

Economic and Social Impact Evaluation Study of the Rural Electrification Program in Bangladesh



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EXECUTIVE SUMMARY

INTRODUCTION

Rural Electrification Program 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 Samities* (PBSs) similar to the rural electric cooperatives that exist in the United States. Sixty-seven PBSs have been organized to date in Bangladesh.

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. Rural electrification has also been identified as one of the four priority areas in order to ensure increasing growth and bringing of pro-poor orientation in the growth process, as has been mentioned in the National Poverty Reduction Strategy Report, 2002. Introducing electricity into different consumers - domestic/household, industrial, irrigation equipment, commercial, street light and office use, provides the necessary infrastructure for accelerated economic activities as well as creating environment for realizing human capabilities. Since 1978 more than a thousand-fold increase (1237times) in terms of number of services connected reveals an annual average growth rate of 40%. The development of rural electrification in Bangladesh is one of the major success stories of external development assistance to a developing nation.

OBJECTIVES OF THE STUDY: BROAD AND SPECIFIC

The **broad objective** of the study was to make an **assessment of economic and social impacts of Rural Electrification Program in Bangladesh**.

In line with the Terms of Reference and the broad objective, the **specific objectives** of the study were:

- To design the economic and social impact evaluation study of the Rural Electrification Program that includes reconfirmation of direct (intended) objectives and identification of broader (indirect) impacts of REP, defining impact indicators, identification of relevant testable hypotheses, and development of appropriate methodology.
- To determine impact of Rural Electrification Program on the various dimensions of human development focussing on standard of living, poverty reduction and gender development.
- To evaluate the impact of Rural Electrification Program on industrial development.
- To assess the impact of Rural Electrification Program on the development of commercial activities.
- To evaluate the impact of Rural Electrification Program on the various dimensions of irrigation and agriculture.
- To put forward logically sound recommendations based on scientifically rigorous impact evaluation in line with the above objectives and the Government's Energy Policy, especially for accelerated development and poverty reduction in a sustainable way through rural electrification.

METHODOLOGY

The first step of designing appropriate methodology was to formulate the study design followed by definition of impact indicators and identification of testable hypotheses. In the process of finalizing of key technical issues, the core team had two meetings with RPPR program partners– USAID, NRECA, REB and reached a consensus on all key issues methodologically crucial for the study.

In line with the objectives of the study, **absence of baseline** (pre-test) measurement observation necessitated adoption of **Posttest-only Control Group Operations Research Design**. ESIES was thus designed to evaluate impact(s) using *'with-without'* (electricity) scenario to gauge the impact of REP on different categories of customers–households, irrigation equipment (pump owners and plot owners), industry, and commercial units. Customers using rural electrification was treated as experimental and those not-using electricity as control variable. An additional sample category for households - the households without electricity in the electrified villages, was included in the study design to evaluate the spillover effect of REP. Data collection techniques applied, include both *quantitative* and *qualitative* methods.

The key features of sampling strategy, finalized after the consensus-building meeting include:

- Selection of PBSs as primary sampling unit, for which *probabilistic sampling strategy* was adopted to ensure desired level of confidence with *probability proportionate to size* (PPS) according to the number of villages electrified.
- Considering age-length of PBSs as the stratification criterion, 23 sample PBSs were selected following *Stratified Random Sampling* procedure. Age-length for three strata are: those- < 6 years, 6 years to <18 years, and 18 years and above.
- Selection of sample sizes for FOUR observation measurement unit–Household (2491), Irrigation equipment (523), Industry (176) and Commercial (528), following appropriate statistical formula. The total sample for quantitative survey was 3718. Based on MIS data of REB (January 2002), the distribution of sample sizes across the sample PBSs followed the PPS method for all the observation measurement unit.

In addition to the quantitative survey following the above mentioned sampling procedure, qualitative information were collected through 27 Focus Group Discussions (FGD) with respective respondents of each observation measurement unit and 9 Group Discussions (GD) with members of Board of Directors, General Manager and other officials of PBSs. A number of Secondary Data Collection Formats (SDCF) were designed to portray an overall community scenario at different levels-Villages, Unions and Upazilas as well as sample PBSs. SDCFs, for information on industries connected, were sent to all 67 PBSs (through REB) to grasp the overall status of industrial connection of REB and provided further insight in analyzing the field data for industrial units.

Impact indicators for each observation measurement units were identified on the basis of review of relevant literature, rigorous brainstorming sessions among the core team members and their familiarization visit vis-à-vis idea-generation visit to two PBSs- Sirajgonj and Gopalganj. For *households*, impact indicators were analysed under three broad categories of variables or measurable objects–Economic, Social and Cultural, and Demographics. The relevant variables for *irrigation* include productivity, cost of production, employment, command area, operational cost, maintenance cost, and others. The broad categories of variables for *industries* include productivity, cost of production, efficiency, diversification, forward and backward linkages, clusters, development of support-service system, and environmental. The concerned variables

for *commercial* units were categorized as business turnover, market expansion, employment and quality.

Hypotheses developed for all observation measurement unit were tested and analysed for respective broad categories of variables for each observation measurement unit, incorporating 54 tests for households, 6 for irrigation, 9 for industry and 4 for commercial units. Apart from hypothesis testing, several statistical methods have been applied to incorporate different dimensions of study objectives and the variability of data set. The methods include factor analysis, cluster analysis, income determination model and TOBIT model analysis.

A total of 14 data collection instruments were administered in the survey. These included 4 quantitative survey instruments, 4 FGD checklists, 5 secondary data collection formats, and one set of group discussion guidelines. Apart from regular exercises relating to developing DCIs, the process of DCI development involved repeated field tests and field orientation with the trainees.

As part of the field implementation, the field functionaries of all categories– *Field Enumerators (56)*, *Field Supervisors (23)*, *Quality Control Officer(12)*, *FGD moderators(11)*, *Note-takers (11)*, *Recorded Data Transcriber (6)*– were selected at the first place after multi-phased screening. The training session for field staff began on 18 May, 2002 at the REB Auditorium. The experiences of familiarization visits by the team members and the experiences gained in the pre-test were used to prepare the training schedule for 10 days. In the training session the trainees were segregated for each observation measurement unit to ensure better understanding of the DCIs and thereby ensuring accuracy in data collection.

On their arrival at the PBSs, in consultation with the General Manager, field supervisors collected list of consuming units from each PBS. On the basis of which the primary samples were selected. The selection of *sample villages* was somewhat different from other observation measurement unit. From each PBS, names of electrified villages (2 near and 2 far) were obtained from GM, and then visits were made to those villages. The selection was made on the basis of distance—one not too far, and one far. The sample households were drawn from the list of connection holders from those selected 2 villages. Similarly, names of 2 non-electrified villages were obtained from GM/PBS, and finally one village for HH interview was selected. In selecting Irrigation Equipment priority was given to the village selected for HH interviews. Electricity driven as well as non-electricity driven large, medium, small and cottage industrial units were included as sampling unit for industry. Commercial Units were mostly drawn as sample from the village selected for HH interviews. In order to complete Focus Group Discussions/Group Discussions, six teams were deployed.

Each of the FEs conducted 2 interviews a day for household, commercial and irrigation units. On the other hand, one working day was assumed optimal to conduct one interview with industrial unit owners. In the total survey, a total of 3,718 interviews were conducted in the stipulated time period.

In order to ensure high quality output in the data collection a quality assurance system was instituted which took care of all systematic arrangements and activities directed towards safeguarding, maintenance and promotion of quality throughout the study period. Quality Control Officers (QCOs) were deployed for each of the 12 quality control clusters. They constantly moved around the sample spots, and thereby ensured quality data through (i) field checking, and (ii) data monitoring.

In order to ensure accuracy and validity of such information, concerted efforts were made by way of the following steps e.g. designing instruments to facilitate information gathering, provisions for cross-checking and consistency in the instruments, regular evening meetings to share team experience of the day and resolving problems jointly.

Data management activities were comprised of registration of questionnaires, data processing and computerization of data. It also included detailed transcription and analysis of the FGD/GD information. For the purpose of data management, 2 Registration Assistants, 8 Coder and Code Verifiers and 8 Editor and Edit Verifiers were employed.

