(Bangladesh)

Power Distribution and Efficiency Enhancement Project

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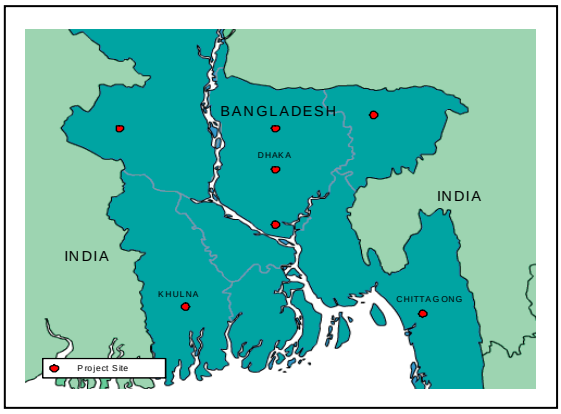
Field Survey: January 2009

1. Outline of the ODA Loan Assistance



Location of the project site

Sunamganj PBS power substation

1.1 Background

Bangladesh has shown a real GDP growth rate of 4-5% in recent years. In order to sustain its economic growth rate in the future as well, the power sector that supports socioeconomic activities will play a very important role. In particular, the electrification rate hovers at an extremely low level of some 15%.[1] The electrification of rural areas where approximately 80% of people live has posed a great challenge in boosting the economy of Bangladesh and also in reducing poverty. Since 1977 when the Rural Electrification Board (REB) was established, the government of Bangladesh has been continuously promoting rural electrification projects. Japan has also been providing assistance to the rural electrification projects through the "Rural Electrification Project (Phase IV-C)," a concessionary loan project, and the like.

In Bangladesh, system loss in urban districts is over 30% on average, whereby alleviation of system loss is an urgent issue. Since the 1990s, the government has been pushing forward a

[1] Household base (as of 1996)

power sector reform program. Amidst expanding electricity demand, the construction of new transformer substations and the upgrading of power distribution systems are growing increasingly important.

Against this background, this project was implemented with the aims of electrifying the rural areas under the jurisdiction of the REB by establishing electrification cooperatives in these areas and enhancing the efficiency of power distribution networks through improving the existing distribution systems in urban districts.

1.2 Objective

The following two projects constitute this project

(1) Rural Electrification Project

The objective of this project is to promote electrification and enhance the efficiency of facilities/equipment in Munshiganj and Sunamganj through establishing Palli Bidyut Samity (PBS, i.e., electrification cooperative) and constructing and/or rehabilitating power distribution systems in the target regions, thereby contributing to improving socioeconomic conditions and developing regional economies in the target regions.

(2) System Loss Reduction Pilot Scheme

The objectives of this project are to reduce system loss in six feeders in total selected in the four areas (Chittagong, Mymensingh, Rajshahi, and Khulna) under the jurisdiction of the Bangladesh Power Development Board (BPDB) and the two areas (Dhanmondi and Jurain) under the jurisdiction of the Dhaka Electricity Supply Authority (DESA), to develop the capacity of the executing agencies in the design, management and operation/maintenance of distribution systems through rehabilitation of power distribution networks and installation of watt-hour meters for measurement, and, based on the result, to formulate a nationwide implementation plan, thereby contributing to a stable supply of electricity and the development of regional economies.

1.3 Borrower/Executing Agency

Borrower: Government of the People's Republic of Bangladesh

Executing agency: Rural Electrification Board

Bangladesh Power Development Board

Dhaka Electricity Supply Authority (currently reorganized as Dhaka Power Distribution Company Limited)

1.4 Outline of the Loan Agreement

Approved Amount/ Disbursed Amount	¥4,376 million / ¥4,003 million
End Notes Exchange Dates/Loan Agreement Signing Date	June 1999 / July 1999
Terms and Conditions	Interest rate: 1%, Repayment period: 30 years (Grace period: 10 years) Procurement: General untied
Final Disbursement Date	September, 2007
Main Contractor (Over 1 billion yen)	None
Main Consultant (Over 100 million yen)	None
Feasibility Studies, etc.	None

2. Evaluation Results (Rating: B)

2.1 Relevance (Rating: a)

2.1.1 Relevance at Appraisal

(1) Rural Electrification Project

In the Fifth Five-year Plan (1997-2002), the issue of "promotion of rural electrification" was listed as one of the nation's four key policies in the power sector. In fact, the amount of public investment appropriated by the power sector reached 10% of the entire plan. During this planning, four priority policies were selected in the power sector, one of which was the expansion of rural electrification.

At that time, the electrification rate of rural areas in Bangladesh including the target areas of this project hovered at a low level of about 15%. It was indeed necessary to promote further electrification of rural areas where 80% of the total population lived. In addition, in the electrified areas, the power loss rate was very high, i.e., 35%. Thus, it was required to take measures to control power theft and to rehabilitate or strengthen antiquated facilities.

Against this background, the necessity of implementing this project was high in that it was expected that roughly additional 120,000 households would be electrified and the efficiency of facilities would be enhanced.

(2) System Loss Reduction Pilot Scheme

Since the 1990s, the government of Bangladesh has been promoting the power sector reform program. Amidst growing electricity demand, the construction of new transformer substations and the improvement of power distribution systems became increasingly important. In particular, power transmission networks were spreading in urban districts at that time, but system loss was extremely high, that is, exceeding 30%. Thus, making effective use of electricity through enhancing the efficiency of existing facilities by optimizing power distribution equipment and preventing power theft and wrongdoing in meter reading was urgently required.

2.1.2 Relevance at Ex-Post Evaluation

(1) Rural Electrification Project

Vision 2021 announced by the Bangladesh Awami League, the present administration, picks up the reform in the energy sector and poverty reduction in the five priority areas. Likewise, it defines the issue of agricultural and rural development as one of 23 priority fields. Thus, the importance of rural development remains high. The National Energy Policy formulated in 1995 is still construed as the basic policy for translating power sector measures into concrete actions. Even after its revision in 2005, rural electrification by REB and PBS still constitutes an important element of the National Policy. The government of Bangladesh has been promoting its rural electrification projects with assistance from international donors including Japan. These projects have raised the electrification rate to over 30% from 15% at the time of project implementation. Nonetheless, there is still a continued need to expand electrification.

(2) System Loss Reduction Pilot Scheme

In the Power Sector Master Plan formulated based on the abovementioned National Energy Policy, a 20-year long-term plan was drawn up concerning power transmission projects. The aim of the power distribution sector is set “to reduce system loss to a minimum and raise the sustainability, reliability, and safety of services.” This project was implemented as part of measures to translate the aim into concrete actions. Thus, the project was very relevant to the government’s policies and needs. Currently, the system loss of the whole BPDB was improved to 16.58% in 2006-07 in comparison to earlier days, but further enhancement of efficiency is

required. Following the measures taken under this project, the measure to spread the rehabilitation of power distribution networks is in progress. Besides the rehabilitation of power distribution networks, demand-side management (DSM) and prepaid meter installation projects are being carried out.

