Republic of Ghana

FY 2018 Ex-Post Evaluation of Japanese Grant Aid Project

"The Project for Improvement of Power Distribution System in the Republic of Ghana"

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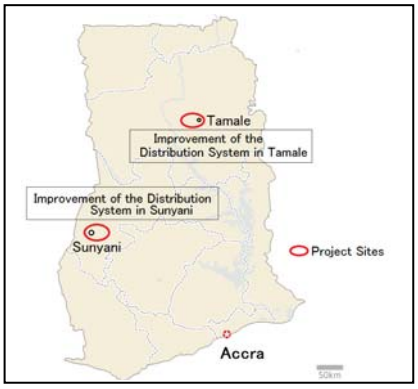
0. Summary

The purpose of the project was to provide stable power supply to the local community of Tamale area of Northern Region and Sunyani area of Brong-Ahafo Region by constructing primary substations and improving distribution grid, thereby revitalizing socio-economic activities and improving living conditions of the community. For Ghana which aims to achieve universal access to electricity by 2020[1], with the power sector as the country's priority issue, this objective is consistent with the policies and needs of the country both at the time of planning and ex-post evaluation. Thus, the relevance is high. Outputs were delivered mostly as planned, and the project cost was within the plan. However, the project period exceeded the plan by about three months to respond to the change of tax exemption procedure of Ghanaian government. Therefore, the efficiency is fair. All of the quantitative effect indicators which were set at the time of planning achieved their target. It can be said that the power distribution grid in the target areas has been appropriately installed and contributed to stable power supply. Furthermore, it was confirmed that the stable power supply improved the services using electricity in medical facilities, educational facilities and local industry. In addition, the living conditions in the unelectrified areas have improved with electrification. Several other positive impacts have also been observed, including a change in the awareness of the executing agency toward work and coordination effect with the project supported by the World Bank. Thus, the effectiveness and impact of the project are high. In regard to the sustainability, there were no major issues in institutional/organizational aspects required for the operation and maintenance of the facilities and equipment installed by the project. The necessary cost for the operation and maintenance has been secured. Periodical checks are also being carried out and the training system for technical skills required for maintenance is substantial. Therefore, the sustainability of the project is high.

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

[1] According to the Ministry of Energy, universal access to electricity means that 90% of the population has access to electricity.

1. Project Description



Project Location

Kotokrom Primary Substation (Sunyani)

1.1 Background

The Ghanaian government placed power supply as the top priority in the 1995 *Ghana Vision 2020* and was focusing on its development. In concrete terms, based on the long-term *Strategic National Energy Plan (SNEP)* announced in 2005, electrification development was eagerly promoted in accordance with *National Electrification Scheme (NES)* and *Self Help Electrification Project (SHEP)* for the areas not covered by NES. As a result, electrification rate reached 66.7% in 2009 which is a relatively high value in the Sub-Saharan region[2]. However, the power utility companies in Ghana faced severe financial situation and replacement of facilities was not sufficiently implemented in response to increasing power demand and aging equipment. Therefore, problems such as high distribution loss rate[3] and poor reliability of the power supply were observed, which hindered stable power supply and further improvement of the electrification rate.

In light of this situation, JICA responded to the request of the Ghanaian government and implemented *Power Distribution System Master Plan Study for Ghana* (2007 – 2008) which included plans for the renewal and enhancement of nationwide power distribution facilities as well as extension of the grid to rural areas. This project was requested by utilizing the above-mentioned master plan to improve the power situation through a reduction of distribution loss and improvement of power supply reliability, thereby achieving accelerated economic growth and improved living conditions.

[2] The average electrification rate in Sub-Saharan region in 2009 was 33%. (World Bank Open Data)

[3] The distribution loss rate is the percentage of power energy that is partially lost due to the resistance of distribution lines during the delivery of power from substations to business and homes. In developing countries such as Ghana, in addition to such technical losses, there are also losses due to power theft and unpaid charges. By improving the distribution loss, efficient supply becomes possible.

1.2 Project Outline

The objective of this project is to provide stable power supply by improving distribution grid through constructing primary substations and distribution lines in Sunyani area in the central west of Ghana and Tamale area in the northeast, thereby contributing to the revitalization of socio-economic activities and to the improvement of living conditions of the target areas[4].

【Grant Aid Project】

Grant Limit / Actual Grant Amount	1,686 million yen / 1,665 million yen
Exchange of Notes Date /Grant Agreement Date	May, 2013 / May, 2013
Executing Agency(ies)	Ministry of Energy (MOE), Northern Electricity Distribution Company (NEDCo) [5]which is a subsidiary company of Volta River Authority (VRA)
Project Completion	July, 2015
Target Area	・Tamale area of Northern Region ・Sunyani area of Brong-Ahafo Region
Main Contractors	(Procurement of Equipment) Mitsubishi Corporation (Installation of Equipment) Aichi Electric Co., Ltd., Yurtec Corporation
Main Consultant	Yachiyo Engineering Co., Ltd.
Preparatory Survey	November 2010 – March 2012
Related projects	＜Technical Cooperation＞ ・Power Distribution System Master Plan Study for Ghana (January 2007 – September 2008) ・The Project on Electrical Engineers Training for African Countries (November 2010 – March 2017) ＜Grant Aid＞ ・The Project for Rural Electrification (E/N June, 1989)(Ashanti Region, Central Region) ・The Project for Rural Electrification (E/N June, 1993)(First period) / September, 1994 (Second period) (Volta Region, Greater Accra Region) ・The Project for Rural Electrification (E/N September 2002, (First period) / August, 2003 (Second period) (Ashanti Region) ・The Project for Rural Electrification (E/N August,

[4] The project outline was described as “by constructing substations and distribution lines (Output), the distribution grid in the areas is expected to improve (Outcome), thereby contributing to the stable power supply (Impact)” in the ex-ante evaluation. However, the description was changed according to the actual situation.

[5] MOE is the responsible organization of the project. The actual executing agency of the project is Northern Electricity Distribution Company (NEDCo). At the time of planning, NEDCo was a part of VRA (Northern Electricity Department), it became independent as a subsidiary company in 2012.