FINDINGS, IMPLICATIONS AND RECOMMENDATIONS

This economic and social impact evaluation study was aimed at assessing the multidimensional aspects of the direct and indirect, tangible and intangible benefits of Rural Electrification Program of Bangladesh. Such impact was assessed for four observation measurement units, namely household, irrigation, industry and commercial activities. Impact by these units were evaluated separately and then attempts were made to synthesise the impact, which are interrelated and interdependent, and produces synergy.

ECONOMIC AND SOCIAL IMPACTS – HOUSEHOLD LEVEL

The economic and social impacts of rural electrification at the household level are multidimensional, and both tangible and intangible. The approximate number of persons who now derive direct benefit of household (domestic) connections of REB would be 20.5 million. The household level impacts are mediated through availability of electricity in the household as well as outside the household (agriculture, fisheries, commercial activities—shops and establishments, and industry). In the later event, the benefits go not only to the 20.5 million people who are connected through domestic connections, but also to those not having domestic connections.

During the last 20 years (1983-2002), the total number of domestic consumers of RE has increased almost 1200 times, from 2852 in 1983 to 3,413,825 in 2002. The estimated average annual growth rate (cumulative of domestic connections) is 42.53%.

The multifaceted impacts and benefits are either direct or indirect. 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.

ECONOMIC IMPACT

Impact on Income

The average annual income of households with electricity (HE) is 64.5% higher than that in the households of non-electrified villages (WE-NEV), and 126.1% higher than that in the households without electricity of electrified villages (WE-EV). The last year's average household income of HE was Tk. 92,963, and the same for WE-EV was Tk. 41,110 and that for WE-NEV was Tk. 56,524.

In terms of broad categories of sources of income, the households with electricity show a relatively higher share on account of non-agricultural sources (66.8% of annual income) than that of the same for non-electrified households (WE-EV and WE-NEV, 57.9% and 51.5% respectively).

The distribution of income by income groups shows a much better-off situation of the electrified households compared to that of their counterparts – non-electrified households. The gini-coefficient of income distribution is 0.53 for electrified households, 0.43 for non-electrified households in electrified villages (WE-EV), and 0.45 for households in the non-electrified villages (WE-NEV). 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.

Estimates show that 16.4% of the annual income of the electrified households can be attributed to electricity. As for non-electrified households in the electrified villages (WE-EV), 12% of the annual income can be attributed to electricity, and it is only 3.6% for the households in the non-electrified villages (WE-NEV).

Extrapolated estimates show that (a) 9.3 percent of the annual income of the total rural households (19.1 million) in Bangladesh can be attributed to electricity, and (b) assuming "all rural households have electricity" the total annual household income – at current market price – will increase to Tk. 1,775 billion from the present Tk. 1,105 billion, i.e., the annual net gain in income will be Tk. 671 billion more than today, of which Tk. 290.8 billion or 43.3% of the increment will be due to electricity. This net gain in annual income due to 100% electrification of rural households is equivalent to 26% of the current GDP (Tk. 2,580.6 billion at current market price) of Bangladesh.

Impact on Employment

Electricity generates employment. The impact on employment was both direct and indirect. In agriculture, an estimated 1.1 million persons are directly involved in farmlands using rural-electricity connected irrigation equipments. Currently, 63,220 industries using rural electricity employ 983,829 persons; and electrified industries, on average, generate 11 times more employment than the non-electrified industries. Rural and wholesale shops using rural electricity employ 848,630 persons. There has been direct employment of 16,223 persons in the PBSs. More so, 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.

Impact on Expenditure

The overall average annual (last year's) expenditure in the electrified households was Tk.94,552. The corresponding figure for the non-electrified households in electrified villages was Tk.61,327, and for households in the non-electrified villages was Tk.68,282. As compared to the differences in the relative income of these three sample categories, the differences in relative

expenditure is less pronounced implying that the electrified households spend relatively more than the other two categories.

The food-non food expenditure pattern in electrified resembled close-to-the national urban pattern and that in the non-electrified close-to-the national rural pattern. Thus, electrification has acted as a factor in urbanizing the consumption pattern of the rural people having electricity in their households.

The distribution of expenditure by recurrent-capital depicts a much progressive pattern in the electrified households as compared to the non-electrified households. The annual average recurrent expenses in the electrified households (Tk.72,676) was 29% higher than that of the households in non-electrified villages (Tk.56,285). The same for capital expenses was as much as 82% higher in the electrified households compared to that in the households of non-electrified villages. More importantly, while share of capital expenses to overall expenditure was 23.1% in the electrified households, it was 17.7% in the households of non-electrified villages. This pattern of distribution of recurrent-capital indicates relatively more stable and stronger domestic economy and better quality of life of the electrified households as compared to their counterparts in the non-electrified ones. Thus, electricity influences strengthening of the domestic economy of households having access to electricity.

The relatively higher standard of living as well as quality of life of the members in the electrified households as compared to the members in the non-electrified households are evident from higher annual per capita expenditure on all items of expenditure. The annual per capita expenditure on food in the electrified households (Tk.7,418.6) was 16% higher than that of the households in non-electrified villages.

The analysis of per capita daily intake of food by the members of households with and without electricity shows the following:

First: In terms of quantity of food consumption, the members of the electrified households are much better off than their counterparts in the non-electrified villages. The members in the electrified households, on average, consume daily 46 gms (4.8%) more than their counterparts in the non-electrified villages. In terms of intake of energy (kilo calories), it was 60 K.Cal (2.6%) more.

Second: In terms of quality of food the differences in food intake were significant. The average daily **protein** intake of the members in the electrified households (182.2 gm) was 34% higher than that of the members in the non-electrified villages. The higher quality is also evident in the fact that while the average K. calorie for the members in the electrified households was only 2.6% higher than that in the non-electrified villages, the money value of food in the electrified household exceeded 15.3%, the money value of food in the non-electrified households.

The average annual household expenses for education incurred by the electrified households was Tk.3,260 – an about 87% higher expenditure than that in the households of the non-electrified villages, and 135% higher than the non-electrified villages.

The average annual healthcare expenditure reported by the electrified households was Tk. 4,325, which is 44% higher than their non-electrified counterparts (Tk. 3,012 and Tk. 2,999). The annual health care expenses for the females of electrified (Tk.1,948) was 85% higher than those in the households of the non-electrified villages and 104% higher than those in the non-electrified households of electrified villages.

The average monthly expenses on fuel reported by the electrified households was Tk.545 and the corresponding amounts for the non-electrified households in electrified villages was Tk.362, and in non electrified villages Tk.385. Spending on kerosene was much higher in the non-electrified than in the electrified households. Electrified households monthly expenses on kerosene was only Tk. 28.3, while it was around Tk.65 in the non-electrified households. On average, the volume of kerosene used as fuel was 1.6 litres per month in the electrified households, 3.3 litres per month in the non-electrified households of electrified villages, and 4.1 litre per month in the households of the non-electrified villages. Nationally speaking, this has significant financial implications on the imports in Bangladesh. Currently, all rural households in Bangladesh annually consume 775.53 million litres of kerosene as fuel for domestic use. If 100% rural households are connected with electricity, the annual volume of consumption will drop down to 366.58 million litres i.e; the projected annual savings will be about 410 million litres. This amount of projected annual savings equals to Tk.7361.1 million, which is equivalent to about 53% of the present rural households expenditure on kerosene, or equivalent to 2.15% of the current annual valuation of national imports (CIF) of Bangladesh. Thus, ensuring 100% electrification of rural households will have major impact not only in reducing the dependency on kerosene, which is purchased in the context of fragile foreign currency reserve situation, but also will have high positive impact on the overall economy of Bangladesh and contribute towards macroeconomic stability (to certain extent). In addition, this will have major sustainability implications in terms of accelerating the process of ensuring an environment-friendly society in Bangladesh.

Impact on Surpluses and Savings

On an average, an electrified household had surplus amounting to Tk.20,287 which is 85 times of the households in non-electrified villages (Tk. 238.4 only) . The situation of households by landownership categories was also better in the electrified households than the comparable households in the non-electrified villages. The rich-poor gap (landless versus large landowner) was much less pronounced in the electrified households (gap of Tk 74,312) than that in the households of non-electrified villages (gap of Tk 9,2791). On average, an electrified households had savings amounting to Tk 28,893, non-electrified in electrified households Tk 9,918, and households in the non-electrified village, Tk 14,007. The influence of electricity on household savings is evident from the higher average propensity to savings in the electrified households which is due mainly to the relatively high income and less proportion of recurrent expenses. Electricity contributes significantly in enhancing the savings rate of the poor in the electrified households, and reduces the rich-poor gaps in savings (by income groups such gap was 6.4 times in electrified households and 18 times in the non-electrified villages).

