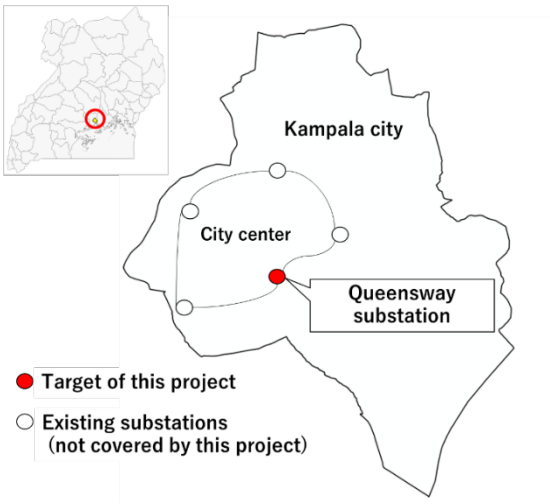
FY2020 Simplified Ex-Post Evaluation Report of Japanese Grant Aid Project

External Evaluator: Juri Ishimoto, Metrics Work Consultants, Inc.

Duration of the Study: December 2020–January 2022

Duration of the Field Study: March 2021–April 2021 (conducted remotely)

Country name	Project for improvement of Queensway substation
Republic of Uganda	



Location of the project site

Outdoor 132 kV gas insulated switchgears

Indoor 33 kV gas insulated switchgears

I. Project Outline

Background	Owing to the increase in demand for electricity resulting from high economic growth in recent years, the Government of Uganda has made the increase in power generation capacity a top priority, and plans are underway to build power plants using hydroelectric, thermal, geothermal, and other technologies. However, the development of power transmission and distribution facilities has been delayed. In particular, the existing facility capacity of the 132/33 kV substation in the capital city of Kampala is approximately 400 MW, and it is operating at a maximum capacity of 320 MW or less (load factor of 80%), while the electricity demand in the city was projected to be 297 MW in 2012 and 407 MW in 2017. It was pointed out that unless the facility capacity were increased through this project, it would not be possible to meet the city's electricity demand.			
Objectives of the Project	The objective of this project was to improve the power supply to the central area of Kampala by installing new 132/33 kV substation equipment in Queensway substation, thereby contributing to improving economic development and people's lives in Kampala.			
Contents of the Project	1. Project Site: Kampala City (population: approximately 1.50 million as of 2014[1]) 2. Japanese side: 1) Civil works: control building (total floor area: 680 m^2), substation foundation (total floor area: 312 m^2); 2) Procured equipment: substation equipment (132/33 kV transformers (40 MVA, 3 units), 132 kV gas insulated switchgears (8 units), 33 kV gas insulated switchgears (14 units), 132 kV control and protection panels (9 units)), 132 kV overhead lines (including two steel towers, approximately 50 m long), and 132 kV underground cables (approximately 350 m long) ; 3) Consulting services: Detailed design, bidding assistance, construction supervision, etc. 3. Uganda side: 1) Securing land for the project site, 2) Provision of water on the site, 3) Implementation of tax exemption and customs clearance procedures, 4) Acquisition of necessary permits and approvals, such as EIA, , 5) Provision of electricity meters, 6) Procurement and installation of equipment for SCADA system[2], etc.			
Implementation Schedule	E/N Date	November 25, 2014		
	G/A Date	November 25, 2014	Completion Date	October 10, 2017 (completion date)
Project Cost	G/A Grant Limit: 3,070 million yen		Actual Grant Amount: 2,415 million yen	
Executing Agency	Uganda Electricity Transmission Company Limited (UETCL)			
Contracted Agencies	Main Contractor: Nishizawa Limited, Kinden Corporation Main Consultant: Yachiyo Engineering Co.			

II. Result of the Evaluation

Summary

The purpose of this project was to improve the power supply capacity to the central area of Kampala (Kampala metropolitan area), the capital of Uganda, by enhancing the 132/33 kV substation facilities of the Queensway substation, which is located in the center of the city. The objective is consistent with Uganda's development policy, development needs, and Japan's aid policy. Therefore, its relevance is high. Among

[1] Kampala Capital City Authority, *Statistical Abstract for Kampala City 2019*, p.23

[2] SCADA (Supervisory Control and Data Acquisition) refers to a system that collects, monitors, and controls information obtained from the equipment and facilities that make up a facility or infrastructure in a single location via a network. In Uganda, data management is conducted using a SCADA system, and this system was also introduced at the Queensway Substation, which is the subject of this project.

the effectiveness indicators, the substation facility capacity and voltage drop ratio of the power receiving end[3] have not been achieved, and the expected outcome (improvement of electricity supply to the Kampala metropolitan area) is considered to be limited. Although some of the effectiveness indicators have not been achieved, small-scale consumers in Kampala city have indicated that voltage fluctuations have reduced and the quality of service has improved since the project has been completed. In addition, the amount of nighttime light and the number of enterprises in the city are on the rise, suggesting that economic activity in Kampala is improving. The number of streetlights using electricity is also increasing, which is considered an improvement in the people's lives in terms of safety. Therefore, the effectiveness and impact of the project is judged to be fair. Although the project cost was within the plan, the project period exceeded the plan. Therefore, the efficiency of the project is fair. As there are no problems with the institutional/organizational, technical, and financial aspects, and the current status of the operation and maintenance system. Therefore, the sustainability of the project is high.

