India

FY 2021 Ex-Post Evaluation Report of

Japanese ODA Loan

"Andhra Pradesh and Telangana Rural High Voltage Distribution System Project"

External Evaluator: Chie Munemori, IC Net Limited

0. Summary

This Project was implemented to reduce the distribution loss of electric power for agriculture and achieve stable power supply by converting to high voltage distribution systems in rural areas of the southern Indian states of Andhra Pradesh and Telangana.

From the time of the Project appraisal to the ex-post evaluation, the objective of the Project is consistent with the policies of the Government of India and the State Governments of Andhra Pradesh and Telangana. At the time of the ex-post evaluation, the demand for electricity for agricultural use in the states of Andhra Pradesh and Telangana over the past three years showed that there is a need for efficient electricity supply, which is consistent with the development needs of the two states. At the time of the Project appraisal, Japan's ODA policy for India identified "promotion of economic growth" as a priority area, and JICA recognized "support for sustainable economic growth through the development of economic infrastructure" as a priority area. Therefore, the Project is consistent with Japan's ODA policy at the time of the Project appraisal. Thus, its relevance and coherence are high.

Regarding the efficiency of the Project, there was a change in the material and capacity of the distribution transformer (hereinafter referred to as the "DTR"), which is one of the outputs of the Project. This change was made based on a review after the Project started. The material was changed because it was less likely to be stolen and more economical than the originally planned material; thus, this change is deemed to be appropriate. Although the Project cost was within the plan, the Project period was significantly prolonged because of state bifurcation, which was difficult to foresee at the time of the Project appraisal, and re-tendering due to the excessively small scope of the civil works, which resulted in the Project period significantly exceeding the plan. Thus, efficiency of the Project is moderately low.

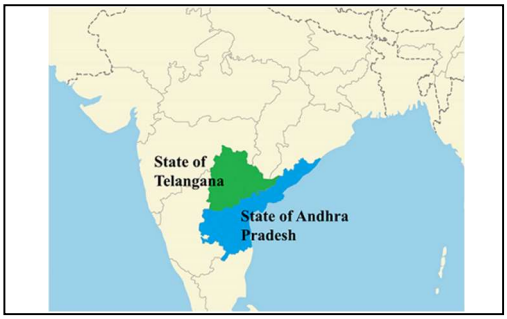
Regarding the effectiveness, most of the operation and effect indicators were achieved. As the calculation method for the distribution loss at the time of the Project appraisal could not be confirmed, the transition from the time of the Project appraisal to the time of the ex-post evaluation was checked using the calculation method usually adopted by the executing agencies. As for the impact, yields increased for 76% of farmers interviewed because the frequency of irrigation pump failure decreased, which reduced the burden of repair costs, and because it has become possible to use electricity for agriculture in a stable manner. Therefore, effectiveness and impact of the Project are high.

From the sustainability point of view, every executing agency has sufficient knowledge and

experience in the technical aspects. The maintenance of the equipment developed by the Project have also been implemented without confusion after the bifurcation of the Telangana State. Regarding policies and systems, the Government of India has been helping to improve the financial situation of the power distribution companies that were economically affected by COVID-19, and all the executing agencies of the Project have submitted detailed plans for using this assistance and are awaiting approval. The financial situations of the executing agencies has not changed since the time of the Project appraisal. Although they are still in the red and are being financed by the state government, sustainability of the project effect is very high as financial resources for maintenance of the equipment and materials developed by the Project have been secured to date, and there is no expectation of any change in this policy in the future.

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

1. Project Description



Project Locations

Small-Capacity DTR

1.1 Background

The Indian power sector was suffering from chronic power supply shortages. At the time of the Project appraisal (FY 2010), India was experiencing a 10.6% shortfall in power supply and a 12.1% shortfall during peak hours. Another issue was the high transmission and distribution loss[1] caused by aging distribution facilities and power theft. The transmission and distribution loss was estimated at a national average of 25.5% in FY 2010, which was extremely high compared to other developing countries such as China (7.5%) and Indonesia (16.5%). In addition, while many states have adopted an independent accounting system with the unbundling and privatization of state electricity department, and power distribution companies became able to manage themselves at their own discretion to a certain extent, their financial situation has been in deficit because electricity rates were set very low for agricultural and residential use owing to policy and social considerations, as well as because some electricity bills were not being recovered owing to theft

[1]Aggregate Technical & Commercial (AT&C) loss. The AT&C loss is a combination of technical loss (technical loss + theft + inefficiency in billing) and commercial loss (default in payment + inefficiency in collection). Commercial loss is not taken into account in the distribution loss, which is one of the Project's operation and effect indicators.

and illegal metering. Such deficits of the power distribution companies were covered by state finances. Moreover, power was supplied to the irrigation pumps by extending low voltage and bare lines through a large capacity transformer, which were vulnerable to electricity theft and resulted in higher distribution losses compared to extending high voltage distribution lines.

1.2 Project Outline

The objective of this Project is to facilitate the reliability and quality of power supply to agricultural services and the reduction of distribution losses by converting to high voltage distribution systems in rural areas of the State of Andhra Pradesh and the State of Telangana,[2] thereby contributing to securing the stable energy supply in the states and improving the efficiency of agricultural production as well as living standards of the rural population.

Loan Approved Amount/ Disbursed Amount	18,390 million yen / 17,473 million yen	
Exchange of Notes Date/ Loan Agreement Signing Date	June 2011 / June 2011	
Terms and Conditions	Interest Rate	0.65%
	Repayment Period (Grace Period	40 years 10 years)
	Conditions for Procurement	General untied
Borrower / Executing Agency(ies)	The President of India/ Telangana State South Power Distribution Company (TSSPDCL), Telangana State North Power Distribution Company (TSNPDCL), Andhra Pradesh South Power Distribution Company (APSPDCL)[3]	
Project Completion	March 2019	
Target Area	16 districts in rural areas of the state of Andhra Pradesh and Telangana[4]	
Main Contractor(s) (Over 1 billion yen)	-	

[2] At the time of the appraisal, the target area was Andhra Pradesh. After the start of the Project, the state of Telangana was separated from Andhra Pradesh, and part of the project area became the state of Telangana.