Impact on Credit

Since both asset and income were found to be higher in the electrified households than in the non-electrified ones, the former has relatively high creditworthiness. The average amount of credit taken in the last year by electrified households was Tk. 9,153, and that by non-electrified households in the electrified villages was Tk. 4,685, and the same for the households in non-electrified villages was Tk. 5,339.

Impact on Ownership and Assets

A higher proportion of the electrified households own cultivable land, as compared to their counterpart non-electrified households. About 79% of the electrified households (HE) reported ownership of cultivable land. The corresponding reporting was 59% for non-electrified

households in the electrified villages and 73% for the households in the villages without electricity.

The average amount of own cultivable land of the electrified households is 178.2 decimals, that of WE-EV 74.2 decimals, and WE-NEV, 147.8 decimals.

During the last five years, the inequality situation of cultivable landownership has improved in the electrified households compared to that in the households of non-electrified villages. The relative share of ownership in the total cultivable land of the bottom 40% of the electrified households has gone up at a higher rate during the last five years, as compared to that in households of the non-electrified villages. The distribution of ownership of cultivable land in the electrified households, although skewed, is still better than that in the non-electrified households. The gini concentration ratio for ownership of cultivable land for the electrified households has dropped slightly from 0.62 in 1997 to 0.61 in 2002 (a decline of 1.6%); the same for non-electrified households in the electrified villages has dropped from 0.69 in 1997 to 0.68 in 2002 (a decline of 1.4%); but for the households in the non-electrified villages this has remained same at 0.67 in 1997 and 2002.

In terms of the absolute size of ownership and the increment, the higher increase in homestead, pond and kitchen garden in the electrified households compared to the others should be treated as a distinct sign of improvements in the standard of living in the electrified households.

During the last five years, in terms of dwelling and non-dwelling rooms, the increase in the electrified households was higher than that in the households of non-electrified villages. The average space of dwelling rooms in the electrified households has gone up to 635 sq. ft. in 2002 from 513 sq. ft. in 1997, and that for households in the non-electrified villages has gone up to 440 sq. ft. in 2002 from 367 sq. ft. in 1997.

During the last five years, ownership of average number of livestock (cow, goat, sheep) and poultry has increased in the electrified households, whereas the ownership of livestock declined in the non-electrified households.

In terms of some household assets, there has been a major change in the electrified households. A high proportion of electrified households reported ownership of electrical appliances such as fan, TV, cassette player, iron, which are almost non-existent in the households of the non-electrified villages.

During the last five years, the asset strength of the electrified households has improved by a much higher rate than that in the two other categories: five-year increase for HE was 19.4%, for WE-NEV 10%, and for WE-EV 2.4%.

With all the fluctuations in the movement of households from one asset group to another, as compared to the non-electrified households, the electrified households have shown a much progressive trend in their economic strengths measured through upward movement of the household asset situation. This was evident in relatively less proportion of households in the low asset group, higher rate in the upward movement of the original (1997) low and medium asset groups (during 1997-2002), and relatively less pronounced downward trend of all the three asset groups.

SOCIAL AND CULTURAL IMPACT

Impact on Education

The overall literacy rate was found much higher at 70.8% in the electrified households, compared to that in the non-electrified with 54.3% in the electrified villages and 56.4% in the non-electrified villages. 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 adult literacy rates for electrified households as compared to non-electrified ones is characterized by relatively high rate for both male and female, relatively less gender disparity, and relatively less rich-poor divide. Therefore, of literacy, it can be forcefully argued that ensuring access to electricity in the households should be seen as a major strategy to reduce the knowledge-poverty (in terms of both raising overall literacy and adult literacy) in rural Bangladesh.

The gross enrolment ratio – one of the major indicators of educational attainment — was high at 64% in the electrified villages, and around 55% 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-base 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.

Impact on Health, Hygiene and Sanitation

In terms of knowledge about the crucial public health issues respondents in the electrified households were reported to be much more aware than those in the non-electrified households. Out of 20 public health issues, on average, the respondents in the electrified households reported awareness about 12.8 issues, those representing WE-EV 8.8 issues, and those in WE-NEV 8.2 issues.

The (poor) landless in the electrified households was found more knowledgeable (61%) about the public health issues than even the rich (large landowner) in the non-electrified villages (59%). This also means, in terms of knowledge-poverty, the economically poor people become knowledge-rich if access to electricity is ensured.

Electricity has contributed spectacularly to the knowledge building about crucial public health issues. Overall, as high as 56% of those having knowledge in the electrified households reported TV as the main source of knowledge, the corresponding figure for TV was 28% in the non-electrified households in electrified villages, and 17% in the non-electrified villages. TV played an immense role as the major source of such enhanced knowledge on health issues.

Although the pattern of sickness did not show any variation by sample categories, the distinctions were pronounced when it came to the question of treating sickness by medically competent persons (MCP). Availing treatment from the MCP was much more pronounced in the electrified households (57%) compared to that in the non-electrified households (43%). The gender disparity in seeking treatment from MCP exists. However, it is much less pronounced in the electrified than that in the non-electrified households. Also, the rich-poor gap between utilization of MCP in sickness was 9.3% points in the electrified households, and as high as 21.8% points in the households of the non-electrified villages. Thus, health poverty reduction—both in terms of awareness on public health issues and utilization of medically competent persons while sick—is possible with ensuring access to electricity in the non-electrified households.

A much higher proportion of child delivery (last birth) in the electrified households were assisted by medically trained persons (36%) as compared to that in the non-electrified households in electrified villages 23.1%. In terms of assistance in child delivery by medically trained persons, the electrified households show a much better situation – both overall, as well as by landownership categories.

The situation of availing of antenatal care (ANC) check-up during pregnancy by medically trained provider, receipt of tetanus toxoid injections during pregnancy, and post natal (PNC) check-up after delivery – all reported by a much higher proportions in the electrified households compared to those in the non-electrified households. All these imply that having electricity in the households positively influences the utilization of ANC and PNC services, and also acts as a health-mediated poverty reduction factor by motivating poor people (through radio/TV) to use ANC and PNC services in need.

Maternal morbidity during pregnancy, delivery, and within 42 days of delivery (postpartum period) is a serious public health concern in Bangladesh. Reduction in the burden of maternal morbidity by ensuring treatment by medically competent person is a major health-mediated poverty reduction strategy of the Government of Bangladesh which has worked much better in the households having electricity compared to those in the non-electrified villages.

One of the most spectacular influences of electricity was found on the infant mortality rate. The infant mortality rate in the electrified households is 42.7/1000 live births, in the non-electrified households in electrified villages 53.8/1000 live births, and in the non-electrified villages 57.8/1000 live births. IMR in the electrified households is 25% less than the national average (57/1000 LB) and 35% less than the national rural average (66/1000 LB). Estimates show that **if access to electricity is 100% ensured in the rural households, and those electrified households maintain the same IMR as the current electrified households, the annual number of infant deaths that could be saved will be around 36,818, i.e., a savings of 101 infant deaths everyday.**

The full immunization coverage among children 12-23 months was significantly higher in the electrified households (60.7%) than that in the households of non-electrified villages (36.5%).

About 68% of the currently married women in the electrified households reported their use of a contraceptive method. The contraceptive prevalence rate is 62.8% in the non-electrified households of electrified villages, and 61.7% in the non-electrified villages. Thus, in terms of attaining the national goal of NRR=1 by 2005 (which is equivalent to TFR= 2.1 by 2005), the electrified households appear to be more close-to-goal than the non-electrified households.

Access to electricity influences significantly in raising CPR among the poor-landless. CPR among electrified poor-households (65.7%) was found 19.5% higher than that among the poor in the non-electrified villages (CPR being 55%). These imply that ensuring access of the poor to electricity will have far reaching impact in the whole demographic future, as well as human development in Bangladesh.

The indication that electricity provides a great impetus in accelerating the process of attainment of the demographic goal of Bangladesh is clearly evident from the fact that a large share of FP use was contributed by the television. As for 22.5% of the family planning users in the electrified household, TV was mentioned as the most influential factor prompted FP use. Thus, electricity and TV together can contribute significantly in expediting the process of reaching the national demographic goals of Bangladesh.

