

SECTOR SYNTHESIS OF POSTEVALUATION FINDINGS

IN THE

POWER SUBSECTOR

December 1997

EXECUTIVE SUMMARY

The Sector Synthesis of Postevaluation Findings (SSPF) in the Power Subsector integrates the major findings and lessons learned from the experience of Bank-assisted projects in the subsector. It is based on Project Performance Audit Reports (PPARs), Reevaluation Studies, Impact Studies and Special Studies prepared by the Post-Evaluation Office. The objective of the SSPF is to identify key factors and lessons learned which may be used in improving the design, implementation and operations of future Bank-assisted projects in this sector. They will also serve as important inputs in planning for and developing sectoral strategies.

The power sector is the largest recipient of Bank assistance, comprising about 20 percent of the total value of Bank lending and technical assistance (TA). From 1967 to 1996, the Bank had financed 196 power projects with 223 loans amounting to \$12.5 billion. During the same period, the Bank provided 274 TA grants, including regional TA, for nearly \$0.1 billion. Thirty two developing member country (DMC) borrowers received Bank assistance to the power subsector with Indonesia receiving the largest support, followed by Pakistan, Philippines, Thailand, India, and the People's Republic of China. Until 1985 Group B countries received the largest share of project loans to the power subsector. From 1985, Group A countries borrowed more from the Bank than any other country group. Group A countries have always been the largest recipient of technical assistance to the subsector.

Thirty six of the 75 postevaluated projects experienced cost overruns. The major factors causing cost overruns were: (i) modifications in engineering designs, (ii) domestic inflation arising from the oil crisis, (iii) implementation delays relating to civil works, and (iv) extension of consultancy services. Cost underruns occurring in 39 projects were attributed to: (i) reductions in project scope or deletions of some project components, (ii) lower bid prices arising from intense competition among contractors, (iii) overestimation of escalation rates at the time of appraisal, and (iv) non-utilization of contingencies. Exchange rate fluctuations affected costs in both ways resulting in overruns or underruns depending on whether there was a depreciation or appreciation of local currencies and the currencies of contractors and suppliers vis-a-vis the US dollar.

Implementation delays averaging 2.8 years (92 percent) occurred in 72 projects. In implementing power projects, project performance has been found to be significantly affected by (i) experience and capability of the executing agency; (ii) appropriateness of technical design; (iii) timely and flexible Bank intervention and supervision throughout the project cycle; (iv) effective incorporation of an O&M program; (v) reliability of demand and load forecasts; (vi) adoption of geological and hydrological investigations and environmental impact abatement measures; (vii) serious implementation of cost recovery mechanisms and tariff reforms; and (viii) timely release of counterpart funding. Objectively verifiable indicators that would evidence attainment of project goals and impacts should be adequately defined while major project risks and assumptions relating to demand and load forecasts have to be identified and monitored; security situation; systems losses; fuel and electricity prices; climatological, hydrological and geological conditions; availability of staff, counterpart funding, and spare parts should be constantly monitored to enhance accountability of the developmental impact of power projects.

Judging from the postevaluation of 75 power projects involving 97 loans amounting to \$2.2 billion or about 18 percent of total lending to the subsector, a number of project objectives were substantially attained. These objectives were (i) expanding, rehabilitating, or upgrading power supply to meet the growing demand for electricity; (ii) reducing dependence on imported oil for energy needs by developing indigenous sources of supply; (iii) improving overall power systems reliability and efficiency; and (iv) improving access of the poor to electricity. About 59 projects (79 percent) were found to be generally successful, 15 projects (20 percent) were partly successful, and only 1 project (1 percent) was unsuccessful.

Bank experience in financing power projects imparted the lessons of (i) assessing critically energy demand to avoid low utilization rates of power plants or in some cases, overcapacity problems; (ii) incorporating appropriate cost recovery and energy efficiency mechanisms on both supply and demand sides and ensuring proper O&M of project facilities; (iii) factoring environmental concerns in designing power projects; and (iv) improving the institutional capacity of power utilities in DMCs with the view to redefining the role of government and enhancing the scope for private sector involvement in power provision.

I. INTRODUCTION

1. The Sector Synthesis of Postevaluation Findings in the Power Subsector analyzes and synthesizes postevaluation experience in Bank-assisted projects in the power subsector as of 31 December 1996. It also identifies key issues and lessons learned which may be used in improving the formulation, implementation and operation of future projects in this subsector. The sector synthesis is based on the findings of postevaluation comprising of Project/Program Performance Audit Reports (PPARs), Technical Assistance Performance Audit Reports, Impact Evaluation Studies, Reevaluation Studies, Special Studies and Country Syntheses of Postevaluation Findings. It also utilizes data stored in the Postevaluation Information System.

II. BANK OPERATIONS IN THE POWER SUBSECTOR

A. Overview of Bank Lending and Technical Assistance

2. The power subsector constitutes activities related to the generation, transmission and distribution of electricity. It comprises about 78 percent of total Bank lending to the energy sector with the remaining 22 percent accounted for by natural gas, refinery, fuel minerals and other energy.

The Bank's first loan to the power subsector was for the Sarawak Electricity Supply Project in Malaysia, which was approved for \$3.1 million on 18 December 1969. The first technical assistance (TA) grant to the subsector was for the Phnom Penh High Voltage Transmission in Cambodia, which was approved on 2 April 1970 for \$80,000. In the 1970s, the Bank assistance to the power subsector was mainly for power generation, transmission, and distribution. In the aftermath of the oil crises, the Bank diversified energy sector investments in developing member countries (DMCs) through the exploration of indigenous sources of energy. As of end 1996, the Bank had financed 196 power projects with 223 loans valued at about \$12,462 million

and 216 TA grants, exclusive of regional TAs (RETAs) amounting to \$80.5 million¹ (Appendix 1). Total support by the Bank to the subsector (inclusive of RETAs) adds up to \$12,555 million, making it the largest recipient of Bank assistance to any single subsector with 20 percent in terms of value of the total assistance provided by the Bank (Table 1). In terms of number of projects assisted, power accounted for 10 percent, ranking second only to irrigation and rural development.

