

**ASIAN DEVELOPMENT BANK**

**PPA: MLD 24009**

**PROJECT PERFORMANCE AUDIT REPORT**

**ON THE**

**SECOND POWER SYSTEM DEVELOPMENT PROJECT**  
**(Loan 1121-MLD[Sf])**

**IN**

**THE MALDIVES**

**December 2000**

## CURRENCY EQUIVALENTS

Currency Unit – Rufiyaa (Rf)

	<b>At Appraisal</b>	<b>At Project Completion</b>	<b>At Operations Evaluation</b>
	(30 August 1991)	(26 January 1998)	(March 2000)
Rf1.00 =	\$0.0952	\$0.0846	\$0.086
\$1.00 =	Rf10.50	Rf11.82	Rf11.55

## ABBREVIATIONS

ADB	–	Asian Development Bank
EA	–	executing agency
EIRR	–	economic internal rate of return
FIRR	–	financial internal rate of return
NPH	–	new powerhouse
OEM	–	Operations Evaluation Mission
OPH	–	old powerhouse
PCR	–	project completion report
PPAR	–	project performance audit report
SDR	–	special drawing rights
STELCO	–	State Electric Company
TA	–	technical assistance
TOR	–	terms of reference

## WEIGHTS AND MEASURES

GW (gigawatt)	–	1,000 megawatts
GWh (gigawatt-hour)	–	1,000 megawatt-hours
kV (kilovolt)	–	1,000 volts
kVA (kilovolt-ampere)	–	1,000 volt-amperes
kVAR (kilovolt-ampere reactance)	–	1,000 units of reactive power
kW (kilowatt)	–	1,000 watts
kWh (kilowatt-hour)	–	unit of electrical energy
MW (megawatt)	–	1,000,000 watts
MWh (megawatt-hour)	–	1,000 kilowatt-hours
VA (volt-ampere)	–	unit of apparent power
W (watt)	–	unit of active power

## NOTES

- (i) The fiscal year (FY) of the Government and STELCO ends on 31 December.
- (ii) In this report, "\$" refers to US dollars.

**Operations Evaluation Office, PE-560**

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**BASIC DATA**  
**Second Power System Development Project (Loan 1121-MLD[SF])**

**Project Preparation/Institution Building**

TA No.	TA Name	Type	Amount (\$)	Approval Date
1338-MLD	Second Power System Development	PPTA	100,000	13 Jul 1990
1605-MLD	Institutional Improvements in the Maldives Electricity Board	A&O	450,000	19 Nov 1991

Key Project Data (\$ million)	As per ADB	
	Loan Documents	Actual
Total Project Cost	10.30	10.54
Foreign Exchange Cost	9.20	9.21
Local Currency Cost	1.10	1.32
ADB Loan Amount/Utilization	9.20 <sup>1</sup>	9.21
ADB Loan Amount/Cancellation		0.51

**Key Dates**

	Expected	Actual
Appraisal	Aug 1991	10 Sep 1991
Loan Negotiations	1-2 Oct 1991	17 Oct 1991
Board Approval	1 Nov 1991	19 Nov 1991
Loan Agreement	23 Jan 1992	23 Jan 1992
Loan Effectiveness	22 Apr 1992	23 Apr 1992
Project Completion	31 Oct 1994	30 Sep 1997
Loan Closing	30 Apr 1995	1 Dec 1997
Months (effectiveness to completion)	30	53

Key Performance Indicators (%)	Appraisal	PCR	PPAR
Economic Internal Rate of Return	27.9	24.7	20.3
Financial Internal Rate of Return	17.4	28.4	26.6

**Borrower** Republic of the Maldives

**Executing Agency** Ministry of Foreign Affairs

**Implementing Agency** State Electric Company<sup>2</sup>

**Mission Data**

Type of Mission	No. of Missions	No. of Person-Days
Fact-Finding	1	8
Appraisal	1	48
Project Administration		
Inception	1	5
Review	4	134
Project Completion	1	20
Operations Evaluation	1	21

A&O = advisory and operational, ADB = Asian Development Bank, PCR = project completion report, PPAR = project performance audit report, PPTA = project preparatory technical assistance, TA = technical assistance.

<sup>1</sup> ADB's loan amount was approved in special drawing rights (SDR) equivalent for SDR6.775 million.

<sup>2</sup> Formerly the Maldives Electricity Board.



## EXECUTIVE SUMMARY

The Second Power System Development Project, which aimed to augment power generating capacity and improve electricity distribution in Malé, was included under the Government's Eighth Five-Year Plan (1991-1995) for sustaining economic growth, and was intended to fulfill an urgent need to meet the suppressed and anticipated demand for electricity in Malé until 1997. This was to be achieved through the supply and installation of two diesel generators with a combined capacity of 8,700 kilovolt-amperes; expansion and improvement of the distribution system; improvement of the State Electric Company's (STELCO's) diagnostic capacity to measure and reduce system losses; and strengthening of STELCO's accounting, management, and planning systems together with staff training and a tariff study. The project scope also included consulting services for project implementation and technical assistance for institutional strengthening.

The Appraisal Mission of the Asian Development Bank (ADB) was completed during September 1991, and ADB's loan of SDR6.755 million (\$9.2 million equivalent) and technical assistance for the Project were approved on 19 November 1991.<sup>3</sup> The overall Project was completed in September 1996, 23 months later than envisaged at appraisal because of implementation delays and contractual disputes. The overall delay was offset in part by the sequencing approach to implementation, which meant that one of the project generators was operational by August 1993, only two months beyond the appraisal schedule. The final project cost of \$10.5 million was slightly above the appraisal estimate of \$10.3 million. ADB's loan disbursements were \$0.51 million less than approved.

The project rationale to augment electricity generation and improve distribution to meet demand requirements and help sustain economic growth proved relevant with electricity consumption increasing between 1991 and 1997 by 13.5 percent per annum. Without the Project, STELCO's generating capacity would have been insufficient and this would have led to extensive overloading, a rise in system losses, and increased operating costs. The operating viability of STELCO would also have been significantly weaker, resulting in an inferior quality of electricity supply. Even so, while the overall project design was appropriate for achieving the main project purpose, there were some deficiencies in detail design relating to technical aspects and institutional strengthening.

The project outputs and operational targets as measured against appraisal expectations were largely achieved. The Project increased total generating capacity in Malé by 7,940 kilowatts. This enabled STELCO to meet forecast peak demands and greatly reduce generation from obsolete and less efficient plant. STELCO's financial performance also exceeded appraisal projections: it improved from a loss-incurring enterprise at appraisal to a profitable one—a performance all the more meritorious because it was achieved with a significant expansion of responsibilities involving electrification development and administration for 13 outer islands that were not anticipated at appraisal. The overseas training program for 26 participants was effective, and the tariff study provided information that was used to adjust Malé tariffs and to price electricity on the outer islands on a basis that more closely reflected their economic development and the operating costs.

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<sup>3</sup> Loan 1121-MLD(SF): *Second Power System Development Project*, for SDR6.755 million; and TA 1605-MLD: *Institutional Improvements in the Maldives Electricity Board*, for \$450,000, approved on 19 November 1991. STELCO was formerly the Maldives Electricity Board.

The socioeconomic benefits from the Project included improved voltage reliability and an end to the need for electricity restrictions and blackouts, and an extra 6,000 kilovolt-amperes for distribution extension. As a consequence, some 3,000 new resident connections of a total 12,750 were made possible. Other socioeconomic benefits included better working conditions, expanded livelihood opportunities in the new connection areas, some higher-paid employment opportunities, and better lighting for residents. No adverse environmental impacts are evident. Potential damaging emission fumes and noise pollution that were identified at appraisal were mitigated through extending exhaust stack heights on the generators, and installing sound insulation at the powerhouse to reduce noise levels below a tolerance level of 60 decibels at the outside boundary.

The Project's financial internal rate of return and economic internal rate of return reestimates of 27 percent and 20 percent, respectively, which take into account the impact of completion delays, system losses, and sustainability of projected benefits, attest to the overall efficiency and sustainability of the Project. However, against this must be set the fact that the envisaged targets for containing system losses and for strengthening STELCO's computer-based accounting and operational management systems did not materialize or were not sustainable.

The Project is rated successful.

The lessons identified in the Project are (i) that, in project designs for improving distribution efficiency, analysis software should be provided together with training in its application; (ii) that, in project design, more rigorous technical audit procedures should be included so as to ensure that intended project items (distribution analysis software and capacitors in this instance) are fully operational; (iii) that stronger contractual terms covering supervisory responsibilities and work performance on subcontract arrangements should be used so as to reduce the potential for contractual disputes and implementation delays; and (iv) that, in the interests of maintaining technical operating efficiency, the tasks of identifying and redesigning the system network to minimize distribution losses should be treated as a full-time operating function within the institutional structure.

Follow-up actions aimed at addressing lessons identified in the Project are recommended. ADB should (i) ensure in all future power project designs that provide distribution monitoring equipment that there is also a sufficiency of training provided, and (ii) provide for more rigorous technical audit procedures for checking power project equipment is fully operational before commissioning. The Government should, as soon as possible, for all future infrastructure projects (i) take steps to ensure stronger contractual terms are introduced to cover subcontracting responsibilities so as to reduce the potential for contractual disputes and project implementation delays, and (ii) act immediately to ensure all capacitors under the Project are connected and operational. STELCO should (i) in its next corporate plan include provision for staff training and familiarization with its computer-based accounting and operational management systems; and (ii) as soon as possible take steps to utilize the software systems provided under the Project to monitor distribution losses and introduce the task of monitoring as part of a full-time operating function for identifying and upgrading the system network (so as to minimize distribution losses).

## I. BACKGROUND

### A. Rationale

1. The Project's rationale reflected the nation's power investment requirements to meet the increasing demand for electricity in Malé, and the operational strategy of the Asian Development Bank (ADB) to assist economic infrastructure projects over the medium term. The Project was included as a priority under the Government's Eighth Five-Year Plan (1991-1995) for sustaining economic growth, which, during the previous five years from 1986, had averaged around 11 percent per annum, when electricity consumption had grown by 19.6 percent per annum.

