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Republic of Sierra Leone

Ex-Post Evaluation of Japanese Grant Aid Project
The Project for Urgent Improvement of Electric Power Supply System in Freetown

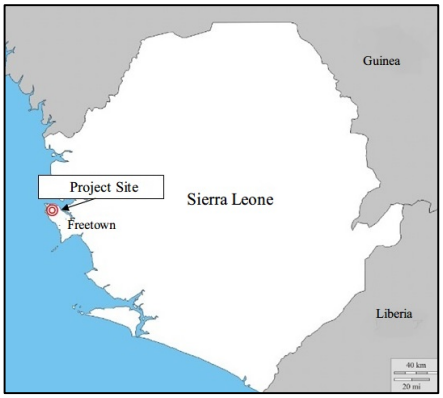
External Evaluator: Kenichi Inazawa, Octavia Japan Co., Ltd.

0. Summary

With an aim to stabilize power supply in Freetown, which was destroyed by the civil war, this project procured and installed electric power generating units while constructing a building for the power station, a substation and distribution lines. Both at the times of before project commencement and the ex-post evaluation, this project is consistent with the policy stipulated in the Second Poverty Reduction Strategy Paper (PRSP-II), which recognizes the power sector as a priority, and with the development needs, such as increasing power generating facilities and power supply; therefore, relevance of this project is high. Although the total power demand still exceeds the supply capacity in Freetown and the outskirts after the project implementation, this project is contributing to the improvement of the power supply system through the procurement and installation of two power generating units at the Kingtom Power Station. On the other hand, the number of electrified households in Regent, one of the target areas in the suburb, is smaller than what was planned because a power feeder panel, which was supposed to be installed by a World Bank project, is not yet in place. Effectiveness and impacts of the project are evaluated to be fair in view of its contribution toward the entre power supply system and the stabilizing operation of the power generating units at the Kingston Power Station. The project period was as planned, and the project cost was within the plan. Thus efficiency is high. No major problems are observed in the institutional aspects of the operation and maintenance carried out by the Executing Agency. On the other hand, sustainability of the project is fair because the Agency has been operating in the red financially, which needs improvement.

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

1. Project Description



Project Location


Power Generating Unit Procured by the Project (Kingtom Power Station)

1.1 Background

In the Republic of Sierra Leone (herein after referred to as "Sierra Leone"), the civil war from 1998 to 2002 devastated the country both economically and socially, which also affected the power sector severely. At that time the Kingtom Power Station was the only power plant supplying electric power in Freetown. However, the facilities were already old, and it experienced frequent failures because maintenance was not properly carried out during the civil war, limiting its power generating capacity. In addition, facilities and equipment of distribution networks and substations in the city also had problems. Thus the power supply capacity was not necessarily sufficient. As a result, residents were not able to receive sufficient power supply[1], downgrading the administrative and public service level. Although well-to-do families were able to generate their own electricity using diesel generators, families who could not afford in-house power generation were forced to live without electricity most of the time. While a majority of commercial industrial facilities also relied on in-house power generation, an increasing number of factories closed down because global oil prices rose and increased production costs, including the cost of purchasing fuel for in-house power generators; it had a major impact on the country's economy and employment. Due to such circumstances, there was an urgent need to reinforce power generating facilities and to rehabilitate power distribution networks.

[1] For example, 77.1% of the residents in Western Area did not receive sufficient electricity in 2008.

1.2 Project Outline

The objective of this project is to stabilize an electricity supply by procuring and installing power generating units (5MW x 2 units) and by constructing a powerhouse, a substation and 11 kV and 33 kV power distribution lines in Freetown, which was devastated by the civil war.

Grant Limit / Actual Grant Amount	【Grant Limit】2,240 million yen in total (Phase-1: 570 million yen, Phase-2: 1,652 million yen, Phase-2 detailed design: 18 million yen[2]) 【Actual Grant Amount】2,232 million yen in total (Phase-1: 568 million yen, Phase-2: 1,647 million yen, Phase-2 detailed design: 17 million yen)
Exchange of Notes Date (/Grant Agreement Date)	Phase-1: August 2007 Phase-2: May 2008 Phase-2 detailed design: January 2008
Executing Agency	National Power Authority (NPA)
Project Completion Date	March 2010 (Phase-1: March 2009, Phase-2: March 2010)
Main Contractor(s)	(Construction Management) ITOCHU Corporation & Dai Nippon Construction (JV) (Procurement of Machinery, Equipment and Materials) Phase-1: Added Value Corporation Phase-2: ITOCHU Corporation
Main Consultant(s)	Yachiyo Engineering Co., Ltd.
Basic Design	August 2006 – March 2007
Detailed Design	January 2008
Related Projects (if any)	【Technical Cooperation Project】

[2] According to JICA's document, this project was implemented in two phases: Freetown's distribution network was constructed in Phase-1 whereas the Kingtom Power Station was reinforced in Phase 2. A detailed design was a part of Phase-2.

[3] Technical training was held on operation and maintenance of diesel power generating facilities as well as power transmission, distribution and transformation facilities with the aim of improving the abilities of the Executing Agency's staff to operate and maintain power supply facilities. More specifically, the training included OJT, technology transfer through lectures and a third country training program.

[4] This project procured and installed one unit of 5 MW diesel power generator at the Kingtom Power Station.

[5] This project was implemented with the purpose of supplying electricity and water mainly in Freetown. Through this project the following was implemented: rehabilitation of the diesel power generator, auxiliaries and common facilities (fuel and cooling water) (targeting the entire unit); the procurement of fire safety equipment; the introduction of prepaid meters; the construction of customers' service centers; the refurbishment and upgrade of high voltage,

	"The Project for Capacity Development for Maintaining Power Supply Facilities[3]" (2011-14) 【Grant Aid】 "The Project for Improvement of Electricity Power Supply to Greater Freetown[4]" (1993) 【Other Projects by International Aid Agencies】 "Power and Water Project[5]," the World Bank (2004-09)

2. Outline of the Evaluation Study

2.1 External Evaluator

Kenichi Inazawa, Octavia Japan Co., Ltd.

2.2 Duration of Evaluation Study

Duration of the Study: September 2012 – August 2013

Duration of the Field Study: February 23 – March 12, 2013, July 13 – 20, 2013

3. Results of the Evaluation (Overall Rating: B[6])

3.1 Relevance (Rating:③[7])

3.1.1 Relevance to the Development Plan of Sierra Leone

Before the project commencement, the government of Sierra Leone developed the "National Economy, Reform and Development Plan (2003-06)" aiming to reconstruct the economy after the civil war. In this plan, the "Reconstruction of Industrial Sector and Infrastructure" was listed as one of the priorities in order to reconstruct the country and stabilize its industry and economy. The government was aware that improvement of electric power infrastructures was essential for attracting private investments, reconstructing its economy and promoting employment.

At the time of the ex-post evaluation, four priority sectors are listed in the PRSP-II developed by the government of Sierra Leone in 2009: electricity, agriculture, roads and human development (education and health). Concerning electricity, it says that the country will "develop new power sources and promote private sector investment." In addition, the government enacted "The National Electricity Act" in September 2011, which states that

medium voltage and low voltage distribution facilities; the construction of 33 kV sub-transmission lines; and the rehabilitation of the 11 kV and low voltage networks.

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

[7] ③: High, ② Fair, ① Low

"improving electricity supply capacity is the most pressing issue for the national economy." Therefore, it can be said that the power sector continues to be viewed important at the time of the ex-post evaluation.

In view of the above, this project, which is designed to support the power sector in Sierra Leone, is consistent with the policy, such as the national and sectoral plans both at the time of before project commencement and at the time of the ex-post evaluation.