	2006 (First period), / August, 2007 (Second period) (Eastern Region, Central Region) ＜International Organization＞ ・Extension of existing low-voltage distribution in the target areas of the project (a part of Sunyani city area) under the Ghana Energy Development and Access Project (GEDAP) (Joint project among the World Bank, African Development Bank, Swiss Economic Affairs Bureau, etc.)

2. Outline of the Evaluation Study

2.1 External Evaluator

Keiko Watanabe, Mitsubishi UFJ Research and Consulting Co., Ltd.

2.2 Duration of Evaluation Study

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

Duration of the Study: October 2018 – February 2020

Duration of the Field Study: January 20, 2019 – February 6, 2019

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

3.1 Relevance (Rating: ③[7])

3.1.1 Consistency with the Development Plan of Ghana

Ghana Vision 2020 (1995) which is effective both at the times of planning and ex-post evaluation places electricity supply as the top priority issue. *NES* (1991-2020) and *SNEP* (2006-2020) aim to the vitalization of economic activities through stable power supply and target universal access to electricity by 2020. Furthermore, *National Energy Policy* (2019) and *Integrated Power Sector Master Plan* (2019-2021) stipulate that even more efficient and stable electricity supply are necessary for achieving universal access to electricity. For this, they say that the effort be made for extension of transmission and distribution gird.

Therefore, the project is well consistent with the Ghanaian development policy throughout the periods of planning and ex-post evaluation.

3.1.2 Consistency with the Development Needs of Ghana

At the time of planning, the Ghanaian government promoted electrification of urban and rural areas, resulting in the improvement of the national electrification rate from 43% (2006) to 66.7% (2009). However, due to the severe financial situation of power utility companies,

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

[7] ③: High, ②: Fair, ①: Low

expansion of transmission and distribution lines could not be made despite an increase of the power demand. There were occasions when power had to be supplied in overload conditions and when distribution lines were extended carelessly to reduce electrification costs, resulting in a high distribution loss rate. Moreover, problems such as poor reliability of power supply were observed due to insufficient replacement of facilities, which hindered stable power supply and further improvement of electrification rate. The target areas, Tamale and Sunyani, are the capitals of the Northern Region and Brong-Ahafo Region, respectively. Therefore, the demand for power were increasing. However, the aging of power distribution facilities caused voltage fluctuations and excessive voltage drops, which disrupted the livelihood, industry, medical care, and education of the local community. In this regard, there was an urgent and high need for stable power supply.

At the time of ex-post evaluation, as shown in Table 1, the national average of electrification rate reached 84.3% in 2018 but to achieve universal access to electricity by 2020 continuous efforts are required to implement efficient transmission and distribution of power. In addition, the electrification rate of the Northern Region where Tamale is located is 62.7% which is still the second lowest at the national level. Since Tamale and Sunyani are the center of industry as regional capital cities and their population are expanding, there is high demand for further expansion of the power grid and stable power supply.

From the above, the project is in line with the development needs of Ghana both at the time of planning and ex-post evaluation.

Table 1: Electrification Rate by Region (by Population)

(Unit: %)

	Region	2009	2011	2013	2015	2016	2017	2018
1*	Northern	43.52	50.00	50.00	54.53	62.69	62.73	62.73
2*	Brong-Ahafo	62.53	67.00	71.70	75.77	79.50	80.18	81.91
3*	Upper West	31.95	40.00	66.90	71.62	75.82	73.57	73.53
4*	Upper East	30.39	44.00	50.60	51.65	58.78	60.62	60.62
5	Greater Accra	95.77	97.00	97.00	96.43	96.61	96.83	96.83
6	Ashanti	80.91	82.00	85.10	90.48	90.62	91.45	91.45
7	Central	69.61	81.00	82.70	84.32	86.87	88.84	88.84
8	Eastern	61.34	80.00	72.80	78.56	80.03	81.29	81.29
9	Volta	58.33	65.00	67.80	79.09	82.87	82.73	82.73
10	Western	59.30	68.00	72.50	78.12	82.34	85.90	85.93
	National Average	66.7	72.00	75.60	80.51	83.24	84.15	84.32

Source: NEDCo/MOE *1-4 are regions where the areas under NEDCo are located.
Note: At the time of ex-post evaluation, there are 16 regions in Ghana after referendum implemented in December 2018.

3.1.3 Consistency with Japan's ODA Policy

Power sector was listed as one of the priority areas of "Economic Infrastructure" in the *Country Assistance Policy for the Republic of Ghana* (2012) at the time of planning. The project was positioned as a contribution to "promoting better access to affordable and efficient energy" as stated in *Yokohama Action Plan* of the fourth African Development Conference in 2008. Therefore, the project was in line with the Japan's assistance program and policy at the time of planning.

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

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

As shown in Table 2, the project was to newly construct 34.5/11.5kV primary substations and procure and install 34.5kV sub-transmission lines and 11.5kV distribution lines including extension work of 34.5kV switchgears in Bulk Supply Points (BSP) in Tamale area of Northern Region and Sunyani area of Brong-Ahafo Region in order to provide stable power supply in the target areas. Outputs were delivered mostly as planned except the following minor changes. A part of the route of sub-transmission lines have been changed because the permission to cross the site on the route where the detour was planned was obtained. Based on the results of on-site survey, there were some changes in the number and type of steel pipes and power poles, and in the installation position of branch lines.