### B. Formulation

2. The Project was formulated as part of a master plan for development of the power sector prepared under ADB technical assistance (TA).<sup>1</sup> A project preparatory feasibility study was completed in 1990 taking into account the master plan's recommendations.<sup>2</sup> The feasibility study evaluated the nation's power requirements and identified what generation and distribution components were needed to satisfy power demand requirements through to 1997. An ADB Fact-Finding Mission was completed in July 1991 and an Appraisal Mission in September 1991. ADB's loan of SDR6.755 million (\$9.2 million equivalent) and TA grant were approved on 19 November 1991.<sup>3</sup> The Borrower was the Republic of Maldives. The Ministry of Foreign Affairs was the Executing Agency for the Project and TA, and the State Electric Company (STELCO) was designated the Implementing Agency.<sup>4</sup>

### C. Purpose and Outputs

3. The project purpose was to augment power-generating capacity and improve electricity distribution in Malé. The outputs included (i) supply and installation of one 2,700 kilovolt-ampere (kVA) diesel generator; (ii) supply and installation of one 6,000 kVA diesel generator; (iii) extension of the new power station; (iv) supply and installation of auxiliaries, switchgear, additional fuel storage facilities, and ancillary plant items; (v) expansion and improvement of the distribution system;<sup>5</sup> and (vi) consulting services for project implementation. In conjunction with ADB's loan, a TA was provided to strengthen STELCO through (i) consulting services to improve STELCO's accounting, financial, commercial, and management systems; (ii) consulting services to help STELCO improve its corporate structure, develop long-term planning capability, and evolve a scheme to encourage private sector participation in the electrification of outer atoll

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<sup>1</sup> TA 911-MLD: *Institutional Improvement of Maldives Electricity Board (MEB)*, for \$350,000, approved on 27 October 1987.

<sup>2</sup> TA 1338-MLD: *Second Power System Development*, for \$100,000, approved on 13 July 1990.

<sup>3</sup> Loan 1121-MLD(SF): *Second Power System Development Project*, for SDR6.755 million; and TA 1605-MLD: *Institutional Improvements in the Maldives Electricity Board*, for \$450,000, approved on 19 November 1991.

<sup>4</sup> Formerly the Maldives Electricity Board.

<sup>5</sup> Including provision of additional substations, power factor correction equipment, high and low voltage cabling, and low voltage equipment.

islands; (iii) staff training; and (iv) a tariff study. Appendix 1 provides further details of the project purpose and outputs.

4. Augmenting power generation and expanding and improving distribution were expected to fulfill an urgent need and meet the anticipated increase in demand for electricity in Malé until 1997. The proposed TA was viewed as essential to enable STELCO to cope with its rapidly expanding operations. The overall project design was considered to have taken appropriate steps to minimize all risks.

#### **D. Cost, Financing, and Executing Arrangements**

5. The estimated total project cost at appraisal was \$10.3 million equivalent, with a foreign exchange component of \$9.2 million. ADB's loan was to be used to cover the full foreign exchange costs associated with civil works, imported equipment, consulting services, and the service charge on ADB's loan during construction. STELCO was to meet the local currency cost of \$1.1 million equivalent. Details of expected project costs and sources of financing at appraisal are presented in the basic data sheet (page ii). The Ministry of Foreign Affairs' Director of External Resources was the appointed project coordinator to act as liaison between the Government and ADB. The director of STELCO was responsible for the overall management of project implementation, assisted by consulting services and two senior engineers: one for generation, and the other for distribution. STELCO's financial administration was responsible for maintaining separate records and accounts for the Project.

#### **E. Completion and Self-Evaluation**

6. ADB's Project Completion Review Mission visited the project site during 6-15 January 1998 and considered the Project successful on the basis that the basic project objectives were met, and the Project was financially and economically viable.<sup>6</sup> ADB's TA for institutional strengthening of STELCO was considered a success on the basis of implementation and improvements achieved. However, the need for further institutional strengthening was identified in order for STELCO to discharge its responsibilities effectively. In this regard, it was concluded that STELCO was still in an early stage of development and required (i) more professional staff, (ii) a considerable amount of staff training, (iii) help with further development of working systems, and (iv) implementation assistance and organizational development support. In the sphere of corporate development, it was also seen necessary to enhance management methods and practices. The specific task of evolving a scheme to encourage private sector participation for the electrification of the outer atoll islands was not addressed. Based on the project completion report (PCR) details, the Operations Evaluation Office (OEO) views the PCR assessment of the Project as realistic.

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<sup>6</sup> A project completion report (PCR) prepared by Energy Division-West was circulated to ADB's Board in July 1998. The PCR discusses the scope, design, implementation, operations, and initial performance of the Project. The PCR estimated a financial internal rate of return of 28.4 percent and economic internal rate of return of 24.7 percent. The corresponding estimates at appraisal were 17.4 percent and 27.9 percent.

## **F. Operations Evaluation**

7. This project performance audit report (PPAR) reviews the findings of the PCR and presents the findings of the Operations Evaluation Mission (OEM) that visited the Project during 26-30 March 2000. Special attention is given to assessing the achievement of purpose,<sup>7</sup> operating performance of STELCO, effectiveness of TA for institutional strengthening, and sufficiency of design for meeting load expansion requirements and avoiding system losses. Related to these aspects are planning issues for the continued financing and expansion of power to the outer islands. Also to be addressed are the development impacts of the Project and environmental consequences of the Project's operations. This PPAR is based on the findings of the OEM after three years of operational data, a review of the PCR, the appraisal report and material in ADB files, discussions with ADB staff, senior officials of the Ministry of Foreign Affairs, other government agencies, and interviews with electricity consumers. Copies of the draft PPAR were provided to the Government, STELCO, and ADB staff concerned for review. Their comments were considered in the preparation of this PPAR.

## **II. PLANNING AND IMPLEMENTATION PERFORMANCE**

### **A. Formulation and Design**

8. The overall engineering approach to planning and design proved appropriate to meet forecast load requirements, improving distribution, and reducing system losses (Appendix 2). TA for a feasibility study of the Project (footnote 2) ensured the choice of diesel generating sets, namely installation of 2,700 kVA unit followed by a 6,000 kVA unit was the optimal development strategy.<sup>8</sup> Technical inputs for design of the distribution system in order to reduce system losses was relevant as was the recommendation to provide distribution analysis software to enable STELCO personnel to monitor and identify the location of losses before determining their cause. The OEM could find no evidence that the analysis software was provided, and on the assumption that it was and could not be located, it was also found that no application training was provided. Therefore, an essential control mechanism for minimizing technical distribution losses was not implemented (para. 52).

9. The attached project TA (footnote 3) added to the overall comprehensiveness of the Project's design in that the accounting, billing, and management systems to be addressed were known to be areas where STELCO needed strengthening. The inclusion of a tariff study was needed to identify weaknesses in pricing and to provide a basis for adjusting electricity tariffs to more closely reflect economic development and operational costs. Training in management operations was designed so that participants could see in a case in Sri Lanka how operations are carried out in a similar organization. This was particularly effective. However, some of the other design elements for institutional strengthening should have been more effective (para. 41),

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<sup>7</sup> The meaning of purpose also encompasses the achievement of project and sector goals and intended developments from the Project.

<sup>8</sup> Consistent with meeting least-cost considerations, anticipated load growth, and the planned rehabilitation/retirement of existing generation sets.

and there was less than full compliance with the Project's financial covenants for ensuring that electricity tariffs were adjusted with variations in fuel costs.

## **B. Achievement of Outputs**

10. The achievement of the outputs is described in section IIIA.

## **C. Cost and Scheduling**

11. The actual project cost of \$10.5 million was slightly above the appraisal estimate of \$10.3 million. The foreign exchange cost of \$9.214 million equivalent was met from the proceeds of ADB's loan, and an undisbursed loan amount of SDR378,889 (\$0.511 million equivalent) was cancelled. The local currency cost of \$1.323 million equivalent was met from STELCO's internal cash generation. The disaggregated project costs for foreign expenditure on civil works, equipment, and consulting services were consistent with appraisal estimates.<sup>9</sup> The attached TA to cover consultants' fees and expenses amounted to \$0.449 million. ADB's loan represented 87 percent of the total project cost, while financing from STELCO represented 13 percent.

12. The Project was completed in September 1996, 23 months later than envisaged at appraisal. There were two extensions on the closing date for ADB's loan from 30 April 1995 to 1 December 1997. The delay in appointment of consultants by about 10 months occurred despite ADB's approval for advance action on recruitment and delayed the overseeing of tender bids. Commissioning of the 2,700 kVA generator was delayed by about two months. Conflicts with the contractor for the 6,000 kVA generator put back its commissioning by 23 months to early October 1996. Parallel delays were experienced for upgrading and expanding the distribution network.<sup>10</sup> A comparison of actual implementation with the appraisal schedule is shown in Appendix 3.

## **D. Consultant Performance, Procurement, and Construction**

13. Project implementation was fraught with delays associated with administration approvals, unclear specifications, delays in tender submissions, and contractual disputes. The performance of the implementation consultants was considered by the Ministry of Foreign Affairs and STELCO satisfactory (para. 15).

14. Procurement was envisaged at appraisal to be undertaken through international competitive bidding for the diesel generator sets and supply of distribution equipment, and through international shopping for the supply of computer and office equipment. To facilitate supervision and implementation efficiency, the contracts for supply of the 2 megawatt (MW) and 6 MW diesel generator sets and civil works were prepared on a turnkey basis.<sup>11</sup> Bid documents

<sup>9</sup> The final combined installed capacity of the two generating sets was 7,940 kilowatts.

<sup>10</sup> The problem was identified by the Implementing Agency as arising from the subcontracting of work from the main contractor to a contractor of less experience and understanding of the main contractor's requirements.

<sup>11</sup> This is preferred when the Executing Agency has insufficient staff available for project management and helps

were prepared according to ADB's *Guidelines for Procurement*. Summary details of contract awards are provided in the PCR (Appendix 2).

