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Rural Electrification in Bangladesh: Management, Engineering, and Financial Assessment

Barbara Deverick
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RURAL ELECTRIFICATION IN BANGLADESH: MANAGEMENT, ENGINEERING, AND FINANCIAL ASSESSMENT

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CONTENTS

LIST OF TABLES xii
LIST OF FIGURES xii
ABSTRACT ix
1. Summary and Recommendations 1
1.1 Introduction 1
1.2 Summary of Major Findings and Recommendations 4
1.2.1 Management System 4
1.2.2 System Planning and Engineering 9
1.2.3 RE Tariffs and Energy Sector Pricing 11
1.2.4 Technical Assistance 13
2. Management and Training 15
2.1 Interagency Relationship 15
2.1.1 Current Dynamics of Interagency Relationships . . . 15
2.1.2 Effects of Interagency Relationships on PBS and REB Operations 19
2.1.3 Recommended Changes in Interagency Relationships for Improved REB and PBS Operations 19
2.2 PBS Operation 20
2.2.1 Comparison of Actual Management of PBS with Guidelines for the Ideal Cooperative. 20
2.2.2 Changes to Existing Management Systems 24
2.3 Customer and Member Relations 26
2.3.1 Current Governance of PBS by Members 26
2.3.2 Response of PBS Management to the Membership . . . 29
2.3.3 Recommended Changes to Improve Customer/ Member Relations 30
2.4 Human Resource Planning at REB and in the PBS System . . . 31
2.4.1 Current Staffing Levels 31
2.4.2 Future Staffing Needs 33
2.4.3 Training Programs 34
2.4.3.1 Specific Training Needs 35
2.5 Technical Assistance for Management and Training 37
2.5.1 Current Impact of Technical Assistance 37
2.6 Conclusions and Recommendations for REB and PBS Management Capabilities 39
2.6.1 Overall Effectiveness in Relation to Objectives and Goals 39
2.6.2 General Recommendations Relating to Management . . 40
3. Engineering and System Planning 41
3.1 RE Project Goals and Objectives 41
3.2 RE Achievements 42
3.3 PBS Power Supply and Delivery 43
3.3.1 Forecasting 43
3.3.2 PDB Generating Capacity 45
3.3.3 Transmission System 47
3.3.4 Subtransmission System 48

CONTENTS (Cont'd)

3.4 PBS Demand Management 48
3.4.1 Load Shedding 49
3.4.2 Load Factor 49
3.4.3 Power Factor 50
3.4.4 System Loss 51
3.5 Electrical Equipment 51
3.5.1 Standards 51
3.5.2 Materials Handling 53
3.5.3 Equipment Procurement 55
3.5.4 Quality 57
3.5.5 Performance 60
3.6 Planning for RE III 62
3.6.1 Schedule 62
3.6.2 Construction of New PBS's 64
3.6.3 Intensification of Existing PBS's 65
3.7 RE III Intensification Capabilities 65
3.7.1 System Engineering and Design 66
3.7.2 System Operations Directorate 67
3.7.3 Equipment and Materials Directorate 68
3.7.4 Superintendents of Engineering Construction 68
3.7.5 PBS Assistant Manager for Construction and Maintenance 68
3.7.6 Summary 69
3.8 Findings and Recommendations 69
4. Energy Pricing and Financial Issues 75
4.1 Commercial Energy Use in Bangladesh 75
4.1.1 Consumption 75
4.1.2 Supply 78
4.2 Commercial Energy Pricing and Supply Costs in Bangladesh 80
4.2.1 Overview 80
4.2.2 Current Prices 81
4.2.3 Commercial Energy Supply Costs in Bangladesh . . . 88
4.2.4 Implications of Current Commercial Energy Pricing Policies 90
4.3 Subsidies Associated with RE 93
4.4 Financial Performance of PBS's 95
4.4.1 Operating Margins 96
4.4.2 Determinants of Financial Performance 100
4.4.3 Conclusions 100
5. Technical Assistance 105
5.1 Background 105
5.2 Impact of Technical Assistance on Institution Building . . 106
5.2.1 Overall Assessment of Technical Assistance 106
5.3 Duration of Technical Assistance 107
5.4 Funds Allocated for Technical Assistance 107
5.5 Number of Advisors 108

CONTENTS (Cont'd)

5.6 Types of Technical Advisors 111
5.6.1 Team Leader 112
5.6.2 Material Management Advisor 112
5.6.3 Maintenance/System Operation Advisor 112
5.6.4 REB Finance Advisor (1) - NRECA 113
5.6.5 Administrative Assistant (1) 113
5.6.6 Short Term Specialists 113
5.7 Assigned Tasks of Advisors 114
5.8 Findings and Recommendations 116

LIST OF TABLES

3.1	Achievements of the Bangladesh Rural Electrification Program (September 1985)	42
3.2	Five-year load forecast for all PBS's - July 1985	44
3.3	Bangladesh Rural Electrification Program implementation and construction schedule	63
4.1	Commercial energy balance, FY 83/84 (thousand metric tons oil equivalent) petroleum products	77
4.2	Bangladesh petroleum product prices (Taka/IG)	82
4.3	Natural gas tariffs	83
4.4	Bangladesh BPDB electricity tariff structure (Taka)	84
4.5	PBS tariffs by year	86
4.6	Average tariff revenues per kWh sold	89
4.7	Economic supply costs of commercial energy (1984-85)	91
4.8	Estimates of RE subsidies	94
4.9	PBS operating margins	97
4.10	PBS financial projections for FY 85/86	99
4.11	PBS energy consumption by consumer category	101
5.1	Funds allocated for technical assistance	108
5.2	Summary of technical advisors	111
5.3	Assignment of advisors tasts	114

List of Figures

3.1	Generation expansion program reserve margins	46

ABSTRACT

This report represents the partial findings of a five-member, multidisciplinary team requested by USAID to assess the progress of the Rural Electrification (RE) Program in Bangladesh. Four areas are assessed in this report: the effectiveness of the management system; the system planning and engineering capabilities; RE tariffs and energy sector pricing policies; and the effectiveness of technical assistance (TA).

The evaluation concludes that the Bangladesh rural electrification management program has been extremely effective and the major administrative units have successfully carried out their basic objectives and major functions. The Bangladesh Rural Electrification Board (REB), which has the major oversight responsibilities for rural electrification, has successfully developed the distribution cooperatives, called Palli Bidut Samities (PBS's), to the point where the local personnel can carry out their primary duties. Furthermore, the evaluation found that the REB has the engineering capabilities to carry out rural electrification in Bangladesh. The competency of the engineering staff is quite high and the experience being gained by the system planning and engineering staff should greatly add to the decisionmaking capabilities of the REB and PBS's over time.

The underlying economic soundness of the PBS's is improving as they mature. The financial performance is generally strongest in those PBS's which supply relatively large amounts of power to irrigation and industrial customers. However, it is likely that most PBS's will not be fully able to meet the current schedule of loan repayment and it appears unreasonable to require all PBS's to begin full repayment only five years after their organization. It is recommended that an attempt be made to tailor repayment requirements more specifically to the economic potential of the various PBS's.

The technical assistance has been successful in building the REB and PBS's into viable institutions. The duration of technical assistance required will be about 12 to 15 years; however, the percentage of funds allocated to technical assistance by total project funding by phase is declining. The number of advisors recommended is 20.

1. SUMMARY AND RECOMMENDATIONS

1.1 INTRODUCTION

This report represents the partial findings of a five-person, multi-disciplinary team requested by USAID to assess the progress of the Rural Electrification (RE) Program in Bangladesh. Four team members spent three weeks in the country, and one team member (responsible for the economic and social assessment) spent six weeks in Bangladesh. This assessment focuses on four areas: The effectiveness of the management system; system planning and engineering capabilities; RE tariffs and energy sector pricing policies; and the economic and social impacts of the implemented program. In particular, the areas the team was asked to assess, and which are contained in this report are as follows:

- Management System:
  - The relationship of the Palli Bidut Samities (PBS's) to the Rural Electrification Board (REB) and other Bangladesh Government (BDG) institutions. Prospects for enhanced financial and managerial self-sufficiency in the short and medium term, and for autonomy in the long run.
  - Effectiveness in day-to-day operations--accuracy of accounts reliability of service, billing, collections, procurement, disbursement, etc.
  - Responsiveness to customer needs.
  - Recommended levels of Technical Assistance (TA) needed to achieve and maintain managerial capabilities necessary to plan

and operate a financially and technically viable electrical distribution system.

- System Planning and Engineering:
  - Capacity of the PBS's and REB to plan and carry out expansion of infrastructure and service delivery ("intensification") at PBS sites.
  - An assessment of existing plans for intensification at PBS sites.
  - Recommendations for implementation of infrastructure expansion and increased service delivery at PBS sites.
  - Recommended levels of TA needed to carry out planned construction and technical system maintenance for the entire RE program, including other donor funded PBS's, through the life of the project.
- RE Tariff and Energy Sector Pricing:
  - A review of pricing policies for other sources of commercial energy which compete with RE in rural areas.
  - A comparison of tariffs by consumer category in various PBS's, with an emphasis on how these tariffs help accomplish efficiency, financial, and equity objectives.
  - A review of non-tariff RE charges, e.g., connection/housewiring charges, etc., which affect consumer financial acceptance.
  - An assessment of the relation between RE tariffs and the economic costs of electricity supply.
  - A review of other existing or planned energy pricing studies.

An analysis of the economic and social impacts is contained in a separate report. The results of this assessment are to be used in the implementation of an anticipated Phase III of the RE program in Bangladesh. The RE program currently is concluding RE II, with the implementation of RE III to begin in fiscal year 1987.

RE is administered by the REB which oversees 33 PBS's, which are in various stages of development. The PBS's are cooperatives that provide electric distribution services to rural areas. The PBS's do not generate any electricity themselves, but buy all of their power from the government-owned Bangladesh Power Development Board (BPDB).

Seventeen PBS's have been funded by AID in RE Phases I and II. AID funding for RE III will provide commodities for an "intensification" of services provided by the existing AID-funded PBS's as well as provide technical assistance (TA) to the REB and the AID- and non-AID funded PBS's. It is expected that intensification will significantly enhance the opportunities for existing PBS's to become self-supporting, in that it will permit the PBS's to provide hook-ups to additional customers while minimizing changes to the existing infrastructure. The remaining sixteen non-AID-funded PBS's are expected to be assisted by other donor organizations in a like manner, although it is likely that between six to eight additional PBS's will be created over the next few years. However, it is clear that the focus of the overall program will shift from providing electricity to new customers outside the existing PBS's to providing service to a greater number of customers within the existing PBS's service areas.

A summary of the report's major findings and recommendations (underlined) is provided below. Details concerning the issues and recommendations are to be found in the remaining chapters. Chapter 2 is concerned with management issues, Chapter 3 with system planning and engineering, Chapter 4 with energy pricing and electricity tariffs, and Chapter 5 with technical assistance.

1.2 SUMMARY OF MAJOR FINDINGS AND RECOMMENDATIONS

1.2.1 Management System

- The initial organization of the PBS's by REB has been excellent. The PBS's appear to be following REB guidelines in most areas.
- It appears that because of the excellent reputation REB has among public officials and government agencies, as well as the public in general, and the general effectiveness of the Chairman and his staff, REB has little problem working with agencies of government at the national, regional, and local levels. The particular relationship among BPDB, REB, and PBS's also appears to be generally good.
- Overall, the directors in the REB appear to have excellent job knowledge and skills to apply their knowledge in carrying out their assigned responsibilities.
- The REB is thinly staffed. The REB Directorate of Finance should be divided into two directorates, one for finance and one for accounts.
- The training of REB and PBS staff has been very good, although some activities of personnel at the PBS's appear to be done by rote, without much understanding of the underlying principles. Follow-up instruction needs to be undertaken at all levels in order that

personnel will be able to cope with problems which arise that are out of the ordinary. In particular, additional training is needed for PBS personnel in operation and maintenance techniques for electric plant equipment, particularly substation maintenance, work order accounting, and materials management and control, as well as management planning and controls. Further training is needed for the local construction contractors utilized by the PBS systems to build short-distance lines. The REB should give thought to training personnel who can be located in the field along with the present superintendent of construction to provide timely technical services and assistance.

- The entire work-order procedure is not functioning appropriately and appears to have logical gaps in its application. Work-order accounting and training needs to be improved as soon as possible.
- The technical advisors are working with the REB and PBS personnel in the implementation of bank collections and to assure accuracy and timeliness of the bookkeeping, and that proper control is exercised by the PBS of the collection process. As the system of bank collection of electric service bills is perfected, it is recommended that more of the PBS systems adopt the system, where practical.
- There have been problems in identifying and appointing key managers in the PBS's, as some have to be replaced after a short period of time. Specific attention needs to be given to recruiting and training of General Managers and Assistant General Managers, with emphasis placed on interpersonal relations, team building, planning, and control.

- Responses and membership inquiries to member requests are made in a timely and effective manner by PBS personnel. Also, member complaints are recorded and handled in an effective way. Resolution of the complaint is recorded and the complaint is registered.
- Member rights have been effectively addressed in RE I and RE II, and member participation in PBS's activities has been excellent. More attention needs to be given to communication between PBS management and membership on current PBS activities. The communication between PBS staff and members of the PBS could be strengthened by adopting the following: (1) holding monthly or quarterly meetings with meter readers to keep them informed on PBS issues of interest so that they can share these with members with whom they come in contact each month. (2) Better use can be made of existing member advisory committees; more frequent meetings to keep these committees informed and receive their input on matters affecting the members. (3) Make better use of board members and member contacts. (4) Hold board meetings at different locations in the PBS service area, and invite opinion leaders to attend the meetings and address the board. (5) Hold open house once a year at headquarters and at district offices. (6) Assure that all employees are aware of the need of good member communications, and keep all employees informed on issues affecting the members. (7) Have periodic information meetings with opinion leaders and news media to address issues affecting the PBS and its members. (8) A periodic newsletter to the members giving them operating reports from the managers and board presidents would be useful. (9) The annual member meeting should provide opportunity

for members to receive information from and give information to the board and management of the PBS.

- It is the practice of irrigation customers to request disconnection during the off-season and leave payment of their last billing until they require the electric service at the beginning of the next irrigation season. The PBS holds a security deposit equal to two months' bill for the irrigation accounts, and this deposit should be applied against the outstanding past-due bills for the irrigation accounts.
- The billing of electric accounts seems to be generally timely, accurate, even though laborious handbilling methods are used. In the large PBS systems, REB should do a study to determine the cost-effectiveness of billing by computer.
- Little work is being done with the average PBS member to help that member find ways of effectively using electricity to improve living standards. Studies should be performed to find out how small power users can be encouraged to more effectively utilize electricity.
- Intensification will place emphasis on recruiting and training of skilled and semi-skilled labor for operations and maintenance, and preventive maintenance of equipment. The training staff needs to be re-evaluated and strengthened in order to meet the changing personnel requirements associated with intensification.
- The REB needs to train PBS personnel in handling emergency situations, particularly in the area of restoring service where there has been an equipment failure.

- There is some problem in transport for the linemen who service the PBS outage calls. Where the PBS cannot furnish motorcycle or jeep transport, the lineman must depend on local transport, which may be bus, rickshaw, or oxcart, or walking. This causes considerable delay in completing repair work and restoring the electric service. The PBS should provide adequate transportation for linemen to make service calls, especially in service outage situations.
- Staff retention has been a problem in the PBS's, especially in key technical and managerial levels. The primary causes of the turn-over appear to be salaries and living conditions in rural areas. Emphasis needs to be placed on providing incentives for the retention of key personnel. Incentives which could be considered are better salaries, better benefits, and performance bonuses. Better benefits would include more vacation time, opportunity for overseas training, furnishing of transport for personal use, low interest loans for purchase of personal transport or other property, or periodic trips into Dhaka or other metropolitan centers for PBS personnel who are located in very rural areas.
- The problem of equitably distributing load shedding will continue to be an issue until BPDB develops adequate generating and transmission capacity. The PBS's and REB need to better monitor and understand the economic costs associated with load shedding to help all parties understand the implications and need for capacity additions.
- While the REB has done an excellent job in defining and carrying out its function in the RE program, there is an inherent tendency in such organizations to become overly bureaucratic and become too

closely involved in the daily operations of the PBS's. The REB should continue in its role with the PBS's as lender, expediter, and helper and institute whatever procedures necessary to assure this role in the future.

1.2.2 System Planning and Engineering

- BPDB is scheduled to have adequate generating capacity by January, 1987. However, there is some uncertainty associated with this goal in that the load is growing faster than forecasted, and questions have been raised about the feasibility of some proposed generating units, as well as the proposed schedule for the other units.
- The BPDB transmission system and subtransmission system will have adequate capacity by the end of 1987, which should alleviate localized load shedding problems.
- As the PBS systems begin to age, much attention will have to be given by the PBS to substation, line, and right-of-way inspections and maintenance.
- More attention needs to be focused on customer characteristics in load forecasting at the PBS level.
- Overall performance of equipment has been good. Quality inspections have resulted in refusing ordered equipment and restricting certain firms from providing equipment. There does not appear to be a need to limit AID funds for expenditures on U.S. equipment. Nevertheless, there is a definite need to improve the detailed material standards for the purchase of equipment.
- The load factor is low, around 25%, due largely to irrigation customers. The use of irrigation systems between 6:00 PM and 9:00

PM should be discouraged using any feasible means. The most cost effective approach appears to be customer education.

- The low power factor has been recognized by the REB and corrective action is being undertaken.
- System losses have been recognized as a problem. Unmetered losses will require a concentrated effort by the PBS's to rectify.
- The REB has done an excellent job in adopting design and material standards. The completion of the development of the detailed material standards to meet the needs of multiple donors should be given high priority.
- The material handling at the warehouse facilities needs to be improved. The use of material standards to verify the receipt of the proper material should be emphasized. The material standards should have drawings of each piece of equipment to aid in identifying equipment received. Inventory control should be improved to properly account for all equipment in stock, status of equipment in transit, and equipment on order.
- The quality assurance of equipment and materials received needs to be improved. A testing program should be included in the inspection process. Hardware should be checked for proper dimensions, thread sizes, and mechanical strengths (i.e., random samples from an order of bolts should be checked for proper size, threading, and torque). Basic electrical tests should be made on the electrical equipment such as transformers, regulators, and reclosures.
- The performance of the electrical equipment appears to be good, especially considering the harsh electrical operating environment in

Bangladesh. The experience with the failure of power transformers gives an indication of the severe operating conditions and consequences. The distribution system design criteria and electrical equipment specifications should be reviewed in light of this harsh operating environment to determine if more stringent specifications are required for transformers, regulators, reclosers, and insulation level.

