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Socio-Economic Impact of Rural Electrification Program (Rep) In Bangladesh and Study on Determination Of Electricity Distribution Cost Of Pabna Pbs-2

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ABSTRACT: *Age of rural electrification in Bangladesh is quit mature now. This is a story of how a cost effective electric energy supply has been changing everyday life style in about 90 percent areas of Bangladesh. It's a journey from darkness to light of conflict between desire and hope after the liberation war. Our study is on how electric energy supply more cost-effectively and with less of losses, which can be more safe and affordable to the rural. There are many factors which may have been contributing towards such change. Our study is a modest attempt to find any missing linkage in energy supply that could be more developed the supply.*
Keywords: *Rural Electrification, REP, BREB, PBS.*

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I. Introduction

We were aware during the course of our study and following discussions with representatives of the power division of the Department of Rural Electrification that there were no established techniques or methodology in this field of socio-economic research. Indeed, in view of uniqueness of the areas studied and the scarcity of suitable data, it is doubtful if any but a most general methodology could be established. Accordingly we describe in greater detail than might be normal, the concepts, definitions and difficulties encountered in our approach to the study in the expectations that such descriptions will be of use in future studies. We highlight a number of reform options and recommendations for industry and household energy use policies. Losses are important as there is an environmental and economic cost associated with them.

Palli Bidyut Samity is the Bengali name of a Rural Electric Society. It is a consumer owned entity organized on the basic principles of Co-operative for distribution of electric power to its members and other consumers. It is an independent corporate body subject to all applicable laws and prescribed Bye-Laws and is responsible for the efficient and effective management of its affairs including proper and successful construction, operation and maintenance of its electric distribution facilities as well as to take measures for effective use of electricity to foster rural development with special emphasis on increase of use of electric power for economic pursuits, such as development of agriculture and establishment of rural industries and assisting the disadvantaged sections of the community for augmenting their income and standard of living. As
per Bye-Laws, the PBS shall at all times be operated on No Loss-No Profit basis for the mutual benefit of all its Members and non-members alike and is expected to repay all indebtedness on schedule. As per REB ordinance -1977 (LI of 1977) the Rural Electrification Board is the registering authority of a PBS.

II. LITERATURE REVIEW

World economies are heavily reliant on energy. Energy shortage has become a global challenge. A developing country like Bangladesh needs an efficient energy system to minimize the losses and proper utilization of generated power. Rural energy and rural energy system is a very popular subject to researchers and planners. A vast literature is available on these fields. This paper provides a background to assist in understanding the different factors affecting energy consumption.

Herran and Nakata reported that the decentralized electrification using local resources can reduce regional disparity in rural and remote areas in terms of supply reliability and cost, as well as promote income generation [4]. Narayan and Singh reported that the relationship between energy consumption and economic growth is crucial for Fiji's development [5]. Akanksha and Kandpal reported that the challenges of providing electricity to rural households are manifold. Ever increasing demand–supply gap, crumbling electricity transmission and distribution infrastructure, high cost of delivered electricity are a few of these [6]. They also comments that energy is at the pivot of sustainable development of communities. This paper presents most of the focus is on households demand, but the few studies analyzing commercial and industrial demand are also reviewed.

Paul Cook noted that the relation between infrastructure and growth intuitively rural electrification is an important part of a country's infrastructure, although it has not always been the case that it has been given priority in a developing country's economic plans for infrastructure [7]. Cooke reviews the literature on the role and relation of infrastructure, particularly infrastructure in rural areas, to economic growth and development. Mulder and Tembe pointed that they analyze the dynamics of the relationship between electricity and socio-economic development by means of a cost–benefit analysis of a typical rural electrification project in Mozambique, assessing the impact of electricity on households, education, agro-business, commerce and the public sector [8].Houthakker pointed that it is economically impossible to store electricity in significant quantities. Since demand fluctuates sharply over time, this means that the capacity of each piece of capital equipment (power-stations, transmission lines, transformers, etc.) is determined by the highest demand which that particular piece of equipment is expected to have to meet at any given moment [9].D. Taylor emphasized that the major shortcoming in the econometric literature on the residential demand for electricity is the failure to deal adequately with decreasing block pricing [10].

Yohanis, Mondol, Wright and Norton reported that Domestic energy consumption depends on the location, design and construction of a dwelling, and the specification of heating systems and their controls together with the efficiency of appliances and the behavior and socio-demographical characteristics of occupants [11]. They also pointed that the electrical energy demand of a household can vary each hour of every day, weekdays and weekends, and for different months of the year. The adoption of energy saving measures is determined largely by income: a low-income consumer can invest only where the payback period is short; whereas a high-income consumer is able to accept longer Payback periods.

Energy demand has trend to increase while sources have long distances from loads. In distribution system, from generation, transmission and distribution have technical loss. Technical loss occurred at transmission lines, power transformer, feeder and terminal which it depend on current in lines. In addition it have loss which caused by wrong measurement and act under cover using, called non-technical loss. Navani, Sharma, Sapra reported that the term “distribution losses” refers to the difference between the amount of energy delivered to the distribution system and the amount of energy customers is billed. They also pointed that as total distribution system losses equals technical losses plus non-technical losses. The reasons cited for such high losses are; lack of adequate T & D capacity, too many transformation stages, improper load distribution and extensive rural electrification etc [12].

We highlight a number of reform options and recommendations for industry and household energy use policies. Losses are important as there is an environmental and economic cost associated with them. In this research, a methodology or a model based on System dynamic approach has been develop to make more energy available at affordable prices to enable all people to use modern energy to meet their basic needs. To slow overall growth of energy consumption through conservation and energy efficiency improvement and to make energy sources more environmentally sustainable.

III. BACKGROUND

Energy and environmental policies are being shaped at the national and international levels in response to a wide range of challenges. Rural Electrification Program (REP) in Bangladesh started its journey in 1978, primarily with the technical assistance of National Rural Electrification Cooperative Association (NRECA) of United States of America with an aim to provide the electricity outside the urban strata. The program is based on the concept of member-owned, Palli Bidyut Samity (PBS) similar to the rural electric cooperatives that exist in the United States. Seventy-eight PBSs have been organized to date in Bangladesh.

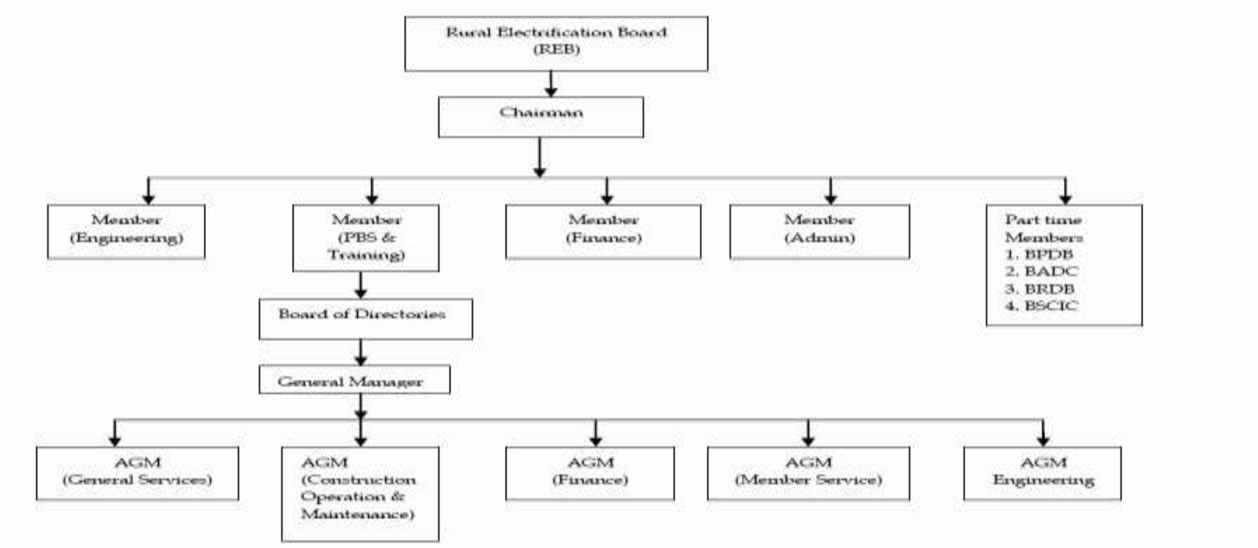
Development plans of Bangladesh has identified rural electrification as one of the major components of overall infrastructure, implementation of which, it is held, can accelerate the pace of economic growth, employment generation, alleviation of poverty and improve living standard. A well planned and organizational rural electrification program was however, not existed till 1970s. The electrification program as carried out by the Bangladesh Power Development Board (BPDB) was mainly limited to urban centers and at best to their peripheries. At that time, the Government of Bangladesh engaged two consulting firms of USA to carry out a comprehensive feasibility study on rural electrification in Bangladesh. The firms studied all related issues in depth and put forward recommendation towards a sustainable and viable rural electrification program. In addition to the new institutional framework, the study emphasized for Area Coverage and Co-operative concept. It is against this backdrop, Rural Electrification (REB) was created by the Government of Bangladesh (GOB) in late 1970's through REB ordinance LI of 1977. The Board is a statutory Government organization primarily responsible for implementing countrywide rural electrification. The Rural Electrification Board of Bangladesh has been providing service to rural member consumers for over 39 years. Continued support from the Government of Bangladesh, the donor community, consulting partners, and member consumers will help this program continue to expand, providing the gift of electricity to millions more Bangladeshi households, businesses, and industries.

Rural Electrification Board Act, 2013 has been established instead of Rural Electrification Board Ordinance, 1977 (Ordinance No. LI of 1977) and the name of Board is Bangladesh Rural Electrification Board, which was responsible for electrifying rural Bangladesh. Since its inception, the purpose of the program has been to use electricity as a means of creating opportunities for improving agricultural production and enhancing socio-economic development in rural areas, whereby there would be improvements in the standard of living and quality of life for the rural people. Today there are 77 operating rural electric cooperatives called Palli Bidyut Samity (PBS), which bring service to approximately 1,55,86,106 new connection being made and more than 3,14,692 km of line has been constructed[1].