One of the most notable findings in the study is related to the use of hygienic latrines. Sixty one percent of the electrified households reported use of hygienic latrines (sanitary, sealed closed), while the corresponding figures for non-electrified households in electrified villages was 29% and for non-electrified villages, 31.7%. Another significant finding was related to the proportion reporting 'open space' for defecation: it was only 5.2% for the electrified, and around 20% for the others. Moreover, 50% of the poor households having electricity use hygienic latrine, while it was only 27.3% among their counterpart poor in the non-electrified villages. More spectacularly, while only 6.8% of the electrified poor-households reported use of open place for defecation, it was as high as 29.2% for the poor in the non-electrified villages.

There has been distinct cultural changes in the hygienic practices due to household electrification. The use of soap after defecation was reported by 66% of the electrified households and only 33% of the households in the non-electrified villages. Besides, use of nothing (not even ash/mud) was reported by only 4.7% of the electrified and as high as 17% of the non-electrified households. Electricity has contributed significantly in promoting the use of soap/ash(mud) as hand-washing materials after defecation (which is televised frequently). In terms of all hygienic behavior and practices, the electrified households depict a much higher standard than the non-electrified households, and that especially as compared to the non-electrified villages.

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, participation in IGAs, 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.

Against this context, it is important to enhance women's role in the decision-making bodies. Women do not have direct access to informal power structure and to many local committees. As

for instance, in PBS's committees, only that person can participate against whose name the electricity connection has been taken; and it is always men who take electricity as their main breadwinner of the household. Although women are the *defacto* managers of the households, they are usually bypassed from membership in various committees. Three women are usually taken as the advisers in the committees, but other women from electrified households are not taken in as general members. There is a scope to include women in the PBS committees in a meaningful manner and to strengthen women's role in the decision-making institutions. Therefore, it is required to involve more women in the top-level management, and in the implementation stage, to formulate more gender-sensitive policies. It is against this context that REP should aim at changing rural women's overall living standard.

Electricity enables all members in electrified households to avail more time after sunset, in comparison with those in WE-EV and WE-NEV. The daily average time from sunset to sleeping is higher for all categories of household members in HE.

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. Both the activities facilitated through electricity also signifies spillover effect of electrification for female members in non-electrified households in the electrified villages as the study results revealed less difference with WE-EV (40.7%) in terms of time allocation for socio-cultural development in comparison with WE-NEV (47.5%).

Male household heads/senior male member in the electrified household spent more time, after sunset, in income generating activities (56.4 mins) as compared to those in WE-EV (50 mins) and WE-NEV (37.3 mins).

Business, emerging as the most prominent activity signifies increased economic activities in the region as has been reflected with higher time spent by WE-EV in comparison with WE-NEV.

Considering income-generating activities for female household heads/senior female members sewing appeared as the one entirely attributable to electricity. The difference in terms of average time spent for sewing in HE is 564.8% and 978.6% higher than WE-EV and WE-NEV respectively. Even for senior female students in HE, sewing can be treated as future source of income which is completely absent in WE-EV and WE-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 rationalise the provision of electricity at the community level to ensure environment conducive to economic growth and higher standard of living.

Impact on Social Environment and Protective Security

Irrespective of availability of electricity in the households, almost all (96%) have said that electricity created significant employment opportunities. The most pronounced among those were creation of scopes for work at night (reported by 63% respondents), expansion of local trade and business activities (54%), generation of employment opportunities for unemployed youth (54%), broadening of scopes for employment in crop agriculture (53%), establishment of small and cottage industries (29%), increase in the opportunities for poultry raising (29%), and increase in the scopes for earning from multiple sources (27%).

Almost everyone (98%), irrespective of access to household electricity, agreed that protective security has increased due to electrification at the household level. The fact that security of mobility at night has increased due to electricity was confirmed by all respondents, irrespective of availability of electricity in their households.

IMPACT ON DEMOGRAPHICS

The reported mean number of children ever born to women was 4.3 in both the electrified households and households in the non-electrified villages. However, the mean number of deaths was relatively less in the electrified households with 50 (ever) deaths per every 100 households, which was high in the non-electrified villages with 62 deaths per every 100 households, and 59 deaths per 100 non-electrified households in the electrified villages. In the electrified households, not only the mean number ever died was relatively low, but also both the incidences of death and severity of death (measured in terms of death of 3 or more members) were less pronounced. As a result, the demographic consequences are distinct: the proportion of ever born still surviving is higher in the electrified households (88.4%) than that in the households of non-electrified villages (85.8%).

In the electrified households there are 912 females for every 1000 males i.e; 88 females are 'missing' against 1000 males. The corresponding missing number of females was lower at 54 in the non-electrified households in the electrified villages, and even higher at 102 in the non-electrified villages. Thus, the estimated missing number of females in the households of the non-electrified villages was about 16% higher than that in the electrified households. This issue of "missing females" has high gender, demographic and human development implications. Estimates done for the whole of rural Bangladesh show a total of 942, 215 missing females in the electrified households, 966,937 missing females in the non-electrified households of electrified villages, and a disproportionately high 2,857,404 missing females in the households

of non-electrified villages. The inferences which can be drawn as to the positive influence of electricity in reducing the missing female population are as follows:

First: The number of missing females is disproportionately high in those villages where there is no electricity. Although the non-electrified villages constitute 49% of the rural population, they represent about 60% of the missing females of rural Bangladesh.

Second: Had there been no-electricity in the electrified households, the approximate number of missing females could have been 163,865 more than today (current number is 942,215), i.e., among other determinants, electricity has contributed in reducing the missing females by 163,865 persons. This implies that access to electricity has been instrumental in reducing the number of missing females in the electrified households by 17.4%.

Third: Had there been electricity in the households of the non-electrified villages the approximate number of missing females could have been reduced by 423,320 persons (i.e., from current 2,857,404 to 2,434,084).

The mean age of the household members was 26 years in electrified, 24.8 years in the non-electrified villages, and 24 years in the non-electrified households in electrified villages. Two important inter-related findings having significant demographic implications are as follows: (a) The mean age of the female members of the electrified households is 1.3 years less than the male members, 25.3 and 26.6 years, respectively. In the non-electrified villages the female mean age is 1.6 years less than their counterpart male members (24 and 25.6 years respectively). This relatively low female age in the non-electrified villages can be explained through relatively high proportion of women in the younger age group and relatively low proportion in the older age group. (b) The proportion of both male and female in the higher age group (45+ including the older age 60+) was relatively high in the electrified compared to those in the non-electrified. As for the younger age group (up to 14 years of age), the proportions of both male and female in the electrified were lower than those in the non-electrified households. Thus, young age structure was more pronounced for the non-electrified than the electrified households.

The average household size of the electrified households is slightly higher (6 person per household) than that in the non-electrified households (5.4 and 5.7 respectively for those in the electrified and non-electrified villages). It is most likely that, this slightly high average household size of the electrified household is due to less poverty-induced out-migration of family members, higher incidence of joint-family structure, and job opportunities in the electrified areas.

The dependency ratio is lowest (0.64) in the electrified households, highest (0.73) in the non-electrified households of electrified villages and in-between (0.68) in the households of non-electrified villages. Thus, compared to the non-electrified, the same number of active population supports a smaller number of dependent population in the electrified households.

Estimates show that availability of electricity in the household contributes 15.7% in the reduction in overall total fertility rate (TFR) (comparison of TFRs in two extreme samples), but availability of electricity in the village but not in the household contributes only 2% in the reduction in TFR.

The TFR of poor in the electrified (2.7) was 26% less than that of the poor in the non-electrified villages, and it was even 7.5% less than that of the rich in the non-electrified villages (2.9). Thus, electricity not only contributes to declining overall TFR, but also contributes significantly to reduction in TFR among the poor.

The survey provided a number of indications about the urbanization of rural life in the electrified areas, as evident from the analysis of the pattern of household expenditure, and asset situation of the electrified households. The qualitative survey gave positive indications about high incidence of in-migration in the electrified areas.

During the last five years, a total of 966 persons have migrated-out from 2491 sample study households. Most out-migration was associated with marriage (ranging between 61% in HE and 72% in WE-NEV), followed by job (22% in WE-NEV and 33% in WE-EV), and education (4.3% in WE-EV, and 6.1% in HE and WE-NEV each).