- The REB has engineering capabilities to implement RE III. Substantial engineering assistance will have to be given to the PBS's in the area of systems operation. This assistance will be necessary due to the growing size of the total rural distribution systems in the country, and the maturing of the existing systems will increase the number and types of operational problems. The types of systems operation assistance required will be substation operation and troubleshooting, line operation and troubleshooting, maintenance, and repair.
- Much of the expertise built up in the private sector to support the PBS's and REB activities is dependent on continued procurements. A smooth transition between RE II and RE III is critical for maintaining private sector firms for RE III.

1.2.3 RE Tariffs and Energy Sector Pricing

- Bangladesh's commercial energy supply strategy is driven by the high cost of petroleum (in terms of foreign exchange), the relative abundance of natural gas deposits, and the rapid depletion of forest reserves and other traditional fuels.

- RE is primarily a substitute for petroleum products (kerosene and diesel). Electricity prices are subsidized, while petroleum prices are significantly above world market prices, which gives an artificial advantage to electricity use. Government pricing policies should attempt to move energy prices toward equivalency.
- BPDB tariffs (except bulk rate tariffs to PBS's) have increased rapidly since 1979, with current BPDB and PBS tariffs being roughly equal on average. There are a number of improvements that could be made in the tariff structures to encourage more efficient electricity use: The BPDB bulk power rate tariff should be increased and include a metered demand charge; the PBS's should explore the use of rates for off-peak productive uses in order to smooth their load curves; and there should be a more active application of demand charges and tariff penalties for low power factors.
- There are significant subsidies flowing to PBS's. These result from a bulk rate tariff apparently below long-run marginal cost, cheap capital, and operating subsidies for the first five years. The bulk supply costs to the PBS's may exceed actual bulk supply revenues by approximately $5.2 million in FY 85, and the annual operating subsidy was over $3 million per year between FY 82 and FY 85.
- The financial condition of the PBS's varies greatly. Currently, four of the PBS's have a positive operating margin and nine have a negative operating margin. The variance is due primarily to the age of the PBS and the structure of its customer base. Financial projections suggest that none of the PBS's which have been energized

for five years will be able to make full principal and interest repayments in FY 86. The REB needs to re-evaluate its requirement that all PBS's be financially self-sustaining after five years, as this may not be a feasible goal for all PBS's. However, once a realistic goal is set for each PBS, definite procedures need to be developed and followed if a PBS does not achieve self-sufficiency during the specified period.

- Costs of electric energy to PBS consumers are considerably below the costs of alternative sources of energy. This provides an opportunity for PBS's to increase their tariffs without significantly affecting growth rates of consumers and average consumption. By doing this in an appropriate fashion, the PBS's could improve their financial performance without adversely affecting the economic impact of RE.

1.2.4 Technical Assistance

- TA has proved to be a necessary part of a rural electrification program in a developing country for the first 12 to 15 years. TA began in Bangladesh in 1978, and therefore one should expect a continuing need for TA.
- The percentage of funds allocated to TA in the Bangladesh rural electrification program has been declining as the program has progressed.
- Technical assistance has been excellent. The contractors providing TA have built a good working relationship with the REB and the PBS's and an abrupt change in contractors would be very detrimental

to the RE program. If a change in the TA contractor is made, it should be made gradually, over a period of one year to 18 months.

- The REB has often used TA as staff additions rather than for institution building. The REB needs to re-evaluate its use of technical assistance with more emphasis placed on transferring knowledge to the REB staff. This may require additional REB staff or a change in the type of personnel on the existing staff.
- The current TA staffing levels have been adequate. However, RE III will require three additional positions over present levels in the areas of maintenance and repair, material handling, and an additional financial analyst. In addition, twenty-four person-months of technical specialists are needed; these should include specialists in computerized billing, power usage, and quality assurance. The most critical areas for TA in RE III are in the areas of material management, management and finance, and operations and maintenance.

2. MANAGEMENT AND TRAINING

2.1 INTERAGENCY RELATIONSHIPS

2.1.1 Current Dynamics of Interagency Relationships.

(1) Rural Electrification Board (REB): The Rural Electrification Board (REB) of Bangladesh was established by an Act of Government in 1977 and began operation in 1978. Its major purpose is to provide electric service to rural Bangladesh through organizing, financing, and administering the rural electric societies Palli Bidyut Samities (PBS's). REB is a part of the Ministry of Energy of Bangladesh. It also closely coordinates its works with the Bangladesh Planning Commission, which reports directly to the President of the country.

The internal organization and operation of the REB is patterned somewhat after the Rural Electrification Administration, an agency of the United States Government which was organized in 1935 to carry out the electrification of rural America. The governance of REB is vested in the Chairman and seven Board members, three of which are full-time members and head major divisions of the REB. The remaining four members are representatives of government agencies which have direct interests relating to the success of the rural electrification program: the Bangladesh Power Development Board (BPDB), Bangladesh Agricultural Development Corporation (BADC), Bangladesh Small and Cottage Industries Corporation (BSCIC), and the Integrated Rural Development Program (IRDP). To date, the REB has been remarkably successful in securing funding from the Government of Bangladesh and donor agencies to carry out a program of rural electrification.

As of June, 1985, the REB had approved the organization of 33 PBS's. Eighteen of the PBS's are energized and in operation, and the other 15 are at various stages of development. REB works with the PBS in the following areas:

(a) carrying out the initial PBS organization activities;

(b) doing the system design and construction;

(c) staffing and training of personnel in PBS;

(d) developing funding, including re-lending program;

(e) monitoring the operations and activities of the PBS;

(f) providing liaison between the BPDB, the bulk power supplier, and other concerned government agencies with the PBS; and

(g) conducting board elections at the PBS.

To carry out these activities, the REB employs consultants, contractors, and technical assistants. During the past seven years REB has been developing both its staff and the staffs in the local PBS systems to carry out their responsibilities.

(2) Palli Bidyut Samity (PBS) and its Relationship to REB: The Palli Bidyut Samity (PBS), a rural electric society, is the creation of the Bangladesh Rural Electric Board (REB). The PBS has proven to be a very effective means of organizing prospective consumers into formal groups for the purpose of providing electric service.

The PBS is governed by a local board of directors, elected by the consumer members of the PBS. However, the PBS is subject to the regulation of REB. The REB initially finances and carries out the construction of power facilities in the PBS service area. The power

facilities are turned over to the PBS by REB and a debt transfer is made from REB to PBS. PBS personnel are trained in advance of their assuming responsibility for the management and operation of the electric plant facilities. The PBS relies on REB to audit, inspect, and monitor the operations of the PBS. In addition, REB provides technical assistance and continued training to PBS personnel, and assures that REB standards are met.

The relationship between PBS and REB appears to be excellent. The REB provides the necessary professional and technical guidance, training, and support to the PBS, and the PBS utilizes the services of REB in a very positive manner to enhance its operation of the electric system. The relationship between the REB and PBS is very similar to the early relationship between the Rural Electrification Administration (REA) and the local rural electric cooperative in the United States.

The PBS systems already in operation are monitored closely by REB to assure that REB standards are met. It appears that as the PBS gains experience and provides evidence to REB of its ability to operate effectively, REB gives the PBS more autonomy. The PBS systems presently in operation are at different stages of development and the newer ones require that REB exercise closer control and provide more training, support and advice, and technical assistance than to the older PBS's.

(3) Bangladesh Power Development Board (BPDB). Bangladesh Power Development Board, which is a part of the Ministry of Energy of Bangladesh, is responsible for the generation and transmission of electric power and energy for the entire country. It distributes electricity in the principal cities of the country, along major roads,

and to villages immediately adjacent to the cities. In addition, the BPDB provides bulk power to all PBS systems.

The BPDB is required to release customers in the rural areas to the local PBS when the PBS can provide the service. BPDB provides only three-phase distribution service connections while the PBS provides either single phase or three-phase service, depending on the requirements of the customer. BPDB's service to the PBS is not always reliable because of the nature of the BPDB's distribution operations, and often results in lengthy power outages for the PBS. During the irrigation season, the BPDB does not have sufficient bulk power to deliver throughout the country during periods of peak electric use; therefore, there is almost daily load shedding for both the PBS and local BPDB operations. The PBS systems also have difficulty getting power delivery points at some load centers simply because the BPDB does not have the facilities available.

Efforts are being made to have both the BPDB retail rates, and the bulk power rate charged to the PBS, more nearly reflect the cost of service. The latest change in the rate charged the PBS by BPDB will result in a major change in the retail rates charged by the PBS systems.

Some PBS rates are somewhat higher than BPDB retail rates and this causes customer relations problems. However, PBS personnel seem to be dealing positively with this problem and are making efforts to maintain good working relationships at the local level between PBS and BPDB personnel, particularly in coordination of load shedding activities.

Each PBS, assisted by REB, negotiates with BPDB for its new power delivery locations and its bulk power supply contracts. The Ministry of

Energy evaluates the success of the PBS systems. Historically, when there has been a dispute about standards of operation between BPDB and PBS, the Ministry has in each case ruled in favor of the PBS standards.

2.1.2 Effects of Interagency Relationships on PBS and REB Operations

It appears that because of the excellent reputation REB has among public officials, government agencies, and the public in general, and the general effectiveness of the Chairman and his staff, REB has little problem in working with agencies of government at the national, regional, and local levels. The local PBS is closely identified with REB and therefore enjoys similar working relationships with government agencies and representatives, particularly the Upazila officials.

The effectiveness of the PBS operations also is reflected in its interagency relationships. From time to time local BPDB personnel may create minor operating problems for the PBS which are usually quickly corrected by the General Manager of the PBS meeting with the local BPDB manager. The Ministry of Energy has in fact required BPDB to adopt some of the operating standards and practices followed by REB/PBS. Because of the high priority which the government of Bangladesh places on the rural electrification program, there appear to be few if any problems in interagency relationships that will hinder the progress of REB and the PBS.

2.1.3 Recommended Changes in Interagency Relationships for Improved REB and PBS Operations

It is not known how closely REB coordinates with BPDB in its load forecasting and long-range planning for meeting the power supply needs at the load centers in the various PBS systems. However, this is a critical area because the PBS's must be assured that the BPDB can deliver the bulk

power to the PBS substations in the necessary quantity and at the time needed.

There appears to be fairly good coordination between BPDB and PBS in load shedding. This should be closely monitored to assure load shedding is indeed necessary since this results in loss of revenues to the PBS as well as presenting potential member problems.

2.2 PBS OPERATION

2.2.1 Comparison of Actual Management of PBS with Guidelines for the Ideal Cooperative

(1) Service Reliability. Service reliability is difficult to measure in the PBS because of the extensive load shedding required by BPDB. The Assistant General Manager in charge of construction and maintenance in the PBS maintains a good reporting system which gives the time of the outage, the number of consumers affected, and the time power is restored. Because of the relatively new electric system which the PBS operates, few outages are caused by lack of preventative maintenance. However, as the electric systems begin to age, more attention will have to be given by the PBS to substation, line and right-of-way inspections, and maintenance. REB is in the process of training the PBS operations personnel to assume this responsibility.

Few outages are reported at night even though the PBS has a dispatcher on duty 24 hours a day. According to PBS personnel, the service reliability of the PBS system appears to be better than for the BPDB distribution system in the rural areas. PBS stations are served off the same BPDB line that serves BPDB's distribution customers. Often PBS personnel will patrol the BPDB lines, find the reason for the outage, and

call it to the attention of BPDB personnel. By the PBS performing this service for the BPDB, the power is restored faster to the PBS system and results in less outage time.

There is some problem in transport for the linemen who service the PBS outage calls. Where the PBS cannot furnish motorcycle or jeep transport, the lineman has to depend on local transport which may be bus, rickshaw, oxcart, or walking. Naturally, this causes considerable delay in completing the repair work and restoring the electric service.

Repairs or changes to be made in the PBS substations have required lengthy outages. However, the technical advisors, working with REB and PBS personnel, have helped them to do systematic planning before undertaking the substations work. This has resulted in the outage time being reduced considerably. In addition, the PBS staff also are being trained to do some of the substation work while the station is energized, which will further reduce outage time.

Management personnel are aware of the importance of continuity of electric service to the PBS consumers and carefully monitor the service continuity. In the older PBS systems they have begun systematic preventative maintenance programs to reduce the number and length of outages.

(2) Accuracy of Accounts

A. Electric Service Accounts:

Through cursory observation, the billing of electric accounts seems to be generally accurate. Contract meter readers read all meters monthly. The electric bills are based on the electric use as obtained from subtracting the meter reading for the previous month from the

current reading. The billing clerks then use a previously prepared billing chart showing the current tariff charges for the various increments of use for the particular class of accounts. The bills are hand-written and delivered to the consumer within five to seven days after the meter is read.

The Assistant General Manager for member services in each PBS visited indicated there are few complaints from consumers about inaccurate bills. A review of the records of complaints substantiated his statement. When a member believes the meter recording the use of electricity to be in error, the PBS will test the meter for accuracy, and if it is in error, render a corrected bill.

In the large PBS systems, REB should do a study to determine the cost effectiveness of billing by computer. A great deal of useful management information relating to the use of electricity and circuit and transformer loadings could be obtained as a by-product of a computerized billing operation.

B. General Ledger Accounts: The PBS systems are following the accounting manual developed by REB and the technical advisors. However the accounting being done in the PBS has not progressed beyond basic bookkeeping. The whole area of plant accounting, including PBS work-order accounting, needs to be examined. Changes should be made which would enable electric plants constructed and in use to be entered into the PBS plant accounts as quickly as possible. REB and PBS personnel need more training in this area.

(3) Collections:

A concerted effort is being made in each of the PBS systems, under guidance of REB personnel, to collect past due accounts for electric service. However, there is one area that needs attention. It is the practice of irrigation consumers to request disconnection during the off season and leave payment of their last billing until they require the electric service at the beginning of the next irrigation season. These accounts are always collected before service is restored at the irrigation pump sets. These late collections tend to distort the amount of uncollectible accounts and amount to an interest free loan to the owner of the irrigation pump. The PBS holds a security deposit equal to two month's bill for the irrigation accounts, and this deposit should be applied against the outstanding past due bills for the irrigation accounts.

Daily payments are made to PBS collectors who are stationed at different locations on different days to collect the bills. Some PBS systems are serving as pilot operations by having various banks in their service area collect their bills. This method of collection provides more accessibility to payment locations for the members as well as a higher degree of security of collections. Technical advisors are working with REB and PBS personnel in the implementation of bank collections to assure accuracy and timeliness of recordkeeping and to assure that proper control is exercised by the PBS of the collection process. As the system of bank collection of electric service bills is perfected, it is recommended that more of the PBS systems adopt the system where practicable.

(4) Materials and Services Procurement and Control:

In general, the PBS systems are following the guidelines developed by REB for obtaining and accounting for materials and services. However, it seems that there are problems in following the REB work order procedures with regard to accounting for materials, labor, and services in connection with PBS construction work. It appears that there is no way to bring salvaged material back into stock through a materials salvaged ticket, nor does there seem to be a procedure for blanket work orders for service drops constructed by PBS personnel. It is not known how the cost of these service drops affects the plant records of the PBS, if, in fact, it does. More training is needed both in the PBS and with REB personnel in work order procedures and records keeping and related accounting.

Some attention should be given to the possibility of combining the two separate materials inventories that are maintained in each of the PBS systems which have been authorized to do line construction work. This would reduce the necessity of the warehouseman keeping two sets of materials records. The technical advisor in materials handling and control who is being requested under RE III could provide valuable assistance to REB in developing a plan of action.

2.2.2 Changes to Existing Management Systems:

(1) Guidelines:

REB and the technical advisors are in the process of revising a number of the management guidelines including policy and procedure manuals as well as basic forms. This will be an ongoing process as the PBS systems mature and change.

REB and the technical advisors have also begun working with the general manager and his immediate staff in each PBS on identifying key management areas and key indicators (operating trends and ratios). They are also helping the general manager and his staff develop plans for managing the activities affecting each of the key performance areas. This is a part of REB's emphasis on self-sufficiency for the PBS, and the program is well received by the PBS staff. However, more training and technical guidance from REB and the technical advisors is needed to help the PBS staff internalize the objectives of the program. There is need for a very disciplined approach to planning for change, following through, and carrying out plans to achieve the desired results.

REB has stated as policy that the PBS's are expected to be financially viable systems, without need for subsidies, and able to repay the construction loan with interest at the end of five years following the date of energization. REB needs to clearly state what the penalties are for failure of the PBS to attain this financial viability at the stated time, and apply these penalties when the PBS fails to meet the viability test.

It is possible that the standards for financial viability for a PBS should vary from PBS to PBS because of the differences in density of consumers, revenue per mile of line, and investment per kWh sold. (See Chapter 4.) Technical advisors need to work with REB personnel to determine if some variation is needed, and, if so, to clearly spell out this variation for the PBS.

(2) Daily Operations

Day-to-day operations in the PBS systems observed seem to be carried out in a fairly consistent manner. However, much activity appeared to be by rote, following procedure without planning for the future or relating actions taken each day to achieve future plans and overall objectives.

There appears to be a need for better coordination of activities between departments in some of the PBS systems. This indicates that the general manager in each PBS could use more training in communications, interpersonal relationships, and team building, as could his key staff members. And while REB has done a good job in training the PBS staff in the basic operations of the PBS and in providing general monitoring, it appears that REB needs to train the PBS personnel in handling emergency situations, particularly in the area of restoring service where there has been an equipment failure.

2.3 CUSTOMER AND MEMBER RELATIONS

2.3.1 Current Governance of PBS by Members: There is strong evidence that REB has done an excellent job in the initial organization of each PBS. The customer/members have grasped the idea that the PBS belongs to them and that they are to choose the board of directors which governs the operation of their PBS.

(1) Application for Service: REB invites potential members to a mass meeting and explanations are given about the organization of the PBS and how the potential member may apply for electric service. The individual applies for service, pays the membership fee, and awaits word from REB/PBS as to whether he qualifies for service. (Prior to the energization of the PBS, REB decides whether the person qualifies for a

service connection. After the PBS lines are energized, the PBS board makes this decision.) If service is not feasible, the individual is told this as soon as possible, and the reason. In instances where there are several persons requesting service connections in the same area and it is not feasible to provide the service, the PBS board members will hold a meeting with the group to explain why the PBS cannot provide service connections. If service is feasible, PBS personnel advise the persons when they might expect to be connected, how to get their houses wired and inspected, information on rate charges, and rules for payment.

However, there is a concern about the follow up actions taken by PBS personnel with members after they are connected to the power lines. There was not time for in-depth study in this area. Observation indicated that the primary emphasis was being given to installation of tube wells. It appears that little work is being done with the average PBS member to help that member find ways of effectively using electricity to improve his standard of living. Small power use promotion was a major part of the rural electrification program in the USA in the early days of the program. A study should be performed to see what the needs are in this area.