Based on the above, this project has been highly relevant with Bangladesh's national policies and development needs at the times of both appraisal and ex-post evaluation.

2.2 Efficiency (Rating: b)

2.2.1 Project Outputs

Table 1: Comparison of the Original and Actual Scope

Outputs	Original	Actual
Rural Electrification Project To establish PBSs Munshiganj and Sunamganj	To be established at two places	Same as planned
Construction/rehabilitation of power distribution networks Munshiganj Sunamganj	Total: 3,981 km 1,945 km 2,036 km	Total: 3,473 km 1,824 km 1,724 km
Transformer substation Munshiganj Sunamganj	8 sites in total 6 sites (New construction – 4: Rehabilitation – 2) 2 sites	8 sites in total 6 sites (New construction – 3, Rehabilitation – 3) 2 sites
Number of electrified households Munshiganj Sumanganj	Total: 173,106 households 105,817 households 67,289 households	Total: 205,821 households 160,827 households 44,994 households
System Loss Reduction Pilot Scheme Rehabilitation and expansion of power distribution networks		

BPDB (33-kv, 11-kv, low-voltage line)	85 km	84.5 km
DESA2	26 km	25.6 km
(33-kv, 11-kv, low-voltage line)		
Increase and rehabilitation of		
pole-mounted power transformers		
BPDB	130 sites	122 sites
DESA	58 sites	65 sites
Rehabilitation of incomer and meters	Roughly 10,000 sites	20,118 sites
Construction of a new substation	1 site	Same as planned
Consulting service	464 M/M	498.05 M/M

(1) Rural Electrification Project

The main modifications include a change in the length of power distribution networks based on the detailed design and a change in the breakdown of the number of power transformer substations in Munshiganj (four new constructions and two substations for rehabilitation to three constructions and three substations for rehabilitation). The number of transformer substations was changed because the construction of new substations was reduced to three sites. The reason was that the control of one existing substation, which had been under the control of the Dhaka Electricity Supply Authority (DESA) and allocated to the target area, was transferred. On the other hand, the number of connected households has not yet reached the planned number in Sunamganj, but 62,000 places have already been connected to power distribution networks. As of this point in time, although not all connectable households are yet connected due to the delay in procurement/installation of meters or power transformers, it is expected that the number of electrified households will increase in the near future. That is, there is no difficulty in achieving the planned number.

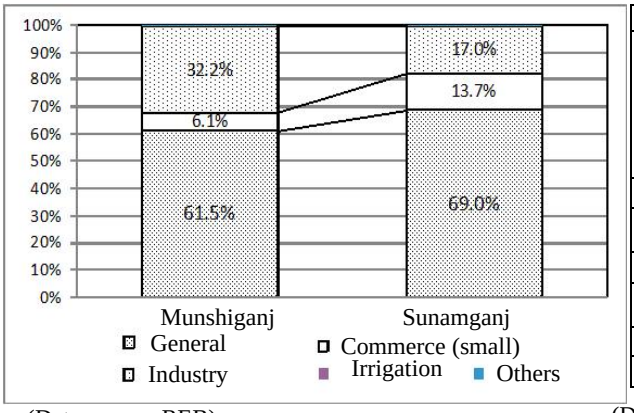
Following table showls the breakdown of consumer mix of each PBS. In all cases, power supply to domestic households accounts for the largest proportion. Munshiganj is located near Dhaka and has large commercial and industrial demand and also a great number of cold storage units for agricultural products. Therefore, it is relatively in advantageous position to secure profitability. On the other hand, the profitability of Sunamganj is low due in part to high

[2] The issue will be discussed in section "3.2 Sustainability." We just note here that the Dhaka Electricity Supply Authority (DESA) is now renamed Dhaka Power Distribution Company Limited (DPDC) at the time of its recent reorganization. Hereafter, in the section on efficiency, the name at the time of the plan (DESA) is used, whereas in discussions about the present situation such as effectiveness and sustainability, DPDC will be used.

maintenance costs because users are scattered and due in part to the fact that general households for which a low power rate is charged account for 70% of demand. Even in Munshiganj, the returns per unit are in the red; thus, the financial structure is evidently unsound. (This issue will be discussed in more detail in the sections on sustainability and financing.)

In Sunamganj, the BPDB still has not released its onwershp on distribution networks (about 500 km) of pocket areas where there is a large demand such as commercial districts. This delay of ownership transfer has an adverse effect upon improving profitability of PBS.[3]

Figure 1: Composition of consumers (on the basis of electricity used)



(Data source: REB)

Table 2: Table of power rate of the PBSs

(In taka/kwh)

Type		Munshiganj	Sunamganj
General	-100 kwh	2.55	2.81
	101-301	2.75	2.86
	301-500	3.9	4.06
	501-	5.4	5.9
Commerce		5.11	5.11
Public utilities facilities		3.28	3.28
Irrigation		2.75	2.87
Small/medium industries		3.95	4.01
Large industries		3.8	3.91
Street lamps		3.75	3.75

(Data source: REB)

(2) System Loss Reduction Pilot Scheme

Based on the detailed design, the number of watt-hour meters for installation or rehabilitation was increased. Besides, the number of transformers was also changed. After the detailed design, no large changes were made and the project was implemented as had been planned. It was reported that there had been frequent operational problems with some of the watt-hour meters installed in Agrabad H-5, FIDC feeder under the control of the BPDB relatively early on, i.e., within one year after their installation.[4] The BPDB concluded that the

[3] At the time the REB was founded, the roles of related organizations in the power sector were divided. It is legally mandated that rural electrification be under the control of the REB and that the control of existing power distribution networks in the areas under the jurisdiction of the REB is to be transferred to the REB. However, according to a source in the REB, the REB is unable to obtain cooperation from the BPDB as to transfer of their control and there still remain pocket areas where the BPDB distributes power within the area under the jurisdiction of the REB. The areas where control has not been transferred have large consumers such as shopping streets. Negotiations on the transfer with the BPDB are at a stalemate.

[4] People in the BPDB claim that the meters installed are made in overseas countries and have no functional problems, but believe that they are not suited to the natural conditions of Bangladesh. Currently, they primarily install home-produced meters.

deterioration in watt-hour meters had been accelerated by the regional characteristic whereby the area was close to the coast. Now, it has been replacing the meters with conventional mechanical watt-hour meters.