Table 2: Procurement and Installation of Equipment and Materials by the Project

Improvement of Distribution System in Tamale Area	Improvement of Distribution System in Sunyani Area
1. Primary Substation	1. Primary Substation
(1) Transformer (34.5/11.5kV, 7.5MVA) 1 set	(1) Transformer (34.5/11.5kV, 7.5MVA) 1 set
(2) 34.5kV Switchgear Cubicle: 2 sets	(2) 34.5kV Switchgear Cubicle: 2 sets
(3) 11.5kV Switchgear Cubicle: 5 sets	(3) 11.5kV Switchgear Cubicle: 5 sets
(4) Station Transformer (11.5/0.43kV, 100kVA) : 1 set	(4) Station Transformer (11.5/0.43kV, 100kVA) : 1 set
(5) Substation building (single story, floor area of some 260m^2): 1 building	(5) Substation building (single story, floor area of some 260m^2) : 1 building
2. 34.5kV sub-transmission line (between Tamale BSP and the UDS Primary substation) : approx. 19 km (including underground section: approx. 5km)	2. 34.5kV sub-transmission line (between Sunyani BSP and Kotokrom Primary Substation) : approx. 8.5 km (including underground section: approx. 0.5km)

3. 11.5kV distribution lines	3. 11.5kV distribution lines
(1) UDS feeder: approx. 0.2km	(1) Hospital feeder: approx. 4.3km
(2) Tolon feeder: approx. 0.7km	(2) New Dormaa feeder: approx. 0.6km
(3) Cheshegu feeder: approx. 0.3km	(3) Chiraa feeder: approx. 0.7km
4. Extension of 34.5kV Switchgear at Tamale BSP: 3 sets	4. Extension of 34.5kV Switchgear at Sunyani BSP: 3 sets
	5. Ring main unit: 1 set
5. Other related equipment	6. Other related equipment
(1) Replacement Parts: 1 set	(1) Replacement Parts: 1 set
(2) Maintenance Vehicle (One Aerial Platform Vehicle)	(2) Maintenance Vehicle (One Aerial Platform Vehicle)
(3) Maintenance Tools and Testing Instruments: 1 set	(3) Maintenance Tools and Testing Instruments: 1 set

Source: Information provided by JICA

11.5kV Switchgear Cubicle
(Tamale Primary Substation)

Main Transformer (Sunyani Primary Substation)

34.5kV Sub-transmission Lines (Right)
(Tamale Area)

34.5kV Switchgear installed at Sunyani BSP

Aerial Platform Vehicle (Tamale Area)

11.5kV Distribution Lines (Sunyani Area)

Source: Photos taken by the external evaluator at the time of ex-post evaluation

3.2.2 Project Inputs

3.2.2.1 Project Cost

Table 3 shows the planned and actual project cost of Japanese side and Ghanaian side. The Ghanaian share exceeded the planed, however the total project cost was within the plan at 99% of the plan. The responsibility of the Ghanaian side included securing project sites, installation of facilities (fences, gates, water supply, drainage, etc.) to the new primary substations, transportation of equipment, custom clearance, tax procedures, permissions required for installation works and entry of restricted areas, and appropriate operation and maintenance of facilities and procured equipment. It was found that the excess of Ghana's share was due to the addition of paving stones at the two substation sites and the construction of two culverts[8] in front of the Tamale substation. Paving stones were intended to prevent the dust and growing weeds and, as a result, the substation sites looked better. One of the culverts was installed to connect the roads to the taxi stand, which had been shifted due to the construction of the Tamale substation. The other culvert was installed to access nearby facilities. These constructions did not result in a significant increase in finance but were appropriate additions.

[8] A structure buried for the same purpose as the bridge to pass through the drainage channel.

Table 3: Planned and Actual Project Cost

(unit: million yen)

	Plan	Actual	Ratio to the Plan
Japanese side	1,686	1,665	99%
Ghanaian side	32	38	119%
Total Project cost	1,718	1,703	99%

Source: Information provided by JICA and executing agency

Note: Actual project cost by the Ghanaian side was 995,937.65 Ghana Cedi (GHS). The cost was estimated based on the IMF statistics (IFS) exchange rate during 2013-2015 when the construction was implemented.

3.2.2.2 Project Period

The actual project period was 26 months compared to 23 months of the plan and exceeded the plan (113% of the planned period.) This was because the Ghanaian government changed the regulations of tax exemption procedure after E/N, which delayed the procurement of equipment, and extended the project period in consideration of the effects of rainy season on installation work and import processes. However, there were no delays in the main construction work, rather it turned out shorter than planned by conducting intensive weekly meeting with construction related staff regarding quality control and process control.

Table 4 shows the comparison between the planned and actual of project period.

Table 4: Planned and Actual of Project Period

Items	Plan	Actual
(1) Implementation Design Period (Detailed Design～Tender/Contract)	June 2013 – October 2013 (5 months)	June 2013 – September 2013 (4 months)
1) Site Survey	June 2013	June 2013
2) Tender Preparation～Tender	July 2013 – October 2013	July 2013 – September 2013
3) Selection of Contractor	October 2013	September 2013
(2) Period of Procurement and Installation of Equipment	November 2013- March 2015 (17 months)	September 2013 – April 2015 (20 months)
1) Preparation and Approval of Shop Drawings	November 2013- March 2014	September 2013 – June 2014
2) Manufacture and Transportation of Equipment	December 2013- December 2014	October 2013 – December 2014
3) Expansion work for switchgear at existing BSP (Tamale and Sunyani)	August-September 2014 (Foundation work) November 2014 (Installation work)	July 2014 – April 2015
4) Work for Substation Foundations	February 2014 – May 2014 August 2014 – November 2014	
5) Installation Work at Substations	December 2014 – March 2015	

6) Work for 34.5kV sub-transmission and 11.5kV distribution lines	December 2014 – March 2015	
(3) Adjustment/Testing, Initial Operation/OJT of Equipment*	March 2015 – April 2015	April 2015 – July 2015
Total	**June 2013 – April 2015 (23 months)**	**June 2013 – July 2015 (26 months)**

Source: For plan, information was provided by JICA. For actual, information was provided by the implementing consultant.
*Note: There is overlap period between "Adjustment/Testing" and "Initial Operation/OJT of Equipment" in plan. The plan is two months from March to April, but if there is no overlap period, it would be three months. In actual, after conducting OJT, adjustment and testing were conducted and then operational guidance was carried out again. It took 4 months from April to July 2015 without any overlapping period. Therefore, the difference of one month is in fact about half a month.

