenditure of each state electric corporation (power generation, power transmission and power distribution) in Haryana state between FY 2013/14 and FY 2016/2017.

Table 13: Income and Expenditure of Each State Electric Corporation (Power Generation, Power Transmission, and Power Distribution) in Haryana State

Unit: 10 million rupees

Fiscal Year	Haryana Power Generation Company	Haryana Power Transmission Company	Haryana Northern Power Distribution Company	Haryana Southern Power Distribution Company	Total
2013/14	-26.31	-175.14	-1,465.00	-2,089.00	-3,755.45
2014/15	104.77	-8.42	-1,481.00	-636.00	-2,020.65
2015/16	27.08	153.98	-465.00	-480.00	-763.94
2016/17	-32.29	74.99	-204.22	-11.96	-173.48

Source: HVPN
Note: FY 2016/17 is a predicted value.

The actual record of the operation and maintenance budget of the power transmission facilities (FY 2012-2016) is shown in Table 14. Although repair costs for the power transmission facilities temporarily increased in FY 2014/15, the operation and maintenance costs had a steady growth every year except for that year. According to HVPN, the operation and maintenance budget is sufficiently secured.

Table 14: Operation and Maintenance Budget of the Power Transmission Related Facilities

Unit: 10 million rupees

Fiscal Year	Power Transmission Facility	Haryana Power Station	Total
2012/13	1,371.08	145.66	1,516.74
2013/14	1,555.50	142.52	1,698.02
2014/15	3,983.26	82.98	4,066.24
2015/16	1,812.10	54.47	1,866.57
2016/17	2,325.64	60.03	2,385.67

Source: HVPN

The key financial data of HVPN (FY 2014/15-2016/2017) is shown in Table 15. Profitability has improved as shown in the increased rate of return on total assets since turning profitable due to the rise in electricity prices in 2015. Although, as it is in its 50 percent level, the current ratio showing the ability to pay is low, the equity to assets ratio is improving annually thanks to the annual increases of capital stock by the government of Haryana. In order to sustain this trend, electricity tariffs must be increased according to the HVPN investment plan.

Table 15: HVPN' Financial Data

Unit: 10 million rupees

Item	FY 2014/15	FY 2015/16	FY 2016/17
(1) Total Assets	989,352.02	1,022,684.66	1,043,657.52
(2) Current Assets	58,561.55	50,703.49	82,426.99
(3) Current Liabilities	115,424.12	126,711.20	149,435.36
(4) Capital	193,671.57	214,877.57	234,877.58
(5) Sales	137,764.15	169,746.45	169,823.13
(6) Net Profit	-842.01	15,285.58	6,925.69
Rate of Return on Total Assets (%) [(6) / (1) x 100]	0.99	1.49	0.66
Return on Sales (%) [(6) / (5) x 100]	-0.61	9.00	4.08
Total Assets Turnover (times) [(5) / (1)]	0.14	0.17	0.16
Current Ratio (%) [(2) / (3) x 100]	50.74	40.02	55.16
Equity to Assets Ratio (%) [(4) / (1)x100]	19.58	21.01	22.51

Source: HVPN

As for the power transmission tariff, the HPVN makes an application to the HERC which approves the new electricity tariff after careful examination. The HERC has approved the multi-year electricity tariff for the 3 years (including price adjustments every year) since 2015. The HERC compares the Annual Revenue Requirement[9] submitted by HVPN with its actual record, and makes the adjustment every year. In this case, the HERC is evaluating the benchmark of the HVPN performance achievement rate (system availability and transmission loss for power transmission) which is set in advance, and providing incentives to HVPN such as provision of additional funds equivalent to a certain percentage of its sales once the benchmarks are achieved. Tariff review has been conducted every year since 2015.

Therefore, no major issues have been observed in terms of the financial aspects of operation and maintenance.

3.4.4 Status of Operation and Maintenance

Site surveys were carried out on the four 220 kV substations completed by the project (Basta substation, Samalkha substation, Sector 20 substation and Sector 72 substation). It was found that the facilities were operated and maintained based on the predetermined manual, and that the operation and maintenance records such as log books were appropriately recorded and managed. There was no issue found in the storage and management status of the spare parts. There was no issue found in the equipment conditions or the operation status. No issue was observed in the procurement of spare parts as the GIS manufacture is also in India.

In light of the above, no major problem has been observed in the institutional, technical, financial aspects and current status of the operation and maintenance system. Therefore, sustainability of the project effects is high.

[9] Annual income that is necessary to provide appropriate services to the customers, cover the operation costs to include staff expenses and investment costs, and obtain appropriate profits.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The objective of this project was to ensure a stable power supply to meet rapidly growing power demand by developing an intra-state transmission and substation system in India's northern state of Haryana, thereby contributing to economic growth and improvement of living conditions in the region. The relevance of the project is high, as the objective was consistent with India's development policies and development needs as well as with Japanese ODA policies. The efficiency of this project is fair, as although the project cost was within the plan, the project period significantly exceeded the plan.

Regarding the operation and effect indicators of this project, such as the capacity operation rate of transmission lines and transformers and system availability, system availability mostly achieved its target values in 2017 (the project completion year). On the other hand, data could not be obtained by the executing agency for the capacity operation rate of transmission lines and transformers and therefore it was difficult to verify the level of achievement. However, the average capacity operation rate in 19 substations of the project was 72% in 2017 (the project completion year), which was verified to be lower than the target value of 75%. This means that the project substations were operated within their installed capacity and with enough remaining capacity. After the implemenation of this project, improvements such as increase in power supply time, stabiliztion of voltage fluctuation, and reduction in power outage hours and frequency were observed in the project target areas. For this reason, it was judged that the project objective of ensuring a stable power supply had been achieved. Also, this project had a certain positive impact on regional economic development through the reduction of operation and maintenance costs for backup power generators as well an increase in productivity and services for bulk electricity users in Gurgaon. Furthermore, there was an improvement of living standards in villages of the central part of Haryana state. No negative impact on the natural environment was observed, and land acquisition was appropriately executed in accordance with the related domestic laws and regulations of India. No resident resettlement was executed. Therefore, the effectiveness and impact of this project are high. Meanwhile, no major problem has been observed in the institutional, technical, financial aspects and current status of the operation and maintenance system. Therefore, the sustainability of the project effects is high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

None

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

(1) Setting a Project Period that is Appropriate for the Project Contents and the Ability of the Executing Agency

In this project, the actual project period was 108 months against a planned project of 30 months (ratio against the plan: 360%). There was an additional output where the procurement package was increased from a planned package of 10 to the actual package of 14 (total of 18 packages to include the split of the existing packages). There were many individual factors affecting the delay. Especially, delay accompanying the acquisition of land and the Right-of-Way, and performance of contractors were common factors of delay for many packages. Meanwhile, there were many procurement packages in the project, and no consultant was hired to support procurement and construction supervision as such no requirement for same was felt by HVPN. HVPN hires the consultants on need basis. In addition, the executing agency was planning to implement a World Bank project in parallel with this project. Considering the above circumstances, the planned project period set at the appraisal seems rather unrealistic.

The executing agency has a tendency not to hire consultants for implementation support of development projects in India's power sector unless there is a special exception. For a project in which employment of consultants is not expected, it would be ideal for JICA to plan a realistic project implementation schedule that can be carried out within the capacity and systems of the executing agency without hiring a consultant. This should be achieved through a sufficient discussion not only of the project implementation capacity of the executing agency, but also bearing in mind the project's characteristics, the number of packages, the implementation risks, and the impacts of on-going or planned development projects by the executing agency when formulating the project.

(2) Establishing Indicators to Measure the Individual Performance of Project Facilities

The capacity operation rate and system availability were set as the operation and effect indicators for the substations of this project. However, these baseline and target values were for the entire state of Haryana, and no operation and effect indicators were set for individual substations. The project facilities are equivalent to 4.5% of the total number of substations and 5.6% of the total power transmission lines in HVPN, and therefore the scale of the project in the

entire HVPN transmission system is limited. In general, if there is a statewide capacity operation rate and system availability, the performance of an individual substation is considered to be comparable. However, it would be ideal to establish operation and effect indicators for individual substations if possible in order to support the overall trends of data.