3.1.2 Relevance to the Development Needs of Sierra Leone

Before project commencement (February 2007), while peak demand was 45 MW in Freetown and the outskirts, a total (rated) power generation plant capacity of the Kingtom Power Station, the only power generating source at that time, was 39.2 MW (seven power generating units in total). However, because only one power generating unit (rated output of 6 MW) was operational at that time, its power supplying capability was low. In view of such situation, the government of Sierra Leone prepared a plan to develop 100 MW of new power sources over a ten-year period starting from 2005. As a part of this plan, the government requested for Japan's Grand Aid to construct new diesel power generators with a total output of 10 MW (2 units) and to rehabilitate power distribution networks with the aim of reducing distribution losses.

At the time of the ex-post evaluation, power demand of Freetown and the outskirts is increasing because of the high economic growth[8] after the end of the civil war. In terms of the entire power supply system, on the other hand, the Kingtom Power Station rehabilitated by this project and the Blackhall Road Power Station[9] developed with the financial assistance of the Arab Bank for Economic Development in Africa (BADEA) are designed to complement the Bumbuna Hydroelectric Power Station[10]. (The Kingtom Power Station and the Blackhall Road Power Station would increase their electricity generation in the dry season when the output of the Bumbuna Hydroelectric Power Station becomes low with a view to supplying electricity to Freetown and the outskirts. On the other hand, the Kingtom Power Station and Blackhall Road Power Station would go standby (planned halt) in the rainy season.) According to the National Power Authority (NPA), the Executing Agency of the Project, the total power demand is approximately 50MW at the time of the ex-post evaluation, whereas the total power generation (rated) output is approximately 32MW (10MW rated output by the Kingtom Power Station,

[8] GDP has been growing at an average 7% in recent years.
[9] It was developed with the assistance of BADEA and began operating in April 2011 (rated output of approximately 16MW: two power generating units).
[10] In addition to the assistance from ESKOM (a South African electricity public utility) and BADEA, it was also assisted by the World Bank and others. It began operating in November 2009.

6MW by the Bumbuna Hydroelectric Power Station, and 16MW by the Blackhall Road Power Station). Because power demand continues to exceed supply as it was the case before project commencement, it can be judged that there is a continued need to stabilize power supply and develop power sources. Concerning the Bumbuna Hydroelectric Power Station, it was expected to generate 50MW (two power generation units) in the rainy season (May-November) and 18MW (two power generation units) in the dry season (December-April). However, a trouble occurred as soon as it was commissioned; one power generating unit failed in November 2012. The remaining unit is barely operating, and the output is as low as 6MW as of March 2013[11]. In view of the situations, there is an urgent need to rehabilitate the Bumbuna Hydroelectric Power Station and to improve the entire power supply system with a view to stabilizing Freetown's power supply. Thus it can be said that there continues to be a high demand for this project.

In addition, although distribution networks in Freetown and the outskirts have been improved through this project, there still remain old distribution networks. Also, there is a distribution loss problem due to pilferage[12], which needs to be addressed urgently.

In view of the above, power shortage continues to be a problem in Freetown and the outskirts at the time of the ex-post evaluation, and there continues to be a need to respond to the increasing power demand. Therefore, it is judged that this project is consistent with the development needs both at the times of before project implementation and the ex-post evaluation.

3.1.3 Relevance to Japan's ODA Policy

According to the assistance policy of Japan to Sierra Leone (ODA policy outlined by the Ministry of Foreign Affairs in 2006), Japan was providing assistance by recognizing the following as priorities: (1) consolidation of peace and nation building after the civil war, which is a prerequisite for the government's efforts toward poverty reduction; and (2) social development and revitalization of productive activities through participation of local residents while promoting administrative capacity restoration[13].

This project follows the Project for Improvement of Electricity Power Supply to Greater Freetown which was implemented with Japan's Grant Aid in 1993. Through the development of electric supply facilities, this project is designed to contribute to the consolidation of peace and

[11] According to NPA, they will outsource the technical inspection to a foreign company to identify the cause by the end of 2013, based on which they hope to fix the problem and resume operation.
[12] The electric power distribution loss is high at 40-50% as of 2010, as per quantitative data provided in the Effectiveness section.
[13] The assistance to power sector is also specified in the Country Assistance Policies issued in December 2012.

economic reconstruction which is relevant to (1) above. Thus it can be said that this project is consistent with the development policy of Japan.

In view of the above, this project has been highly relevant with the country's development plan, development needs, as well as Japan's ODA policy; therefore its relevance is high.

3.2 Effectiveness[14] (Rating:②)

3.2.1 Quantitative Effects (Operation and Effect Indicators)

Table 1 shows the targets set before project implementation and actual data after project completion in reference to the operation and effect indicators concerning power generating facilities and distribution network. Because power supply was concentrated in the central Freetown and that electricity was not available in some parts of the suburbs before project implementation, this project also intended to electrify 3,200 households in an area near the Regent Substation, a suburb of Freetown, by procuring power distribution equipment and materials.

Table 1: Data Concerning Direct Effects of the Project (Actual before project implementation, target after project completion, and actual after project completion)

	Actual (2007)	Target After Completion (2010)	Actual After Completion (2012)
【Improvement of Kingtom Power Station】			
a) Power generating capacity (rated output)	6.0MW	16.0MW (out of which 10MW by this project)	10.0MW
b) Reduction in the number of power blackouts attributed to the improvement in the power generating system (times/day)	1	0.5	0.5 (1 time per day after November 2012)
【Rehabilitation of 33/11 kV Distribution System in Freetown】			
c) Reduction of power distribution loss in Freetown and the outskirts	40% or lower	Approximately 30%	40% or little less
d) Electrification of non-electrified communities in Regent Area	None	3,200 households	187 households

Source: JICA document and NPA's response

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

a) Improving Power Generating Capacity (Rated Output) of the Kingtom Power Station and the Project Effects in Terms of the Power Station's Role in Entire Power Supply System

As stated earlier, only one power generating unit (rated output of 6.0 MW) was operational at the Kingtom Power Station before project commencement. The plan was that the power generating capacity would be increased to 16.0 MW after the completion of this project by procuring and installing two new power generating units (with the output of 10 MW in total: 5 MW each x 2 units). According to NPA, however, the existing power generating unit (6.0 MW), broke down and was decommissioned in 2008 because it was already becoming old before project commencement[15]. As a result, the two units (10 MW in total as mentioned earlier) that have been procured and installed by this project are the only ones operational at the time of the ex-post evaluation (see Table 1). Therefore, despite the fact that the power generating units were procured and installed by this project as planned, generating and supplying power as per the expectation without problems, the Kingtom Power Station has not been able to achieve a total output of 16.0 MW.

On the other hand, as stated earlier, the Kingtom Power Station is one of the power generating facilities complementarily supplying electricity to Freetown. The changes in generated energy of the Bumbuna Hydroelectric Power Station, the Kingtom Power Station and the Blackhall Road Power Station are shown in Figure 1 (2011) and Figure 2 (2012) below. These figures show that when the Bumbuna Hydroelectric Power Station operates in the rainy season (May-November), the Kingtom and Blackhall Road Power Stations reduce their outputs, whereas their outputs are relatively high in the dry season (December-April). With regard to Figure 1, no energy was generated from January to March 2011 in the Blackhall Road Power Station because it began operating in April 2011. With respect to Figure 2, the power generating unit of the Bumbuna Hydroelectric Power Station had a problem in November 2012 as mentioned above, which led to low rate of utilization and significant reduction in the generated energy from this month onward. It can be observed that this in turn increased the rate of utilization of the Kingtom Power Station. In other words, it is judged that the Kingtom Power Station is properly functioning as one of the complementary power generating facilities, supporting NPA's total power generation.

[15] Although it was procured in 1995, it broke down before its estimated service life most probably because maintenance was not sufficient during the civil war in the late 1990s.