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

Column

Contribution to Efficiency and Sustainability of the Project:

The Role of the Implementing Consultant and Contractors

The project was delayed for about four months because equipment could not be procured as planned due to the changes of the Ghanaian government regulations on tax exemption. As a result, the project decided to extend six months considering the effect of rainy season on the installation work and import process. However, the construction period was shortened by about two months after quality control based on intensive supervision by the implementing consultant and contractors. In fact, the difference from the plan was three months in total. This owed a lot to the work of the implementing consultant and the contractors. It is considered that it became possible by the implementing consultant and the contractors to collaboratively check the quality and process control with the executing agency in detail and proceed with construction. In addition to instructing the officers of the target area offices of the executing agency on construction and technical maintenance methods such as safety management in daily work and how to climb electricity poles, the implementing consultant and the contractors hold a meeting every week to review the implementation status and plan for the next week. Technical transfer was also made to the staff of the headquarters on construction supervision and conflict management with sub-contractors through close information sharing by holding monthly meeting. As a result, the capacity of the executing agency for the basics of construction supervision has been upgraded. The executing agency has utilized these skills not only for maintenance after the project implementation, but also for their other projects.

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

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects

At the time of planning, (1) Annual total of outage duration, (2) Voltage drop, and (3) Number of electrified households of the target areas were set as indicators for quantitative effects. Table 5 shows the target and actual of quantitative indicators. For all indicators, targets have been achieved.

Table 5: Indicators of Quantitative Effects

Indicator		Baseline	Target	Actual				
		2010	2018 3 Years After Completion	2014 1 Year Before Completion	2015 Completion Year	2016 1 Year After Completion	2017 2 Years After Completion	2018 3 Years After Completion (Target Year)
(1) Annual Total of Outage Duration (hours/year)	Tamale	125	88	100.06	23.7	3.47	1.11	49.57
	Sunyani	27	19	39	10.9	10.4	9.6	11.4
(2) Voltage Drop (%)	Tamale	Max 25	10 (management standard) or less	10.39	2.77	2.77	1.62	0.00
	Sunyani	Max 37	10 (management standard) or less	13.39	11.31	1.85	4.16	3.0
(3) Number of Electrified Households	Tamale	5,084	9,000	8,063	11,126	11,884	10,602	13,203
	Sunyani	4,577	8,957	6,757	7,500	8,250	9,240	10,441

Source: Information provided by JICA, Results of questionnaire to the executing agency

(1) Annual Total of Outage Duration

Annual total of outage hours of Tamale area in 2015 when the project was completed (23.7 hours) was largely improved from the previous year (100.06 hours). After that, it was in the single digit range. In the target year 2018, it increased again to 49 hours, however, it was still within the target value. The reasons of increase in outage hour in 2018 were because Ghana Grid Company Ltd. (GRIDCo) which is the transmission source to NEDCo had implemented rolling blackouts for, but not limited to, repairing switchgears of BSP at distribution source. In other words, it was confirmed that the increase in annual outage hours in 2018 was not due to this project but an external factor.

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

On the other hand, in Sunyani area, the project improved the annual total of outage duration from the range of 30 hours before the project to around 10 hours after 2015. The target was reached in 11.4 hours in 2018 against the target value of 19 hours.

(2) Voltage Drop

The indicator of voltage drop improved significantly in Tamale area in the project completion year and in Sunyani area one year after project completion. It was identified that the reason that the voltage drop of Sunyani area improved one year after the completion was due to the fact that the renewal work of GRIDCo's switchgear at BSP was about one year later than Tamale area. The value at the target year of Tamale and Sunyani areas were 0% and 3% respectively and reached the target which was 10% or less.

(3) Number of Electrified Households

In Tamale area, the number of households increased by about 3,000 household (up about 38%) from 2014 to the year 2015, when the project was completed. While, in Sunyani area, there was an increase by 743 households (up about 11%) from 2014 to 2015. The target values of Tamale and Sunyani areas were 9,000 and 8,957 households respectively, while the actual households which were electrified were 13,203 and 10,441 households respectively. The both areas have reached their targets.

As described above, the significant improvement was observed in (1) outage hours and (2) voltage drop at the year of project completion or one year after the completion. The actual values obtained from the executing agency were the values specifically for the areas among others where power was transmitted and distributed from the newly established substations in this project. Therefore, it is considered that the contribution of the project is significant. In this regard, it can be said that the achievement of the three indicators of quantitative effects was achieved by the project.

3.3.1.2 Qualitative Effects (Other Effects)

The effects on the local society which were set as qualitative effects were not the direct effects from the project but the indirect effects. Therefore, it was considered as impact. Hence, their results are shown in 3.3.2 Impact below.

In light of the above, the project has largely achieved its objectives and the effectiveness is high.

3.3.2 Impacts

3.3.2.1 Intended Impacts

In this project, as a result of stable power supply, the improvement effects were expected on (1) medical services, (2) educational environment, (3) local economy through local industry, and (4) living conditions of the unelectrified areas before the project. The following is the summary of the results of qualitative surveys on these impacts conducted during the site visit[10].

All of the 36 people who were interviewed in the qualitative surveys answered that electricity had been supplied stably after the completion of the project. Regarding power outage, they have pointed out that the frequency was dropped after the project compared with before except the times of planned outages due to maintenance and outages during rainy seasons. It was also noted that the recovery time became shorter. In the event of a planned outage, it was found that NEDCo gives the notice 72 hours earlier through radio and mobile application. Therefore, it was possible to prepare in advance, for example by disconnecting power from the equipment or preparing for generator. Furthermore, according to the area offices of both target areas of NEDCo, it was identified that customer complaints decreased after the completion of the project. It is considered that the stable power supply made this happen, and it can be said that the project contributed to the stable power supply of the target areas. On the other hand, although the power supply has been stabilized by the project, internal problems were seen by individual cases. Some small facilities such as private sawmill and bar use residential power for their business, resulting in the frequent short-circuit. Some medical facilities required additional breakers due to the increasement of equipment.