End

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
(1) Project Outputs (a) Procurement and installment of power transmission lines, transmission towers, and related facilities	Total length of transmission lines: 492 km	Total length of transmission lines: 582.7 km
(b) Procurement and installation of transformers and substation related facilities (circuit breakers, switching, current transformers, arresters, insulators, etc.)	220 kV Substations: 14 locations	220 kV Substations: 13 locations 132 kV Substations: 6 locations
(2) Project Period	March 2008 - August 2010 (30 months)	March 2008 - February 2017 (108 months)
(3) Project Cost Amount Paid in Foreign Currency	21,287 million yen	385 million yen
Amount Paid in Local Currency	5,077 million yen (1,781 million rupees)	18,147 million yen (10,026 million rupees)
Total	26,364 million yen	18,532 million yen
ODA Loan Portion	20,902 million yen	11,809 million yen
Exchange Rate	1rupee = 2.85 yen (As of October 2007)	1 rupee = 1.81 yen (Average between 2008-2016)
(4) Final Disbursement	March 2016	

Kingdom of Bhutan

FY2017 Ex-Post Evaluation of Japanese ODA Loan Project

"Rural Electrification Project"

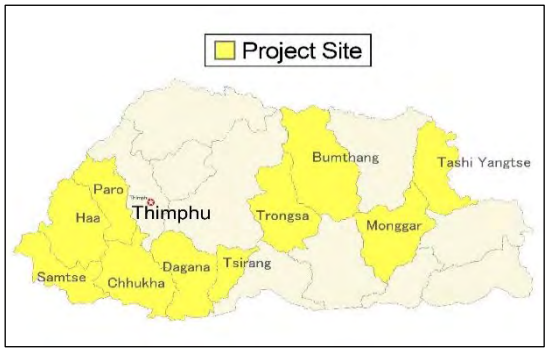
External Evaluator: Mitsue MISHIMA, OPMAC Corporation

0. Summary

The project aimed to improve access to electricity for unelectrified households by developing power distribution networks in rural areas of Bhutan where the poverty rate is high, thereby contributing to an improvement in the living environment of rural residents, including the poor, and the promotion of economic and social activities in these areas. This project is highly relevant as it aligns well with "Gross National Happiness (GNH) ", a unique concept set out by the Royal Government of Bhutan as the principle of national development, with the national development plan priorities based on GNH and development needs as well as with Japan's ODA policies. The efficiency of the project is fair, as it was completed within the planned project cost, but with the project period exceeding the plan. Electrification was promoted generally as planned in the target rural areas contributing to an overall improvement of electrification rate on the national scale. The effectiveness and impacts of the project are high; electricity consumption is increasing steadily, showing early signs of various socioeconomic impacts that align with the GNH concept. Bhutan Power Corporation limited (BPC), the organization responsible for the operation and maintenance (O&M) of the project, has increased their number of staff to respond to the rapid rural electrification progress. To improve its operation and maintenance in remote areas where road access is limited, BPC is training local technicians, helping them to conduct O&M, and making efforts to enhance their capabilities. The financial status of BPC and the O&M of the facilities are in a good state. Therefore, the sustainability of the project is high.

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

1. Project Description



Project Location[1]

Power Distribution Transformer and 33kV Power Lines (Monggar Dzongkhag, Narang Gewog[2])

1.1 Background

Bhutan has taken advantage of its ample water resources to generate more electricity (485MW as of June 2006, increasing to 1,505MW after all generators of the Tala Hydro Power Plant started operations in March 2007) than its national demand (128MW as of June 2006). Electricity exported to India is Bhutan's major source of foreign exchange. However, only 39.0% of Bhutan's rural households had access to electricity as of 2005. Improved access to electricity in rural areas was urgently needed.

The government of Bhutan maintains GNH as its fundamental development principle to achieve an equal, happy society without relying on economic growth measured by GNP. A long-term *A Vision for Peace, Prosperity and Happiness* was defined in 1999, in which road construction and rural electrification were identified as important policy goals in terms of the correction of urban-rural disparity, poverty reduction and the promotion of industries. Under the long term vision, a goal was set for "100% household power access by 2020 at the latest " in *The 9th five-year plan* (July 2002 - June 2008).

Under these circumstances, the rural electrification master plan was formulated in October, 2005, with support from JICA in order to achieve the 100% rural power access goal. This project was proposed as part of the Bhutan government's *10th five-year plan* (July 2008 - June 2013), carried out under the master plan.

1.2 Project Outline

The project aimed to improve access to electricity for unelectrified households by developing power distribution networks in rural areas of Bhutan where the poverty rate is high, thereby contributing to an improvement in the living environment of rural residents and the promotion of

[1] Prepared based on the national land map of 2013 by the National Land Commission (NLC).
[2] As administrative units in Bhutan, there are Dzongkhag (Districts) and then the Gewog, which is an administrative unit within a Dzongkhag. Gewog consist of Chiwog which comprise one or more villages.

economic and social activities in these areas.

Loan Approved Amount/ Disbursed Amount	3,576 million yen / 3,237 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	April 2007 / May, 2007
Terms and Conditions	Interest 0.01%
	Repayment Period (Grace Period) 40 Years (10 Years)
	Conditions for Procurement General Untied
Borrower / Executing Agency	Government of Bhutan / Department of Renewable Energy, Ministry of Economic Affairs (DRE)[1]
Project Completion	June 2014
Main Contractor(s) (Over 1 billion yen)	—
Main Consultant(s) (Over 100 million yen)	Nippon Koei Co., Ltd.
Related Studies (Feasibility Studies, etc.)	• "The Integrated Master Plan Study for Dzongkhag-wise Electrification in Bhutan" (2003-2005) • "Special Assistance for Project Formation (SAPROF) for Bhutan Rural Electrification Project" (March 2006)
Related Projects	Technical Assistance Project Related to ODA Loan "Improvement of Efficiency for Rural Power Supply" (Phase I: June 2008 to June 2011, Phase II: March 2012 to September 2014)

Note: 1. Department of Energy, Ministry of Trade and Industry (DOE) at the time of Loan Agreement (L/A) signing

2. Outline of the Evaluation Study

2.1 External Evaluator

Mitsue, MISHIMA, OPMAC Corporation

2.2 Duration of Evaluation Study

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

Duration of the Study: December 2017 – January 2019

Duration of the Field Study: January 27 - February 16, 2018, May 26 - June 1, 2018

2.3 Constraints during the Evaluation Study

As for the selection of target areas for qualitative study regarding project effectiveness and impacts, coverage of areas with various characteristics (remote areas, high poverty rates, etc.) was attempted. However, the study was limited to areas relatively accessible from main roads due to time and budget constraints.

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

3.1 Relevance (Rating: ③[4])

3.1.1 Consistency with the Development Plan of Bhutan

From the time of appraisal of the project to the present, rural electrification has been one of the major priorities for the Royal Government of Bhutan.

At the time of project assessment, rural power access was identified as an important state goal in the long term "Vision for Peace, Prosperity and Happiness" (1999). Under this long term vision, the 9th five-year plan (July 2002 - June 2008) set the goal of 100% rural power access by 2020. The subsequent 10th five-year plan (July 2008 - June 2013) and 11th five-year plan (July 2013 - June 2018) both continued to focus on rural power access, targeting an early completion of the 100% rural power access by 2018, instead of 2020 as specified at the time of appraisal . The Royal Government of Bhutan, elected by the people for the first time in 2008, targeted an even earlier completion of 100% power access by 2013, indicating the priority issue to be solved at the early stage. DRE, which is responsible for rural electrification, is working on the *12th five-year plan* (draft as of May 2018) with a call for "Electricity for All" and a target of 1600 households on grid[5] (including 1,429 households currently on solar power + 100 households currently without power), in an effort to increase as much on-grid power access as possible.

3.1.2 Consistency with the Development Needs of Bhutan

Most of the land in Bhutan consists of steep mountains with poverty-ridden villages scattered throughout the country (see Photo 1). At the time of project assessment, 70% of Bhutan's population was in rural areas, and only 39% of rural households had access to electricity (2005).

Photo1: Monggar Dzongkhag, Narang Project Target Area

In Bhutan, poverty reduction has remained a priority from the time of appraisal to the ex-post evaluation. Improved access to energy is one of the GNH indicators underlined by the Royal Government of Bhutan. According to a social survey conducted when the rural electrification master plan was being created, power access was regarded as the most important issue by rural residents, and it was expected that power access would contribute to improvements in the quality of life, to poverty reduction and

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

[4] ③: High, ②: Fair, ①: Low

[5] Power supplied from lines connected to the nation-wide transmission and distribution system as opposed to independent "off-grid" supply sourced from a localized system enabled by solar and/or small-scale hydro generation.

socio-economic development. When the project was started, it was confirmed that there has always been a high need for electricity for rural residents.

3.1.3 Consistency with Japan's ODA Policy

At the time of project assessment (2007), one of the four key areas in the *Country Assistance Policy for Bhutan* was "economic infrastructure development" including improvement of rural power access, which makes the project consistent with Japan's ODA policy. The assistance policy in the *Medium-Term Strategy for Overseas Economic Cooperation Operations for Bhutan* (April 2005) identified support for poverty reduction as an important area, emphasizing "support in areas with many poor households" which included rural infrastructure development. The project is also consistent with this policy.

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

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

Although the project execution agency was defined as DRE, BPC was responsible for equipment procurement and construction works (See Table 1 for planned and actual project output). Reasonable explanations have been given for all the differences between the planned and actual.