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

Overall Rating [4]	**B**	**Relevance**	③[5]	**Effectiveness and Impact**	②	**Efficiency**	②	**Sustainability**	③

<Special Perspectives Considered in the Ex-Post Evaluation/Constraints of the Ex-post Evaluation>

- Implementation of remote survey: Because of the COVID-19 pandemic, the field information necessary for the evaluation was collected via remote survey from Japan. All field surveys of the facilities developed under the project and interviews with project personnel and others were conducted by local consultants under the direction of the External Evaluator.
- Adoption of supplementary indicator (improvement of planned outage hours): During the project planning stage, planned outages were mainly caused by distribution lines overloading, and it was expected that the project would improve the planned outage hours in Kampala (1776.7 hours in 2013) by reducing the overload conditions of existing facilities. Since this project was expected to make a direct contribution, "outage hours in Kampala metropolitan area" was adopted as a supplementary indicator of effectiveness in this evaluation. However, since it is difficult to predict the increase in electricity demand in the target area, a target value was not set for this indicator. Additionally, since it is not possible to judge the degree of achievement by comparing target values with actual values, the indicator has been used only as reference information in judging the effectiveness of this project.
- Utilization of satellite data: In order to verify the qualitative effect of this project in "contributing to the economic activity of Kampala city," satellite data (nighttime light), which has been recognized to have a high correlation with economic activity, was utilized, and the secular change in the amount of nighttime light in Kampala city was confirmed.

1 Relevance

<Consistency with the Development Policy of Uganda at the Time of Ex-Ante Evaluation>

At the time of the ex-ante evaluation, *Uganda's National Development Plan* (2010/11 to 2014/15) and *Grid Development Plan* (2012 to 2028) listed the development of economic and social infrastructure as a priority issue, and it was necessary to improve the power supply capacity in Kampala. This project aimed to improve the power supply capacity of Kampala city by enhancing the facilities of the Queensway substation, which is located in the center of the city, and constructing a new transmission line. This is consistent with the development policy of the country.

<Consistency with the Development Needs of Uganda at the Time of Ex-Ante Evaluation>

At the time of the ex-ante evaluation, it was pointed out that the power supply capacity was insufficient to meet the rapidly increasing power demand in Kampala city, and frequent power outages were observed. Since this project aimed to stabilize power supply by enhancing the power distribution facilities, it is recognized to be consistent with the development needs of the country.

<Consistency with Japan's ODA Policy at the Time of Ex-Ante Evaluation>

In *Japan's Country Assistance Policy for Uganda* (2012), Japan identified contributing to the stable supply of energy resources by supporting the development of electricity infrastructure as one of the priority issues in order to support sustainable economic growth in the country. Therefore, this project is recognized to be consistent with Japan's ODA policy.

<Evaluation Result>

In light of the above, the relevance of the project is high.

2 Effectiveness/Impact

<The logic behind the project to the realization of impact>

The project aimed to improve the power supply capacity to the Kampala metropolitan area (Outcome) by enhancing the 132/33 kV substation facilities at the Queensway substation (Output). Furthermore, it aimed to improve economic activities and people's lives in Kampala city (Impact). Figure 1 shows the logic from the implementation of the project to the realization of the impact.

The expansion of the Queensway substation will increase the substation facility capacity, which will contribute to the increase in the substation facility capacity in the entire Kampala metropolitan area. In addition, the reinforcement of the substation facilities is expected to improve the voltage drop ratio of the power receiving end of the substation. Moreover, transmission and distribution losses occurred because of the lack of high-voltage transmission lines before the project[6], and the construction of the 132 kV transmission line is expected to reduce the transmission and distribution losses in the Kampala metropolitan area. The improvement of the power supply capacity to the Kampala metropolitan area will improve the situation with the overload and aging of the existing transmission and distribution facilities, reduce the

[3] The voltage drop (transmission end voltage - receiving end voltage) that occurs during transmission as a percentage of the receiving voltage.

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

[5] ③: High, ②: Fair, ①: Low

[6] At the time of the ex-ante evaluation, the Queensway substation was receiving power from existing substations in Kampala using low-voltage rather than high-voltage transmission lines. Since some of the power is lost as heat when it flows through the transmission line, it is necessary to reduce the current flowing through the transmission line (increase the voltage and transmit the electricity). However, the low voltage transmission caused line power loss.

need for periodic maintenance of the facilities, and improve the duration of planned power outages in the metropolitan area. Furthermore, it is assumed that stable power supply to the city will be realized, which will lead to the improvement of the economic activities of factories and companies and the people's lives.

Based on the aforementioned logic, regarding effectiveness, this evaluation verifies whether the power supply capacity to the Kampala metropolitan area has been improved by confirming the improvement status of the substation facility capacity, voltage drop ratio, transmission and distribution losses, and power outage time. As for the impact, the improvement of the economic activities and people's lives in the city is verified based on the results of interviews and the secular change in the amount of nighttime light.

