Kingdom of Bhutan

FY2017 Ex-Post Evaluation of Japanese ODA Loan Project

"Rural Electrification Project"

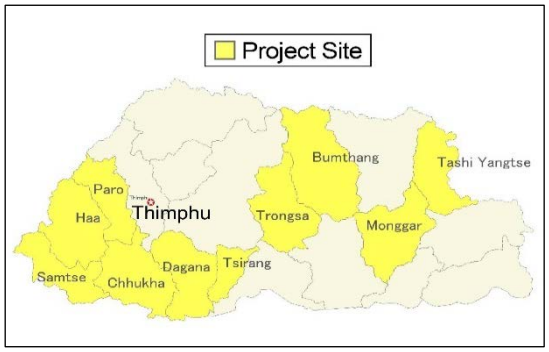
External Evaluator: Mitsue MISHIMA, OPMAC Corporation

0. Summary

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

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

1. Project Description



Project Location[1]

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

1.1 Background

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

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

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

1.2 Project Outline

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

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

economic and social activities in these areas.

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

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

2. Outline of the Evaluation Study

2.1 External Evaluator

Mitsue, MISHIMA, OPMAC Corporation

2.2 Duration of Evaluation Study

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

Duration of the Study: December 2017 – January 2019

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

2.3 Constraints during the Evaluation Study

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

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

3.1 Relevance (Rating: ③[4])

3.1.1 Consistency with the Development Plan of Bhutan

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

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

3.1.2 Consistency with the Development Needs of Bhutan

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

Photo1: Monggar Dzongkhag, Narang Project Target Area

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

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

[4] ③: High, ②: Fair, ①: Low

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

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

3.1.3 Consistency with Japan's ODA Policy

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

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

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

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

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

Table 1: Output Plans and Actuals

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

Source: JICA document, Questionnaire to BPC

3.2.2 Project Inputs

3.2.2.1 Project Cost

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

Table 2: Project Cost (Plan/Actual)

Unit: million yen

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

Source:JICA and BPC Documents

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

3.2.2.2 Project Period

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

Table 3: Project Period Plan and Actual

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

Source: BPC Document, answers to questionnaires

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

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

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

(Conditions for calculation)

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

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

Project Life: 30 years

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

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

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

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

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

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

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

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

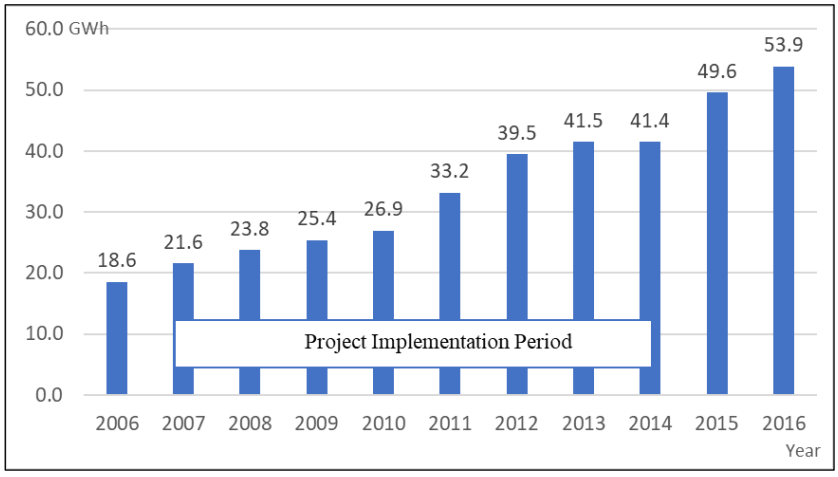
	Baseline	Target	Actual		
	2006	2014	2014	2015	2016
	Baseline year	2 years After Project Completion	Project Completion Year	1 year After Project Completion	2 years After Project Completion
(1) Rural Electrification Rate[1] (%)	56.3[2]	83.9	97	98	99.5
(2) Contribution by the Project to Total Households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