(2) Rights and Responsibilities

Members in each energized PBS certainly appear to be exercising their rights, especially in electing the board of directors to govern the operations of their PBS. Most members are also carrying out their responsibilities as members, which were explained to them by REB or PBS personnel when they signed their membership applications. These responsibilities are basically: to pay for the electricity they use as

prescribed by the PBS; to inform the PBS of any problem they have with the electric system; to inform the PBS of any known case of power theft; to grant a right-of-way for power facilities on their property; to attend member meetings; and to be informed and vote on issues affecting the PBS, particularly the election of directors.

The PBS must maintain continuing communications with the members, using all possible means to keep the membership informed and involved. The PBS should make full use of all personnel contacts with members to keep members informed. Also, REB should continue to emphasize with the PBS Board of Directors and General Manager and the Assistant General Manager for member services, the need for member communications. Additional training in member communications techniques should be provided for the entire PBS staff. The strength of the PBS lies in the loyalty of the membership and the support it maintains. Specifically, this area can be strengthened by:

A. Holding monthly or quarterly meetings with meter readers to keep them informed on PBS issues of interest so that they can share these with the members they come in contact with each month.

B. Making better use of existing member advisory committees, holding more frequent meetings to keep these committees informed, and receiving their input on matters affecting the members.

C. Making better use of board members in member contacts by having them hold quarterly or semiannual meetings in their directorate district to report to the members and hear member concerns.

D. Holding board meetings at different locations in the PBS service area and inviting opinion leaders to attend the meeting and address the board.

E. Holding open house once a year at headquarters and at district offices where the board members are on hand to meet members, answer questions, and hear their concerns.

F. Assuring that all employees are aware of the need for good member communications and keeping all employees informed on issues affecting the members so that they can give correct answers to members.

G. Having periodic information meetings with opinion leaders and the news media to address issues affecting the PBS and its members.

H. Preparing a periodic newsletter to the members giving an operating report from the manager and board president would be useful. This could be delivered by the meter readers.

I. Providing opportunity in the annual member meeting for members to receive information from, and give information to, the board and management of the PBS.

2.3.2. Response of PBS Management to the Membership

(1) Requests

Responses to member requests are made in a timely and effective manner by PBS personnel. Members of the Board of Directors provide strong support in this area, often assisting in communicating with the members.

(2) Inquiries:

Responses to member inquiries also are promptly responded to by PBS personnel. REB personnel will also assist in responding to inquiries relating to the type of electric service which can be furnished, especially to commercial and industrial customers.

(3) Complaints

Member complaints are recorded and handled in an effective way, with the resolution of the complaint being recorded in the complaint register. The contents of the register are reviewed to determine if there are patterns of complaints, such as wrong meter reading or high bills, and appropriate action is taken by the PBS staff to reduce these complaints.

(4) Right of Appeal

Members may and do exercise their right of appeal for redress from management decisions in the PBS to the Board of Directors. There is also indication that some PBS members have appealed local PBS board decisions to the REB, although these instances appear to be rare. This right of appeal is very important for preserving the rights of the members to be heard by their elected representatives, the Board of Directors. In general, the PBS board and staffs are very responsive to the needs of the members when these needs are made known to them.

2.3.3 Recommended Changes to Improve Customer/Member Relations

The PBS systems need to give stronger emphasis to continuing communications with their members. All employees of the PBS must be informed about PBS programs and policies so that as they come in contact with members they can discuss the programs and policies, the reasons for these policies, and how the policies affect the members. Continued

efforts should be made to meaningfully involve members with the PBS. Some help from REB and, possibly, technical assistance will be needed to do this.

2.4 HUMAN RESOURCE PLANNING AT REB AND IN THE PBS SYSTEMS:

2.4.1 Current Staffing Levels

REB

(1) Job knowledge and skills: Overall, the directors in REB appear to have excellent job knowledge and the skills to apply this knowledge in carrying out their assigned responsibilities. Below the directorate level, because of work loads, the REB staff is not fully trained and has not been able to take full advantage of the opportunities to learn from the technical advisors. During the next few years, if REB is to supply the future support, training, and technical guidance needed by the PBS systems, it must see that its personnel fully utilize the opportunities to work with and be trained by the technical advisors who will be working with REB for the next two to five years.

(2) Staff Retention: There are some problems with staff retention in lower level positions of REB because of the salary levels. This is being overcome in some cases by contracting for services which cannot be obtained by employment under the regular salary schedules. In general, employees are proud to be a part of the REB. Staff retention with the key personnel does not appear to be a major problem at this time.

PBS

(1) Job Knowledge and Skills: The PBS staff has sufficient job knowledge and skills to provide for basic operations of the PBS system. This, in itself, is amazing when one realizes that none of the staff has

more than five years experience, and most have much less than five years. As an example, lineman trainees had to literally be taught how to hold a screw driver and a wrench when they began their training. However, because of the work load, REB and the technical advisors have not been able to follow up with one-on-one training and observation to assure the training is being put into practice. Additional training is needed for PBS personnel in operation and maintenance techniques for electric plant equipment, particularly substation maintenance, work order accounting, and materials management and control, as well as management planning and controls.

The PBS general managers and their immediate staffs need further skills training in interpersonal relationships, coordination, and team work. As each PBS develops, the training needs will change and the training emphasis should change. REB staff must be aware of these individual needs and be prepared, from an institutional standpoint, to meet these needs if the PBS systems are ever to achieve autonomy.

(1) Staff Retention: There is some problem in retaining key staff persons in the PBS systems, including general managers. This problem is exacerbated by the rural location of the PBS offices and the salary scales. Key management personnel, particularly general managers and assistant general managers for construction, operations, and maintenance, have little difficulty in finding positions in more urban settings which pay more than the positions in the PBS. Incentives which could be considered to reduce turnover of key employees of the REB and the PBS are:

A. Better salaries.

B. Better benefits including:

(a) More vacation time.

(b) Opportunity for overseas training.

(c) Furnishing of transport for personal use.

(d) Low interest loans for purchase of personal transport or other property.

(e) Periodic trips into Dhaka or other metropolitan centers for PBS personnel who are located in very rural areas.

C. Performance bonus.

2.4.2 Future Staffing Needs:

REB

REB is thinly staffed. It has given some attention to future staffing needs. There is indication that additional personnel are needed in the Training and Equipment and Materials Directorates to meet specific work goals in these directorates. A recommendation has been made to divide the directorate of finance into two directorates, one for finance and one for accounts. This recommendation is a good one because the work load of the present directorate is very heavy. In the future, there will be need for more support in the area of operations and maintenance for the PBS systems. REB should give thought to training personnel who can be located in the field along with the present superintendents of construction. Here, they could provide timely technical service and assistance to the 33 PBS systems in the operation and maintenance of their electric plants. The REB needs to guard against becoming overly

bureaucratic and becoming too closely involved in the daily PBS operations.

PBS

The PBS systems, in general, are reasonably well staffed. There is some indication that additional billing clerks and linemen will be needed as the number of consumers increases through the intensification program. The problem of lack of adequate transport for linemen in some PBS systems makes for very inefficient use of a lineman's time in that he must walk or use public transport in the form of a rickshaw, bus, or ox cart to get to the member's premises.

Efforts should continue to be made in the future to recruit and train the best possible general managers and assistant general managers for the PBS systems. As the management of these systems grows more complex, and the environment in which they operate changes more rapidly, management must be able to respond quickly to the needs of these growing and dynamic organizations.

2.4.3 Training Programs:

The training program which REB has developed with guidance and assistance of the technical advisors is good. A major problem is that REB has been unable to fully implement the program due to an insufficient number of instructors and classrooms. There is also a problem with follow-up to assure the training is being put to use by both REB and PBS personnel. Again, this is due largely to lack of REB personnel. Also, there could be better scheduling and coordination to assure the REB personnel who are in the field working with PBS personnel give feedback

to the Director of Training and his staff to assist them in evaluating the success of their training programs.

The major training areas which need to be given strong emphasis are:

A. Electric plant operations, including construction, materials control, operation, and maintenance.

B. Financing and accounting.

C. Management - Human Relations and management for planning and control.

D. Institutionalization of training given by technical advisors.

2.4.3.1. Specific Training Needs

(1) Construction: Better training and follow-up with construction contractors and PBS employees supervising construction are needed so that the contractors know the difference between good line construction and poor line construction.

(2) Materials Control: Additional training and follow-up is needed for both REB and PBS personnel in stores accounting and control and how their work relates to plant accounting.

(3) Operations: Training relating to load management, power factor, and substation operations is needed.

(4) Maintenance: Preventive maintenance training and follow-up are needed, especially those relating to line and station inspections, right-of-way reclearing, etc. Training is needed which will focus on reducing outage time; little or no attention has been given to planning how outage time may be reduced. Training should be given to REB personnel in maintenance and repair of electrical station and line equipment.

(5) Financing: The major training need here relates to debt financing and rate making with focus on long-range financial forecasting and planning.

(6) Accounting: The work order accounting procedure developed by REB is not well understood nor followed by the PBS systems. Much additional training and follow-up are needed here.

Most accounting procedures in the PBS systems are followed by rote without understanding the purpose or intent. More training needs to be given relating to the purpose behind the procedures if PBS personnel are going to be able to make decisions.

(7) Human Relations: All management personnel, including the general manager, in the PBS systems need training and follow-up training in basic human relations skills, particularly in the areas of communication and coordination.

(8) Management Information: The training in this area has been very limited. General managers and their immediate staffs need training in developing and utilizing data base information in key performance areas in order to plan and control the operations of the PBS effectively. Technical advisors will need to assist REB in the strengthening of training programs in this area.

(9) Institutionalization of Training Received by REB Personnel from Technical Advisors: REB has, in most instances, used the technical advisors as adjuncts to their staffs and has not really emphasized knowledge and skills transference from the TA's to the REB personnel. REB must begin at once to give strong emphasis to this area if it is to

carry out the support services it is scheduled to provide to the PBS systems.

2.5 TECHNICAL ASSISTANCE FOR MANAGEMENT AND TRAINING:

2.5.1 Current Impact of Technical Assistance

(1) Technical Areas: The progress of the program of rural electrification in Bangladesh is outstanding given the contraints under which the program has developed. This is particularly true as it relates to the development of qualified technical personnel to plan, write guidelines, construct, and operate electric plant facilities. The success of the project is due in large measure to the amount and quality of the technical assistance which has been provided in the first two phases of the rural electrification program. As the program moves into the third phase of the RE program, continuing technical assistance will be required with primary emphasis being on transference of knowledge, skills, and experience to the REB personnel. This TA should especially focus on REB personnel responsible for training, guiding, expediting and helping the staff in the PBS's.

Special assistance is needed in both REB and PBS systems in the development of a more effective materials handling program. REB needs assistance in implementing its plan for establishing an adequate shop to repair the larger pieces of electrical apparatus for the PBS systems. The PBS systems personnel need further training in the operation and maintenance of electric plant facilities, particularly substation maintenance, as well as in how to plan for the orderly execution of a major maintenance job. Further training is needed for the local construction contractors used by the PBS systems to build short distance

lines. It appears that more technical assistance will be needed by REB during the third phase of RE because of the additional numbers of PBS systems to be served and the fact that each of the 40 PBS systems will be in a different stage of development. At the same time, REB personnel will be working with the technical advisors to acquire further knowledge and skills.

(2) Managerial Areas: Technical assistance in the area of management has been provided since the inception of the RE program. This included the development of training manuals and the training of the REB staff, boards of directors, general managers, and supporting management personnel in the local PBS, as well as development of written policy and operational procedures. This assistance, along with the guidance and support for the PBS provided by REB, has enabled the rural electrification program in Bangladesh to advance more rapidly than in many other developing countries. However, assistance in the area of managerial planning and controls needs to be strengthened, with emphasis given to teaching management concepts as they relate to the key performance areas for a PBS as well as to the basic methods and techniques for measuring and improving performance in each of these areas. To accomplish this, the financial and accounting programs in each PBS need strengthening so that the data base generated from these areas are sufficiently reliable for progress evaluation and planning purposes.

2.6 CONCLUSIONS AND RECOMMENDATIONS FOR REB AND PBS MANAGEMENT CAPABILITIES:

2.6.1 Overall Effectiveness in Relation to Objectives and Goals:

(1) Program and Planning: The success of REB in carrying out its basic objective and major functions to establish and maintain an effective program of rural electrification in Bangladesh is without question. Its effectiveness in developing the PBS systems to the point where the local PBS personnel can carry out the day-to-day operations in so short a period of time is without parallel.

The local PBS systems have achieved a high and commendable measure of effectiveness at this point in their development in both overall program and operational goals. The challenge for both REB and the PBS systems is to continue to enhance their levels of performance while coping with ever increasing work loads in a constantly changing environment.

(2) Execution and Control: REB and the PBS systems are moving into an accelerated program with Phase III of the RE program. Much effort will be needed to assure that programs are carried out in the most effective and efficient way to reach the stated goals. Care must be exercised to assure that the necessary management control data are available to assess progress and to do further planning. Managers at all levels in REB and PBS systems must be planners, decision makers, implementors, coordinators, communicators, and team builders. Each is necessary to execute the plans and provide the necessary controls to assure that the agreed upon goals are achieved and program objectives reached. Much technical assistance will be needed in the next three to

five years to assure the effectiveness of the total management teams in REB and the PBS systems.

2.6.2 General Recommendations Relating to Management:

(1) Management Policies: Management policies which were written by REB with technical assistance must be revised as needs change. This is necessary in order to provide current guidelines to both REB and PBS personnel in making the decisions which are necessary in the day-to-day management of the rural electrification program. The updating and revision of some manuals has already begun and this should be continued. New manuals may need to be developed relating to forecasting and to management's planning role in assuring the continuity of the PBS and its financial viability. Policies on effective and productive power utilization and load management should be reviewed.

(2) Technical Assistance: Technical assistance has been most effective in RE program Phase I and II and should be strengthened in Phase III as previously stated. Major emphasis in Phase III should be given by technical advisors to training, direct participation in the implementation of systems which they have helped to develop, monitoring and reviewing performance to assure training is being put to the proper use, and to advising on problem areas in conjunction with REB and PBS personnel. It is believed that should new organizations be chosen to provide technical assistance for Phase III of the RE program, at least a year, and possibly 18 months, would be required for them to reach the level of effectiveness which the present organizations have achieved in providing technical assistance.

3. ENGINEERING AND SYSTEM PLANNING

This chapter reviews and assesses the electrical engineering and system planning aspects of the Bangladesh Rural Electrification (RE) program. Section 3.1 describes the goals and objectives of the program. Section 3.2 describes the technical achievements of Phases I and II by reviewing construction progress. Section 3.3 describes the power supply and power delivery situation for the PBS's by reviewing load forecasting, generating capacity, and the transmission and subtransmission systems. Section 3.4 describes the demand management problems that the PBS's are experiencing indicated by load shedding, load factor, power factor, and systems losses. Section 3.5 discusses several aspects of the electrical equipment such as standards, material handling, quality and performance. Section 3.6 reviews the planning for implementation of Phase III. Section 3.7 describes the capabilities of the REB and PBS's to perform the implementation of Phase III. Section 3.8 gives the conclusions and recommendations.

3.1 RE PROJECT GOALS AND OBJECTIVES

The goal of the Bangladesh RE program is to electrify the rural areas of the country by the year 2005. In order to achieve this objective, the REB has a five-phase plan for the development of the country from 1978 to 2005 with 80 to 99 PBS's. Phases I and II are in construction and are scheduled to be completed by mid-1988. Phase III is in the planning stage with the donor funding agreements in final negotiations. The REB has adopted standards for design of 11-kV distribution systems and specifications for materials. The REB engineering objectives are to plan,

design, and construct distribution systems. After construction, the REB will monitor and review the operation of the distribution systems under the control of the PBS's.

3.2 RE ACHIEVEMENTS

The impressive achievements of the rural electrification program in Bangladesh are summarized in Table 3.1.

Table 3.1

Achievements of the Bangladesh Rural Electrification Program (September 1985)

1.	PBS's approved in Phase I and II	33
2.	PBS's registered with REB	32
3.	PBS's energized	19
4.	33/11 kV substations energized	37
5.	Miles of distribution line energized	7,274
6.	Villages energized	4,344
7.	Meters installed	169,298
8.	Residential customers	130,420
9.	Households with service	326,050
10.	Commercial customers	27,761
11.	Pumps and Tube wells	5,947
12.	Industrial customers	3,413
13.	Other customers	1,757

Source: REB Director of Planning

3.3 PBS POWER SUPPLY AND DELIVERY

This section defines and describes the PBS bulk power supply and delivery situation. Section 3.3.1 describes the REB load forecasting. Section 3.3.2 discusses the status of the nation's generating capacity as provided by the Bangladesh Power Delivery Board (BPDB). Section 3.3.3 reviews the problems of the transmission system. Section 3.3.4 discusses the status of the subtransmission system.

Each of the PBS's in operation purchases power from the BPDB. The tariff between the PBS and BPDB is based only on energy usage (kWh). A demand charge is not included in the tariff. Each PBS works with local BPDB personnel in the day-to-day operation of the electrical system.

3.3.1 Forecasting

Forecasting of future PBS capacity requirements is done at several levels in REB. The Director of Program Planning makes the initial recommendation for building a new PBS. Upon approval by the REB to construct the new PBS, the capacity requirements are given to BPDB. The Director of Planning has a 20-year plan and a five-year plan. He works on a daily basis with the BPDB, Ministry of Energy, and the Presidential Planning Commission to coordinate future capacity requirements.

The Member of Engineering and Director of System Engineering and Design also work with BPDB to insure that the timing and location of PBS substations are coordinated.