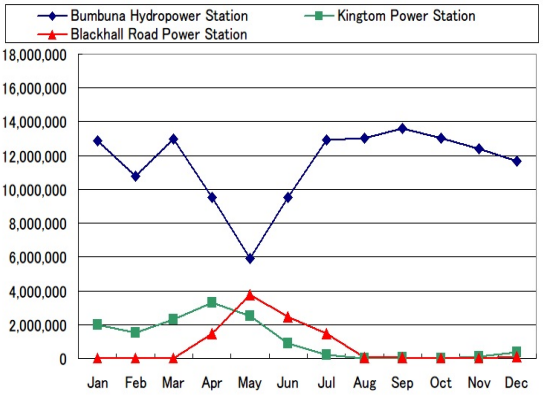


Figure 1: Generated Power (kWh) at Three Power Stations (2011)

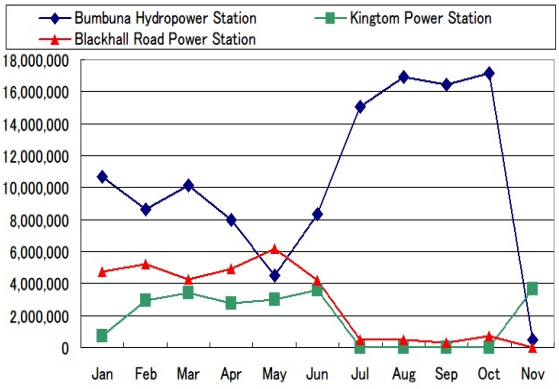


Figure 2: Generated Power (kWh) at Three Power Stations (2012)

With reference to the contribution of this project to the improvement in NPA's power generating operation, data is shown in Table 2 on the operation indicators concerning the overall operation of NPA's power generating facilities since the project commencement.

Table 2: Overview of NPA's Operation

Indicator	2007	2008	2009	2010	2011	2012
1. Electric Power Production (MWh)	30,681	138,538	132,855	175,045	182,863	189,894
2. Auxiliary Power Production (MWh)	2,250	321	508	833	N/A	N/A
3. Auxiliary Power Ratio (%)	7.3	0.23	0.38	0.48	N/A	N/A
4. Net Electric Power Production (MWh)	28,431	138,217	132,348	174,212	160,963	167,994
5. Sales Power Production (MWh)	17,341	76,395	67,540	82,339	N/A	N/A
6. Transmission and Distribution Losses (MWh)	11,090	61,822	64,808	91,873	N/A	N/A
7. Transmission and Distribution Loss Ratio (%)	39.0	44.7	49.0	52.7	N/A	Slightly less than 40
8. Electricity Tariff Collection Rate (%)	N/A	N/A	55 or lower	Around 55	N/A	N/A

Source: NPA

The most significant data concerning electric power production will be analyzed below with a view to reviewing the operation status.

The following can be said about the electric power production: (1) Before project

commencement in 2007, only one power generating unit was operational at the Kingtom Power Station, and the power supply to Freetown and the outskirts was at a critical level; (2) In the hope of improving this situation, NPA purchased electricity from a domestic Independent Power Producer (IPP) to supply electricity in the said areas, as a result of which 138,538 MWh of energy was secured[16] in 2008; (3) NPA continued to rely on IPP in 2009[17] in securing 132,855 MWh of energy, which is almost the same level as 2008; (4) In 2010, the two power generating units supported by this project began operating at the Kingtom Power Station (March 2010), and the electric power production increased from the previous year. The increase was also thanks to the Bumbuna Hydroelectric Power Station, which was commissioned at the end of 2009. On the other hand, NPA stopped purchasing electricity from IPP; (5) In 2011 the trend continued. The Blackhall Road Power Station began its operation (April 2011), and NPA secured 182,863 MWh of electric power; and (6) In 2012 the situation continued to be similar to the previous year, and the electric power production was stable until October 2012 although it has been decreasing since November 2012[18].

In view of the above, it is observed that this project is making a certain contribution to increasing the total electric power production of NPA. On the other hand, it is apparent that NPA needs to continue striving to stabilize the electric power supply system in Freetown.

b) Reduction in the Number of Power Blackouts Attributed to the Improvement in the Power Generating System

As shown in Table 1, the number of power blackouts was expected to decrease to 0.5 times per day in Freetown and the outskirts after the completion of the project. As planned, the target was achieved one and a half years after the completion. However, as discussed earlier, the power generating unit of the Bumbuna Hydroelectric Power Station failed, and it has become difficult to meet the power demand of Freetown and the outskirts given the generation capacity of the Kingtom and Blackhall Road Power Stations. Influenced by such external factor, the number of blackouts on the average has increased to once a day since then. At the moment, whether or not the number of blackouts goes down again is subject to the restoration of the power generating unit at the Bumbuna Hydroelectric Power Station. As stated earlier, the technical inspection is planned to be carried out by the end of 2013, which will identify what

[16] NPA purchased electricity from the IPP by signing a one-year contract. The purchasing cost was borne by the World Bank.
[17] NPA purchased electricity by extending the (one-year) contract from the previous year by one year.
[18] As mentioned earlier, it is because one power generating unit is broken at the Bumbuna Hydroelectric Power Station while the other unit is operating at a low output level.

has caused the failure of the power generating unit.

c) Reduction of Power Distribution Loss in Freetown and the Outskirts

With regard to the rate of power distribution loss ratio in Table 1, while the target was around 30% after project completion, the current ratio is slightly less than 40%, which is higher than planned. One reason is that electricity distribution is not efficient because many old distribution lines still exist in the city center. High rates of pilferage also explain why the distribution loss is high. As shown in Table 2, NPA's transmission and distribution loss ratios are 55% or below in 2009, around 55% in 2010, and slightly less than 40% in 2012. Since 2010 NPA has been implementing a program against electricity pilferage, called "MACPI," with the support of the central government, the police and the national army. Although the transmission and distribution loss ratio started to decline owning to the patrolling and tightened security in the areas with reported cases of pilferage, the ratio remains high. Thus NPA needs to strengthen its efforts to control electricity pilferage in order to stabilize power supply.

d) Electrification of Non-Electrified Communities in Regent Area

With respect to the electrification of non-electrified communities in Regent Area, although 3,200 households were expected to be electrified after the completion of the project, the actual number of electrified households is 187 households in the target area as of March 2013 as shown in Table 1. Before project commencement, it was envisaged that a 33 kV distribution line between the Freetown Substation and the Wilberforce Substation would be constructed by the World Bank's "Power and Water Project," whereas a 33 KV distribution line between the Wilberforce Substation and the Regent Substation would be constructed by this project, which would enable the distribution of the transmitted electricity from the Bumbuna Hydroelectric Power Station to Regent Area (see Figure 6). However, a 33 kV power feeder panel[19], which was supposed to be procured and installed at the Wilberforce Substation by the World Bank, is not yet in place while the 33 kV distribution line is completed. The absence of electricity supply through the high-voltage 33 kV distribution line in Regent Area is responsible for the limited number of electrified households[20]. Meanwhile, the World Bank approved a new project,

[19] The World Bank initially planned to procure and install a power feeder panel as a part of the Power and Water Project. Although there was an agreement between the World Bank and NPA, it was not executed. JICA communicated in writing several times up until the time of the ex-post evaluation, requesting for the procurement and installation.

[20] It is said that the procurement and installation could not be performed within the contract period set by the project because mainly the contractor appointed by the World Bank and NPA had some communication problem, which prolonged the procedure and coordination between the two parties. Currently the number of electrified households is

"Energy Access Project[21]" for Sierra Leone in June 2013. It is planned that through this new project, a 33 kV power feeder panel which was not fulfilled by the Power and Water Project will be procured and installed. The number of electrified households in Regent Area is expected to increase when the power feeder panel becomes operational[22].

Figure 3: Regent Area
(developing as a residential area)

Figure 4: Distribution Line Between Wilberforce and Regent (Left: 11 kV Distribution Line, Right: 33 kV Distribution Line)

not increasing because the electricity is supplied from the Kingtom Power Station only through the low-voltage 11 kV distribution line.