2.2.2 Project Period

This project was set for a period from July 1999 to March 2005 (69 months). In fact, it covered the period from July 1999 to June 2005 (72 months), slightly longer than planned. The delay was due primarily to the necessity to redesign power distribution networks in conjunction with expanding demand in the target areas of the System Loss Reduction Pilot Scheme. Although the onset of the construction work was delayed, the construction period was almost as had been planned. The Rural Electrification Project was implemented as had been planned. The REB, the executing agency, has rich experience in instituting PBSs. That is, it was equipped with full executing capacity, leading to efficient implementation of the project.

2.2.3 Project Cost

The total cost of the project was planned to be ¥7,050 million, whereas the actual cost was ¥5,962 million, lower than planned. This was due to cutbacks in the cost of the Rural Electrification Project portion in which the number of transformer substations was reduced and the exchange rate favorably fluctuated (1 taka = ¥2.59 at the time of appraisal and 1 taka = ¥2.01 on average during the implementation period of the project). On the other hand, as for the System Loss Reduction Pilot Scheme portion, with increases in the number of rehabilitated watt-hour meters and consulting service cost, the project cost was pushed up slightly from ¥1,493 million at the time of planning to ¥1,540 million.

Although the project cost was lower than planned, the project period was slightly longer than planned; therefore the evaluation for efficiency is moderate.

2.3 Effectiveness (Rating: a)

2.3.1 Rural Electrification Project

(1) Munshiganj

The number of electrified households has steadily increased and has grown to exceed the planned number to a great degree. At the same time, a rate of the system loss has been kept low, i.e., at levels of 11-13%, and the collection rate of electricity charges[5] is maintained at a high level of 100%. All these indicators demonstrate that management is sound. Although there are constraints such as load shedding due to the shortage of power supply capacity in recent years, the PBS itself maintains the service at a high level.

Table 3: Management of the PBS in Munshiganj

Name of an indicator (unit)	1999	Planned value (2005)	2007	2008
Number of electrified villages (out of 909 villages)				880
Number of electrified households (connected households)		105,817	156,666	160,827
Electrification rate (total number of households: 213,000)			73%	75%
Peak Load (kw)			57,090	53,810
Forced outage hours / year			19.61	8.99
System loss (%)	46%	15%	13.83%	11.17%
Amount of electricity supply (mwh)			213,556	228,420
Amount of electricity sales (mwh)			184,028	202,993
Charge collection rate (%)			105.88%	104.1%

Data source: PBS in Munshiganj

(2) Sunamganj

The number of electrified households has been steadily growing. That is, it has been augmented from about 12,000 households at the time of appraisal to roughly 45,000 households. It is expected that it will be increased to 62,000 households in the near future. Thus, the number has nearly reached that of the plan. System loss has been maintained at levels of

[5] The collection rate of electricity charges includes cases in which the charges for the preceding months have been collected. Therefore, in some cases, the rate goes beyond 100%. The average number of months required for the collection of one electricity bill is 1.7 months in Munshiganj and 1.9 months in Sunamganj.

13-14%, which has attained the goal the plan as well. The collection rate of electricity charge has attained almost 100%. We evaluate, therefore, that management is good from both the technical and administrative aspects. However, in our interviews with people related to PBSs (electrification cooperatives), they expressed concern over a financial issue. To put it in specific terms, its profitability is low due to the facts that its target households are smaller in number than those of the large-scale PBS in Munshiganj, for example, and that general households (whose power rate is set low) constitute a large segment of its consumers. Moreover, its maintenance cost tends to be high because of its geographical condition where the area is vulnerable to flood damage during the rainy season (to be discussed in detail in 2.4 Sustainability).

Table 4: Management of the PBS in Sunamganj

Indicator (Unit)	1999	Planned value (2005)	2007	2008
Number of electrified households	12,445	67,289	40,801	44,994
Electrification rate			63%	n.a
Peak Load (kw)			n.a	n.a
Forced outage hours / year			16	10
System loss (%)	46%	15%	13.95%	13.58%
Amount of electricity supply (mwh)			29,725	35,467
Amount of electricity sales (mwh)			24,783	30,056
Charge collection rate (%)			102.47%	99.68%

Data source: Sunamganj PBS

Shortages in the electricity supply (from BPDB) can be pointed out as an issue common to both PBSs. This is an issue of the whole Bangladesh power sector, which is an external factor beyond the scope of the project. However, when supply shortages occur, power supply to large cities such as Dhaka is sometimes prioritized, which significantly affects electricity supply to rural areas. Actually, both PBSs stopped the construction of new distribution lines since 2007 due to shortages in the electricity supply, resulting in the slowing down of growth in the number of electrified households. There are also situations occurring that may affect the project

effectiveness, such as a decrease in the amount of electricity sales due to load shedding.

Reference: Outline of the power sector in Bangladesh

Reinforcement of power generation capacity hardly progressed during the former administration. In addition, the closing of old power plants occurred at the same time. Due to these reasons, shortages in the electricity supply are currently a serious problem in Bangladesh. Therefore, supply disruption at the peak time of demand is occurring frequently in the project target area, affecting the effectiveness of the project.

Table 5: Outline of the Bangladesh power sector

(In MW)

	2005	2008
Installed Capacity	5,025	5,275
Public (BPDB)	3,735	3,985
Private (IPP)	1,290	1,290
Generation capacity	4,030	3,782
Peak demand	3,751	5,500
Supply-demand Gap	279	(1,718)

Data source: BPDB

Although this is a problem due to a external factor beyond the scope of the project design, adequate power generation capacity is the premise for ensuring the sustainable effects of rural electrification (electricity distribution project). Therefore, it is necessary to reinforce power generation capacity as soon as possible.

(3) Results of Economic Internal Rate of Return

The EIRR of this project was calculated by converting the increase of power consumption[6] and the saving of fuel costs (kerosene)[7] through electrification into economic benefits and by assuming initial investment and operation/maintenance expenses as economic costs. The

[6] As for the power rate per unit, the price rate for general households is set low for political reasons and is not suited for calculating economic benefits. Hence, a power rate of 5.11 taka/kwh for commercial districts was used in this calculation. Furthermore, it was converted to the border (reference) price.

[7] As for the saving effect of fuel costs, the amount of kerosene consumption before and after this project was estimated based on the findings of the beneficiary sample survey (discussed in section "2.4 Impact") carried out in this field survey, and the difference was taken as an economic benefit.

following table indicates the result.

Table 6: Results of EIRR

	Original Figure	Ex-Post evaluation
Munshiganj	9.98%*	12.96%
Sunamganj		9.18%

*Note: The EIRR at the time of appraisal is an overall value of the Rural Electrification Project (Phase V.A) that was implemented at the same time.