15. The initial less than satisfactory performance of the main contractor, whose work did not comply with contract specifications, led to unnecessary delays in implementation and damages claims by STELCO. These claims and counterclaims by the contractor were settled amicably and in the final assessment of the quality of materials supplied, equipment performance, and quality of civil works as finally completed were satisfactory.<sup>12</sup> The consultant's input in finalizing drawings and overseeing the civil works contract for the 6,000 kVA generator proved important in dealing with this project phase.

## **E. Organization and Management**

16. Organization and management was consistent with arrangements envisaged at appraisal and generally satisfactory except for delays in the appointment of consultants (para. 12) and award of contracts.

17. ADB provided adequate monitoring during project implementation with four review missions, one inception mission, and one project completion mission. Coordination meetings were held during review missions with the Ministry of Foreign Affairs, STELCO, and consultants to solve problems and minimize delays. The decision to appoint consultants with responsibility for full implementation services including preparing tender documents, overseeing bid evaluations, and awarding contracts, in addition to attending to technical aspects of implementation and supervision, was considered by STELCO appropriate and helpful.

18. Compliance with loan covenants was satisfactory except for delays in the compilation and furnishing of financial statements. Operational covenants for STELCO relating to staff training, environmental matters, tariff restructuring and adjustment, and achievement of financial targets were complied with.

## **III. ACHIEVEMENT OF PROJECT PURPOSE**

### **A. Operational Performance**

19. Operational performance of the Project is assessed in terms of the expected achievements at appraisal toward (i) augmenting generating capacity, (ii) meeting demand for power, and (iii) improving distribution system reliability and reducing system losses. The adequacy of maintenance is also reviewed.

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ensure competitive bidding. For the 6 MW generator, the international bid contractor used a subcontractor for the civil works and installation from which numerous problems arose including faulty planning, organization defects, and substandard construction.

<sup>12</sup> The Project was deemed complete with commissioning of the 6,000 kVA generator at the end of September 1996. Although upgrading and expansion of the distribution component was largely complete, full implementation was not complete until September 1997.

20. With the Project's added capacity, STELCO's total installed capacity of 11,490 kVA for Malé was expected to be sufficient to meet the demand for power up to 1997 of 64.2 gigawatt-hours (GWh). Actual power sales were 52.3 GWh in 1997, rising to 64.7 GWh in 1999. Because STELCO extended the date for the planned retirement of obsolete generator units at the old powerhouse, the actual generating capacity for Malé was higher at 14,470 kVA. Deferring retirement of the obsolete generators was justified in terms of having available more freedom to deal with commissioning and maintenance requirements of the newer units.

21. The operational performance of the two generators provided under the Project has been highly satisfactory. Up to March 2000, there had been no major outages in six and a half years of operation for the 2,700 kVA unit and three and a half years for the 6,000 kVA unit. As of March 2000, the first unit indicated 34,085 hours of operation, and the second 26,640 hours. These are equivalent to online availability of, respectively, 65 and 79 percent and compare favorably with the performance of similar units in developed countries. Maintenance records for the two generators show that the recommended oil changes, injector cleaning, and turbo unit preventive maintenance were carried out. General maintenance around the new powerhouse is exemplary.

22. The provision of distribution equipment enhanced system capacity to distribute the additional generation provided and to reduce technical losses. This was achieved by providing substations with capacitors and 11 kilovolt (kV) cabling sufficient to distribute approximately 6,000 additional kVA in the Malé system. The extra cabling, besides expanding the operating system, was also used to replace 3.3 kV cabling that could not carry the higher voltages generated. The project distribution component allowed for new connections and relieved overloaded circuits so that previous restrictions on electricity usage by consumers were lifted.

23. Reported system losses for 1994-1999 increased from 12.6 to 14.3 percent with a single year decline to 10.7 percent in 1996, and did not match the improvement level of around 12 percent that was assumed for projection purposes.<sup>13</sup> Some 1.6-2 percentage points of the expected early savings in avoided transformer losses were not realized due to delays in implementation. While the additional substations contributed to savings in technical losses, the capacitors provided under the Project were installed but not connected.<sup>14</sup> The failure to connect these capacitors translates into an estimated 5 percentage points reduction in system losses forgone. Another contributing factor was the significant overloading at 15 of the 68 substations, which require upgrading. (These considerations are further discussed in Appendix 2). Also important for the proper planning and design of distribution circuits is the monitoring and distribution analysis software for computer simulation of the system. The Project included the supply of such software for the specific purpose of helping planning engineers identify early where design improvements and upgrades on the system needed to be made. The software could not be located by the OEM. STELCO staff who were involved in the Project could not recall that the software had been provided.

## **B. Performance of the Operating Entity**

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<sup>13</sup> The addition of new substations and replacement of overloaded 3.3 kV conductor cable with larger 11 kV cable, and the addition of capacitors at substations, should have reduced system losses by about 5 percent.

<sup>14</sup> STELCO could not advise why the capacitors had not been connected.

24. STELCO's financial performance at appraisal (1990 being the last available full-year accounts) was considered unsatisfactory<sup>15</sup> but was expected to improve considerably following increased electricity sales and commissioning of the new power station in 1992. STELCO's operating profit was expected to increase to Rf20.8 million in 1996, representing a return on total revenues of 12 percent, and a return on equity of 26.9 percent. The consolidated accounts were forecast to maintain a rate of return on average net fixed assets to 1996 at around 16.6 percent and a debt-service ratio of about 2 percent. Electricity tariffs for Malé were projected to increase in line with an 8 percent domestic rate of inflation after 1992. Electricity tariffs for the outer islands, which were below those for Malé, were to be brought into line with those applying to Malé electricity subscribers.

25. STELCO's actual financial performance for Malé operations proved better than forecast. For the period 1990 to 1998, operating revenues increased by an average of 21 percent per annum, and net fixed assets by 33 percent per annum. Year-end net surplus (profit) after depreciation and loan service charges climbed from a loss of Rf0.28 million in 1990 to Rf29.93 million in 1996 and to Rf62.12 million in 1998. Profit performance relative to operating revenue and return on equity was strong and ADB's financial loan requirement (i) to ensure operating expenditures to operating revenue did not exceed 0.9, and (ii) to maintain a debt-service ratio of at least 1.3 times net revenues was comfortably achieved. Table 1 summarizes the financial statements of STELCO for 1990-1998. Appendix 4 provides further details.

26. Table 2 compares the financial performance of STELCO in 1998 with and without the outer island operations. In 1990, electricity sales on the outer islands excluding Gan (site of an airfield) were 369 megawatt-hours or 1.7 percent of STELCO's total sales. By December 1998, expansion in electricity distribution had been extended from 5 to 18 outer islands, and sales to the outer islands excluding Gan represented 15.7 percent of total consumption. In line with this expansion, tariff rates for electricity are generally higher than in Malé and reflect the higher costs of electrification. The islands where tariff rates are lower than in Malé are Gan, Hithadhoo, Kulhudhuffushi, and Thinadhoo, where the tariff for business purposes is 75-93 percent of the Malé tariff. Even so, the tariff rates have been significantly increased and are now much more closely aligned with the rates in Malé.<sup>16</sup>

**Table 1. Financial Performance of STELCO**  
(Rf million)

Item/Fiscal Year Ending	1990	1994	1995	1996	1997	1998
Gross Revenue	51.0	117.0	154.5	171.9	195.6	230.4
Fuel Costs	26.4	40.9	45.9	52.5	60.4	65.5
Other Operating Expenditure	17.4	19.7	24.9	41.2	31.1	29.0
Gross Operating Surplus/(Loss) <sup>a</sup>	12.9	59.8	88.2	79.2	103.5	135.8
Surplus/(Loss) Before Tax	(0.3)	33.7	50.2	29.9	51.3	62.1
Dividend Provision <sup>b</sup>	0.0	8.0	8.0	8.0	12.0	8.0
Net Fixed Assets	39.8	117.4	202.8	270.4	335.8	383.5
Long-Term Loans	31.1	97.3	90.3	172.2	186.5	206.9
Total Assets	40.8	202.0	290.8	353.9	391.2	455.8

**Performance Indicators**

<sup>15</sup> STELCO reported an operating loss for 1990 of Rf0.28 million.

<sup>16</sup> At appraisal, the tariff on these outer islands was the same for all consumer categories and less than 50 percent of the effective tariff in Malé.

Current Ratio <sup>c</sup>	1.9	6.4	42.9	3.0	1.8	2.5
Debt-Service Ratio <sup>d</sup>	(0.1)	5.5	10.2	1.6	3.1	3.4
Operating Expenditure/Revenue (Ratio)	0.9	0.5	0.5	0.5	0.5	0.4
Return on Operating Revenue (%) <sup>e</sup>	(0.5)	28.8	32.5	17.3	26.2	26.9
Return on Equity (%)	(1.0)	35.2	25.0	16.4	25.1	25.0
Equity to Total Assets (%)	30.7	47.4	68.9	51.3	52.3	54.6
Return on Net Fixed Assets (%)	(0.7)	28.7	24.8	11.0	15.3	16.2
Average Revenue/Tariff (Rf/kWh)	2.4	2.7	3.0	3.6	3.7	3.6

kWh = kilowatt-hour, STELCO = State Electric Company.

<sup>a</sup> Before depreciation and loan service costs.

<sup>b</sup> To Ministry of Finance.

<sup>c</sup> Ratio of current assets to current liabilities.

<sup>d</sup> Surplus before tax/interest expenditure.

<sup>e</sup> Surplus before tax/operating revenue.

**Table 2. Financial Performance of Malé versus Outer Islands**  
(Rf million)

<b>Item</b>	<b>Malé Operations</b>	<b>Outer Islands<sup>a</sup></b>
Gross Revenue	184.9	45.4
Average Revenue (Rf/kWh)	3.7	3.4
Gross Operating Income	120.0	15.8
Operating Profit/(Loss)	78.0	(4.9)

kWh = kilowatt-hour.

<sup>a</sup> 18 outer islands.