**Table 1: Distribution of Bank Assistance By Sector
(1967-1996)**

	Project		TA		Total		%
	Loans	\$	Grants ^a	\$	\$ mn	share	
	No.		No.				
	mn	mn	mn	mn			
Agriculture & Agro-	470	13,732.4	870	382.3	14,114.7		22.3
Energy	264	15,877.2	315	120.4	15,997.6		25.3
of which: Power	223	12,461.7	216	80.5	12,542.2		19.8
Industry and Nonfuel	73	2,353.7	113	35.2	2,388.9		3.8
Finance	147	5,986.6	209	59.4	6,046.0		9.6
Transport &	238	12,740.5	355	143.3	12,883.8		20.4
Social Infrastructure	260	9,493.6	491	186.6	9,680.2		15.3
Multisector	40	1,633.4	22	15.7	1,649.1		2.6
Others	7	406.9	323	132.3	539.2		0.8
Total	1,499	62,224.4	2,698	1,075.1	63,299.5		100.0

^a Excludes Regional TAs.

4. Thirty-two DMCs received Bank assistance for the power subsector (Appendix 1). Indonesia was the largest recipient with 25 loans and 19 TAs totaling \$2,517 million or around 20 percent of total lending to the subsector. Six DMCs (the People's Republic of China, India, Indonesia, Pakistan, Philippines and Thailand) accounted for over four-fifths of total Bank assistance to the subsector. By country grouping, DMCs in Group A and Group B were the major recipients garnering 50 percent and 45 percent of the total value of Bank assistance to the subsector. From the start of Bank lending to the power subsector in December 1969 until 1985, a large share of project loans was provided to Group B countries in order to accelerate power development in support of their overall growth objectives. From 1985, Group A countries, with their increasing need to develop and expand power systems, borrowed more from the Bank for power than any other country group. Group A countries have always had the highest share of technical assistance to the subsector.

5. Of the other 216 TAs to the power subsector (excluding RETAs), 126 TAs were advisory (ADTAs), with total assistance amounting to \$52 million (65 percent); and the remaining 90 TAs were for project preparation (PPTAs) with \$28 million (35 percent) (Appendix 2). The ADTAs were usually for institutional development and improving financial management of power utilities while PPTAs were for preparing feasibility studies and engineering designs of power plants. Many RETAs involved studies on regional energy surveys and regional power demand.

¹ Inclusive of RETAs, there were 274 TA grants, amounting to \$93 million.

B. Postevaluation Operations

6. As of end December 1996, a total of 75 power projects, completed between 1969 and 1990, had been postevaluated (see Appendix 3). This represents around 38 percent of Bank approved power projects and involves 97 loans valued at \$2,242 million. Of the 75 postevaluated projects 68 percent (51 projects with 69 loans) were approved in the 1970s and the remaining 32 percent consisting of 24 projects with 28 loans were approved in the 1980s. These projects were completed between 1973 and 1992 with 16 projects (21 percent) completed in the 1970s, about 48 projects (64 percent) completed in the 1980s, and 11 projects (15 percent) completed in the 1990s. The postevaluated projects covered 19 DMCs: 12 from Group A, 4 from Group B, and 3 from Group C. Two re-evaluation studies were conducted: one for the Pipri I and II Thermal Generation Projects in Pakistan and the other for the Rural Electrification Project in Sri Lanka. One impact evaluation study was prepared on Bank operations in the power subsector for Thailand. None of the TAs to the subsector has so far been postevaluated.

7. Of the 75 evaluated projects, 58 or 77 percent were rated generally successful (Table 2). Group B countries had the highest percentage of generally successful power projects at 79 percent, followed by Group C at 78 percent. Seventy five percent of Group A projects were rated generally successful. Group A countries had the highest number and percentage of partly successful projects at 8 and 25 percent, respectively. Group B countries had 7 projects rated partly successful or 21 percent. Group C countries had 1 partly successful and 1 unsuccessful projects. Groups A and B had no projects rated unsuccessful.

**Table 2: Performance of Postevaluated Power Subsector Projects
by Country Groupings**

Country Group	Generally Successful		Partly Successful		Unsuccessful		Total	
	No.	%	No.	%	No.	%	No.	%
Group A	24	75.0	8	25.0	0	0.0	32	100.0
Group B	27	79.4	7	20.6	0	0.0	34	100.0
Group C	7	77.8	1	11.1	1	11.1	9	100.0
Total	58	77.3	16	21.3	1	1.3	75	100.0

III. PROJECT DESIGN, IMPLEMENTATION PERFORMANCE AND DEVELOPMENTAL IMPACT

A. Project Design

1. Immediate Project Objectives and Long-term Goals

8. Bank assistance to the power subsector has been aimed at meeting the following immediate end-of-project objectives: (i) expanding, rehabilitating and/or upgrading power supply systems in DMCs to meet the growing demand for electricity; (ii) reducing dependence on imported oil by developing indigenous sources of energy; (iii) improving overall power systems reliability and efficiency by reducing systems losses and load shedding; and (iv) improving access of the rural poor to power via rural electrification projects. The long-term goal of power projects has generally been economic growth, while rural electrification projects are generally aimed at poverty alleviation and improvement in the quality of life of the poor by improving their access to electrical power.

2. Experience with Project Design

9. The final designs of most power generation projects were conceptually and technically commensurate with stated project objectives. Power generation projects benefited from detailed planning and feasibility preparation, given some 45 PPTAs were provided for the preparation of engineering designs and detailed cost estimates of power plants.