[3] At the time of the appraisal, executing agencies were Andhra Pradesh Central Power Distribution Corporation (APCPDCL), Andhra Pradesh Northern Power Distribution Corporation (APNPDCL), and Andhra Pradesh Southern Power Distribution Corporation (APSPDCL). There was a change in the name of the power distribution companies due to bifurcation of the state of Telangana after the start of the project.

[4] At the time of the appraisal, the 16 rural districts were in the state of Andhra Pradesh. After the start of the Project, some of the districts became part of the state of Telangana due to its separation.

Main Consultant(s) (Over 100 million yen)	Voyants Solutions Private Limited
Related Studies (Feasibility Studies, etc.)	F/S: Transmission Corporation of Andhra Pradesh Limited (2009)
Related Projects	-

2. Outline of the Evaluation Study

2.1 External Evaluator

Chie Munemori, IC Net Limited

2.2 Duration of Evaluation Study

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

Duration of the Study: December 2021 – December 2022

Duration of the Field Study: March 1 – 20, 2022 and May 15 – 26, 2022

3. Results of the Evaluation (Overall Rating: A[5])

3.1 Relevance/Coherence (Rating: ③[6])

3.1.1. Relevance (Rating: ③)

3.1.1.1 Consistency with the Development Plan of India

The *Eleventh Five Year Plan* (April 2007 – March 2012), which was the development plan of India at the time of the Project appraisal, promoted the development of new power sources and identified power sector reform, transmission and distribution facility enhancement, and rural electrification as key issues. The Government of India launched the Accelerated Power Development and Reform Programme (hereinafter referred to as the "APDRP") in March 2003 and the new APDRP in 2008 to deal with high transmission and distribution losses[7] and increase efficiency of the distribution sector from the facility and financial point of view. In the *Draft National Electricity Policy* prepared in 2021 at the time of the ex-post evaluation, the development of new power sources and enhancement of power transmission and distribution network facilities were set as policy objectives to meet the rapidly growing electricity demand. In the same year, the Government of India launched the *Revamped Distribution Sector Scheme* (hereinafter referred to as the "RDSS"), which aims to strengthen the supply infrastructure of the distribution utilities to solve Aggregate Technical & Commercial (AT&C) losses across the country.

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

[6] ④: Very High, ③: High, ②: Moderately Low, ①: Low

[7] AT&C loss. For details, refer to footnote 1.

From the time of the Project appraisal to the time of the ex-post evaluation, India has set forth in its policy the strengthening of the power transmission and distribution facilities of the power sector. The Project is consistent with the development plan of India, as the aim of the Project is to develop the high-voltage distribution network, thus reducing the distribution loss and providing stable supply of electricity for agricultural use.

3.1.1.2 Consistency with the Development Needs of India

Agriculture remains the major industry in the states of Andhra Pradesh and Telangana from the time of the Project appraisal to the ex-post evaluation. The share of agricultural electricity consumption in the total electricity supply in the state was high at 30–40% from the time of the Project appraisal to the time of the ex-post evaluation, indicating that the need for efficient and stable electricity supply to irrigation pumps used by farmers is still high.

Before the Project, 20 to 30 irrigation pumps were connected to one DTR at the end of a low-voltage line, which resulted in frequent DTR failures due to overloads and frequent irrigation pump failures caused by voltage fluctuations. When one DTR failed, all the irrigation pumps connected had to stop operation. Prior to the implementation of the Project, the average frequency of irrigation pump failure was about three times a year. Once a breakdown occurred, the irrigation pumps could not be operated for 3 to 7 days during repair, which posed a challenge to the stable supply of electricity for agricultural use.

3.1.1.3 Appropriateness of the Project Plan and Approach

The objective of the Project is to reduce the distribution loss of electricity for agricultural use and to realize a stable supply of electricity by converting to high voltage distribution systems. Interviews with the executing agencies and farmers confirmed that the Project reduced the distribution loss because of the installation of the high voltage distribution systems close to the irrigation pumps, and that the installation of small-capacity DTRs reduced transformer failures, resulting in a more stable supply of electricity to the farmers. Therefore, it is evaluated that the logic of the Project was appropriate.

The selection criteria for the target areas included areas where many irrigation pumps were in use and the areas with many unregistered irrigation pumps. Selection criteria for the feeders to be connected included that they be dedicated to agriculture and that they have a high distribution loss. It is evaluated that these selection criteria were appropriate for achieving the outputs of the Project.

3.1.2 Coherence (Rating: ②)

3.1.2.1 Consistency with Japan’s ODA Policy

Japan’s ODA Policy for India, formulated in May 2006, set "promotion of economic growth"

as a priority objective. In response, JICA identified "support for sustainable economic growth through the development of economic infrastructure" as one of the priority areas for assistance. The power sector is a major one for JICA's yen loans to India, and stable energy supply was positioned as one of the development issues in this priority area of assistance. To strengthen power generation capacity and transmission and distribution capability in India, where energy demand is expanding, JICA has made the core of its support the development of high-efficiency power supply facilities (power plants and transmission/distribution networks), improvement of the efficiency of existing aging facilities, and reduction of power distribution losses. The Project was in line with these policies.

3.1.2.2 Internal Coherence

Through interviews with the JICA India Office and executing agencies, whether there were linkages and synergies with other JICA projects, including those in other sectors, was inquired. However, none of the agencies indicated that such synergies and linkages were planned or have taken place.