[21] The budget is approximately 1.6 billion yen. It aims to reduce the electric power distribution losses in Freetown and the Western region while improving NPA's finance. In addition, the International Development Association (IDA) of the World Bank group is planning to implement budget support with the aim of promoting the reform of the power sector. (The budget is approximately 3.5 billion yen.) By these two projects, high distribution loss ratio is expected to reduce, and NPA's finance is expected to improve.

[22] Many residents in Regent Area are requesting to join the electricity service at the time of the ex-post evaluation according to NPA. While residents are required to pay connection charges (roughly USD 100-130) in order to join the electricity service, their capacity to pay is not of concern because many households are relatively rich in this area according to NPA.

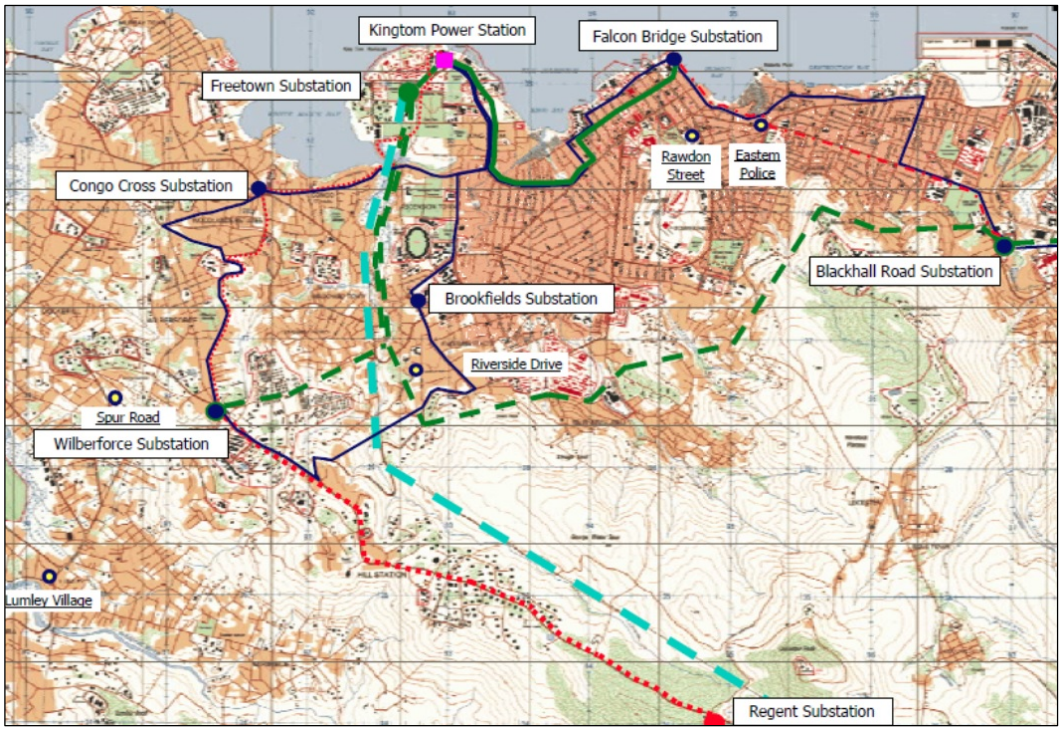


Figure 5: Power Stations, Substations and Distribution Networks in Freetown and the Outskirts (Locations of Project Sites[23])

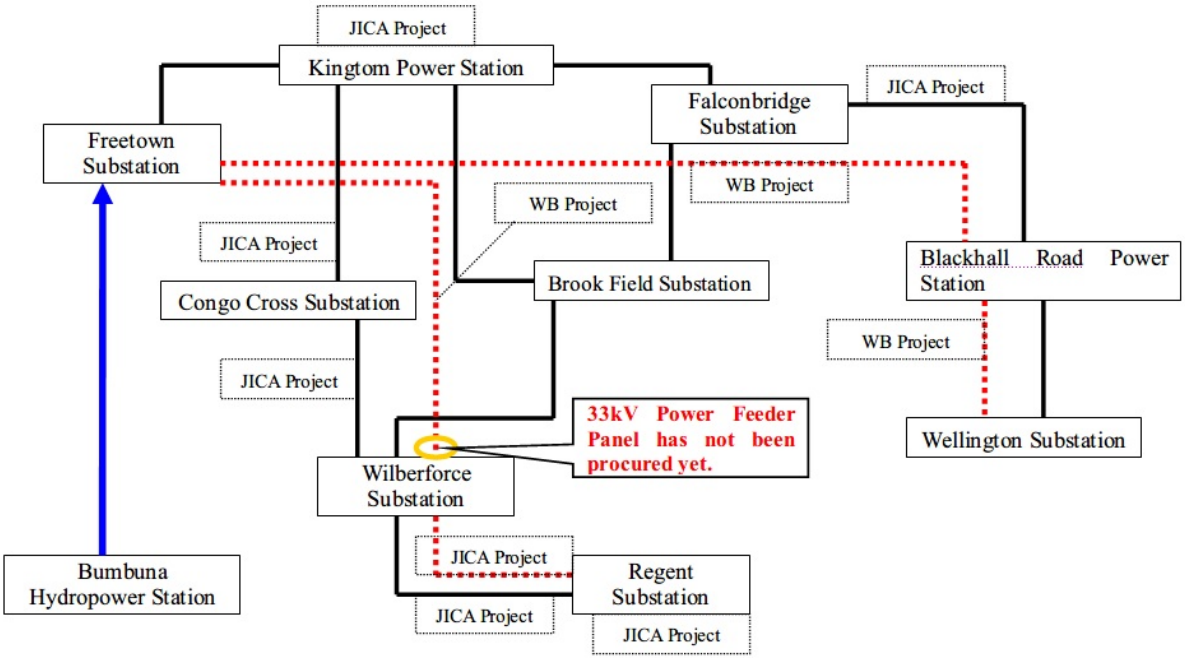


Figure 6: Power Stations, Substations and Distribution Networks in Freetown and the Outskirts (Schematic[24]) (Black lines represent 11 kV distribution lines, red dotted lines represent 33 kV distribution lines, and a blue heavy line represents a 161 kV transmission line)

[23] Source: JICA's Basic Design Study Report
[24] It was created based on the document prepared by the main consultant of this project.

3.2.2 Qualitative Effects (Stabilization of the Power Generating Facility Operation and the Improvement in the Power Supply Capacity)

Before project commencement it was envisaged that staff members' abilities to maintain power generating facilities would improve at the Kingtom Power Station through this project, which would improve the facility operation and thereby lead to less failures. The two power generating units procured and installed by this project are functioning properly at the time of the ex-post evaluation (as of March 2013). In addition, it has been confirmed that power station staff are making use of the instructions given by the generator manufacturer. Even after the completion of the project they occasionally contact the manufacturer by email for advice on the proper operation of the units. In view of the above observations during the field visits, it is believed that, with continuous and proper maintenance, less troubles and failures are foreseen at the power station, promoting further stabilization of the operation and improvement in the power supply capacity. According to the interviews with some staff members at the power station, they also commented, "If we take practical training on maintenance[25] continuously and carry out our day-to-day activities carefully, it is possible to prevent troubles and failures of the power generating units procured and installed by this project while improving the durability of the facilities."

3.3 Impact

3.3.1 Intended Impacts

3.3.1.1 Contribution to Living Environment and Economic Vitalization through Stable Supply of Electricity

As a part of this ex-post evaluation study, an interview-based beneficiary survey was carried out targeting residents in Freetown and Regent Area[26]. Given the nature of random sampling, it was presupposed that the survey's interviewees would include households receiving electricity from the Bumbuna Hydroelectric Power Station and Blackhall Road Power Station as well as those who largely rely on in-house power generators. Additionally, the survey questions were designed to assess the impacts of electricity connection on living environment. Therefore, it should be noted that the results of this survey do not necessarily represent the direct impacts of

[25] Currently the technical and maintenance capacities of staff members of the power station are being developed further through JICA's technical corporate project, "The Project for Capacity Development for Maintaining Power Supply Facilities."