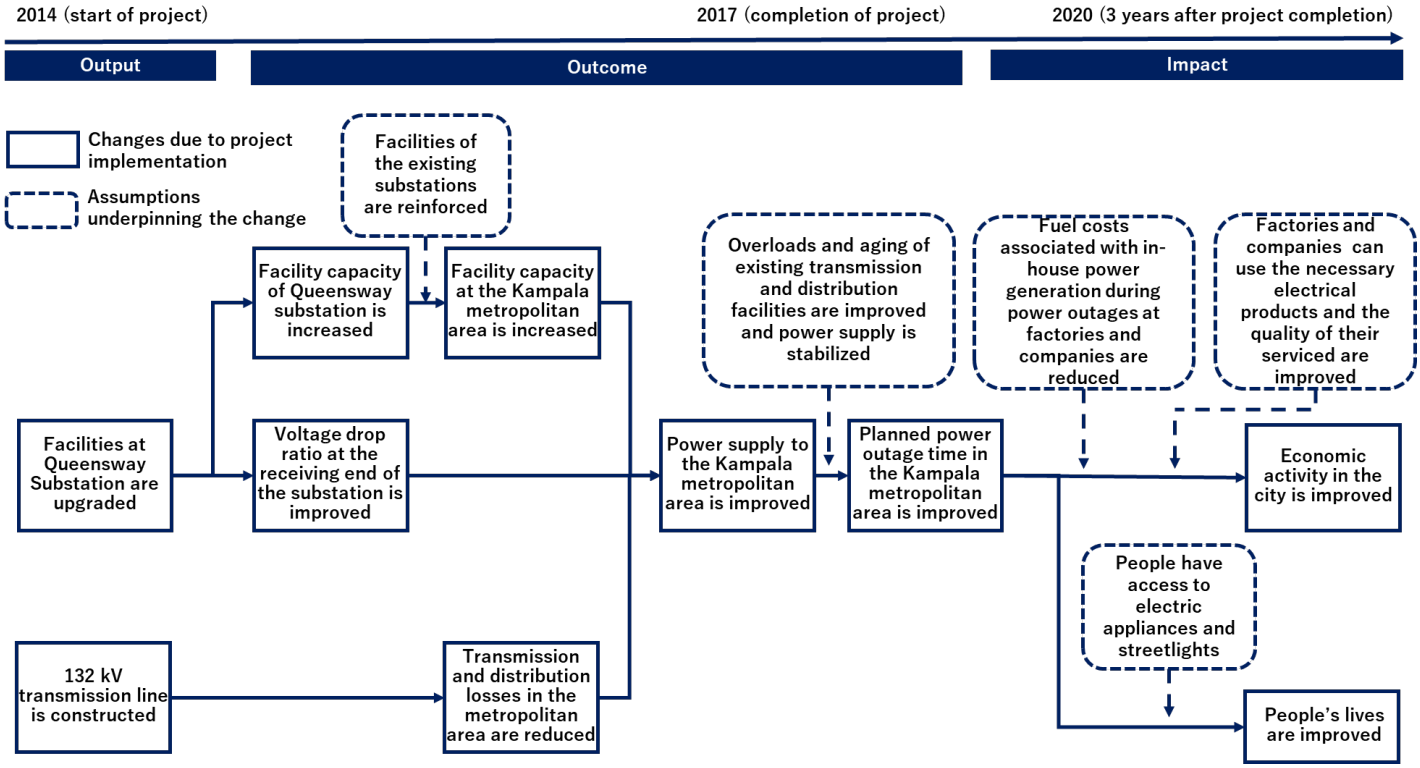


Figure 1: Logic of the project

<Effectiveness>

(1) Substation facility capacity (MVA) at Kampala metropolitan area

The actual value is 540 MVA against the target value of 700 MVA, which is far below the target. Since the actual value is 80 (540–460) against the assumed increase of 240 (700–460), the degree of achievement of the target is about 33%. Hence, this target is judged to be not achieved.

This indicator includes not only the facility capacity of the Queensway substation but also that of other substations in the Kampala metropolitan area. Therefore, the reinforcement of other UETCL substations was also required to achieve the indicator. However, because of the delay in the reinforcement of existing substations, this indicator has not been achieved. In particular, the facility capacity of the existing substation (Mutundwe substation), which is not covered by the project, was planned to be increased from 120 MVA to 240 MVA by 2020, but owing to delays in the plan, its capacity will be increased after 2022.

If only the facility capacity of the Queensway substation is compared, the actual capacity is 80 compared to the planned 120 (target achievement: approximately 67%). The reason for the underachievement is that one transformer at the Queensway substation failed in 2019 and is currently under repair (see "4 Sustainability" below). In view of the fact that without the expansion of this substation, the supply would be even lower than the target, the project is considered to have contributed to the expansion of the substation facility capacity within Kampala city. However, the target is considered to have not been achieved because the planned target of 120 has not been achieved.