3.1.2.3 External Coherence

Through interviews with the JICA India Office and executing agencies, whether there were linkages and synergies with other donors was inquired. However, none of the agencies responded that there were such synergies or linkages. On the other hand, it was confirmed that Rural Electrification Corporation Limited (hereinafter referred to as the “REC”) and the World Bank have been promoting the development of high-voltage power distribution networks in rural areas through their loans. In particular, the REC project implemented by the Telangana Southern State Power Distribution Corporation (hereinafter referred to as the “TSSPDCL”) as a previous phase of the Project covered the areas including those covered by this Project. Moreover, although the REC project and the Project were not coordinated for collaboration, the Project may have contributed to accelerating the development of the high voltage power distribution network in the region.

Based on the above, from the time of the appraisal to the time of the ex-post evaluation, the Project was in line with the Indian government’s policy for the power sector and consistent with the development needs; thus, relevance is high. On the other hand, no linkage with other JICA projects was confirmed. Although it was confirmed that other projects financed by the World Bank and REC loans are promoting the development of high-voltage power distribution interconnections in rural areas, there was no specific linkage with the Project. Therefore, its relevance and coherence are high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The civil works and procured equipment for the Project are as follows.

	Unit	Plan	Actual
Replacement of large-capacity DTR with small-capacity DTR			
16 kVA	number	50,581	1,580
25 kVA	number	43,014	89,952
Conversion of LT line (0.4 kV) to HT line (11 kV) and construction of new HT line			
Conversion of LT to HT line	km	26,957	14,408
Construction of new HT line	km	4,622	2,012
Replacement or new installation of supporters (poles, braces) (added to long span)			
Construction of AB Cable (Ariel Bundled Cable)	km	20,426	15,164
Insertion of intermediate poles and braces	number	97,253	148,575

There is a discrepancy between the planned and actual number of small-capacity DTRs installed. The material of the DTR coils envisioned at the time of the Project appraisal was copper, but copper windings were vulnerable to theft. Thus, aluminum windings were used in the implementation phase. In addition, as the costs of purchasing 16 kVA and 25 kVA DTRs were comparable, and the number of irrigation pumps that could be connected was one or two for 16 kVA DTRs, whereas three or four could be connected to 25 kVA DTRs, the 25 kVA DTRs were primarily installed. As a result. most of the small-capacity DTRs installed were 25 kVA. Moreover, the number of DTRs required to connect to the same number of irrigation pumps is smaller with 25 kVA[8]. Since 25 kVA was the main type of DTR installed by the Project, the total length of HT line required was significantly reduced. The reason for the increase in the number of supports is as follows: after the Project started, the location of the supports was determined to match the site environment, resulting in an increase in the number of supports.

3.2.2 Project Inputs

For details, refer to "Comparison of the Original and Actual Scope of the Project."

3.2.2.1 Project Cost

The total Project cost at the time of the Project appraisal was JPY 27,480 million (foreign

[8] Example: If 10 irrigation pumps are to be connected, a 16-kVA DTRs would require 5 transformers, whereas a 25-kVA DTRs would require 3 to 4 transformers.

currency JPY 387 million; and local currency JPY 27,093 million), and the Japanese ODA Loan was JPY 18,590 million (all local currency). The actual Project cost was JPY 19,091 million and the ODA Loan portion was JPY 17,473 million. The main reasons for the difference between the planned and actual Project cost are the fluctuation of the foreign exchange rate and the reduction in the cost of interest during construction and consulting services. The exchange rate was JPY 1.88 for INR 1.00 in 2010 at the time of the Project appraisal and it became JPY 1.55 for INR 1.00 in 2019 when the Project was completed. The reduction in consulting services was for the following reasons: bidding assistance, which was originally planned as part of consulting services, was not implemented; moreover, some of the expenditures originally planned to be funded by the ODA Loan were covered by TSSPDCL's own funds. As a result, the total Project cost was reduced to 69% of the planned amount, which was within the plan.

3.2.2.2 Project Period

The Project period was planned to be 56 months from June 2011 to January 2016, but the actual Project period was 94 months from June 2011 to March 2019, exceeding the plan (167% against the plan). The plan at the time of the Project appraisal was for the Project period to be 4 years and 8 months (56 months) from the signing of the L/A to the start of operation of the facilities. With regard to contractor procurement, delays occurred owing to delays in the approval of tender documents by the State Audit Committee. The delay by the Audit Committee was due to the impact of the separation of the state of Telangana in 2014. In Telangana, which separated from the state of Andhra Pradesh, the necessity and significance of the Project had to be explained to newly appointed politicians and had to be understood by them, which took time to explain and gain their understanding.

Another cause of the delay was the re-tendering due to unsuccessful bids. The reason for the unsuccessful bidding was the non-participation of local contractors due to the excessively large civil work package. The package that was re-tendered was the Kamam district package of TSNPDCL. The bid was originally submitted as one package in Khammam district. However, as the bid was unsuccessful, the package was divided into three packages with JICA's consent. The second tender was also unsuccessful; thus, it was decided to divide the contract into eight packages. In addition, civil engineering work coincided with the crop harvesting season, causing delays in construction. As a result, the actual Project period significantly exceeded the plan.

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

The economic internal rate of return (EIRR) was calculated to be 18.73% at the time of the Project appraisal in FY 2010. The recalculation at the time of the ex-post evaluation resulted in 23%. The parameters used to calculate the EIRR are as follows: the costs were Project expenses and operation and maintenance expenses, and the benefits included reduced distribution losses,

reduced DTR failures, and reduced electricity theft. The Project life was 30 years, and essentially the same parameters were used for the EIRR recalculation for the time of the ex-post evaluation. EIRR is recalculated only for TSSPDCL, as necessary information was obtained from TSSPDCL only.

The financial internal rate of return (FIRR) was not calculated at the time of the Project appraisal, as Project implementation does not directly relate to increase in revenue from electricity charges.