[26] Sample size was 100-110. 70-80% of the total samples were randomly selected from Freetown whereas 20-30% from Regent Area although it also depends on the questions.

this project (e.g., whether or not electrification is sufficient).

First of all, the main purposes of using electricity are shown in Figure 7. Many respondents listed indoor lighting, electric appliances and charging mobile phones. When the respondents were asked which electric appliances they actually use at home, many people listed TV, mobile phones and refrigerators as seen in Figure 8. Figure 9 shows impacts of electrification. Answers are various: it has improved studying environment; it has facilitated conversation among family members; it has improved relations with neighbors; and it has improved nighttime security. The above results indicate the impact of electrification on living environment for people and communities. Figure 10 shows monthly electricity charges; around 60% of respondents pay 51,000 Sierra Leonean Leone per month (roughly 1,200 Japanese yen). Additionally, as seen in Figure 11, while most people said that electricity charges are "neither cheap nor expensive," relatively many people also answered "expensive" or "very expensive." As a follow up question, they were asked if they plan on continuing using electricity service for the next 6 to 12 months. All respondents said "they would continue using electricity." In view of the above, it can be observed that people feel the benefits and reliability of electricity service as well as the impacts of electrification. Thus a possibility cannot be denied that electricity service subscription will be promoted if sufficient power is secured.

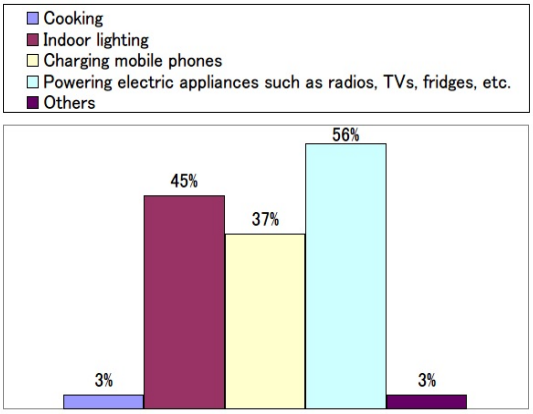


Figure 7: What is the main use of electricity?
(Multiple answers allowed)

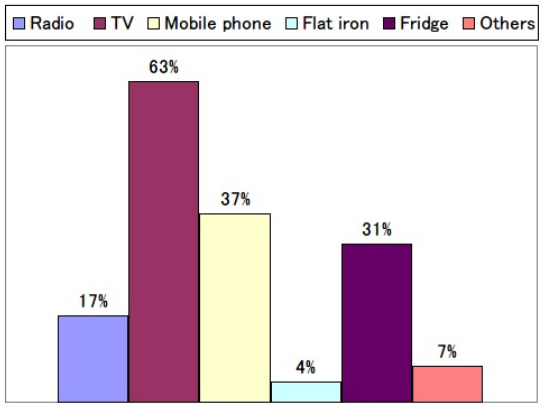


Figure 8: What electric appliance do you mainly use at home?
(Multiple answers allowed)

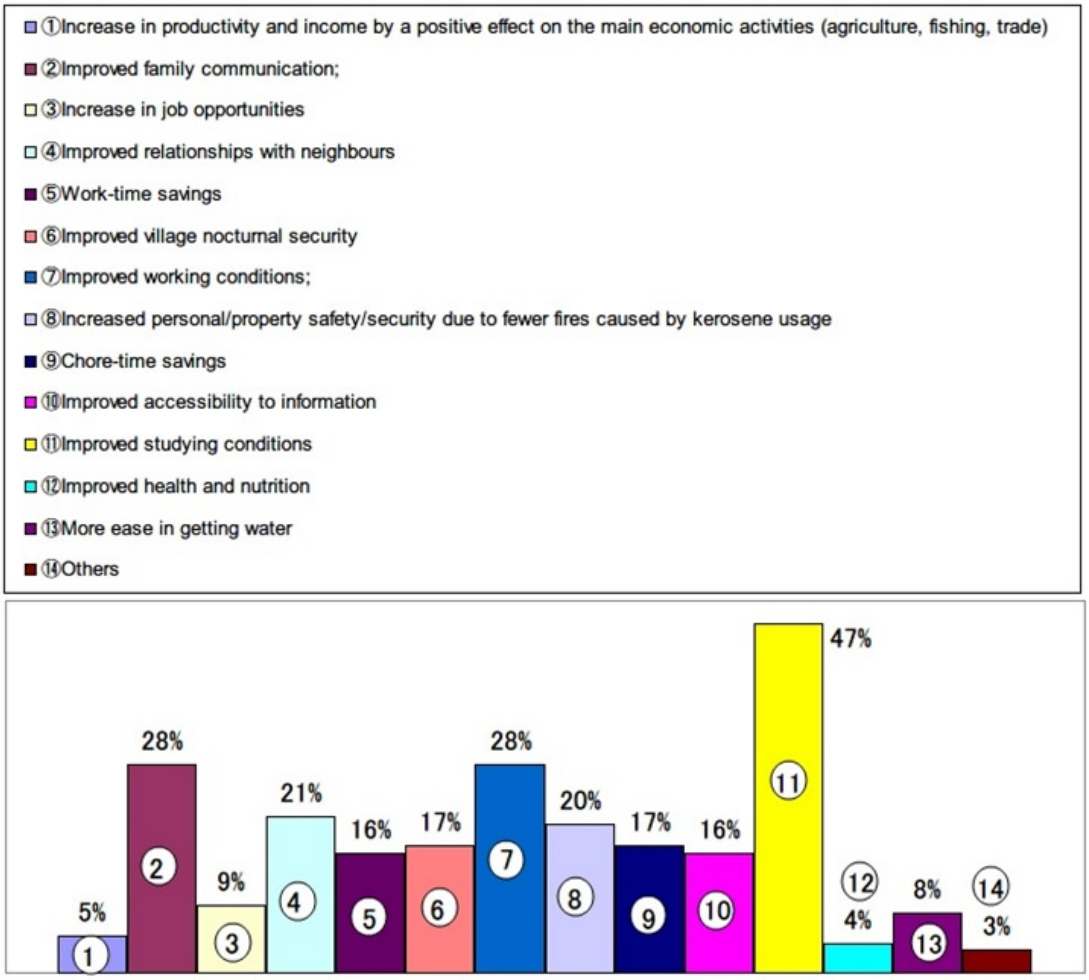


Figure 9: What is the impact of electrification?
(Multiple answers allowed)

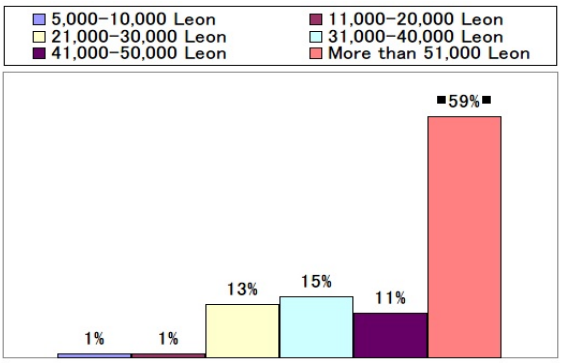


Figure 10: How much do you pay for the monthly electricity bill?

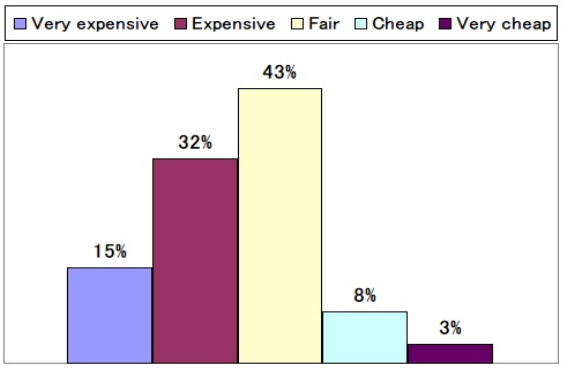


Figure 11: What do you think about the monthly electricity charge?