Website	**www.reb.gov.bd**
Number of Approved Projects	**83**
Number of Approved PBSs	**77**
Number of PBSs organized	**77**
Number of PBSs electrified	**77**
Number of District included in RE program	**61**
Number of Upazillas included in RE program	**453**
Number of villages energized	**58,505**
Distribution Line constructed (Km)	**□ 3,14,692**
Number of 33/11KV Sub-station constructed	**757**
Average system loss (77 PBSs)	**12.48%**
Number of population in Program Area	**10,39,03,270**
Category wise connection -	
Domestic	**13,866,977**
Commercial	**1,106,381**
Char Inst.	**207,280**
Irrigation	**220,292**
General Power	**1,50,969**
Large Power	**4,969**
Street Light	**15,110**
Solar	**14,128**
Total	**15,586,106**

Table 1: Rural Electrification Board at a Glance (as on June' 2016)

REP aimed initially at electrification of irrigation pumps and tube-wells, agro-based industries and serving domestic and commercial loads of only those villages, which fall right alongside the electrical distribution facilities built for irrigation purposes. To date, electricity made available through PBS areas, is intended to use for all possible applications that serve the purpose of improved living conditions of rural populace.



The Organization and Function of BREB (Bangladesh Rural Electrification Board)

IV. SOCIAL AND ECONOMIC BENEFITS OF RURAL ELECTRIFICATION

- Allow activities to occur after daylight hours, including education. In impoverished and undeveloped areas, small amounts of electricity can save large amounts of human time and labor. In the poorest areas, people carry water and fuel by hand, their food storage may be limited, and their activity is limited to daylight hours.
- Reduce isolation through telecoms.
- Improve safety with the implementation of street lighting, lit road signs.
- Improve healthcare by electrifying remote rural clinics.
- Reduces the need for candles and kerosene lamps with their inherent fire safety risks and improves indoor air quality.
- Improve productivity, through the use of electricity for irrigation, crop processing, and other activities [3].

V. SOCIO-ECONOMIC IMPACT

5.1 Economic and Social Impact – Household Level

Economic and social impacts of rural electrification at the household level are multidimensional; both tangible and intangible. The multifaceted impacts and benefits are either direct or indirect. Rural area consume above 65 percent of supplied electricity in household level in 2015 [13]. The direct impacts are mostly economic, and reflected in enhanced income, and employment, and optimized expenditure pattern, surpluses, savings, and asset building. Most indirect impacts are related to the social and cultural aspects of life, which include, among others, such areas as education, health, women's status, modernization etc. These direct and indirect benefits together produce synergy in economic growth, poverty reduction, and human development.

5.2 Impact on Income

The average annual income of households with electricity is higher than that in the households of non-electrified villages. As compared to the non-electrified households, the electrified households show a higher income inequality but with higher income in the comparable groups. This means, the electrified households can be characterized as being relatively high income inequality with relatively high income.

Bangladesh Bureau of Statistics says, the average monthly household income in 2010 is estimated at Tk. 11,479 at the national level, Tk. 9,648 in rural area and Tk. 16,475 in urban area. In 2005, the same was Tk. 7,203 at the national level, Tk. 6,095 in rural area and Tk. 10,463 in urban area. Average nominal income increased by 59.38 percent at the national level, 58.27 percent in rural area and by 57.48 percent in urban area in 2010 relative to 2005. Real incomes grew by 15 percent at the national level, 13 percent in rural areas and 14 percent in urban areas. Such increases over a five year period are indeed small and this primarily reflects significant under-reporting of income. [14]

5.3 Impact on Employment

Electricity generates employment. The impact on employment was both direct and indirect. In agriculture, women in the electrified compared to those in the non-electrified households are involved more in household level income-generation activities and depict better re-allocation of time for remunerative employment; unemployment rate is relatively low in the electrified households; and relatively higher share of non-agricultural employment in the electrified households indicates modernization effect of electricity on occupation. On the top of all these, there has been an enormous spill-over effect of rural electrification on employment in various support-services.

5.4 Impact on Education

Compared to the non-electrified households, the overall literacy rates for both male and female in the electrified were significantly higher, especially due to the household's access to electricity which has contributed much both in economic terms as well as in raising awareness about value of education. The rich-poor divide in literacy was also less pronounced in the electrified than that in the non-electrified households.

The quality of education measured in terms of household expenditure on education, marks (grades) obtained in the last final examinations, school drop-outs, school attendance rate, and time spent for study by students at night – all found much improved in the electrified than in the non-electrified household. Electricity matters in improving the quality of education. This quality improvement in the electrified households works through vary many channels: more time available for study after the sunset, the quality of that time due to sufficient light and fan for comfort, strengthening the knowledge-based due to access to TV (which in turn increases the appetite for learning), parents (especially mothers/other elder female members) devote more time in assisting children's education compared to before electricity etc.

According to Bangladesh Bureau of Statistic, literacy rate of population over stands at 57.91 percent at national level, compared with 51.9 percent in 2005. In rural area, literacy rate in 2010 was 53.37 percent, compared with 46.7 percent in 2005. Literacy rate was in urban area 70.38 percent in 2010, compared with 67.6 percent in 2005. In 2010, enrolment rate of children aged 6-10 years for both sexes at the national level was 84.75 percent, compared with 80.38 percent in 2005. The enrolment rate for girls is higher than that of the boys in both rural and urban areas. Total literacy rate in 2015 was 63.6 percent. [15]

5.5 Impact on Gender Dimensions: Women's Empowerment, Changing Status and Modernization Effects

Electrification has contributed to the positive development on women's socio-economic status. Electricity has left a profound impact on women's mobility, decision-making, freedom in using income and savings, better utilization of credit, knowledge about gender inequality issues, household work plan according to convenience, changes in attitude in terms of reducing healthcare disparities, increase in overall years of schooling for both boys and girls, preference to send girls to schools, awareness of legal issues (as for example, marriage for girls at 18 and boys at 21), and awareness about negative impact of dowry.

Although, women in the non-electrified villages are working inside and outside home, they have less control over utilization of their earnings, decision-making; and their level of awareness of fundamental rights is low. One of the significant facts that emerged is that if electricity is provided to them these women can benefit substantially with more power or status.

Electricity enables all members in electrified households to avail more time after sunset, in comparison with those in EV and NEV. The daily average time from sunset to sleeping is higher for all categories of household members. Socio-cultural development is the most prominent activity after sunset for household of their electrification status. Watching TV/listening radio is the major activity for senior members both male and female in HE followed by socialization. Business, emerging as the most prominent activity signifies increased economic activities in the region as has been reflected with higher time spent by EV in comparison with NEV. Electricity plays the role of a catalyst in having a quality education both by extended time period and by creating comfortable environment through electrical appliances. For landless electrified household, longer study hours for students and more time spent for socio-cultural development by the female household heads, acted as a catalyst for reducing human poverty. Higher allocation of time by the male household heads, the principal earner of the family in most cases, can contribute in reducing income poverty in an indirect fashion. The interplay of all those, actually create the environment for new opportunities to overcome the hardship of poverty.

Providing electricity at the household level is crucial to ensure better standard of living as the effective use of time shapes up the life style for each individual concerned. Given the study results, the better use of additional time attributed to electricity, has facilitated the electrified household members to explore new range of activities as well as extended time period for the old ones. Comparing the pre and post electrification time allocation pattern for electrified household members, the study results revealed increased time allocation for activities like income generating activities or watching TV, which address income as well as human poverty. In the electrified household, reduced household chore for female members and reduced gender gap in terms of daily average time for studying is clearly indicative of improved gender status.

Thus, it can be recommended that to ensure better use of time after sunset by efficient allocation across different activities, it will be important to provide electricity at the household level. Electricity available at the household level should be a priority from the perspective of poverty reduction and women empowerment too, as the study revealed improved gender status in HE in the post - electrification period. Dominant spillover effect reported by higher difference in terms of time allocation between HE and WE-NEV, also rationalize the provision of electricity at the community level to ensure environment conducive to economic growth and higher standard of living.

5.6 Impact on Direct Users of Domestic Electricity: Problems of Supply Interruptions

Changes in habits mediated through electricity have taken place. The pattern of favorable changes in habit and in leisure activities have direct positive impact in improving the quality of life and changing mind -set of people towards better life. This can be denoted as electricity-driven demand creation for improved standard of living.

Irregularity of power supply and load shedding are acute problems in REP. Irregular power supply mostly takes place in the summer and the 6-10 PM is the time of most irregular supply. These findings are sufficient enough to raise the question of quality of electricity supply through REP in the PBSs. The policy implications are straight forward: regularity in power supply needs to be ensured (or frequency of irregularity needs to be minimized); power supply during prime time, 6-10 PM should be made regular; and all mitigation efforts should be directed to address the problem of irregular supply during the summer season. It is most likely that more generation of is the most important route to resolve the issue of irregular power supply, because of the increasing population size and increasing demand for electricity in the rural households.

5.7 Impact on Irrigation and Agriculture Production

In agriculture, REP has contributed significantly in attaining food self-sufficiency through use of productive and efficient irrigation equipment, and generated stable employment opportunities. Electrified irrigation equipment in general is more dependable compared to diesel operated. Both operational cost and energy cost of electrified equipment on average three-fourths as compared to those of diesel operated ones. Electrified irrigation equipment creates employment for two persons for almost half of the year and with the electrification of irrigation equipment more than one hundred thousand additional employments have been created throughout the year in rural areas of the country. As land use intensity and cropping intensity through electrified equipment is higher and cost of operation of the same is lower (including breakdown and associated problems) in comparison with diesel equipment, electrified irrigation has got distinct advantages over other types of irrigation. Electric equipment works with about 0 percent pollution. It’s more clean and safe than diesel equipment.

As the contribution of electricity is evidentially clear in the agriculture sector of Bangladesh, therefore, more generation of electricity, on the one hand, and better distribution of the same, on the other, is recommended. The REB needs to entertain its initial mission of connecting all irrigation pumps and think its mission/goal about engaging itself into generation of electricity too.

5.8 Social Impact of Mass Media

With all the fluctuations in the movement of households, industrial and irrigational electrified area from one asset group to another, as compared to the non-electrified area, the electrified area have shown a much progressive trend in their economic strengths measured through upward movement of the people asset situation.

VI. OVERVIEW OF PABNA PBS 2

Since its inception in 1983, Pabna PBS-2 is playing a vital role in agriculture, industrial and socio-economic development of Pabna district. The Rural Electrification program conducted by Pabna PBS-2 has acted a leap-forward in the development of socio-economic structure of rural areas in Pabna district as well as entire Bangladesh. It has significant and sustained impact on life style, growth of business and commercial activities in rural areas. It is a consumer owned entity organized on basis of principles of co-operative for distribution of electric power to its member and operates on “NO Loss – No Profit” basis for the mutual benefits of all its members.