EIRR at appraisal is an overall value including other PBSs. Thus, it is difficult to make a simple comparison, but in Munshiganj, the number of connections grew steadily and exceeded the mean value at the time of appraisal. On the other hand, in Sunamganj, the EIRR slightly decreased from the value at the time of appraisal. In the background lies the fact that operation and maintenance expenses are high, for instance, because electrified households are scattered over a wide area due to geographical features.

Our comprehensive analysis of the effects of rural electrification confirms that both the number of electrified households and the electrification rate have steadily grown through the establishment of PBSs and that the management of PBSs has been sound. Therefore, this project has largely produced the planned effects, and its effectiveness is high.

2.3.2 System Loss Reduction Pilot Scheme

(1) DPDC (formerly DESA) (Feeders of Dhanmondi and Jurain)

The following table indicates changes in the system loss of the target feeders. As can be seen, each feeder shows an improvement greater than planned. Particularly, the loss rate of the Dhanmondi feeder is markedly low, that is, less than 5%. The Jurain feeder suffered a great system loss rate of over 70% before the project's implementation, but now it has dropped to some 17%, indeed a great improvement. These figures demonstrate that the project has successfully developed efficient power distribution systems. In DPDC, the improvement in non-technical loss is particularly remarkable. This was due in most part to accurately measuring the amount of electricity used through replacing or sealing watt-hour meters as well

as to the decreased rampancy of power theft and wrongdoing in meter reading through rectifying illegal connections of lead-in wires.

Table 7: Change in the system loss of the target feeders

		Before implementation		Planned value		Actual	
Name of feeder		1996	2001	2005	2006	2007	2008
Dhanmondi	**System loss**	**36.70%**	**20.00%**	**11.00%**	**8.20%**	**6.00%**	**4.95%**
	Technical	4.50%	3.50%	5.00%	4.20%	4.00%	3.95%
	Non-technical	32.20%	16.50%	6.00%	4.00%	2.00%	1.00%
Jurain[8]	**System loss**	**71.70%**	**24.50%**	**17.77%**	**17.20%**	**16.99%**	**16.50%**
	Technical	11.00%	5.50%	6.00%	6.00%	6.00%	6.00%
	Non-technical	60.70%	19.00%	11.77%	11.20%	10.99%	10.50%

Data source: DPDC

The power supply has now doubled the amount before the project. This project has obviously contributed to the development of infrastructure for a stable power supply in the target areas. In comparison to the time of appraisal, the number of connections has decreased. This is because redevelopment of the regions has been promoted, and major consumers primarily consist of large-scale shopping centers and schools. Thus, power consumption has doubled.

Table 8: Key operation indicators of the Dhanmondi feeder

Indicator	1998	2001	2006	2007	2008
Number of connections	60	71	30	26	22
Rate of electrification	86%	86%	92%	92%	100%
Maximum output (MW)	1.4	2.9	3.7	3.8	4
Peak load (MW)	1.6	3.2	3.75	3.9	4.3
Amount of electricity sales (mwh)	4,225	5,840	9,660	10,340	10,925
Charge collection rate	79%	80%	95%	113%	108%

Data source: DPDC

[8] The Jurain feeder was integrated with the Paperbag feeder in 2004 when the underground cable was found to be damaged. Hence, the figures in the table are for the Paperbag feeder.

(2) BPDB

The following table indicates the change in system loss of the target feeders around the time of the project's implementation. In each area, the situation has been greatly improved from the time of appraisal, and the planned value has been attained. Officials in charge in every region, particularly the FIDC feeder, believe that there is still room to improve non-technical loss. That is, if the mechanical watt-hour meters that themselves cause power loss are replaced in greater number with prepaid meters that are able to measure the amount of electricity consumed more accurately and power-saving awareness among users is heightened, system loss will be maintained at 8-9%.

As for the Agrabad H-5 feeder, overload is imposed on some transformers because of increasing demand. A person in charge believes that if the capacity of more transformers is expanded, system loss caused by overload will decrease.

Table 9: Change in the system loss of the four feeders of the BPDB

		At the time of appraisal	Planned value	Actual			
Name of feeder		1996	2001	2005	2006	2007	2008
Kachijhulee	**System loss**	**41.0%**	**20.0%**	**14.8%**	**13.5%**	**12.6%**	**11.0%**
	Technical	7.3%	4.5%	n.a	n.a	n.a	n.a
	Non-technical	33.7%	15.5%	n.a	n.a	n.a	n.a
Shahebbazar	**System loss**	**29.4%**	**20.0%**	**13.0%**	**12.0%**	**11.5%**	**10.0%**
	Technical	6.90%	4.50%	3.12%	3.11%	3.07%	3.00%
	Non-technical	22.50%	15.50%	9.88%	8.89%	8.43%	7.00%
Agrabad-H5	**System loss**	**43.2%**	**20.0%**	**16.0%**	**15.0%**	**14.0%**	**13.0%**
	Technical	10.3%	6.0%	10.0%	10.0%	10.0%	10.0%
	Non-technical	32.9%	14.0%	6.0%	5.0%	4.0%	3.0%
FIDC	**System loss**	**44.7%**	**20.0%**	**16.0%**	**15.0%**	**14.5%**	**15.8%**
	Technical	6.7%	4.0%	6.0%	6.0%	6.0%	6.0%
	Non-technical	38.0%	16.0%	10.0%	9.0%	8.5%	9.8%

Data source: BPDB

The number of connections and the amount of power supply per feeder are indicated below. Data on the values at the time of appraisal and current actual values were not available. Thus, it is difficult to make a comparison. Yet we can see that the key indicators such as the number of connections, the amount of power supply, and the collection rate of electricity charges have generally improved or expanded. Thus, we can assert that a system for stable power supply has been established.

Table 10: Key operation indicators of the four feeders of the BPDB

	Indicator	1998	2006	2007	2008
Kachijhulee	Number of connections	n.a	3,420	3,600	3,705
	Amount of electricity supply (mwh)	n.a	8,572	8,452	9,167
	Charge collection rate	82%	109.9%	119.67%	81.37%
Shahebbazar	Number of connections	1784	2445	2635	2750
	Amount of electricity supply (mwh)	454.1	622.7	670	700
	Charge collection rate	82%	90%	91%	93%
Agrabad-H5	Number of connections	n.a	220	250	309
	Amount of electricity supply (mwh)	n.a	n.a	n.a	n.a
	Charge collection rate	82%	95%	98%	96%
FIDC	Number of connections	1,400	1,900	2,000	2,100
	Amount of electricity supply (mwh)	n.a	n.a	n.a	n.a
	Charge collection rate	n.a	n.a	n.a	n.a

Data source: BPDB

Based on the above analysis, the effectiveness of this project consisting of the Rural Electrification Project and the System Loss Reduction Pilot Scheme is summarized. The electrification rate of the target areas has steadily increased with the Rural Electrification Project and has already achieved the target value. Likewise, the feeder's system loss has been significantly reduced through implementation of the System Loss Reduction Pilot Scheme, thus greatly contributing to the development of efficient power distribution networks.