10. In some cases, a number of inadequate project designs resulted in cost overruns, changes in project scope, and implementation bottlenecks. Specifically, failure to carry out adequate locational, geological or hydrological surveys necessitated a revision in project scope. This was evident in the Mindanao Power projects in the Philippines where major geological faults were discovered at project sites; Xeset Hydropower Project in Lao People's Democratic Republic where unexpected rock formations led to changes in the layout of the powerhouse; West Sumatra Power Supply Project (Indonesia) where poor rock conditions necessitated more excavation work; Bowatena Power Project (Sri Lanka) where low water availability limited the power generation capacity; and Fuel Conversion Project (PRC) where inadequate assessment of soil conditions led to changes in the technical specifications of coal pulverizers. Inadequate ancillary infrastructure resulted in cost overruns and implementation bottlenecks. This was the experience in the West Zone Power Project in Bangladesh and the Pipri Thermal Generation Project in Pakistan where shortages in railwagons to transport fuel was aggravated by the poor state of rail tracks that prolonged turnaround time. In the Power Project in Samoa and the Power System Expansion Project in Thailand a lack of cooling facilities led to the overheating of generating equipment. Furthermore, negative externalities could have been mitigated in a number of projects if environmental safety features were incorporated in the project design. For example, noise emissions by diesel generators under the Power System Development Project in the Maldives and the Tarbela Hydropower Project in Pakistan could have been abated and disruption of marine life in the circulating water system of the Pipri Project in Pakistan could have been avoided. Cost overruns and revisions in project scope could have been minimized if security situations in project sites were carefully assessed as in the case of the Mindanao Power Projects and the Negros-Panay Interconnection Project and if cheaper alternative sources of power supply were explored as in the case of Thailand's Power Transmission and Substation Expansion Project. Finally, more reliable forecasts of electricity demand and power supply could have provided a sound basis for estimates of power plant capacity to allow for more efficient generation and utilization of available power supply. While constraints were imposed on the physical completion of the projects in terms of higher costs and time delays, these weaknesses in project design, however, did not impede in the achievement of the stated project objectives.

B. Implementation Experience

1. Project Costs and Cost Variances

11. Total project costs of the 75 postevaluated projects amounted to \$4,942 million, 10 percent lower than appraisal estimates² with Group B countries accounting for almost half of the costs (\$2,426 million). Thirty nine power projects (or 52 percent of total postevaluated projects) experienced cost underruns averaging 26 percent compared to appraisal estimates. (Appendix 5). Substantial cost underruns were recorded in projects in Pakistan, Indonesia, and the Philippines. The cost underruns were attributed to: (i) reductions in project scope or deletions of some project components; (ii) lower bid prices arising from intense competition among contractors; (iii) depreciation of local currencies and the strengthening of the US dollar against the currencies of suppliers; and (iv) overestimation of escalation rates at the time of appraisal.

² Appendix 4 provides cost variances of individual projects. Appendix 5 provides country performance in terms of cost variations.

12. Cost overruns, in turn, were incurred in the remaining 36 projects. The major reasons for cost overruns were: (i) modifications in engineering designs necessitating to correct weaknesses in the original project design, (ii) domestic inflation arising from the oil crisis; (iii) implementation delays relating to civil works; (iv) appreciation of currencies of contractors and suppliers vis-à-vis the US dollar; and (v) extension of consultancy services.

2. Implementation Schedule

13. The average implementation delay for all postevaluated power projects was 2.8 years (or 92 percent behind the scheduled completion date) (Appendix 6). The longest delays occurred in the Garung Hydroelectric Project in Indonesia (8.5 years); Rural Electrification Project in the Philippines (7.5 years); Saigon Power Project in Viet Nam (7.3 years); and Second Sulawesi Power Project in Indonesia (7 years).

14. Implementation delays were mostly attributed to: (i) lengthy tendering, bidding and procurement arrangements due to unfamiliarity of executing agencies with Bank procedures; (ii) staff constraints in executing agencies; (iii) lack of counterpart funds or their slow release by Government; (iv) land acquisition and right-of-way difficulties; (v) slow decision-making process of government and executing agencies; (vi) late engagement of consultants; (vii) inadequate follow-up and supervision by the Bank; (viii) modification(s)/alteration(s) in project scope and design as well as engineering specifications; (ix) additional civil works such as excavation due to inadequate geological surveys; (x) shortages of materials such as transmission poles; (xi) occurrence of natural calamities such as floods, typhoons and earthquakes; (xii) law and order problems; (xiii) late completion of original project in the case of follow-up and supplementary loans; and (xiv) unrealistic implementation schedules envisioned during appraisal.

3. Physical Achievements

15. The civil works associated with the postevaluated power projects were on the whole satisfactorily completed. The physical achievements of the 75 postevaluated power projects involved (i) construction of about 65 power plants, of which 52 were hydro-powered, 7 diesel-powered, and the rest either coal-fired, or powered by a combination of steam and gas (e.g., combined cycle) or other energy sources; (ii) construction of about 20 dams or reservoirs with associated weirs, canals, tunnels, penstocks, and tailrace works; (iii) installation of about 90 generator and auxiliary units, and about 18,900 transformers and capacitors; (iv) construction, expansion or rehabilitation of some 4,335 terminal stations, substations, grid stations and switchyards; (v) construction of approximately 67,300 km. of transmission lines, underground and overhead cables, and poles; (vi) construction of about 5 load despatch centers or facilities; and (vii) provision of electrical, radio and communications, telemetering and other power line equipment. Physical completion of some power projects was constrained by design deficiencies as highlighted in para 10.

4. Operational Performance

16. Upon completion of power projects, electricity generation, service, and reliability have been found to increase in most cases. Transmission and distribution lines were observed by postevaluation missions to be functioning within satisfactory technical standards and the networks of substations were being operated effectively. These resulted in improved quality and more reliable power transmission and distribution through reductions in voltage fluctuations and power outages. In cases where power failures occurred, faster restoration of power system was observed. The projects enabled power companies to meet the growing demand for power. Savings in capital and operating costs were realized as a result of economies of scale as in the case of the Java EHV Transmission Project which provided a large scale hydro and coal based generation. However, operational efficiency in many instances has been constrained by (i) low systems utilization, (ii) high systems losses, and (iii) frequency of mechanical/ technical breakdowns. Low systems utilization could have been avoided with more extensive hydrological surveys and updated power demand projection. High system losses occurred from overheating and inadequate transmission and distribution systems, lack of power factor improvement devices, defective meters, inefficient accounting and billing systems, pilferage and illegal or unaccounted-for consumption of electricity. Some power projects that introduce new technology such as computerized systems to power companies enable such companies to benefit from a reduction in systems losses and minimize voltage fluctuations and power outages. However, to further reduce system losses, monthly systems loss and collection performance targets for power utility companies have been set up including a system of verification and updating of billing ledgers, checking and calibration of energy meters and streamlining of procedures for recourse to the courts of law cases against theft of electrical energy. Inadequate maintenance of facilities resulted in frequent mechanical/technical breakdowns. Some power projects in Indonesia, Bangladesh, Malaysia, Philippines, Solomon Islands, Sri Lanka and Viet Nam experienced O&M difficulties attributed to reasons outlined in para. 32.