The most recent five-year load forecast prepared by the Director of Planning in July 1985 is shown in Table 3.2. The table shows the number

Table 3.2 Five-year load forecast for all PBS's - July 1985

	Connection target					
Year	SFYP	1985-86	1986-87	1987-88	1988-89	1989-90
Connections:						
Residential	119118	141694	214900	288325	363942	451614
Commercial	25824	28770	38323	47904	57771	69211
Deep tube well	1064	1278	1973	2670	3388	4220
Shallow tube well	3960	4496	6232	7974	9768	11848
Low lift pump	886	1073	1681	2291	2919	3647
Industrial	2845	3166	4208	5253	6329	7577
Total	153697	180477	267317	354417	444117	584117

	Load (in kW)					
Year	SFYP	1985-86	1986-87	1987-88	1988-89	1989-90
Connections:						
Residential	19059	22671	34384	46132	58231	72258
Commercial	5165	5754	7665	9581	11554	13842
Deep tube well	15960	19170	29595	40050	50820	63300
Shallow tube well	15840	17984	24928	31896	39072	47392
Low lift pump	10632	12876	20172	27492	35028	43764
Industrial	71125	79150	105200	131325	158225	189425
Total	137781	157605	221944	286476	352930	429981
Coincidental Peak load (kW)	80000	91510	128867	166337	204922	249660

	Energy (in MWh)					
Year	SFYP	1985-86	1986-87	1987-88	1988-89	1989-90
Connections:						
Residential	42882	51010	77364	103797	131019	162581
Commercial	11621	12947	17245	21557	25997	31145
Deep tube well	23345	28041	43290	58582	74336	92591
Shallow tube well	15840	17984	24928	31896	39072	47392
Low lift pump	8164	9888	15490	21112	26899	33607
Industrial	76815	85482	113616	141831	170883	204579
Total	178668	205351	291933	378775	468206	571895

Source: REB Director of Planning

of customers, load demand, and energy sales projected over the next five years. One can make several observations concerning this projection. First, the peak demand of the PBS's will triple in the next five years while the peak demand of the country is expected to double. Second, the relationship between peak demand and energy sales has at its foundation the assumption of a constant annual load factor of 26% for the five-year period. This indicates that on a planning basis, no improvement in the load factor is expected in the next five years.

In summary, forecasting is very difficult during this expansion period because of uncertainties in the number of customers, their energy demand (kW), and energy usage (kWh) patterns. The present forecasting is reasonable and should be improved through experience gained with customer energy usage characteristics. Attention should be given to better understanding customer energy usage characteristics and improving forecasting techniques. The ability to accurately forecast future energy demand and usage is essential to the long-range development of rural electrification.

3.3.2 BPDB Generating Capacity

The BPDB Power System Master Plan Study was published in February 1985 as an interim report. The plan projected total system capacity increasing from 1017.5 MW in 1985 to 7195.0 MW in 2005. For the five-year period 1985-1990, planned capacity is expected to double to 2071.5 MW. The BPDB Reserve margin is shown in Figure 3.1. This curve shows a deficiency in generating capacity during all of 1986 and 1987.

Two observations can be made. First, portions of the country are presently experiencing load shedding on a daily basis, and during the

ORNL–DWG 86-10610

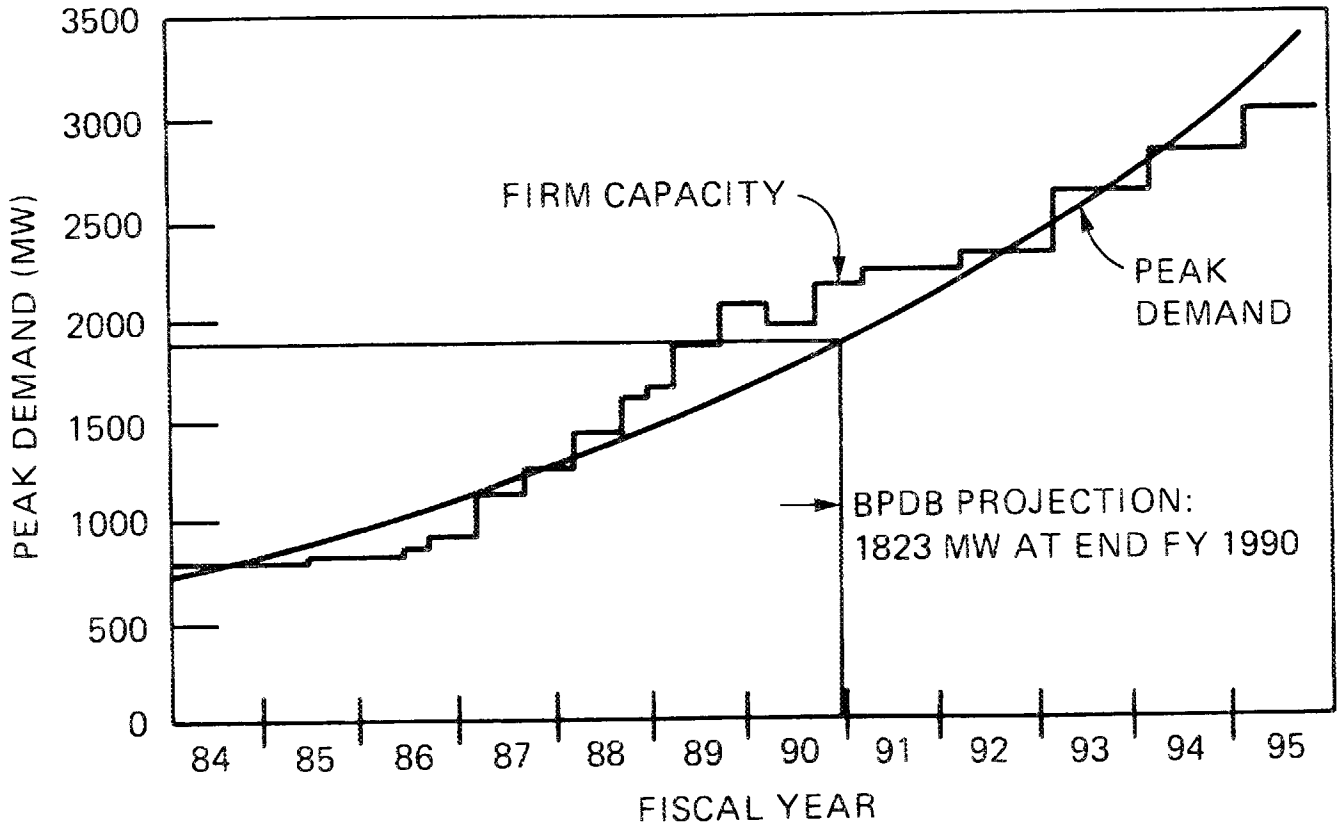

Fig. 3.1. Generation expansion program reserve margins.

Source: Bangladesh Power Development Board Power System Master Plan (1985-2005) Executive Summary (of Interim Report) February 1985.

irrigation season, this load shedding is widespread. In fact, some PBS's must shed 50% of their load during the peak hours of 6 p.m. to 9 p.m. Two factors which lead to this situation are (1), inaccurate forecasting of future load growth, i.e., load is growing faster than expected and (2), inability to meet the planned capacity addition schedule. Improved performance in these two areas is indicated.

The second observation is the effect of the planned generation addition of the Kaptai Hydro Power Station in 1989 as described in the master plan. Units 4 and 5 are being added with a rating of 50 MW each for a total of 100 MW. There seems to be some doubt if the units can be counted as firm capacity during the peak load season due to insufficient water resources. The peak load season occurs during the irrigation season (December to May) when the water resources are not available to drive the additional units. If this is the case, then the five-year plan of doubling generating capacity from 1985 to 1990 would be 10% short of its goal. The hydro power station was proposed to USAID in 1981 and not recommended.

3.3.3 Transmission System

The BPDB transmission system is a 132-kV system. The system is built on double circuit towers designed for operation at 230 kV. Only one of the two circuits has been strung and is in operation. The one circuit in operation is not yet at capacity and there is spare capacity for expansion with the additional circuit and increase in voltage level.

The installation of new 132-kV substations and new PBS substations is being coordinated to allow for separate breakers to supply the 33 kV subtransmission line to the PBS substation. This should greatly improve

the reliability of service delivery to those PBS substations. During 1986 and 1987, BPDB is increasing the capacity in 20 substations (132 kV/33 kV) that serve PBS substations. Until this capacity is added, some PBS substations will be experiencing load shedding on a daily basis due to these capacity deficiencies.

3.3.4 Subtransmission System

The subtransmission system is owned and operated by BPDB. The voltage level is 33 kV. The BPDB serves customers with 33 kV/400V line-to-line three-phase distribution transformers. The nominal service voltage is 230 volts. The PBS serves their distribution substations with this subtransmission system and then distributes power with 11 kV feeders. The terms and conditions for RE II required BPDB to undertake a program of rehabilitation and maintenance of 33/11 kV substations and subtransmission lines which supply PBS substations. The PBS's presently have to assist BPDB in the repair and maintenance of the 33 kV lines until this rehabilitation program is completed.

3.4 PBS DEMAND MANAGEMENT

The demand management of the load profile of a PBS's customers can have a dramatic effect on the utilization of installed facilities and, therefore, the revenue collected. Power factor and system loss were originally designed to be benign factors to the distribution system. However, the assumptions in the original design have not been realized and design changes and operational changes have been necessitated. While the REB and PBS's have recognized these factors and have started corrective actions, the results have not yet been realized and their effectiveness is yet to be determined.

3.4.1 Load Shedding

The PBS's have been experiencing load shedding for the last year and are expected to have this problem until at least December 1987. The problem is twofold. Because of an insufficient capacity in the BPDB subtransmission system in some locations, load shedding is occurring on almost a daily basis at some PBS's. The other side of the problem is a deficiency in total system generating capacity which is experienced during the irrigation season. These capacity problems are beyond the control of the PBS and must be tolerated until BPDB increases its system capacity.

The PBS's have been judicious and have generally not connected more load than their system capacity. Therefore, if they had sufficient BPDB capacity they would not have any load shedding.

There is a reduction in energy sales and a loss of revenue associated with load shedding. If a PBS with a 15 MW peak demand must shed 10% of its peak load for four hours on a daily basis, then a 6.8% reduction in energy sales and revenue can be expected. This calculation is based on a 15 MW peak demand, 25% load factor, 32,850 MW annual energy sales without load shedding, 6 MWh shed per day and an annual total reduction in energy sales of 2,190 MWh.

Also, the load shedding is increasing the loading cycles on the electrical equipment and could have an effect on equipment lifetime and maintenance.

3.4.2 Load Factor

The load factor is the ratio of the average load over a designated period of time to the peak load occurring in that period. The load factor can theoretically range from 0 to 1. The load factor is an indication of

utilization of the installed facilities. The greater the load factor, the greater the utilization of the facilities. A low load factor, 20 to 40%, indicates a peak loading problem. That is, the facilities have a low average usage but during very short periods a high usage is experienced. The load factor for the PBS is averaging about 25%. The cause of this low load factor is the irrigation load which uses electricity from December to May and then does not consume any electricity for the remainder of the year. The cause of the poor load factor has been recognized by the REB and PBS's. Their solution is to educate the irrigation customers and persuade them to not use their pumps from 6 a.m. to 9 p.m. The effectiveness of this approach is yet to be determined.

3.4.3 Power Factor

The power factor, which is an expression of the relationship between the useful current and the total current in an electrical device, in the original design criteria was envisioned not to be a problem. The assumption of a large portion of energy sales to domestic consumers which traditionally have good power factors led to a system design believed to have good power factor. The actual experience, however, is that commercial and industrial loads have had the large portion of energy sales. These consumers use motors which have varying and poor power factor. As a result, REB has had to start requiring industrial customers to correct their power factor with capacitors. Also, REB is purchasing and planning to install static capacitors as the first step in power factor control. At a later date, switched capacitors will be utilized.

3.4.4 System Loss

The system loss of each PBS is reviewed on a monthly basis by REB. The losses are averaging about 21% for all PBS's and includes technical losses and unmetered losses. The technical losses are attributed to the distribution lines and transformers. The unmetered losses are attributed to theft of service, estimated meter readings, and meter reading errors. The problem is in determining the extent of losses attributable to technical factors and to unmetered losses. The main interest is in reducing the unmetered losses. Some changes have been made to reduce the technical losses.

3.5 ELECTRICAL EQUIPMENT

This section reviews the problems and challenges with electrical equipment and material by discussing the areas of standards (Section 3.5.1), materials handling (Section 3.5.2), equipment procurement (Section 3.5.3), quality (Section 3.5.4), and performance (Section 3.5.5).

3.5.1 Standards

The REB has adopted the U.S. REA standards for system design and material specifications. These standards have provided for a consistent design and construction of the PBS distribution systems across the country and across donor countries. In moving from RE I, which was funded by USAID, to RE II, which was funded by several countries, an adjustment had to be made in the method of specifications for materials. In RE I the materials were specified according to manufacturers' catalog numbers, a common practice in the U.S. However, in Re II, equipment was procured from suppliers in many different countries which were not familiar with nor did they utilize the U.S. catalog system. As a result, the material

specifications were revised to provide more detailed functional specifications and requirements and to remove the catalog number specification method. Adjustments have been made to the specifications allowing equipment procurement from many foreign suppliers; this has satisfied the procurement policies of the donor countries.

The development of detailed functional specification is, however, an ambitious undertaking requiring considerable engineering experience and manpower. The detailed specifications have been developed by Gilbert/Commonwealth during 1984-85 using their home office support. The actual use of these specifications has just begun in the last half of 1985. Because of these changes in the procedures for specifications, there has been a period of time when the specifications have been less than desirable.

Another problem with specifying a particular piece of equipment has arisen in RE II and will be experienced in RE III. This occurs when new equipment is ordered and must be both functionally equivalent and design equivalent. Without being able to cite a model number or equivalent in the specifications, complete compatibility cannot be assured.

An example of this occurred during RE II when Motorola communications equipment was desired for the World Bank-funded PBS's. The procurement of this particular equipment was desirable so that it would be compatible with RE I equipment. By being compatible, the repair training, experience, and spare parts capabilities developed could be used for the new equipment as well. Equipment from a different manufacturer would require additional training and spare parts to be on store. In the tender

process, the two lowest bids met the specifications but were not design equivalent.

3.5.2 Materials Handling

This section discusses the problems associated with the handling of equipment and materials from the time they enter the country until they are installed as part of the PBS distribution system. First, a summary of the handling of the equipment is given, followed by a summary of some of the problems.

The Director of Equipment and Materials is responsible for the material during this period. Because the majority of equipment utilized in the rural electrification of Bangladesh must be obtained from foreign suppliers, the efficient handling of this equipment is critical.

Equipment and material shipped to Bangladesh is received at the main REB warehouse in Khulna in the southwest part of the country. The material is offloaded, identified, inspected, and stored. The material must be stored according to requirements of the donor country which funded its purchase. Payment for 90% of the order is made when the supplier ships the material. Upon receipt, the REB sets aside 120 days for inspection. If no problems are found with the material, then the last 10% of the payment is made to the supplier. Records of receipt, inspection, and acceptance of the material must be kept. Then, the material must be transported by local transportation contractors to the proper PBS. Material purchased by a donor country must be sent to the PBS being constructed by that donor. At the PBS, the material is stored according to ownership by REB or PBS. The majority to date is owned by the REB because they are building the initial facilities and intensification of

facilities. However, the PBS may purchase material from the REB for minor construction and must keep material for connections and replacements. Separate storage of PBS material is, therefore, required. After the storage of REB material at the PBS, it is then transported to the job site for installation. There are many steps in the process, the majority of which are carried out with manual labor with almost no handling machinery. The solution of the problems identified below would improve the overall efficiency of this operation:

1. Transport on U.S. ships. Fifty percent of material purchased with USAID funds must be transported to Bangladesh using U.S.-owned shipping companies. Arranging shipment with these constraints is not an easy task.

2. Identification of the material and equipment. The number and variety of parts required to build a distribution system is enormous and identifying one part from another is not an easy task. It is further complicated because there are apparently no drawings associated with the REB list of materials or description of parts.

3. Storage of parts. The efficient storage of material to prevent damage and to allow easy retrieval is a necessity in a warehousing facility.

4. Segregation of material by donor purchase. The requirement to separately store material according to donor complicates the warehousing.

5. List of Materials. The REB list of materials has been reported to be difficult to work with because of the index scheme utilized and illogical order of organization of material in the list. Also, additions to the list appear to be difficult.

6. Separate stores at PBS. The requirement of two physical stores at the PBS seems to be unnecessarily complicated.

7. Return of material to stores. The return of material to stores and proper accounting appears to be a procedure not yet used.

3.5.3 Equipment Procurement

The policy for procurement of commodities with AID funding has been to restrict the sources to the United States and developing Third World countries. The World Bank funding restricts the sources to countries contributing to the Bank and developing Third World countries and requires the selection criteria for a procurement to be low bid regardless of quality or compatibility. Other individual country donors usually restrict procurement of commodities to their country.

The countries which have provided equipment to the RE project were reviewed with the Director of Procurement. Because no summary records are kept, an exact accounting is not possible. Based on his experience, the countries providing equipment were ranked based upon the amount of equipment procured from that country. Countries providing the most equipment are, in order, the United States, Brazil, South Korea, Thailand, Bangladesh, and a group consisting of India, Taiwan, Japan, Finland, France, and Sweden.

In discussing the sources of equipment with the technical advisors, there appears to be some second sourcing which brings in equipment from countries such as China and the Soviet Union which are not on the above list. Not all the suppliers from countries from which equipment is procured are original equipment manufacturers, but instead order equipment from another country not on the restricted list of countries. The AID

policy of restricting procurement to Third World countries to build up their manufacturing capabilities and world competitiveness is working. In the case of South Korea's power equipment business, they are providing equipment that is of equal quality to equipment manufactured in the United States and at a competitive price. This would indicate that the AID procurement policy with Third World countries should be reviewed. In addition, because a U.S. standard design criteria has been adopted, some of the equipment procured is typically only used in the U.S. and is therefore only available from U.S. manufacturers (i.e., voltage regulators).

In reviewing the procurement procedure with the Director of Procurement, the procedure the REB is using is excellent. A tender bidding process is used. The invitation for bid is prepared by the Directorate of Procurement and is given a financial and engineering review. (The technical assistance advisors also participate in the review.) The bids received are given a financial and engineering review including technical assistance advisors to select the contractor for award.

The REB has been coping with three problems in the procurement of equipment:

1. The selection criteria for a bid at first was heavily oriented to selecting a bid based on costs. This has been modified; now adherence to specifications, quality, and cost are all considered.

2. As described in Section 3.5.1, the specifications have been changed from specifying a catalog number to detailed technical

specifications. The transition from one method to another has created some problems in completely specifying the required equipment.

3. The ability to procure new equipment and to maintain compatibility with existing installed equipment is essential. Maintaining compatibility by using the present procurement method of competitive bidding is difficult in some instances. The usual method to insure compatibility in those instances is to source the procurement.

In summary, the equipment procurement procedure utilized by the REB is very good. The REB needs to continue selecting equipment based upon specifications, quality, and cost. The completion of the detailed technical specifications for equipment is essential to procurement of the proper equipment. Based upon the experience to date, there does not appear to be a need to limit AID commodity purchases to United States suppliers. There also does not appear to be a need to limit purchases to Third World countries as well. There is a need for some AID commodity purchases to be made on a sole source basis.

3.5.4 Quality

The quality of equipment and material procured is determined by the standards used in the tendering process. Three checks can be made to determine if the quality of the equipment and material is meeting these standards. First, the manufacturing plant can be inspected prior to ordering or manufacturing of the equipment to ensure that the supplier has adequate production facilities, techniques and quality assurance inspection.