A new phenomenon of in-migration into the electrified village has been reported. Many have said that, because of electricity, new economic activities have emerged, which has created more employment opportunities, and that, in turn, gave impetus for people in the non-electrified villages toward electrified villages for work. The occupational pattern has changed in the electrified villages. In addition, due to the availability of improved educational and health facilities people are also attracted toward electrified villages. Electrified villages have better agricultural facilities due to electricity-driven equipments for land preparations, irrigation, threshing, husking and demand for labour during harvesting has increased. All these have been instrumental in reducing out-migration for job from electrified villages, and in increasing in-migration (both temporary/seasonal and permanent) to electrified from non-electrified villages. Because of the combined effect of all these factors mediated through rural electrification a tendency has been developed among people to shift their residence from non-electrified to electrified villages. As a result, the price of land in the electrified villages has increased.

IMPACT ON DIRECT USERS OF DOMESTIC ELECTRICITY: CONSUMER PREFERENCES, DEMAND, BENEFITS, PROBLEMS OF SUPPLY INTERRUPTIONS, AND WILLINGNESS-TO-PAY MORE

The average amount of expenses incurred for domestic connections was Tk.1,480 per household with Tk. 253 to the PBS (as membership fee and guarantee deposit), Tk.953 for purchase of wiring materials, Tk. 218 for wiring charges (to technician), and Tk. 55 for 'other' purposes. Thus, the one-time capital expenditure required to get domestic connection is about US\$26, with 64% for wiring materials and only 17% to the PBS. Thus, as capital expenditure for domestic connections, rich spent 48% more than the poor, and the most part (73%) of the increased expenditure was due to the wiring materials and related charges. The policy makers should note that this amount of one time cost of connection, equivalent to just 4.2% of the annual net income of the landless non-electrified households in the electrified villages, is relatively low.

As a means of household lighting, all the consumers prefer electricity to any other means. Before having electricity, as means of lighting, 51% had the habit of using lantern and 49% *kupee*. They used to light the lanterns/*kuppes*, on average, for 3.05 hours per night. Now, with the electricity in households, they use electricity, on an average, 4.6 hours per night for lighting. This means, on average, electrified households now have 1 hour 33 minutes additional lighting hours available for leisure and/or for income generation activities. Thus, compared to before electricity, they now have 51% more time for lighting per night. Among all the economic (landowning) categories, the landless households reported highest extent of change: 55% more lighting-time now than before electricity.

Consumers of electricity reported use of both tungsten bulbs and fluorescent tubes. **Considering a total of 3,413,825 domestic RE connections, the approximate number of**

total tungsten bulbs in use would be 12.6 million and the number of fluorescent bulbs 1.54 million.

The estimated average number of various electrical appliances purchased per 100 households was as follows: 168 fans, 53 TVs, 46 cassette players, 30 irons, 5 refrigerators, 4.3 mobile phones, and 2.4 juice machine. **Estimates show that nation-wide, due to REB (with 3413825 domestic connections as on June 2002), the total number of various electrical equipments sold (indication about the market) would be 5,735,226 fans, 1,795,672 TV, 1,570,356 cassette players, 1,010,492 irons, 170,691 refrigerators, 146,794 mobile phones, 81,500 juice machines, and 9,900 toasters.**

The future market for electrical appliances would be a huge one: the market for refrigerator would be 6 times higher than now, the market for charger lights will increase by 4.2 times, the market for TV will increase by 61%. Increase in the number of domestic connections will further expand the market for electrical appliances, and thereby, will have enhanced impact on people's standard of living and quality of life, by way of increased latent demand for modernization of rural life.

The source(s) of purchase or procurement of the electrical appliances now possessed by the households indicate development of relevant market close-to-consumers. This also indicates an expansion of employment opportunities in the commercial establishments selling and repairing electrical appliances.

The consumers prefer electricity for seven different reasons/purposes (proportion of reporting being different): for the quality of light, comfort, more time for household chores, watch TV, listen radio, and iron cloths and generate more income. Another prominent benefit of electricity was the availability of longer work hours and leisure due to lighting.

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.

Eighty seven per cent of the consumers (domestic) never faced problem of disconnection associated with the non-payment of bills. About 13% had experienced a disconnection for non-payment of bills. Further probing has shown that, 23% of the respondents ever faced trouble in paying the bill. Three reasons were mentioned: 67% could not pay due to want of money, 14% each did not get the bill in time and got incorrect bill. Thus, two notable issues are in order:

First: A 28% of those having had trouble in paying bills (6.5% of all consumers) were due to the causes associated with PBS management (incorrect bill or disbursement of bill not in time). This implies that, at least 28% of the problems associated with bill payment or delayed payment can be resolved by improving the relevant management parts of the PBSs.

Second: A 67% of those ever experienced trouble in paying bills (15.6% of all consumers) were associated with the non-availability of cash at the time of bill payment. Compared to the rich segment of the consumers, a higher proportion of the poor has mentioned so. However, based on this findings, it would be difficult to draw any firm conclusion about what can be done by PBS to resolve the issue. This is at least because of two reasons: (a) the average amount of bill is not so high as compared to the income (for landless category, monthly bill would be at best 4% of monthly income), (b) uninterrupted or irregular cash flow is a reality among many in the rural

areas. Cash-flow has a seasonal characteristics in the rural areas, and that especially among the poor.

Irregularity of power supply and load shedding are acute problems in REP. About 85% of the customers have said, power supply irregular. Of these, 72% said that such irregular power supply is almost a daily affair. 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.

A large number of the domestic consumers are willing-to-pay more for electricity than now providing better quality is ensured. About 45% of the consumers have expressed their willingness-to-pay more for electricity providing their is no power fluctuations and round-the-clock availability of electricity is ensured. On average, the customers are willing to pay 7.42% more amount than now if better quality of services are guaranteed

An average household pays Tk. 147.22 per month as electricity bill. Assuming this rate to be true for overall REPs domestic connections, the estimated annual revenue comes to Tk.5,007 million (for 3,413,825 domestic connections, June 2002). If better quality of services are ensured (i.e, no power fluctuation and round-the-clock availability of electricity) and people pay as per their willingness-to-pay more, then the estimated amount of annual revenue from domestic connections would be Tk. 5,378.5 million, i.e; an annual increment of Tk. 371.5 million. It is most likely, if quality of electricity supply is really ensured, the actual extent of increment in the revenue will be much higher than the estimated Tk. 371.5 million.

DEMAND FOR ELECTRICITY AND REASONS FOR NOT HAVING ELECTRICITY

Around 94% of the non-electrified households have expressed their willingness to have electricity in their households. Respondents showing willingness to have electricity at their households reported multifarious reasons for such willingness. A close scrutiny of the reasons shows that people's demand for electricity at their households is primarily determined by both the socio-cultural and economic needs associated with desire for enhanced quality of life.

According to our estimates, 17.88% of the rural households in Bangladesh have electricity connections, and 65% of the households in the villages with electricity do not have access to electricity. What are the reasons for households' inaccess to electricity even in the electrified villages? The reasons reported include financial insolvency, hassles to get connection, non-inclusion in PBS master plan, paid membership fee long ago but not yet connected, paid money but not yet connected, hassles of regular payment of bill, and completed wiring awaiting connection. The reported reasons show a pattern worth further analysis: Some will get the connection soon (those who paid money and completed wiring); many will not get connection because of their financial insolvency and because of non-inclusion in the master plan; and many are less interested due to the hassles in getting connection as well as hassles of paying the bill on a regular basis. Thus, two categories of problems can be resolved with PBS management intervention, and thereby, increase the number of direct beneficiaries of electricity: those who

paid money and completed wiring, and those who have reported various forms of hassles associated with getting connection and paying the bills.

In general, people in the non-electrified households are not adequately aware about the costs associated with household electricity. About 50% of the respondents in non-electrified household are fully unaware about the one time amount of money (investment) required to get electricity connection. About two-fifths of the respondents in the non-electrified households are unaware about the approximate amount of monthly bill to be paid for domestic use of electricity. About 91% were found unaware about the per unit tariff for domestic use of electricity. The extent of unawareness about the unit tariff was more pronounced among the poor than among the rich landowner categories. **Thus, inadequate knowledge about one time investment, approximate monthly bill and unit tariff were highly pronounced among the respondents in the non-electrified households, implying that dissemination of these information would be necessary to make activities more transparent, which, in turn, will facilitate people's informed decision-making in having electricity connections at their households.**

IMPACT ON POVERTY REDUCTION AND HUMAN DEVELOPMENT

About 40% of the population in the electrified households are below **absolute poverty line**. The corresponding figures for the population in non-electrified households of electrified villages is 51%, and that for the population of non-electrified villages is 43.4%. Compared to the national level of absolute poverty (44.3%) the electrified household's level is 11% less implying that electricity has contribution in poverty reduction.