(2) Voltage drop ratio of the power receiving end at Queensway substation (%)

The actual result was 6.97% against the target of 4.02%. Hence, this target has not been achieved. The main reasons are the failure of a transformer at the Queensway substation developed under the project and delays in the maintenance of surrounding substations which were not targeted by the project. Because of the failure of one transformer at the Queensway substation, the other transformers were overloaded and the overall voltage drop ratio was high. In addition, the completion of the existing substations (Karma power station, Ayago power station, and the transmission line between Karma and Kawanda) has been delayed, and not enough reactive power[7] is being delivered to the transmission grid (and Queensway substation) as envisaged at ex-ante evaluation, hence resulting in lower transmission grid voltages and a high voltage drop ratio.

(3) Transmission and distribution losses at Kampala metropolitan area (MW)

The target value was 22.1, while the actual value was 22.0. Hence, the target has been achieved.

[7] Normally, in order to prevent voltage rise due to resistance of transmission lines, etc., power (reactive power) that does not create a load and cancels out the voltage rise is fed in.

Table 1: Ex-ante and ex-post comparison of effectiveness indicators

	Baseline 2014 Baseline Year	Target 2020 3 years after Completion	Actual 2017 Completion Year	Actual 2018 1 Year after Completion	Actual 2019 2 Years after Completion	Actual 2020 3 Years after Completion
Substation facility capacity (MVA)*1	460	700	560	560	540	540
Voltage drop ratio of the power receiving end (%)*2	4.43	4.02	NA	6.67	7.87	6.97
Power transmission and distribution loss (MW)*3	17.3	22.1	NA	30.9	16.1	22.0

Source: Questionnaire responses and interviews with UETCL

*1: Total facility capacity (132 kV transformers) of the Queensway substation and existing substations not covered by the project (Lugogo, Kampala North, Mutundwe, and Kawaala).

*2: Actual values are calculated by simulation.

*3: (Power generation in Kampala metropolitan area + received power at Kampala metropolitan area) - (Total demand in Kampala metropolitan area and surrounding areas). The target value is higher than the baseline value because during project planning, it was stated, "the increase in the amount of electricity supply would lead to an increase in transmission and distribution losses, and it would be possible to reduce the increase in losses compared with the case wherein the project was not implemented (24.8)."

(4) Power outage hours in Kampala metropolitan area (Reference Information)

As indicated in the previous section <Special Perspectives Considered in the Ex-Post Evaluation/Constraints of the Ex-post Evaluation>, the above supplementary indicators have been adopted in this evaluation and used as reference information in judging the effectiveness of the project. Data regarding the number of power outage hours provided by UETCL is shown in Table 2. It should be noted that at the time of planning, only the planned outage hours were confirmed, but the actual values could not be collected separately for planned and forced (accidental) outages. Therefore, Table 2 shows the total hours for both planned and accidental outages.

The number of power outage hours has decreased significantly to 2157 hours in 2019 compared to 5640 hours in 2014. According to UETCL, the main reason for planned outages both before and after the implementation of the project is the scheduled maintenance of substations. It was noted that the reinforcement of the 132/33 kV substation facilities at Queensway substation through the project has created substantial grid flexibility and minimized the need for outages during routine maintenance, leading to a reduction in the number of planned outage hours. It should be noted that power outage hours have increased from 2018 to 2019. According to UETCL, it is attributed to emergency loadshedding that was carried out at the end of 2019 due to outage of the Owen Falls – Lugogo 1 and 2 transmission lines and towers collapsed as a result of vandalism.

Table 2: Power outage hours of each substation in Kampala city

Substation	2014	2015	2016	2017	2018	2019
Lugogo	665	1220	649	1014	481	528
Kampala North	1874	877	489	591	639	761
Mutundwe	1901	1930	774	576	220	264
Kawaala	232	276	93	119	65	320
Queensway	968	354	173	452	71	285
Total	5640	4658	2178	2752	1476	2157

<Impact>

(1) Improvement of economic activities in Kampala

Interviews with small-scale consumers

With cooperation from the Uganda Small Scale Industries Association (USSIA), interviews were conducted with small-scale consumers belonging to the association[8]. From the interviews, it was confirmed that the quality and quantity of electricity had improved after the completion of the project. At the time of the ex-post evaluation, some consumers said that they were able to provide stable service, which led to customer acquisition and increased revenue. The main power-related problems during project planning were voltage fluctuations caused by aging transmission and distribution facilities and overloads. 25 of the 30 companies responded that electrical products failed because of high voltage and that they could not be used because of low voltage. After the completion of the project, most of the companies responded that there were no problems with voltage fluctuations. Although two companies pointed out at the ex-post evaluation that voltage fluctuations were still observed, it was also reported that the fluctuations are not as frequent as they previously were and that they are improving. A beverage company had experienced significant losses because of oxidized milk caused by low voltage and insufficient power. However, after the project was completed, there were no problems with both voltage and power supply, and the company's profit margin has stabilized. In addition, a welding company had lost customers when its operations were halted because of power shortages, but the company said that it is now operating at all times.