According to BPC, the difference in the number of target villages resulted from the administrative change in how the villages were counted from the time of appraisal to when the project was executed. There was no significant change in the villages covered by the project. The number of connections changed in response to the actual situation which surfaced when a more detailed survey was conducted. Similarly, the difference in the new installation / rehabilitation of medium voltage lines is explained by the actual measurements collected by the detailed survey turning out to be different from the plan. As for the change in consulting services, development support for capacity building (such as for equipment inventory and management) was not fulfilled. This is a reasonable change, as BPC was already capable of these tasks at the time of project execution and no support was needed, according to BPC and the executing consultant. Meanwhile, phase 2 project preparation was beginning while the project was under way, so a preparation service for phase 2 bidding was added to the consulting service. As such, the difference in consulting services was a response to the actual needs of the time. Power transformers were stored in warehouses in various areas as spare parts, but they were already almost all in use in these areas at the time of the ex-post evaluation.

Table 1: Output Plans and Actuals

Items	Plan (at the time of appraisal)	Actual
Target	10 Dzongkhag: Bumthang, Chukha, Dagana, Haa, Monggar, Paro, Samtse, Trashi Yangtse, Trongsa, Tsirang 547 Villages 15,322 households	As planned 1,132 Villages 16,241 households
Constructions (1) Medium voltage (33kV/11kV) lines new installation and rehabilitation	76 feeders, total length 912km	64 feeders, 1,024km
(2) New low voltage lines and supporting devices	Total length: 1,478 km	Total length: 1,692 km
(3) Transformer installation	1,310	1,159 (1,077 installed and 82 stored at warehouses as spares)
(4) Consulting services	(i) Review of the detailed design of the project, preparation of tender documents and construction supervision (ii) Setting of indicators and targets useful for operation and maintenance (iii) Capacity building of the executing agency other relevant entities	(i) and (ii) as planned. (iii) training was canceled, phase 2 bidding preparation added instead.

Source: JICA document, Questionnaire to BPC

3.2.2 Project Inputs

3.2.2.1 Project Cost

The total project cost came within the plan at 3,681million yen compared to the 4,357 million yen of the plan (84% of the plan). The Japanese ODA loan portion was 91% of the plan, and the portion paid by the Royal Government of Bhutan came at 75% of the plan. According to the breakdown in Table 2, procurement costs of materials and equipment went up while taxes came down significantly. Resources and equipment transportation, construction and consulting services also came down. According to a BPC report, there was actually exemption for most of the taxes budgeted for in the plan, resulting in the negative difference. The decrease in costs can also be explained by smaller price tags for materials and equipment transportation and construction due to competitive biddings and fluctuation in the yen-ngultrum exchange rate (24% reduction) during project implementation.

Table 2: Project Cost (Plan/Actual)

Unit: million yen

Items	Plan (2007)		Actual (2015)	
	Total	ODA Loan portion	Total	ODA Loan Portion
Procurement of Materials and Equipment	2,048	2,048	2,572	2,438
Transportation of Materials and Equipment and Construction Works	862	862	687	683
Consulting Services	188	188	115	115
General Administration	286	0	288	0
Tax and duties	495	0	17	0
Interest During Construction	1	1	1	1
Price Escalation	169	169	—	—
Physical Contingencies	308	308	—	—
Total	**4,357**	**3,576**	**3,681**	**3,237**

Source:JICA and BPC Documents

Note: Exchange rate at the time of appraisal:US$1=Nu.45.5(Nu=Ngultrum, currency unit of Bhutan), US$ = JPY 117, Nu.1 = JPY2.57 (Cost Calculation in January, 2007), Actual exchange rate US$1=Nu. 51.43, US$ = JPY 98.52, Nu.1 = JPY1.95 (IMF International Financial Statistics (IFS) annual average exchange rate: 2007-2015).

3.2.2.2 Project Period

The planned project period was from May 2007 (L/A signed) to December 2012 (68 months). The actual was from May 2007 (L/A signed) to June 2014 (86 months) exceeding the plan (126% of the plan). This was mainly due to delays in the transportation of materials and equipment and in construction (18 months' delay). Delays in the transportation of equipment were because the project covered remote areas in the mountains without road accessibility.

Table 3: Project Period Plan and Actual

	Plan	Actual
L/A Signing	May, 2007	May, 2007
Consultant Selection / Contract	April 2007 - July 2008	April 2007 - July 2008
Detailed Design Survey / Bidding Preparation	April 2007 - September 2010	April 2007 - May 2008
Procurement of Materials and Construction Bidding	April 2008 - September 2011	October 2008 - January 2011
Transportation of Materials and Civil Works	April 2009 - December 2012	April 2009 - June 2014
Project Completion	December 2012	June 2014

Source: BPC Document, answers to questionnaires

Note: Definition of project completion of the project is the commencement of operation of all target facilities

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

At the time of appraisal, the Economic Internal Rate of Return (EIRR) was calculated for the items below. Compared to the 14% EIRR at the time of appraisal, for the time of the ex-post evaluation it was calculated at 9.4% (with Project Life starting in the year when the L/A was signed) and 10.2% (with Project Life starting in the year of completion). It was estimated that power consumption would increase by 3% annually at the time of appraisal, but the actual was 0.6% annually, resulting in the smaller EIRR.

(Conditions for calculation)

Cost: Project cost (not including taxes), operation and maintenance expenses

Benefits: Effect as alternative to existing energy sources (wood, kerosene, etc.), increase in revenue from electricity sale.

Project Life: 30 years

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

3.3 Effectiveness and Impacts[6] (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

(1) Percentage of electrified rural households and numbers achieved through this project

In comparison of planned and actual Operation and Effect Indicators, the actual number of households by the project came to approx.106 % of the plan (Plan: 15,322, actual: 16,241). At the time of completion, the project had contributed to 18% of electrified households in rural area in the country. This contribution rate in two years from project completion had been estimated at 17% at the time of appraisal, showing a very close result. The 100% electricity access goal was not achieved by 2013 as the Royal Government of Bhutan had hoped. However, as of 2014 (project completion year), the rural electrification rate in all Bhutan had already reached 97% and in 2016 it was achieved at 99.5%. The goal to hit 100% by 2018 is likely to be achieved. At the time of appraisal, it was estimated that the rural electrification rate would be 83.9% two years after project completion (2014), but the project was accelerated as the Royal Government of Bhutan revised its goal to achieve 100% earlier, by 2013.

It is possible that this project and the subsequent program (Rural Electrification Project Phase 2), as well as ADB loans to rural electrification projects provided in parallel with Japanese ODA loans, contributed to a speedy development. It should be pointed out that the nation-wide master plan led by JICA clarified the economic importance and priorities of rural electrification paving the way to speedy way to determine the projects.

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

Table 4: Rural Electrification Rate and Number of Households[1] through the Project

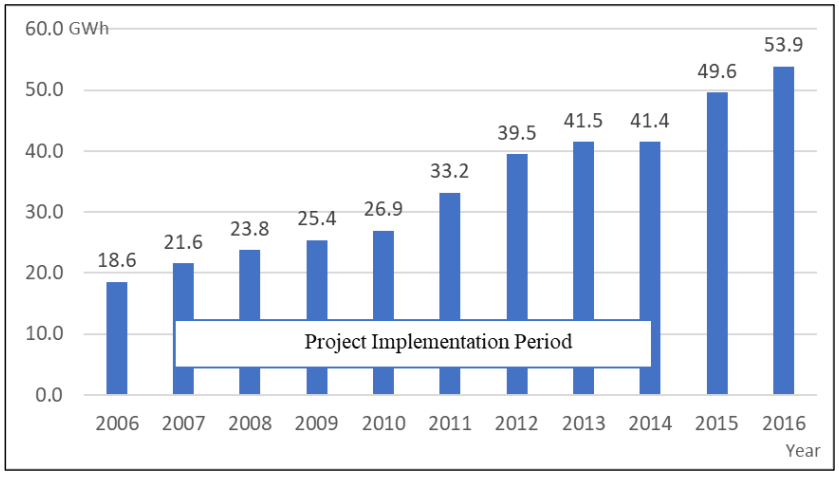
	Baseline	Target	Actual		
	2006	2014	2014	2015	2016
	Baseline year	2 years After Project Completion	Project Completion Year	1 year After Project Completion	2 years After Project Completion
(1) Rural Electrification Rate[1] (%)	56.3[2]	83.9	97	98	99.5
(2) Contribution by the Project to Total Households (%)[3]	—	17.4	18.7 (as of November 2015)	—	—
(3) Number of Households by the Project[4]	—	15,322	16,241	—	—

Source: JICA and BPC documents, etc.
Note 1: This term is described "Electrification rate of households in rural areas" in Ex-ante evaluation document of this project, indicating "electrification rate of rural households at national level". The term "rural electrification rate" is used in this table.
Note 2: Estimated as of June, 2007
Note 3: This figure includes institutions such as schools, health units, temples, government buildings, etc
Note 4: Calculated as an approximate percentage of the total number of electrified households by the project to the total number of the electrified households by BPC.