Therefore, this project has largely produced the planned effects, and its effectiveness is high.

2.4 Impact

2.4.1 Rural Electrification Project

(1) Improvements in the living environment

As stated in the objective of the project, a overall goal of the Rural Electrification Project is "to contribute to improvements in socioeconomic conditions and regional economic development in the target areas through electrification." In order to confirm the changes in socioeconomic conditions brought by the project to the target areas, we carried out a survey on the sense of satisfaction and changes through electrification on general households in each PBS.[9]

The main findings are outlined in the following table. We were able to confirm that the degree of overall satisfaction was high and that people equally shared the understanding that electrification had brought about changes in their living environment and contributed to its improvement. On the other hand, a sense of discontent with the cutoff of power supply was expressed in great number, thereby affecting the degree of satisfaction.

Figure 2: Degree of satisfaction with living after electrification

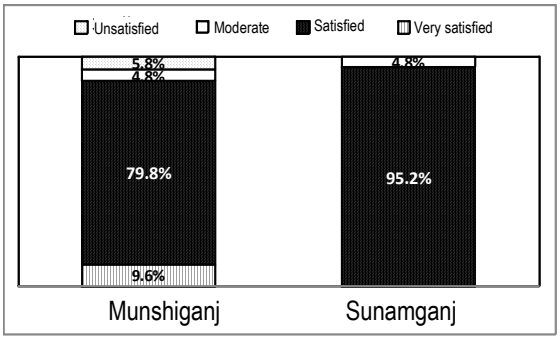
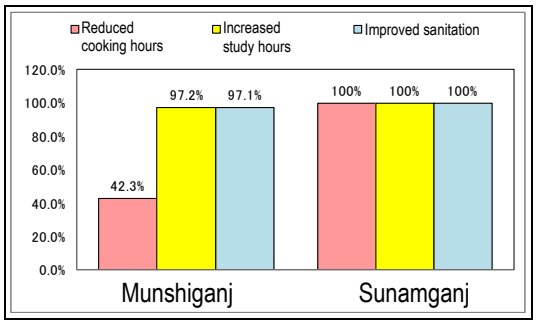


Figure 3: Improvements in the living environment through electrification



The largest change caused by electrification can be observed as improvements in the living environment. We tried to see improvements in the main domestic chores and study hours through our survey and confirmed that people were indeed aware of improvements in almost all items. In particular, all respondents in Sunamganj recognized some improvements, thus endorsing the significant effects of this project. There were various responses: shortened hours

[9] The survey was conducted as a face-to-face interview by using a question sheet. The number of samples was 104 households for each PBS, that is, 208 households in total.

of domestic chores, particularly cooking; increased study hours of children; improved convenience by using TV and electric appliances (electric fan, refrigerator, etc.); obtaining information and knowledge (in synchrony, improvements in the sanitary environment); and improved safety at night, to cite a few. In the villages we visited for our field survey, 60-70% of residents had a TV set. We collected many comments asserting that people enjoyed the indirect effects of electrification. For instance, people watch health programs, thereby enhancing awareness of their living. Similarly, in one household in which the head was a school teacher, a personal computer and a printer were used to prepare teaching materials in addition to a TV set and refrigerator. Thus, people certainly enjoy the various benefits of electrification.

On the other hand, people expressed a sense of dissatisfaction with the load shedding. In particular, strong discontent is prevalent among people with the load shedding at peak hour in the evening and at night when electricity is specially needed. As stated above, this is a problem caused by an external factor that is beyond the control of the project design. Almost all respondents replied that power supply is cut off almost every day. The findings indicate that the average hours of load shedding amounts to three to four hours at peak hour.

Figure 4: Beneficiary survey

Figure 5: Printer bought by a resident

(2) Improvements in the economic environment

Views on the increase in income by electrification were variable depending upon the region. Particularly in Sunamganj, there are marked improvements. It is difficult to measure the direct contribution of electrification to earnings because changes in the economic environment and income are affected by other extrinsic factors (regional features, etc.). According to our

interview survey in the local area, many respondents felt that electrification acted as a trigger for the vitalization of regional economic activities, thus demonstrating extensive effects of electrification.

As a secondary effect of this project, the amount of kerosene that has been used as fuel for lighting since former days has been reduced by about 70% in comparison to the days prior to electrification.[10] This effect is significant from the viewpoint of reducing the consumption of fossil fuels as well as cutbacks in living expenses.

[10] This result was obtained under current circumstances in which power supply is frequently cut off. It is expected that a better effect can be expected when a stable supply of power is ensured.

Figure 6: Increased income

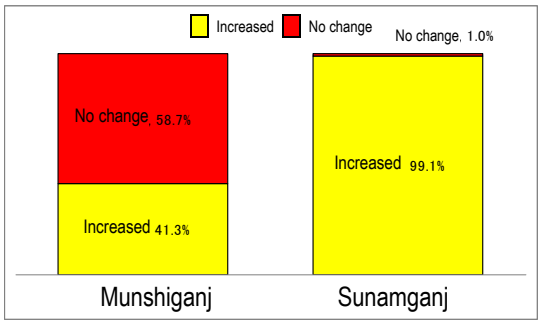
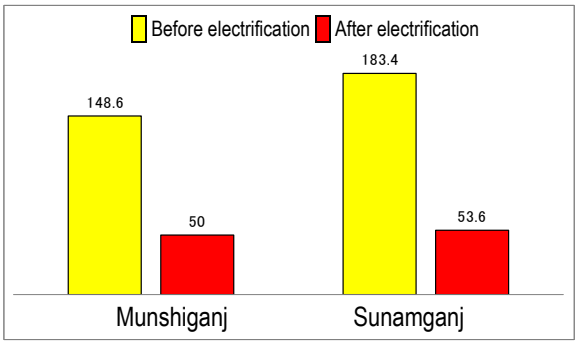


Figure 7: Change in the consumption of kerosene

(In taka)



The interview carried out during field survey on business owners in Sunamganj revealed that a cultivated area under irrigation projects was enlarged by electrification and the operation and maintenance expenses were cut down, thereby increasing agricultural productivity. Rice-cleaning business owners admitted that operation and maintenance expenses were reduced. The survey also discovered that a new business had been created, whereby rice hulls are reprocessed into fuel.

On the other hand, Munshiganj has the geographical advantage of being situated close to Dhaka and blessed with relatively better economic conditions. Hence, the effect of increased earnings cannot be clearly observed. Nonetheless, the people of the PBS argue that electrification promoted the construction of cold storage units for agricultural products and as a result enhanced the convenience as the key place of goods distribution to Dhaka, the capital of Bangladesh, and other cities.