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

(2) Electricity Consumption

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

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



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

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

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

3.3.1.2 Qualitative Effects (Other Effects)

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

3.3.2 Impacts

3.3.2.1 Intended Impacts

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

Table 5: Qualitative Survey Target Areas and Interviewees

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

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

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

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

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

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

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

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

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

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

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

Public Administration and Service Institution Officers

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

Villagers

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

Source: Interview Results

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

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

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

Photo 2: Langthel Gewog Community Center,
Trongsa Dzongkhag

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

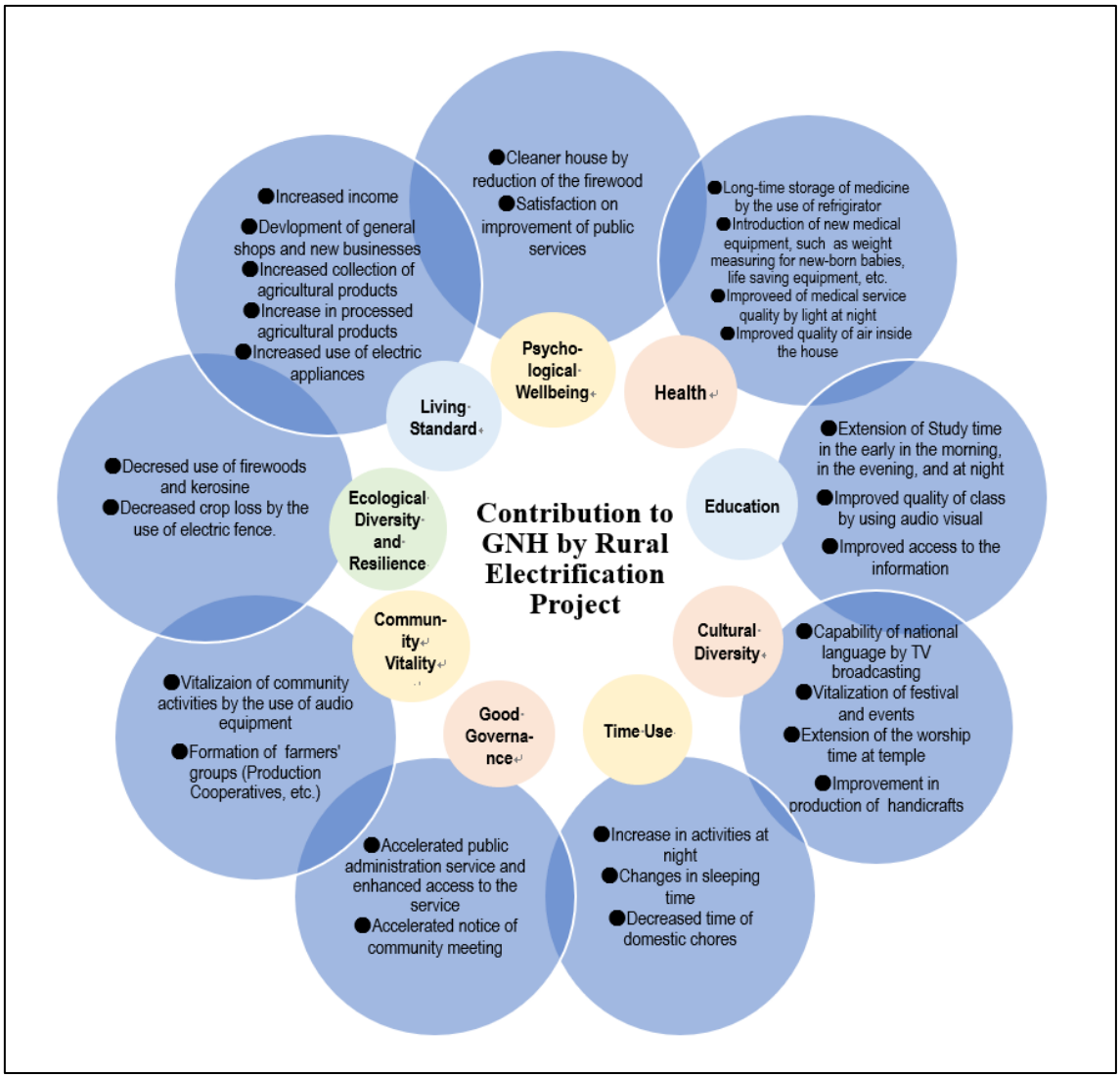
Photo 4: Langthel Gewog, Trongsa Dzongkhag
Left: House electrified by the Project
Right: Storage for Potatoes, where temperature is controlled by the electricity supply