5. Institutional Development

17. Postevaluation results revealed the following constraints to institutional development of most executing and implementing agencies for power projects: (i) lack of qualified manpower; (ii) weak accounting, financial management, and systems planning; (iii) deficient data maintenance, monitoring, and reporting procedures; (iv) centralization of decision-making authority; and (v) lack of autonomy of power corporations, heavy state intervention, and limited private sector participation in their operations. Recruitment and retention of staff with the requisite skills was a major institutional problem in power corporations of Bangladesh, Fiji, Indonesia, Pakistan, Philippines, Sri Lanka, and Samoa. This was attributed to low salaries and remuneration, the exodus of qualified staff such as electrical engineers to foreign countries, and the pervasive dearth of staff with technical qualifications at the national level as in the case of many South Pacific DMCs. The provision of a training component under the project scope or as a TA for institutional strengthening on a continuing basis should be emphasized to develop a cadre of trained staff and ensure the availability of technically qualified personnel. This will also help strengthen the manpower complement of these power entities. An intensification of training efforts requires commitment, financial support, and time to yield tangible results. Another area worth looking into is the competitiveness of these agencies in attracting well-trained personnel. Perhaps the compensation package should be compared with competitors who somehow manage to attract these personnel away from the executing agencies.

18. Power utility corporations in several DMCs such as Bangladesh, Indonesia, Kiribati, Pakistan, Solomon Islands, Sri Lanka, and Samoa have limited institutional capabilities in

accounting, budgeting, and financial audit and control procedures, as well as in systems planning and management. Related to these constraints is the paucity of updated and accurate data and records required for effective planning, control, and management of power utility corporations. In Pakistan, for instance, the accounting system used to be based on obsolete procedures and records which did not provide management with meaningful and timely financial information needed for decision-making and control of operations. The adoption of different accounting systems and practices at district levels in Indonesia and the inexperience of accounting staff have rendered accounting records unreliable and of minimal utility. In Bangladesh, management was not provided with reports required for controlling operations due to the lack of an asset accounting system, and budgeting was done to satisfy government planning requirements, with little monitoring of performance against the budget. While the accounting system of the executing agency in the Solomon Islands was computerized following the consultants' recommendation under a Bank TA, accounting was still manually done as local staff were not experienced and qualified in the implementation of a modern power utility accounting system. In Sri Lanka, features of poor coordination with other agencies, inadequate preparation of new projects, and delays in decision-making and implementation reflected institutional weaknesses in systems planning and management capabilities. The institutional strengthening component of Bank-funded power projects included consultancy services to study and develop effective accounting and financial management systems, audit and control procedures, corporate planning functions, and computerized management information systems within the institutional structures of executing agencies for power projects.

6. Financial Performance

19. Power utility corporations in many DMCs, notably in Bangladesh, Fiji, Indonesia, Kiribati, Lao PDR, Malaysia, Nepal, Pakistan, Philippines, PRC, Solomon Islands, and Thailand were commonly characterized by: (i) slowdown in revenues because of capacity constraints on energy generation; (ii) high debt service burdens; (iii) high distribution losses; (iv) major increases in operating costs, particularly fuel; and (v) inability to raise tariff levels to achieve covenanted rates of return. In most cases, income generated by power companies is insufficient to cover operating costs and debt service and to finance a portion of capital expenditures. Therefore, covenanted levels of financial performance indicators such as debt-equity ratio, debt-service ratio, accounts receivable and self-financing ratio were achieved only with difficulty. In some cases, governments have intervened to improve the financial performance of power utility corporations as in the case of Bangladesh where government loans were converted to equity as part of a financial rehabilitation plan, or in Thailand where government loans were rescheduled and operating costs of the utility were partly reimbursed through tax credits and import duty rebates. The overall financial performance and the viability of power entities are contingent upon their ability to adjust tariffs and to fully recover costs.

C. Developmental Impact

1. Economic and Financial Rates of Return

20. The economic internal rates of return (EIRRs) ranged from a negative number to positive 49 percent during postevaluation compared to appraisal estimates of 5 percent to 43 percent. About two-thirds of the 42 projects with EIRR calculations at appraisal and postevaluation stages incurred lower ex-post EIRRs. The divergence was attributed mainly to higher than expected operating costs, time overruns, and differences in price assumptions. It may be noted that in a number of instances, the ex-post EIRRs may not be comparable to appraisal estimates due to differences in methodology and assumptions used. In 35 PPARs, the EIRRs were not calculated chiefly because of the difficulty of measuring consumers' willingness to pay for electricity and of estimating cost savings resulting from choosing one technological alternative over another (e.g., hydro over diesel generation).

21. The financial internal rates of return (FIRRs) of postevaluated power projects ranged from a negative number to a high positive 39 percent compared to appraisal estimates ranging from a low of 6 percent to a high 26 percent. Of 46 projects with FIRR calculations during appraisal and postevaluation stages, about three-fourths experienced lower actual FIRRs. This divergence in FIRRs was attributed to differences in revenue and cost assumptions as PPAR calculations used lower revenue figures (following shortfalls in tariff adjustments, energy sales and generating capacity), and higher operating costs (mainly on account of fuel price increases and implementation delays). The lower FIRRs reflect the inability of executing agencies to alter tariffs to take into account sharply rising operating costs. The lesson is that tariff levels should be closely monitored to ensure that tariff adjustments move in tandem with cost adjustments. Three power projects - the Guddu Combined Cycle in Pakistan, Negros-Panay Interconnection in the Philippines, and the Sixth Power Distribution in Thailand - yielded FIRRs above 30 percent, substantially higher than appraisal estimates. The deviation between appraisal and postevaluation estimates can be traced to lower investment outlays in the case of the first two projects arising from overestimation of physical and price contingencies, and from the reduction of project scope; and from higher selling margins and significant reduction of systems losses in the case of the latter.