Here some information of Pabna PBS-2 up to Jun 2016:

WEBSITE	www.pabnapbs2.org.bd
DATE OF REGISTRATION	09-05-1980
DATE OF ENERGIZATION	06-01-1983
AREA	1204 Sq. Km

NO. OF UPAZILA	07
NO. OF UNION	38
NO. OF ZONAL OFFICE	04
NO. OF AREA OFFICE	00
NO. OF COMPLAIN CENTRE	09
NO. OF CONTROL ROOM	01
NO. OF VILLAGE	812
NO. OF VILLAGE ELECTRIFIED	791
% OF VILLAGE ELECTRIFIED	97.13%
LINE CONSTRUCTION REQUIRED FOR TOTAL ELECTRIFICATION	N/A.
TOTAL LINE CONSTRUCTED	4324.745 Km.*
TOTAL CONSUMER CONNECTED	224977
CATEGORY WISE CONNECTIONS	
(i) DOMESTIC	194775
(ii) COMMERCIAL	12995
(iii) CHARITABLE INSTITUTION	2172
(iv) IRRIGATION	2080
(v) INDUSTRY	2063
(vi) STREET LIGHT	214
NO. OF CONSUMERS PER Km.	52*
REVENUE PER Km. (TK.)	6.77 Lac*
IMPROVEMENT OF POWER FACTOR	0.95
NO. OF SUB-STATION (33/11 KV) Active	7
MAXIMUM DEMAND	44 MW
AVERAGE REVENUE (PER UNIT)	TK. 5.13*
AVERAGE COST (PER UNIT)	Tk. 8.29*
OPERATING MARGIN (Jul,15 to Jun,16)	(TK. 283656308.23)
NET MARGIN (Jul,15 to Jun, 16)	(TK. 279948808.23)
SYSTEM LOSS (as per Billing Meter)	
THIS MONTH (JUN, 16)	26.02 %
YEAR TO DATE (2015-16)	17.13 %
COLLECTION	
THIS MONTH (JUN, 16)	97.90%
YEAR TO DATE(Up to JUN,16)	85.26%

Table 2: PABNA PBS-2 (2015-16) at a Glance

Now we can easily get information about get a new connection, billing and tariff rate or about PBS form the individual website of each PBS[2].

6.1 Methodology

We were aware during the course of our study and following discussions with representatives of the power division of the Department of Rural Electrification that there were no established techniques or methodology in this field of socio-economic research. Indeed, in view of uniqueness of the areas studied and the scarcity of suitable data, it is doubtful if any but a most general methodology could be established. Accordingly we describe in greater detail than might be normal, the concepts, definitions and difficulties encountered in our approach to the study in the expectations that such descriptions will be of use in future studies. We highlight a number of reform options and recommendations for industry and household energy use policies. Losses are important as there is an environmental and economic cost associated with them.

In this research, a methodology or a model based on System dynamic approach has been develop to make more energy available at affordable prices to enable all people to use modern energy to meet their basic needs. To slow overall growth of energy consumption through conservation and energy efficiency improvement and to make energy sources more environmentally sustainable.

Today BREB have 78 operating rural electric cooperatives called Palli Bidyut Samity (PBS).For research, we choose the Pabna PBS-2 which is establish nearest my home town. We collected some primary data from Pabna PBS-2, BREB and BERC.

6.2 Objective

The scope of this study is the analysis of the costs that are associated with the power transfer as well as the realization of new methods and tools concerning the calculation and the allocation of these costs. The power distribution costs, which are charged to the market participants, are a central issue of the new cosmos of electricity markets. The increased requirement for fair and transparent pricing in the competitive environment as well as the complexity introduced by unbundling the services point out why this issue is of great importance. In general, the cost associated with the distributed power may be categorized as follows:

- Cost associated with the power losses.
- Cost caused by system congestion.
- Fixed cost of the power system.

6.3 Pabna PBS-2 Imports from BPDB

Pabna PBS-2 imports electricity only from government sector to meet their consumer demand, Pabna PBS-2 imports electricity from two Public sectors i.e. Pabna Grid and Sahazadpur Grid under PDB.PABNA PBS-2 does not import energy from any others to provide electricity to the different level of consumers. In this chapter we discuss about Energy Purchase and purchase cost from Public and private sector for one year (2015-2016), also explain about different grid capacity, supply and peak demand, system loss, KWh sold to the consumers. In July 2015, PABNA PBS-2 import 19876972 KWh units, where 11880126 units from Pabna grid which is 56.87% of total unit import for this month, 9011558 units from Shahazadpur grid which is 43.13% of total unit. As per statistics both grids provide electricity to PABNA PBS-2.

Import point	July				August			
	Peak Demand	KWh Purchase	Total KWh (Sold)	SL %	Peak Demand	KWh Purchase	Total KWh (Sold)	SL %
Shahazadpur Grid	22MW	9,011,558	14,682,658	29.72	22 MW	9,342,893	17,212,692	22.74
Pabna Grid	30 MW	11,880,126			30 MW	12,935,108		
Total	**52 MW**	**20,891,684**	**14,682,658**		**52MW**	**22,278,001**	**17,212,692**	

Import point	September				October			
	Peak Demand	KWh Purchase	Total KWh (Sold)	SL %	Peak Demand	KWh Purchase	Total KWh (Sold)	SL %
Shahazadpur Grid	22 MW	9,835,107	18,578,621	16.22	22 MW	9,252,986	18,991,115	9.00
Pabna Grid	31.5 MW	12,341,351			30 MW	11,616,023		
Total	**53.5MW**	**22,176,458**	**18,578,621**		**52 MW**	**20,869,009**	**18,991,115**	

Import point	January				February			
	Peak Demand	KWh Purchase	Total KWh (Sold)	SL %	Peak Demand	KWh Purchase	Total KWh (Sold)	SL %
Shahazadpur Grid	20 MW	7,802,425	13,457,910	12.30	21 MW	8,349,536	13,543,474	15.99
Pabna Grid	18 MW	7,542,432			20 MW	7,772,110		
Total	38MW	15,344,857	13,457,910		41MW	16,121,646	13,543,474	

Import point	November				December			
	Peak Demand	KWh Purchase	Total KWh (Sold)	SL %	Peak Demand	KWh Purchase	Total KWh (Sold)	SL %
Shahazadpur Grid	22 MW	6,739,385	14,898,008	3.03	19.5 MW	7,506,763	13,426,652	12.36
Pabna Grid	31.5 MW	8,624,226			18.5 MW	7,813,790		
Total	53.5 MW	15,363,611	14,898,008		38.0 MW	15,320,553	13,426,652	

Import point	May				June			
	Peak Demand	KWh Purchase	Total KWh (Sold)	SL %	Peak Demand	KWh Purchase	Total KWh (Sold)	SL %
Shahazadpur Grid	25 MW	10,363,123	17,457,841	14.17	25 MW	12,947,832	18,603,269	26.38
Pabna Grid	25 MW	9,976,788			25 MW	12,319,776		
Total	50 MW	20,339,911	17,457,841		50 MW	25,267,608	18,603,269	

Import point	March				April			
	Peak Demand	KWh Purchase	Total KWh (Sold)	SL %	Peak Demand	KWh Purchase	Total KWh (Sold)	SL %
Shahazadpur Grid	25 MW	9,552,069	15,252,148	15.64	25 MW	11,054,736	17,119,410	19.31
Pabna Grid	23.5 MW	8,528,328			25 MW	10,161,211		
Total	48.5 MW	18,080,397	15,252,148		50 MW	21,215,947	17,119,410	

Table 3: Energy Import of PABNA PBS-2, 2015-16

In February 2016, PABNA PBS-2 import 1621646 units, where 7772110 units from Pabna grid which is 48.21 % of total unit import for this month, 8349536 units from Shahazadpur grid which is 51.79 % of total unit import for this month.

The rest of the month energy import analysis showed in the Table:4. The demand of the electricity varies with different season in Bangladesh, like as winter, summer, and rainy season. We try to show relevant analysis for winter and summer seasons. In June 2016, the energy import is 24977711units, which is high import from previous months and system loss is also comparatively high and it's an effect of summer season because in the summer, energy consumption of different consumer is high, especially for domestic side. Same as at September, 2015 the energy import is 99995867 units which is also quite high. On the other hand, the energy import for the month of November, December, January and February are low to compare as other months of the year. It is seasonal effect of winter when the domestic consumer consume lower amount of electricity and same as some industries are consume lower amount of energy as per demand of production. In December 2015, the energy import is 69081906 units, which is low import from previous month and November 2015 and January 2016, the energy import quit same and the system loss is very low during the year 2015-2016.

Again the energy import demand is high for the month of March, April, May and June 2016. For June 2016, energy import is 113934171 units which highest amount of import for the year and the system loss is also comparatively high 6.574 MU. As per statistics, only grid provides electricity to PABNA PBS-2.

Total Import energy purchase cost of PABNA PBS-2 is 1041151825 taka and gives 2% surcharge to BPDB with their energy purchase cost as purchase cost.

Also we present energy import scenario in this chapter by showing graphical figure.

Fig 1: Month wise Energy Import (MU) of PPBS-2

From graphical representation of above figure, the energy import is high in July, October 2015 and April, May, June 2016. On the other hand, energy import is comparatively low in November, December 2015 and January, February 2016. Season to season the energy import and supply to the consumer may vary.

6.4 Substations of PABNA PBS-2

There are 7 substations under PABNA PBS-2 which are connected with different grids. The energy storage and consumption different form one substation to another substation based on the location, consumer demand, industrial zone, transmission distance and many factors. The imported energy may reduce during the transmission process due to system loss. PABNA PBS-2 all substation names with their capacity listed below and the proposed are indicated with star (*) sign.

1. Pabna-1*, 5MVA
2. Sujanagar, 10 MVA
3. Bera-2 (Masumdia), 10 MVA
4. Kashinathpur, 15 MVA
5. Bera-1*, 10 MVA
6. Bhaghabari, 10 MVA
7. Shanthia, 15 MVA

6.5 System Losses

Month	Grid Wise Import (MKWh)	Substation Wise Import (MKWh)	Unit Sold at Consumer End (MKWh)	33 KV Line Loss (MKWh)	Sub-station System Loss (MKWh)	Total System Loss (MKWh)
July	20.892	19.877	14.683	1.015	5.194	6.209
August	22.278	19.845	17.213	2.433	2.632	5.065
September	22.176	21.779	18.579	0.398	3.200	3.598
October	20.869	20.618	18.991	0.251	1.627	1.878
November	15.364	15.327	14.989	0.037	0.338	0.375
December	15.321	15.223	13.427	0.097	1.797	1.894
January	15.345	14.786	13.458	0.559	1.328	1.887
February	16.122	15.830	13.543	0.292	2.286	2.578
March	18.080	17.632	15.252	0.448	2.380	2.828
April	21.216	20.457	17.119	0.759	3.337	4.097
May	20.340	19.735	17.458	0.605	2.277	2.882
June	25.268	24.978	18.693	0.290	6.284	6.574

Table 4: System Loss of PABNA PBS-2 in 2015-16

In Table 4,
Total System Loss= Grid to sold energy at Consumer end.
Sub-station System Loss= Substation to Sold energy at Consumer end.
33 KV Line Loss= Energy loss between Grid and Sub-station.