While the Project cost was within the plan, the Project period exceeded the plan drastically. Thus, the efficiency of the Project is moderately low.

3.3 Effectiveness and Impacts[9] (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

The Project defined the following as operation and effect indicators: (1) distribution loss, (2) reduction in failure of DTRs, (3) rate of unauthorized irrigation pump sets, (4) improvement in voltage profile, and (5) improvement in efficiency of irrigation pump sets. The concept of each indicator, the target set at the time of the Project appraisal, and the actual data for FY 2021 at the time of the ex-post evaluation are explained below. As the Project was completed in 2019, the actual results for 2021 is confirmed, which is two years after the Project completion.

Table 1: Baseline, target, and actual values for operation and effect indicators

Indicator*	Distribution Company (Current executing agency)	Baseline (FY 2010) (FY 2012 for distribution loss)	Target 2 years after completion (FY 2018)	Actual 2 years after actual completion (FY 2021)
Distribution loss (%)	Central (TSSPDCL)	12.9	11.0	7.7
	North (TSNPDCL)	13.1	10.5	6.8
	South (APSPDCL)	11.2	10.5	8.2**
Reduction in failure of DTRs (%)	Central (TSSPDCL)	9.00	1.0	0.75
	North (TSNPDCL)	9.11	1.0	1.0
	South (APSPDCL)	7.12	1.0	2.00**
Rate of unauthorized pump sets (%)	Central (TSSPDCL)	20.0	0.0	0.0
	North (TSNPDCL)	15.0	0.0	0.0
	South (APSPDCL)	15.0	0.0	0.0
Improvement in voltage profile (%) (reduction in tail-end voltage drop)	Central (TSSPDCL)	12.0	6.0	6.0
	North (TSNPDCL)	14.0	6.0	5.0
	South (APSPDCL)	10.0	6.0	5.0

[9] When providing the sub-rating, Effectiveness and Impacts are to be considered together.

Improvement in efficiency of irrigation pump sets	Central (TSSPDCL)	80	95	94
	North(TSNPDCL)	80	95	98
	South(APSPDCL)	80	95	95

Source: Executing agencies
*Indicators for the Project area, not for the entire central, northern, and southern regions.
**Note: Figures for Krishna, Guntur, and Prakarasam districts (currently under the jurisdiction of Andhra Pradesh Central Power Distribution Company Limited (APCPDCL) are for the year 2021 only. The evaluator contacted APCPDCL through APSPDCL to confirm the distribution loss for these three districts but was unable to obtain data prior to 2020. The three districts of Krishna, Guntur, and Prakarasam were initially under the jurisdiction of Southern Electricity Distribution Corporation; after the state's separation in 2014, they became under the jurisdiction of APSPDCL. After the separation of APSPDCL and APCPDCL in 2019 after the completion of civil works, they came under the jurisdiction of APCPDCL and are maintained by APCPDCL to date. The two districts of Anantapur and Kurnool were initially under the jurisdiction of Central Distribution Corporation; with the bifurcation of the state of Andhra Pradesh in 2014, the two districts came under the jurisdiction of APSPDCL, but until the civil works were completed, the project was carried out by the TSSPDCL, the successor of the Central Distribution Corporation. Currently, APSPDCL is responsible for the maintenance.

(1) Distribution Loss (%)

As the calculation method at the time of the Project appraisal could not be confirmed, the definition of distribution loss as "(amount of electricity received from substations – amount of electricity actually transmitted and billed)/amount of electricity received from substations," which is the calculation method normally used by executing agencies, was adopted, and confirmed the transition from the time of the Project appraisal (FY 2010) to the target year (FY 2021). At the time of the Project appraisal, the target was set to be at least 80% below the baseline. Even with the distribution loss calculated using the method normally employed by executing agencies, the earliest year available (FY 2012) was compared to the actual figures (FY 2021), and if the actual figures were 80% or below of FY 2012, it was considered the target has been achieved. The distribution loss of TSSPDCL was 12.9% in FY 2012 and 7.7% in the target year FY 2021 (59.7% of FY 2012); for TSNPDCL, 13.1% in FY 2012 and 6.8% in the target year FY 2021 (51.9% of FY 2012); and for APSPDCL, 11.2% in FY 2012 and 8.2% in the target year FY 2021 (73.2% of FY 2012). Since all the figures are below 80%, it could be observed that the targets were achieved.

(2) Reduction in Failure of Distribution Transformers (%)

The method used to calculate the failure of distribution transformer at the time of the Project appraisal was "the number of transformers that failed/total number of transformers installed." Since the failure of a transformer can disrupt the power supply to multiple irrigation pumps connected to it, stable power supply to irrigation pumps can be confirmed by checking the percentage of transformers that failed. APSPDCL's transformer failure rate (2.00%) did not meet the target figure. The reasons for not achieving the target figure were asked to APSPDCL, but no clear answers were obtained. The reason for the current transformer failure was also inquired by interviewing farmers, but there was no answer that it was due to overloading caused by connecting many irrigation pumps to a single transformer, as frequently occurred before the project was implemented. TSSPDCL and TSNDPCL achieved the target figure.

(3) Rate of unauthorized pump sets (%)

Unauthorized irrigation pump sets are defined as pumps that have not applied for electricity use to a power distribution company and have connected irrigation pump wires to low-voltage lines without permission. Unauthorized irrigation pump sets cause many irrigation pumps to be connected to the transformer exceeding its specification, resulting in the transformer being overloaded and leading to transformer failure. Percentage of the unauthorized irrigation pump sets is calculated as "number of unauthorized irrigation pumps/total connected irrigation pumps." By considering percentage of the unauthorized irrigation pump sets, it is possible to check the frequency of transformer overloads caused by irrigation pumps connected to the power lines without permission and transformer failures, which is an indicator to confirm whether the Project contributes to stable power supply. Moreover, this indicator is to check whether the Project contributes to the prevention of power theft and the reduction of distribution losses. Prior to the implementation of the Project, electricity was supplied to irrigation pumps by extending low-voltage bare wires. Because of the low voltage and the bare wires, it was possible for unauthorized individuals to steal power by hooking up irrigation pump wires like hangers. This was one of the reasons for the high distribution loss. The Project has made unauthorized use of power lines difficult and eliminated unauthorized irrigation pumps by converting power lines to high voltage lines and using covered wires for low-voltage lead-in lines. All executing agencies have achieved the target figures.