Photo 5: Weaving at night

Photo 6: General Shop

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

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



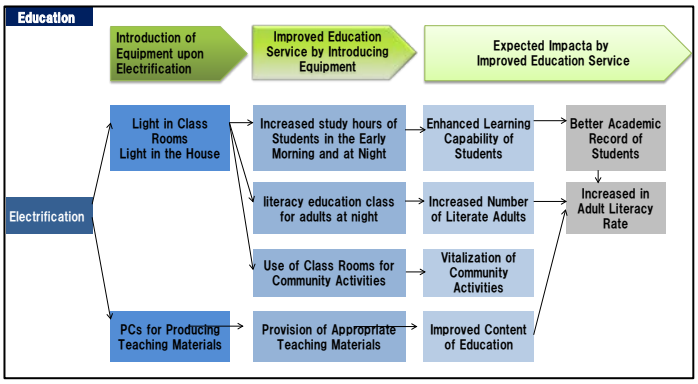
Source: Result of qualitative interview for the Ex-post evaluation on the Project

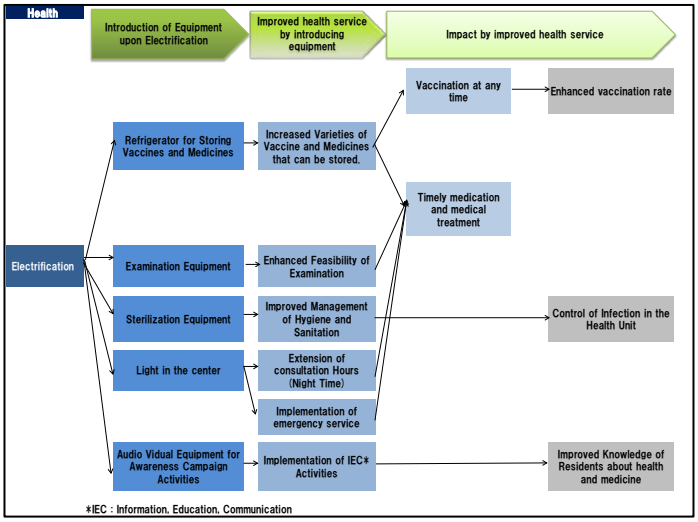
Figure 2: Contribution to GNH in Bhutan by the Project

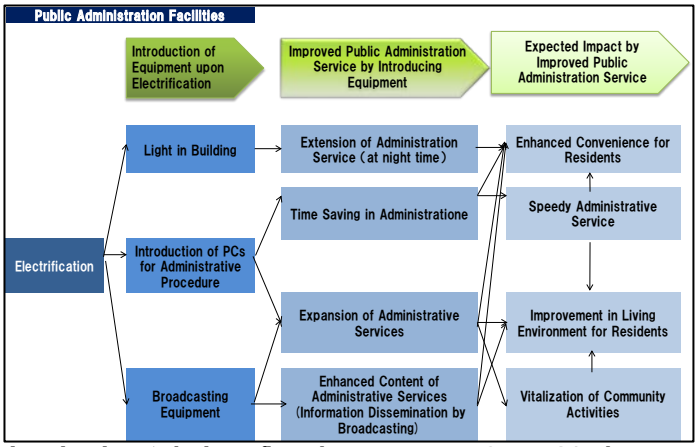
[Box] Discussion of the Logic Flow of the Effects and Impacts of the Rural Electrification Project in Bhutan