2. Socioeconomic Impact

22. The primary socioeconomic benefits cited in the PPARs for power projects include (i) upgrading the quality of life of peoples and communities; (ii) increasing the availability of electricity for final consumption and for increasing economic output; and (iii) generating additional employment opportunities. In newly electrified villages, household surveys indicated a better standard of living for families due to the availability of home lighting to improve education and literacy; enrichment of social and cultural life by encouraging social activities; improvement of personal safety, especially in rural areas; and providing a sense of modernization. Meanwhile, the increase in household connections to electricity grids have enabled the wider use of electrical appliances such as television sets, radios, irons, and refrigerators allowing for an improvement in the quality of life. On the other hand, the installation of irrigation pumps provide an opportunity for greater agricultural productivity which in turn may have translated to higher agricultural incomes. Small- and medium-scale industries were also established in newly electrified project areas and several industrial estates were likewise developed following the completion of the Sarawak Electricity Supply. Most of these socioeconomic results, however, were non-quantifiable except for the number of household connections in electrification projects. Benchmark or performance targets were not set during appraisal for comparison against actual socioeconomic benefits.

3. Environmental Impact

23. Adverse environmental impacts were generated in a number of cases in several DMCs. In the Power System Development Project in Maldives, noise from generators and soot particles were causing negative externalities on a school constructed 50 meters away from the power plant. For hydropower projects such as Trengganu Hydropower in Malaysia and Canyon Hydropower in Sri Lanka, the construction of a dam, while beneficial in alleviating flooding in downstream areas through improved water flow regulation, was found to cause erosion and siltation on river banks. In Pakistan's Rural Electrification Sector Loan, ground salinity has emerged as a serious problem on small irrigated farms as a direct result of water pumped by engines run on diesel and electricity. Lake water in Indonesia's Minahasa Power Project, in turn, was found to have been contaminated by excessive fertilizer runoff from surrounding agricultural lands, and hydraulic conditions were impeded by excessive weed growth. For coal-fired power plants such as the Fuel Conversion Project in PRC, and the Mae Moh Power projects in Thailand, adverse impacts on ambient air and water quality have been observed due to emission of ashes, particulates, and gases caused by coal combustion. Similar effluent and pollution problems were encountered in the Pipri Thermal projects in Pakistan. The environmental impact of power transmission and distribution projects was mostly encountered during the construction phase with the cutting of trees during land clearing, particularly for rerouted cables and lines. In Fiji's Second Power Project, concern was expressed by the Postevaluation Mission over uncontrolled denudation along access and service roads, though scarred sites were expected to regenerate vegetation. Noise levels, electrostatic interference, and other electromagnetic effects were addressed during the design of the Load Despatch and Transmission Project of Pakistan, and the PPAR suggested monitoring of the health effects of long term exposure to electromagnetic fields. In some instances, environmental/ecological considerations were taken into account in appraisal reports. In cases where adverse environmental impact was expected appropriate remedial measures were incorporated in the design. This is true for the Fourth and Fifth Mindanao Power Projects and Trengganu Hydropower Projects, among others. These experiences highlight the importance of identifying environmental impact and the inclusion of environmental abatement measures in project design.

4. Project Ratings and Sustainability

24. A total of 33 postevaluated power projects in Fiji, Nepal, Pakistan, Sri Lanka, and Thailand were generally successful (Appendix 7). Postevaluated power projects in PRC, Kiribati, Maldives, Myanmar, and the Republic of Korea were also generally successful although a trend could not be established from the one PPAR prepared for each of these countries. Three power projects that were postevaluated in Bangladesh were all partly successful, as was the one power project each postevaluated for Solomon Islands and Papua New Guinea. Indonesia, Lao PDR, and Samoa. Three projects in Malaysia were rated generally successful, one was partly successful and another was unsuccessful. The only postevaluated power project in Viet Nam was rated partly successful.

25. The only unsuccessful power project in Malaysia (Mini-Hydropower Sector Project) was inadequately maintained, and suffered from low generating capacities. Consequently, the project objectives of meeting electrification needs of the rural areas and saving fuel costs were not achieved. Postevaluation findings of 15 partly successful projects cited low systems

utilization, operational problems, reduced financial and economic returns, deteriorating financial viability of power corporations, and inadequate institutional strengthening as reasons why project objectives were only partially achieved.

26. Factors contributory to high levels of success in power projects in most DMCs include (i) involvement of a capable and experienced executing agency, as in power projects in Thailand; (ii) effective application of coordinated technical standards and specifications, and O&M procedures as in the case of Korea; (iii) timely and flexible Bank intervention at all stages of the project cycle as in Myanmar; (iv) adherence to cost estimates and implementation schedules as in Maldives; and (v) evident socioeconomic benefits, both quantifiable and unquantifiable, in the form of emerging industrial zones, savings in fuel imports, and improved institutional development of power corporations as experienced in Fiji, Lao PDR, Nepal, Pakistan, Philippines, and Sri Lanka.

27. The sustainability of the benefits of these postevaluated power projects would be largely dependent on cost recovery by power corporations through the timely adjustment of tariffs in line with costs adjustments; provision of adequate funds for the maintenance of project facilities; institutional capability of the executing agency to manage and operate the project; retention of competent staff through adequate remuneration and continuous training; reduction in the level of systems losses; and increase in energy generating capacity to fully utilize systems load and to meet increases in power demand.

IV. ISSUES AND LESSONS LEARNED

28. This section summarizes the critical sectoral issues and major lessons learned from postevaluation experience of power projects.