27. The operating loss status for the outer islands is common to all the new STELCO supply areas except the outer islands of Fuvah Mulaku and Kaafu Villingili. Critical to their financial viability is the cost of fuel and wages associated with providing a continuous supply where low average loads prevail. The positive aspects are that the more established administrations of STELCO, namely Gan, Hithadhoo, Kulhudhuffushi, Thinadhoo, and Thulusdhu all show an operating profit. Thulusdhu, which has the lowest turnover, is comparable in operating size to five of the outer islands experiencing operating losses, and is significantly smaller in operating size than four more that are showing an operating loss. This would suggest that with improved administrative efficiencies, more than half of the 13 loss-incurring outer island operations are capable of returning an operating profit.

### C. Economic Reevaluation

28. Estimates at appraisal for the Project's economic internal rate of return (EIRR) and financial internal rate of return (FIRR) were calculated, taking into account project investment costs, expected incremental increases in electricity sales, and associated operating costs. Incremental electricity sales were forecast, assuming an average load factor of 70 percent for the additional generation provided, system losses of 12 percent, and a continuation of historical load-growth trends.<sup>17</sup> The appraisal EIRR of 27.9 percent and FIRR of 17.4 percent were inelastic to variations in investment costs and incremental sales, but very sensitive to variations in annual fuel costs.<sup>18</sup> The removal of fuel taxes, which amounted to 70 percent of the financial fuel cost, were the main reason for the higher EIRR estimate. The EIRR and FIRR appraisal estimates are compared with the reestimates at project completion and for this PPAR in Table 3.

**Table 3: Overall Project EIRR and FIRR Estimates**  
(percent)

Item	Appraisal	PCR	PPAR
EIRR	27.9	24.7	20.3
FIRR	17.4	28.4	26.6

EIRR = economic internal rate of return, FIRR = financial internal rate of return,  
PCR = project completion report, PPAR = project performance audit report.

29. The PCR repeated the approach adopted at appraisal, taking into account the actual scheduling of investment costs, completion date, operating revenues, and fuel and other operating costs to FY1997. The PCR's higher FIRR of 28.4 percent reflects a decision to hold

<sup>17</sup> Demand for electricity had been growing at nearly 20 percent per annum, but was considered suppressed on account of the current restrictions on the use of appliances, and the frequency of outages. Under the Project, electricity sales were forecast to increase by 27 percent in 1993 with growth thereafter falling to 8 percent in 1996 and to around 5 percent after 2004.

<sup>18</sup> For example, a 10 percent increase in fuel costs without a corresponding increase in the electricity tariff reduced the appraisal FIRR from 17.4 percent to 6 percent.

fuel costs after 1996.<sup>19</sup> The slightly lower EIRR of 24.7 percent arises because of compensating assumptions involving the standard conversion factor and average revenue tariff.

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<sup>19</sup> At appraisal, fuel costs were projected to increase at 2 percent per annum in real terms.

30. The OEM's higher than appraisal FIRR is largely explained by lower fuel costs. The lower EIRR is explained by the lower tariff resulting from the removal of fuel taxes.

31. The FIRR of 26.6 percent, which is higher than the weighted average cost of capital, confirms the financial viability of the Project.<sup>20</sup> The EIRR is a highly satisfactory 20.3 percent and confirms the economic viability of the Project. Both results are insensitive to changes in the underlying projection assumptions and fuel prices. If for example, fuel prices were to increase by 40 percent for 2001 and thereafter to hold constant in real terms, the EIRR would fall from 20.3 percent to 18.5 percent. Appendix 5 provides details of the methodology, assumptions, sensitivity, and workings underlying the FIRR and EIRR reestimates.

#### **D. Sustainability**

32. From a technical perspective, the Project consists of two distinct components, one comprising the two diesel generating sets and the other comprising the distribution equipment. Both components are in good condition and well maintained. Operational sustainability of the generating sets is dependent on protection from overloading and preventive maintenance, while that of the distribution equipment is dependent on routine maintenance, regular monitoring, and system protection devices. Both of these maintenance concerns are sufficiently taken care of by STELCO. Staff commitment to maintenance is at present, high, particularly for the generating sets. Shortage of trained personnel and/or lack of adequate spare parts would adversely affect the sustainability of maintenance.

33. With the additional availability of power from the rehabilitated generating sets, further expansion of generating capacity does not become essential until 2001. ADB Loan 1532-MLD(SF) provides for the supply and installation of two additional 6,000 kVA generators, and these are expected to be commissioned in 2001. This additional generating capacity will ensure that consumer demand for electricity does not overload the Project's generators, thereby avoiding unnecessary system losses, outages, and distribution voltage irregularities. The additional capacity will easily meet the projected increase in consumer demand, and the physical benefits of the Project are, therefore, considered sustainable.

34. The financial and economic viability of the Project is robust and relatively insensitive to adverse increases in fuel and other operating costs without any compensating increase in electricity tariffs. For example, a 20 percent increase in overall operating costs from 2001 would decrease the FIRR from 26.6 percent to 26 percent. Overall, the Project's financial and economic benefits are considered sustainable.

### **IV. ACHIEVEMENT OF OTHER DEVELOPMENT IMPACTS**

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<sup>20</sup> The weighted average real cost of capital is about 11 percent.

## A. Socioeconomic Impact

35. The absence of a socioeconomic baseline survey at appraisal or during implementation makes it difficult to comprehensively assess the socioeconomic impact of the Project. All the project loan components were for expansion and rehabilitation of the power system on Malé, the resident area for 70,000 of the Maldives total population of 280,000. The remainder of the Maldives population is scattered over approximately 200 islands with the next largest population group comprising less than 3,000 persons. Except for two islands near to Malé, the only practical method of supplying electricity to the other islands is by way of independent systems. Electricity is available on most islands: STELCO supplies Malé and 18 outer islands, and private generating sets provide the rest of electricity supplied.

36. At the time of appraisal, STELCO was unable to meet load growth requirements on Malé, and it was necessary to impose limitations on consumer usage. This took the form of restrictions on the use of appliances during peak hours, but suppressed demand was also a factor associated with incomplete distribution coverage. With the commissioning of the Project, voltage reliability was restored, the need for electricity restrictions and blackouts was eliminated, and an additional 6,000 kVA was made available for distribution extension to 3,000 new resident connections of a total 12,750 so that all forms of suppressed demand were eliminated.<sup>21</sup> Existing users reported improved voltage, fewer breakdowns or blackouts, and no restrictions on the use of appliances. New users invariably identified the advantages of obtaining electricity supplied from STELCO as improving the environment in which people lived and expanding the possibilities of commercial activities.

37. The socioeconomic benefits specific to the Project included improved working conditions at STELCO for staff, employment creation, and increased opportunities for higher paid employment.<sup>22</sup> Coinciding with the augmentation in generation capacity and growth in electricity demand, Maldives gross domestic product increased from Rf1.69 billion in 1991 to Rf4.3 billion in 1998, and gross domestic product per capita more than doubled from Rf7,553 to Rf16,203 reflecting an average growth of 11.5 percent per annum or 3.8 percent in real terms. Indirectly, the Project helped sustain tourism and investment flows to the Maldives.

38. The Project was gender neutral, yielding no particular social or economic benefit to women through its implementation.<sup>23</sup>

## B. Environmental Impact

39. No adverse environmental impacts are evident. Mitigation of potential detrimental impacts to a nearby school and residential area, which are associated with exhaust emissions and noise from the Project's generators were made a specific task of the implementation consultants. As a result, changes were made to the exhaust stack height of both generators,

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<sup>21</sup> In addition to the new resident connections, new business connections were also made.

<sup>22</sup> Significant in this regard are the increased opportunities though small, in technological construction, electrical engineering, supply management skills, and maintenance services. The number of trained electrical engineers at STELCO was increased from two to six. The Project's distribution expansion also provided for increased business trade in electrical appliances and lighting.

<sup>23</sup> Government institutions in the Maldives, including those directly concerned with the Project, employ a relatively high proportion of women, including women in senior positions, who were involved in administration of the Project.

and additional sound insulation installed in the powerhouse to limit the noise at an opposite school boundary to 60 decibels.<sup>24</sup> The decision to replace all overhead distribution cabling with underground cabling enhanced safety, significantly improved the aesthetics, and reduced the scope for illegal connections.

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<sup>24</sup> This decibel level is typical of requirements in the United States for urban residential areas.

### C. Impact on Institutions and Policy

40. The Project's attached TA for institutional strengthening<sup>25</sup> was for (i) upgrading STELCO's computer-based accounting and operational management systems, including inventory and asset management controls, payroll procedures, personnel management, staff training, and further development of management information systems for integrating billing and operational indicators; (ii) advising on introducing legislation for a regulatory framework, including making recommendations for amendments to STELCO's Charter; and (iii) rationalizing STELCO's tariff structure for the supply of electricity to outer islands with special regard to introducing an automatic fuel-price adjustment clause.

41. The OEM held discussions with STELCO in relation to the effectiveness of ADB's TA, the appropriateness of the recommendations in the consultant's TA final report (submitted in May 1994), and the measures adopted to strengthen STELCO's institutional capacity. STELCO advised that although design and conduct of the study were appropriate, actual progress toward strengthening the operations of STELCO was very limited. However, on further discussion, it was established that STELCO's assessment had been made in reference to different consultants. No one could confidently vouch for the effectiveness of the TA's implementation, apart from three executives who had participated in the external training program. OEM interpreted this as an indicator of the limited effectiveness of the TA, and made the evaluation in the consultant's report and performance of STELCO's accounting and administrative systems (which were the main focus of TA strengthening) the principal basis for assessing effectiveness.

42. The consultant's TA report systematically addresses the specific tasks required under the TA terms of reference, and with comparisons with what was achieved and the status at appraisal. The details suggest that the consultants implemented each task in accord with the TA's terms of reference. Improvements for consolidating accounting and administrative systems and in providing recommendations for a regulatory framework and tariff restructuring are identified. Deficiencies in completeness or effectiveness are also identified. These include deficiencies in the systems introduced for asset management, personnel management, billing, and development of a program for encouraging private sector involvement in the electrification of the outer islands. The effectiveness of corporate training in Malé, although deemed overall a success, was also judged to be constrained by the irregular attendance of course participants. The external training programs for 26 participants to visit the Lanka Electric Company in Sri Lanka was favorably reported, and their usefulness reconfirmed from OEM's interviews with three of the participants. OEM's overall assessment is that there remain significant weaknesses in STELCO's computer-based accounting and management systems. As these systems are the prime focus for TA institutional strengthening, this suggests that the inputs at TA implementation were either insufficient or not sufficiently sustainable to be judged successful.<sup>26</sup> The TA is, therefore, assessed less than successful.