As we found from the Table 4, Total loss of energy in summer is much higher than winter. Heat increases the line resistance and resistance makes the amount of loss higher. 33 KV Line losses are quite similar but sub-station system losses differ huge. Where form October, 2015 to January, 2016; during winter season, system losses were below than 2 MKWh. In July 2015 and June 2016; both of these in summer, we found the total system loss about 3 times higher than winter. PBS says illegal use of electricity is also responsible for this. Illegal use of electricity rise in summer very badly. That's why; loss is much higher in summer. PBS try to stop illegal use of electricity but public awareness can stop this "Thief Loss". PBS also has some loss for storms during summer and rainy season.

We know that there are certain losses which affect the economy of the power system. It is a well-known fact that all energy supplied to a distribution utility does not reach the end consumer. A substantial amount of energy is lost in the distribution system by way of Technical and Non-Technical losses. The distribution system accounts for highest technical and non-technical losses in the power sector. In Bangladesh, the percentage of transmission and distribution losses has been quite high. Distribution line losses are comprised of two types: Technical losses and Non-Technical losses.

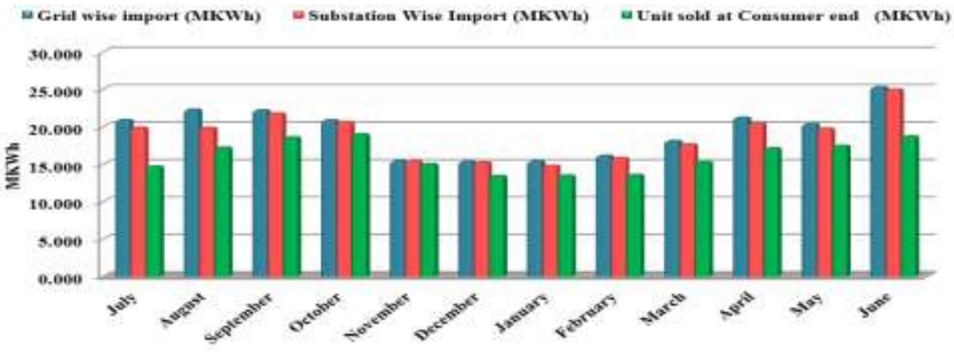


Fig 2: Grid and Sub-station wise import with Unit sold at consumer end

6.6 Technical Losses

The technical losses are due to energy dissipated in the conductors, equipment used for transmission line, transformer, sub transmission line and distribution line and magnetic losses in transformers.

6.7 Non-Technical Losses

Non-Technical losses are more difficult to measure because these losses are often unaccounted by the system operators and thus have no recorded information. For example, if a monthly-read meter is read incorrectly such that the consumption is one month is too low, when the meter is read correctly next month, there will be additional KWh recorded. The missing KWh will initially appear to be losses of electricity.

6.8 Load Factor

Load factor is defined as the average load divided by the peak load in a specified time period. It is a measure of variability of consumption or generation; a low load factor indicates that load is highly variable, whereas consumers or generators with steady consumption or supply will have a high load factor. Its value is always less than one because maximum demand is always higher than average demand, since facilities likely never operate at full capacity for the duration of an entire 24-hour day or a month.

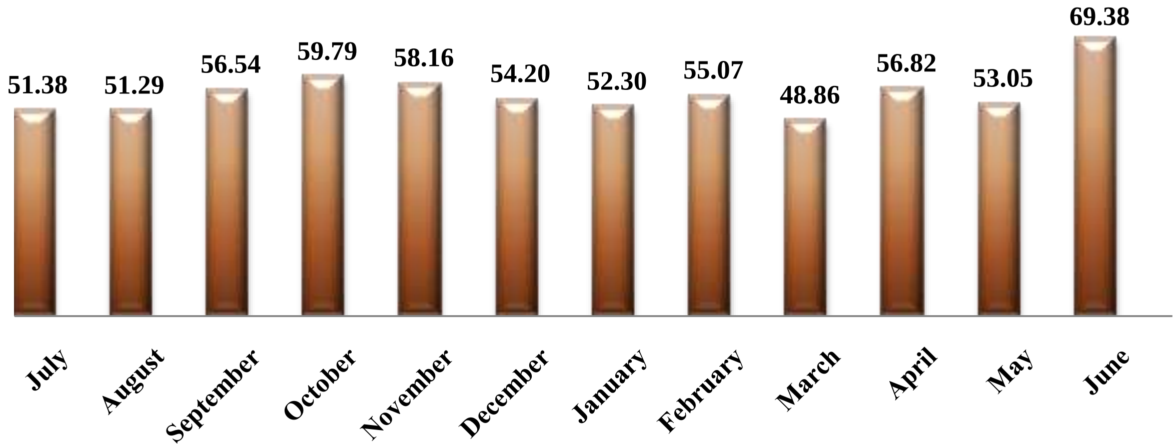


Fig 3: Month wise Load Factor of PPBS-2, 2015-16

Load factor graph of PABNA PBS-2 shows that, Peak Demand is quite vary over the year. PBS should take necessary steps to reduce sudden peak values and Electrical Rates are designed so that customers with high load factor are charged less overall per KWh.

6. 9 Consumers Analysis

In making of revenue sheet we use Electricity rate, used electricity in KWh, Consumer class, and revenue in monthly and finally we calculate it in yearly. In analysis part we want to show that rate changing of electricity, Number of consumer and its increment or decrement in monthly, used electricity in KWh and its monthly status and revenue increment or decrement in monthly. From these analysis we will see that the present condition of the revenue of BREB.

If we look at July-2015, Domestic consumer consumed total 10871108 units, Number of total consumer 131723and total revenue 49113888 TK where minimum slab was 130765 units.

Customer Class	July							August						
	Rate	Unit	%	Revenue	%	Consumers	%	Rate	Unit	%	Revenue	%	Consumers	%
Domestic														
Minimum		130765	0.89	741870	0.89	8243	6.26		85367	0.50	482400	0.51	5360	3.98
1-50	3.82	4902469	33.43	21138057	25.39	96425	73.20	3.82	3027858	17.60	13144943	13.90	63141	46.89
1-75	3.87	2884715	19.67	11746172	14.11	23293	17.68	3.87	4941100	28.72	20603081	21.79	59241	43.99
76-200	5.01	1790918	12.21	9000374	10.81	1175	0.89	5.01	2825978	16.43	14220725	15.04	2503	1.86
201-300	5.19	782985	5.34	4091803	4.92	1249	0.95	5.19	1334063	7.75	6988712	7.39	2597	1.93
301-400	5.42	300785	2.05	1661955	2.00	1268	0.96	5.42	391359	2.27	2156091	2.28	1397	1.04
401-600	8.51	34373	0.23	294764	0.35	30	0.02	8.51	25375	0.15	225641	0.24	388	0.29
600++	9.93	44098	0.30	438893	0.53	40	0.03	9.93	11704	0.07	117121	0.12	36	0.03
Total	*41.75*	*10871108*	*74.12*	*49113888*	*59.00*	*131723*	*100%*	*41.75*	*12642804*	*73.49*	*57938714*	*61.27*	*134663*	*100%*
Commercial	9.58	1640245	11.18	16365254	19.66	14043		9.58	1829681	10.64	18191361	19.24	14499	
Charitable Inst.	4.98	177441	1.21	972004	1.17	2335		4.98	202370	1.18	1094392	1.16	2365	
Irrigation	3.8	144760	0.99	596912	0.72	1463		3.8	355890	2.07	2054619	2.17	1429	
General Power	7.42	1427379	9.73	11389965	13.68	1697		7.42	1288540	7.49	10207796	10.79	1653	
Large Power	7.32	402270	2.74	4782501	5.75	1		7.32	880062	5.12	5050059	5.34	50	
33KV	0	0	0.00	0	0.00	0		0	0	0.00	0	0.00	0	
Street Light	0	3390	0.02	24982	0.03	68		0	3390	0.02	24982	0.03	68	
Grand Total	*74.85*	*14666593*	*100%*	*83245506*	*100%*	*151330*		*74.85*	*17202737*	*100%*	*94561923*	*100%*	*154727*	

Customer Class	September							October						
	Rate	Unit	%	Revenue	%	Consumers	%	Rate	Unit	%	Revenue	%	Consumers	%
Domestic														
Minimum		57705	0.31	431190	0.41	4791	3.50	0	79200	0.42	445500	0.41	4950	3.54
1-50	3.82	3450401	18.58	14896532	14.18	68640	50.17	3.82	5138050	27.07	22180376	20.65	102121	73.02
1-75	3.87	4396150	23.68	18476326	17.59	58529	42.78	3.8	3753259	19.78	14924934	13.90	26502	18.95
76-200	5.01	4506101	24.27	22675741	21.58	4007	2.93	5.14	3820900	20.13	19716126	18.36	3068	2.19
201-300	5.19	892050	4.80	4645815	4.42	643	0.47	5.36	1086797	5.73	5898532	5.49	2932	2.10
301-400	5.42	474182	2.55	2574616	2.45	182	0.13	5.63	43376	0.23	248582	0.23	175	0.13
401-600	8.51	18487	0.10	157824	0.15	20	0.01	8.7	11763	0.06	104388	0.10	82	0.06
600++	9.93	5511	0.03	54999	0.05	11	0.01	9.98	1830	0.01	18688	0.02	17	0.01
Total	*41.75*	*13800587*	*74.33*	*63913043*	*60.83*	*136823*	*100%*	*42.43*	*13935175*	*73.42*	*63537126*	*59.16*	*139847*	*100%*
Commercial	9.58	2175252	11.72	21536314	20.50	15214		9.8	2162948	11.40	22587471	21.03	15631	
Charitable Inst.	4.98	233235	1.26	1248518	1.19	2392		5.22	210766	1.11	1243854	1.16	2406	
Irrigation	3.8	293984	1.58	1713358	1.63	1413		3.82	298131	1.57	1182685	1.10	1414	
General Power	7.42	1248979	6.73	10202677	9.71	1660		7.66	1263237	6.66	10329766	9.62	1663	
Large Power	7.32	812144	4.37	6426799	6.12	51		7.57	1106086	5.83	8484233	7.90	51	
33KV	0	0	0.00	0	0.00	0		0	0	0.00	0	0.00	0	
Street Light	0	3390	0.02	25012	0.02	68		0	3390	0.02	25701	0.02	68	
Grand Total	*74.85*	*18567571*	*100%*	*105065721*	*100%*	*157621*		*76.5*	*18979733*	*100%*	*107390836*	*100%*	*161080*	