A. Key Issues in the Power Subsector

29. The key issues that emerged from the findings of the PPARs which may be relevant for future power projects are (i) cost recovery and tariff reforms; (ii) timely and adequate O&M; (iii) low systems utilization and demand-supply gaps; (iv) reduction of systems losses; (v) shortage of qualified personnel; (vi) development of institutional capability in systems planning and management, financial control, and data maintenance and reporting; (vii) environmental control; (viii) lack of counterpart funding; and (ix) private sector participation in power provision.

1. Tariff Reforms

30. The financial viability of power utilities in many DMCs such as Bangladesh, Fiji, Indonesia, Kiribati, Lao PDR, Malaysia, Nepal, Pakistan, Philippines, PRC, and Solomon Islands depends largely on how electricity tariffs are managed. In these DMCs, tariff levels were generally too low, leading to perennial deficits in power utilities and their inability to satisfy relevant financial covenants. Tariff structures were complicated, with too many consumer categories and slabs of rates, and with a significant degree of cross-subsidization among user

groups. The timeliness and adequacy of tariff increases should enable these power utilities to generate revenues to cover fully their operating costs and debt servicing liability, and finance a substantial part of future capital expenditures. But power utility corporations do not usually enjoy autonomy in tariff-setting, and many DMC governments are reluctant to approve such tariff increases. Prices charged for electricity must indicate to energy consumers the true economic costs involved in supplying their requirements and reduce the power company's vulnerability to adverse market conditions. Such tariff reforms would require full government support. The experience of the Mae Moh Power projects in Thailand demonstrates successful implementation of tariff reforms, a departure from the previous practice of direct government subsidies through low tariffs, to a new policy of full cost recovery in the power subsector with automatic adjustment in tariffs immediately after a fuel cost increase. In the subsequent Power Distribution Project, after seven increases in power tariffs, a review of the tariff structure led to a moderate decrease in it. This demonstrated to consumers that economic benefits derived from efficiency and productivity gains would be shared through tariff reductions.

31. Low systems utilization characterized a number of power plants in Indonesia, Lao PDR, Malaysia, Pakistan, Papua New Guinea, Philippines, Thailand, and Viet Nam. This was due to low generating output coupled with lower than projected demand for electricity as planned industrial development did not take place. In such situations, demand side management techniques such as identifying and implementing initiatives to improve the utilization of energy supply capacity by altering characteristics of energy demand or consumption patterns need to be considered. Such initiatives imply lowering tariffs for non-peak hours instead of constructing new generating capacity. The neglect of the pricing factors in electricity demand forecasts was found to be an important source of error in systems development decisions. The importance of price variables in affecting power demand could be considered to balance the costs of low systems reliability as against the cost of systems expansion.

2. Timely and Adequate Operation and Maintenance

32. The reliability of power supply and sustainability of project benefits are contingent upon the efficient operation and upkeep of project facilities. In some DMCs, governments are more concerned with obtaining new generating equipment than with the proper maintenance of existing equipment. O&M problems were ascribed to non-availability of spare parts for long-term routine or periodic maintenance; government restrictions on the imports of spares; the lack of technical personnel to conduct such maintenance, especially for power equipment incorporating high technology; and inadequacy of budgetary allocations for O&M. Changes in operational concept as in the Pakistan Gas Generation Project considerably affected the project's operational performance and maintenance costs.

33. The importance of adequate and timely maintenance of power facilities and equipment needs to be emphasized, even if it results in supply interruptions. A successful maintenance policy is showcased in the Second Power Project in Fiji, where an effective arrangement for preventive routine maintenance and major overhauls were provided in the organizational structure of the executing agency with a full complement of personnel and equipment. Institutional capability to maintain and repair transmission and distribution systems became evident in the speedy reconstruction of lines and restoration of power supplies when a cyclone hit the country in March 1983. The Korean experience in the Second Power Transmission and Distribution Project similarly affirmed the overriding importance of a well-

devised set of construction and design standards, without which the system would become an incoherent agglomeration of materials and equipment that is difficult to maintain, modify, or expand. The Korea Electric Power Corporation has established a system of national construction, design, and O&M standards separately for rural areas and urban areas, which ensures efficiency in maintenance and expansion procedures. Clearly, these experiences highlight the importance of having a highly capable executing agency, identification of spare-parts which are not readily available, and the provision of adequate budgetary allocations for O&M.

3. Low Systems Utilization and Demand-Supply Gaps

34. In some cases, high demand for electricity could not be met by the low generating capacity of the power plant. In these cases, demand side management has been prescribed as a tool to close the demand-supply gap. For a country with high demand like Indonesia, management of electricity demand is done by working closely with larger commercial and industrial companies to reduce and rationalize their energy consumption. A parallel lighting program for residential consumers was also supported while the power utility pursued aggressive load management programs that incorporate peak load and time of day pricing in tariffs, and service options that reflect different voltages, consumer classes, and different levels of reliability and availability. In Thailand, construction of new power projects has been deferred on account of uncertainty in demand to avoid underutilized capacity, although in some projects expensive installation of cables and lines prompted the practice of installing capacity larger than required to avoid digging of new roads or erecting new poles for future expansion plans. Malaysia's First Sarawak Electricity Supply Project offers a success story of continuous surveillance of load forecasting in conjunction with generating plant commissioning dates to avoid a shortage or an excess of capacity. The energy sales forecasts of commercial staff were continuously upgraded and reconciled with the power station's demand forecasts prepared by engineering staff to improve the accuracy of demand forecasts. Updating forecasts would be helpful in monitoring performance and will allow for timely response to changing market conditions.