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<sup>25</sup> Previous ADB support for institutional strengthening (footnote 1) provided for the introduction of new accounting and administrative systems and was completed in mid-1990. STELCO was unable to benefit fully from these systems because of shortages in skilled accounting staff.

<sup>26</sup> **STELCO's management systems remain dependent on further improvements to computer operational capabilities, training, and enhancement of staff working incentives.**

## V. OVERALL ASSESSMENT

### A. Relevance

43. The Project's rationale to expand generation capacity, reduce technical losses, and improve reliability was sound and premised on the need to meet economic growth consistent with optimal efficiency and least-cost development. Without the Project, STELCO's generating capacity would have been insufficient and would have led to extensive overloading, a rise in system losses, increased operating costs, and further consumer restrictions and load shedding. Without the benefit of TA for institutional strengthening of STELCO, STELCO's operating viability would have been significantly weaker and this would have resulted in an inferior quality of service.

### B. Efficacy

44. Actual achievements under the Project were as envisaged at appraisal except for the delay to completion, lack of improvement in system losses, and limited effectiveness of the TA for institutional strengthening at STELCO (para. 47). The seriousness of the overall 23-month delay to completion was offset by the less than expected increase in load demand and earlier rehabilitation of an existing 1,000 kVA generator. The Project increased total generating capacity in Malé by some 7,940 kW, which enabled STELCO to meet forecast system peak demands, and greatly reduce generation from less efficient and obsolete plant located at the old powerhouse. STELCO's financial performance also exceeded appraisal projections,<sup>27</sup> and the enterprise improved from incurring losses to making a profit despite a significant expansion of operations to the outer islands.<sup>28</sup> The overseas training program for 26 participants in Sri Lanka provided direct exposure to an equivalent organization where concepts and methods were being practiced, and were of considerable help. Detracting from these accomplishments, the envisaged targets for containing system losses were not achieved, and the anticipated strengthening of STELCO's computer-based accounting and operational management systems which was the main focus of the TA did not materialize or was unsustainable.

### C. Efficiency

45. Operational efficiency proved satisfactory and in line with appraisal targets. Maintenance of the project generators and new powerhouse systems is of a high order and is accompanied by a strong commitment from staff. The project reestimates of 26.6 percent FIRR and 20.3 percent EIRR, which take into account the impact of completion delays and system losses, attest to the overall efficiency of operations and confirm the viability of the Project.

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<sup>27</sup> Including performance measured against ADB's financial loan covenants.

<sup>28</sup> At appraisal, STELCO supplied electricity to five outer islands. As of end 1998, STELCO supplied electricity to 18 islands, and each had an independent supply system. Twelve of the island operations were running at a financial loss. Recent fuel-cost increases are likely to exacerbate their financial situation.

## D. Sustainability

46. The quality of civil works remains sound and should long outlast the projected economic life of 2021. The project generator sets are well maintained and kept in serviced order. The FIRR and EIRR reestimates take into account the need for periodic overhaul and future generating expansion to avoid overloading and early deterioration. The distribution equipment is properly housed and all cabling conduits protected and laid underground. Connection of the project capacitors is expected to reduce system losses up to 5 percent but is not accounted for in the FIRR and EIRR reestimates. Institutional strengthening benefits require reinforcement and a renewed focus to improve management practices. Progress on ADB's Third Power System Development Project will ensure that the growth in electricity demand does not lead to overloading and that the physical benefits of the Project are sustained. Weaknesses in the mechanism and timeliness of the approval process for adjusting electricity tariffs in response to (i) the higher cost burden of electricity development on the outer islands, and (ii) increases in fuel costs and inflation, will lower the projected net financial benefits from the Project in the absence of compensating adjustments to the tariff or lower taxes on fuel.

## E. Institutional Development and Other Impacts

47. The Project enhanced local capability in civil works construction, opened opportunities for improving accounting, computer, and managerial skill levels, and achieved its socioeconomic aims of making unrestricted power available to consumers on Malé. The increased availability and reliability of electricity supply is considered to have enhanced Malé as a business center and destination for tourism.

## F. Overall Project Rating

48. The overall project rating is successful. Detracting from a higher assessment are (i) the delays in completion, (ii) efficacy deficiencies relating to the achievement of system-loss targets, (iii) weaknesses in institutional-strengthening achievements relating to STELCO's computer-based accounting and operational management systems, and (iv) STELCO's failure to fully follow through on commitments relating to electricity tariff adjustments with variations in fuel costs. Table 4 summarizes the project assessment.

**Table 4: Assessment of Overall Project Performance**

Criterion	Assessment	Rating (0-3)	Weight (%)	Weighted Rating
1. Relevance	Highly Relevant	3	20	0.60
2. Efficacy	Efficacious	2	25	0.50
3. Efficiency	Efficient	2	20	0.40
4. Sustainability	Likely	2	20	0.40
5. Institutional Development and Other Impacts	Little	1	15	0.15

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<b>Overall Rating</b>	<b>S</b>	<b>2</b>	<b>100</b>	<b>2.05</b>
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Assessment Ratings:

Relevance: 3 = highly relevant; 2 = relevant; 1 = partly relevant; 0 = irrelevant.

Efficacy: 3 = highly efficacious; 2 = efficacious; 1 = less efficacious; 0 = inefficacious.

Efficiency: 3 = highly efficient; 2 = efficient; 1 = less efficient; 0 = inefficient.

Sustainability: 3 = most likely; 2 = likely; 1 = less likely; 0 = unlikely.

Institutional Development and Other Impacts: 3 = substantial; 2 = moderate; 1 = little; 0 = negligible.

Overall Rating:

HS = highly successful  $2.5 < HS \leq 3.0$

S = successful  $1.6 \leq S \leq 2.5$

LS = less than successful  $0.6 \leq LS < 1.6$

U = unsuccessful  $< 0.6$

## **G. Assessment of ADB and Borrower Performance**

49. ADB's performance is assessed as satisfactory, based on ADB's involvement in the overall project design and implementation elements. These include (i) ensuring that the Project was technically feasible, and that project design was consistent with least-cost development considerations; (ii) overseeing general effectiveness of implementation and loan administration relating to procurement and contracting in accord with competitive bidding procedures and appropriate supervision; and (iii) close monitoring through timely review missions. Detracting from the assessment result are (i) weaknesses in the TA design, (ii) the practical ineffectiveness of ADB's support for strengthening STELCO's computer-based accounting and operational management systems, and (iii) failure to ensure that the intended distribution analysis software was delivered (and training given).

50. The Borrower's performance is assessed as satisfactory. Detracting from a higher assessment rating are (i) weaknesses in institutional-strengthening achievements relating to STELCO's accounting and operational management systems, which are without a shared commitment from the Borrower to ensure they are made effective; (ii) failure to fully follow through on commitments relating to electricity tariff adjustments with variations in fuel costs; and (iii) failure to ensure that the intended capacitors were installed.

## **VI. ISSUES, LESSONS, AND FOLLOW-UP ACTIONS**

### **A. Key Issues for the Future**

51. There are no key issues for the future identified by the OEM.

### **B. Lessons Identified**

52. The lessons identified in the Project are (i) in project designs for improving distribution efficiency, distribution analysis software should be provided together with training in its application (para. 8); (ii) in project design, more rigorous technical audit procedures should be included so as to ensure that intended project items (distribution analysis software and capacitors in this instance) are fully operational (paras. 8 and 23); (iii) stronger contractual terms should be used covering supervisory responsibilities and work performance on subcontract arrangements so as to reduce the potential for contractual disputes and implementation delays (para. 15); and (iv) in the interests of maintaining technical operating efficiency, the tasks of identifying and redesigning the system network to minimize distribution losses should be treated as a full-time operating function within the institutional structure .

### C. Follow-Up Actions

53. The following follow-up measures (Table 5) are recommended for ADB, Government, and STELCO to reflect the weaknesses in project design and lessons identified.

**Table 5: Recommendations for ADB, Government, and STELCO Follow-Up**

Follow-Up Actions	Unit Responsible		Timing
	Action	Monitoring	
<b>1. For ADB</b>			
(i) Should ensure in all power project designs that provide distribution monitoring equipment that there is also a sufficiency of training provided	IED/IWD	OEO/PED/PWD	All future power projects
(ii) Should adopt more rigorous technical audit procedures for checking power project equipment is fully operational before commissioning	IED/IWD	OEO/PED/PWD	All future power projects
<b>2. For Government</b>			
(i) Should take steps to ensure stronger contractual terms are introduced on future infrastructure projects covering supervisory and subcontracting responsibilities so as to reduce the potential for contractual disputes and project implementation delays	MOFT	MOFT	As soon as possible
(ii) Should act to ensure all capacitors provided under the Project are connected and operational	MOFT/ STELCO	MOFT	Immediate
<b>3. For STELCO</b>			
(i) Should include in its corporate plan provision for staff training and familiarization with its computer-based accounting and operational management systems	STELCO	MOFT	Next corporate plan
(ii) Take steps to utilize the software systems provided under the Project and introduce the task of monitoring and identifying distribution losses as part of a full-time operating function for redesigning and upgrading the system network	STELCO	MOFT	As soon as possible

IED = Infrastructure, Energy, and Financial Sectors Department (East); IWD = Infrastructure, Energy, and Financial Sectors Department (West); MOFT = Ministry of Finance and Treasury; OEO = Operations Evaluation Office; PED = Programs Department (East); PWD = Programs Department (West); STELCO = State Electric Company.