Figure 8: Henhouse in which the temperature is electrically controlled

Figure 9: Electric rice-cleaning machine bought after electrification

2.4.2 System Loss Reduction Pilot Scheme

(1) Impact on regional development

The scale of each project is small, but extensive improvements in power supply brought about by the project have fulfilled a certain role in the development of infrastructure in the target areas. As a typical example, the Dhanmondi feeder (under the control of DPDC) that has been improved by the project supplies electricity to a commercial district called Elephant Road in Dhaka. This district has been vigorously redeveloped in the last few years into a major point of business where a shopping mall and a university have been built. The owner of the largest shopping mall in the Dhanmondi stated in our interview, "The stabilized power supply in comparison to the former days has yielded very good effects on business by extending business hours and reducing electricity costs (by decreasing the frequency of the use of in-house power generation equipment). The occupation rate by tenants has increased." Other shop owners of the shopping street whom we interviewed expressed similar views. We believe that the findings of our interview endorse the role fulfilled by this project in the development of regional economy.

On the other hand, the Jurain feeder is located on the outskirts of Dhaka, an area where land was once used as farmland. In conjunction with urban development, the area has now turned into a residential district where relatively low-income people live. As for the four feeders under the control of the PDB in the target area, their equipment was rehabilitated or strengthened in the areas where urban development had already progressed, thus making the manifestation of changes less salient. Yet the project has evidently achieved a higher quality of services such as increased reliability of power supply and shorter time to restart power

supply.

Figure 10: An area to which the Dhanmondi feeder supplies power

Figure 11: An area to which the Agrabad feeder supplies power

(4) Impact on improvements in the power distribution sector

As discussed in section "2.3 Effectiveness," extensive improvements in system loss made by the pilot project are not limited only to improvements in the target feeders. That is, the pilot project also gave an opportunity to start measures towards improving the entire system. In fact, subsequent to the pilot project, the power distribution sections of DPDC and the BPDB have been promoting improvements by implementing a five-city power distribution improvement project, the greater Khulna power distribution project, and other similar projects in many areas. Not all the components of JICA's pilot project have necessarily been adopted in these subsequent projects. Nonetheless, we can assert that the outcome (positive or negative) of the pilot project is used as know-how such as improving the system design by taking regional features into account. Thus, this can be counted as an effect of this project.

2.4.3 Impact on the natural environment and society

The Ministry of Environment approved the project's impact on the natural environment at the time of appraisal. There is no report on any specific problems during the implementation of the project. To execute the Rural Electrification Project, it was necessary to acquire land at a planned site for a transformer substation of the PBS headquarters, but the land acquisition had been already completed prior to the implementation of the project.[11] There was no need to

[11] In the System Loss Reduction Pilot Scheme, the land owned by the Bangladesh Power Development Board was

relocate residents in conjunction with implementing the project.

2.5 Sustainability (Rating: b)

2.5.1 Executing agency

2.5.1.1 Structural aspects of Operation and Maintenance

(1) Rural Electrification Project

No changes have been made to the systems of the REB and PBS since the time of appraisal. In the management of the PBSs, the members of the management board who are elected by residents form a decision-making body and the responsibilities for administrative work rest with the general manager appointed by the REB. The REB is deeply involved in the management of the PBSs and actively provides support through managerial and technical guidance. The management of the organization and system is stable. In the PBSs, we have heard neither dissatisfaction nor problems as to the present organization/system including its staff size.

The staff of technical experts of the PBSs is in charge of daily maintenance and is composed of regular employees and limited-term employees. Women are actively employed for office work such as accounting. In particular, almost all employees working in the accounting department are women.

Table 11: Number of staff members in the PBSs

	Munshiganj	Sunamganj
Operation/maintenance	195	66
Accounting	310	109
Customer service	12	13
General affairs	51	22
Total	568	210

Data source: Munshiganj and Sunamganj PBSs

used. Hence, it was necessary neither to acquire land nor to relocate residents.

Figure 12: Repair plant at the PBS headquarters

Figure 13: Window for electricity charge payment

(2) System Loss Reduction Pilot Scheme

1) BPDB

The power distribution section of the BPDB has been separated, and currently, West Zone Power Distribution Company Limited (WZPDCO) and South Zone Power Distribution Company Limited (SZPDCO) are respectively responsible for the target feeders. The staff size of the business office that is in charge of each feeder is approximately 100 persons, nearly all of whom have been transferred from the PDB. The staff size per feeder has not been clearly grasped, but each office has reported to us between five and seven technical experts constitute a team to carry out works in rotation and that there is no special problem as to shortage of personnel. The BPDB operations have been separated as part of the sector reforms. Yet both companies are subsidiaries of the PDB, thereby causing no actual changes in relationship and structure.

2) DPDC

As part of the power sector reform, DESA was reorganized as DPDC in October 2005. That is, the public corporation was reorganized as an ordinary limited company. At present, it carries out business as Dhaka Power Distribution Company Limited. The staff of the target business office is 73 persons, out of whom 61 persons work for the technical section. The director of a business office responded that the size of his staff was appropriate. DPDC is in essence an organization financed by the government, and there are no big changes in its actual capital structure. We found out through our interview with people of one business offices that they positively construed the reorganization and expressed the view that “each business office is

more clearly delineated than in the age of the public corporation, and an evaluation system geared to performance has been introduced. As a result, some positive changes have taken place such as heightened awareness of the workers."

2.5.1.2 Technical aspects of Operation and Maintenance

(1) Rural Electrification Project

The maintenance section of a PBS is solely responsible for the operation and maintenance of transformers and power distribution lines and the adjustment of accuracy of watt-hour meters. Each PBS has the capacity to carry out such works single-handedly. We have detected no technical problems. Some maintenance works are carried out by limited-term employees under the supervision of an engineer. A three-rung vocational ability evaluation system depending upon the degree of expertise has been introduced, thereby establishing a mechanism to assign and train staff members equipped with proper technical standards.

The staff members of the REB and PBSs are obligated to periodically undergo a given training course in OJT based on the number of service years and position. The content of such training covers all the works of the PBS such as management, accounting and finance, and technology. It accepts overseas trainees as well. Thus, it has rich programs of training.

Table 12: Training provided by the REB

Year	Course	Participants	Training period
2005	281	5,973	22,253
2006	339	7,785	35,091

Data source: REB

(2) System Loss Reduction Pilot Scheme

Regular maintenance is carried out as per the annual maintenance plan. No perceptible technical problems have been identified. Similarly, an expert who accompanied the writer questioned technical experts in charge of each feeder and confirmed their knowledge and expertise as to their assignments. Thus, it is surmised that there are no particular problems. The BPDB has established training centers in local areas, and each section provides training.