The inspection of plants has been focused on factories in Asia (primarily India, Korea, and Thailand), due to the developing nature of

these suppliers in the world market. The plant inspections are made by a consulting team advisor. No REB representative is sent on plant inspections due to foreign travel restrictions by the GOB. A new approach is to be implemented for these plant inspections whereby inspectors stationed in various parts of the world who make inspections on behalf of Gilbert/Commonwealth's other operations will be used. The inspection of a plant does not guarantee quality as there have been cases when the inspection did not identify problems but the material was rejected upon delivery. Also, recommendations have been made not to order from some suppliers based upon plant inspections.

The second check to ensure quality is to include in the standards a specific request for factory testing and reporting on equipment and material. This is being done in some cases for power equipment such as transformers. Consideration should be given to expanding the use of factory testing. The third check of quality is to have the equipment and material inspected upon delivery. The present inspections are based on visual inspection of equipment. A more rigorous procedure should be established to include testing. There are a number of simple tests requiring very little equipment which could be effective in insuring the quality of materials.

The Director of Procurement deals with suppliers in resolving any quality problems identified upon inspection of equipment and material. The actual inspections are the responsibility of the Director of Equipment and Material. In reviewing the occurrence of quality problems with the Director of Procurement, only six invitations (bids) out of 500 awarded can be cited as having quality problems. One of the difficulties in

examining the quality issue is that records are kept on each invitation, but no summary statistics are available. The six cases cited are:

1. & 2. Two companies from India were awarded contracts for delivery of bare conductor and did not deliver the conductor. Both companies were blacklisted. When a company is blacklisted by REB, they will not place any additional orders with that company until the present order is brought into compliance. Also, they inform other government agencies of the problem with the supplier.

3. A Korean company was boycotted due to inferior anchor logs. The company corrected the problem and is now in good standing.

4. A Korean firm providing hardware was blacklisted due to inferior parts. Twenty percent of the order was rejected and the company was requested to replace the hardware. The company has never replaced the parts.

5. A Taiwan company supplying single phase electric meters was blacklisted due to quality problems.

6. A Korean firm supplying insulators has been blacklisted due to quality problems. The resolution of the problem has not been finalized.

In summary, the quality problems appear to be minor as indicated by the number of instances involving actions with a supplier. However, the number of verbal reports gathered during this assessment from REB and the consultants who visit the field installations indicates a greater quality problem. These reports indicate problems with hardware, strength of materials, and protective coatings (i.e., premature rusting is appearing).

3.5.5 Performance

The performance of the electrical equipment appears to be good but the experience with power transformers gives an indication of possible future expectations. The electrical operating environment in Bangladesh is very severe and harsh when compared to the United States. The voltage regulation on the 33kV system is very poor; extremes of 25kV to 39kV have been observed. The number of line faults (short circuits) on the 33kV and 11kV lines is reported to be high. The daily load shedding at some substations and seasonal load shedding during irrigation season throughout the country increase the number of switching and loading cyclings on equipment. All of these factors increase the electrical and mechanical stresses on equipment and will affect its lifetime.

A review of equipment performance with the Director of System Operations was made and the following summary is provided:

1. Power Transformers. The first 26 substations used GE three phase transformers. Four of these failed during 1983-84, three were 5-MVA and one was 2.5-MVA. A consultant was hired to determine the cause of the failures. The analysis highlighted the harsh operating environment and suggested the electrical and mechanical stresses as the cause. A recommendation was made to specify transformers with a cylindrical core and copper windings in future purchases. The present specifications do not specify a particular type of construction and the transformers purchased were of rectangular core construction with aluminum windings. The rectangular type of construction is not as expensive and not as rugged.

The next eight substations installed used Korean single phase transformers. These have less operating time and have had no problems reported.

2. Voltage Regulators. The first 26 substations used GE voltage regulators and a few problems were experienced with component failures in the control circuitry. The next eight substations used McGraw-Edison regulators. Moisture and logic problems have been identified and corrected by the manufacturer. Additional problems are foreseen with the design of the drive gear mechanism internal to the regulator.

3. Distribution Transformers. The majority of transformers have been supplied by Korea, and there are approximately 37,000 from all sources in use. About 250 have failed, with 90% of the failures attributed to overloading conditions.

4. Meters. Three phase and single phase revenue meters have performed well. The only exception was a shipment received early in RE I of single phase meters supplied by Taiwan which had poor workmanship that resulted in inaccuracies.

5. Insulators. There have been several instances of pole burning, each presumably caused by Korean-supplied insulator failures. Apparently, the ceramic coating is failing due to mechanical wear and is causing the insulator to fail. Due to the quantity of installed insulators, this is a difficult problem to resolve and the only practical method is to wait for failure and make replacements.

In summary, the harsh operating environment is placing unusually severe performance conditions on electrical equipment. Some of the problems are caused by inferior materials and manufacturing and other

problems are caused by unforeseen design requirements. This situation indicates a need for continual review and improvement of design and material standards.

3.6 PLANNING FOR RE III

This section reviews the plans being made by REB and the PBS's for the proposed RE III Project. Section 3.6.1 shows the schedule for Phase II and III. Section 3.6.2 reviews the planning for the construction of new PBS's for Phase III. Section 3.6.3 reviews the plans for the intensification of existing PBS's during Phase III.

3.6.1 Schedule

The schedules for Phases II and III are shown in Table 3.3. Phase II began in July 1982 and will be completed in June 1988. Phase III was scheduled to begin in April 1985 and end in June 1994. There are three comments to be made about the schedule for Phase III.

1. Commitment of Funding. The project is obviously keyed on the commitment of funding by donor countries. The Phase III plan shown here was based on funds being committed during the 2nd Quarter of calendar year 1985. As of the date of this report, funds have not been committed. The World Bank negotiations have been completed and are being approved by the GOB. REB has started the tender notice process for the World Bank funding.

2. Procurement of Equipment. The procurement of equipment from international suppliers is a long process. With the commitment of funds, the distribution of funding from the various donors is determined. The development of the procurement schedule and materials requires about three months. The tendering and ordering of materials requires 12 months and

Table 3.3 Bangladesh Rural Electrification Program implementation and construction schedule

Task	Phase II	Phase III
1. Funding Committed	Jul. 82-Sept. 82	Apr. 85-Jun. 85
2. Material & Equip. Tendering-Intl.	Jan. 83-Jun. 86	Oct. 85-Dec. 89
3. Material & Equip. Delivery - Intl.	Jan. 84-Jun. 87	Oct. 86-Dec. 89
4. Material Tendering Local	Apr. 84-Jun. 87	Jan. 87-Dec. 88
5. Material Delivery Local	Jan. 85-Mar. 87	Oct. 87-Jun. 89
6. Land Acquisition for Headquarters sites	Jan. 83-Dec. 84	Jan. 85-Mar. 86
7. Headquarters Cost	Apr. 83-Dec. 87	Jan. 86-Jun. 93
8. Organize PBS	Apr. 83-Jun. 84	Jan. 86-Dec. 87
9. Membership drive	Jul. 83-Sep. 85	Apr. 86-Mar. 88
10. Line Design	Oct. 83-Dec. 84	Oct. 86-Sep. 88
11. Substation const.	Jan. 84-Dec. 85	Apr. 87-Dec. 88
12. Line Staking & ROW Clearing	Oct. 83-Dec. 86	Oct. 86-Sep. 88
13. Base System Line Const.	Jan. 84-Mar. 88	Oct. 86-Jun. 94
14. Training for PBS staff	Oct. 83-Jun. 87	Apr. 86-Jun. 94
15. Commissioning of Line Sections	Jan. 84-Mar. 88	Jan. 87-Jun. 94
16. Energize - Consumer Connections	Apr. 84-Jun. 88	Apr. 87-Jun. 94

Source: A Brief on Bangladesh Rural Electrification Program, Rural Electrification Board, January 1985.

the manufacture and delivery another 12 months. Therefore, after the commitment of funds, there is a lapse of approximately 27 months before electrical construction materials are available.

3. Transition from Phase II to III. As the project makes the transition from Phase II to III, attention must be given to the workloads placed on various functions. If the project begins too soon, then equipment begins flowing into the warehouses and sites while crews are still waiting for construction on Phase II to finish. On the converse, if the project begins too late, then construction on Phase II is completed and there is a dead time when construction firms have no work and will focus attention elsewhere. The transition of work from Phase II to Phase III must be examined closely and the workloads of construction firms adjusted in an effort to keep a consistent pace.

Summary. There is a window of opportunity (apparently October 1985 to July 1986) for scheduling the beginning of Phase III in order to take full advantage of the scheduling of material procurement and construction.

3.6.2 Construction of New PBS's

Seven new PBS's will be constructed using funds from other donors. Under the initial planning for the rural electrification program in 1976-78, a total of 99 PBS's were believed to be required for the complete rural electrification of the country. This number of PBS's has been revised downward to about 80 based upon experience to date of the area a PBS can cover. A set of criteria for selecting the order of the construction of the PBS's has been developed. The seven PBS areas have been selected and initial contacts in these areas will begin in 1986.

3.6.3 Intensification of Existing PBS's

The 17 PBS's funded by USAID in Phases I and II will be intensified by USAID in Phase III. The 16 PBS's funded by other donors during Phases I and II will also be intensified by the other donors. During Phases I and II, the average PBS constructed will cover an area of 500 sq. miles with two 5-MVA substations and 500 miles of distribution lines. Intensification by USAID will add one 10-MVA substation (this will double the existing capacity of the PBS) and about 200 miles of distribution lines to each of the 17 PBS's. The planning for Phase III intensification began in January 1985 when the REB requested expansion plans from the energized PBS's. The PBS's have a local consulting engineer who developed plans for adding another substation and more distribution lines. These plans are being reviewed for approval by the REB. After approval, no further work can be done until the funding for Phase III is committed. After funding is committed, the procurement schedule and list of materials can be prepared based upon approved intensification plans.

3.7 RE III INTENSIFICATION CAPABILITIES

This section reviews the capabilities of the REB and PBS's to implement the engineering plans for Phase III. The review consists of a discussion of the responsibilities and organization of the directorates reporting to the REB Member of Engineering. These directors and their staff are responsible for the planning, design, procurement, construction, and operation of the electrical facilities in the PBS's. The directorates are:

1. System Engineering and Design
2. Equipment and Materials
3. Superintendents of Engineering Construction
4. System Operations

At the PBS's, the Assistant General Manager for Maintenance and Construction and staff are responsible for the daily operation of the distribution system. The organization and manpower of the PBS Assistant General Manager for Maintenance and Construction are also reviewed.

3.7.1 System Engineering and Design

This directorate is responsible for review and monitoring of PBS planning and design; development of standards for engineering design and material specifications; preparation of material type and quality for procurement (tender documents); review of tender documents; and preparation and award of contracts for REB engineering design, line construction, and substation construction. The directorate is presently divided into four deputy directorates for (1) system planning, (2) material planning, (3) design and material standards, and (4) engineering and construction contracts.

A reorganization to five deputy directors has been proposed and is being reviewed by REB. System planning would be divided into two deputy directorates, one responsible for PBS's in the Western part of the country and the other for the Eastern part. Material planning would also be divided into two deputy directorates based upon project donors and would assume the design and material standards responsibilities. The engineering and construction contracts would remain as presently organized.

REB Contractors. The REB engineering design, line construction, and substation construction are performed by local contractors. This

directorate is responsible for contracting for these services and is also responsible for monitoring the engineer design contractors. The superintendents of engineering construction are responsible for monitoring the line and substation construction contractors. All the contractors are trained and approved by REB before being contracted to do any work.

The REB has encouraged private enterprise in contracting for services. Initially, 12 companies were trained for engineering design services to REB, but this number has been reduced to eight companies based on performance. These engineering design contractors perform the initial designs for a new PBS to be constructed. The design contractors are rated according to the number of projects they can simultaneously handle. A total of 53 line construction contractors have been approved with 35 more in the qualifying process. The contractors are rated and categorized (50 miles of line, 25 miles and renovation) according to the amount of construction work they have successfully completed. There are 24 substation construction contractors approved for work. The REB has stopped tendering for construction work because of performance problems and collusion among contractors. REB has had to resort to fixing the price per job and assigning the work to the contractors. Future work for an individual contractor is based upon performance.

3.7.2 System Operations Directorate

The system operations directorate works with energized PBS's to review, monitor, advise and assist them in the operation of the PBS distribution system. The directorate has two deputy directors, one for line operations and the other for substation operations. A reorganization to seven deputy directorates has been proposed and is being reviewed by

REB. The new directorates would divide the country by the Eastern Zone and Western Zone and assign three directorates to each zone. In the Eastern Zone, there would be two directorates to assist PBS operations, administration, maintenance, and repair. The third directorate would be responsible for substation operations in that zone. The assignment of the three directorates in the Western Zone would be the same as those in the Eastern Zone. The seventh directorate would be for maintenance and repair, and would be responsible for the workshop facilities, procedures, and repairs.

3.7.3 Equipment and Materials Directorate

The equipment and materials directorate is responsible for the receiving, inspection, warehousing, inventory control, and dispersement of construction materials procured for the rural electrification program. The directorate is responsible for the three central warehouses. The largest warehouse is in Khulna where all the internationally procured equipment is received.

3.7.4 Superintendents of Engineering Construction

The superintendents of engineering construction are responsible for monitoring and inspection of line and substation contractors. There are four superintendents, and their responsibilities are divided into four areas covering the country.

3.7.5 PBS Assistant Manager for Construction and Maintenance

This manager is the PBS engineer responsible for all engineering activities in the PBS. The engineer oversees the maintenance of the substation and distribution lines, connection of customers, extension of service facilities, disconnection of unpaid accounts, and problems when

service is interrupted. The engineer has a staff that includes linemen, storekeepers, meter testers, engineering assistants, and a local engineering consultant. The engineer is recruited and extensively trained by the REB. At the present, the REB is having difficulty staffing this position because it provides good training and experience but not as much pay when compared to private industry in the country. Other contributing factors to the high turnover rate are the requirements of rural living and the responsibilities and wealth of daily engineering and management problems encountered in the work. As a result, the REB is attempting to recruit twice as many engineers for this position as required in order to have a sufficient supply of trained individuals. This will also allow the trainees to be more slowly phased in and help the existing engineers' workload.

3.7.6 Summary

In summary, the REB has the engineering capabilities to carry out RE III for both building new PBS's and intensifying existing PBS's. The staffing is lean, even considering the proposed additions to the staff. The competency of the staff is high. The maturity of the deputy directors and assistant engineers during RE II should greatly add to the depth of experience and decisionmaking capabilities of the REB engineering activities.

3.8 FINDINGS AND RECOMMENDATIONS

The following are the findings and recommendations of the engineering and system planning assessment.

1. The REB has done a good job in fulfilling the tasks and requirements of RE I and RE II. Based upon the performance to

date, REB has the ability to complete Phase III assuming sufficient resources and technical assistance are provided.

2. The present forecasting of PBS loads is reasonable, but more attention needs to be focused on understanding customer characteristics.

3. The ability of BPDB to provide sufficient generating capacity in the country over the next five years is debatable. Load shedding will be a problem during RE III.

4. The BPDB transmission system (132 kV) and subtransmission system (11 kV) will have adequate capacity by the end of 1987. This will alleviate the local shedding problem.

5. Load shedding has been occurring on a daily basis in some locations and on a seasonal basis country-wide for the past year and is projected to occur for another year. This load shedding will reduce energy sales and revenues and place additional stresses on electrical equipment.

6. The load factor on PBS systems is low, around 25% due to irrigation customers. The use of irrigation systems during 6:00 p.m. to 9:00 p.m. should be discouraged using any feasible means. The use of time-of-day meters or time clock control is probably economically unjustified. The most cost effective approach appears to be customer education and appeal to not use power during peak load periods.

7. The low power factor has been recognized by REB as a problem and REB has begun corrective action by adding fixed capacitors to the PBS distribution systems.

8. The system loss has been recognized as a problem. REB is beginning to analyze the losses to determine the extent of technical losses and unmetered losses. Upon analysis, the REB will probably find that the technical systems loss is reasonable and the high system loss is due to unmetered losses from theft and diversion. The reduction of unmetered losses will require a concerted effort by the PBS to find those individuals responsible.

9. The REB has done an excellent job in adopting design and material standards. There have been difficulties in adjusting the standards to the needs of multiple donors, which appears to have resulted in standards less than desirable. The completion of development of the detailed material standards and use of the standards in procurement should be given high priority attention.

10. The material handling at the warehouse facilities needs to be improved. The use of material standards to verify the receipt of the proper material should be emphasized. The material standards should have drawings of each piece of equipment to aid in identifying equipment received. Inventory control should be improved to properly account for all equipment in stock, status of equipment in transit, and equipment on order.

11. The quality assurance of equipment and materials received needs to be improved. A testing program should be included in the inspection process. Hardware should be checked for proper dimensions, thread sizes, and mechanical strengths (i.e. random

samples from an order of bolts should be checked for proper size, threading, and torque.) Basic electrical tests should be made on such electrical equipment as transformers, regulators, and reclosers.

12. The performance of the electrical equipment appears to be good, especially considering the harsh electrical operating environment in Bangladesh. The experience with the failure of power transformers gives an indication of the severe operating conditions and consequences. The distribution system design criteria and electrical equipment specifications should be reviewed in light of this harsh operating environment to determine if more stringent specifications are required for transformers, regulators, reclosers, insulation levels, etc.

13. REB and PBS's have made plans for RE III and have progressed to the point where they are waiting for completion of donor agreements. If RE III does not begin during FY 1986, then the transition from Phase II to Phase III will be disrupted, resulting in a period of no construction activity. A period of no construction would jeopardize the viability of the private contractors recruited and trained for REB construction activities.

14. The REB has engineering capabilities to implement RE III. Substantial engineering assistance will have to be given to the PBS's in the area of systems operation. This assistance will be necessary due to the growing size of the total rural distribution systems in the country, and the maturing of the

existing systems will increase the number and types of operational problems. The types of system operation assistance required will be substation operation and troubleshooting, line operation and troubleshooting, maintenance, and repair.

4. ENERGY PRICING AND FINANCIAL ISSUES

This chapter of the assessment considers two general topics: (1) the economic and distributional implications for RE of current commercial energy pricing policies in Bangladesh, and (2) the financial performance of AID-financed PBS's. On the basis of this analysis of economic and financial issues, recommendations are presented regarding appropriate energy pricing reforms and relevant technical assistance needs. In order to provide an appropriate framework for this economic and financial analysis, this chapter begins with a brief discussion of the general pattern of commercial energy demand and supply in Bangladesh.