(4) Improvement in Voltage Profile (% reduction in tail-end voltage drop)

The voltage profile is calculated as "(reference voltage – tail end voltage) / reference voltage." If a voltage drop occurs, a lower voltage than originally required to operate the irrigation pump sets is supplied and leads to irrigation pump set failure. By checking the voltage profile, it is possible to confirm whether the voltage is close to the one required to operate the irrigation pump sets; thus, it is an indicator that can be used to determine whether the Project is contributing to stable power supply. All executing agencies have achieved the target figures.

(5) Improvement in Efficiency of irrigation pump sets

Efficiency of irrigation pump sets is calculated as "actual amount of water lifted out by irrigation pump sets (m^3) / amount of water which is technically possible for an irrigation pump set to lift out according to its specifications (m^3)." A sudden voltage drops to the irrigation pump sets, or an overload of the transformer will cause a malfunction in the operation of the pump sets and reduce the amount of water that can be lifted. By checking whether the pumps can lift an amount of water close to the amount that can be lifted according to the pump specifications, it is possible to confirm whether the irrigation pumps are operating well and, in turn, whether the water supply to farmers is stable. At the time of the Project appraisal, irrigation pumps with 3

horsepower (hp), 5 hp, and 7.5 hp specifications were included. However, as the APSPDCL does not monitor irrigation pump's operating efficiency and the 3 hp irrigation pumps were not in use at the time of the ex-post evaluation, sample data were collected for irrigation pumps with 5 hp and 7.5 hp. TSNPDCL and APSPDCL achieved the target figures.

3.3.1.2 Qualitative Effects (Other Effects)

For details, refer to "Impacts."

3.3.2 Impacts

3.3.2.1 Intended Impacts

The impacts expected to be achieved by the Project were "improvement of living standard of the rural population (e.g., reduced repair costs of irrigation pump sets)," "local economic development," "improvement of the electricity supply and demand situation in the states through improved electricity distribution efficiency in rural areas," and "mitigation of climate change." To confirm the occurrence of these impacts, the following indicators were set, and farmers were interviewed during the site visits. A total of 25 farmers from 12 sites responded. Regarding "mitigation of climate change," it was assumed at the time of the Project appraisal that the Project would contribute to the reduction of greenhouse gas emissions. In fact, as details in "3.3.2.2 Other Positive and Negative Impacts," greenhouse gas emissions were not calculated by the executing agencies and, therefore, could not be confirmed.

Table 2: Indicators for impacts and situation before and after the Project

Indicator	Before the Project	After the Project
Percentage of irrigation pump repair costs in farmers households	① Frequency of repair of irrigation pump set Average (yearly): About 3 times ・Once a year (2 farmers) ・Twice (5 farmers) ・3 times (12 farmers) ・4 times (3 farmers) ・5 times (1 farmer) ・6 times (1 farmer) ・Too often to count (1 farmer)	① Frequency of repair of irrigation pump set Average (yearly): About 0.1 time ・0 (23 farmers) ・Once (2 farmers)*

	② Repair costs as a percentage of household income Average: 17%	② Repair costs as a percentage of household income Average: 0.3%
Whether water shortage to crops has improved or not	The irrigation pump sets failed about three times a year. Each time, water supply was not available for 3 to 7 days for repair.	About 0.1 times a year, the irrigation pump sets fail owing to defects in parts. The number of days required for repair is unchanged.**
Whether crop yields has increased or not	－	Compared to before the project was implemented, 76% of the respondents increased their yields.***
Local economic development		Since the increase or decrease in the number of companies, the change in the number of electricity consumers by category was checked. Executing agencies have consumers categories according to the use of electricity to ascertain the number of consumers. Comparing the number of commercial customers in 2021 with the number of commercial customers in 2012, after the start of the project, the number of commercial customers increased by 150%.

Improved electricity demand and supply conditions in the target states by increasing the efficiency of electricity distribution in rural areas	Since it was impossible to check electricity demand and supply with breakdown of rural and non-rural areas, state-wide figures from a report by the Central Electricity Authority, Government of India. ・The state of Andhra Pradesh At the time of the Project appraisal, the supply was 10,428 MW compared to peak electricity demand of 12,018 MW from April to December 2010 (13.2% shortfall compared to demand). ・The state of Telangana At the time of state separation, the supply was 6,648 MW compared to peak electricity demand of 7,884 MW from April to December 2014 (15.7% shortfall compared to demand).	・The state of Andhra Pradesh At the time of the ex-post evaluation, the supply was 11,570 MW compared to peak electricity demand of 11,570 MW from April to December 2021 (no shortfall compared to demand). ・The state of Telangana At the time of the ex-post evaluation, the supply 13,595 MW compared to peak electricity demand of 13,622 MW from April to December 2021 (0.2% shortfall compared to demand).

*Two respondents who answered that their irrigation pump sets were repaired "once a year" were asked about the cause of failure. They indicated that the failure was due to a malfunctioning of parts of the irrigation pump set. Both respondents indicated that they do not feel the need for frequent repairs.