Table 13: Training carried out by the BPDB

Year	Course	Participants
2006-07	257	3,852

Data source: BPDB

2.5.1.3 Financial aspects of Operation and Maintenance

(1) Rural Electrification Project

1) REB

The payment of interest by PBSs accounts for the largest portion of REB's revenue. As of now, its annual income and expenses are in good shape. The equity capital ratio on the balance sheet is high, i.e., 63-64%, and its largest portion comes from the government's funds. Thus, the government injects capital into the REB and maintains the importance of rural electrification in its policy. Considering this, there will be no concern over its financial sustainability as long as the financial state of the REB is stable. However, it is inferred that the present deteriorated financial condition of the PBSs may have a negative impact on the finances of the REB that heavily depends upon the payment of interest by the PBS. Even under current circumstances, it depends upon funds from overseas donors for the majority of new investments and a further deterioration in its finances may become an obstacle in the long-term expansion of the rural electrification project. Hence, it is necessary to take measures to improve the income and expenses of the PBSs.

Table 14: Profit and loss statement (REB)

(In 1,000 taka)

	2005-06	2006-07
Gross revenue	1,957,107	2,355,215
Interest Payment from PBSs	1,891,766	2,131,579
Other income	65,341	223,636
Gross expenditure	276,363	433,145
Current profit	1,680,744	1,922,070
Payment of interest	462,363	492,247
Net profit	1,218,381	1,429,823

Data source: REB *The fiscal year is the accounting year of Bangladesh (July - June).

2) PBS

The financial state of each PBS is indicated below. The PBS in Sunamganj has been in the red each year. The PBS in Munshiganj narrowly maintained a positive balance, but slipped into the red due to the rise in the power procurement cost in October 2008. It has been in the red since then.

Table 15: Profit and loss statement of each PBS (summary)

(In taka)

Munshiganj	2006-07	2007-08
Gross revenue	664,664,604	660,165,115
Gross expenditure	583,779,843	653,284,353
Current profit	**80,884,761**	**6,880,762**
Sunamganj	2006	2007
Gross revenue	62,571,394	68,982,963
Gross expenditure	93,647,666	105,786,024
Current profit	**(31,076,272)**	**(36,803,061)**

Data source: PBSs in Munshiganj and Sunamganj

A breakdown of expenses per Kwh is shown in the following table. The operating cost of the PBS in Sunamganj is particularly high. It is assumed that in the background lie the following factors: the operation and maintenance cost is high due to the geographic condition of being susceptible to flood disasters; the business scale is small to start with; and it is structurally difficult to maintain profitability because of the composition of consumers. Furthermore, a curb had been placed on the sale price of electricity to a low level[12] in the first place and in October 2008, the wholesale price from the PDB was raised, thereby worsening profitability.

A person in charge of each PBS replied that the operation and maintenance budget had been allocated in a proper amount so far and no major problems had been reported. We could detect no obvious problems, either, from the preparation of spare parts, as will be discussed below, or the conditions of regular maintenance. Yet there is a possibility that a deteriorating financial state may have an adverse effect on future sustainability. Therefore, proper measures should be taken. The following table summarizes indicators pertaining to the profitability of both

[12] Refer to Table 2: Power rate table of the PBSs in section “2.2.1 Output.”

PBSs such as cost and profit per unit. In every item, cost per unit goes beyond profit per unit.

Table 16: Profitability of the PBSs

(In taka)

Item	Munshiganj	Sunamganj	Average of all PBSs
Profit per Kwh	**(0.40)**	**(2.02)**	**(0.07)**
Income per Kwh	**3.56**	**4.09**	**3.77**
Cost per Kwh	**3.96**	**6.11**	**3.84**
(Power purchase cost)	2.77	2.42	2.56
(O&M expense)	0.56	1.11	0.57
(Depreciation)	0.40	1.52	0.44
(Interest Payment)	0.23	1.06	0.27
Net income and expense*	0.23	0.56	0.64

Data source: REB

*Net income and expense = Income － Direct expenses (Power buying costs and O&M expenses)

The problem with the financial structure of PBSs is not limited only to these two PBSs but applicable to every PBS in Bangladesh. The REB says that only 18 PBSs out of 70 nationwide are in the profit or break-even position, and points out the necessity of improving the profitability of PBSs. To address this problem, the REB requested the Energy Regulatory Committee of the Government to raise the power selling price in January 2009. The request is now being reviewed by the Committee. The new administration has postponed the rise for the next six months. Hence, even if the price hike is approved, it will take effect after a given period.

(2) System Loss Reduction Pilot Scheme

1) BPDB

Table 17: Profit and loss statement

(In ten million taka)

	2005-06	**2006-07**
Income	**4656.84**	**4958.33**
Income from power sale	4585.88	4798.57
Other operating income	70.96	159.76

Expenditure	**5351.69**	**5636.65**
Fuel costs	1560.71	1675.98
Power buying cost (IPP)	2538.16	2516.6
Other power generation costs	575.45	764.05
Wheeling charge (For transmission)	116.16	121.55
Power distribution costs	449.52	435.05
Customer service	29.95	27.02
General/administrative expenses	81.74	96.4
Operating profit	**-695**	**-678**
Non-operating expense	**243**	**226**
Current profit	**-938**	**-904**

Data source: BPDB

In the last several years, the PDB has been in the losing position and shows a worsening tendency. It has been pointed out that this situation has been caused by inefficient management such as high fixed expenses in addition to the lack of supply capacity and an increasing amount of electricity bought from IPP at higher procurement costs. As a result, the worsening tendency continues as can be seen from the fact the liquidity rate dropped from 95% in 2005-06 to 91% in 2006-07 on the balance sheet. Based on the facts that government capital is injected into the PDB and that its importance in the Bangladeshi economy is recognized, we believe that the probability that it will plunge into financial crisis is low. Nonetheless, its financial soundness is not good as a business entity as can be seen from the fact that the liquidity rate is below 100%. The finances of the BPDB are an issue that will have extensive influence on the sustainability of the whole power sector in Bangladesh. Thus, some measures should be taken. As discussed in the section on the finances of the PBS, the power selling price was amended in October 2008 with the aim of improving the finances of the PDB, and it is expected that it will bring about certain effects. However, the fundamental cause of the PDB's deteriorating financial conditions derives from its inadequate supply capacity. It is essential to improve the finances under a long-term plan including strengthening supply capacity.

2) DPDC

In case of DPDC, an operating surplus has been secured in recent years as shown by its profit and loss statement below. We can conclude that there are no problems in general with its business operation each year. On the other hand, long-term liabilities account for nearly 30% on the balance sheet. This high ratio of liabilities stems from implementing power distribution-strengthening projects with loans. Overseas debts (development fund) account for 17% of the gross capital.