Like absolute poverty, the **hard core poverty** was also most prominent among population in the non-electrified households in the electrified villages (27.1%). In the electrified households, 21.8% of the population were found below the hard core poverty line. The corresponding value for the population in the non-electrified villages was 23.1%.

The incidence of cost-of-basic needs (CBN) poverty shows that both the lower and upper poverty lines are much less pronounced for the electrified households than the non-electrified households. The high incidence of both lower and upper poverty among the population of non-electrified households, and high gaps in those incidences between the electrified and non-electrified households with electrified households showing the least incidences (51% less in lower poverty line and 37% less in upper poverty line) signify that access to electricity in the poor households (not in the villages only) had much impact in poverty reduction. **Thus, ensuring poor people's (households) access to electricity should be assigned with high priority in any future poverty reduction strategy for the rural Bangladesh.**

In terms of incidence of poverty, one of the most interesting findings was the positive relationship between the age length of electricity in the household and the declining incidence of absolute poverty. 42.4% population in the households with 3 years of age-length of electrification are poor (below absolute poverty line), which drops down to 37.1% if the household age-length of electrification is 4-5 years, and further falls down to 33.9% if households electrification age is 6 years. This is quite a revealing finding, which shows that electricity influences poverty reduction, overtime, with a gestation period.

Human Development Index (HDI) values obtained for electrified household is 0.642, for non-electrified households in the electrified villages is 0.440, and for non-electrified households in the non-electrified villages is 0.436. Based on the analysis of HDI of 3 categories of sample households, the following inferences are in order:

First : The HDI for electrified households (HE) 0.642 is substantially higher than the overall HDI of Bangladesh (0.478). The electrified households' HDI corresponds to the lower-mid-level index for medium HDI countries. This implies that, by ensuring 100% access to household electricity in the rural areas, Bangladesh may raise its HDI ranking substantially from current 145th position to a position of around 100 (corresponding to the ranking of such countries as Egypt, Bolivia, Indonesia, Honduras). **Thus, electricity's potential impact on enhancement of national HDI could be very significant.**

Second: Even the non-electrified households in the electrified villages (WE-EV), which are predominantly poor, represents an HDI almost similar to that of the Bangladesh country average. The former category's HDI value is even higher than the households in the non-electrified villages (which are economically better off than the non-electrified households in electrified villages). This imply that, HDI increases with the village level electrification even when household's access to electricity is denied. This, as found in the survey, is most likely influenced by the relatively low infant mortality rates and higher combined gross enrolment.

Third: The differences in HDI values between the electrified HHs and the non-electrified households in the electrified villages is 45.9%; between the non-electrified households in the electrified villages and the non-electrified villages is less than 1%, and that between the electrified households and the households in the non-electrified villages is 47.2%. This implies that, provisioning of access to electricity for the non-electrified households will have spectacular impact in raising HDI in Bangladesh. **Thus, village electrification without electrifying the households will have not much effect on improving human development and increasing HDI values. Or, in other words, universal rural household electrification will have spectacular impact on human development in rural Bangladesh.**

To recapitulate, electricity at the household level impacts upon almost all economic variable, improves living standard and quality of life, and reduces poverty.

- 1) Both absolute poverty and hard-core poverty are significantly less pronounced in the electrified than those in the non-electrified households.
- 2) Electricity contributes to income-poverty reduction. The average annual income (last year's) of the electrified households (Tk.92,963) is much higher (65%) than that in the households of non-electrified villages. The annual income of the poor (landless category) in the electrified (Tk.58,864) was around 50% higher than that in the non-electrified households.
- 3) Electricity has income-enhancing effect. 16.4% of the income of electrified households can be attributed to electricity. The corresponding figures for the non-electrified households in electrified villages was 12% and for those in the non-electrified villages only 3.6%. Other things being the same, 100% electrification of rural households (currently 17.88% of rural households are electrified) might increase the annual rural income by Tk.671 billion (which is equivalent to the 26% of the current GDP), and as high as 43% of this incremental income can be attributed to electricity.
- 4) The electrified households are much better-off than the non-electrified ones in terms of all human development indicators, namely human longevity (measured using infant mortality rate as proxy), human knowledge, and per capita real income. Bangladesh is a low HDI country (ranks 145 out of 173 countries) but the HDI value for electrified village-segment corresponds to the medium HDI countries such as Egypt, Indonesia, Honduras, Bolivia.

Thus, ensuring household access to electricity alone can be seen as a necessary precondition to significantly improve human development scenario of Bangladesh.

- 5) Electricity contributes significantly in asset-building of the poor. The cultivable landownership distribution is less skewed in the electrified than in the non-electrified – the bottom 40% of the electrified households own 3.7% of total cultivable land, whereas the bottom 40% of the households in non-electrified villages own only 1.6% of the total land. During the last five years, changes in the land ownership of the bottom 40% was more progressive in the electrified households than in the households of the non-electrified villages. The gini-concentration ratio of cultivable land ownership was 0.61 for electrified and 0.67 for non-electrified segments. Similar changes (during the last five years) in favor of the poor in the electrified households as compared to the poor in the households of non-electrified villages were evident in the ownership of other capital assets—dwelling/non-dwelling rooms, livestock and poultry, agricultural equipments and household durable.
- 6) Electricity has had significant impact in strengthening the socio-economic foundation and in improving the quality and living standards of the people in the electrified households. This has been amply reflected in the dynamics of self-assessed poverty status by the respondents.
- 7) Electricity has major demographic impacts. The population growth rate in the electrified household segment is less than that in the non-electrified. This is evident from the relatively low total fertility rate (TFR) as compared to the non-electrified segment. Young age structure and dependency ratios were relatively less pronounced in the electrified than those in the non-electrified household. Electricity in the household contributed 16% of the reduction in TFR. The TFR of the poor in the electrified household is 26% less than that of the poor in the non-electrified villages. As compared to the non-electrified villages, in-migration was much more pronounced in electrified villages mainly due to access to electricity and other associated modern amenities. Population survival rate is higher in the electrified than in the non-electrified villages. Among others, this is evident from the relative low infant mortality rates in the electrified, 42.7/1000 live births against 57.8/1000 live births in the non-electrified villages.
- 8) Electricity has played an immense role in improving people's overall health status, especially for those in the electrified households, and more so for the poor, women and children. The electrified households are much better endowed than the non-electrified households in the electrified villages and significantly better-off than the households in the non-electrified households in terms of the following health indicators: awareness of crucial public health issue, seeking treatment by medically competent person while sick, use of medically trained persons in child delivery, accessing ANC and PNC check-ups, use of TT immunization, seeking treatment of medically competent persons in maternal morbidity, rate of full immunization of children (vaccines against 6 diseases), aversion of infant deaths, intake of Vit-A capsule to prevent nightblindness among children, use of family planning methods, use of hygienic latrines, use of hand washing materials after defecation. In all these indicators, not only that the rich-poor divide was less pronounced in the electrified compared to the non-electrified households, but also the poor (landless) in the electrified have shown much better health outcomes than their counterparts in the non-electrified households, especially than those in the non-electrified villages.

- 9) Electricity has significant influence on education, especially on quality of education. This influence is much more pronounced among the poor and girls in the electrified households than the poor and girls in the non-electrified households. Compared to the non-electrified, the electrified households fare much better in terms of overall literacy rate; adult literacy rate; enrollment ratio; expenditure on education; performances in terms of examination results, attendance rate, dropout, and average time spent on study (after sunset, 6 PM). The overall literacy rate in the electrified (70.8%) is 26% higher than that in the non-electrified households. The same for the female is 31% higher: the rates being 65% in the electrified and around 49% in the non-electrified. The rich-poor gap in literacy is 20% in the electrified households, but it is as high as 60% in the households of non-electrified villages. The literacy rate among the poor in the electrified (66%) is about 41% higher than that of the poor in the non-electrified villages. The similar pattern holds true for adult literacy. In addition, the average annual household expenditure on education was 87% higher in the electrified (Tk.3,260) compared to that in the non-electrified villages (Tk.1,746).