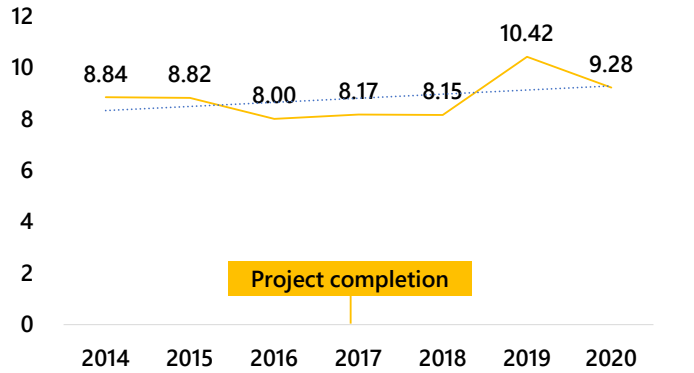
Secular change in the amount of nighttime light

It was observed that the amount of nighttime light in Kampala city increased between 2014 and 2020 (Figure 2 (blue dotted line approximates the orange broken line to see the overall trend)). If the amount of nighttime light have increased after the project's completion (2017), it is estimated that the project would be contributing to improved economic activity in Kampala city. Figure 2 shows that the amount

[8] Responses were collected from 30 companies in Kampala, including construction, manufacturing, and lifestyle-related services (laundry and hairdressing).

of light increased and decreased between 2014 and 2017 with no specific trend, but there was an overall increasing trend and a significant increase after 2019. While nighttime light is an indicator of ground brightness at night and it has been found to be highly correlated with gross economic product, it is difficult to gauge the extent of economic activity based on nighttime light levels alone. Therefore, in order to comprehend the scale of economic activity in Uganda, the average amount of nighttime light was calculated in other countries over the period 2017–2020. It was found that the amount was 2.0 in Kigali, the capital of neighboring Rwanda, and 10.0 in Nairobi, a major African city. Kampala's average amount of nighttime light over the same period was 9.3, suggesting that the city has been experiencing the same level of economic activity as Nairobi is.

In addition, the average change in nighttime light within Kampala city is shown in Figure 3, where the increase in amount of nighttime light between 2017 and 2020 is shown in order of magnitude as blue, green, yellow-green, yellow, orange, and red. From the figure, it can be seen that the amount of nighttime light has increased throughout the city, and the increase is particularly noticeable around the Queensway substation, which is located at the center of Kampala city. Since no other power transmission and distribution networks were constructed before and after the implementation of the project, it is assumed that the project has contributed to the increase in the amount of nighttime light (activation of economic activities) in Kampala city.



Source: Earth Observation Group, Payne Institute for Public Policy, Colorado School of Mines, VIIRS Nighttime Day/Night Band Composites Version 1

Figure 2: Secular change in the amount of nighttime light

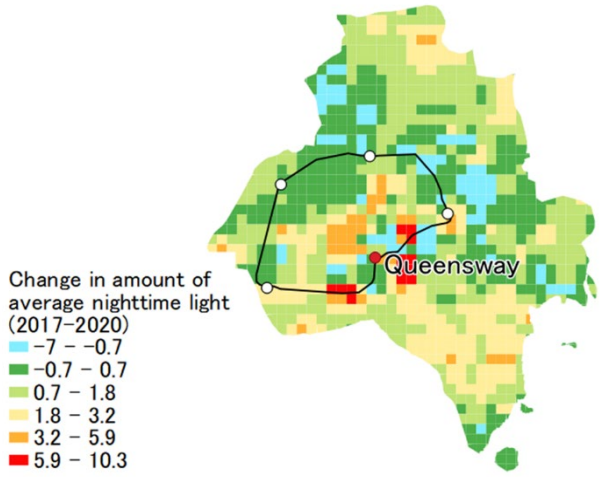


Figure 3: Change in the amount of average nighttime light in Kampala city[9] (2017–2020)

As other reference information, we collected the number of annual trade permits[10] issued by Kampala city (Table 3). Since almost all legitimate enterprises are required to obtain a permit, the number of permits issued can be viewed as the number of enterprises. Since the number of permits issued increased between 2014 and 2018, the number of enterprises is also expected to be on the rise.

Table 3: Annual number of trade permits issued in Kampala

2014	2015	2016	2017	2018	2019
46,493	97,013	63,636	60,536	63,594	NA

Source: Kampala City Statistical Abstract 2019, p. 100

(2) Improving the living environment of residents

The number of streetlights in the living environment of the residents, which may be particularly related to electricity, was identified (Table 4). Streetlights are an important element in ensuring that residents live safely, especially at night. The number of streetlights has increased after the implementation of the project (2019) compared with before its implementation (2014).

Table 4: Number of street lights in Kampala city

Source of supply	2014	2019
Electricity (connected to the hydroelectric power plant system)	NA	3,698
Solar battery	NA	1,738
Total amount	3,449	5,436

Source: KCCA Strategic Plan 2014/15-2018/2019, KCCA Statistical abstract 2019

During the aforementioned interviews with small-scale consumers, the changes in living environment were also confirmed. They answered that before the completion of the project, power outages occurred at night and theft occurred owing to the lack of streetlights, but at the time of the ex-post evaluation, such problems had not been occurring.