**Although water supply shortages due to irrigation pump sets failures rarely occur, the state of Andhra Pradesh still has a limited agricultural power supply of 9 hours per day. Water is not supplied in the remaining 15 hours. In the state of Telangana, there is 24-hours-a-day power supply for agriculture, and irrigation pump set failures have virtually ceased; thus, there are few cases of crops not being supplied with water. Before the Project, the hours of electricity supply for agriculture was 7 hours per day in Andhra Pradesh and 7 to 9 hours per day in Telangana.

*** There are multiple factors that contributed to the increase in crop yields. In addition to the

increased efficiency of irrigation pump sets operation, which has allowed the farmers to have two harvest seasons per year, there are several other factors, such as the increased hours of water supply per day, the growing of mangoes and coconuts, which have higher market value than rice, which has traditionally been grown, and the use of machinery in farming.

3.3.2.2 Other Positive and Negative Impacts

The Project was classified as Category C based on the JBIC Guidelines for the Confirmation of Environmental and Social Consideration (April 2022) as it does not fall into sensitive sectors or have characteristics of significant involuntary resettlement.

At the time of the Project appraisal, registration for the Clean Development Mechanism (CDM) was being considered. The project was also expected to contribute to the reduction of greenhouse gas emissions by 74,666 metric tons/year CO_2 equivalent by improving the efficiency of energy use through a reduction in the power distribution loss. However, no application for CDM registration was made and no GHG emissions were calculated. The reason for not applying for CDM registration was asked to the executing agency and it became clear that, at a performance review meeting with the Government of India, they were urged to adopt electricity using renewable energy sources, and it led to the installation of solar panels, which have less environmental impact than the Project. Therefore, there is no longer any motivation to register the Project under the CDM. There was no resettlement and land acquisition in the Project.

The selection criteria for the target areas included the following: 1) areas with many irrigation pump sets in use, 2) areas with many unauthorized irrigation pump sets, 3) areas with more frequent transformer failures, and 4) areas with no security concerns. The selection criteria for the feeders to be connected included the following: 1) the feeders are dedicated to agriculture, (2) the feeders have a high distribution loss, and 3) a number of years has passes since they had been installed. Therefore, it was not necessary to select beneficiaries considering gender and those who are prevented from participating in society in a fair manner.

Based on the above, the Project has generally achieved the operation and effect indicators of effectiveness. Although executing agencies did not achieve some of the indicators, all of the figures have improved compared to those at the time of the Project appraisal. For impact, among the intended impacts at the time of the Project appraisal, indicators were set at the time of the ex-post evaluation for "improvement of living standard of the rural population (e.g., reduced repair costs of irrigation pump sets)," "local economic development," and "improvement of the electricity supply and demand situation in the states through improved the electricity distribution efficiency in rural areas." Improvement was observed in all indicators. Regarding "climate change mitigation," it was assumed at the time of the Project appraisal that the Project would contribute to the reduction of greenhouse gas emissions. However, the actual GHG emissions could not be

confirmed because they were not calculated by the executing agency. Based on the above, the Project has mostly achieved its objectives. Therefore, the effectiveness and impacts of the Project are high.

3.4 Sustainability (Rating: ③)

3.4.1 Policy and System

At the time of the Project appraisal, the Government of India was working to reform the power sector, promote investment, protect consumer interests, and provide electricity to all citizens through the *New Electricity Act 2003*, which came into effect in May 2003, by introducing the principle of competition. This stance remains unchanged at the time of the ex-post evaluation. In June 2021, the government announced that it would aid worth approximately USD 41 billion over the next five years to rescue the power distribution companies that had been economically hit by the COVID-19 pandemic. The assistance includes funding for smart meters and installation of separate feeders to supply electricity at different feeders for different categories of consumers. The government expects that the use of the assistance will improve the financial situation of the electricity distribution companies. All executing agencies of the Project have submitted detailed plans for the use of the assistance and are awaiting approval. By using this support, once the smart meters are in place, the distribution companies would be able to monitor electricity consumption in real time and plan the distribution of electricity efficiently. Regarding feeders, there are currently cases where the same feeder is used to supply electricity to different categories of customers.[10] In such cases, if the power supply is disrupted owing to a small capacity consumer, the power supply to large capacity consumers using the same feeder will also be disrupted. The disruption in the supply of electricity to large capacity consumers will have a negative impact on the electricity sales of the distribution company. This situation can be remedied by supplying power through different feeders for different customer categories. In the state of Telangana, 24-hours-a-day agricultural power supply was made available in 2017. In the state of Andhra Pradesh, the supply was 9 hours per day (8 a.m. to 5 p.m.) in 2019 and prior to 2019, the supply was 7 hours per day. From the above, policy and system of the Government of India are in place to continue the effects of the Project.

3.4.2 Institutional/Organizational Aspect

TSSPDCL, TSNPDCL, and APSPDCL, all of which were the executing agencies of the Project, are the power distribution companies responsible for the construction, operation, and maintenance of power distribution facilities in their jurisdictions, and this role has not changed even at the time of the ex-post evaluation. The department in charge of operation and maintenance of the

[10] For example, the same feeder is used to supply electricity to commercial category consumers who use large amounts of power and to those who do not.

equipment installed by the Project is the operation and maintenance department in the regional office (called “circle office”) of each distribution company. This has not changed from the time of the Project appraisal. The department is responsible for operation and maintenance of the Project equipment together with the existing equipment. The number of personnel in this department before and after the implementation of the Project is as follows: TSSPDCL decreased by 16%, TSNPDCL increased by 13%, and APSPDCL decreased by 24% after the Project. The significant decrease in APSPDCL is because in 2019 APSPDCL was separated from APCPDCL. Although the number of personnel in each executing agency has changed, it is evaluated that there is no problem as the equipment items of the Project have been properly maintained and managed.