(1) Improvement of Medical Services

In medical facilities, main problems related to power at the time of planning were that as there were many outages and voltage fluctuations, not only medical equipment but also air conditioners and vaccine refrigerators broke down or could not be utilized. All four medical facilities interviewed answered that they had more stable power supply than before the project. It was pointed out that there was almost no equipment failure due to voltage drop or voltage fluctuation, which prevented the refrigerator from breaking down and wasting vaccines. They also stressed that medical care at night and emergency care on weekends could now be provided without difficulties (Nyankpala Health Center, Chiraa Health Center). Before, since the lighting

[10] The qualitative surveys were conducted in Tamale and Sunyani areas. The following sites were visited and interviewed on the electricity situations before and after the project and effects by the stable power supply. Two medical facilities each (Tamale area: God Care Community Hospital and Nyankpala Health Center, Sunyani area: Sunyani Regional Hospital and Chiraa Health Center), two educational facilities each (Tamale area: Faculty of Agriculture and Faculty of Renewable Natural Resources of University of Development Studies, Bisco Senior High School, Sunyani area: Chiraa Senior High School, Sunyani Nursing Training College), local industries (7 sites at Tamale area and 4 sites at Sunyani area), former non-electrified areas (Tamale area: 4 households, Sunyani area: 7 households).

were not available at the health center level, they used to refer and transfer the patients to higher medical facilities for medical care at night and emergency care. However, it was said that they did not have to refer and transfer the patients just because of power. Furthermore, a biomedical engineer at the Sunyani Regional Hospital which is the fourth largest hospital in Ghana responded that the power situation was greatly improved because a special transmission line was drawn up at the hospital by the project. They newly introduced a set of CT scan and X-ray equipment and built a new ICU unit on maternal and new born children as planned. The equipment in these facilities were utilized without problem.

The effect on fuel cost saving due to the stable power supply was also raised by the medical facilities which used generators[11].

Therefore, it was confirmed that the stable power supply by the project improved the environment of medical facilities, which led to upgrading of medical services. Moreover, it contributed to the efficient management.

(2) Impacts on Educational Environment

The main problems in regard with power in educational facilities at the time of planning were the same as medical facilities such as frequent and prolonged outage, voltage fluctuation, and voltage drops. For this, PCs, laboratory equipment, air conditioners could not be used and sometimes broke down. All four schools interviewed responded that the stable power supply eliminated failures in electric appliances such as PCs, fans and air conditioners and their availability led to the improvement of educational environment. The responses included that the students staying in dormitories could study at night time without problem (Bisco Senior High School, Chiraa Senior High School, Sunyani Nursing Training College) and that the library at the University of Development Studies (UDS) was now available at night. Even audiovisual equipment could be utilized at class, which led to the enhancement of the quality of courses.

Furthermore, it was also pointed out that the outdoor lighting on campus at night time led to safety measures against thieves or for female students (UDS).

Therefore, it can be said that the project contributed to a certain degree to the improvement of educational environment, and security and safety.

(3) Impacts on Local Economy

In order to assess the impacts on local economy, interview survey was conducted mainly to the medium-sized enterprises such as hotels, a shea butter factory and a corn mill factory, small-sized enterprises such as small factories and supermarkets, as well as self-employed in the

[11] Prior to the project, Sunyani Regional Hospital usually refueled the two generators with 3,000 litter of diesel in two months. However, at the time of ex-post evaluation, after 3,000 litters were refueled in August 2018, more than 1,000 litter remained six months later in February 2019.

areas where power was distributed by the project. The main problems in regard with power in these enterprises and shops before the project were similarly equipment shutdowns and failures due to frequent power outage, voltage fluctuations and voltage drops.

Small-sized shops and private businesses were able to introduce new electric equipment and to work at night and busy periods due to the stable power supply. For example, the sewing shop newly purchased an electric sewing machine and an embroidery machine, the supermarket increased number of products by installing refrigerator and freezer, and the barber equipped with dryers and electric hair clippers. It was confirmed that the stable supply contributed to a certain degree to customer acquisition and income improvement. In addition, the corn mill factory and the shea butter mill factory which in the past had to spend money on repairing equipment that broke down due to sudden voltage fluctuations and fuel costs for generators also reported that stable power supply led to significant cost reduction. Furthermore, the service industries such as hotel and apartment management answered that the customer complaints on outage decreased and generator cost was reduced.

It was confirmed that the project contributed to a certain extent to the development of local economy and income generation by small and medium enterprises utilizing electric equipment and devices, operating at night, and saving cost for repairing equipment and fuel for generators.

(4) Impacts on Unelectrified Areas

Regarding the unelectrified areas prior to the completion of the project, four households in Tamale areas and seven households in Sunyani areas were visited and interviewed. Almost all households answered that they have been getting stable power supply. Before the project, since the areas had not been electrified, they spent the time with lanterns and flashlights and were not able to do much productive activities at night. It was also said that they could use lighting, televisions, mobile charging, electric fans, etc. after electrification. There were also some households which started sewing business and bars in their property, which led to income generation (One household each in Tamale and Sunyani). Many pointed out that the convenience of life improved (two households in Tamale). For example, in the past it took two hours for a round trip to go to the mill to buy corn flour, the staple food, however, various shops have been opened after the power supply in the surrounding areas. As a result, the community no longer needed to shop far away. There were also some households responding that lighting at night allowed children to do homework or read and write after helping household works (two households in Tamale, four households in Sunyani), and that livestock thieves have decreased, and snakes could be identified by keeping the outdoor lights on at night. Therefore, the project also contributed to improving the lives of residents in terms of children’s learning, security and safety.

CT Scan at Sunyani Regional Hospital

Corn Mill Factory (Sunyani Area)

Shear Butter Factory
(Tamale Area)

Sawing Shop Opened after Electrification
(Sunyani Area)

Source: Photos taken by the external evaluator at the time of ex-post evaluation

3.3.2.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

At the time of planning, the project was classified as category “B” according to the “JICA Guidelines for Environmental and Social Consideration (April 2004)”. It was judged that the project did not fall in the large-scale distribution sector in the Guidelines and that its undesirable impact on environment was not significant. Furthermore, it was considered that the project sites did not fall under the sensitive characteristics and susceptible areas listed in the Guidelines.