(2) Electricity Consumption

The Ex-ante evaluation document shows the actual amount of electricity sold at the time of appraisal (617Gwh) and the target amount to be sold two years after project completion (843Gwh), assuming a 36% growth.

This figure is close to the total electricity sold in the target Dzongkhag, including the urban areas. This project specifically targeted rural areas and thus the analysis of electricity consumption focuses only on rural households over the years after the appraisal. Among the rural households covered by this project, power consumption more than doubled from 21.6GWh in 2007 to 53.9Gwh in 2016, two years after project completion. It is possible to conclude that the effects of the project are included in this growth.



Source: BPC "Power Data Book" (2016) p.34-70, total power consumption in rural households target dzongkhags only.

Figure 1: Rural Domestic Electricity Consumption Trend Covered by the Project

The Ex-ante evaluation document indicated that a collection rate of electricity charges would be maintained at 95% in two years after project completion. In 2016, two years after project completion, collection rate of electricity charges was 97.2%. This collection rate is not a direct effect of this project. This will be analyzed in "4. Sustainability".

3.3.1.2 Qualitative Effects (Other Effects)

Qualitative effects of the project identified at the time of appraisal were: (1) better living conditions (more opportunities to access information, improved educational and health care / hygiene environments, and reduced domestic labor) and (2) promotion of socioeconomic activities. A comprehensive analysis of these effects is described in the next section "3.3.2 Impacts".

3.3.2 Impacts

3.3.2.1 Intended Impacts

A qualitative study was conducted by interviewing residents in the target areas and collecting observations on how access to electricity has realized the intended effects and impacts (improvement in the quality of living and the vitalization of socioeconomic activities). As shown in Table 5, a total of 101 residents were interviewed in five Gewog in four Dzongkhag.

Table 5: Qualitative Survey Target Areas and Interviewees

Interviewees	Selected Areas/Institutions/Target people			
Dzongkhag officers[1] (4)	Chukha	Tsirang	Trongsa	Monggar
Gewog officers (12)	Logchina	Mendrelgang	Dragten Langthel	Narang
Representatives of Chiwogs = (Tshopas, 9)[2]	Zedokha	*Tashhipang *Mendrelgang *Pemashon *Riserboo *Dzomlingkhor	Baling Jangbi Dang Dung	*Khalong *Thrinangphu *Gomchu *Narang Pangkang
Public facilities Officers (18)	School Community Center BHU	-	School Community Center BHU RNR Office	School Community Center BHU RNR Office
Villagers (58)	Senior Citizen Adult Male, Female Members of Farmer Group Youth (in their 20's)	-	Senior Citizen Adult Male, Female, Students (in the 10s) Members of Farmers Group Business Owners	Senior Citizen Adult Male, Female Monk Members of Farmers Group Youth (in their 20's)

BHU: Basic Health Unit, RNR: Renewable Natural Resource
Note 1: It was mainly Dzongkhag Development Planning Officers that were interviewed. The Dzongkhag officers in Monggar were absent due to a national event and could not be interviewed during the site survey
Note 2: In Chiwog marked "*" representatives could be met and were interviewed. No "*"shows the chiwogs where only public facilities officers and villagers were interviewed.

Target locations for the interview survey were selected based on the number of beneficiaries, and where there were no constraints on the safety, poverty rate and GNH indicators. The

Chukha, Trongsa and Monggar Dzongkhag were selected representing western, central and eastern Bhutan. Furthermore, target Gewog were selected from these places through purposive sampling with consideration of: 1) local accessibility and safety, 2) number of beneficiaries, 3) the socioeconomic situations of the target villages[7]. Tsirang was added to the list, as it was located on the way to the other three Dzongkhag and representatives of the Dzongkhag, Gewog and villages were available for interviews. Interviewees were selected in order to collect diverse observations including administrative staff (Dzongkhag / Gewog officers, Chiwog representatives, Renewable Natural Resource Center (RNR) staff, school teachers and Basic Health Unit staff), rural residents of various age groups (from teenagers to seniors in their 90's) and occupations (farming groups, business owners, monks)and ensuring a gender balance. Questions were asked regarding status and changes before and after electrification, as well as about positive and negative effects and impacts at the household and regional levels. These interviews employed a semi-structured method recording raw observations and the opinions of interviewees.

As shown in Table 6 and 7, results from the qualitative research confirmed the apparent effects and impacts in many locations with regard to the intended 1) improved living conditions and 2) increased socioeconomic activities, as specified at the time of appraisal. Many pointed out a significant decrease in wood and kerosene use, and some even stated this as the most significant impact. Before electricity, wood was the energy source for cooking, and collecting wood was a time-consuming chore. For lighting, people used to rely on lamps using kerosene, which is a costly source of energy. With electricity, time which used to be spent on wood collection and kerosene purchase can be used for other productive activities. Also, burning less wood has resulted in better hygiene. These comments were commonly voiced in all locations. For household activities, electric appliances have reduced time spent on domestic chores enabling women to spend more time on weaving. Other observations included more efficient farming with electric machinery, additional activities such as poultry farming, better services in administration, education and healthcare, all thanks to newly installed equipment. These impacts are also pointed out in existing evaluations on rural electrification[8]. Access to electricity not only enables better education, healthcare and administrative services but also changes how people can utilize their time, creating a synergy for additional impacts. (See Box: Logic flow for improvements in education, healthcare and administrative services in relation to Bhutan's Rural Electrification projects).

[7] In reference to JICA Theme Evaluation, *Consideration on Economic and Social Indicators of Rural Electrification* (2003), the target villages were selected in view of difference in access to the road. There are characteristics such that: Logchina Gewog and Dragten Gewog are near a main road which was constructed before this project; to Langthel Gewog, it takes about 2 hours by foot from the nearest road, Narang gewog has improved road access during this project implementation. In addition, Langthel Gewog has an ethnic group with traditional clothes and customs, called the Monpa. The Monpa community was targeted.

[8] For example, World Bank (2008) "The Welfare Impact of Rural Electrification: A Reassessment of the Costs and Benefits", etc.

Improved education, healthcare, administrative services and machine-aided farming are also due to initiatives of the Royal Government of Bhutan from before and after the time of project completion, which focused on IT enablement. These provided new community centers in rural areas, new IT classes at schools, more electric equipment for health service units and more loans granted for farm machineries. At around the same time as this project, improvement of road accessibility is a factor that can be said to have contributed to the intended economic development impacts in many ways with this project. For example, better access to the urban market through road access improvement can lead to an increase in sales channels for an increased volume of agricultural products.

With regard to poverty reduction, it was mentioned that the project had had an impact in the form of increased income in Langthel Gewog in Trongsa and Narang Gewog in Monggar Dzongkhag, where the poverty rate is relatively high. Unlike in Chukha, where the poverty rate is relatively low, people in these villages pointed out that they were able to start growing vegetables using the time saved by electricity, which helped with food security. From this, it is possible to say that the project had an impact on poverty reduction.

An interesting view was shared by Gewog representatives in multiple locations who said that there is a tendency for young people who had left their villages to return from the city now that rural life can offer the conveniences that come with electricity. Thus, the population drain from rural to urban areas is alleviated. Further investigation would be required to determine whether rural electrification projects actually contribute to a prevention of population drain from rural areas to urban centers.

Table 6: Answers on Effects and Impacts of the Project according to Region and Target Interviewees

Public Administration and Service Institution Officers

Effect/Impact		Chukha			Tsirang			Trongsa						Monggar				
		Logchina Gewog			Mendrelgang Gewog			Drangten & Langthel Gewogs						Narang Gewog				
		Dzongkhag Officer	Gewog Officer	School	Dzongkhag Officer	Gewog Officer & Chiwog Representative	School	Dzongkhag Officer	Gewog Officer	School	Community Center	BHU	RNR	Gewog Officer	Community Center	School	BHU	RNR
Improvement of Living life	Decrease in domestic chores		■			■		■	■	■						■		
	Work/study in early morning / evening		■	■		■	■		■	■	■			■		■		■
	Less use of wood / kerosene		■	■		■		■	■	■	■	■		☆		■	■	
	Better access to information / communication		■	■		■	■	■	■	■			■	■	■	■		■
	Better educational activities	■	■	■	■	■	■	■	■	■			■	■		■	■	
	Better healthcare / hygiene	■	■	■		■		■	■	■	■	■	■			■	■	☆
	More efficient admin. services		■	■	■	■		■	■	■	■	■	■	■	■		■	
	Better use of time		■	■		■	■	■	■	■	■		☆	■	■	■		■
Development of Economic and Social Activities	More efficient farming	■	■		■	■		■	■				■	■	■			
	Less damage/loss of crops				■			☆	■				☆					
	Increased farming activities					■			■				■	■	■	■		■
	Increased commercial activities		■		■													
	Increased business activities								■									
	Increase in Income		■			■			■							■	■	☆
	Vitalization of Community Activities and Events		■			■	■	■	■	■						■		