Table 3: The number of personnel working for operation and maintenance department

(Unit: number)

	Before the Project	After the Project
TSSPDCL	8,716	7,361
TSNPDCL	5,465	6,153
APSPDCL	8,457	6,408

Daily maintenance is performed by assistant engineers in the regional offices using manuals. Each assistant engineer has a specific facility (such as transformer, breaker, and meter) for which he or she is responsible for maintenance. When there is a problem with the equipment for which they are responsible, the assistant engineer first takes care of it, and if necessary, the supervising higher-level engineer addresses it. The Director of Operations at the headquarters is ultimately responsible for operation and maintenance.

The staff turnover rate is 0% in all executing agencies. All of them provide training to their staff to maintain their motivation and update knowledge and skills. They have training center within their organizations that plan and conduct training and provide their personnel with opportunities to learn about maintenance and the latest trends in the power sector. Based on the above, it is fair to say that the executing agencies of the Project have an appropriate organizational structure to sustain the effects achieved by the Project.

3.4.3 Technical Aspect

An engineering degree is required at the time of recruitment as a requirement for personnel of the executing agencies. After being hired, the personnel participate in training programs planned and conducted by the agency's training center to improve their knowledge and skills. The content of the training includes operation and maintenance of power distribution facilities, defect prevention, safety management, and disaster management. The operation and maintenance of the facilities developed by the Project is being implemented in accordance with the manuals and no

major malfunctions have occurred to date. Therefore, it is judged that the company has sufficient technical skills necessary for the operation and maintenance of the Project.

3.4.4 Financial Aspect

The financial status of the executing agencies at the time of the Project appraisal had been in the black since 2006 and steady since then, mainly because of a decrease in the distribution loss. Considering the financial status for the past three years at the time of the ex-post evaluation, all of them have been in the red. TSSPDCL and TSNPDCL's revenues and expenditures have been slightly changing, and APSPDCL's revenues and expenditures have been gradually decreasing since 2018. This is due to the separation of APSPDCL and APCPDCL in 2019. The main cause of the financial pressure on the respective distribution companies is the very low agricultural electricity tariffs, which are 100% compensated by the state government subsidies; thus, at the time of the appraisal, it was considered that there were no problems regarding Project implementation, operation and maintenance, and repayment resources for the yen loan. In the case of a negative balance at the time of the ex-post evaluation, all executing agencies were compensated by the state government subsidies. A breakdown of revenues and expenditures in the financial statements at the time of the ex-post evaluation shows that electricity purchase costs tend to exceed electricity sales costs. This is the reason for the deficit tendency. When the executing agencies were asked about the background of this, they responded that, while the electricity purchase cost by the executing agencies rises each year, the electricity rates paid by consumers do not rise in line with the increase in the cost. Electricity rates are determined by the State Electricity Regulatory Commission as noted below. The commission is reluctant to raise the electricity rates, as it does not want to lose the support of citizens for the state government. Each year, the executing agencies submit to the State Electricity Regulatory Commission the past three years' actual revenues and expenditure and projected revenues for the same year, as well as the electricity rates for each customer category. After the commission approves the submitted actual and forecasted expenditures and revenues, it determines the electricity tariffs for each category of customers. Electricity tariffs are reviewed in some years but not in others. The financial situation remains unchanged from the time of the appraisal as the companies are in the red and the state government is covering the deficit. One prospect for improving the deficit position other than the compensation by the state government is the support announced by the Indian government in June 2021 to improve the financial situation of the power distribution companies that were economically hit by the COVID-19 pandemic. As described in detail in 3.4.1, the executing agencies of the Project plan to use this assistance to develop smart meters and separate feeders for different categories of consumers. This is expected to improve the financial situation of the power distribution companies. As this support is limited to five years, continuous efforts by the executing agencies are required to improve the financial situation over a long period of time. In

addition to the fact that the financial resources necessary for the operation and maintenance of the equipment and materials developed under the Project have been secured to date, and that appropriate maintenance are being implemented, no significant changes in the size of the budget are expected in the future. Thus, it is concluded that there is no problem with the financial situation to ensure the sustainability of the Project.

3.4.5 Environmental and Social Aspect

It was verified during the ex-post evaluation that there were no negative impacts on the natural environment that were not initially anticipated during the Project implementation. It was also confirmed that there were no negative impacts on residents or specific groups that were not anticipated at the time of the Project appraisal. In short, it was confirmed that no negative impacts on the natural environment, residents or specific groups were identified both at the time of the Project appraisal and at the time of the ex-post evaluation.

3.4.6 Preventative Measures to Risk

There were no identified risks at the times of both the Project appraisal and the ex-post evaluation.

3.4.7 Status of Operation and Maintenance

Among the sites developed by the Project, the evaluation team visited 12 sites where small-capacity DTRs, HT lines, and intermediate poles were set up in a concentrated fashion, and verified the status of the facilities' operation and maintenance. The regional offices of the three executing agencies are responsible for the day-to-day operation and maintenance of the facilities and equipment installed by the Project. Interviews with regional office staff during the site visits revealed that the facilities and equipment saw no major problems so far. Interviews with farmers verified the frequency of transformer and irrigation pump set breakdowns, which were found to be infrequent. Questionnaire surveys were also conducted for the target areas that were not physically visited by the evaluator, and it was confirmed that no major problems had occurred to date. Routine maintenance is performed by assistant engineers in the regional offices based on a manual. When a transformer has a problem, farmers are supposed to call the assistant engineer at the regional office and ask the office to address it.

In the event of any problems with the facilities or equipment installed by the Project, the respective power distribution company is responsible for maintenance. The cost will also be borne by the power distribution companies. Irrigation pump sets, which are not included in the scope of the Project, are maintained by the farmers. Thus, it is fair to say that there is no problem in the situation of operation and maintenance to sustain the effects of the Project.

No major issues have been observed in the policy/systems, institutional/organizational, technical, financial, and environmental and social aspects including the current status of the operation and maintenance system, and preventative measures to risk, although there is a minor problem that the financial status of the executing agencies has remained in the red from the time of the Project appraisal to the time of the ex-post evaluation. Therefore, the sustainability of the Project effects is high.