Customer Class	November							December						
	Rate	Unit	%	Revenue	%	Consumers	%	Rate	Unit	%	Revenue	%	Consumers	%
Domestic														
Minimum	0	179476	1.21	995760	1.16	11064	7.82	0	305857	2.28	1632870	2.02	18143	12.57
1-50	3.82	3133418	21.04	13527257	15.70	62304	44.03	3.82	3494981	26.05	15087801	18.65	69479	48.12
1-75	3.8	4038178	27.12	16695776	19.37	54028	38.18	3.8	2699100	20.12	11158055	13.79	36059	24.98
76-200	5.14	3050680	20.49	16017520	18.59	13481	9.53	5.14	2003000	14.93	10563095	13.06	10707	7.42
201-300	5.36	204873	1.38	1111394	1.29	531	0.38	5.36	71000	0.53	556935	0.69	7055	4.89
301-400	5.63	20194	0.14	114867	0.13	47	0.03	5.63	19000	0.14	178120	0.22	2846	1.97
401-600	8.7	5250	0.04	46575	0.05	36	0.03	8.7	200	0.00	3615	0.00	75	0.05
600++	9.98	1059	0.01	10744	0.01	7	0.00	9.98	200	0.00	2346	0.00	14	0.01
Total	*42.43*	*10633128*	*71.41*	*48519893*	*56.30*	*141498*	*100%*	*42.43*	*8593338*	*64.04*	*39182837*	*48.44*	*144378*	*100%*
Commercial	9.8	2013043	13.52	20425239	23.70	15742		9.8	1902050	14.18	19397750	23.98	16472	
Charitable Inst.	5.22	167773	1.13	967117	1.12	2424		5.22	111562	0.83	690179	0.85	2443	
Irrigation	3.82	151100	1.01	628226	0.73	1368		3.82	142824	1.06	589731	0.73	1367	
General Power	7.66	1092372	7.34	8979355	10.42	1666		7.66	1386104	10.33	11267043	13.93	1662	
Large Power	7.57	828497	5.56	6630367	7.69	53		7.57	1278993	9.53	9736592	12.04	53	
33KV	0	0	0.00	0	0.00	0		0	0	0.00	0	0.00	0	
Street Light	0	3390	0.02	25356	0.03	68		0	2940	0.02	21976	0.03	51	
Grand Total	*76.5*	*14889303*	*100%*	*86175553*	*100%*	*162819*		*76.5*	*13417811*	*100%*	*80886108*	*100%*	*166426*	

Customer Class	January							February						
	Rate	Unit	%	Revenue	%	Consumers	%	Rate	Unit	%	Revenue	%	Consumers	%
Domestic														
Minimum	0	299111	2.22	1924740	2.36	21386	14.52	0	320276	2.37	2141100	2.68	23790	15.80
1-50	3.82	3202624	23.81	14001924	17.17	70716	48.00	3.82	3395362	25.09	14687308	18.38	68681	45.62
1-75	3.8	2785430	20.71	11638434	14.27	42152	28.61	3.8	2985418	22.06	12369338	15.48	40990	27.23
76-200	5.14	1768901	13.15	9388251	11.51	11844	8.04	5.14	1144371	8.46	6125667	7.67	9744	6.47
201-300	5.36	278660	2.07	1520868	1.87	1090	0.74	5.36	123033	0.91	839207	1.05	7190	4.78
301-400	5.63	26127	0.19	149095	0.18	80	0.05	5.63	12200	0.09	70861	0.09	87	0.06
401-600	8.7	20319	0.15	177875	0.22	44	0.03	8.7	1000	0.01	10325	0.01	65	0.04
600++	9.98	7342	0.05	73573	0.09	12	0.01	9.98	495	0.00	5065	0.01	5	0.00
Total	*42.43*	*8388514*	*62.37*	*38874760*	*47.68*	*147324*	*100%*	*42.43*	*7982155*	*58.98*	*36248871*	*45.37*	*150552*	*100%*
Commercial	9.8	1884971	14.02	19239421	23.60	16473		9.8	1814245	13.40	18624983	23.31	16537	
Charitable Inst.	5.22	103273	0.77	655073	0.80	2428		5.22	107685	0.80	677381	0.85	2487	
Irrigation	3.82	435053	3.23	1726327	2.12	1763		3.82	1133579	8.38	4363548	5.46	1423	
General Power	7.66	1304960	9.70	10655172	13.07	1659		7.66	1282806	9.48	10479920	13.12	1672	
Large Power	7.57	1329619	9.89	10363715	12.71	52		7.57	1211264	8.95	9480576	11.87	52	
33KV	0	0	0.00	0	0.00	0		0	0	0.00	0	0.00	0	
Street Light	0	2820	0.02	21948	0.03	52		0	2820	0.02	21948	0.03	52	
Grand Total	*76.5*	*13449210*	*100%*	*81536416*	*100%*	*169751*		*76.5*	*13534554*	*100%*	*79897227*	*100%*	*172775*	

Customer Class	March							April						
	Rate	Unit	%	Revenue	%	Consumers	%	Rate	Unit	%	Revenue	%	Consumers	%
Domestic														
Minimum	0	325938	2.14	2009880	2.24	22332	14.51	0	288727	1.69	1590750	1.61	17675	11.18
1-50	3.82	3706829	24.32	16027637	17.82	74702	48.52	3.82	3662325	21.41	15850482	16.04	74416	47.09
1-75	3.8	2811623	18.45	11629867	12.93	37828	24.57	3.8	3760339	21.98	15537238	15.72	49918	31.59
76-200	5.14	1961070	12.87	10517525	11.70	17505	11.37	5.14	2408884	14.08	12690264	12.84	12344	7.81
201-300	5.36	204654	1.34	1125770	1.25	1153	0.75	5.36	796077	4.65	4340448	4.39	2939	1.86
301-400	5.63	29185	0.19	172387	0.19	323	0.21	5.63	32702	0.19	200612	0.20	660	0.42
401-600	8.7	9186	0.06	82243	0.09	93	0.06	8.7	7215	0.04	64696	0.07	77	0.05
600++	9.98	5486	0.04	55125	0.06	15	0.01	9.98	3771	0.02	37760	0.04	5	0.00
Total	*42.43*	*9053971*	*59.40*	*41620434*	*46.28*	*153951*	*100%*	*42.43*	*10960040*	*64.06*	*50312250*	*50.91*	*158034*	*100%*
Commercial	9.8	1980303	12.99	20355176	22.64	16710		9.8	2188524	12.79	22440964	22.71	16946	
Charitable Inst.	5.22	154892	1.02	910721	1.01	2512		5.22	198162	1.16	1130745	1.14	2525	
Irrigation	3.82	1253755	8.23	4825156	5.37	1852		3.82	1225132	7.16	4727442	4.78	1851	
General Power	7.66	1434289	9.41	11637526	12.94	1672		7.66	1294333	7.57	10559883	10.69	1657	
Large Power	7.57	1362623	8.94	10555367	11.74	51		7.57	1239474	7.24	9633127	9.75	51	
33KV	0	0	0.00	0	0.00	0		0	0	0.00	0	0.00	0	
Street Light	0	2820	0.02	21948	0.02	52		0	2580	0.02	21948	0.02	52	
Grand Total	*76.5*	*15242653*	*100%*	*89926328*	*100%*	*176800*		*76.5*	*17108245*	*100%*	*98826359*	*100%*	*181116*	

Customer Class	May							June						
	Rate	Unit	%	Revenue	%	Consumers	%	Rate	Unit	%	Revenue	%	Consumers	%
Domestic														
Minimum	0	158661	0.91	1351365	1.24	15015	9.28	0	215186	0.95	1001595	1.00	11129	6.77
1-50	3.82	1974412	11.32	8989379	8.28	57885	35.79	3.82	1662023	7.33	6941102	6.90	57947	35.26
1-75	3.8	1829580	10.49	7661654	7.06	28370	17.54	3.8	1788088	7.89	3466759	3.44	29832	18.15
76-200	5.14	6491502	37.21	34729645	31.98	54533	33.72	5.14	6494227	28.64	13083990	13.00	54733	33.30
201-300	5.36	1167066	6.69	6377424	5.87	4878	3.02	5.36	5151334	22.72	26925906	26.75	4878	2.97
301-400	5.63	268650	1.54	1532075	1.41	783	0.48	5.63	1989495	8.77	1613422	1.60	783	0.48
401-600	8.7	101673	0.58	889980	0.82	217	0.13	8.7	110582	0.49	973086	0.97	219	0.13
600++	9.98	38725	0.22	387351	0.36	35	0.02	9.98	38489	0.17	578539	0.57	38	0.02
Total	*42.43*	*12030269*	*68.96*	*61918873*	*57.02*	*161716*	*100%*	*42.43*	*17449424*	*76.95*	*54584399*	*54.23*	*164363*	*100%*
Commercial	9.8	2218323	12.72	22641310	20.85	17064		9.8	2364341	10.43	24063610	23.91	17327	
Charitable Inst.	5.22	201145	1.15	1147639	1.06	2546		5.22	211080	0.93	1197514	1.19	2558	
Irrigation	3.82	463543	2.66	2520559	2.32	1844		3.82	157672	0.70	660699	0.66	1620	
General Power	7.66	1390468	7.97	11468622	10.56	1661		7.66	1305017	5.76	10493551	10.43	1659	
Large Power	7.57	1139528	6.53	8872746	8.17	51		7.57	1185632	5.23	3226573	3.21	51	
33KV	0	0	0.00	0	0.00	0		0	0	0.00	0	0.00	0	
Street Light	0	2580	0.01	21948	0.02	52		0	2580	0.01	21947	0.02	52	
Grand Total	*76.5*	*17445856*	*100%*	*108591697*	*100%*	*184934*		*76.5*	*22675746*	*100%*	*100647773*	*100%*	*187630*	

Table 5: Monthly Revenue data of PABNA PBS-2

VII. POWER FACTOR CALCULATION

The ratio between active power and reactive power is called power factor. The standard value of power factor is 0.95 which is fixed by BREB. The value of Power factor improves by using capacitor or auto PFI plant.

Fig 4: Relation between KW, KVA and KVAR

To help understand this better all these power are represented in the form of triangle. Mathematically, $\mathbf{S^2 = P^2 + Q^2}$ and **electrical power factor** is expressed with active power or apparent power.