Villagers

Effect/Impact		Chukha					Trongsa						Monggar					
		Logchina Gewog					Langthel Gewog						Narang Gewog					
		Senior	Farmer G	Adult Women	Adult Men	Youth	Senior	Farmer G	Adult Women	Adult Men	Students	Business Owners	Senior	Farmer G	Adult Women	Adult Men	Youth	Monk
Improvement of Living life	Decrease in domestic chores	■	■	■			■	■	■	■		■			■	■	■	
	Work/study in early morning / evening	■		■	■			■	■	■	■		■	■	■	■	■	■
	Less use of wood / kerosene	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Better access to information / communication			■		■		■		■	■	■	■	■	■	■	■	■
	Better educational activities			■	■	■			■		■			■	■	■		
	Better healthcare / hygiene	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■
	More efficient admin. services	■			■	■		■					■	■	■	■	■	■
	Better use of time	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Development of Economic and Social Activities	More efficient farming		■		■	■		■					■	■	■	■		
	Less damage/loss of crops				■	■	■		■	■						■		
	Increased farming activities		■			■		■		■		■		■			■	
	Increased commercial activities														■			
	Increased business activities											■				■	■	
	Increase in Income	■	■	■	■		■	■	■	■		■	■	■	■	■		■
	Vitalization of Community Activities and Events						■						■		■			■

Source: Interview Results

Note: In the above table, senior means those in their 70s and upwards, adult male and female groups are in their 30's to 60's, Students are in their teens, and the young are in their 20's. ■ are effects and impacts which were commonly pointed out in each group. ☆ is the item emphasized as the most significant impact.

Table 7: Main Comments on Effects and Impacts of the Project

(1) Better living conditions	
Decrease in domestic chores	With household appliances (rice cookers, washers etc.), less time is spent on domestic chores.
Work/study in early morning / evening	Longer hours at school in the early morning / evening. At home, lighting enabled farming and reading during early / late hours. More time to study at home for children.
Less use of wood / kerosene	Less reliance on wood and kerosene.
Better access to information / communication	Internet and mobile phones provide access to information and better communication means. Better access to information through mobile phones, PCs, TVs. (Some see this as a negative impact with more time spent on screen) Shorter time needed for invitations to community meetings by mobile phone.
Better educational activities	Enrichment of classes with AV equipment use. IT education with computers, commencement of non-formal education in evenings.
Better healthcare / hygiene	Healthcare units can now provide timely treatment and prevention with use of refrigerator for medicines. Life-saving and weight measuring equipment, and other devices have improved healthcare services for newborns. Night-time childbirth and other emergencies supported better with lighting. At home, air quality is improved by eliminating indoor wood burning and kerosene lamps. Cleaner air with no soot has helped reduce respiratory problems.
More efficient admin. services	More efficient services at Gewog offices and community centers with use of PCs and printers. In addition, at RNR offices, refrigerators were introduced after electrification and thus medicine such as vaccines for livestock could be stored, which led to timely support.
Better use of time	Less need for time-consuming wood collection. The time saved now used for new activities by adults and children alike. With less time spent on household chores people can spend more time on leisure. Women can spend more time weaving in the evenings.
(2) Enhanced socioeconomic activities	
More efficient farming	More efficient farming with power equipment (dryers threshers, etc.). Lighting enabled night-time farming.
Less damage / loss of crops	Electric fences keep off wild animals reducing damage to crops (30% - 40% damage reduction).
Increased farming activities	Formation of dairy production cooperatives to purchase equipment for producing cheese, butter, yogurt etc. More efficient farming and less time spent on wood collection led to additional farming activities such as poultry and vegetable farming.
Increased commercial/business activities	More retail and new businesses such as auto repair, brick production etc. More efficient carpentry with power tools.
Increased income	Increased income due to reduced damage to crops, additional farm products, secondary income from weaving
Vitalization of Community Activities and Events	Revitalized community events using lighting and microphones (festivals etc.). Longer visitor hours at temples by the light during night.

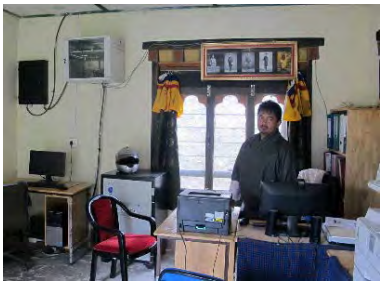


Photo 2: Langthel Gewog Community Center,
Trongsa Dzongkhag

Photo 3: Class Room in Central School, Mendelgang Gewog,
Tsirang Dzongkhag

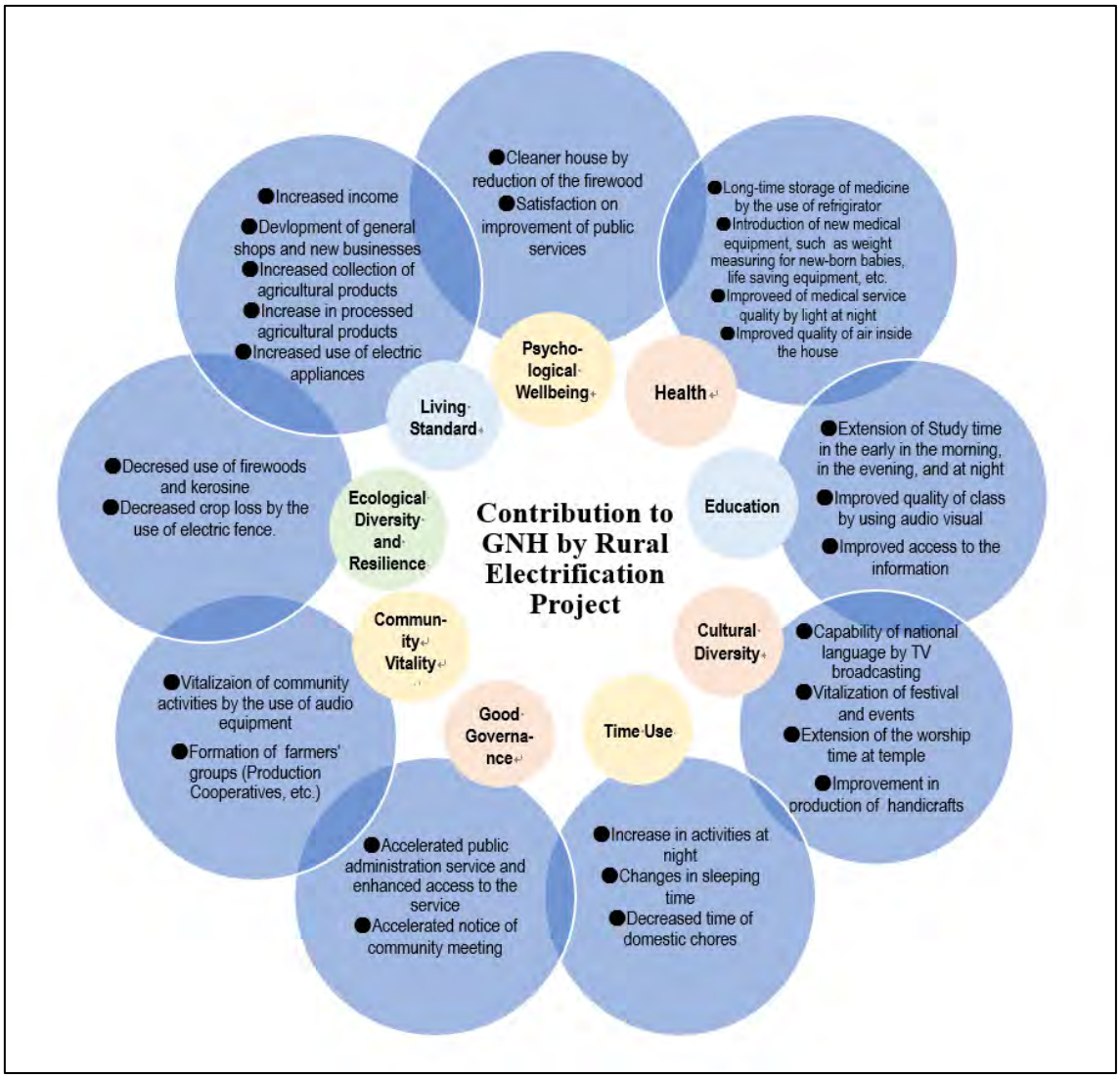
Photo 4: Langthel Gewog, Trongsa Dzongkhag
Left: House electrified by the Project
Right: Storage for Potatoes, where temperature is controlled by the electricity supply

Photo 5: Weaving at night

Photo 6: General Shop

Photo 7: Electric Appliances
(Rice cookers and a water boiler)

Figure 2 illustrates how the effects and impacts discussed above align with the nine domains of GNH, the development principle embraced by the government of Bhutan: (1) Psychological Wellbeing, (2) Health, (3) Education, (4) Cultural Diversity and Resilience, (5) Time Use, (6) Good Governance, (7) Community Vitality and Resilience, (8) Ecological Diversity and Resilience, (9) Living Standards. The effects and impacts of this project are likely to have positive ones in respective GNH domains, that is, it can be considered that the project is contributing to the betterment of GNH.