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

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







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

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

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

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

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

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

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

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

3.3.2.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

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

(2) Resettlement and Land Acquisition

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

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

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

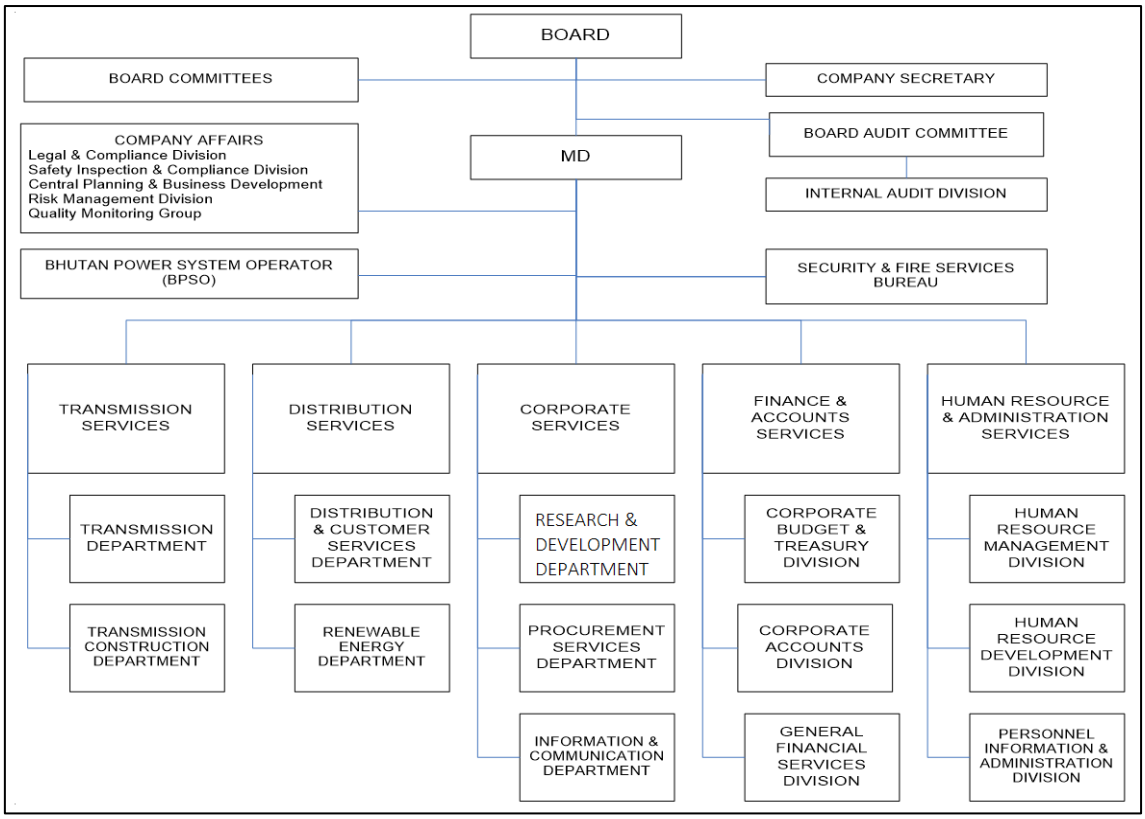
3.4 Sustainability (Rating: ③)

3.4.1 Institutional / Organizational Aspect of Operation and Maintenance

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

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

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



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

Figure 3: BPC Head Office Organization Chart

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

3.4.2 Technical Aspect of Operation and Maintenance

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

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

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

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

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

3.4.3 Financial Aspect of Operation and Maintenance

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

Table 8: BPC Key Profit and Loss Indicators

Unit: Million Nu

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

Source: BPC

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

Table 9: Financial Analysis of BPC Key Indicators

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

Source: BPC

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

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

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

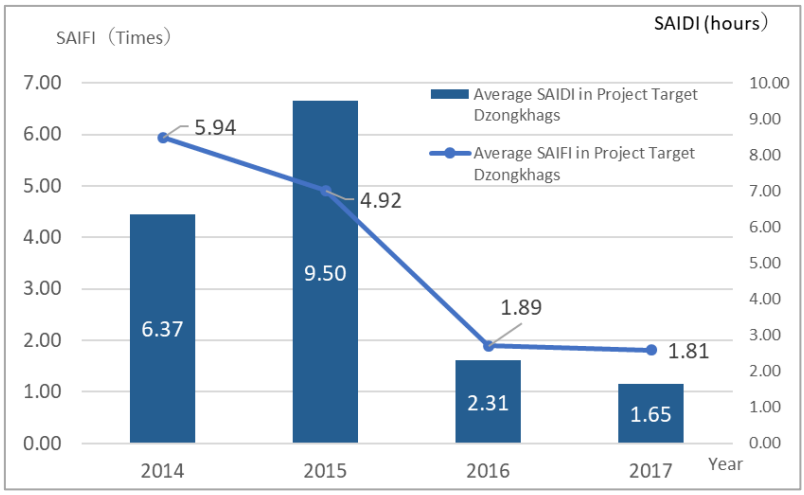
Every year around in October, ESD in each Dzongkhag submit an O&M budget request for the following year to DCSD at the head office. These requests are approved by the head office by mid-December. According to the Finance Department, budget requests are thoroughly reviewed and usually approved as requested.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

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

3.4.4 Status of Operation and Maintenance

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

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



Source: Calculation based on BPC document

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

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

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

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

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

None

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

Importance of Feasible and Useful Planning in Rural Electrification

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

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

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

END

Comparison of the Original and Actual Scope of the Project

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