In Ghana, a preliminary environmental assessment was required for construction of substations of more than 1 MVA in the transmission/distribution system. NEDCo implemented a preliminary environmental assessment and obtained an environmental permit from the

Environmental Protection Agency without problem. The implementation status of the monitoring items listed in the environmental permit could not be confirmed in the records. However, interviews with the regional offices for the Environmental Protection Agency in the target areas and the implementing consultant provided evidence that monitoring was properly conducted. Moreover, it was confirmed from the surrounding residents that there had been no negative impacts on natural and social environment before, after and during the project.

(2) Resettlement and Land Acquisition

There was no resettlement and land acquisition. All land permits for public lands such as military land and lands owned by the National Animal Research Institute have been acquired prior to construction. There were no particular problems with the acquisition.

(3) Unintended Positive/Negative Impacts

Other impacts include 1) the coordination effects with the project supported by the World Bank and 2) change in awareness of NEDCo staff toward work. There were no negative impacts from the project.

1) Coordination Effects with the World Bank support Project

The coordination effects with the distribution improvement project (Ghana Energy Development and Access Project (GEDAP)) supported by the World Bank was observed. GEDAP is the project to extend the distribution lines. Therefore, in areas far from substations, the distribution loss rate became high and the voltage became low. As a result, stable power supply was not realized in these areas. The primary substations constructed by the project became a transit point and provided stable power supply to the areas where GEDAP laid distribution lines. Besides, the project has enabled GEDAP to extend the distribution lines further. Therefore, the project realized a coordination effect that has enabled electrification to wider areas.

2) Change in Awareness of NEDCo Staff toward work

According to the NEDCo staff members, the project not only transferred the technical skills on operation and maintenance of procured equipment through OJT, but also taught important things in daily work such as project management, time management, safety measures during construction, how to hold efficient meetings, how to climb electrical poles, and how to manage dispute with contractors. These skills have currently been applied to other projects. It can be said that the experience of this project has changed the awareness of NEDCo staff toward work and has put a certain impact on effective and efficient working style.

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

3.4 Sustainability (Rating: ③)

3.4.1 Institutional / Organizational Aspect of Operation and Maintenance

NEDCo is a distribution company covering 64% of the geographical area of Ghana. The daily maintenance of substations newly constructed in the project is under the jurisdiction of each area office. However, they are supervised by NEDCo headquarters and basically headquarters visit each area office for monitoring quarterly. The maintenance plan is formulated by NEDCo headquarters, and the staffing and budget for maintenance are also managed by the headquarters. At the time of ex-post evaluation, total number of staff members was about 900, of which about 200 were at the headquarters and the rest were allocated to the five area offices. Table 6 shows the operation and maintenance system of the target area offices at the time of ex-post evaluation. There were 194 employees in the Tamale area office and 182 employees in the Sunyani area office. The officers in charge of maintenance were 6 at the headquarters, 22 at the Tamale office and 30 at the Sunyani office. It was increased from the time of planning. Although it will be described later in “Status of Operation and Maintenance”, it is considered that the organizational structure has been in place to conduct basic maintenance judging from the fact that they have achieved the planned maintenance rate almost every year. Besides, the outsourcing could be secured to cover the structure in an emergency.

It was also confirmed that, as planned, three operators have been employed for 24-hour operation and 24-hour security personnel and daytime cleaner have been outsourced for the personnel at the two primary substations constructed in the project. Accordingly, the structure to fulfill the required functions has been in place.

Therefore, there is no major problem in institutional/organizational aspects for sustainable maintenance of the project.

Table 6: Operation and Maintenance System at the time of Ex-post Evaluation

	At the time of Planning	At the time of ex-post evaluation	At the time of Planning	At the time of ex-post evaluation	Plan	Actual
	Areas of Responsibility		Number of Maintenance personnel		Number of personnel for New Substation	
NEDCo (At the time of planning, NEDCo was one department of VRA)	Control overall management of the distribution system of 5 operational areas of Northern Region, including the following two areas	・In charge of distribution system covering 64% of Ghana ・Maintenance of BSP ・Supervision and Maintenance of primary substations	None	6 (2 engineers + 4 crews	None	6
Tamale Area Office	・Tamale BSP ・Newly built USD Primary substation ・34.5kV sub-transmission and 11.5kV distribution lines	・Newly built USD Primary substation ・34.5kV sub-transmission and 11.5kV distribution lines	12	22 (194 in total)	6 (3 operators, 2 Security guards, 1 Cleaner)	As planned 3 Operators were hired. Security guards and cleaner are outsourced.
Sunyani Area Office	・Sunyani BSP ・Newly built Kotokrom Primary substation ・34.5kV sub-transmission and 11.5kV distribution lines	・Newly built Kotokrom Primary substation ・34.5kV sub-transmission and 11.5kV distribution lines	11	30 (182 in total)	6 (same as above)	Same as above

Source: Information provided by JICA, Interview results by the executing agency

3.4.2 Technical Aspect of Operation and Maintenance

The staff in charge of maintenance must have a technician level (completed a technical diploma courses for three years after senior high school) or higher. One or two engineers with graduate degrees are allocated in each office. In addition, NEDCo plans a training plan every year and works on technical improvement. Almost all related staff at the headquarters and area offices have received the technical training courses such as on distribution line planning, maintenance, protection and control system. It is, therefore, considered that they have the basic skills and knowledge on maintenance. Moreover, the training courses provided by the training institutions of VRA and Electricity Company of Ghana can be utilized as needed.

There were no technical issues raised by the staff in charge of operation and maintenance of the target area offices and no particular problems in technical aspects were observed with regard to the operation and maintenance of the project. It was found that the operators of the substations under this project were assigned with a comprehensive understanding of NEDCo

business, through training in various departments before going into operation, etc. In addition, it was confirmed by the site visit that the maintenance manuals and spare parts prepared by the project were kept neatly at the two substations and they were utilized as necessary.

All NEDCo staff who participated in OJT during the project and in the related training courses organized by the JICA's "Project on Electrical Engineers Training for African Countries" were still working at the time of ex-post evaluation. They have utilized the enhanced capacity to formulate effective distribution and transmission plans and maintenance plans. It is considered that these capacities have contributed to a certain extent to the sustainability of the project effect. It was, however, identified that the provided aerial platform vehicles could only be handled by the staff who have received OJT. The technical transfer to other staff was identified to be particularly necessary at the Sunyani area office since some of such staff will reach to retirement age soon.