Table 18: Profit and loss statement of DPDC

(In 100 thousand taka)

	2006-07	**2007-08**
Operating income	**137,659**	**153,040**
Income from sales of electricity	136,003	151,509
Other income	1,656	1,531
	-	-
Operating expense	**131,133**	**145,081**
Power buying cost	114,806	121,772
Power distribution cost	11,028	14,809
General office work and maintenance expense	2,019	2,921
Depreciation	3,279	5,578
Operation profit	**6,526**	**7,959**
Non-operating income	3,333	4,003
Non-operating expense	4,062	3,899
	-	-
Current profit	**5,796**	**8,063**
Special profit	4,598	(191)
Net profit	**10,395**	**7,872**

Data source: DPDC

By integrating the above information, we conclude that DPDC has not yet made substantial changes from an organization financed by the government although it was incorporated into a limited company. The liabilities consist of a share of loans made by the government for the

most part, which will not have an immediate negative effect on sustainability in implementing projects, since the business is stable each year. We assess that in general, there are no problems.

2.5.2 Current status of Operation and Maintenance

(1) Rural Electrification Project

The operating conditions of current equipment are good and no problem has been reported. Because the demand has been growoing in Munshiganj PBS, the PBS considers that it will be necessary to construct a new transformer substation to maintain optimal operating conditions. Each PBS applies a merit-based personnel system, which is called Performance Target Agreement (PTA). It signs a contract each year on the targets concerning business operations with the REB, and business is operated according to the mechanism in which wages are adjusted according to the degree of performance. Recent PTA of both PBSs indicates that the targets have been maintained in general over the average of all PBSs although the main targets, including system loss and number of months for collecting receivables, have not been achieved. We evaluate, therefore, that there are no problems with performance.

PTAM indicators are composed of about 20 indicators such as system loss, collection rate of electricity charges, and conditions of maintenance. They are evaluated depending upon comprehensive performance. It is possible to procure watt-hour meters and almost all spare parts domestically, and the PBS headquarters carry them in its inventory.

(2) System Loss Reduction Pilot Scheme

1) BPDB

A yearly maintenance plan is formulated, in which frequency of maintenance is set for each item of operation (for instance, tree trimming twice a month, alignment of electric poles once a month, etc.). The maintenance records of each office indicate that maintenance has been carried out as planned. We see no problems.

2) DPDC

The working conditions of power distribution lines and transformers are good. There are no problems. It was confirmed that maintenance had been carried out as per the yearly

schedule and how it was carried out had been in accordance with the plan. It was found that nearly 20% of the watt-hour meters installed in the Kachijhulee and Shahebbazar feeders were defective initially. Also, a problem arose with many watt-hour meters within one year after installation. At present, they have been replaced with home-made mechanical watt-hour meters. A staff member of a business office believes that natural conditions such as being close to the ocean and moisture have affected the functions of the watt-hour meters.

Based on the above data, we evaluate the sustainability of this project comprehensively: as for the conditions of operation and maintenance at this point in time, there are no perceptible problems with the organization, techniques, or maintenance works of the executing agency. However, financial deterioration continues. If this continues further, there is a possibility that the financial situation may affect operation and maintenance works. Hence, though some problems have been observed in terms of financial condition of the executing agency, sustainability of this project is low.

3. Conclusion, Lessons Learned and Recommendations

3.1 Conclusion

(1) Rural Electrification Project

The electrification rate and the number of electrified households have markedly increased. Thus, we could confirm that the project had greatly contributed to improvements in the residents' socioeconomic conditions. The management capacity of the PBSs is generally high although it is faced with financial problems. The project's objective has been well achieved and it is also expected that the effect will be sustained in the future.

(2) System Loss Reduction Pilot Scheme

System loss has been reduced extensively in the target areas. The project's objective of developing efficient power distribution networks has been generally achieved. In addition, we evaluate that this scheme has fulfilled its role as a pilot project from the fact that power distribution network improvement projects have ensued subsequent to the measures taken by the scheme.

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

3.2 Lessons Learned

None

3.3 Recommendations

(1) Rural Electrification Project (for the executing agency)

The initial objective of rural electrification through establishing PBSs was satisfactorily achieved. However, there is concern that problems in the overall power sector may negatively affect the sustainability of the outcome of the project in the future. It will be necessary for the entire power sector to address the following issues.

1) Reduce the load shedding through securing power supply capacity by developing new power resources
2) Improve profitability through review of procurement costs (or power selling price), expansion of the number of connections by promoting the transfer of equipment owned by the BPDB, and securing of large consumers in industrial and commercial circles

(2) System Loss Reduction Pilot Scheme (for the executing agency)

The BPDB suffers chronic deficits, which leads to a hike in the wholesale power price and affects the finances of power distribution enterprises (the REB, for instance). In order to establish financial soundness of the whole sector, there is a need to build a framework for the proper sharing of costs as the entire power sector. It has been proven that the effectiveness of the pilot project is high. Its efficient management leads to improvement of finances. Hence, a similar measure should be vigorously taken in other regions as well.

Comparison of the Original and Actual Scope

Item	Original	Actual
1.Project Outputs		
(1) Rural Electrification Project		
1) Establishment of PBSs	Two PBSs	Established as planned
2) Munshiganj and Sunamganj		
3) Construction/rehabilitation of power distribution networks	Total: 3,981 km	Total: 3,473 km
4) Transformer substations	6 new substations	4 new substations
5) Number of electrified households	Total: 123,317 households	Total: 205,821 households
(2) System Loss Reduction Pilot Scheme		
1) Rehabilitation/expansion of power distribution networks	Total: 111 km	Total: 109.1 km
2) New installation or repair of pole-mounted transformers	Total: 188 sites	Total: 187 sites
3) Repair of incomers and meters	About 10,000 sites	20,118 sites
4) Construction of a new substation	One site	As planned
5) Consulting service	464 M/M	498 M/M
2.Project Period	July 1999 - March 2005 (69 months)	July 1999 - June 2005 (72 months)
3.Project Cost		
Foreign currency	4,593 million yen	¥4,213 million yen
Local currency	¥2,457 million yen (949,000,000 taka)	¥1,749 million yen (1,070,000,000 taka)
Total	¥7,050 million yen	¥5,962 million yen
Japanese ODA loan portion	¥4,376 million yen	¥4,003 million yen
Exchange rate	1 taka=¥2.59 (As of October 1998)	Rural Electrification Project 1 taka=¥2.01 (Average of Jan. 1999 - Dec. 2005) System Loss Reduction 1 taka=¥2.17 (Average of Jan. 1998 - Dec. 2003)