<Other positive and negative impacts>

(1) Impact on the natural environment

During the planning stage, the project was classified as Category C under *JICA's Guidelines for Environmental and Social Considerations* (2010) as it was determined that the project would have minimal undesirable impacts on the environment. The installation of the 132 kV underground cable and construction of the substation required an Environmental and Social Impact Assessment (ESIA), and it was approved by the National Environment Management Authority (NEMA) in February 2016. The ESIA required environmental mitigation measures during construction, such as delivering goods and equipment during low traffic hours and transplanting trees outside the substation site. According to UETCL, whether the mitigation measures outlined in the ESIA were implemented had been monitored regularly by officials of the Kampala Metropolitan Authority and the National Environmental Management Authority. The project implementation consultant also responded that no impact occurred on the natural environment during construction. The site visits also confirmed that the trees around the substation had not been cut down in excess. No complaints were reported from the residents.

[9] The area within the black line indicates the Kampala Metropolitan Area.
[10] It is valid for one year from the date of issue.

(2) Impact on the social environment (land acquisition, resettlement)

The land for the substation was owned by the Pan African Movement, a non-governmental organization chaired by the Ugandan Minister of Justice, and it was planned that UETCL would pay compensation to the organization based on its assessment. According to UETCL and the project implementation consultant, the payment was made as planned and the site was acquired before construction without any problems. Regarding the land for the 132 kV transmission line, permission for use of the road had also been obtained from the relevant authorities without any problems before construction. No resettlement has occurred.

<Evaluation Result>

As described above, the implementation of the project has increased the substation facility capacity of the Queensway substation, which has contributed to the increase in the facility capacity of the entire Kampala metropolitan area. It was also confirmed that the transmission loss and outage time in the metropolitan area were reduced. However, owing to the delay in the implementation of other projects and the failure of one transformer at the substation, the substation facility capacity has not reached the target level for the entire region, and the target voltage drop ratio of the power receiving end has not been met. Therefore, the expression of the expected outcome (improvement of power supply capacity to the Kampala metropolitan area) is judged to be limited. Although not achieved, small-scale consumers in Kampala city responded that the voltage fluctuation situation has improved and the quality of service has improved compared with their situation before the completion of the project. In addition, economic activities in Kampala are considered to have improved, as the amount of nighttime light and the number of enterprises in the city have increased. The number of streetlights that use electricity is also increasing. This may indicate that people's lives are also improving in terms of safety. No negative impacts on the natural environment or cases of resettlement were identified. Therefore, the effectiveness and impact of the project are fair.

3 Efficiency

<Output>

This project involved the reinforcement of 132/33 kV substation facilities and the construction of a 132 kV transmission line at the Queensway substation located in the center of Kampala city. The items to be borne by the Japanese side (see "I. Project Outline: Contents of the Project" above) were generally implemented as planned. Regarding the control building and the foundations for the equipment and the 33 kV gas insulated switchgear, some discrepancies were observed in the project completion report. However, this was mainly due to differences in the way the reports were written. In addition, through interviews with the project implementation consultant and site inspections, it was confirmed that the project had been implemented as planned. It was also confirmed that all the items to be borne by the Ugandan side were implemented as planned.

<Project cost>

The total project cost of this project was 2,415 million yen against the planned amount of 3,070 million yen, which was within the plan (79% of the plan). The reason the project cost was lower than the amount planned was that the contract was concluded at a lower amount than the original planned price.

<Project period>

The actual duration of the project was 36 months, while the planned duration was 27 months. Hence, the duration exceeded the plan (133% of the plan). The reasons for exceeding the planned duration were the presidential elections, torrential rains, and failure of the installed equipment. During the implementation of the project, the presidential election and torrential rains (November 2015 and April 2016) delayed the construction of the project and consequently, the completion date was extended from January 2017 to June 2017. Further, during the handover test conducted in June 2017, the 132 kV Busbar B gas insulated switchgear for the Incoming Lugogo Line failed. Therefore, these replacement activities also caused the extension of the completion date of the works from June 2017 to October 2017.

<Evaluation Result>

As described above, although the project cost was within the plan, the project period exceeded the plan. Therefore, the efficiency of the project is fair.

4 Sustainability

<Institutional/Organizational Aspect>

At the time of ex-post evaluation, the Operation and Maintenance Department (257 employees) of UETCL was responsible for the operation and maintenance of the transmission lines developed under the project as per the plan. The Operation and Maintenance Substation Unit (57 employees) of the Department is responsible for the maintenance of the Queensway substation. The daily operation of the substation is remotely monitored and controlled 24 hours a day by the Control Unit of the Department (19 employees) through the SCADA system. According to UETCL, the operation and maintenance of the Queensway substation is remotely monitored by the SCADA system, and there has been no major failure or accident due to shortage of staff.

As described above, the scope of responsibility for the daily operation and maintenance of each facility and the equipment developed under the project is clear, and no serious accident or breakdown caused by insufficient personnel has occurred so far. Therefore, it is considered that there are no problems with the institutional and organizational aspect.