3.3.1.2 Contribution to Economic Reconstruction

Agriculture and mining are the main industries in Sierra Leon[27]. Before the project commencement, agricultural and mining production areas were devastated, and the economy was in a state of collapse due to the civil war. During the project implementation, however, the gross domestic product (real GDP) grew by an average of 5.2%[28] per year. The economic growth is also influenced by factors other than this project, and it is difficult to prove the cause-effect relationship between this project and the economic impacts. However, this project plays not too small a role in supporting the economy and economic development as it supplies electricity in Freetown and the outskirts that are the hub of the national economy. To supplement above information, real estate and hotel business managers (who are commercial-scale utility customers) were interviewed during the field study. They commented on this project and its economic impacts as the following: "Electricity in Freetown is still in a serious situation. On the other hand, we believe that an increase in power supply is inextricably linked to business growth and that supporting the development of power generating facilities is quite meaningful. Without such support, we would have to use emergency generators more frequently, which would require more fuel and would force us to bear even higher costs. On top of that, insufficient supply of electricity could lead to social turmoil, which would worsen security situations."

3.3.2 Other Impacts

3.3.2.1 Impacts on the Natural Environment

In Sierra Leone the National Environmental Action Plan was established in 1993 and the Environmental Protection Act was enacted in 2000 in accordance with the action plan. Under this act, a project executing body, such as NPA, is obligated to conduct an environmental impact assessment (EIA) when implementing a project to construct power plants or power transmission lines. Concerning this project, NPA carried out the EIA before the end of April 2007, which was approved in February 2008 according to NPA.

With regard to the environmental impacts of the Kingtom Power Station, the two power generating units were procured and installed by reference to the standards of Japan[29] because

[27] Main export products are cacao and coffee beans in the case of agriculture and diamonds, gold and bauxite in the case of mining. These are the main sources of foreign currency.
[28] Source: World Development Indicators, World Bank, 2012
[29] NOx emission should be 950 ppm or lower; SOx emission should be 250 ppm or lower; oil emission should be 50 ppm or lower; soot dust emission should be 100mg/Nm3 or lower; noise should be 110 dB or lower (when the power generator is operating), vibration should be 65 dB or lower at the boundary of the premises (when the power generator is operating).

environmental standards for power generating facilities had not been established in Sierra Leone. In addition, as waste oil disposal facilities were procured and installed by this project, no environmental pollution has been caused by oil spill. It has been confirmed through the interviews with staff of the Kingtom Power Station that currently there is no environmental issues (e.g., air pollution, noise, odor, etc.) inside the premise of the power station.

It is the Technical Service Department[30] of NPA that manages environmental and safety issues. Although they do not have periodic environmental monitoring, a system is in place to address issues in a timely manner whenever the need arises.

3.3.2.2 Land Acquisition and Resettlement

No resettlement was required for this project. On the other hand, land needed to be acquired for the construction of the Regent Substation (approximately 670 m^2 was acquired). The Ministry of Lands, Housing, Country Planning and the Environment of Sierra Leone negotiated with a landowner (1 person). Instead of monetary compensation, alternative land was provided for the acquired land based upon the mutual agreement between the ministry and the landowner. Although the ministry did not disclose detailed information about the landowner or the alternative land[31], they said that the provided land was of the same or higher value in the same area (inside Regent). As for the land acquisition process, it went smoothly because both parties agreed upon the terms before the commencement of this project. Thus it can be said that there was no problem with the land acquisition.

Figure 12: The Exterior of the Kingtom Power Station

Figure 13: Power Distribution Unit Control Room (Inside the Kingtom Power Station)

[30] This department is responsible for managing safety of staff handling power generation and distribution facilities and environmental issues.

[31] Detail information could not be obtained presumably because of the personal information protection as only one person was subject to the relocation.

【Conclusion on Effectiveness and Impacts】

Through this project 10 MW power generating capacity was procured and installed at the Kingtom Power Station as per the initial plan. The Kingtom Power Station, which is one of the power supply facilities complimenting the Bumbuna Hydroelectric Power Station and the Blackhall Road Power Station, is fulfilling its function thereby contributing to a stable power supply in Freetown and the outskirts. On the other hand, with regard to the electrification in Regent Area, which was one of the planned outputs of this project, the number of electrified households is low because a 33 kV power feeder panel, which was supposed to be procured and installed at the Wilberforce Substation by the World Bank, is not yet in place.

In view of the above, this project has somewhat achieved its objectives, therefore its effectiveness is fair.

3.4 Efficiency (Rating: ③)

3.4.1 Project Outputs

Table 3 shows planned and actual outputs of this project.

Table 3: Planned and Actual Outputs of This Project

Planned Outputs (At Appraisal)	Actual Outputs (At Ex-Post Evaluation)
【Planned Inputs from the Japanese Side】 1) Extension of Power Station ①Procurement & installation of diesel engine generators (output capacity: 5 MW x 2 units) ②Construction of a powerhouse ③Procurement of spare parts and tools 2) Improvement of Power Distribution Network ①Construction of 33 kV Regent Substation ② Extension of 33 kV distribution lines (between the Wilberforce Substation and the Regent Substation) a) 33kV: approx. 3.2km of underground cable and approx. 1.3km of overhead line b) 33 kV power feeder panel in the Wilberforce Substation: one additional unit[32]	【Actual Inputs from the Japanese Side】 Implemented as planned

[32] While the feeder panel, which was supposed to be procured and installed by the World Bank (the 33 kV), was meant for receiving 33 kV electricity transmitted from the Freetown Substation shown in Figure 6, this feeder panel procured and installed by this project is meant for transmitting 33 kV power to the Regent Substation after receiving

③Construction of 11 kV power distribution lines a) Between Kingtom Power Station and Congo Cross Substation: totally 3.8km (approx. 3.3 km of overhead line & approx. 0.5 km of underground cable) and one set of 11 kV power feeder panel b) Between Congo Cross Substation and Wilberforce Substation: approx. 2.5 km ④Procurement of the following equipment and materials (installation was to be done by the Sierra Leonean side) a) Between Falcon Bridge Substation and Blackhall Road Substation: approx. 3.4 km (0.8 km of overhead line and 2.6 km of underground cable) b) Between Regent Substation and the following distribution substations: 1) Guma Water Reservoir: approx. 1.3km (500 kVA and 200 kVA transformers (one each) and 2 units of RMU[33]) 2) Radio transmitting station: appox. 1.6km (315 kVA and 200 kVA transformers (one each) and 2 units of RMU) 3) Wilberforce line: approx. 100m ⑤ Procurement of spare parts and tools	
【Planned Inputs from the Sierra Leonean Side】 【Extension of Kingtom Power Station】 (1) Construction of a powerhouse (one story, partially two stories) with total floor approx. 1,087 m^2 (including building utilities) (2) Construction of foundations for Diesel Engine Generator (DEG) & auxiliary equipment 【Power Distribution System】 (1) Installation of equipment and materials between Falcon Bridge Substation and Blackhall Road Substation: approx. 3.4 km (0.8 km of 11kV overhead line and 2.6 km of underground cable) (2) Installation of equipment and materials between Regent Substation and the following distribution substations: 1) Guma Water Reservoir: approx. 1.3km of 11 kV overhead line	【Actual Inputs from the Sierra Leonean Side】 Almost implemented as planned. With regard to "(4) under 【Power Distribution System】," maintenance tools were not procured in this project because they were donated by another project supported by BADEA and Saudi Fund For Development (SFD) to avoid duplication.

it with the panel supported by the World Bank. Thus it is different from the feeder panel discussed earlier in connection with the World Bank project.