4.1 COMMERCIAL ENERGY USE IN BANGLADESH*

4.1.1 Consumption:

There are several distinguishing characteristics of commercial energy consumption in Bangladesh. First, much of it has been supply constrained. That is, consumption of certain commercial energy products--especially electricity and natural gas--has often been constrained by supply shortages.** Second, commercial energy consumption per capita is very low, e.g., 36 Kg of oil equivalent per annum in 1984. As a result of such low consumption, the addition of a single new

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*Commercial energy in Bangladesh is derived from coal, petroleum, natural gas, and hydropower. Non-commercial energy use is not reviewed here since RE is a commercial source of energy and typically substitutes only for other forms of commercial energy. However, commercial energy use accounts for less than 50% of total energy use in Bangladesh, with this percentage being much lower in rural areas.

**This complicates the task of making energy demand projections.

industrial consumer can lead to a discrete increase in total commercial energy consumption. For example, in 1981 two fertilizer plants accounted for 38% of natural gas consumption, while four electric power plants accounted for 38%. Third, the level of commercial energy consumption varies significantly according to geographical region, and is much higher in the East than in the West.

Commercial energy use can be analyzed according to consumption by sector. In this context, most commercial energy in Bangladesh is consumed in three sectors: industrial, residential, and transport.* As indicated in Table 4.1, commercial energy use is dominated by the industrial sector, which accounts for approximately 44% of commercial energy use. The next most important sectors are residential, transportation, and agriculture--accounting for 24%, 19%, and 6% respectively of commercial energy use. Within the industrial sector, the consumption of electricity accounts for roughly one-half of total commercial energy use, with the remaining balance derived from natural gas (22%), Petroleum Products (17%), and coal (12%). Residential consumption is dominated by kerosene (50%), electricity (27%), and natural gas (23%). The transportation sector relies exclusively on petroleum products and coal, while agriculture utilizes mostly diesel fuel (82%) and some electricity (12%).

When commercial energy use is analyzed by source of energy, it is apparent that about 43% of such energy is consumed in the form of

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*Non-energy uses of potential energy supplies, e.g., natural gas as a fertilizer stock, are excluded.

Table 4.1. Commercial energy balance, FY83/84
(thousand metric tons oil equivalent)
Petroleum Products

	Coal	Crude Oil	LPG	Gasoline	Naptha	Jet Fuel	Kerosene	Diesel	Fuel Oil	Non-Energy	Total	Natural Gas	Electricity	Total
Primary Production	-	-	-	-	-	-	-	-	-	-	-	2,009	281	2,290
Imports	177	1,057	-	-	-	54	41	276	87	-	485	-	-	1,692
Exports & Foreign Bunkers (-)	-	-	-	-	24	-21[a]	-	-10	-21	-13	-159	-	-	-159
Primary Supply														3,836
Transportation and Losses														
Thermal Power Generation	-	-	-	-	-	-	-19	-55	-167	-	-241	-720	961	0
Oil Refining	-	1,088	7	48	94	4	297	216	231	94	991	-	-	-97[b]
Ener.Sec.Use & Losses(1)(c)	-	-7	-	-7	-3	-3	-22	48	21	-23	11	-102	-404	-502
Stock Drawdown	-	39	-	-4	3	1	20	8	15	1	44	-	-	83
Net Supply Demand	177	-	7	51	-	35	317	483	185	63	1,139	1,188	839	3,343
Demand														
Industry	137	-	-	-	-	-	-	11	178	-	189	241	536	1,103
Transportation	40	-	-	51	-	35	-	351	8	-	445	-	-	485
Agriculture	-	-	-	-	-	-	10	120	-	-	130	-	17	147
Commercial	-	-	2	-	-	-	-	-	-	-	2	56	79	137
Residential	-	-	4	-	-	-	306	-	-	-	310	137	163	610
Other Sectors	-	-	-	-	-	-	-	-	-	-	-	44	44	
Non-Energy Uses	-	-	-	-	-	-	-	-	-	63	62	743[d]	-	817

[a] IBRD estimate.
[b] Horizontal balancing item.
[c] Vertical balancing item. Items and totals converted to oil equivalents separately and may not add after rounding.
[d] Fertilizers.

Source: World Bank

petroleum products, 33% as electricity, 17% as natural gas, and 7% as coal. Petroleum product consumption is dominated by such middle distillates as diesel fuel (45%) and kerosene (29%), and by fuel oil (17%).

Most petroleum product consumption occurs in transportation (41%), households (29%), or industry (18%). Most electricity consumption is divided between industry (64%) and households (19%), while natural gas goes to industry (56%) and households (32%).

4.1.2 Supply:

Commercial energy in Bangladesh is derived from natural gas, hydropower, petroleum, and coal.* The former two energy resources are available domestically, while the latter two are imported. These energy resources can also be characterized by their geographical distribution. Natural gas fields exist both on- and off-shore in the East Zone. Similarly, developed hydropower capacity and potential exists primarily in the southeast. Substantial coal deposits exist in the northwest. However, their utilization is not expected to be economically viable in the foreseeable future.

Reasonably well developed supply systems exist for electricity, petroleum products, and (to a lesser extent), natural gas.** Up until 1982, completely separate power grids existed in the East and West

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*Peat deposits exist in the Faridpur and Khulna districts. Some consideration has been given to their use in a 30 MW pilot power plant in Faridpur.

**Many of these systems were rebuilt after the War of Liberation in the early 1970's.

Zones,* supplying about 426 MW and 237 MW of available capacity in theEast and West, respectively. These grids were connected at the end of 1982 by a 500 MW interconnector; and, their combined capacity has increased to roughly 1,010 MW by 1985. At the same time, the rural distribution network has been expanded significantly by the rural electrification program. Natural gas is supplied to Dhaka and Chittagong and to several other smaller towns via pipelines. Natural gas is also supplied via pipeline to several cement and fertilizer factories and to power stations. Petroleum products are either imported directly or refined in Chittagong from imported crude oil. Refinery production is such that insufficient amounts of kerosene and diesel fuels are produced, while excess amounts of gasoline/naphtha and fuel oil are produced (and thus exported).

Bangladesh's commercial energy supply strategy is driven by at least three factors: (1) the high cost (in foreign exchange) of petroleum imports; (2) the relative abundance of natural gas deposits; and (3) the rapid depletion of forest reserves and other traditional fuels. These factors jointly determine a strategy aimed at reducing use of petroleum products by substituting the use of natural gas and encouraging a more energy-efficient economy. This substitution of natural gas for petroleum is achieved by inter alia making gas supplies available to more urban areas, by increasing the use of gas fired power plants (and by transmitting this electricity to the West Zone), and by developing the

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*BPDB also operates a few MW of isolated generating units in both zones. Significant amounts of captive generation also exist.

supply of electricity (as a substitute for kerosene and diesel) in rural areas.* Another important part of any energy supply strategy involves the establishment of appropriate energy pricing policies. This topic is considered below.

4.2 COMMERCIAL ENERGY PRICING AND SUPPLY COSTS IN BANGLADESH

4.2.1 Overview

Commercial energy prices in Bangladesh are, in general, set by the Government, while non-commercial energy prices are for the most part market determined. Commercial energy prices are uniform throughout the country.** The electricity tariffs charged to PBS consumers are an exception since these are set by each PBS with the assistance and approval of the REB (see below). As is usually the case, existing commercial energy prices are determined by a variety of economic, financial, and distributional concerns. The latter two factors have tended to predominate so that energy prices have often been set below economic supply costs (petroleum prices since 1982 are an exception). Recently, however, international aid donors (especially the World Bank) have promoted the adoption of energy prices which reflect actual supply cost and have provided technical assistance to help establish what such prices should actually be.

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*The use of compressed natural gas as a substitute for gasoline or diesel oil, and of liquified petroleum gas as a substitute for kerosene (lighting), gasoline (transport), or diesel oil (pumping) is also being considered.

**Differences in transportation costs do result in inter-regional variations, however.

4.2.2 Current Prices

Current and past ex-depot prices for petroleum products are summarized in Table 4.2. These prices were last increased in March 1983. The Ministry of Energy and Mineral Resource is authorized, however, to automatically increase these prices by up to 10% if supply costs increase. Recent natural gas prices for the Titas Gas Company are presented in Table 4.3.*

Electricity is supplied in Bangladesh by the BPDB and (in rural areas) by the PBS's. BPDB tariffs are the same throughout the country for various categories of consumers. Changes in these tariffs must be approved by the Cabinet. Tariffs for various types of PBS consumers vary only slightly among PBS's. Changes in the tariff structure of any PBS must be approved by the REB. BPDB and PBS tariffs in recent years are summarized in Tables 4.4 and 4.5, respectively.

BPDB tariffs have increased rapidly during the last six years, i.e., by an average of 38% in 1979, 47% in 1980, 28% in 1982, 3.2% in 1983, 13% in 1984, and approximately 20%** in 1985. In contrast to this general pattern of annual increases, the bulk supply rates that BPDB charged to the PBS's remained constant at Tk. 0.78 between January 1981 and August 1985 and increased by only 22% in September 1985. Other important changes in BPDB rates have occurred with the introduction of both peak/off-peak energy charges for certain large consumers and demand

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*Titas Gas Company is the only gas distribution company with significant numbers of domestic, commercial, and industrial consumers.

**Assessment team estimate.

Table 4.2. Bangladesh Petroleum Product Prices (Taka/IG)

Product	July 82		July 85	
	Ex. depot price	Import parity[a,b] c.i.f. Chittagong	Ex. depot price	Import parity c.i.f. Chittagong
Premium gasoline	69.3	29.1	75.6	
Regular gasoline	63.8	27.3	66.7	
Jet fuel	42.0	30.2		
Kerosene	32.8	29.9	32.8	35.2
Diesel oil	32.8	28.6	32.8	33.5
Fuel oil	24.5	18.8	24.5	

[a]F.o.b. Singapore plus freight to Chittagong.

[b]Exchange rate July 1982, Tk. 22 = US $ 1.00.

Table 4.3. Natural gas tariffs[a]
(Titas Gas Co.) (Tk. per MCF)

	July 82	July 83	July 84
Electric power	10.5	11.5	13.05
Fertilizer	10.5	11.5	13.05
Industrial	31.0	36.0	36.0
Commercial	31.0	36.0	36.0
Domestic (metered)	27.0	34.0	34.0
Domestic (unmetered)			
Single burner/month	35.0[b]	45.0	
Double burner/month	65.0[b]	80.0	

[a]Excludes meter rental charges where applicable and excise duties.

[b]Irrespective of consumption.

Table 4.4. Bangladesh BPDB Electricity Tariff Structure (Taka)

	Min. Monthly Charge/KW[a]	Energy Charge/KWH[b]	Energy Charge/KWH[c] Peak	Energy Charge/KWH[c] Off-peak	Demand Charge per KW[a]
		March - April 1985			
A. Domestic		0-250 KWH: Tk. 0.6 250-400 KWH: Tk. 0.85 above 400 KWH: Tk. 2.25	-	-	-
B. Irrigation	Tk. 250/HP/yr[d]	Tk. 1.0	-	-	-
C. Industry	-	Tk. 1.7	Tk. 4.0	Tk. 1.2	-
D. Commercial	Tk. 45	0-100 KWH: Tk. 1.85 above 100 KWH: Tk. 2.5	-	-	-
E. Consumers above 50 KW (except Jute Mills)	Tk. 70	Tk. 1.7	Tk. 3.25	Tk. 1.0	
F. Jute Mills above 50 KW	Tk. 70	Tk. 1.45	-	-	-
G. 5 MVA or above	Tk. 65	Tk. 1.55	Tk. 3.0	Tk. 0.9	-
H. PBS's	Tk. 50	Tk. 0.78	-	-	-
		Sept. 1985 - Present			
A. Domestic	-	Up to 100 KWH: Tk. 1.0 Up to 350 KWH: Tk. 1.1[f] Above 350 KWH: Tk. 275[f]	-	-	Tk. 10
B. Irrigation	Tk. 250/HP/yr[d]	Tk. 1.4	-	-	Tk. 30
C. Industry	-	Up to 5 KW: Tk. 1.95 Above 5 KW load: Tk. 2.05	Tk. 5.85	Tk. 1.95	Tk. 30
D. Commercial	Tk. 45	Gov't: TK. 2.15 - 2.8 Commercial: Tk. 25-30	-	-	Tk. 10
E. Consumers above 50 KW (except Jute Mills)	Tk. 70	Gov't: Tk. 2.25 Commercial: Tk. 2.80 Irrigation: Tk. 1.9 Industry: Tk. 2.0	Tk. 6.75 Tk. 5.7	Tk. 2.7 Tk. 1.9	Tk. 30

Table 4.4. Bangladesh BPDB Electricity Tariff Structure (Taka) (Continued)

	Min. Monthly Charge/KW[a]	Energy Charge/KWH[b]	Energy Charge/KWH[c] Peak	Energy Charge/KWH[c] Off-peak	Demand Charge per KW[a]
		Sept. 1985 - Present (Continued)			
F. Jute Mills above 50 KW	Tk. 70	TK. 1.65	-	-	Tk. 30
G. 5 MVA or above	Tk. 65	Tk. 1.75	Tk. 4.95	Tk. 1.65	Tk. 30
H. PBS's	Tk. 50	Tk. 0.95	-	-	-
		July 1982 - June 1983			
A. Domestic		0-50 KWH: Tk. 0.50 50-250 KWH: Tk. 0.60 250-400 KWH: Tk. 0.70 Above 400 KWH: Tk. 2.0	-	-	-
B. Irrigation	Annual Charge Tk. 250/H.P./yr[d]	Tk. 0.5/Tk. 1.0[e]	-	-	-
C. Industry	Annual Charge Tk. 90 (single phase Tk. 500 (3 phase)	Tk. 1.5	Tk. 4.0	Tk. 1.1	-
D. Commercial	Tk. 45	0-100 KWH: Tk. 1.4 above 100 KWH: Tk. 2.5	-	-	-
E. Consumers above 50 KW (except Jute Mills)	Tk. 35	Tk. 1.55	Tk. 3.15	Tk. 0.9	-
F. Jute Mills above 50 KW	Tk. 35	Tk. 1.3	-	-	-
G. 5 MVA or above	Tk. 65	Tk. 1.35	Tk. 2.5	Tk. 0.8	-
H. PBS's	Tk. 50	Tk. 0.78	-	-	-

[a]For consumers without time of day meters.
[b]For consumers with time of day meters.
[c]Per KWH of contracted or connected load.
[d]Not less than Tk. 1000/yr for single phase or Tk. 3000/yr for 3 phase.
[e]Up to 250 KWH/more than 250/KWH.
[f]Rate applies to all consumption.

Source: BPDB

Table 4.5. PBS tariffs by year (Tk./KWH)[a, b]

PBS	Tariff Category: Domestic						Small Commercial						Irrigation						Industry						Street Light[c]					
	80/81	81/82	82/83	83/84	84/85	85/86	80/81	81/82	82/83	83/84	84/85	85/86	80/81	81/82	82/83	83/84	84/85	85/86	80/81	81/82	82/83	83/84	84/85	85/86	80/81	81/82	82/83	83/84	84/85	85/86
Dhaka	0.75	0.75	0.80	0.80	0.80	1.0	-	-	1.25	1.25	1.40	1.80	0.70	0.85	1.0	1.0	1.15	1.60	0.95	1.05	1.45	1.50	1.70	2.10	60.0	60.0	60.0	70.0	75.0	85.0
Tangail I	-	0.75	0.80	0.80	0.80	1.0	-	-	-	1.25	1.35	1.60	-	0.85	1.0	1.0	1.15	1.50	-	1.05	1.50	1.50	1.65	1.85	-	60.0	60.0	70.0	70.0	85.0
Comilla I	0.75	0.75	0.75	0.80	0.80	1.0	-	-	1.25	1.25	1.50	1.70	0.80	0.85	1.0	1.0	1.10	1.50	0.90	1.05	1.40	1.50	1.70	1.90	60.0	60.0	60.0	70.0	70.0	85.0
Chandpur	0.75	0.75	0.75	0.80	0.80	1.0	-	-	1.25	1.25	1.50	1.70	0.70	0.85	1.0	1.0	1.25	1.50	0.90	1.05	1.40	1.50	1.70	1.90	60.0	60.0	60.0	70.0	70.0	85.0
Habigonj	-	-	0.75	0.80	0.80	1.0	-	-	1.40	1.40	1.35	1.60	-	-	1.0	1.0	1.0	1.40	-	-	1.45	1.50	1.65	1.80	-	-	60.0	70.0	70.0	85.0
Mouivibazar	0.75	0.75	0.80	0.80	0.80	1.0	-	-	1.30	1.30	1.40	1.60	0.70	0.85	1.0	1.0	1.0	1.40	0.90	1.05	1.50	1.50	1.65	1.80	60.0	60.0	60.0	70.0	70.0	85.0
Pabna I	-	0.75	0.75	0.80	0.80	1.0	-	-	1.25	1.30	1.40	1.60	-	.85	1.0	1.0	1.25	1.45	-	1.05	1.45	1.50	1.70	1.95	-	60.0	60.0	70.0	70.0	85.0
Pabna II	-	0.75	0.75	0.80	0.80	1.0	-	-	1.25	1.25	1.50	1.70	-	0.85	1.0	1.0	1.15	1.40	-	1.05	1.45	1.50	1.70	1.85	-	60.0	60.0	70.0	70.0	85.0
Shirajgonj	0.75	0.75	0.75	0.80	0.80	1.0	-	-	1.25	1.25	1.60	1.75	0.70	0.85	1.10	1.10	1.25	1.50	0.90	1.05	1.50	1.50	1.70	1.90	60.0	60.0	60.0	70.0	70.0	85.0
Jessore I	0.75	0.75	0.75	0.80	0.80	1.0	-	-	1.25	1.25	1.60	1.70	0.70	0.85	1.0	1.0	1.25	1.50	0.90	1.05	1.45	1.50	1.70	1.85	60.0	60.0	60.0	70.0	70.0	85.0
Jessore II	0.75	0.75	0.80	0.80	0.80	1.0	-	-	1.25	1.25	1.50	1.70	0.70	0.85	1.0	1.0	1.25	1.50	0.90	1.05	1.45	1.50	1.70	1.80	60.0	60.0	60.0	70.0	70.0	85.0
Natore I	0.75	0.75	0.80	0.80	0.80	1.0	-	-	1.25	1.25	1.60	1.70	0.70	0.85	1.15	1.15	1.25	1.50	0.90	1.05	1.50	1.50	1.70	1.85	60.0	60.0	60.0	70.0	70.0	85.0
Natore II	-	-	0.80	0.80	0.80	1.0	-	-	1.25	1.25	1.50	1.60	-	-	1.15	1.15	1.25	1.50	-	-	1.50	1.50	1.70	1.85	-	-	60.0	70.0	70.0	85.0

[a] For the original AID financed PBS's.