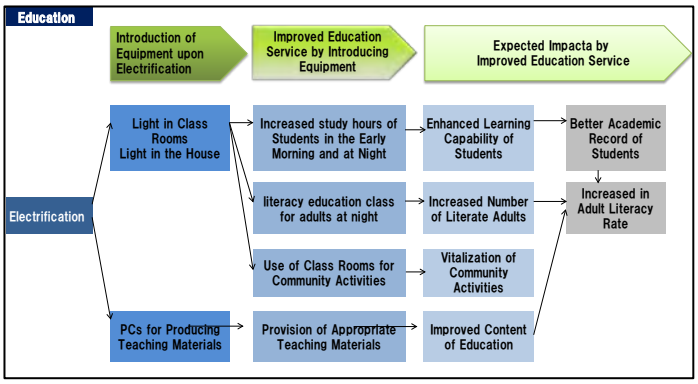
Source: Result of qualitative interview for the Ex-post evaluation on the Project

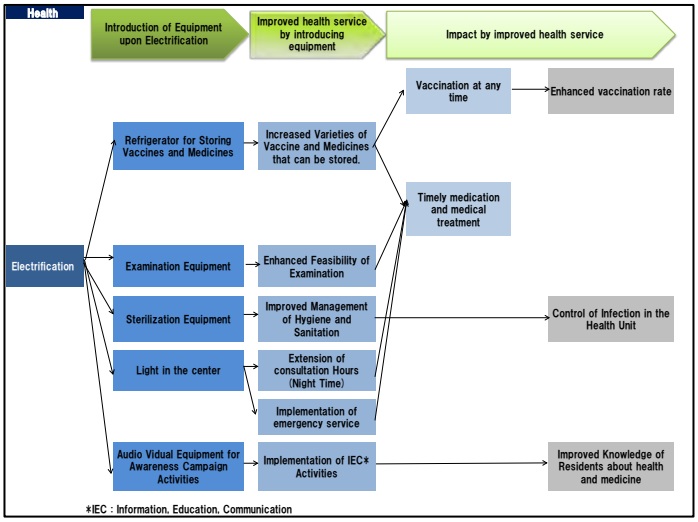
Figure 2: Contribution to GNH in Bhutan by the Project

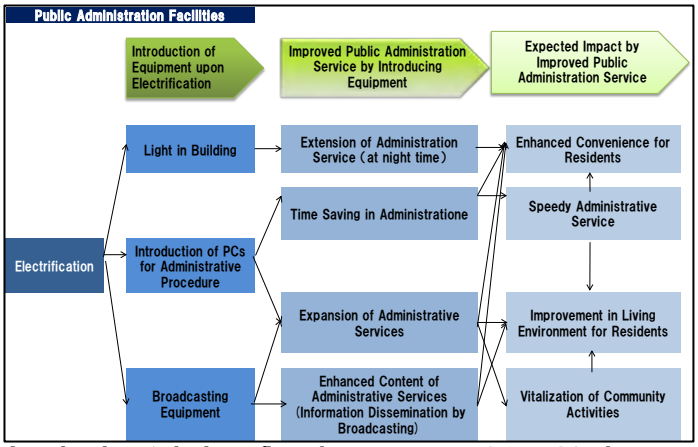
[Box] Discussion of the Logic Flow of the Effects and Impacts of the Rural Electrification Project in Bhutan

Logic flow charts of the effects and impacts of the rural electrification project on the education, health and public administration sectors are presented below, referring to (and partly editing) charts in the JICA Theme Evaluation "Study on Economic and Social Effect Indicators of Rural Electrification (2013)". Education, health, and public administration services were improved thanks to the introduction of electrical equipment and the expected impacts as a result of these improved services are shown in the charts below. The improved services in the charts were verified through the qualitative survey in this ex-post evaluation. In the survey, opinions were collected commenting that electrification had had impacts on improving the academic record of students, enhancing the vaccination rate, on more timely medication and better medical treatment. To what extent the project contributed to the realization of these impacts, however, requires further verification.

Chart: Logic flow of Education, Health and Public Service Improvement by Rural Electrification in Bhutan







Source: Referring to (and partly editing) the logic flow charts on pp. 11-13,15 JICA Theme Evaluation " Study on Economic and Social Effect Indicators of Rural Electrification (2013)"

[Column] Voices of Beneficiaries about the Effects and Impacts of Rural Electrification in Bhutan

Electricity has given us the gift of light; making our night into day··· Seeing urban Bhutan with electricity always invoked a sense of longing and I always imagined its arrival in my community. Now with electricity I feel a sense of equality and also opportunity for my household and community. (96 year-old Woman, Narang Gewog, Monggar Dzongkhag)

When we went to the school, we used to wake up in the dark and help with bringing in firewood before going to school. Every week we also carried a certain amount of firewood for cooking to the school as a contribution to the school. When we studied in the house at night, we used to study in very dim light and in stuffy rooms filled with smoke, giving us constant coughs and watery and red eyes.
After electrification, the inside of the house became clean and visibility increased.
Before electrification, collecting firewood, fetching water, guarding the crops and caring for the livestock took up all our time in addition to attending school. Weekends and holidays were generally spent either collecting firewood or taking livestock to pasture. With electricity, we have more time to use as we want. Before electrification, we were always disappointed when we visited our villages and sensed that we were missing out. However, with electrification, we are able to feel a sense of comfort.
(Woman and men in their 20s, Narang Gewog, Monggar Dzongkhag)

Before electrification, a lot of time was consumed in collecting firewood. After electrification, this work was not required, and we had more time. With more time, people started to grow vegetables, gaining cash income and having more variety in their meals. With an electric fence around the farm land, it became unnecessary to have a guard to protect the crops during the collection period. Before electrification, the crop collection ratio was roughly 50% – but now it is about 80%.
(Man in his 40s, Langthel Gewog, Trongsa Dzongkhag)

Now with electricity, we have been able to study from 5 am to 7 am in the early morning and from 7 PM to 10:30 PM at night. In the kitchen, firewood became unnecessary as we had electric cooking appliances and a boiler. We have a refrigerator for storage and fans in the dining room. Electrification has lit up the temple at night for people to visit. The temple also has more contributions from the community in cash as community members now have cash income thanks to electrification. (Monk, Narang Gewog, Monggar Dzongkhag)

Before electrification we had to work in the house with very low visibility. The inside of the house was dirty and stuffy due to smoke from use of firewood. We suffered from food insecurity and had very little time for anything other than being involved in the household work. After electrification we started to use electric appliances. Children are able to study at night better, hygiene and health have improved, more information sharing is done by mobile phone, and we have more safety and security. Everything has become much easier and convenient.
(Woman in her 40s, Narang Gewog, Monggar Dzongkhag)

With electrification, rearing the cow is now much easier at night. We have more time and energy now as a result of a drastically reduced time for housework thanks to electric cooking appliances, and we are able to work for a longer time until night. This has made it possible for us to own more livestock. Additional animals increased our income. In addition, after electrification, government support services for the rearing livestock (RNR) have improved.
(Woman in her 50s, Logchina Gewog, Chukha Dzongkhag)

3.3.2.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

At the time of appraisal, this project was classified as Category B (Impact on environment is not serious considering characteristics in the given sector, project and region) based on the *JBIC Guidelines for Confirmation of Environmental and Social Considerations* (2002). Although it was planned that some distribution lines would run through protected areas, the adverse impact on the natural environment was not expected to be severe. This is because the distribution line routes were planned along roads, and the use of covered wires would minimize the width required for forest clearing. Reviewing the content of IEE approved by the National Environment Commission in 2007 and confirming the situation at the time of project implementation with BPC, the environmental clearance required for the project was granted. In accordance with the environment management and monitoring plan, the environmentally-friendly distribution line strategies considered at the time of appraisal were executed and alleviation countermeasures were taken.

(2) Resettlement and Land Acquisition

The distribution lines were planned in such a way that they didn't interfere with land usage when they passed through private property. Power line poles were installed on land where the owner's permissions were given as an obligation. No resettlement was expected to be necessary. IEE reports and other project documents confirmed that there was indeed no resettlement, nor were any other issues, such as land acquisition, involving problems of compensation.

In summary, as result of a review on the existing documents and hearings from BPC, it can be seen that there was no negative impact on either the natural or social environment during project execution. No other noteworthy negative or positive impacts were observed.