[33] Operating switches for the substations

2) Radio transmitting station: appox. 1.6km of 11 kV overhead line 3) Wilberforce line: approx. 100m of 11 kV overhead line (3) Power distribution equipment & materials for the substations 1) 500 kVA and 200 kVA transformers (1 each) and 2 units of RMU 2) 315 kVA and 200 kVA transformers (1 each) and 2 units of RMU (4) Procurement of spare parts and tools for power distribution facilities (5) Procurement of operation & maintenance manuals for power distribution facilities and implementation of On-the Job Training (OJT)	

The outputs, which were to be contributed by the Japanese side and the Sierra Leonean side, have been achieved almost as planned. However, as discussed earlier, a 33 kV power feeder panel, which was supposed to be procured and installed at the Wilberforce Substation by the World Bank, is not in place at the time of the ex-post evaluation. As a result, no electricity is being supplied through the 33 kV distribution line between the Wilberforce Substation and the Regent Substation. When interviewed, the World Bank commented that they would install a 33 kV power feeder in their new project entitled, "Energy Access Project."

3.4.2 Project Inputs

3.4.2.1 Project Cost

The planned project cost was 2,259 million yen (out of which 2,240 million yen was the grant limit and approximately 19 million yen was to be borne by the Sierra Leonean side). In reality, the actual project cost approximately 2,249 million yen (out of which 2,232 million yen was borne by the Japanese side and approximately 17 million yen was borne by the Sierra Leonean side), which is almost as planned (99% of the plan).

3.4.2.2 Project Period

The project was planned to take 2 years and 8 months (32 months) from August 2007 to March 2010. In reality, the procurement and installation work by the Japanese side was carried out from August 2007 to March 2010 as planned, and the construction and other works by the Sierra Leonean side were conducted from February 2008 to March 2009[34] (100% of the plan).

[34] According to the interview with NPA concerning the delivery and installation of the power generators and equipment, it was confirmed that there was no procedural delay, including transportation.

The project cost was within the plan, and the project period was as planned; therefore, efficiency of the project is high.

3.5 Sustainability (Rating: ②)

3.5.1 Institutional Aspects of Operation and Maintenance

The Executing Agency of this project is NPA. Meanwhile the Ministry of Energy and Power (MEP)[35] supervises the Agency. NPA has seven departments (Management Planning, Technical Services, Personnel Management, Commercial, Financial, Information Technology and Legal) with a total of 770 employees at the time of the ex-post evaluation (as of March 2013). The Kingtom Power Station supported by this project is managed by the Technical Service Department which has 98 staff members. Similarly, the Transmission and Distribution Division (under the Technical Service Department) is responsible for the operation and maintenance of the procured and installed power distribution facilities and equipment. The division has 212 staff members who are stationed in primary substations in Freetown and the outskirts, including the Regent Substation. Before the commencement of the project (as of 31 August 2006), NPA had totally 593 employees, out of which 72 staff were at the Kingtom Power Station and 78 staff at the Transmission and Distribution Division. According to NPA's executives, "the staffing level is sufficient for the operation and maintenance of the facilities and equipment procured and installed by this project. We will continue our endeavor to secure adequate human resources and train employees so that we can expand the electric power supply services to areas other than Freetown in the near future." Considering that the number of staff engaged in the operation and maintenance has increased as compared to before the project commencement as well as the comment of NPA's management, it is thought that no major problems are observed in the institutional aspects of the operation and maintenance of this project.

3.5.2 Technical Aspects of Operation and Maintenance

After the completion of the project, 8 staff members of NPA participated in a 4-week training course in Ghana to learn about power distribution networks and to improve maintenance skills[36].

[35] MEP which supervises NPA is a governmental organization, which promotes energy related policies in Sierra Leone. NPA implements MEP's policies on the ground.

[36] At the time of the ex-post evaluation, JICA's Technical Corporation Project, "The Project for Capacity Development for Maintaining Power Supply Facilities (2011-14)," is on-going, through which training sessions and practical training are being offered to NPA staff. For example, lectures were given to 39 staff members on "Theories

The interviews with staffs of the power station and the Transmission and Distribution Division, which intended to check their technical levels, have confirmed that they understand the importance of operation and maintenance and are familiar with the facilities and equipment procured by this project. Additionally it was confirmed that experienced staff have relevant qualifications, such as electric engineering, and that OJT is being provided to newly recruited staff.

On the other hand, NPA's management commented in an interview, "The facilities and equipment, such as the Kingtom Power Station, were not sufficiently maintained before the project commencement. When the power generating units were introduced, the manufacturer gave instructions and advice, which has been useful for operating the power generating facilities. However, proper maintenance is only possible with many small efforts, and we think continuous training is important." It has been reaffirmed that NPA intends to place an importance on continuous training for its staff and that there is a demand for such training.

In view of the above, NPA continues to train its staff, and staff members have relevant qualifications while OJT is provided as needed. Thus it would appear that there are no major concerns in the technical aspects of NPA's operation and maintenance at the time of the ex-post evaluation. Nevertheless, based on the above comment of NPA's management, it is important to continue the training of staff in order to improve their operation and maintenance capabilities.

3.5.3 Financial Aspects of Operation and Maintenance

Table 4 is NPA's profit-and-loss statement (P/L) for the past three years, which describes NPA's financial situation[37]. Recurring expenses exceed recurring incomes, and recurring loss for the period is increasing year by year. Operating expense accounts for a large portion of recurring expenses, and the main expense is diesel fuel used to generate power at the power station. Diesel price has been increasing every year[38], which is one of the major factors affecting NPA's finance. While NPA is ending in the red every year, the government of Sierra Leone is covering a large amount of NPA's loss. (The loss is made up yearly. As of the end of FY2011, 297,168 million leone has been provided by the government cumulatively to compensate for the

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and Exposition for Operation and Maintenance of Diesel Generators" and "Comprehensive Understanding about Power Supply System," while practical training was given to a total of 114 staff members through the inspections of the power generating facilities procured by this project, overhaul and periodic performance testing. Similarly, workshops on technical and managerial aspects have been organized for a total of 44 staff members. As seen above, various supports are being provided to improve the technical capacities of NPA staff members.

[37] At the time of the ex-post evaluation, NPA is in a middle of a financial audit (expected to be completed by October 2013). Thus there is a possibility that 2010-11 data will be slightly revised in the future. The 2012 data is not publicly available at the time of the ex-post evaluation.

[38] Setting 2008 as a base year, it has increased by 90% at the time of the ex-post evaluation.

accumulated deficit of 338,090 million leone.) The government of Sierra Leone has shown its direction to focus its effort on improving the power supply in Freetown. It also expressed its intension to continue supporting NPA financially for the time being. However, NPA still needs to strive to improve its finance so that it will not be dependent on the public fund. More specifically, NPA needs to reduce power distribution losses by stepping up its measures against electricity pilferage and by rehabilitating old distribution networks so as to increase operating income. NPA also needs to make efforts to minimize operating expenses other than diesel fuels to the extent possible. NPA's management commented on the issue in an interview, "Although recurring income is on the increase, recurring expense has also been increasing every year. Even though we have financial support from the government, we will continue to endeavor to improve our finances."

Table 4: NPA's Income and Expenditure

(Unit: 1,000 leone)

	2009	2010	2011
Recurring Income (A) = (B) + (C)	139,536,976	124,769,302	138,760,237
Operating Income (B)	90,714,761	122,009,222	135,485,965
Non-Operating Income (C)	48,822,215	2,760,080	3,274,272
Recurring Expense (D) = (E) + (F)	158,672,103	151,107,924	177,728,407
Operating Expense (E)	142,879,427	125,104,896	145,288,359
Non-Operating Expense (F)	15,792,676	26,003,028	32,440,048
Recurring Loss for the Period (G) = (D) - (A)	(19,135,127)	(26,338,622)	(38,968,170)
Income Tax etc. (H)	0	0	0
Net Loss for the Period (I)	(19,135,127)	(26,338,622)	(38,968,170)

Source: NPA
Note: 1,000 Leon is roughly 23 Japanese yen (as of March 2013)

The operation and maintenance cost of this project is reflected in the operating expense shown in Table 4. It was difficult to capture how much of the operating expense was spent for the Kingtom Power Station and the Regent Substation due to the unavailability of accurate data. However, according to NPA's management, funds have been allocated for the necessary expenses despite the fact that diesel and other costs increased year after year. On the other hand, staff members on the ground at the Kingtom Power Station and the Transmission and Distribution Division commented that fund allocation is not necessarily timely because

procurement and delivery of spare parts are delayed from time to time. Therefore, it seems that there is room for improvement in terms of timely allocation of operation and maintenance funds and procedures.