[b] Most PBS's have minimum monthly charges for most categories of consumers. This is typically based on 20 KWH and 18 KWH consumption for domestic and commercial consumers respectively, horse power for irrigation consumers, and on connected load (KW) for industrial consumers. There is a monthly demand charge of Tk. 30/KW for industrial consumers over 25 KW. Tariff penalties for industrial and irrigation consumers with power factors below .85 also exist.

[c] Tk./Month/Light

Source: REB

charges for all categories of consumers except PBS's. Current BPDB tariffs are still somewhat inconsistent with the structure of supply costs since small domestic and irrigation consumers pay the lowest rates.* Nevertheless, the most recent tariff revision represents a significant step towards the rationalization of BPDB tariffs.

The level and structure of any PBS's tariffs have, in general, been affected by at least five factors: (1) the cost of power purchased from BPDB; (2) the level of BPDB rates to individual consumers (because a PBS and the BPDB often supply consumers in the same area); (3) the requirement that repayment of the REB loan begin after five years; (4) a recent World Bank covenant that, on average, per kWh PBS tariff must not be less than the average per kWh BPDB tariff;** and (5) the ability to pay for PBS consumers.

It is evident from Table 4.5 that there is very little inter-PBS variation in tariffs. This is undoubtedly due to the strong role which REB and its consultants have played in setting tariffs. In all PBS's, tariffs are lowest for domestic consumers and highest for industrial consumers. Over time, domestic tariffs have remained relatively stable in five years, increasing 25% in nominal terms and decreasing in real terms. In contrast, both irrigation and industrial tariffs have more than doubled in nominal terms.

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*Probably due to distributional reasons.

**As of September 1985, the average BPDB tariff is estimated to be Tk. 1.7/kWh.

Average tariff revenues per kWh sold in each PBS are summarized in Table 4.6 for FY 83/84, FY 84/85, and the first quarter FY 85/86. These figures suggest the need for an increase in average tariffs in PBS's if the World Bank covenant requiring an average tariff of Tk. 1.7/kWh by December 1985 is to be met.

4.2.3 Commercial Energy Supply Costs in Bangladesh

The economic supply cost of energy should measure the opportunity cost of the resources used to obtain the type of energy in question. The appropriate measure of this opportunity cost depends *inter alia* upon the nature of the energy source and the alternative markets available to it. For example, petroleum is a tradeable energy source. Thus its supply cost in Bangladesh is determined by the market price for petroleum (perhaps f.o.b. Singapore) plus transport cost to Bangladesh. In contrast, natural gas is produced domestically within Bangladesh, exists in a fixed supply, and has limited export market potential. This means that the economic supply cost is determined by the economic cost of production plus a depletion premium.* Finally, electricity is a non-tradeable, non-exhaustible energy source. Thus its supply cost equals its economic cost of production--the so-called long-run marginal cost (LRMC). This LRMC typically varies with voltage level and the time of consumption (i.e., during the peak or off-peak period).

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*This premium is added to the production cost because an increment of present production leads to the more rapid substitution of some more expensive alternative source of energy.

Table 4.6. Average tariff revenues per KWH sold (Tk./KWH)[a]

	PBS	FY 83/84	FY 84/85	1st quarter FY 85/86[b]
1.	Dhaka	1.28	1.43	1.58
2.	Tangail I	1.29	1.39	1.59
3.	Comilla I	1.30	1.52	1.66
4.	Chandpur	1.17	1.34	1.43
5.	Habigonj	1.39	1.54	1.63
6.	Moulvibazar	1.40	1.57	1.79
7.	Pabna I	1.20	1.35	1.33
8.	Pabna II	1.22	1.36	1.42
9.	Shirajgonj	1.14	1.38	1.43
10.	Natore I	1.18	1.32	1.35
11.	Natore II	1.24	1.41	1.32
12.	Jessore I	1.19	1.36	1.42
13.	Jessore II	1.13	1.43	1.55

[a]Variations in average revenues/KWH overtime in a given PBS are due to changes in: (1) tariffs, (2) average consumption per consumer, and (3) the mix of consumers.

[b]First quarter FY 85/86 includes July 1 - September 30, 1985. The average for this quarter may not be exactly comparable with the averages for FY 83/84 and FY 84/85 due to the seasonality of irrigation load.

Source: REB

Table 4.7 summarizes recent estimates of the economic supply costs of petroleum products, natural gas, and electricity, and compares these costs with their current market prices in Bangladesh, as described above. The results of this comparison clearly indicate that relative price distortions currently exist within the commercial energy sector. That is, kerosene and diesel oil are priced at roughly their economic supply costs while natural gas and electricity are priced significantly below. Of particular relevance to RE in Bangladesh is the relation between petroleum product and electricity prices. Since electric energy in rural areas primarily substitutes for petroleum products, the subsidization of electricity prices relative to petroleum prices clearly provides an "artificial" incentive for petroleum product consumers, e.g., households, tubewells, and rice mills, to switch to electricity.*

4.2.4 Implications of current commercial energy pricing policies

Looking at the entire commercial energy sector, it is clear that, on efficiency grounds, electricity and natural gas prices should continue to rise toward their economic supply costs. This will reduce the financial appeal of RE to potential consumers, but should lead to efficiency gains.

Within the specific context of RE, BPDB should consider the adoption of a bulk rate tariff to the PBS's which more closely reflects supply cost and incorporates both an energy charge and a demand charge. Such a

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*This is not to say that there is no economic rationale for switching to electricity. In fact, least economic cost comparisons suggest that such a rationale exists in Bangladesh. However, this relative price distortion may promote electrification in cases when it is not justified on efficiency grounds.

Table 4.7. Economic supply costs of commercial energy (1984-85)

Energy product	Petroleum		Natural gas		Electricity	
	Supply cost (TK./IG)[a]	Mkt. price as % of supply cost	Supply cost (Tk/MCF)	Mkt. price as % of supply cost	Supply cost (Tk/KWH)	Mkt. price as % of supply cost
Petroleum						
Kerosene	35.20	93				
Diesel oil	33.49	98				
Natural Gas						
(bulk consumers e.g. electric power)			24.0[b]	54		
Electricity						
(bulk 33 KV consumption)					1.76[c]	54

[a] F.O.B. Singapore plus freight to Chittagong.
[b] Based on estimates derived by Monenco and Brutec, and by the Bangladesh Energy Planning Project.
[c] Tentative World Bank estimate for 1984.

demand charge should help reduce capacity shortages within the BPDB grid and improve the BPDB load factor by providing an economic incentive for the PBS's to improve their load factors.

PBS tariff increases (especially for productive use and large residential consumers) can be justified on efficiency grounds.* Moreover, financial comparisons of the costs of using electricity or petroleum products for pumping, motive power, or lighting suggest that there is room for such tariff increases. In this way, some of the economic benefits of RE which occur in the form of cost savings could be transferred to the PBS's in the form of higher tariff revenues. In addition, the PBS's should strive to ensure that demand charges are applied when economical, and that tariff penalties for low power factors are enforced.** Finally, within this general framework of higher (but more economically rational) tariffs, the possibility of offering relatively low tariffs (set roughly at off-peak energy costs) to productive use consumers who restrict their consumption to off-peak periods should be seriously considered.***

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*There is also a financial justification--see Section 4.4 below.

**The REB has tentatively approved the adoption (as of December 1985) of tariffs which include an energy charge plus a demand (or capacity) charge for all categories of consumers except small domestic and commercial ones.

***The relatively low tariffs PBS's charge irrigation consumers might be at least partially justified in this fashion--as long as irrigation pumping is restricted to off-peak periods. Such a tariff should be accompanied by programs to inform consumers of the benefits of increasing/reducing off-peak/peak consumption.

4.3 SUBSIDIES ASSOCIATED WITH RE

For the purpose of this section, an economic subsidy is considered to exist when a resource is supplied at a price which is less than its economic (or opportunity) cost. At least four such subsidies can be identified in the current RE program in Bangladesh: (1) bulk electricity is supplied to the PBS's at a subsidized rate by BPDB; (2) a subsidy equal to any positive difference between operating expenses and revenues is paid to each PBS by the BDG during its first five years of operation;* (3) the capital required to build the backbone system of each PBS is supplied thru REB, and, ultimately, from the BDG and international donors at the subsidized interest rate of 3%;** and (4) within a given PBS, there are cross subsidies between various categories of consumers. The first three such subsidies generally transfer resources (or income) from the BDG, other BPDB consumers, or foreign donors to the PBS. The fourth subsidy transfers resources among consumers in a given PBS. Since PBS domestic and irrigation tariffs are lowest, and commercial and industrial tariffs are highest, resources are transferred from the latter two types of consumers to the former two types. Estimates of the magnitudes of the first three types of subsidies are provided below in Table 4.8.

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*It is unclear whether the energy cost component of operating costs which is used in the determination of the appropriate subsidy is calculated based on actual line losses or on target line losses (which are generally lower).

**During the five-year grace period, the subsidized interest rate is only 0.75% per year. This interest is capitalized to be repaid starting in year six.

Table 4.8. Estimates of RE subsidies

PBS	Bulk Tariff Subsidy (Tk, X 10^3)[a]		Operating subsidy for 1st 5 years (Tk X 10^3)[b]				Interest subsidy on PBS Loan (TK X 10^3)[c]
	FY 85	FY 86 (est.)	FY 82	FY 83	FY 84	FY 85	
1. Dhaka	30352	28736	4282	1070	0	0	20424
2. Tangail	19587	16553	1885	1128	2215	425	17802
3. Comilla I	17038	15138	2839	2567	2696	0	23000
4. Chandpur	8062	5072	914	2103	3828	2975	17250
5. Habigonj	10486	11755	115	1454	1783	0	13800
6. Moulvibazar	13073	14713	2667	1991	2266	0	11744
7. Pabna I	5858	5851	-	1509	2240	2531	11730
8. Pabna II	5496	5524	601	1852	2189	2180	11500
9. Sirajgonj	16541	12988	2718	3232	4994	1612	17250
10. Natore I	9829	91212	3833	2760	4043	899	15143
11. Natore II	11693	10490	873	2432	2066	612	17250
12. Jessore I	11682	8654	2327	2857	4181	2889	18400
13. Jessore II	9881	10682	3266	3367	4179	992	17250
Total	169578	157368	26320	28322	36680	15115	212543

[a]Equals (Tk.1.76 - Tk.0.78) X KWH's purchased for FY 85, and (Tk.1.76 - Tk.0.95) X estimated KWH's purchased for FY 86.

[b]Assumes the subsidy paid each year equals the calculated operated deficit, i.e. (billed tariff revenue and other operating revenue) - (cost of power + O&M + government duty + depreciation).

[c]Estimated for the sixth year of PBS operation, given the estimated total utility plant as of June 1985. Interest subsidy = [total utility plant X (14.5% - 3%)], where 14.5% is the assumed market rate of interest.

The results presented in Table 4.8 indicate the magnitude of resources transferred to the PBS's via the first three types of subsidies described above.* At present, the largest source of subsidy is the low interest rate paid by PBS's on REB loans. Over time, this subsidy is likely to become relatively more important as the BPDB bulk tariff rate moves closer to LRMC and as growth rates of energy consumption in PBS's level off.

It is clear from Table 4.8 that existing PBS's have been heavily subsidized. One might argue that these subsidies--especially with respect to the interest rate and bulk supply tariff--reduce incentives for efficient PBS construction and operation, while improving the distributional impact of RE. In addition, such subsidies affect the financial performance of the PBS's. The final section in this chapter analyzes this financial performance.

4.4 FINANCIAL PERFORMANCE OF PBS's**

This section attempts to evaluate the financial performance to date of AID-funded PBS's, and to distinguish at least some of the factors which affect this performance. In this context, a PBS's financial performance will be evaluated based on its ability to meet the financial

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*Except for the operating subsidy, results presented in Table 4.7 should be viewed as approximations. This is due to *inter alia* uncertainties concerning LRMC at the 33 KV level and the actual investment in total utility plant for each PBS.

**Financial performance should not be confused with economic performance. A poor financial performance does not necessarily imply a poor economic performance. In contrast, a good economic performance indicates at least the potential for a good financial performance.

convenants under which it was established. Namely, that a PBS be able to repay--starting five years after its formation--the REB loan used to finance the construction of its backbone system.*

For a variety of reasons, it is not a simple or straightforward task to provide a consistent evaluation of the financial performance of 13 separate PBS's. First, the PBS's are of different ages. Second, their backbone systems have different technical and cost characteristics. Third, they supply areas with significantly different economic characteristics and potentials. Finally, any evaluation (but especially those for relatively new PBS's) depends heavily on assumptions concerning rates of growth of the number of consumers and average consumption per consumer. Yet experience with the PBS's suggests such growth rates are highly volatile.**

4.4.1 Operating Margins:

Evidence concerning financial performance is obtained most readily by analyzing the PBS's operating margins (positive or negative) during the years since energization. This information is summarized in Table 4.9.

Data presented in Table 4.9 indicate that only four of 13 PBS's had positive operating margins during the most recent fiscal year. On the other hand, all the PBS's except Pabna I either reduced their operating

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*Repayment is to be made over a 25 year period at an interest rate of 3%. Interest at 0.75% per annum during the initial five-year grace period is capitalized.

**For example, the growth rates during FY 84/85 of total consumers ranged between roughly 13% and 150% in the 13 PBS, while changes in average consumption per consumer ranged between -17% and 73%. As PBS mature, the volatility of these rates should be reduced.

Table 4.9. PBS operating margins[a] (Tk x 10^3)

PBS	FY 81/82	FY 82/83	FY 83/84	FY 84/85
Comilla I	(2839)	(2567)	(2696)	761
Shirajgonj	(2718)	(3232)	(4994)	(1612)
Dhaka	(4282)	(1070)	1138	5024
Jessore I	(2327)	(2857)	(4181)	(2889)
Jessore II	(3266)	(3367)	(4179)	(992)
Pabna I	-	(1509)	(2240)	(2531)
Pabna II	(601)	(1852)	(2189)	(2180)
Habigonj	(115)	(1454)	(1783)	969
Natore I	(3833)	(2760)	(4043)	(899)
Natore II	(873)	(2432)	(2066)	(612)
Chandpur	(914)	(2103)	(3828)	(2975)
Moulvibazar	(2667)	(1991)	(2266)	2256
Tangail	(1885)	(1128)	(2215)	(425)

[a]Operating margin = (billed tariff revenues + other operating revenue) - (cost of power + O&M + gov't + depreciation).

Source: REB

deficits or increased their positive margins between FY 83/84 and FY 84/85. This trend of improving PBS financial status is unlikely to continue into FY 85/86, however. This is because the five-year grace period will expire for most PBS's; consequently, they must begin (at least in theory) making repayments of principal and interest. The projected financial status of these 13 PBS's in FY 85/86 is summarized in Table 4.9.* None of the PBS's are projected to be able to make full principal and interest payments in FY 85/86, although roughly seven PBS's can likely make partial payments.** This repayment problem should lessen in the future ceteris paribus as the number of consumers and average consumption per consumer increases. Nevertheless, these financial projections emphasize the need for a careful assessment of the repayment requirements imposed on PBS's.***

Table 4.10 also presents the average tariff for each PBS which is required in FY 85/86 (given the projected mix of consumers and average consumption per consumer) if the PBS is to cover operating costs and make whatever principal and interest payments are due.**** The "required"

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*The results presented in Table 4.8 and 4.9 are not exactly comparable since in the former no provision is made for bad debt.

**The relative financial strengths of the PBS's cannot be ranked according to the results presented in this table since some PBS's will have to repay principal and interest for only a few months in FY 85/86 while others must pay over the full 12 months.

***The current requirement that depreciation accounts be fully funded should also be analyzed since these revenues could be used to make up much of the interest and principal repayment shortfall in many PBS's.

****The required rate increases are likely biased downward due to the assumed zero price elasticity of demand. This bias is offset somewhat, however, by the exclusion of other operating revenues from the calculation.

Table 4.10. PBS financial projections for FY 85/86 (Tk x 10^3)

PBS	Estimated tariff revenues[a]	Operating expenses[b]	Principal and interest expenses[c]	Margin	Average tariff required to break even (Tk.)
Comilla I	31943	31204	12479	(11741)	2.40
Shirajgong	17338	27656	9258	(9576)	2.31
Dhaka	60146	51776	12720	(4350)	1.79
Jessore I	18157	20615	4612	(7070)	2.40
Jessore II	22375	20794	10477	(8896)	2.46
Pabna I	12209	14066	1211	(3068)	2.12
Pabna II	11563	12815	1279	(2531)	2.08
Habigonj	24633	22925	0[d]	1708	less than 1.7
Natore I	23511	21615	9418	(7522)	2.30
Natore II	22137	22273	1547	(5627)	1.84
Chandpur	10591	14988	1230	(5627)	2.61
Moulvibazar	30945	26869	4980	(904)	1.76
Tangail	34932	33924	1488	(480)	1.74

[a]Assumes average tariff of Tk. 1.7/KWA, and excludes other operating revenues.

[b]Includes O&M, depreciation (at 2.5%), power cost, and allowance for bad debt (2%).

[c]Assumes repayment of principal at the rate of 4%/year, and interest on principal of 3%/year. Principal is assumed equal to long term debt as of FY 85/86 which occurs after the grace period expires.

[d]Grace period still in effect.

Source: NRECA

tariff increases are relatively large for many PBS's. Once again, this situation may improve over time as loads on the PBS systems increase.

4.4.2 Determinants of Financial Performance

Table 4.11 provides information which may be useful in determining specific factors which affect the financial performance of PBS's. For example, three of the four PBS's with positive operating margins in FY 84/85 are relatively mature--being electrified in 1980 or 1981. Perhaps more importantly, these four PBS's supply relatively larger amounts of power to irrigation and industrial consumers. Since much of this consumption occurs off peak, it contributes to a higher load factor and better financial performance.* This result concurs with the general belief that viable RE typically depends upon the development of adequate productive uses for electricity.**

4.4.3 Conclusions

The most obvious point to make is that it is still very early to evaluate the financial performance of the original 13 PBS's. All except one of these have been energized less than five years. Moreover, the backbone systems of these PBS's were typically far from complete at energization. Thus there is little evidence available concerning the financial performance of mature PBS's.

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*In some cases, specific economic factors may lead to good financial performance. For example, the presence of tea gardens in Moulvibazar.

**It is obvious that the development of domestic load cannot contribute to the financial viability of PBS's under current conditions since the energy cost alone of supplying these consumers, roughly Tk. 0.95/(1-average losses)=Tk. 1.19 kWh, considerably exceeds the domestic tariff of Tk. 1/kWh.