4. Reduction of Systems Losses

35. The single most important operational challenge facing many power utility corporations is the reduction of systems losses, which occur for technical and administrative reasons. Technical losses were attributed to decrepit, inadequate and overloaded transmission and distribution systems. Reduction of technical losses in such cases would involve considerable financial investment in rehabilitating existing dilapidated systems or expanding systems. Administrative losses were traced to unmetered supplies, defective metering, thefts or unaccounted for electricity consumption; and inefficient accounting, billing and collection systems of power utility corporations. Because systems losses result in wastage of energy, increase the cost of energy sold, and undermine the financial liquidity of power corporations, concerted efforts need to be made to control such losses. In a number of projects, loss reduction programs were implemented usually involving progressive metering of all electricity consumers, recertification of energy meters, resealing and rehabilitation of service terminal connections, and enactment or revision of electricity legislation to enforce accountability and curb illegal practices of jumping or bypassing of electricity connections. Loss reduction

programs such as the one successfully implemented in Nepal's Second Power Project and in Pakistan's Tarbela Hydropower (Units 9 & 10) Project should be more aggressively replicated.

5. Shortage of Qualified Personnel

36. Difficulties in recruiting and retaining suitable technical and managerial personnel of power utility corporations were identified as a major cause of institutional weakness. The absolute shortage of qualified staff was felt in the discontinuity of staff responsible for specific functions and in terms of certain functions being performed regularly, notably O&M. Staffing problems of executing agencies were attributed to several factors, among which are (i) the limited margin of autonomy of public enterprises to determine staff remuneration; (ii) the intense competition for available qualified local staff among the public sector entities; (iii) the non-availability of the required skills; (iv) short term nature of contracts for expatriate staff positions; and (v) difficulties in timing the availability of external funds used in recruiting expatriate staff. Best practices in human resource development were in evidence in the Tarbela Hydropower Project in Pakistan, where the Water and Power Development Authority has been able to attract and retain qualified manpower due to its competitive salary structure relative to other agencies, the prestige attached to the institution, and the training opportunities offered to its staff. Regular training programs may be pursued to ensure continuous availability of capable personnel. A greater degree of autonomy for executing agencies to determine staff remuneration may allow compensation to move toward market levels allowing them to compete for qualified technical personnel.

6. Institutional Strengthening and Capacity Building

37. The establishment of a strategic planning function in the institutional set-up of utility corporations to serve as a focal point for sectoral planning and policy formulation including systems development and expansion has been broached in many instances. This allows power corporations to identify clear and achievable objectives, and conduct technical assessments of resources and options. The planning unit would undertake forward investment planning, synchronize operations of all power projects making up a grid, coordinate activities, implement sectoral reforms, and streamline the organizational structure including the improvement of financial management and the establishment of computerized management information systems. Bank assistance for institutional support to the EGAT and the MEA in power projects in Thailand offer the best example of successful institution strengthening and capacity building components in power subsector projects. A common feature of both these agencies was their strong commitment to strategic planning, which was viewed as a valuable tool for internal management reform. Their corporate plans offered a more coherent and systematic process for setting sectoral objectives and targets, and increased performance accountability. In time, the EGAT and MEA were able to improve power planning and financial management and to establish themselves as mature power utilities.

7. Environmental Control

38. The environmental and health impacts of power plants in DMCs such as Indonesia, Maldives, PRC, Sri Lanka, Thailand, and Samoa necessitate adopting mitigative measures in

the design of these plants to (i) conserve and manage ecological systems, (ii) control pollutants and wastes, and (iii) protect public health. Ecological balance would be crucial for hydropower plants as low water levels have been found to affect agriculture (due to non-availability of water for irrigation) and fisheries industries in downstream areas. In the Maninjau Hydropower Project in Indonesia, for instance, local fish farmers had to abandon their trade because of seasonally low water levels in the lake, which drained their fishponds. Remedial conservation measures such as the provision of fish ladders in designing reservoir dams would permit fish migration for spawning. Soil erosion along slopes and dam embankments and siltation brought about by accumulation of debris are other environmental concerns for hydropower projects, requiring soil conservation measures and periodic declogging as part of O&M included at the project design stage. In the case of thermal power plants, environmental problems relate to disposal of overburden and ash; emission of particulates and gases from combustion; discharge of dust, soot, and other effluents; and frequency interference, visual obstruction, noise and vibration. These externalities warrant the incorporation of abatement measures during the project design stage. For transmission projects, land clearing including that of mangroves and forests during construction work along right of way corridors have been noted as major environmental impacts and should therefore be addressed by reforestation plans and resettlement programs. Best practices of environmental control are reflected in Thailand's Mae Moh Unit 4 Power Project, where a network of 19 air quality monitoring stations were established by the EGAT in the vicinity of the project to monitor continuously both meteorological conditions and pollutant levels, as well as dust and total suspended particulates fall rates. Compliance with both international and local ambient air quality standards by the EGAT have consequently been noted. One result of this monitoring was that development of Mae Moh beyond 10 units was found to be inadvisable on environmental grounds.

8. Lack of Counterpart Funding

39. The lack of counterpart funding is an issue not unique to the power subsector. The lack of local financing was found to afflict a number of power projects in Indonesia, Malaysia, Pakistan, and the Philippines. Unreliable government counterpart funding has delayed the completion and constrained the operations of these projects. The identification of core priority projects and provision of timely availability of committed funding for these projects should therefore be realistically assessed during country programming, preferably jointly with other donors. A likely shortage of funds would alter priorities and may necessitate a reduction in project scope. If procedures obstruct funding, mechanisms should be streamlined to facilitate timely release of funds. Meanwhile, if difficulties originate from underlying fiscal management problems, then appropriate fiscal policy reforms may need to be pursued further in policy dialogues.