IMPACT ON IRRIGATION AND AGRICULTURAL PRODUCTION

In agriculture, REP has contributed significantly in attaining food self-sufficiency through use of productive and efficient irrigation equipments, and generated stable employment opportunities.

Electricity powered irrigation equipments, on average, cover 10 acres more net area, 12 acres more total area, and 3 acres more new-to-irrigation area as compared to the diesel operated irrigation equipments.

Average number of days of irrigation in last year for DTW-E was 130 days, for DTW-D 128 days, STW-E 114 days, STW-D 117 days, LLP-E 112 days and LLP-D 82 days.[>]

Land use intensity under irrigation of electricity powered equipment is higher in comparison with diesel operated ones' except for STW.

94 % of total cropped area of the sample plots under electrified irrigation is engaged in cereal cultivation. Of all cropped areas under DTW-E, the largest part is used for cereal production. Similarly, 94% of total cropped area under STW-E are engaged in growing cereals. Potato is also being grown in areas under STW-E. Jute, Masur, Mustard, Cauliflower, Tomato, Melon are being grown in 2% of the total area under the same type of irrigation equipment. 100% of total cropped area under LLP-E is being used for cultivation of rice. Rice is being cultivated in 96% cropped area under DTW-D. Potato being grown in 3% of cropped area and Bean in 1% area under DTW-D. In the total cropped area under STW-E, 94% of area are being used for cereal production, 5% for Potato, and 1% for Chilly. 80% of total cropped area under LLP-D deals with Boro, and for Aman.

The above reveals that with the development of irrigation facilities, Boro cultivation has grown up significantly and it pushed out other variety of rice. **The commendable achievement of the country towards relative food self sufficiency have been made possible because of shift towards HYV and especially high yielding Boro followed by HYV Aman at a massive scale. The contribution of REP in attaining the same can be attributed to the facts that REB has ensured uninterrupted supply of water through more than 103 thousands of**

[>] DTW= Deep tubewell, STW= Shallow tubewell, LLP= Low lift pump, E= Electricity powered machine, D= Diesel operated machine, HYV= High yielding variety, WTO= World Trade Organization.

electricity operated irrigation equipment to approximately 2.3 million of acres of land under HYV Boro and HYV Aman.

Average, yield per acre (productivity) under electricity powered irrigation is 24 % higher than that of diesel operated ones.

Cropping intensity in plots using electrically powered irrigation is 193, the corresponding figure for plots irrigated by diesel is 191 and for plots with no irrigation or rain-fed is 181. It implies that electrified irrigation intensifies the land use by 12% points more than rain-fed/no irrigated land, while diesel powered irrigated land intensifies by 10% points.

Electrified irrigation equipment in general are 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. Maintenance cost ranges between 7-10 % of operational cost, cost of repairing for an average electricity operated equipment is almost one and a half less than that of diesel operated one.

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 employment have been created through out 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. It is once again established that HYV crops and HYV Boro has been greatly facilitated by Rural Electrification contributing to spectacular growth in food production and thereby growth of Gross Domestic Product in the country. Therefore, in order to secure further growth in food production, particularly in the backdrop of WTO considerations, where countries are supposed to capitalize on their competitive advantage-electricity as a source of power needs to be made widely available in the rural areas of the country.

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.

IMPACT ON INDUSTRIAL DEVELOPMENT

Industry is the second highest consumer of rural electricity using 42.3% of the total MWH. During the last twenty years (1983-2002), the total number of industrial consumer of rural electricity has increased 3210 times and the average number of industrial connections per PBS has increased 550 times.

A substantial growth in industrial output (both in terms of volume and value) has been identified in the study. During last five years, the growth in value was about 295% in electrified industries. The total volume of output (in terms of ton) has increased by 78 percent, while the same growth was only 8 percent in non-electrified industry. The volume of output in terms of piece unit (other than ton and maund) grew up by 121% in electrified households, and it was -0.44 percent (negative) in non-electrified industries during the last five years.

The total employment in 63,220 industries in 67 PBSs is 983,829. Electrified industries, on average, generate 11 times more employment than the non-electrified. During the last five year, the overall growth in employment in electrified industries was 52.8% with 41% for male and 121% for female. But the growth of skilled labour force was 78.6% with 55% for male and 417% for female labors. The total growth in employment in non-electrified industries during this period was 28.6% with 16.2% for male and 56.3% for female. The increase in the number of skilled labor was 41% with 11% for male and 170% female. The male labour force of electrified industry (last year) shares 79% of total working hours, and the same was 70% in case of non-electrified industries.

Electrified industries are both cost-efficient and productive. The average cost of production is Tk. 0.65 to produce output of one Tk. for electrified industries while the same was Tk.0.84 for non-electrified industries. Similarly the productivity in electrified industries is Tk.131.07 per hour and in non-electrified industries Tk. 45.38 per hour. The low cost of production and high productivity have also reflected in the net revenue of the electrified industry which amounted to Tk. 302.4 billion, last year. All these indicators – productivity, low cost of production and high profit, indicate the efficient performance of electrified industries over the non-electrified industries.

RE connected industries have strengthen the local industrial base by promoting backward and forward linkages and diversification which later forms agglomeration by attracting and generating diversified services. The study shows that 3 industries were expanded through backward and forward linkages, another 13 went for diversification, and 9 expanded through sub-contracted arrangements. The shares of these industries are not much pronounced compared to the total RE connected industries. But once this process has started, it would be intensified in the future.

All these highlight the significant contribution of RE connected industries and underscore the need for further expansion of rural electrification for a rapid growth of industries. In view of the above stated, the following suggestions can be forwarded for policy-scrutiny:

- 1) The rural electrification should be expedited to cover more villages and areas.
- 2) The local bazar or village market should be brought under rural electrification with utmost priority to provide incentives for establishing small and cottage industries, which, *inter alia*, will act as a powerful factor to stop or minimize the rural-push migration.
- 3) The quality of supply should be improved and load shedding should be brought under minimum levels without increasing the tariff, initially.
- 4) Those people who have successfully expanded their industries with the RE- connection should be encouraged to contribute to the Board of Management.
- 5) In the north and southwest region, expansion of many RE connected industries are inhibited due to the absence of gas supply. REB may take initiative to speed up the process of gas-based electricity production and distribution in the north and southwest regions for accelerated industrialization.
- 6) Local agro-based industries should be encouraged to generate more income and employment in the country, and thereby facilitate the process of minimizing forced rural-to-urban migration.

- 7) More security measures should be adopted to save the rural consumers from accidents caused by electricity.

Rural electrified industries have been playing a pivotal role in changing the living condition of the rural people whose fortune was tied-up with subsistence agriculture till the coming of rural electrification. More and more people have been shifting their traditional stereotype business to the more dynamic industrial venture. Development of agglomeration resulting from industrial concentration in many rural areas, generated income and urban facilities and thus contribute in reducing the rural-urban gap.

Modernization of agriculture has taken place during the last twenty years. Such modernization has augmented the output, in one hand, but ousted many small and marginal farmers, on the other. This process of uprooting has been accelerated and aggravated by population pressure, river erosion and many other natural calamities and man made reasons. Rural electrification has, to some extent been able to absorb these ousted people in their concerned areas. But the most striking feature in this process is the participation of many female labors of both skilled and unskilled, who otherwise have been confined to household work.

IMPACT ON COMMERCIAL ACTIVITIES

Rural electricity has acted as a leap-forward in the development of commercial activities in rural Bangladesh. Out of the total shops in Bangladesh an estimated 24% are using rural electricity.

Electrified shops are more attached to market and wholesale shops are all the more attached to marketplace. In some cases availability of electricity has given rise to constellation of shops, on other cases already existing constellation of shops have been served with electricity.

Quite a number of electrical appliances are used in the shops and they are found to be profitable. Fridge is spectacular in its contribution both financially and emotionally.

Business turnover be it daily, weekly or monthly for electrified retail shops are more than double than that of non-electrified. For wholesale electrified it is eleven-fold. Similar is true for volume of business, business hours, volume of customers, employment of electrified shops then non-electrified. Generally, the traders of electrified areas appear more vibrant than those of non-electrified. Sometime electricity appear as world-view, as an outlook, as status symbol and all pervasive 'source of power'. More professional approach toward business is visible among electrified traders than non-electrified.

Those traders who are yet to get the benefit of electricity are ready to invest for electricity as they think it worth from the business point of view.