Table 4.11. PBS energy consumption by consumer category

	Month/year officially electrified	Number of consumers and average consumption by consumer category (12/84)								Total consumption per month by consumer category (MWH) (12/84)							
		Irrigation		Domestic		Small commercial		Industrial		Irrigation		Domestic		Commercial		Industrial	
		No.	Av. cons. (KWH/mo.)	No.	Av. Cons. (KWH/mo.)	No.	Av. Cons. (KWH/mo.)	No.	Av. Cons. (KWH/mo.)	Total	(%)	Total	(%)	Total	(%)	Total	(%)
Comilla I	1/81	280	1450	8927	24	1611	41	194	3359	406	30	218	16	66	5	652	49
Chandpur	12/81	145	2183	5993	28	1936	36	174	966	376	44	168	23	68	10	168	23
Dhaka	6/80	578	1573	11844	34	795	71	373	2559	909	39	407	18	57	2	952	41
Jessore I	6/81	337	1232	6003	31	1418	48	116	1861	415	47	186	21	68	8	216	24
Jessore II	2/81	293	877	7129	23	1589	30	96	1786	334	47	160	72	48	7	171	21
Pabna I	1/84	152	1049	3570	31	854	37	90	1802	159	34	110	24	32	7	216	24
Pabna II	1/83	104	568	4141	31	1008	53	86	1670	59	15	128	33	54	14	144	37
Shirajgonj	4/81	683	873	6395	43	1459	54	235	1782	596	44	276	20	78	6	419	31
Natore I	3/81	590	966	6256	29	642	54	142	1467	570	57	181	18	35	4	208	21
Natore II	6/82	310	671	6454	30	1286	40	178	1768	208	27	194	25	51	7	315	41
Habigonj	10/82	23	1277	4299	30	1086	47	101	4839	29	4	127	18	51	7	489	70
Moulvibazar	6/81	11	281	6090	28	515	37	72	10087	3	0.3	172	19	19	2	726	79
Tangail	10/81	551	525	5500	31	266	69	140	5103	171	14	289	24	18	2	714	60
Average		312	977	6354	30	1113	45	157	2729	321	32	201	20	50	5	410	43

[a]Percent of total consumption in the PBS excluding streetlighting.

Source: AID

Given this caveat, some tentative conclusions can be drawn. First, the underlying economic soundness of the PBS's is improving as they mature. There is evidence to suggest that, over time, deficits are being reduced or surpluses increased (ignoring, for the moment, principal and interest repayment requirements). Second, financial performance is generally strongest in those PBS's which supply relatively large amounts of power to irrigation and industrial consumers. Such consumers pay tariffs in excess of the financial costs of delivered energy and generally provide loads which, if properly managed, increase PBS's load factors without making excessive demands on peak capacity. Third, it is likely that most PBS's will not be able to meet fully the current schedule of loan repayment. This problem is apt to be most severe immediately after the expiration of the five-year grace period. Moreover, loan repayment may become a more severe problem confronting the REB as PBS's located in areas with less productive use potential come of age. PBS tariff increases and better load management practices can undoubtedly help mitigate this problem.*,** In addition, however, one might question the usefulness of imposing uniform loan repayment requirement on all PBS. It appears unreasonable to require all PBS's to begin full repayments only five years after energization. It is

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*A more meaningful definition of the date of energization, i.e., one which more accurately reflects when the backbone system is relatively complete, would also be useful.

**Evidence suggests that most RE consumers were previously paying significantly more for alternative sources of energy. Thus they should be willing and able to pay higher PBS tariffs. This gap between electricity and alternative energy costs provides an opportunity for the PBS's to increase their net revenues. This opportunity will be reduced, however, as the BPDB bulk supply rate continues to increase.

recommended that an attempt be made to tailor repayment requirements more specifically to the economic potentials of the various PBS's. A longer grace period may be necessary and appropriate for PBS's located in less developed areas. Similarly, individual PBS's should be encouraged to adopt tariffs which are consistent with their financial requirements and the economic conditions in their supply areas.

5. TECHNICAL ASSISTANCE

This chapter will review the technical assistance being provided to the Bangladesh Rural Electrification Program. The donor organizations have reached an agreement whereby only USAID provides technical assistance funding and all donors--USAID, World Bank, Kuwait, Finland, Asian Development Bank, Denmark and Canada--fund commodity purchases. The technical assistance provided by USAID must, therefore, be reviewed and assessed in relation to the entire rural electrification program including all donors and not just the USAID portion of the rural program. The technical assistance will be assessed according to length of time required, funds allocated, and number of advisors.

5.1 BACKGROUND:

In 1962, U.S. President Kennedy initiated an arrangement with USAID and the NRECA to electrify developing countries in the world using the successful model of rural electrification developed in the United States. Rural electrification began in the U.S. in 1935 and by 1962 had essentially completed the area coverage of the U.S.

The NRECA is an organization which represents the more than 1,000 rural electric cooperatives in the U.S. As the U.S. Government's involvement in the U.S. Rural Electrification Program has been reduced, the NRECA has increased its activities in a number of areas. A good example of this is the working relationship with USAID. When the agreement was initiated, the NRECA created an international group to respond to AID's technical assistance needs.

5.2 IMPACT OF TECHNICAL ASSISTANCE ON INSTITUTION BUILDING

The impact of technical assistance has been great in building both REB and the PBS systems into viable institutions which will continue as such into the future. The training programs which have been developed and implemented with respect to organizing, constructing, managing and operating a complex electric utility have enabled the PBS systems to have qualified personnel who are effectively carrying out their job responsibilities. This program will need to be continued by REB and modified as the needs change to assure that both the REB and the PBS systems continue to be viable organizations.

5.2.1 Overall Assessment of Technical Assistance

Throughout REB, beginning with comments from Chairman of REB, and going through the level of Assistant Directors, strong support was found for the quality of technical assistance which has been given to date to REB, in the development and implementation of the rural electrification program. The same is true with the PBS systems. Each PBS contacted indicated a high regard for the technical advisors and the type of training, advice, and assistance given to the PBS personnel by these advisors.

One non-AID donor representative contacted gave the following statement, "NRECA/GC [Gilbert Commonwealth] technical assistance is good. The advisors stay in touch. They are timely with their feedback and there are no complaints from their client, REB. In fact, REB says NRECA/GC gives integrity to the Rural Electrification Program in Bangladesh."

5.3 DURATION OF TECHNICAL ASSISTANCE

The duration of time that technical assistance should be provided to a developing country's rural electrification program varies from country to country. USAID and NRECA have worked together in Central America, South America, the Middle East, and Southeast Asia in bringing rural electrification to these areas. There have been varying degrees of success in these programs, but the most successful has been in the Philippines which was recently completed, and the ongoing program in Bangladesh. Based upon these experiences, technical assistance has been found to be a necessary part of a rural electrification program in a developing country for the first 12 to 15 years. Technical assistance began in Bangladesh in 1978 and, therefore, if history is any indicator, another five to seven years of technical assistance will be required.

5.4 FUNDS ALLOCATED FOR TECHNICAL ASSISTANCE

The percentage of funds allocated to technical assistance in the Bangladesh rural electrification program has been declining as the program has progressed. Table 5.1 shows the RE I, RE II and proposed RE III projects in relation to donors' funding and funding for technical assistance. The RE I project was funded only by USAID. RE II and RE III have funding (or potential funding) from several donors with the agreement that only USAID fund technical assistance. In fact, for RE III, the other donors' funding is contingent upon USAID funding technical assistance. As shown in Table 5.1, the percentage of funding allocated to technical assistance for each phase is declining from 17.3% for RE I, 8.8% for RE II to 6.6% for RE III. Also, the cumulative percentage of

total funding for technical assistance is declining from 17.3% for RE I, 11.6% for RE I and RE II to 9.3% for all three phases.

Table 5.1. Funds allocated for technical assistance

Project	Donor	Funding US$ (1000)	Funding for T/A 2US$ (1000)	Percentage of funding for T/A By Phase	Percentage of funding for T/A Cumulative
RE I Original	USAID	50.0	5.0		
RE I Amendment	USAID	19.1	6.97		
Total RE I		69.1	11.97	17.3	17.3%
RE II	USAID	50.0	12.73		
	World Bank	48.0			
	Kuwait	30.0			
	Finland	6.0			
	ADB	10.3			
Total RE II		144.3	12.73	8.8	
Total RE I & II		213.4	24.70		11.6
RE III	USAID	58.6	11.65		
	World Bank	80.0			
	Denmark	8.0			
	Canada	30.0			
Total RE III		176.6	11.65	6.6%	
Total		390.0	36.35		9.3

5.5 NUMBER OF ADVISORS

The number of advisors for each phase of the rural electrification program is reviewed below.

RE I. Technical assistance has been provided since the inception of the Bangladesh rural electrification program in 1978 and has been a key to the success achieved. The technical assistance has been accomplished

by the consulting team of NRECA and GC under contract to the REB. The RE I initially projected the technical assistance needs from 1978 to 1982 at about 15 advisors. However, in 1981 the amount of technical assistance was evaluated to be insufficient and additional resources were deemed to be required. Therefore, the amount of technical assistance was increased to 24 advisors by an amendment to the RE I project.

RE II. The amount of technical assistance provided during RE II was arranged by a contract between REB and NRECA/GC which began July 10, 1984 and will end after 36 months on July 9, 1987. The contract provides an initial staff of 17 advisors, plus 24 person-months of short term specialists. The staff is reduced by three after 18 months on January 10, 1986 to 14 advisors.

The staff will be further reduced by three more advisors on July 10, 1986 to a total of 11 advisors. The 11 advisors will remain for the last year and complete their work on July 10, 1987, when Phase II RE will be completed. The NRECA/GC are working under an unofficial verbal agreement with REB to keep the staff at a constant level of 17 advisors during the entire 36 month period. This is being done by not using the 24 person-months of short term specialists plus some person-months allocated but not utilized in the RE I TA contract. These person-months will not, however, be sufficient to provide a level staffing of 17 advisors for the 36 month period, and by October 1986, a reduction of advisors will be required. The present TA contract was based upon only the RE I and RE II requirements and did not envision the requirements for the RE III project. The contract will have to be amended during FY 86.

RE III. The technical assistance for RE III is proposed to cover the period July 1987 to July 1991, a total of 48 months. This would extend the total duration of technical assistance in Bangladesh to 12 years. The number of advisors recommended is 20 plus 24 person-months of technical specialists. The team should be staffed with 20 advisors for the 24 months and then reduced in the last 24 months. At the end of the first 24 months, the technical assistance needs should be formally reviewed based upon the needs and plans at that time to determine any adjustments in the number of advisors during the last 24 months of the contract. Table 5.2 shows the 17 advisors working under the Phase II Project and the three additional positions recommended for Phase III. The last column weights relative importance of the TA subject area for RE III. (One is most important, eight is least important.) The weighting is <u>not</u> for each individual position.

Table 5.2. Summary of technical advisors

	Advisors	Name	Affiliation	REB Director	Relative importance of area for RE III
1.	Team Leader	Brac Biggers	NRECA		1
2.	Management	George King	NRECA	PBS Mgt. Operation	3
3.	Management	Vesta Orr	NRECA	PBS Mgt. Operation	3
4.	Inst. Training	Paul Fleek	NRECA	Training	7
5.	Tech. Training	Ed Wheeler	NRECA	Training	7
6.	PBS Finance	John Hinton		Finance	4
7.	PBS Finance	Ed Thiessen	NRECA	Finance	4
8.	System Operation	Myk Manon	NRECA	Sys. Operation	2
9.	System Operation	Ray Cowan	NRECA	Sys. Operation	2
10.	Engineering	Eugene Leffler	GC	Member Engineering	6
11.	Dist. Planning	John Kerr	GC	Sys. Engr. & Design	6
12.	Const. Design	Vacant	GC	Eng. Construction	6
13.	Const. Cord & Sub	John Allard	GC	Chief Engr.	6
14.	Construction		GC:	Superintendents of	5
15.	Construction		GC:	Engineering	5
16.	Construction		GC:	construction	5
17.	Construction		GC:		5
18.	REB Finance		NRECA	Finance	4
19.	Material Mgt.		NRECA	Equipt. & Material	2
20.	Maintenance		NRECA	System Operations	3

Note: Short-Term Specialists are allocated in RE II but not being utilized. For RE III Short-Term Specialists will be required in the areas of computer billing, power usage and quality assurance.

5.6 TYPES OF TECHNICAL ADVISORS

The types of advisors for RE III will not change dramatically from those presently employed. There is a need for revising the team leader's role and adding three new types of advisors in the areas of material management, maintenance, and system operations and REB finance. In addition to the advisors, the position of administrative assistant should be added. The following paragraphs describe these advisors.

5.6.1 Team Leader

The team leader works with the REB Chairman and is responsible for the overall technical assistance activities. His time should be divided between administrative duties (20%) and advising (80%). The team leader's advisory duties include management of advisors assignments, administering the provision and maintenance of local housing of the technical assistance team, monthly contract accounting and reporting, supervision of a support staff of 33 Bangladeshis, and provision and maintenance of 20 vehicles for advisors. The day-to-day implementation of these administrative activities can be carried out by an Administrative Assistant under the direction of the team leader. If no assistant is provided, then his allocation of time to these administrative details increases to about 80%.

5.6.2 Material Management Advisor

The Material Management Advisor would work with the Director of Equipment and Material to improve the operation of the warehouse in Khulna. The warehouse is the primary facility where all foreign purchased materials are delivered, identified, inspected, stored and then dispersed to the proper PBS. The advisor would assist the Director in implementing and improving the procedures and record systems to accomplish this warehousing task.

5.6.3 Maintenance/System Operation Advisor

The Maintenance/System Operations Advisor would work with the Director of System Operations to provide technical assistance in the improvement and development of maintenance and repair procedures and facilities. The maintenance and repair of three-phase meters, voltage

regulators, and oil circuit reclosers is done by this central REB facility in Dhaka. As the numbers of these types of equipment installed in the field increases, the efficient maintenance and repair of this equipment is essential. Also, due to the great reliance on foreign-supplied equipment and the difficulties in obtaining reasonable parts, service and information from these suppliers, the maintenance, repair, trouble shooting, and diagnostics of equipment problems becomes critical.

5.6.4 REB Finance Advisor (1) - NRECA

The Finance Advisor provides expertise in finance and accounting to the REB Director of Finance. The use of accounting information in REB and the PBS is essential for management planning and control.

5.6.5 Administrative Assistant (1)

The Administrative Assistant would report to the team leader and be responsible for the daily operations of the consultants offices. The specific duties include: (1) administering the provision and maintenance of local housing for the technical assistance team, monthly contract accounting and reporting, supervision of a support staff of 33 Bangladeshis, and provision and maintenance of 20 vehicles for the team.

5.6.6 Short Term Specialists

Three types of specialists will be required: computerized billing, power usage, and quality assurance. The Computer Billing Advisor would assist the PBS's in moving from manual billing to computer billing. The Power Use Advisor would develop REB skills in helping the rural electric customers in ways of productively using electricity. A Quality Assurance Advisor would work for Director of Equipment and Material and be responsible for providing extensive assistance in the areas of quality

assurance and inspection of materials and equipment. The activities would include development of material specifications, development of testing procedures and method for arriving materials, and review and recommendation of manufacture testing.

5.7 ASSIGNED TASKS OF ADVISORS

During Phase I and Phase II the consultants have been assigned the four primary tasks and one administrative task as shown in Table 5.3. The suggested division among the tasks for RE III is also shown.

Table 5.3. Assignment of Advisors Tasks

Task	RE I & II	RE III
1. Development of Standards, Procedures and Guidance	13.5%	10%
2. Training	7.6%	15%
3. Direct Participation in Implementation of Systems	34.0%	25%
4. Monitor, Review and Advise	40.6%	45%
5. NRECA/GC Administration	4.3%	5%
	100.0%	100.0%

Task 1 is the development of standards, procedures, and guidelines; significant progress was made here during Phase I and Phase II. The Phase III work in this area will be the modification and updating of these manuals and the development of new ones as required.

Task 2 provides training of REB, PBS, and local contractors (engineering design, line construction, and substation construction). During RE I and II, the advisors roles have changed from those of preparing the training manuals and doing the actual classroom teaching to one of primarily preparation and revision of manuals. Only special subjects such as sectionalizing are still being taught by the advisors. During RE III there are still courses which have been identified and need to be developed. The entire team of advisors should assist the two training advisors to develop and comment on new and revised courses.

Task 3, the direct participation in implementation of systems, will continue in RE III. This task appears to consume more of the advisors' time than the 34% allocated. There seems to be a tendency of the REB to treat the advisors as key personnel in the organization, and, as such, their involvement in daily activities is greater than desirable from a technical assistance point of view.

Task 4 is the monitoring, reviewing, and advising of REB and PBS personnel, and will continue in RE III. The emphasis of this task should increase with an emphasis on getting REB and PBS personnel to take the initiative, formulate responses, and make recommendations to advisors.

In summary, the REB needs to utilize the technical assistance advisors to strenghten the ability of their own personnel to operate independently rather than depending on the technical assistance advisors as key personnel.

5.8 FINDINGS AND RECOMMENDATIONS

The following findings and recommendations can be made based on the assessment of the needs of technical assistance for the Phase III rural electrification project.

1. The technical assistance has been successful in building REB and PBS's into viable institutions. However, the need to continue TA at or above current levels cannot be overstated. There are several reasons why these levels are crucial. First, as stated elsewhere in this report, there is a high rate of turnover in some critical areas of management and operations, and until this situation is stabilized, continued TA is required. Secondly, the system is expanding greatly and becoming more complex. The latter phenomenon is due in part to the increase in the number of donors. There is considerable evidence that the current levels of expertise in the REB and the PBS's would not permit service to be continued under all possible operating conditions. Finally, continued TA is needed to enforce standards on the entire system.
2. The duration of technical assistance required will be about 12 to 15 years. Phases I and II will provide eight years and Phase III is proposed to provide four years, bringing the total at the end of Phase III to 12 years.
3. The percentage of funds allocated to technical assistance by total project funding by Phase is declining.
4. The number of advisors recommended for Phase III is 20.

5. The types of advisors to be added to the present team should be in the areas of finance, maintenance, and materials handling.
6. The duties of the team leader should be redefined to decrease the administrative burden on his time. The addition of an administrative assistant would allow this redefinition.
7. REB needs to use the advisors more effectively. The assigned tasks of the advisors should be modified to increase institutional aspects of technical assistance and to reduce reliance on the advisors as key personnel.
8. If another contractor is selected, the transition of the consulting activities of the present organization to another would require about 18 months during which time the quality of technical assistance could suffer.
9. The most critical areas for TA in RE III are in the areas of material management, management, operations and maintenance, and finance.

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