<Technical Aspect>

The staff responsible for the operation and maintenance of the substations and transmission lines developed under the project is qualified at the Engineer level (Bachelor's degree in Electrical Engineering) or Technician level (completion of a Diploma course in Electrical Engineering). The staff is also registered with the Uganda Institute of Professional Engineers (UIPE) (Engineering) and the Engineers Registration Board (ERB). Dealing with power outages caused by transmission lines requires skills in designing and constructing transmission lines, locating faults, assembling towers, etc. For substations, the staff needs skills in assembling, installing, maintaining, and commissioning equipment. The staff is equipped with these skills. In addition, any power outages due to poor maintenance skills of the staff were not reported by UETCL.

During the implementation of the project, the UETCL staff was trained on the installation and operation of the equipment developed under

the project and they were provided with operation and maintenance manuals of the major equipment. According to UETCL, the training helped them understand the substation equipment better and improve their maintenance skills to deal with the problems that occurred in the substation. The manuals are also utilized for the proper operation and maintenance of substation facilities and for the management of abnormalities.

In addition, UETCL provides technical training on transformer assembly, commissioning, and software utilization. Additionally, on-the-job training on equipment operation and troubleshooting in case of failure is provided. Labor management training in communication, leadership, management, project management, etc., is also provided.

As described above, the staff members in charge of operation and maintenance have knowledge and qualifications of electrical engineering, and are equipped with the necessary skills in case of power failure. A system to maintain the technical level by the provision of training and the use of manuals has been established. Therefore, it is considered that there are no problems with the technical aspect.

<Financial Aspect>

UETCL's operating sales are growing, and a certain amount is set aside each year for maintenance (Table 5). In 2018, the exchange rate of the Ugandan shilling against the US dollar remained at a high level, resulting in a foreign exchange loss. Although other operating losses have been incurred because of high selling costs resulting from the increase in the purchase price of power plants, UETCL's financial status improved in 2019.

Table 5: Profit and loss statement of UETCL

(Unit: million Ugandan shillings)

Item	2014 (Ex-ante evaluation)	2017 (Completion Year)	2018 (1 year after Completion)	2019 (2 years after Completion)
Revenue	750,328	599,037	1,091,150	1,115,766
Cost of sales	-611,752	-445,367	-975,691	-944,323
Operating cost	-59,330	-22,137	-49,274	-45,178
Other operating income	54,994	17,531	29,500	122,963
Total income	**134,240**	**149,064**	**95,685**	**249,248**
Maintenance expenses	-5,465	-2,788	-7,159	-7,806
Administrative expenses	-81,686	-58,211	-113,649	-145,934
Financial costs (foreign exchange losses, etc.)	-25,017	-	-81,513	-
Total cost	**-112,168**	**-60,999**	**-202,321**	**-153,740**
Operating profit	**22,072**	**88,065**	**-106,636**	**95,508**
Finance costs	-2,214	-212	-588	-
Income tax expenses	-3,262	-25,599	31,698	-30,869
Annual Profit	**16,596**	**62,254**	**-75,526**	**64,339**

Source: UETCL Annual Report for 2015, p. 51, Annual Report and Financial Statements for 2018, p. 13, 2019, p. 10

With regard to the maintenance of the facilities developed under the project, the budget for cleaning, replacing lights, and purchasing equipment for the Queensway substation has been maintained annually (Table 6). In 2020, the maintenance budget was increased to repair one transformer that failed in 2019 and to strengthen the preventive maintenance and protection of other transformers. At the project planning stage, it was estimated that US$300,000 (approximately 1,115 million Ugandan shillings) would be required annually for the procurement of spare parts to ensure the continued operation of the substation. According to UETCL, the budget at the time of the ex-post evaluation was much lower than expected, as there was no need to purchase spare parts every year and stocks were maintained.

Table 6: Maintenance budget for the Queensway substation

(Unit: million Ugandan shillings)

2017	2018	2019	2020
NA*1	25	27	3,929

Source: UETCL responses on questionnaires

*1: The Queensway substation was completed in 2017. The budget for the substation equipment developed under this project was generated since the following year (2018).

As described above, it is considered that there are no problems with the financial aspect, as the financial status is generally good and the necessary budget for maintenance and management has been secured.