4. Conclusion, Lessons Learned, and Recommendations

4.1 Conclusion

This Project was implemented to reduce the distribution loss of electric power for agriculture and achieve stable power supply by converting to high voltage distribution systems in rural areas of the southern Indian states of Andhra Pradesh and Telangana.

From the time of the Project appraisal to the ex-post evaluation, the objective of the Project is consistent with the policies of the Government of India and the State Governments of Andhra Pradesh and Telangana. At the time of the ex-post evaluation, the demand for electricity for agricultural use in the states of Andhra Pradesh and Telangana over the past three years showed that there is a need for efficient electricity supply, which is consistent with the development needs of the two states. At the time of the Project appraisal, Japan's ODA policy for India identified "promotion of economic growth" as a priority area, and JICA recognized "support for sustainable economic growth through the development of economic infrastructure" as a priority area. Therefore, the Project is consistent with Japan's ODA policy at the time of the Project appraisal. Thus, its relevance and coherence are high.

Regarding the efficiency of the Project, there was a change in the material and capacity of the DTR which is one of the outputs of the Project. This change was made based on a review after the Project started. The material was changed because it was less likely to be stolen and more economical than the originally planned material; thus, this change is deemed to be appropriate. Although the Project cost was within the plan, the Project period was significantly prolonged because of state bifurcation, which was difficult to foresee at the time of the Project appraisal, and re-tendering due to the excessively small scope of the civil works, which resulted in the Project period significantly exceeding the plan. Thus, efficiency of the Project is moderately low.

Regarding the effectiveness, most of the operation and effect indicators were achieved. As the calculation method for the distribution loss at the time of the Project appraisal could not be confirmed, the transition from the time of the Project appraisal to the time of the ex-post evaluation was checked using the calculation method usually adopted by the executing agencies. As for the impact, yields increased for 76% of farmers interviewed because the frequency of, irrigation pup failure decreased, which reduced the burden of repair costs, and because it has become possible to use electricity for agriculture in a stable manner. Therefore, effectiveness and

impact of the Project are high.

From the sustainability point of view, every executing agency has sufficient knowledge and experience in the technical aspects. The maintenance of the equipment developed by the Project have also been implemented without confusion after the bifurcation of the Telangana state. Regarding policies and systems, the Government of India has been helping to improve the financial situation of the power distribution companies that were economically affected by the COVID-19, and all the executing agencies of the Project have submitted detailed plans for using this assistance and are awaiting approval. The financial situation of the executing agencies has not changed since the time of the Project appraisal. Although they are still in the red and are being financed by the state government, sustainability of the project effect is very high as financial resources for maintenance of the equipment and materials developed by the Project have been secured to date, and there is no expectation of any change in this policy in the future.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

It is recommended that efforts to improve the financial situation be accelerated. This includes raising electricity rates. As noted above, electricity rates are determined by the State Electricity Regulatory Commission; thus, the discretion of the executing agencies is limited. However, every year, they submit to the commission their actual expenditure and revenue for the past three years, their projected expenditure for the same year, and their electricity rates for each customer. Through these opportunities, it would be possible to propose an increase in electricity rates to the commission. In addition, it is expected that efforts will be strengthened to prevent the underpayment of electricity charges due to theft and illegal metering. Interviews with the executing agencies during the ex-post evaluation have revealed that, by strengthening routine patrols and examining data to identify areas where electricity losses have occurred, feeders and areas where electricity theft is frequent have been identified, resulting in more efficient detection of electricity theft and a significant reduction in the amount of unpaid electricity.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

<u>Ensuring a sufficient number of days for appraisal missions to scrutinize the size of the civil works package and the project schedule</u>

In addition to the impact of the state separation of Telangana, there were other factors that caused delays in the Project, such as excessively large civil works packages, which resulted in

unsuccessful bids and the need for re-tendering, and the need to coordinate civil works with the crop harvesting timing. At any project's planning stage, the executing agencies and JICA need to consider the size of civil work packages that contractors can easily participate in and create a project schedule that considers the harvesting period of agricultural crops. It is necessary to investigate at the time of the appraisal what kind of civil work package size would facilitate contractor participation, including the form of contract package usually used by executing agencies. As there was no time to conduct such a survey at the time of the appraisal of this Project owing to the short duration of the appraisal mission, it is necessary to ensure a sufficient number of days for the appraisal mission for any future project.

End

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs	- Number of large-capacity DTRs replaced with small-capacity DTRs: 16 kVA: 50,581 25 kVA: 43,014 -Conversion of LT line to HT line: 26,957 km -Construction of new HT line: 4,622 km -Construction of AB Cable (Ariel Bundled Cable): 20,426 km - Number of inserted intermediate poles: 97,253	- Number of large-capacity DTRs replaced with small-capacity DTRs: 16 kVA: 1,580 25 kVA: 89,952 -Conversion of LT line to HT line: 14,408 km -Construction of new HT line: 2,012 km -Construction of AB Cable (Ariel Bundled Cable): 15,164 km - Number of inserted intermediate poles: 148,575
2. Project Period	June 2011–January 2016 (56 months)	June 2011–March 2019 (94 months)
3. Project Cost		
Amount Paid in Foreign Currency	JPY 387 million	None
Amount Paid in Local Currency	JPY 27,093 million (INR 14,411 million)	JPY 19,091 million (INR 12,873 million)
Total	JPY 27,480 million	JPY 19,091 million
ODA Loan Portion	JPY 18,590 million	JPY 17,473 million
Exchange Rate	INR 1 = JPY 1.88 (As of September 2010)	INR 1 = JPY 1.69 (Average between January 2014 and December 2019)
4. Final Disbursement	October 2019	