From the above, no particular problems have been observed in technical aspects of the operation and maintenance of the project.

3.4.3 Financial Aspect of Operation and Maintenance

Table 7 shows the profit and loss of the executing agency after the project completion which was obtained from the NEDCo annual reports (2016 and 2017). Overall financial status of NEDCo is far from favorable in terms of business balance. However, since they have made efforts to raise collection rate of charges through increasing demand households, introduction of prepaid meters, working to respond to unpaid customers[12], etc the deficit of business balance has decreased since the time of planning[13].

The necessary cost for maintenance (Repair cost) accounts for about 2-3% of operational cost and the maintenance of substations, sub-transmission lines and distribution lines is carried out reliably every year according to the maintenance plan. As described above in "Institutional /Organizational Aspect of Operation and Maintenance", the necessary personnel cost for newly constructed substations by the project has been secured.

It was confirmed from NEDCo that they have budgeted for detailed checking to be conducted in 2019 with other substations, which is due to every four years. There is no system to get financial assistance from VRA or MOE. However, even if emergency response is required, it was confirmed that it could be managed within NEDCo.

[12] In order to raise collection rate of charges, NEDCo is introducing prepaid meters. According to NEDCo's 2017 report, they have introduced 90,000 in 2015, 25,000 in 2016, 125,000 in 2017 and 225,000 in 2018. As of 2017, it accounts for 36% of all customers. NEDCo also warns unpaid customers multiple times and publishes their names on the radio, if still unpaid.

[13] One of the reasons for the decrease in income is due to payments by government agencies, which are large customers. Besides, the distribution loss rate of 30% (2017) per year is also a major reason.

The operation and maintenance of this project does not require a large financial burden and it is considered that the budget for conducting maintenance as scheduled has been allocated judging from the maintenance implementation rate. Emergency response is not regarded as a major problem. Therefore, there are no particular financial issues to sustain the effectiveness of the project.

Table 7: Profit and Loss Statement of the Executing Agency

(Unit: Ghana Cedi)

	Before Project			After Project	
	2008	**2009**	**2010**	**2016**	**2017**
Income	**55,180**	**59,851**	**83,512**	**615,259**	**611,921**
Power sales	53,957	58,655	82,306	599,704	592,751
Others	1,223	1,196	1,206	15,555	19,170
Expenditure	**91,238**	**97,894**	**121,542**	**616,446**	**622,002**
Operation Cost	72,149	72,689	89,372	514,221	513,281
Power Purchase	36,792	42,318	54,377	309,372	324,527
Repair Cost	1,262	1,476	2,460	10,235	15,444
Operation Cost Ratio (%)	(1.7%)	(2.0%)	(2.7%)	(2.0%)	(3.0%)
Others	32,095	27,895	32,535	194,614	173,309
Depreciation	19,089	25,205	32,170	102,225	108,721
Balance	**-36,058**	**-38,043**	**-38,030**	**1,187**	**-10,081**

Demand Household	278,476	307,871	342,906	742,396	841,967
Purchased power (GWh)	529	565	644	1,125	1,224
Power supply power （GWh）	429	460	517	816	854
Power Sale (GWh)	392	417	464	683	708
Distribution Loss Rate	19%	18%	20%	27%	30%

Source: Information provided by JICA for “Before Project” (2008-2010), NEDCo Annual Reports for “After Project” (2016-2017)

Note: Figures of “Before Project” (2008-2010) are for VRA-Northern Electricity Department.

3.4.4 Status of Operation and Maintenance

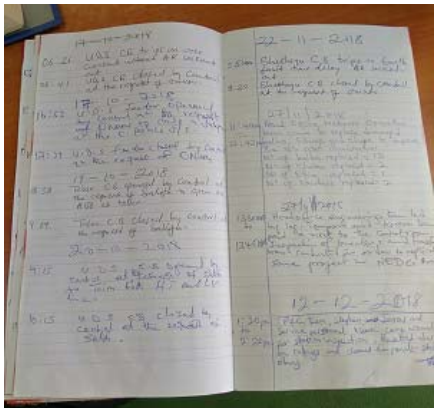
It is considered that the status of operation and maintenance is good. The primary substations, sub-transmission and distribution lines which were newly equipped have not suffered any major failure by the time of ex-post evaluation. The daily inspections at both substations have been performed by operators and recorded. The equipment has been functioning without any problem. It was also confirmed by site visit that both substations were neatly organized and clean. However, it was found that the primary substation in Tamale did not have a fixed logbook but recorded in the notebook by the operator only when something had happened. Therefore, the contents of the record were not standardized by the operator. On the other hand, at the primary substation in Sunyani, operators checked every hour using a logbook format developed by its area office.

Disconnections during the sandstorm and rainy seasons occur several times a year, but qualitative survey showed that the time to recover from a power outage was shorter than before, suggesting that it is responding as quickly as possible. There are still enough spare parts, and if spare parts are required from Japan, they have contact with distributors and Japanese suppliers. Therefore, there is no problem in obtaining spare parts.

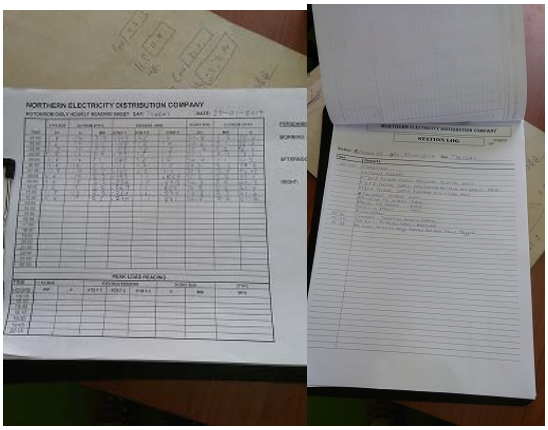
The maintenance implementation rate is one of NEDCo's key performance indicators (KPI). According to the NEDCo annual reports (2016, 2017), the scheduled maintenance implementation rate of primary substations, sub-transmission and distribution lines other than daily checking achieved at high ratio of 99.2% (2016) and 98.1% (2017) against target value of 95% for both years. Therefore, it can be expected to continue the implementation.