9. Private Sector Participation in Power Provision

40. The integration of independent power producers into power supply operations has been proposed as a supply side solution to achieve optimal utilization of generating capacities, greater power availability, and lower systems costs. While private sector participation in power supply could augment generating capacity, which otherwise could lag behind demand because of budgetary constraints and limited internal cash generation of public utilities, this should be made in a manner that would entail the least cost to the nation. One outstanding issue in private sector involvement in power provision is that it complicates management and reduces the

economies of scale in operations as in the case of the Secondary Towns Power Distribution Project of Sri Lanka. Governments should carefully weigh the benefits and costs of allowing greater private sector participation in power generation compared with having the public sector provide power and improving their efficiency instead. Under the Load Despatch and Transmission Project, the Pakistani Government has adopted a two-pronged approach to enhance private sector participation in power by privatizing existing thermal generation plants and distribution systems, or encouraging the private sector to set up new thermal capacity, small hydropower plants, and selected transmission lines. A package of incentives has been developed which includes attractive bulk tariffs; comprehensive security for investments in terms of power purchases, foreign currency remittances, and protection against force majeure risks; exemptions from corporate income tax, lower equipment import duties, and income tax on equity repatriation; and financing arrangements. Similar initiatives in Thailand under the Sixth Power Distribution Project involved the granting of greater autonomy to the EGAT in purchasing power from independent power producers and moving towards its commercialization, corporatization, and privatization in the future.

B. Major Lessons Learned

The following lessons have been learned in Bank experience with power projects.

41. (1) Project Identification: (i) seeking least cost location of projects; (ii) considering the stage of economic development in selecting electrification projects; (iii) establishing a system of technical standards and specifications for the grid before investments are made; (iv) synchronizing operations of power plants; (v) adopting sector lending or integrated systems approach; (vi) choosing projects with capable executing agencies to the extent possible and strengthen such agencies as necessary; (vii) exploring a range of technological alternatives; (viii) adopting technology suited to local conditions; (ix) selecting projects that upgrade technology and rehabilitate old systems; and (x) ensuring completion of reforms and adopting low-risk options before follow-up investments are made.

42. (2) Project Preparation: (i) obtaining comprehensive information on geological and hydrological conditions; (ii) obtaining comprehensive information on sources of energy supply; (iii) carrying out power market surveys; (iv) carefully assessing the competence of consultants; (v) providing for verifiable indicators that will give specific information on the achievements of project goals and impacts should be identified using the logical framework approach; (vi) developing realistic project designs; (vii) preparing detailed cost estimates; (viii) using a phased or pilot approach for complex power projects; (ix) conducting a thorough EIRR and FIRR analysis at appraisal; (x) conducting sensitivity tests on self-financing ratios; (xi) strengthening the capacity of executing agency through institution building components; (xii) including environmental abatement measures in project design; (xiii) assessing staffing policies of executing agencies; (xiv) assessing technical conditions of old equipment; (xv) providing for ancillary infrastructure in project design; (xvi) reappraising projects when there are radical changes in scope; (xvii) allowing flexibility for changes in scope and implementation of distribution projects due to right-of-way difficulties; and (xviii) providing technical assistance for policy and engineering design studies.

43. (3) Project Negotiation: (i) defining self-financing ratios in covenants clearly; (ii) including time-based implementation of tariff reforms in covenants; (iii) stipulating a financial

recovery plan for power utilities with deficient financial management and accounting systems; (iv) factoring environmental concerns in loan covenants such as appropriate environmental legislation; (v) building into loan provisions the updating of demand and load forecasts; and (vi) prescribing a Bank action plan in case of non-compliance with loan covenants.

44. (4) *Project Implementation*: (i) determining realistic implementation schedules; (ii) strengthening interagency coordination; (iii) agreeing with cofinanciers and other donors on simplification and harmonization of project implementation procedures; (iv) improving data collection and reporting procedures of executing agencies; (v) implementing O&M programs; (vi) familiarizing executing agencies with the Bank's procurement/ tendering procedures; (vii) expediting consultant selection and hiring processes; (viii) updating and monitoring load and demand forecasts; (ix) increasing the frequency of Bank review missions to remote areas; (x) monitoring reimbursements/ disbursements closely; (xi) streamlining procedures for release of counterpart funding; (xii) allowing flexibility in the use of surplus funds; (xiii) assisting executing agencies in establishing sound management information systems; (xiv) ensuring ample supply of imported spare parts; (xv) decentralizing procurement and expediting procurement arrangements; and (xvi) expanding training components to address human resource constraints in executing agencies. To assist the staff of the Projects and Programs Departments in the Bank, the lessons learned are presented in matrix form, by country, by source and by activity as shown in Appendix 8.

V. CONCLUSIONS

45. Postevaluation findings of power projects indicated the following factors as crucial to successful project performance: (i) experience and capability of the executing agency; (ii) appropriateness of technical design; (iii) timely and adequate availability of counterpart funding; (iv) reliability of demand and load forecasts; (v) flexible Bank intervention and increased supervision throughout the project cycle; (vi) adoption of geological, hydrological, and environmental impact investigations and abatement measures; (vii) effective application of O&M standards and procedures; and (viii) determined implementation of cost recovery mechanisms and tariff reforms. Objectively verifiable indicators that will provide specific information on the achievements of project goals and impacts should be identified using the logical framework approach. These could include foreign exchange savings on imported fuel, targeted reduction in systems losses, increase in systems reliability, and the number of consumer connections provided. This could enhance the specificity of the developmental impact of power projects as well as accountability of the executing agency. Close periodic monitoring of major project risks and assumptions, notably demand forecasts, generating capacity, systems losses, fuel and electricity pricing, geological and climatological (e.g., rainfall) conditions, and the security situation would improve project administration and facilitate economic and financial evaluation of projects at completion and postevaluation

46. Judging from the generally successful rate of 79 percent and an unsuccessful rate of only 1 percent for power projects, a number of project objectives have been substantially met. These include (i) expanding, rehabilitating or upgrading power supply to meet the growing demand for electricity; (ii) reducing dependence on imported sources by developing indigenous sources of energy; (iii) improving overall power systems reliability and efficiency; and (iv) improving access of the poor to power. Bank experience in financing power projects, however, has shown that sustaining the success rate achieved would require increasing emphasis on (i) critically assessing energy demand to avoid underutilization or overcapacity of

power supply; (ii) incorporating appropriate cost recovery and energy efficiency mechanisms on both supply and demand sides ensuring proper O&M of project facilities; (iii) considering environmental factors in energy development; and (iv) improving the institutional capacity of energy entities in DMCs as executing and implementing agencies with a view to redefining the role of government and enlarging the scope for private sector participation in the subsector.