Estimates pertaining to the contribution of rural electricity on sales turnover of retail and wholesale shops reveal the following:

- 1) In case of electrified retail shops, rural electricity's contribution to the additional sales turnover is 34.51% and the same to the overall sales turnover is 17.26%.
- 2) In case of electrified whole sale shops, rural electricity's contribution to the additional sales turnover is 15.08% and the same to the overall sales turnover is 11.23%.

- 3) For overall Bangladesh, the total annual (2001) sales turnover of retail and wholesale shops is Tk.1274.1 billion of which RE connected shops' share is Tk.301.2 billion i.e; RE connected shops contribute 23.64% of the total annual sales turnover of all shops in Bangladesh.
- 4) Most importantly, out of the total annual (2001) sales turnover of retail and wholesale shops in Bangladesh (Tk.1274.1 billion) rural electricity's share is Tk.174.9 billion, i.e.; rural electricity's contribution (through commercial connections) to the national overall annual sales turnover of retail and wholesale establishments is 13.72%.

As there is clear impact of electricity on trade and business with presumable multiplier effect, electricity should be made widely available in rural areas.

Cost-benefit considerations at a given point in time may not be encouraging but given the longer benefit with multiplier effect - investment in generation and distribution of electricity is strongly recommended.

Although complain resolution rate at PBS is commendable (97%), customer care on the part of REB-PBS is not much praiseworthy. The whole approach of REB should be more customer-oriented and toward that, the PBSs need to be activated further.

Those who are yet to get electricity have been found to use diesel generators for lighting and other purposes. REB can think of better-options, other than electricity, for them.

Need for electricity is there but demand is yet to emerge. REB can think of networking with local organizations, associations to translate those needs into effective demand.

PBS: IMPACT ON LOCAL GOVERNANCE AND DEMOCRATIZATION

PBS members elect the Board of Directors by direct voting which creates an opportunity to build a social network among the users and to have control over the mechanisms that allow their voices at the PBS management level. Since electricity created congenial environment for political and social gathering, community and courtyard meeting, people spend longer period in union council, clubs, cooperatives and *samities* and strongly participate in local level decision making.

Less than one-third of the PBS members (29.6%) were found to know the eligibility criteria to be a Director, about one-fourth (23.9%) of the PBS members reported to attend the last AGM and majority of the PBS members (65%) never casted their vote. Mentioned reasons for not participating in PBS election were – distance of PBS election centers from the household, lack of time and transport fare etc. Majority of the PBS members (60.3%) appeared to be ignorant about the roles of the elected directors in PBS management. The rate of attendance in last AGM by the PBS members of the electrified villages is low (23.9%).

Majority of the respondents (70%) in electrified villages reported that PBS played useful role for members. The average number of complains were 7199.81 per PBS in 2000 and the number of complains resolved were 6987.85 (97.1%). The number of complains per PBS and the percentage of those resolved proves the nature of accountability to the PBS members and level of efficiency.

Local governance contributes to the required scaling up of the rate of poverty reduction through enhancing the developmental choices available at the local level and a better inclusion of all social groups in these choices. PBS system is one of the best existing models of local governance and decentralization in Bangladesh. The model of PBS can be replicated in other sectors of development and resource management for the better future of Bangladesh.

To achieve the objective of rural power supply for poverty reduction, governance system of PBSs should be improved and democratization should be the norm of implementing the PBSs' activities. The following recommendations are advanced to improve good governance of PBS and to strengthen democratic practices in PBS management:

- 1) To strengthen local governance and to ensure transparency and accountability, the "Best Actors" of human governance should be involved for development of PBS.
- 2) The motivational and awareness activities for the PBSs members to make them aware of the rights and obligation should be strengthened.
- 3) Since the poor have weak social networks and they are excluded from mechanisms that allow their voices to be heard, PBS can play an important role in building trust and norms for coordinated actions to extend people's freedom and to exercise choice by creating institutional structures that in turn create capabilities.
- 4) All the electricity users should be the members of PBS for better participation in local level planning, decision-making and implementation.
- 5) Constraints of participation in PBS election faced by the PBS members should be eliminated.

RECOMMENDATIONS

1. Based on the empirical findings of this Study it would be pertinent to conclude that rural electricity has profound and far-reaching economic, socio-cultural and demographic impacts on life and living of the rural people in Bangladesh. Access to rural electricity has significant and sustained impact on the reduction of both income-poverty and all dimensions of human poverty (health, education, women empowerment). The Study's findings also indicate that rural access to this commodity has deep-rooted impact on agricultural development, industrialization, and business and commercial activities. In addition, it has impact on human capital formation through knowledge building mediated through electricity-driven media exposure. Thus, in order to accelerate the process of economic growth, strengthening pro-poor orientation in growth process and to further human development in Bangladesh, access to electricity of the households and social and economic institutions should be expanded within shortest possible time.
2. Vigorous efforts are needed to devise appropriate strategies (means and ways) to increase the coverage of the non-electrified households in the electrified villages (65% households in the electrified villages, which is equivalent to 33.5% of all rural households in Bangladesh) in to the scheme of the rural electrification program. This will contribute to both increasing socio-economic impacts as well as improving the financial viability of the PBSs.
3. Special policies and strategies should be designed and implemented to accelerate the process of poor peoples' access to electricity.

4. Analyses of numerous and diverse impacts of rural electrification provide adequate logical basis to argue that rural electrification should be given top most priority as a catalyst for ensuring accelerated human development, poverty reduction and economic growth in Bangladesh. Therefore, rural electrification should be viewed as the cornerstone of national poverty reduction strategy.
5. Due to the richness in content and diversity, and potential high knowledge-building and policy utility (for almost all economic and social sectors) of the Study, the findings should be widely disseminated for both awareness raising amongst the masses of people and for policy advocacy purposes among both the development partners and high level policy makers, including those amongst the people's elected representatives. To expedite this dissemination process to these different target populations, the production of relevant materials in the form of short films, documentary, booklets would be useful.
6. It is due to the innovative nature of the study design that the methodology used in the Study should be disseminated among the relevant research community — both at home and abroad. An in-depth understanding of the study methodology will be of high utility for the capacity building of REB staff members who are involved in the designing and evaluation of socio-economic impacts of rural electrification. The dissemination of this innovative study design would be useful for all RPPR partners and other stakeholders in their quest for developing the system for measuring impacts under the RPPR Program.
7. The production and publication of research-based books – one in Bangla and the other in English – on the subject “Economic and Social Impact of Rural Electrification Program in Bangladesh” would be useful for a broader audience. This would be the first of its kind in Bangladesh and perhaps elsewhere as well.
8. The empirical data-base produced in this Study is huge, and of high quality in terms of accuracy and depth. This database should be profitably used in the future as a baseline and/or as a benchmark for all subsequent socio-economic impact evaluation studies of rural electrification in Bangladesh.
9. Considering the availability of a wealth of data produced in this research and prepared in a working database, it is highly recommended that all possible secondary analyses be conducted for better understanding of many dimensions of relevant impact to expedite the process of informed policy and decision making by the concerned authorities. Secondary analyses are also suggested to strengthen and generate a new knowledge-base on the subject.
10. The knowledge gap of all stakeholders about various relevant dimensions of the impact of rural electrification is still considered to be high. Thus, in order to minimize this knowledge gap, further more focused and in-depth studies should be launched on areas of specific interest, such as migration and rural electrification, the relationship between poverty reduction and age-length of domestic connections, the relationship between willingness-to-pay and quality services, electricity's role in improving people's health, relationship between electricity and mortality and morbidity, electrification's role in empowerment of women, and the PBS as a good governance model. These studies should be conducted on a priority basis, in which poverty reduction, production, and human development areas should be assigned as the top priorities.

11. The development needs of the entire Bangladesh Rural Electrification Program and the probable requirements of the donors and development partners will likely require similar large-scale impact assessment studies to be conducted in the future on a periodic basis with the recommended interval being a minimum five years.
12. In order to expand the concept of sharing best practice experiences worldwide and to lend support to the partner-countries, all members of the donor community and other development partners involved in rural electrification, such as NRECA, could gainfully utilize the innovative design and methodology of this research to study economic and social impact of rural electricity programs in other countries such as Costa Rica, Bolivia, Philippines, India, Indonesia, Vietnam, Nicaragua, Ecuador, Panama, Ghana, El Salvador, etc. The national research and policy partners in these partner countries can be trained on this Bangladesh Methodology, which will also contribute to their own national capacity building efforts.