**APPENDIXES**

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<b>Number</b>	<b>Title</b>	<b>Page</b>	<b>Cited on (page, para.)</b>
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## OBJECTIVES, TARGETS, RESULTS, AND ECONOMIC IMPACT<sup>a</sup>

Objectives	Targets	Results	Economic Impact
<b>Project</b>			
To augment power generating capacity and improve electricity distribution in Malé.	Supply and installation of (i) 1 x 2,700 kVA generator, (ii) 1 x 6,000 kVA generator, (iii) 19 x 315 kVA substations, (iv) 20 kVAR capacitor banks, (v) 10,000 meters of 11 kV cabling conductor, (vi) auxiliary switchgear, and (vii) distribution software for system analysis, computers, and office equipment.	All equipment items were supplied and installed.  (The distribution software is not being used.)	Generation capacity was increased as targeted.  The distribution network was expanded with approximately 6,000 kVA of generation.
<b>Operations</b>			
To enhance the quality of supply.	Eliminate restrictions on consumption.	Achieved.	Eliminated consumer inconvenience and need for backup generation. Eliminated the cost of blackouts and unreliable distribution voltages.
To improve operational efficiency.	Reduce distribution technical losses to achieve a sustained overall system loss of 12 percent or less.	Not achieved. System losses reduced marginally from 13.6 percent to 12.5 percent in 1994 and 1995, reduced to 10.7 percent in 1996 and then increased to 14.6 percent in 1997.	Negligible.
To meet the anticipated demand for electricity in Malé until 1997.	Meet projected electricity sales of 53,395 kWh in 1995 and 62,532 kWh in 1996.	Achieved. Actual demand was less than forecast.	Enabled existing plant to be serviced and some obsolete and less efficient plant to be retired.
To strengthen the institutional effectiveness of STELCO.	Develop further STELCO's computer-based accounting, financial, billing, and management systems.	Not achieved or improvements only marginal.	Negligible.
	Improve long-term planning capability.	Achieved.	STELCO extended operations to 14 outer islands.
	Develop a scheme to encourage private sector participation in development of outer island electrification.	Not achieved.	Outer islands without STELCO electricity remain supply constrained, except those under private resource management.

Objectives	Targets	Results	Economic Impact
kV = kilovolt, kVA = kilovolt-ampere, kVAR = kilovolt-ampere reactance, kWh = kilowatt-hour, STELCO = State Electric Company. <sup>a</sup> Although some similarity in format exists, this comparison is not intended to represent a logical framework. A logical framework was not prepared for this Project at appraisal.			
<b>Operations (Cont'd)</b>	Staff training in supervisory management, accounting, computer applications, systems management, budgeting, and billing procedures.	Overseas training for 26 participants was effective.	Enhanced social motivation to see principles in operation. Raised staff productivity and helped achieve corporate goals.
		Local training for staff was less than effective.	Expected productivity improvements not realized.
	Tariff study.	Achieved. Results used to adjust Malé and outer island tariffs in 1996.	Enhanced the financial and economic viability of STELCO and shifted the onus of paying for the cost of electricity to the consumer.
	Developing recommendations for legal and regulatory controls for electrical systems and appliances.	Recommendations were developed and accepted but are still to be made effective.	Negligible. Recommendations still to be adopted.
Project viability/efficiency	EIRR = 27.9 percent. FIRR = 17.4 percent.	EIRR = 20.3 percent. FIRR = 26.6 percent.	Project is economically viable.
<b>Inputs</b>			
Project cost	\$10.3 million	\$10.5 million	Least-cost development.
Project funding			
– ADB	\$9.2 million	\$8.7 million	Met foreign capital constraints.
– Government	\$1.1 million	\$1.8 million	Participatory commitment.
Consulting services	35 person-months	35 person-months	Provided knowledge transfer. Ensured implementation was sound and followed best practices.
– Implementation			
Technical assistance	15 person-months	3.5 person-months	Stronger management skills helped decisions on tariffs leading to enhanced viability of STELCO.
– Institutional strengthening			

ADB = Asian Development Bank, EIRR = economic internal rate of return, FIRR = financial internal rate of return.

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**Objectives****Targets****Results****Economic Impact**

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Source: Operations Evaluation Mission.

## TECHNICAL PERFORMANCE

### A. Increase in Generating Capacity

1. The additional generating capacity provided by the project generators was to enable the State Electric Company (STELCO) to meet a forecast demand of 15,000 kilovolt-amperes (kVA) for electric power through 1997 without reliance on the existing capacity installed in the old powerhouse (OPH). The generating plant at the OPH was planned to be retired and/or transferred, thereby removing a source of noise and particulate pollution in the city center.
2. The project design was well conceived and based upon a least-cost method<sup>1</sup> of providing additional generation and distribution system improvements for Malé. Selection and installation of a 2,700 kVA generator and a second 6,000 kVA generator were made on the basis of the forecasts for demand available at the time of project appraisal.
3. Changes in design during project implementation included an increase in exhaust stack height and the addition of sound proofing to the new powerhouse (NPH). These changes were due to the building of a school facility near the NPH resulting in a need to provide for lower sound and more dispersed exhaust emissions. The changes in design were minor but their impact significant, and their likely necessity anticipated at appraisal.
4. The Project resulted in the addition of 7,940 kilowatts (kW) of generating capacity to the Malé electrical system. In addition, distribution system improvements totaling about 6,000 kVA of substation capacity, 2,000 kilovolt-ampere reactance (kVAR) of capacitors, and nearly 10,000 kilometers of 11-kilovolt (kV) distribution cable were provided.
5. At the time of the Operations Evaluation Mission (OEM), operations at the OPH had been reduced to 4,091,598 kilowatt-hours (kWh) compared to 71,584,913 kWh generation from the NPH (data relate to 1999). Existing generators at the OPH had either been retired, were being serviced, or were available on standby.
6. Operational performance of the two generating sets provided by the Project has been very satisfactory. There have been no major outages of either unit as of March 2000 which represents over six years of operation since completion for the 2,700 kVA unit and three and a half years for the 6,000 kVA unit. As of 22 March 2000, the 2,700 kVA unit (unit 4 in NPH) indicated 34,084.54 hours of operation, and the 6,000 kVA unit (unit 5 in NPH) indicated 27,640.88 hours of operation. These are equivalent to online availability of 65 and 79 percent respectively, and compare well to performance of similar units in developed countries.
7. A further indicator of the impact of the additional generating capacity is that the total 1999 output of the two project generating sets amounted to about 37.4 gigawatt-hours, which is about 49.6 percent of the Malé system's total generation for that year. This proportion would have been even higher had it not been for the addition of a 5,400 kVA generator in the unit 1 position in 1998. This newer unit has exhibited higher values of generated power per liter of fuel than unit 4 (approximately 4 kWh/liter versus 3.66 kWh/liter) and, therefore, has been assigned a higher priority for generation on a merit basis. Unit 5 has consistently shown a high efficiency in fuel use (4.04 kWh/liter) and has become the base load unit when available.
8. The maintenance of the two project units by STELCO appears to be of high quality and consistent with the recommendations of the manufacturer. A review of available records at the NPH indicates that recommended oil changes, injector cleaning, and turbo unit preventive maintenance

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<sup>1</sup> Generator capacity, timing of installation, and system improvements were determined under TA 1338-MLD.

have been performed in a timely manner. The general housekeeping in and around the NPH is exemplary.

9. The maintenance capability of STELCO staff is limited by lack of a workshop area, limited welding capability, and a lack of machine tools for fabrication or repair of parts. These deficiencies could be overcome by the development in Malé of private sector facilities and services or by direct employment, combined with the provision of tools and workspace during the installation of the new switchgear house under the Asian Development Bank's Third Power System Development Project.

## **B. Distribution, Rehabilitation, and Extension**

10. The distribution equipment included in the Project was to expand the service of the Malé system, improve reliability, and reduce distribution losses by approximately 4-5 percent. The detailed design of the distribution system improvements is not well documented but the conceptual design is a logical approach to providing the distribution capacity necessary for the additional generating capacity and loads. Particularly relevant was the aim to reduce system losses by voltage increases in feeder cables and the addition of capacitors for power-factor correction. Additional system-loss savings were to be derived from the conversion of the remaining overhead circuits to underground ones.

11. The expected impact of the provision of distribution equipment included in the Project was twofold: to provide system capacity to distribute the additional loads, and to reduce system losses by a multifaceted approach (para. 12). The first was achieved as the Project provided substations and cabling sufficient to distribute approximately an additional 6,000 kVA in the Malé system. The specific impact of this was that some 3,000 new connections were made, overhead circuits were replaced with underground circuits, overloaded circuits were relieved, and restrictions on usage were relaxed. In this, the actual impact reflected the expected impact well.

## **C. System Losses**

12. A reduction in distribution system losses was to be accomplished under the Project by eliminating the losses associated with the operation of the OPH; reducing the incremental losses of overloaded substations and cables by the addition of new ones; replacing all 3.3 kV feeder cables with 11 kV cables;<sup>2</sup> and by adding capacitors at the substations for power-factor correction.<sup>3</sup> The actual impact on overall system losses was not what was expected. Reported Malé system losses for 1994-1999 increased from 12.6 percent to 14.3 percent, albeit with a single-year decline to 10.7 percent in 1996. It is very doubtful that the system improvements under the Project have had a significant effect on losses as the major loss reduction features were not implemented (para. 14).

13. Several conditions combined to defeat what was a sound plan to lower technical losses. The additional substations provided by the Project unquestionably contributed to savings in losses and added distribution capacity. However, the benefits were not fully exploited. As of the OEM, the total substation capacity of the Malé system was 27,745 kVA in 68 installations of which only three were not yet in service. Based upon the 12,300 kW (14,470 kVA) 1999 system peak, the installed capacity is equal to about 190 percent of system peak load. However, 15 of the substations were measured with a more than 75 percent loading at times other than during system peak. Several of these heavily loaded substations are of 750 kVA and 630 kVA and represent the largest substations in the

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<sup>2</sup> Losses in cables are proportional to amperage levels to the second power. At constant load, amperage varies inversely to voltage. A conversion to 11 kV from 3.3 kV could reduce amperage to 30 percent of initial values and losses to about 9 percent of original values.