<Current Status of Operation and Maintenance>

After routine maintenance in March 2019, unknown person entered the Queensway substation and vandalized the substation grounding copper wire. The transformers were left disconnected to the grounding system and this subsequently led to failure of Transformer No.3 (TX 3) when it was exposed to fault. According to the post-incident investigation by the manufacturer conducted in February 2020, the other two transformers (Transformer No.1 (TX 1) and 2 (TX 2)) had sustained mild damage during the incident; and were still in operation at the time of ex-post evaluation. UETCL believes that in addition to non-earthed substation operating condition due to theft of earthing conductor, the reason why the transformers got damaged is the weak design of the tertiary winding of the transformers. The damaged TX 3 is currently in the process of being repaired and UETCL has scheduled to embark on reinforcement for the tertiary winding of TX 1 and 2 as recommended by the manufacturer, upon completion of repairs of the already damaged TX 3. The reason for the time taken to repair TX 3after the discovery of the malfunction is as follows. After the malfunction was confirmed, the transformer could not be opened on site, and it took time to assess the degree of damage. It also took time to locate a contractor who could handle the problem, as malfunctions of this sort do not occur frequently. Since the parts needed for the repair were not available in Uganda, UETCL contacted the manufacturer in Japan, estimated the cost of the repair, and applied for a budget. However, after approval was granted, it was found that the spare materials were taxable, yet the tax was not included in the budget estimates; and consequently, UETCL needed to reapply for the budget. In addition, after the procurement funds were secured, the manufacturer was unable to send engineers to repair the transformer because of the travel ban imposed owing to the COVID-19 pandemic. For this reason, UETCL is currently importing the parts and the transformer repairs are scheduled to commence by the Japanese supplier in January 2022 at a company that specializes in repairing substation equipment. It should be additionally noted that on 2nd November 2021, while awaiting reinforcement of its tertiary winding, TX 1 malfunctioned and is currently pending repair. The repairs for TX

1 are expected to be completed by the end of March 2022.

UETCL has strengthened security at the substation and is checking the operation of the substation more regularly. In the near future, permanent staff members are to be appointed at the substation office. UETCL also stated that preventive measures would be taken to prevent theft and destruction, such as using copper clad steel instead of pure copper. As the process of applying for and securing funds for the repairs would take some time, UETCL said it was also considering credit agreements with providers of replacement parts.

For the maintenance of substation equipment, substation staff visually inspects the condition of the equipment daily. In addition, the Operations and Maintenance Department tests the operation of the substation equipment and performs routine maintenance on transformers, switchgear, and other equipment twice a year. Cleaning inside the Queensway substation is carried out daily by staff, while cleaning outside the substation is outsourced to a private company and carried out on a regular basis. The site visit confirmed that spare parts were stored at the substation. According to UETCL, the inventory is managed through the system and a record book, and a sufficient number of spare parts is available.

As described above, at the time of the ex-post evaluation, it was found that one of the transformers developed under the project had a problem and was out of service. The necessary parts have been arranged and repairs are scheduled to be completed at the end of FY2021. Since preventive measures are being taken, it is judged that there is no serious concern about the status of operation and maintenance. The operational status of other facilities and equipment is good, daily inspections and regular preventive maintenance are conducted, and spare parts are systematically procured. Therefore, it is considered that there are no problems with the current status of the operation and maintenance system.

<Evaluation Result>

As described above, no major problems have been observed in the institutional/organizational, technical, and financial aspects and the current status of the operation and maintenance system. Therefore, the sustainability of the project's effects is high.

III. Recommendations and Lessons Learned

Recommendations to Executing Agency:

One transformer developed under the project has been out of service since March 2019 and is currently under repair. In addition to external factors such as the COVID-19 pandemic, the reasons it has taken time to repair the transformer are the procurement of parts that are unavailable in Uganda repair measures, and the complexity of the procurement process. When reinforcing substation facilities in the future, as well as the prompt repair of transformers, it is desirable to confirm that the parts are available in Uganda and to check thoroughly that there are no mistakes in the procurement procedures if the parts are difficult to obtain and must be procured from overseas.

Recommendations to JICA:

None.

Lessons Learned for JICA:

(1) Setting indicators

"Substation facility capacity," which is an effectiveness indicator of the project, included not only the facility capacity of the Queensway substation constructed under the project, but also the capacity of other substations located in Kampala city. However, the reinforcement of the facilities of other substations was delayed more than planned and the target value was not met. Indicators should be set to verify the direct effects of the project, especially in terms of effectiveness. In cases of supporting a part of a power supply network, such as from power generation to transmission, it is necessary to determine the extent to which the project is directly related to the project objectives, and to set appropriate quantitative indicators to measure the effectiveness of the project. For example, in order to verify the effect of this project itself, it is considered that an indicator should have been set for only the facility capacity of the Queensway substation.

With regard to the "Voltage drop ratio of the power receiving end," when asking UETCL for the actual values, the response was that the voltage drop ratio always fluctuates and that all the data on voltage drop ratio is not stored indefinitely by the SCADA system.. For example, the realistic measure would be to calculate the voltage drop ratio by taking the voltage value for the day of the month with the highest electricity consumption of the year and the period with the highest electricity consumption during the day into consideration. However, for the indicators set in the project, the actual (baseline) and target values were calculated by simulation, and there was no prior decision on how to collect specific data, as described above. Since difficulty is expected in checking the data retrospectively, it is important for JICA to agree with the implementing agency on the definition of the set indicators and the specific calculation method at the project planning stage or at the latest, by project completion.

(2) Materials and equipment to be procured for the project

As mentioned above, one of the reasons it took so long to repair the transformers developed under this project was that spare parts for the substation equipment were not available in Uganda and had to be imported from overseas. The impact of the COVID-19 pandemic has also made it even more time-consuming to procure these parts than it would have been in previous years. Given that there will be similar restrictions on travel and transportation in the future, it is even more important to consider whether it is possible to carry out repairs in Uganda at the time of project formation.

Control building

Control panel

Grounding part of transformer

Transformer under repair