7.1 Power Factor Calculation

In **power factor calculation**, we measure the source voltage and current drawn using a voltmeter and ammeter respectively. A wattmeter is used to get the active power. Now, we know **P = VICos** □ watt.

For this **Cos** □**=P/VI**

Hence, we can get the electrical power factor. Now we can calculate the reactive power
Q= VISin □ VAR**.** This reactive power can now be supplied from the capacitor installed in parallel with load in local.

7.2 Power Factor Adjustment

7.2.1 Domestic (Household) Applicability

Subject to established rules and regulations of the Palli Bidyut Samity, applicable for single phase and three phase 50 cycles, electricity connection of the following category of consumers:
Domestic water pumps for household use up to 1.5 H.P.

7.2.2 Commercial Applicability

Subject to established rules and regulations of the Palli Bidyut Samity, applicable for single phase and three phase 50 cycles, electricity connection of the following category of consumers:
Hat- bazaar , shop (including tailoring shop),Commercial enterprise, Government and semi government office, Private clinic, Practicing chamber, Community center and community hall, Rest house, Cinema hall, Mobile Tower, Petrol/CNG pump Station.

7.2.3 Charitable Institution Applicability

Subject to established rules and regulations of the Palli Bidyut Samity, applicable for single phase and three phase 50 cycles, electricity connection of the following category of consumers:
Masjid, Temple, Church, Pagoda, School, College, Madrasah, Club, Orphanage, Charitable institution (Not complex), Charitable dispensary, Crippled rehabilitation center etc.

7.2.4 Power factor adjustment for Domestic (Household), Commercial, Charitable Institution
Power factor adjustment will be applicable as per BERC order issued from time to time.(PFC Formula stated in SCHEDULE-GP & SCHEDULE-LP of this rate schedule).

7.2.5 Irrigation Applicability
Subject to established rules and regulations of the Palli Bidyut Samity, applicable for single phase and three phases 50 cycles connections of all kinds of irrigation pump consumers. PBS calculate power factor penalty for all pumps greater than 5 HP.

7.2.6 General Power
Subject to the established rules and regulations of the Palli Bidyut Samity, applicable for contracted load up to 50KW with single phase or three phases, 50 cycle connection of all types of usage. Generally Palli Bidyut Samity will implement secondary metering (L.T. metering) for such types of consumer. Supply voltage will be 230/400 voltage. Types of consumer under this category will be as follows:

- All types of industries and industrial complex.
- Government office complex.
- Government and charitable hospital complex.
- Charitable, religious and education complex.
- Small Industries related to production or fabrication.
- Union Paribar Kalian Kendra.
- Cantonment, air, naval base/installation etc.
- Police station, Camp, Outpost and BGB Camp, BOP Installation etc.

In Pabna PBS 2, maximum of P.F. penalty are recorded form this slab.

7.2.7 Large Power
Subject to the established rules and regulations of the Palli Bidyut Samity, applicable for contracted loads up to 50KW with three phases, 50 cycles connection of all types of usage. Generally Palli Bidyut Samity will implement primary metering (H.T metering) connection for such type of consumer. Supply voltage will be 6350/11000 voltage. If primary metering is not possible, then 2.5% additional unit (for transformer loss) will be added with secondary metering (L.T. metering) unit, but the tariff and other charges will be applicable as per LP consumer. Type of consumers under this category will be as follows:

- All types of industries and industrial complex.
- Government office complex.
- Government and charitable hospital complex.
- Charitable, religious and education complex.
- Small Industries related to production or fabrication.
- Cantonment, Air, Naval base/installation etc.

7.2.8 Power Factor Adjustment for Irrigation, General Power and Large Power
The member- consumers for above 15 horse power load shall have to be agreed to maintain unity power factor as nearly as practicable. The measured power factor(as per PBS instruction 300-5) will be corrected or adjusted for consumers having power factor less than 95%(Ninety five percent).

Table 6: Power Factor Penalty of PABNA PBS-2

Month	JUL,15	AUG,15	SEP,15	OCT,15	NOV,15	DEC,15	JAN,16	FEB,16	MAR,16	APR,16	MAY,16	JUN,16	Per Unit Taka
KWh	207	442	418	478	440	482	412	1428	15669	9106	6657	4553	7.38
Taka	1536	3299	3201	3663	3370	3691	3156	10922	119788	69754	40266	34875	

7.2.9 P.F Correction Multiplication Factor
Correction or adjustment of the power factor will be made by increasing the actual KWh consumption that is by multiplying actual KWh consumption in meter with above power factor correction (PFC) Multiplication factor. If the P.F is smaller than 0.95 at the consumer end, the consumer will be charged for the actual consumption (KWh) as per meter reading.

7.2.10 P.F. Penalty Formula
Consider,
x/y = z
E**x** z = E_C
E_C **x** R = Energy Billed for P.F. penalty
Where,
x = 0.95
y = consumer P.F.
z = Multiplying factor
R = Energy Rate
E_C = Energy consumed after P.F. correction
E = Energy consumed (KWh)

7.2.11 Power Factor Correction Example
Let A industrial allowable power factor value is 0.95 but Average power factor is 0.81 which is lower than 0.95, so in that case Power factor correction

$$= \frac{\text{Allowable power factor}}{\text{Average power factor}} = \frac{0.95}{0.81} = 1.17$$

As we know that if the value of power factor correction is greater than 1 then we have to pay an extra bill.
Let The industry consumption unit is 3000 KWh. So,
Billing Unit =Consumption Unit × Powerfactor correction
= (3000×1.17)
= 3510 KWh
So extra power factor correction billing unit = (3510-3000) KWh
= 510 KWh
If per unit rate is 5 Taka, then the amount of extra bill = (510× 5) Taka =**2550** Taka
In this process power factor penalty are calculated.

7.2.12 The Benefits for High Power Factor
i. Power loss and voltage drops of motor's wire are decreased.
ii. Motor work's without interval when voltage drop are less and motor's lifetime are increased because of less temperature of motor.
iii. If voltage drops is less then system loss also less.
iv. Kilowatt hour consumption is less due to less motor wiring system loss.
v. The instruments efficiency is increased with feeder capacity.

All types of irrigation and industrial motor connecting Committee recommends identified size Capacitor or auto PFI to be established. According to the PBS rule, if power factor are less than 95% then a penalty added with monthly bill. So if we use fixed size capacitor or auto PFI for increasing the power factor then all the consumer and also PBS are benefited.

VIII. ELECTRICITY COST AND RATE

8.1 Electricity Cost
Cost is an important term in any business, where profit or loss is a concern. Supplying electricity is a business also. Cost of electricity is how much one spent or pays to generate, distribute or consume electricity. Electricity is the major power source in all over the world. That's why, cost of electricity is important to improve economic and social benefits.

8.2 Electricity Purchase Cost (EPC)
Electricity purchase cost is purchasing cost of electricity and consist with bulk price and wheeling charge. Bulk price is paid to the Generation Company and wheeling charge is paid to the Transmission Company by the Distribution Company. As a distribution wing, PABNA PBS-2 pays BPDB or their IPPs bulk price to buying electric energy and wheeling charge to PGCB for wheeling.

8.2 Bulk Rate
BPDB sales their generating electricity to distribution companies with bulk rate. BERC fixed this rate as per situation. Distribution companies are also purchase electricity from some private generation companies. But rate is much lower than bulk rate.

8.3 Wheeling Charge

PGCB is paid wheeling charges by the distribution companies. The company has taken infrastructure development projects for further development of its operation. In order to financial new investment, ensure proper maintenance of its existing assets, PGCB requires to be paid at better rates than what it is now getting from the distribution companies. At the bulk supply level, it is evident that the cost of purchase from rental power plants is the major contributor to losses. The exact quantification of losses will require a more detailed study of supply and losses at different voltage level and to different bulk purchasers. A more immediate requirement is to address the generation plan in the short term so that lower cost of power is available in the grid. In the medium to long term, given the role of private and public sector in generation, to enhance competitiveness, it is recommended that a concerted effort to establish a competitive dispatch regime for electricity generation through a cooperative pool. At the retail level, cross – subsidies arise between the different categories of customers

8.4 Distribution Cost

Expense for distributing the electric energy to consumers is said to be distribution cost. Operation and maintenance cost, Consumer selling expenses, Administration and general expenses, Depreciation and amortization expenses, Tax expenses and interest expenses are included in distribution cost.

Distribution Cost = Operation & Maintenance Expenses + Consumer selling expenses + Administration & General Expenses + Depreciation & Amortization + Tax Expenses + Interest Expenses

Month	EPC	Distribution Cost						Total Distribution Cost	System Loss (Taka)	Total Supply Cost
		OME	CSE	AGE	DAE	TE	IE			
July	8.903	0.538	0.790	0.382	0.830	0.067	0.350	2.958	8.231	20.092
August	9.494	0.424	0.526	0.340	0.836	0.070	0.350	2.545	1.926	13.965
September	10.000	0.769	0.959	0.458	1.433	0.047	0.350	4.016	2.531	16.547
October	9.410	0.417	0.580	0.304	0.910	0.074	0.350	2.635	0.636	12.681
November	6.928	0.437	0.520	0.324	0.925	0.079	0.350	2.636	0.034	9.598
December	6.908	0.533	0.580	0.415	0.938	0.053	0.295	2.814	1.091	10.813
January	6.919	0.941	1.196	0.536	0.967	0.068	0.350	4.058	0.614	11.591
February	7.269	0.494	0.521	0.432	0.970	0.028	0.350	2.795	1.772	11.836
March	8.153	0.422	0.510	0.434	0.976	0.051	0.350	2.742	1.717	12.612
April	9.567	0.552	0.726	0.473	1.014	0.029	0.350	3.144	3.042	15.752
May	9.172	0.566	0.611	0.438	1.023	0.060	0.350	3.047	1.380	13.599
June	11.393	0.945	1.768	3.355	1.037	0.073	0.453	7.631	9.637	28.662
Grand Total	**104.115**	**7.038**	**9.286**	**7.891**	**11.860**	**0.697**	**4.249**	**41.021**	**32.612**	**177.748**

Table 7: Distribution and Total Supply Cost in 2015-16 of PABNA PBS-2

8.4.1 Operation & Maintenance Expenses (OME)

All types of expenses for operational and maintenance is included as OME. Operation supervision and Engineering, substation expenses, overhead line expenses, meter expenses, consumer installation expenses are in operation and maintenance expense. In Table 7 all data are describe in crore taka.

8.4.2 Consumer Selling Expenses (CSE)

Consumer selling expenses are consumer related expenses. Field supervision, meter reading expenses, consumer records/collection expenses, consumer assist/demonstration/selling expenses and sales to freedom fighter are including in CSE.