<sup>3</sup> Losses were also reduced by the conversion of the distribution feeders (underground cables) from 3.3 kV to 11 kV, by the removal of the station transformer losses upon partial retirement of the OPH, and by the provision of additional transformers to decrease the excessive loading on those units already in service.

Malé system. Loading above 75 percent of rated load on a transformer produces excessive losses. These substations should have their connected loads rearranged to reduce their loading. Also, measured neutral currents are high on many of the substations indicating that poor phase current balance is present.<sup>4</sup> Several percent of the system losses are probably attributable to these phase imbalances, which can be corrected by a concerted effort to reconnect consumers so that the single-phase loads are more evenly spread across the three phases of the substation serving the respective consumers.

14. The capacitors supplied under the Project for power factor correction were installed in the substations as planned but were not actually connected to the system. The connection of 2,000 kVAR of these capacitors would have potentially reduced the losses in the 11 kV feeder cables and 11 kV-230/400 volt substations by some 17 percent, which translates to a 5 percent reduction in total system losses forgone.

15. The delays in the Project combined with a strict adherence to the concept of "firm capacity" and its associated reserve margin requirements<sup>5</sup> required the continued operation of the OPH with its 4,000 kVA of capacity as a reserve. This was also premised on the expected or forecast system peak demands, which exceeded the 11,475 kVA (9,750 kW) firm capacity of the NPH from 1996 or 1997. Thus, the expected decline in losses due to lower transformer losses in the OPH was not totally realized. These losses originate as the older units (except for unit 13, rated 800 kW) in the OPH generate power at 400 volts and must have their output transformed to 3.3 kV or 11 kV for distribution. These transformation losses can be as much as 1.6-2 percent. However, as the operation of the OPH was greatly reduced by the Project, and the bulk of the power generated at the OPH is produced by the 11 kV unit 13, a high percentage of the expected loss reduction due to decommissioning the OPH will have been realized. A reasonable estimate is that about 1.5 percent of additional system losses were avoided.

16. A reduction in distribution system losses requires that a theoretical base level of loss be established by computer simulation of the system with distribution analysis software. This software is also vital for the proper planning of distribution circuits and systems. The Project had included the supply of such software for the specific purpose of establishing such capability in STELCO.<sup>6</sup> This software could not be located nor could STELCO staff who were involved in the Project recall that it was ever provided. The lack of such software, assuming that the STELCO staff would have become proficient in its use, has resulted in STELCO continuing to rely on consultants from other projects to provide load-flow and other types of analysis of the system. These results become outdated quickly in a system evolving as Malé's has. As the Asian Development Bank is currently involved in other power sector loans in Malé and in STELCO, this type of software should be included as part of the scope of supply in ongoing or subsequent loans.

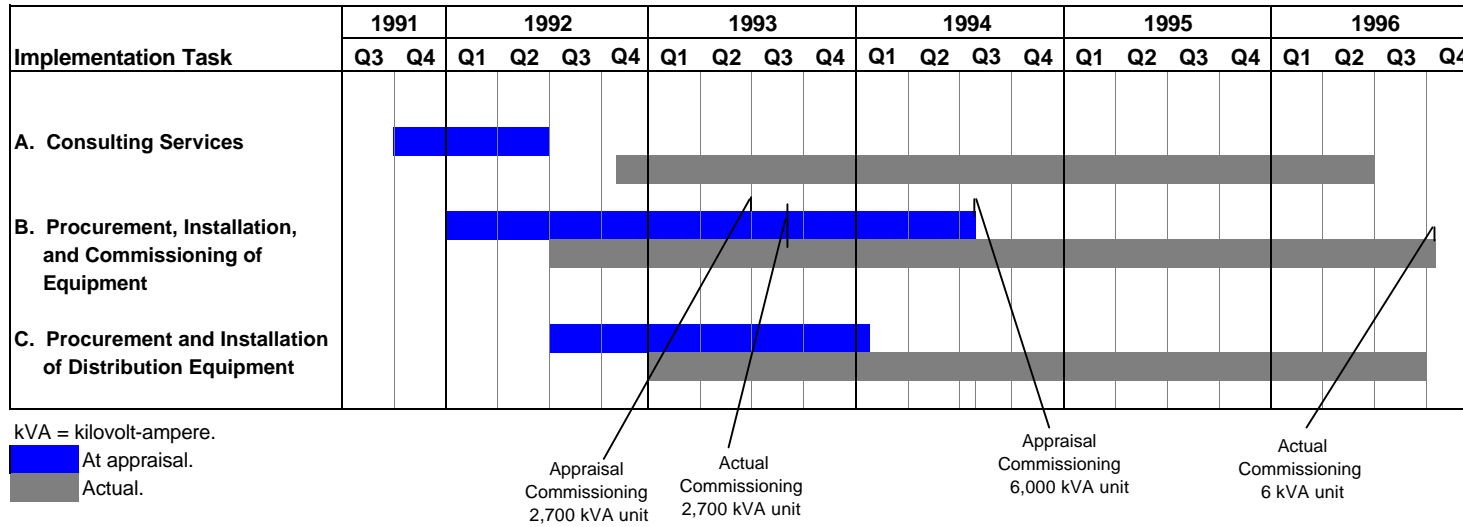
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<sup>4</sup> An imbalance in the loading of the three phases creates high levels of neutral currents with corresponding losses in the neutral conductor and increases in transformer losses.

<sup>5</sup> "Firm capacity" for diesel generation has been defined as 85 percent of the remaining capacity of the system after the loss of the largest capacity unit. For the NPH, installed capacity is 20,612 kVA and firm capacity is 11,475 kVA, as the largest unit is rated 7,112 kVA (unit 5).

<sup>6</sup> The Project's provision of distribution analysis software was a particularly relevant, albeit very small, addition to the scope of the Project. Such software can allow STELCO personnel to determine the theoretical technical losses of the distribution system as a base from which to determine the actual cause of system losses.

### APPRAISAL AND ACTUAL IMPLEMENTATION SCHEDULES



**FINANCIAL STATEMENTS: STELCO**  
**Table A4.1: Summary Income Statement, 1998**  
(Rf million)

Item	Malé	S, Gan	Ku, Fushi	Thinadu	Favilaku	Hanimdu	Thulusdu	Gadho	Didho	Naifaru	Eydafushi	Ga, Villy	K, Villy	Hulufaru	Hitadu	Maafushi	H'Meedu	Velidhoo	Guraidhoo	Total
<b>Turnover</b>	<b>184.93</b>	<b>9.17</b>	<b>3.81</b>	<b>2.58</b>	<b>4.86</b>	<b>0.41</b>	<b>1.27</b>	<b>0.99</b>	<b>1.50</b>	<b>2.46</b>	<b>1.33</b>	<b>1.48</b>	<b>2.81</b>	<b>0.28</b>	<b>7.08</b>	<b>1.77</b>	<b>1.90</b>	<b>1.13</b>	<b>0.62</b>	<b>230.37</b>
Cost of Fuel and Oil	48.27	3.52	1.59	1.06	1.24	0.20	0.41	0.81	0.73	1.11	0.48	0.46	0.99	0.30	2.44	0.68	0.69	0.42	0.15	<b>65.54</b>
Cost of Spares	(4.74)	1.00	0.03	(0.58)	(0.30)	0.17	0.03	(0.77)	(0.33)	0.22	(0.09)	(0.19)	0.01	0.29	1.89	0.17	0.13	0.54	0.46	<b>(2.09)</b>
Salaries and Wages	7.72	1.06	0.42	0.35	0.42	0.23	0.27	0.24	0.26	0.44	0.33	0.23	0.35	0.22	0.61	0.18	0.32	0.48	0.06	<b>14.17</b>
Repairs and Maintenance	0.74	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	(0.00)	0.02	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	<b>0.84</b>
Transmission and Distribution Expenses	7.66	0.17	0.39	0.07	0.05	0.03	0.08	0.11	0.03	0.07	0.25	0.01	0.04	0.00	0.56	0.02	0.05	0.00	0.28	<b>9.87</b>
Desalination Expenses	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.01</b>
Customer Service Expenses	5.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.76	0.00	0.00	0.00	0.00	<b>6.03</b>
Other Direct Expenses	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.02	0.00	0.00	0.00	0.00	0.05	0.00	<b>0.21</b>
	<b>64.92</b>	<b>5.76</b>	<b>2.44</b>	<b>0.91</b>	<b>1.42</b>	<b>0.63</b>	<b>0.79</b>	<b>0.38</b>	<b>0.69</b>	<b>1.83</b>	<b>1.01</b>	<b>0.52</b>	<b>1.47</b>	<b>0.85</b>	<b>6.27</b>	<b>1.05</b>	<b>1.21</b>	<b>1.50</b>	<b>0.94</b>	<b>94.58</b>
<b>Gross Operating Income</b>	<b>120.00</b>	<b>3.41</b>	<b>1.36</b>	<b>1.68</b>	<b>3.44</b>	<b>(0.21)</b>	<b>0.48</b>	<b>0.61</b>	<b>0.81</b>	<b>0.63</b>	<b>0.32</b>	<b>0.96</b>	<b>1.33</b>	<b>(0.57)</b>	<b>0.82</b>	<b>0.72</b>	<b>0.69</b>	<b>(0.37)</b>	<b>(0.32)</b>	<b>135.79</b>
<b>Less: Administration Expenses</b>																				
Printing and Stationery	0.57	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.03	0.02	0.01	0.06	0.00	<b>0.85</b>
Transport Charges	0.04	0.03	0.24	0.02	0.03	0.03	0.01	0.00	0.04	0.01	0.02	0.01	0.06	0.05	0.11	0.05	0.05	0.17	0.03	<b>1.00</b>
Traveling	0.06	0.11	0.07	0.02	0.03	0.01	0.02	0.02	0.03	0.02	0.04	0.02	0.16	0.03	0.03	0.01	0.03	0.15	0.01	<b>0.89</b>
Vehicle Running Expenses	0.20	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.01	0.00	<b>0.25</b>
Telephone and Fax	0.40	0.07	0.00	0.08	0.03	0.00	0.03	0.03	0.00	0.06	0.05	0.02	0.02	0.00	0.07	0.04	0.01	0.00	0.04	<b>0.96</b>
Postage	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.32</b>
Rent and Rates	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	<b>0.08</b>
Insurance	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.14</b>
Staff Welfare	0.45	0.04	0.02	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.01	0.01	0.01	0.00	<b>0.63</b>
Recreation Expenses	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.19</b>
Incentive Payments	0.66	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	(0.00)	0.01	0.00	0.01	0.01	0.01	0.00	0.00	<b>0.73</b>
Allowances	4.50	0.63	0.31	0.23	0.24	0.17	0.20	0.15	0.18	0.20	0.20	0.14	0.26	0.15	0.40	0.11	0.17	0.04	0.05	<b>8.33</b>
Entertainment	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.08</b>
Scholarships Expenses	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>1.67</b>
Training and Development	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.41</b>
Consultation Fee	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.00</b>
Celebration Expenses	2.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.00	<b>2.35</b>
Repairs and Maintenance	1.57	0.05	0.09	0.12	0.10	0.07	0.07	0.03	0.09	0.08	0.11	0.10	0.05	0.06	0.09	0.05	0.01	0.02	0.02	<b>2.75</b>
Hiring Charges	0.24	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.07	0.01	0.01	0.04	0.00	0.01	0.01	<b>0.45</b>
Advertising	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(0.00)	<b>0.07</b>
Provision For Bad Debts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.00</b>
Audit Fees	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.03</b>
Bank Charges	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.04</b>
Other Expenses	0.14	0.05	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.13	0.00	0.02	0.00	0.00	<b>0.46</b>
Depreciation	29.03	1.40	0.44	0.28	0.61	0.14	0.07	0.59	0.64	1.91	1.31	0.79	0.13	0.03	0.40	0.41	2.89	0.00	0.00	<b>41.06</b>
	<b>43.05</b>	<b>2.45</b>	<b>1.28</b>	<b>0.81</b>	<b>1.11</b>	<b>0.44</b>	<b>0.41</b>	<b>0.84</b>	<b>1.01</b>	<b>2.35</b>	<b>1.77</b>	<b>1.10</b>	<b>0.77</b>	<b>0.35</b>	<b>1.32</b>	<b>0.76</b>	<b>3.26</b>	<b>0.52</b>	<b>0.16</b>	<b>63.73</b>
<b>Net Operating Profit</b>	<b>76.95</b>	<b>0.96</b>	<b>0.08</b>	<b>0.87</b>	<b>2.33</b>	<b>(0.65)</b>	<b>0.08</b>	<b>(0.23)</b>	<b>(0.20)</b>	<b>(1.72)</b>	<b>(1.45)</b>	<b>(0.14)</b>	<b>0.56</b>	<b>(0.91)</b>	<b>(0.50)</b>	<b>(0.04)</b>	<b>(2.57)</b>	<b>(0.89)</b>	<b>(0.48)</b>	<b>72.05</b>