On the other hand, although any trouble has not happened at present, an appropriate insulated cover on one of cable outlets of the switchgear installed by the project at Sunyani BSP should be urgently required for safety. This was happened because GRIDCo renewed their switchgear after the project and one of cable outlets became extra.

Based on the above, it can be concluded that the equipment and facilities by this project are likely to be used continuously.



Logbook at the Primary Substation in Tamale



Logbook at the Primary Substation in Sunyani

Source: Photos taken by the external evaluator at the time of ex-post evaluation

No major problems have been observed in the institutional / Organizational, technical, financial aspects and current status of the operation and maintenance system. Therefore sustainability of the project effects is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The purpose of the project was to provide stable power supply to the local community of Tamale area of Northern Region and Sunyani area of Brong-Ahafo Region by constructing primary substations and improving distribution grid, thereby revitalizing socio-economic activities and improving living conditions of the community. For Ghana which aims to achieve universal access to electricity by 2020[14], with the power sector as the country's priority issue, this objective is consistent with the policies and needs of the country both at the time of planning and ex-post evaluation. Thus, the relevance is high. Outputs were delivered mostly as planned, and the project cost was within the plan. However, the project period exceeded the plan by about three months to respond to the change of tax exemption procedure of Ghanaian government. Therefore, the efficiency is fair. All of the quantitative effect indicators which were set at the time of planning achieved their target. It can be said that the power distribution grid in the target areas has been appropriately installed and contributed to stable power supply. Furthermore, it was confirmed that the stable power supply improved the services using electricity in medical facilities, educational facilities and local industry. In addition, the living conditions in the unelectrified areas have improved with electrification. Several other positive impacts have also been observed, including a change in the awareness of the executing agency toward work and coordination effect with the project supported by the World Bank. Thus, the effectiveness and impact of the project are high. In regard to the sustainability, there were no major issues in institutional/organizational aspects required for the operation and maintenance of the facilities and equipment installed by the project. The necessary cost for the operation and maintenance has been secured. Periodical checks are also being carried out and the training system for technical skills required for maintenance is substantial. Therefore, the sustainability of the project is high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

(1) Development of a checklist for daily inspection of substations and its implementation

The record of daily inspection at the primary substation in Tamale area was not standardized with no record format. A format should be developed and standardized checkup should be performed in order to clarify the contents to be checked and to grasp the operation status. The Sunyani area office has created a format and used it at substations. It is

[14] According to the Ministry of Energy, universal access to electricity means that 90% of the population has access to electricity.

recommended that the NEDCo headquarters should prepare a unified checklist including other substations as soon as possible to secure quality assurance.

(2) Attaching an appropriate cover for the cable outlet of the switchgear installed in the Sunyani BSP

After GRIDCo renewed a switchgear at BSP after the project completion, the number of the connecting cables between the switchgear installed by GRIDCo and the switchgear by the project was reduced to one cable from previously connected by two cables. Therefore, one of the cable connections of the switchgear of the project remains open. NEDCo has attached a plastic cover in the hole, however, the replacement with an insulated cover was pointed out for safety at the time of defect inspection of the project. The cover at the BSP in Tamale has been replaced, but the cover at the BSP in Sunyani has not been done due to out of stock. NEDCo headquarters should contact the distributor or manufacture as soon as possible to install the appropriate cover.

(3) Technical Transfer for Aerial Platform Vehicles

Currently, there is no particular issue on operation and maintenance of aerial platform vehicles since 2 drivers and 3-4 maintenance officers who have received OJT by the project kept working. However, one of drivers at Sunyani area office was about to retire. It is, therefore, proposed that technical transfer to other officers should be promoted with a view to the future. NEDCo headquarters should cooperate with Sunyani area office to conduct OJT and increase the number of staff members who can operate and maintain the aerial platform vehicles.

(4) Enhance Customer Care

By the results of qualitative survey, it was confirmed that the project largely contributed to the society and economy of target areas and significant effect was achieved. However, it was heard that some of business customers used residential voltage and their equipment was broken down due to frequent short-circuit. In addition, there were some medical facilities which require additional breakers in their property due to the increase in the equipment. The stable power supply has been realized by the project, however, in some cases the effects of the project were not fully demonstrated due to individual internal problems. If they could consult with NEDCo, appropriate response or advice could be provided. However, many customers do not even know about consulting with NEDCo. It is expected that the customer care should be enhanced such as through increasing the communication channels with customers and strengthening public relations in order to increase customer satisfaction and to avoid power trouble due to improper use. By such enhancement of customer care, the effects of the project can be further enhanced.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

Implementation of OJT and strategic collaboration with JICA's other technical cooperation activities for ensuring effective operation and maintenance of the project

Although no soft component was implemented in the project, OJT was conducted on initial operation instruction and methods of operation and maintenance in order to acquire reliable operation and maintenance skills. In addition, the executing agency has leaned from the Japanese side through OJT during the construction period such as on project management, time management, safety measures during construction, how to hold efficient meetings, how to clime poles, dispute management with contractors. These skills have been applying to other projects and duties. This project has strengthened the capacity of NEDCo staff and has brought a change in their awareness. In addition, NEDCo officers at the headquarters received the training courses in Japan on distribution grid and transmission line planning through the related technical cooperation project "Project on Electrical Engineers Training for African Countries" (November 2010 – March 2017). Those skills from the training have been utilized their transmission planning and quality control. It can be said that these capacity building and change in awareness have been reflected in good operation and maintenance of the project. Therefore, even if soft component is not implemented, in the case that key staff members for operation and maintenance of the project are anticipated to work continuously in the operation and maintenance department, involving them in OJT and training in Japan strategically could lead to effective operation and maintenance. In concrete way, it is important to conduct continuous OJT while involving executing agency as much as possible throughout the project period, and to collaborate with related technical cooperation projects.

END