8.4.3 Administration and General Expenses (AGE)

Administrative and General Expenses are broken into operation and maintenance expenses, with the bulk of the expenses being operation based. Operation expenses include administrative and general salaries, office supplies and expenses, administrative expenses transferred, outside services, property insurance, injuries and damages, hired service and rents. Maintenance expenses include only maintenance of general plant.

8.4.4 Depreciation & Amortization Expenses (DAE)

The depreciation expenses included as a cost is the monthly depreciation for all used and useful assets. In a broader economic sense, the depreciation cost is the aggregate amount of capital that is "used up" in a given period, such as a fiscal year. This value can be examined for trends in capital spending and accounting aggressiveness. PABNA PBS-2 calculates 20% depreciation of its assets per year.

8.4.5 Tax Expenses (TE)

All type of tax is included in tax expenses such as expense for revenue stamp, municipal tax, land and development tax etc.

8.4.6 Interest Expenses (IE)

Expenses of payable interests on loans from bank, BREB or from any other loans are included as IE. In 2015-16, PABNA PBS-2 pays 2.546 crore Taka.[16]

In Fig 5, DAE was quite abnormal in September, 2015. AGE was very high in July, 2016 respect the other months. CSE rise in September, 2015 January, 2016 and June 2016 above 200 % from rest of the months. OME increased in the same months where CSE rise.

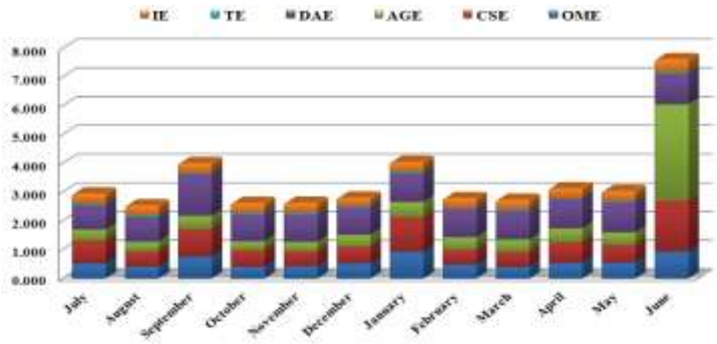


Fig 5: Distribution Cost (In 10^7 Taka) of PPBS-2 in 2015-16

8.4.7 System Loss (BDT)

Calculate system loss KWh in taka. System loss in taka is help to calculate the distribution cost more correctly and showed an economical figure of system loss. PABNA PBS-2 had a system loss of 45.819 crore taka in 2015-16. [17]

System Loss (Tk) = System Loss (Energy) XSystem loss (Tk/Unit)

8.5 Revenue

The revenue is the amount of income that a PBS should have opportunity to earn in order to maintain operations and attract capital for investment, but still maintains least cost for consumers. Revenue of PABNA PBS-2 is 8 to 10.5 crore taka per month in 2015-16. [18]

8.5.1 Total Revenue (TR)

Total revenue is the total earning money of a PBS. A PBS earns its revenue from two sources. One is from sales of energy to the consumers and the other is revenue from other operating sources.

Total Revenue = Revenue from sales of energy + Revenue from others.

Month	Energy Import (MU)	Energy Purchase Cost (10^7Tk)	Energy Sell (MU)	Distribution Cost (10^7Tk)	Total Supply Cost (10^7Tk)	Revenue from Sell Energy (10^7Tk)	Revenue from other sources (10^7Tk)	Total Revenue (10^7Tk)	System Loss %	Surplus (+/-) (10^7Tk)	System Loss (10^7Tk)	System Loss (Tk/Unit)	Distribution Cost (Tk/Unit)	Total Revenue (Tk/Unit)
July	20.892	8.903	14.683	2.958	20.092	8.346	0.413	8.759	29.72	-11.333	11.190	1.802	7.620	4.193
August	22.278	9.494	17.213	2.545	13.965	9.477	0.403	9.880	22.74	-4.085	6.352	1.254	2.597	4.435
September	22.176	10.000	18.579	4.016	16.547	10.528	0.818	11.346	16.22	-5.201	3.142	0.873	3.524	5.116
October	20.869	9.410	18.991	2.635	12.681	10.762	0.279	11.040	9.00	-1.640	0.837	0.446	1.722	5.290
November	15.364	6.928	14.989	2.636	9.598	8.638	0.388	9.026	2.44	-0.572	0.042	0.113	1.782	5.875
December	15.321	6.908	13.427	2.814	10.813	8.108	1.090	9.197	12.36	-1.616	1.205	0.636	2.908	6.003
January	15.345	6.919	13.458	4.058	11.591	8.172	0.426	8.598	12.30	-2.993	1.193	0.632	3.472	5.603
February	16.122	7.269	13.543	2.795	11.836	8.008	0.311	8.319	15.99	-3.517	2.213	0.858	3.372	5.160
March	18.080	8.153	15.252	0.976	12.612	9.011	0.921	9.932	15.64	-2.680	2.365	0.836	2.924	5.493
April	21.216	9.567	17.119	1.014	15.752	9.901	0.333	10.234	19.31	-5.518	4.420	1.079	3.613	4.824
May	20.340	9.172	17.458	1.023	13.599	10.204	0.291	10.494	14.17	-3.104	2.145	0.744	2.536	5.160
June	25.268	11.393	18.693	1.037	28.662	10.756	0.361	11.118	26.02	-17.544	10.426	1.586	9.238	4.400
Grand Total	233.270	104.115	193.405	28.506	750.833	111.911	6.034	117.945	-	-59.803	45.530	-	-	-

Table 8: Import energy, Purchase cost, Expenditure, Sell energy, Revenue, Distribution cost of energy according to the Thesis Calculation on PABNA PBS-2

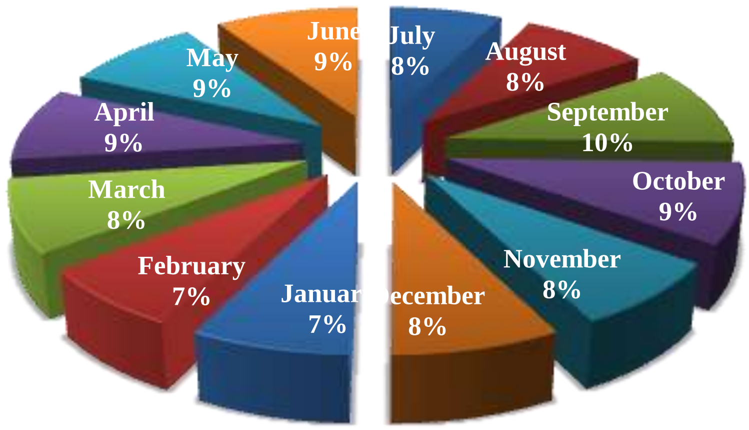


Fig 6: Revenue per Month (in %), 2015-16

8.5.2 Revenue from Sales Energy
Revenue from only selling energy to the consumers are in this category. These amounts are collecting through the electricity bills from the consumers. Demand charge, corresponding energy rate and some other charges are included in this revenue.

8.5.3 Revenue from Others
Revenue from others is actually summation of operating revenue from other sources, non-operating margins-interest and non-operating margins-Others.

Revenue from others = Other Operating Revenue + Non-operating Margins- Interest+ Non-operating Margins-Others

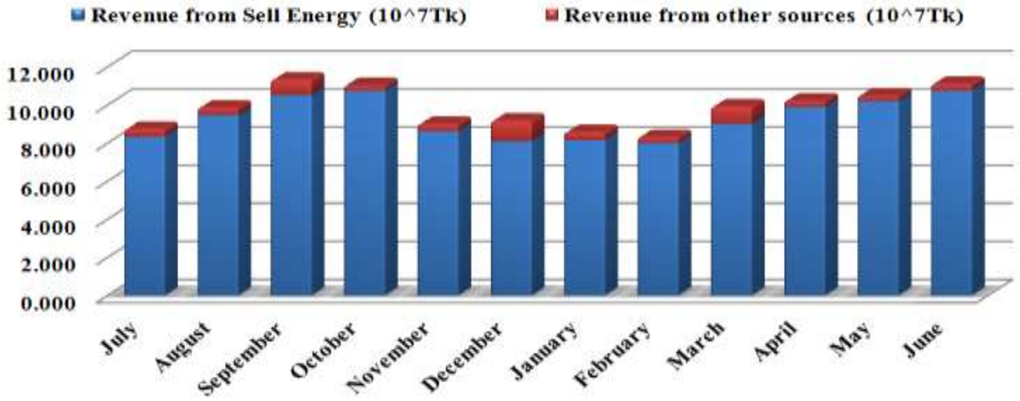


Fig 7: Monthly Total Revenue of PPBS-2 (10^7 Tk)

8.5.4 Other Operating Revenue
Late payment charge, miscellaneous service revenue, rent for electric property and other electric revenue are calculated as other operating revenue.

8.5.5 Non-operating Margins- Interest
Interest from bank deposit, interest from employee loans (Home loan) related with this part. PBS calculates this as revenue and employee have to pay about 10% interest on their home loan.

8.6 Total Supply Cost (TC)
From purchase to supply electric energy to the consumers, total cost is said to be the Total Supply Cost. This is the total operational expenses of a PBS. In 2015-16 fiscal year, PABNA PBS-2 showed about 71.425 crore taka [19] as their total supply cost where my energy purchase cost is,

Total Supply Cost (TC) = Energy Purchase Cost+ System Loss (in Tk) + Distribution cost (DC)

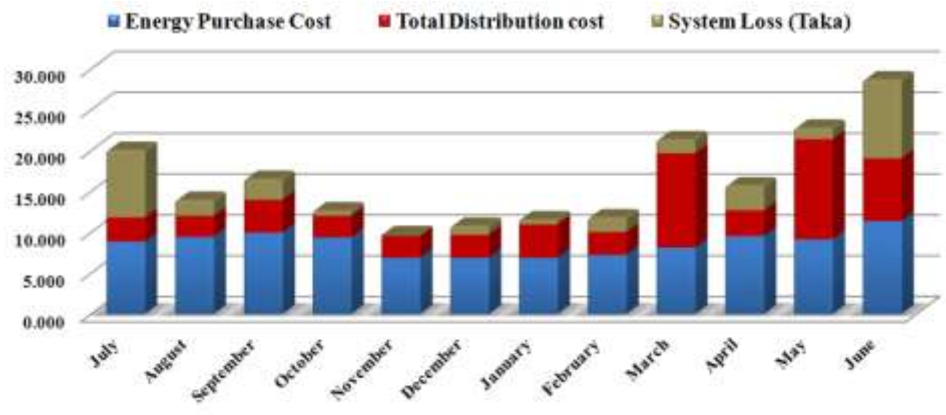


Fig 8: Monthly Total Supply Cost of PPBS-2

8.7 Surplus

Surplus defines the profit or loss of a PBS. It's also known as operating margin in PBS.