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

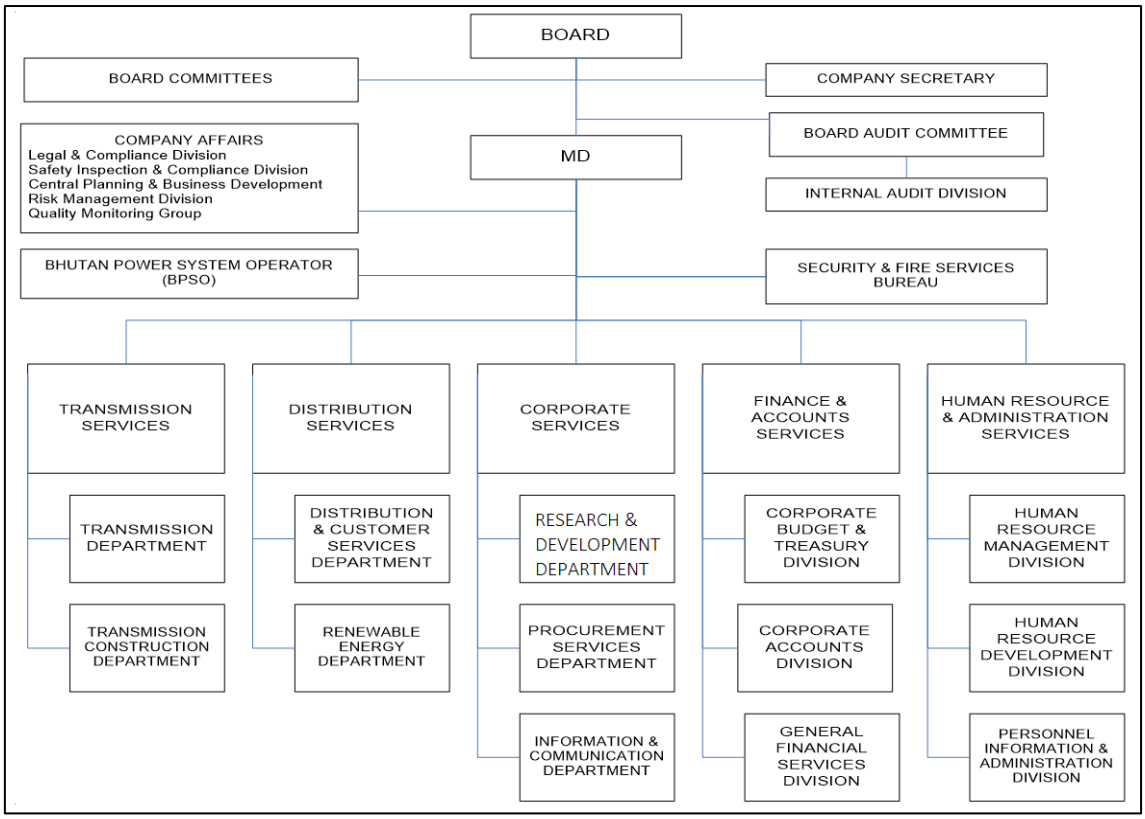
3.4 Sustainability (Rating: ③)

3.4.1 Institutional / Organizational Aspect of Operation and Maintenance

The total number of BPC employees was 2,338 according to its *Power Data Book 2016*. This headcount had increased by 900 since the time of appraisal. The BPC organization chart is shown in Figure 3. The Distribution & Customer Services Department (DCSD) is located at the head office, under which Regional Corporate Offices (RCOs) are deployed. The DCSD also manages Electricity Service Division (ESD) in the Dzongkhag centers, and Service Centers are deployed in remote areas to supplement ESD. Additionally, with support from the ADB, BPC

deploys Village Electrical Entrepreneur Electrical Technicians (VEEET) in remote areas. VEEET are village residents who are trained and qualified by BPC to support billing and collection services as well as simple repairs.

Fifty four percent of BPC employees are under 35. Interviews with those in charge of operation and management indicated these younger staff are highly motivated to learn new skills. ESD offices have various numbers of employees depending on the scale of facilities and the number of consumers they serve. There is no apparent lack of workers.



Source: BPC Web Page http://www.bpc.bt/organogram/ (As of June, 2018)

Figure 3: BPC Head Office Organization Chart

Taking into account the BPC organization chart, employee headcount by department / responsibility and how the head office DCSD and regional offices work together, no apparent problem is found with the organizational aspect of operation and management. Even in remote areas in each dzongkhag where human resources are limited, problems are solved by training and trusting local residents to perform some services.

3.4.2 Technical Aspect of Operation and Maintenance

Of the total number of BPC employees, 12% (289) have university degrees, 39% (908) are graduates of vocational schools or with similar qualifications and the rest have no higher

education than higher secondary school diplomas. Going forward, a new employment policy of BPC is to require at least diplomas from Vocational Training Institutes from those wishing to qualify for technical positions. Standard maintenance work and simple repairs are handled by each ESD, and periodic inspections on transformers and troubleshooting are handled by the Begana Training Center, which is located just outside of Thimphu, the capital of Bhutan.

BPC assesses employees' training needs on a yearly basis to provide appropriate training in-country or abroad, according to individual training plans. New hires are given onboard training for over a month, and subsequently take refresher training every two to three years. BPC conducts the necessary training for employees depending on their technical level.

Daily maintenance and periodic inspections are performed in each ESD according to the standards defined in the Operation and Maintenance (O&M) Manual completed in 2012. From 2008 to 2014, JICA conducted a Technical Cooperation Project, "Improvement of Efficiency for Rural Power Supply", which included support for creating the O&M manual and a "pocket book" as well as capacity development for problem solving and so on, on the part of the ESD managers in charge of operation and maintenance. All BPC head office staff and ESD managers interviewed during rural area site surveys commented that the JICA technical cooperation had contributed to their O&M capacity development and had provided access to necessary expertise. Some ESD staff commented that managers shared the problem-solving skills learned through the JICA technical cooperation with other staff, who in turn utilized the knowledge in their daily operations. The JICA technical cooperation project was implemented in parallel with this project in a timely manner, which appears to have contributed to enhanced O&M skills in BPC staff.

In summary, the educational levels of technical staff and periodic training implementation seem to be appropriate, and no apparent issues have been found with the technical aspect.

3.4.3 Financial Aspect of Operation and Maintenance

Key indicators from the BPC P&L over the last four years (2014 - 2017) (Table 8) show revenues from power sales and wheeling charges tending to increase. In 2017, the net profit was down in comparison to the previous fiscal year due to an decrease in income from construction contracts and an increase in power purchase. However, profit after taxes has been maintained at a steady level. As shown in the key financial indicators (Table 9), current ratios showed decreasing trend; however, it has been over 100%, and other indicators are not the level of concern, suggesting an overall healthy status of BPC finances.

Table 8: BPC Key Profit and Loss Indicators

Unit: Million Nu

Items	2014	2015	2016	2017
Revenue	**7,273.9**	**9,759.8**	**11,852.7**	**11,507.0**
Income from sale of electricity	4,032.7	4,588.1	4,798.8	6,627.2
Income from construction contracts	2,419.5	4,282.1	6,017.8	3,446.4
Wheeling charges	575.1	632.3	658.8	1,034.8
Other Income	246.7	257.4	377.3	398.8
Expenditure	**5,680.8**	**7,798.0**	**9,601.3**	**9,614.6**
Purchase of electricity	1,493.4	1,550.1	1,408.3	3,699.3
Construction material consumed and sub-contracting charges	2,197.7	3,892.9	5,471.3	3,132.6
Operation and maintenance Cost	267.9	311.8	407.5	427.2
Other	1,721.8	2,043.2	2,314.3	2,355.6
Profit /Loss Before Income Tax	**1,593.1**	**1,971.6**	**2,251.4**	**1,892.6**
Profit /Loss After Income Tax	**1,003.0**	**1,380.7**	**1,576.6**	**1,328.0**

Source: BPC

Note: Income from Construction Contract means transmission and distribution lines construction contract revenue.

Table 9: Financial Analysis of BPC Key Indicators

Items	2014	2015	2016	2017
Financial Indicator (Million Nu)				
①Total Asset	24,651.6	25,185.5	27,766.6	28,964.2
②Current Asset	5,707.9	5,422.8	6,548.9	5,853.6
③Current Liability	3,021.7	2,997.7	4,744.2	5,732.1
④Equity	13,035.6	13,717.6	13,837.5	13,694.8
⑤Revenue	7,273.9	9,759.8	11,852.7	11,507.0
⑥Net Profit	1,003.0	1,380.7	1,576.6	1,328.0
Financial Analysis				
Return on Asset (%) ⑥/①	4%	5%	6%	5%
Net Profit Margin (%) ⑥/⑤	14%	14%	13%	12%
Current Ratio (%) ②/③	189%	181%	138%	102%
Total Asset Turn Over ⑤/①	0.30	0.39	0.43	0.40
Capital Adequacy Ratio (%) ④/①	52%	54%	50%	47%

Source: BPC

BPC power purchase expenditure is relatively low compared to their power sales income. This is partly explained by the fact that the power purchase price is set low. Power sold by BPC is priced at 2.23Nu (low voltage) to 5.74Nu (high voltage) /kWh on the average (from January 2016), while the power sold by the three government-owned plants (Chukha, Kurichhu, Tala), which supply most of the power purchased by BPC, is priced at 1.59 Nu/kWh (since January 2017).