STELCO = State Electric Company.

**Table A4.2: Summary Income Statement, STELCO: Selected Years 1990-1998**  
(Rf million)

<b>Item</b>	<b>1990</b> (for appraisal)	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>Growth Rate</b> <b>Percent per Year</b>
<b>Total Revenue</b>	<b>51.50</b>	<b>154.47</b>	<b>171.23</b>	<b>196.35</b>	<b>230.89</b>	<b>20.6</b>
Operating Revenue	51.00	147.40	161.98	178.64	218.81	18.2
Operating Expenditure	43.29	86.55	107.28	75.18	83.02	8.5
<b>Gross Operating Profit</b>	<b>7.71</b>	<b>60.85</b>	<b>54.70</b>	<b>103.46</b>	<b>135.79</b>	<b>43.1</b>
Less:						
Finance Interest	2.62	4.91	19.24	16.49	18.10	27.3
Depreciation	4.27	5.76	5.53	35.65 <sup>a</sup>	55.57 <sup>b</sup>	57.0
<b>Year End Net Surplus</b>	<b>(0.28)</b>	<b>50.18</b>	<b>29.93</b>	<b>51.32</b>	<b>62.12</b>	
Prior Year Adjustment	0.00	0.00	0.00	(5.61)	28.72	
Transfer to Treasury	0.00	(8.00)	(8.00)	(12.00)	(8.00)	
<b>Surplus Carried Forward</b>	<b>(0.28)</b>	<b>42.18</b>	<b>21.93</b>	<b>33.71</b>	<b>82.84</b>	
<b>Performance Indicators (%)</b>						
Net Surplus/Total Revenue	(0.5)	32.5	17.5	26.1	26.9	

STELCO = State Electric Company.

<sup>a</sup> Includes adjustment for unreconciled debtors of Rf9.27 million.

<sup>b</sup> Includes grant of Rf28.72 million.

Source: Compiled from STELCO Summary of Audited Accounts.

## FINANCIAL AND ECONOMIC PERFORMANCE

### A. Methodology of Appraisal Report

1. The financial internal rate of return (FIRR) for the Project was calculated for the period 1992 to 2021, and in general accord with Asian Development Bank's guidelines. The approach was to calculate the interest rate for which the sum of the discounted incremental revenue benefits from the Project equaled the sum of the discounted investment plus incremental operating and fuel costs. All values were priced at constant 1991 prices, except fuel. Investment costs, inclusive of physical contingencies and taxes, were disbursed over three years to 1994. Operation and maintenance costs were based on a fixed amount (\$20 per kilovolt-ampere [kVA]) plus \$5,000 per gigawatt-hour for generating plant, and 1.5 percent of the capital cost of distribution plant. Fuel prices were calculated at the price to the State Electric Company inclusive of taxes. A specific fuel consumption of \$0.271 per kilowatt-hour (kWh) was assumed, and fuel prices were projected to increase at 2 percent per annum in real terms.<sup>1</sup> An average load factor of 70 percent was assumed for the available generation from the Project. System losses including own consumption were projected at a constant 12 percent, and an FIRR of 17.4 percent was obtained. The FIRR result was found to be robust and inelastic to variations in investment costs and incremental sales, but sensitive to variations in annual fuel costs. A 10 percent increase in fuel costs without a corresponding increase in the electricity tariff reduced the FIRR from 17.4 to 6 percent.

2. The economic internal rate of return (EIRR) of 27.9 percent was calculated by adjusting the cost and benefit streams of the FIRR calculation so as to correspond to economic revenues and costs. No adjustment for taxes and duties was necessary on imported plant and equipment, which was to be allowed in duty free. Fuel taxes of 45 percent were removed and a standard conversion factor of 0.6 applied to other costs and benefits.

### B. Approach and Methodology of PCR/PPAR

3. The project completion report (PCR)/project performance audit report (PPAR) followed the same approach as at appraisal. Differences apply concerning the actual scheduling of investment costs and commissioning, and in matters relating to the revaluation of investment costs at 1997 and 2000 prices, assumptions for and application of the standard conversion factor, projections for fuel costs, and imputed incremental sales volumes relating to the Project. These, with regard to the PCR estimates, are (i) an oversight in not revaluing investment costs from their nominal values, (ii) a large change in the standard conversion factor applied from 0.6 to 0.9, (iii) a decision to hold fuel and oil costs constant after 1996,<sup>2</sup> and (iv) calculation of incremental benefits based on system losses which are held constant after 1996 at their 1997 level of 12.6 percent. These factors, excluding (ii) which is not applicable to the FIRR calculation, explain the PCR's (larger than appraisal) FIRR result of 28.4 percent. They, together with the compensating inclusion of factor (ii), largely account for the slightly smaller EIRR (compared with appraisal) of 24.7 percent.

### C. Specific Assumptions

4. The PPAR estimates revalue investment costs at 2000 prices, using the World Bank's manufacturers' unit value index to revalue foreign expenditures, and use the Maldives gross

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<sup>1</sup> The fuel consumption of \$0.271/kWh included a 45 percent fuel tax.

<sup>2</sup> The appraisal calculations projected fuel prices to increase by 2 percent per annum in real terms.

domestic deflator to revalue local currency expenditures. Other specific assumptions used to calculate the FIRR/EIRR reestimates are as follows:

- (i) projections are up to 2021;
- (ii) all costs and benefits are valued in constant 2000 prices;
- (iii) incremental electricity sales are calculated total actual sales for Malé up to 1999 less imputed without project sales. After 1999, total actual sales are projected at 11 percent up to the maximum generating capacity less losses and own auxiliary use of the two project generators. This maximum occurs in 2002 and is thereafter held constant to 2021. Without-project sales are based on the firm generating capacity at the old powerhouse of 4,450 kVA plus 1,000 kVA of rehabilitated capacity in 1993 plus 2 x 2,700 kVA Wartsila generators installed at the new station less anticipated system losses. Losses are projected from 13 percent at appraisal to 17 percent in 1995 and kept constant thereafter;
- (iv) financial fuel prices are based on actuals up to 1998, thereafter adjusted to 2000 prices and projected at Rf3.87/kWh. Economic fuel prices are calculated less 45 percent for taxes;
- (v) financial and economic electricity tariffs are projected at the average rate of Rf3.87/kWh applying the 1999 adjusted to 2000 prices; and
- (vi) a standard conversion factor of 0.9 is applied to nontradables, for which it is assumed that all local currency expenditures apply.

#### D. Sensitivity Analysis

5. The following tables show the base case results and sensitivity to changes in assumptions and projections:

**Table A5.1: FIRR/EIRR Sensitivity to Parameter Changes**

Item	FIRR	EIRR
<b>A. Base Case (Incremental)</b>	<b>26.6</b>	<b>20.3</b>
<b>B. With the Following Changes:</b>		
40 percent increase in fuel prices for 2001 and thereafter held constant <sup>a</sup>	24.3	18.5
10 percent increase in electricity tariffs after 2000 and thereafter held constant	29.2	22.6
10 percent increase in operation and maintenance cost, excluding fuel after 2000 and thereafter held constant	26.3	20.0

EIRR = economic internal rate of return, FIRR = financial internal rate of return.

<sup>a</sup> Based on recent international fuel price increases.