Surplus = Total Revenue- Total Supply Cost

As we see in Fig 9 surplus of Pabna PBS 2 is in negative position due to high distribution expenses and system loss. In Fig 7.4 distribution cost was abnormally high in March and May, 2016. In July, 2015 and June, 2016 system loss (Taka) was also high. Total supply cost was above 20 crore taka in March, May and June, 2016 where highest revenue was around 10 crore taka in average. This is a huge gap. [20]

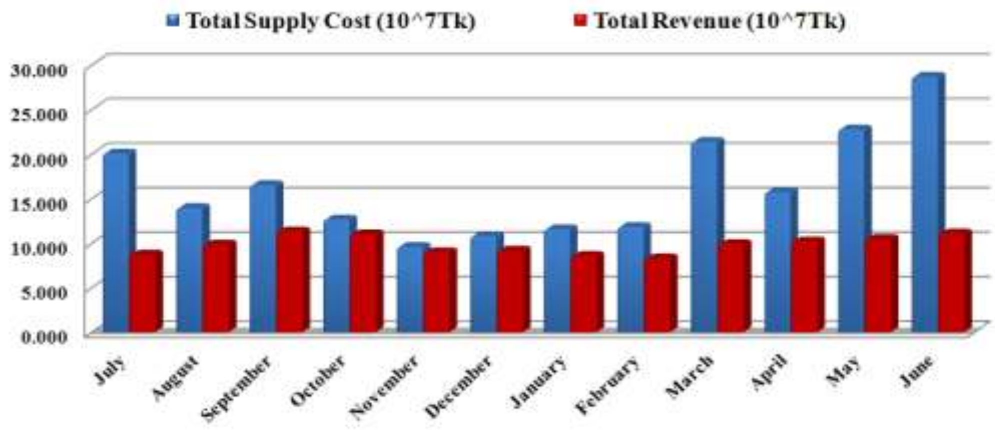


Fig 9: Monthly Revenue with Supply cost of PPBS-2

8.8 Per Unit Cost Calculation

Per unit cost calculated to find cost or revenue of one unit energy that's why we assume profit and loss in short. Here we listed some per unit calculation for PABNA PBS-2,

8.8.1Distribution Cost (Tk/Unit)

In July, 2015 PABNA PBS-2 had 20.092 crore taka Total Supply Cost, 8.903 crore taka Energy Purchase Cost and Energy sell is 14.683 MU. So the Distribution cost (Tk/Unit) of July, 2015

Distribution Cost (Tk/Unit) = ((Total Supply Cost - Energy Purchase Cost) / Energy Sell)*10

= ((20.092– 8.903) / 14.683) * 10

= 7.62Tk/Unit

8.8.2 Revenue (Tk/Unit)

In July, 2015 PABNA PBS-2 had 8.759 crore taka Total Revenue and import 20.892 MU energy. So Revenue on July, 2015 was,

Revenue (Tk/Unit) =(Total Revenue / Energy Import)*10
= (8.759 / 20.892) * 10
= **4.193**Tk / Unit

8.8.3 System Loss Tk/Unit (SL)

System loss (Tk/Unit) is calculated the price of each unit in system loss.
In July, 2015PABNA PBS-2 had purchased 20.892 MU with 8.903 crore taka and Energy sell is 14.683 MU. So the system loss (Tk/Unit) of July, 2015 is

System loss (Tk/Unit) = ((Purchase cost/Sell Energy)-(Purchase cost/Import Energy))*10

$$=\left(\frac{8.903\text{ crore}}{14.683\text{ MKwh}}-\frac{8.903\text{ crore}}{20.892\text{ MKwh}}\right)* 10$$

=**1.802** Tk / Unit

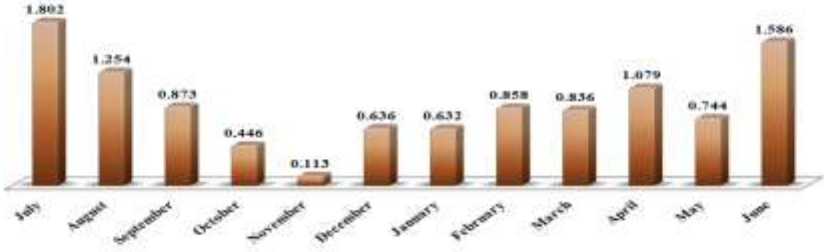


Fig 10: Month wise System loss (Tk/Unit), 2015-16 of PPBS-2

8.9 Tariff Rate

This is for information of all concerned that in accordance with the BERC Order Dated: 27 August 2015, the new tariff rates with respect to retail sales of electricity of Bangladesh Rural Electrification (BREB) has been made effective bill from month September 2015 shown in Table-9 . In this table, it's also shown rate and slabs change since December, 2009.

Consumer Class	Slab	Before Dec,2009	01-Dec-09	Slab	01-Dec-11	01-Feb-12	01-Mar-12	Slab	01-Sep-12	Slab	01-Mar-14	01-Sep-15
Domestic	0-25	0	0	Minimum	0.00	0.00	0	Minimum	0.00	Minimum	0.00	0.00
	0-100	2.53-2.90	2.64-3.03	00-100	2.77-3.18	2.90-3.34	3.08-3.55	00-75	3.36-3.87	1-50	3.74	3.36-3.87
	101-300	2.57-2.95	2.81-3.23	101-300	3.25-3.73	3.45-3.95	3.67-4.20	76-200	4.05-4.63	1-75	3.87	3.80
	301-500	3.89-4.15	4.28-4.56	301-500	5.21-5.54	5.63-5.98	5.98-6.35	201-300	4.18-4.79	76-200	5.01	5.14
	500++	4.99-5.95	5.64-6.72	500++	6.87-8.18	7.42-8.83	7.88-9.38	301-400	6.88-7.30	201-300	5.19	5.36
								401-600	7.18-7.62	301-400	5.42	5.63
								600++	9.38	401-600	8.51	8.70
										600++	9.93	9.98
Commercial		5.11-5.15	5.62-5.66	Flat	6.80	7.33	7.79	Flat	9.00	Flat	9.58	9.80
				Off-peak	5.23	5.88	6.25	Off-peak	7.22	Off-peak	8.16	8.45
				Peak	9.31	9.66	10.26	Peak	11.85	Peak	11.85	11.98
Charitable		3.28-3.35	3.28-3.35		3.45-3.52	3.62-3.70	3.85-3.93		4.45-4.54		4.98	5.22
Irrgation		2.60-3.05	2.60-3.05		2.73-3.20	2.87-3.36	3.05-3.57		3.39-3.96		3.39-3.96	3.82
General Power		3.91-4.10	4.30-4.51	Flat	5.27	5.67	6.02	Flat	6.95	Flat	7.42	7.66
				Off-peak	4.41	4.86	5.16	Off-peak	5.96	Off-peak	6.64	6.90
				Peak	6.75	6.90	7.33	Peak	8.47	Peak	9.00	9.24
Large Power		3.80-3.95	4.18-4.34	Flat	5.14	5.55	5.90	Flat	6.81	Flat	7.32	7.57
				Off-peak	4.40	4.86	5.16	Off-peak	5.96	Off-peak	6.62	6.88
				Peak	7.55	7.60	8.08	Peak	9.33	Peak	9.33	9.57
33KV				Flat	4.88	5.28	5.61	Flat	6.48	Flat	7.20	7.49
				Off-peak	4.30	4.78	5.08	Off-peak	5.87	Off-peak	6.55	6.82
				Peak	7.34	7.44	7.91	Peak	9.14	Peak	9.28	9.52
Street Light		3.75-3.85	4.12-4.23		4.90	5.28	5.61		6.48		6.93	7.17

Table 9: Tariff rate since 2009 to 2016

8.10 Bill Explanation

➢ **What all utility bills should contain?**

Bills–for electricity–should always be dated and contain the following information (Usually on the first page of the bill) –

- Your Name and Address.
- Your customer account or reference number (Always quote this when you contact your supplier).
- The name of your supplier and its contact details.
- How much you need to pay (Including any money owed from previous bills) and when you need to pay by.

➢ **More Detailed Information -**

The following more detailed information about the amount of energy you've used is often found on a separate page of the bill–

- Billing Period – The period in which you used the energy you're being charged for.
- Meter Readings–Difference between the previous and latest reading is the amount of energy (Measured in Kilo watt Hours or KWh) you've used.
- The amount your supplier is charging you for each KWh of electricity. If you pay a standing charge (Which covers things like meter readings and the cost of keeping you connected to the network) you'll pay a single rate; if not then you will pay a higher price for a given number of units and then a lower rate thereafter.

  Meter Number– If your supplier has changed your meter during the billing period you'll see readings for two different meter numbers. [21]

IX. LIMITATIONS

There are few limitations we faced are mentioned below-

- In this study the data of PABNA PBS-2 we have used, collected from BREB (Bangladesh Rural Electrification Board) and PABNA PBS-2 but we think some of these data are assumption.
- The distribution cost of PABNA PBS-2 we have calculated are almost the same as that given by BERC. The slight difference of cost caused by the data that are assumption.
- In this thesis, we have discussed about electricity distribution structure and calculated the distribution cost but the tariff rate of electric power depends on generating, transmission, distribution cost. To calculate the tariff rate of electric power, transmission and distribution cost needs to be calculated along with the generation and transmission cost.

X. FUTURE OUTLINE

Usually, Tariff rate of electrical power depends on transmission and distribution cost. If electricity supply costs are high then electrical tariff rate will high and committed negative result. In this paper, we discussed about Distribution cost of a PBS, how to calculate, with example. We also discussed about important terms. Interested people can study to calculate the Distribution cost and electricity tariff. This paper will also be helpful to get knowledge a stable electricity distribution structure to meet the future electricity crisis of Bangladesh.

XI. CONCLUSION

Electricity distribution cost is important issue in our country. Because electricity tariff rate and distribution cost are related with our economic growth. When electricity tariff rate becomes high then poor people of our country suffers a lot. By thinking about them, electricity tariff rate of our country should be low. Government has given highest priority to power development in Bangladesh and is committed to generating electricity will sufficient for all citizens by 2021. Our government should take step for improvement our power station. In our power station, generators efficiency rate is low. It should be increased to a high value by taking necessary steps.

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