Electricity charges are lower in rural areas than in urban centers, and rural households are eligible to use up to 100 kWh of power monthly, free of charge. This does not apply to power used by businesses such as general shops, even when they operate in rural areas. This system is designed to provide easier access to electricity for the needy, with consideration for households in poverty, who tend to use less electricity. Expenses incurred by the free electricity in rural areas can be justified by other BPC income from power sales or lower power purchase expenses.

The BPC power charge collection rate is excellent at 97.2%, thanks to a convenient means of payment. In order to simplify billing and payment by residents in rural areas where is far from ESD of BPC, power metering is carried out via SMS, and rural residents are given various payment options including door-to-door collections, automatic payments from accounts at Bhutan National Bank or Bank of Bhutan and internet online banking.

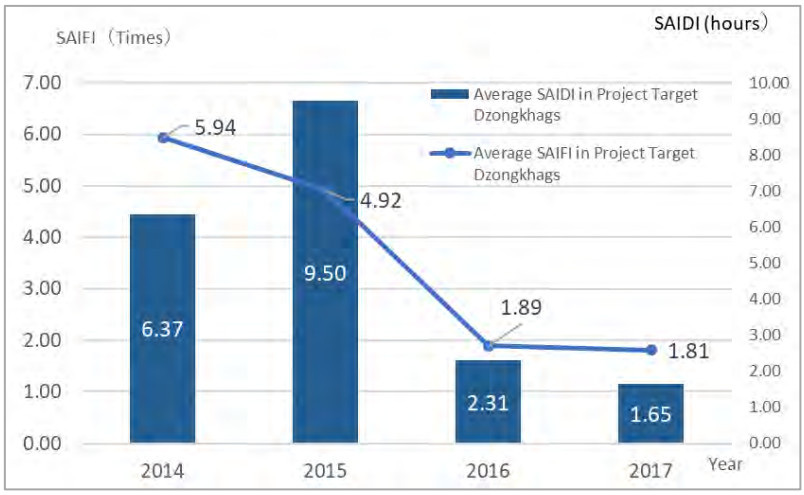
Every year around in October, ESD in each Dzongkhag submit an O&M budget request for the following year to DCSD at the head office. These requests are approved by the head office by mid-December. According to the Finance Department, budget requests are thoroughly reviewed and usually approved as requested. Hearings at the main office DCSD and Dzongkhag ESD confirmed that there is no apparent shortage in the O&M budget.

To summarize, no problems have been found in the main financial results of BPC from the last four years, and there is a sufficient allocation of O&M budget, responding well to the rapid expansion of power facilities. Power charges are either free or set low for rural residents, and there are currently no financial strains due to the state policy of setting low prices for power generated by the domestic hydro power plants which supply the power purchased by BPC.

3.4.4 Status of Operation and Maintenance

At the time of the February 2018 field study, no issues were reported by BPC. Periodic inspections were being performed according to the manual. Project facilities checked by the evaluator in Chukha, Trongsa and Tsirang where the evaluator visited among target areas did not show any sign of problems. Interviews with consumers in these areas indicated that BPC took appropriate measures whenever they experienced a blackout and that customer inquiries about problems were handled appropriately.

Figure 4 shows the average System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI) per household in the target Dzongkhags. Over the course of four years after project completion (2014), the SAIDI went up once in 2015, but both indexes indicated tendency of improvement in 2016 and 2017. According to BPC, the efforts and performance indicators of ESD employees are reflected in their salaries, providing them with an incentive to analyze the causes of interruptions in order to improve services. This may explain the improvement in SAIFISAIDI.



Source: Calculation based on BPC document

Figure 4 SAIFI/SAIDI Trends in Target Dzongkhags by the Project

No major problems are observed in the institutional, technical, financial aspects and current 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 project aimed to improve access to electricity for unelectrified households by developing power distribution networks in rural areas of Bhutan where the poverty rate is high, thereby contributing to an improvement in the living environment of rural residents, including the poor, while promoting economic and social activities in these areas. This project is highly relevant as it aligns well with GNH, a unique concept set out by the Bhutanese government as the principle of national development, with national development plan priorities based on GNH and development needs as well as with Japan's ODA policies. The efficiency of the project is fair, as it was completed within the planned project cost but with the project period exceeding the plan. Electrification was promoted generally as planned in the target rural areas contributing to an overall improvement of electrification rate on the national scale. The effectiveness and impacts of the project are high; electricity consumption is increasing steadily, showing early signs of various socioeconomic impacts that align with the GNH concept. BPC, the organization responsible for the O&M of the project, has increased their staff to respond to the rapid rural electrification progress. To improve its operation and maintenance in remote areas where road access is limited, BPC is training local technicians, helping them to conduct O&M, and making efforts to enhance their capabilities. The financial status of BPC and the O&M of the facilities are in a good state. Therefore, the sustainability of the project is high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

None

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

Importance of Feasible and Useful Planning in Rural Electrification

Prior to the project implementation, rural electrification, with the goal of 100% household power access, has been a priority for the government of Bhutan. With this background, a master plan for rural electrification to encompass all rural Bhutan was formulated through the Japanese technical cooperation, taking into consideration the needs and capabilities of the project executing agency. The master plan was prepared in order to be highly effective, clarifying prioritization in the area, examining the technical relevance of power projects, making cost comparisons with solar power generation and with a set of assessment standards, such as accessibility from roads. Comparisons were also made with all technical, economic and social situations for the creation of a rural power project. This accelerated the execution of this and subsequent projects as well as rural power projects financed by other donors such as ADB, significantly contributing to an overall advancement of the electrification of Bhutan and an early realization of project effects.

While this project was under way, technical cooperation was also implemented to enhance the O&M capabilities of BPC, as discussed in the master plan. Meanwhile, the government of Bhutan was taking action on the national vision to maximize GNH, introducing various initiatives including a special pricing scheme for rural electricity users, equipment and facility enhancement at schools and administrative centers as well as support for machine-aided farming. All of these contributed to an early realization of the various impacts intended by the project.

All this suggests that, when implementing rural electrification projects, good project design should examine multiple aspects in order to formulate a highly effective plan that meets the needs of the recipient country at the time of project planning. This may include the human and technical capacities of the recipient country during construction and the O&M phase after completion of the project, as well as giving special consideration to electricity pricing for rural residents and the potential for socioeconomic development in the target region. By preparing a plan which leads to immediate implementation in a timely manner, providing a well-considered response to the challenges and needs of the recipient country, more significant effects and impacts from a rural electrification project can be expected both at household and regional levels.

END

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs	10 Dzongkhag: Bhumthang, Chukha, Dagana, Haa, Monggar, Paro, Samtse, Trashi Yangtse, Trongsa, Tsirang	The same as planned
	547 Villages	1,132Villages
	No. of Electrified Households: 15,322	No. of Electrified Households:16,241
(1) Medium voltage (33kV/11kV) distribution line construction and rehabilitation	• 76 feeders • Total Length: 912 km	• 64 feeders • Total length: 1,024 km
(2) Low voltage distribution line construction and auxiliaries	• Total: 1,478km	• Total: 1,692km
(3) Installation of Transformers	• 1,310	• 1,159
(4) Consulting Service	(i) Review of the detailed design of the project, preparation of tender documents and construction supervision (ii) Setting of indicator and targets useful for operation and maintenance (iii) Capacity building of the executing agency (inventory management of BPC, pointing out issues regarding improvement of the management of BPC) and other relevant entities	(i) and (ii) were implemented as planned. (iii) Capacity building of the executing agency and other relevant agencies were cancelled. TOR for preparatory works for bidding on "Rural Electrification Project (Phase 2) was added.
2. Project Period	May 2007 - Dec. 2012 (68 months)	May 2007 - June 2014 (86 months)
3. Project Cost		
Amount Paid in Foreign Currency	2,591 million yen	2,497 million yen
Amount Paid in Local Currency	1,766 million yen (687 million Nu.)	1,184 million yen (607 million Nu.)
Total	4,357 million yen	3,681 million yen
ODA Loan Portion	3,576 million yen	3,237million yen
Exchange Rate	1Nu. = 2.57 yen (As of January 2007)	1 Nu. = 1.95 yen (IFS average between 2007 and 2015)
4. Final Disbursement	June 2015	