3.5.4 Current Status of Operation and Maintenance

Through this evaluation study, no major problems were observed in the operation and maintenance status of the power generating facilities and the distribution and transformation facilities procured and installed at the Kingtom Power Station. With regard to the power generating facilities at the Kingtom Power Station, the staff members at the Station check the status of air intake and exhaust valves, starter valves and fuel valves every 4,000 hours as a periodic preventive maintenance in addition to the routine inspection (e.g., checking exteriors and fuel oil levels). Furthermore, another set of periodic preventive maintenance is performed every 8,000 hours, such as dismantling of cylinder head, inspection of fuel injection valves, and replacement of nozzles[39]. With respect to the distribution and transformation facilities, in addition to the patrolling inspection, which examines the status of equipment and appearance of each part, they inspect the control systems and panels. All of these operation and maintenance tasks follow the operation and maintenance manuals[40]. According to the site visits and interviews with operation and maintenance technicians at the Kingtom Power Station and the Transmission and Distribution Division, it has been confirmed that the facilities and equipment are operating properly without any particular problems.

With regard to working hours of the above mentioned staff members, they work in three shifts around the clock to carry out the operation and maintenance tasks. A system is in place to respond to emergencies in a timely manner.

Spare parts are properly stored at the Kingtom Power Station, the Transmission and Distribution Division and the Regent Substation. NPA commented that although procurement takes long in some cases, NPA is making efforts to secure necessary spare parts in recognition of the importance of facilities and equipment developed by this project.

For reference, data on outage hours of the two power generating units procured and installed at the Kingtom Power Station after the completion of project is provided in Table 5 below.

[39] It was carried out during the first half of 2013.
[40] JICA's Technical Corporation Project mentioned earlier is involved in these operation and maintenance tasks.

Table 5: Outage Hours of the Two Power Generating Units
Procured and Installed at the Kingtom Power Station

(Unit: hours)

Unit Name	Type of Outage	2010	2011	2012
1) Niigata 7	Preventive maintenance and machine trouble	0.0	1,056.0	107.0
	Stand-by (planned outage)	1,448.5	5,926.5	4,763.4
2) Niigata 8	Preventive maintenance and machine trouble	0.0	1,344.0	51.0
	Stand-by (planned outage)	1,430.0	5,295.0	5,029.0

Source: NPA

Normally, preventive maintenance is carried out at 4,000 hours after the commission of power generating units. In this case, the two power generating units installed at the Kingtom Power Station ("Niigata 7" & "Niigata 8") were commissioned in March 2010. In 2011 "4,000 hour maintenance" was carried out, including the inspections of air intake and exhaust valves, starter valves and fuel valves, for the two power generating units[41]. Apart from such preventive maintenance, both units had outage due to troubles in 2011 and 2012[42]. This is why Niigata 7 recorded 1,056 hours and Niigata 8 recorded 1,344 hours of outage due to preventive maintenance and machine troubles in 2011, and similarly Niigata 7 recorded 107 hours and Niigata 8 recorded 51 hours of outage in 2012. At the time of the ex-post evaluation (as of March 2013), both units are operating properly without problems.

On the other hand, a "stand-by (planned outage)" refers to times during which the Kingtom Power Station stops operating (planned outage) in the rainy season (normally June-December) when the Bumbuna Hydroelectric Power Station is operation on a full scale. According to NPA, the stand-by hours were short in 2011 because the two power generating units at the Kingtom Power Station began operating in April 2010. It was also mentioned that the stand-by hours of 2011 and 2012 were as planned for both Niigata 7 and Niigata 8.

In view of the above, it can be confirmed that the Kingtom Power Station is operating properly at the time of the ex-post evaluation. Additionally it can be judged that the power station is fulfilling its role in complementing the Bumbuna Hydroelectric Power Station.

[41] It required around 600-700 hours.
[42] Fuel injection pumps broke for the both power generating units. This is mainly because some kind of objects went inside the injection pumps (jamming). Investigation of the causes and restoration work were carried out for a few rounds.

【Conclusion on Sustainability】

At the time of the ex-post evaluation, no major problems are observed in the institutional and technical aspects of the operation and maintenance carried out by NPA. On the other hand, the financial aspects have room for improvement; NPA needs to improve its finances by reducing power distribution losses and increasing profitability. Therefore sustainability of the project effect is fair.

Figure 14: Power Distribution Control Room (Inside the Regent Substation)

Figure 15: Procured Power Distribution Transformer (Inside the Regent Substation)

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

With an aim to stabilize power supply in Freetown, which was destroyed by the civil war, this project procured and installed electric power generating units while constructing a building for the power station, a substation and distribution lines. Both at the times of before project commencement and the ex-post evaluation, this project is consistent with the policy stipulated in the Second Poverty Reduction Strategy Paper (PRSP-II), which recognizes the power sector as a priority, and with the development needs, such as increasing power generating facilities and power supply; therefore, relevance of this project is high. Although the total power demand still exceeds the supply capacity in Freetown and the outskirts after the project implementation, this project is contributing to the improvement of the power supply system through the procurement and installation of two power generating units at the Kingtom Power Station. On the other hand, the number of electrified households in Regent, one of the target areas in the suburb, is smaller than what was planned because a power feeder panel, which was supposed to be installed by a World Bank project, is not yet in place. Effectiveness and impacts of the project are evaluated to

be fair in view of its contribution toward the entre power supply system and the stabilizing operation of the power generating units at the Kingston Power Station. While the project period was as planned, the project cost was within the plan. Thus efficiency is high. No major problems are observed in the institutional aspects of the operation and maintenance carried out by the Executing Agency. On the other hand, sustainability of the project is fair because the Agency has been operating in the red financially, which needs improvement.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

・It takes a long time to procure spare parts in some cases at NPA. For the stable operation of the power generators, it is deemed important to accelerate the allocation of operation and maintenance budgets and see to it that spare parts are procured and placed smoothly.

・It is preferable that the central government of Sierra Leone make a progress on the restoration of the Bumbuna Hydroelectric Power Station, which is the largest power supply source for Freetown and the outskirts, so that it can operate properly and fulfill its complementary role to thermal power stations.

・At the time of the ex-post evaluation, the World Bank is planning to procure and install a 33 kV power feeder panel at the Wilberforce Substation as a part of its new project. It is preferable that NPA coordinate and discuss with the World Bank immediately and concretely.

・Although the central government of Sierra Leone has been covering NPA's deficits, it is preferable that NPA should develop a management improvement plan which focuses on improving and strengthening its finances and should make efforts to resolve the deficit issue in accordance with the said plan.

4.3 Lessons Learned

・With regard to the procurement and installation of a 33 kV power feeder panel at the Wilberforce Substation, lost benefits persist until it is duly installed. During and after the project implementation, JICA attempted to coordinate with NPA and the World Bank to check the progress with a view to facilitating the realization of the planned procurement and installation. However, as it turned out that the procurement and installation of the power feeder panel is not completed yet at the time of the ex-post evaluation. Therefore, it would have been beneficial for NPA and even for JICA to have sufficiently coordinated with the World Bank to ensure that the

said procurement and installation work would be implanted in accordance with the plan from the design stage. For similar projects in the future, it is considered necessary to thoroughly discuss the issue of communication among different parties involved in the project, procurement for different components, and progress of installation from the planning stage.