Brazil "State of Goias Rural Electrification Project"

Report Date: February 1999

Field Survey: August 1998

Project Summary

Borrower:	Centrais Elétricas de Goiás S.A. (CELG)
Executing Agency:	Centrais Elétricas de Goiás S.A. (CELG)
Guarantor:	Federative Republic of Brazil
Exchange of Notes:	November 1989
Date of Loan Agreement:	September 1991
Final Disbursement Date:	December 1997
Loan Amount:	¥12,832 million
Loan Amount Disbursed:	¥12,489 million
Procurement Conditions:	General Untied
Loan Conditions:	Interest: 4.0% (3.25% for consultant component)
	Repayment Period: 25 years (7 years grace period)

Reference

(1) Currency:

1988	Cruzado (Cz$)
Jan. 1989 – Feb. 1990	Novo Cruzado (NCz$)
Mar. 1990 – Jul. 1993	Cruzeiro (Cr$)
Aug. 1993 – Jun. 1994	Cruzeiro Real (CR$)
Jul. 1994 – Present	Real (R$)

(2) Exchange Rate:(IFS yearly average market rate)

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Yen/$	128.1	137.9	144.7	134.7	126.6	111.2	102.2	94.06	108.7	120.9
Brazilian currency/ Dollar Note 1	95.27	1.03	24.84	147.86	1.641	32.16	639.3	917.67	1,005.1	1,078.0
CPI rising rate Note 2 (%)	994	1864	1585	475	1149	2489	929	22	9	4

Note 1: Conversion rates are for $US 1 billion in 1988, $US 1 million 1989-92 and $US1,000 from 1993 onward.
Source: IFS yearly average rate.
Note 2: Brazilian Institute for Geography and Statistics (IGBE) figures for the national consumer price index (INPC)

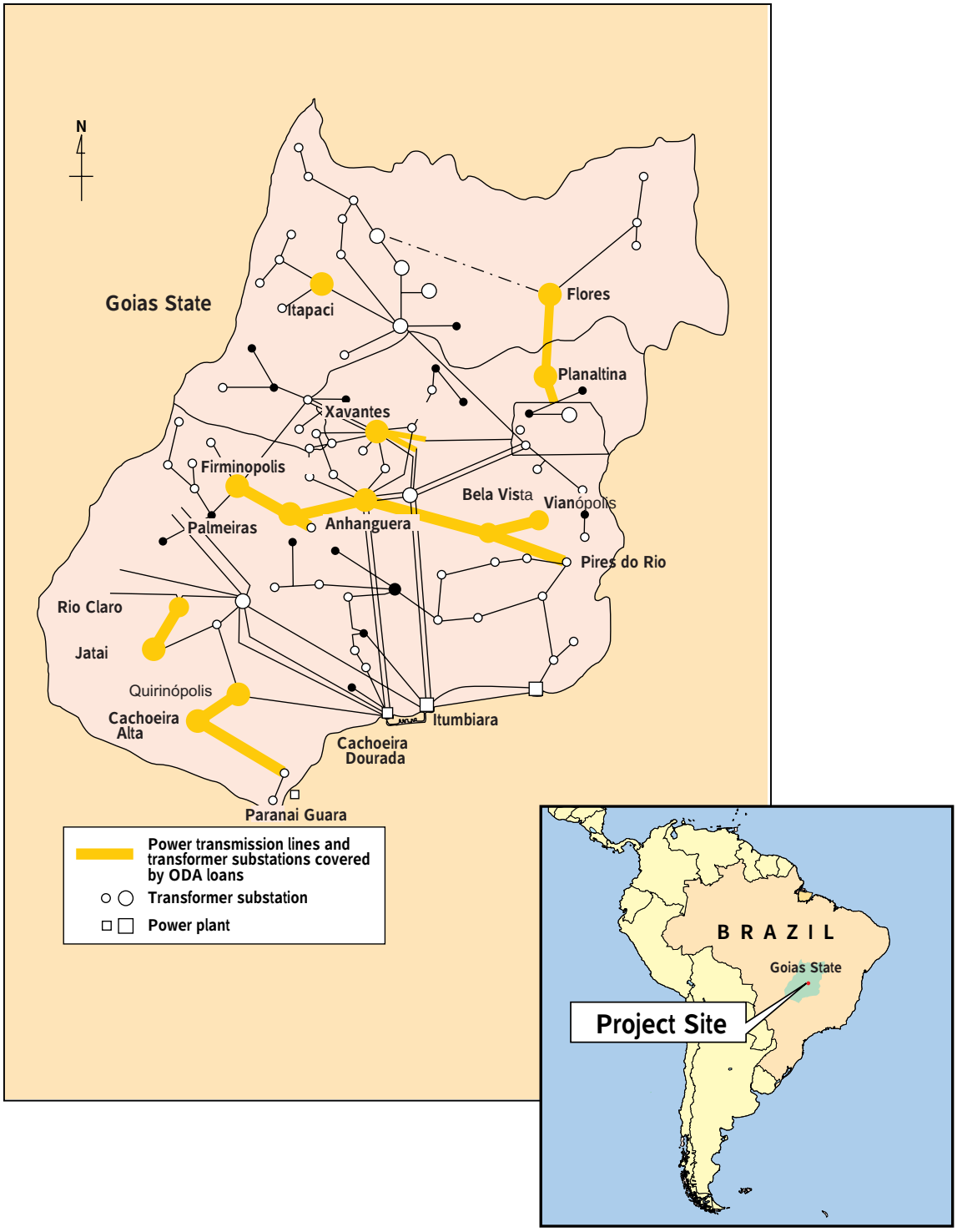
(3) Rate at the time of appraisal: US$1 = ¥143
(All local currency portion calculations use $US.)

(4) Fiscal Year: January - December

(5) Abbreviation:

CELG:	Centrais Elétricas de Goiás
ELETROBRAS:	Centrais Eletricas Brasileiras S.A.
DNAEE:	Departamento Nacional de Águas e Energia Elétrica
ANEEL:	Agência Nacional de Energia Elétrica (Name change from DNAEE December 1996 as a result of restructuring)
PRONI	Programa Nacional de Irrigação

Project Location



1. Project Summary and Comparison of Original Plan and Actual

1.1 Project Summary and JBIC Portion

The target area of this project, i.e. the "State of Goias Rural Electrification Project," is the state of Goias in the mid-western region of Brazil. The State of Goias has a population of approximately 4.02 million, an area of approximately 340,000 km², and a population density of 11.8 / km², less than the 17.2 / km² for the whole Brazil (1991 figures).

According to IBGE (the Brazilian Institute for Geography and Statistics) Goias State is divided into twelve regions[1], and the target of this project was seven of these regions in the southern part of the state (numbered 354-360) as shown on the map of Goias. The combined area of these seven regions is approximately 200,000 km², around 60% of the total area of Goias of 340,000 km². These regions lie between 200 – 1000m above sea level and are extremely flat with soil consisting mainly of sandy red clay, known in Brazil as the "Cerrado."[2] The climate consists of two distinct seasons: a dry season (March – August) in which forest fires are common, and a wet season (September – February).

This project has as its objective improvement in agricultural productivity in the southern region of the Brazilian state of Goias. Specifically it involves the construction of substations and electricity supply facilities for the transmission and distribution of electricity, in response to electricity demand in the agricultural sector (increase of electricity supply to irrigation facilities) and for the purposes of advancing electrification in the region. In the central and the southern regions of Goias, agricultural development was already proceeding before the project commenced, and the state had adopted from a cost-effectiveness perspective a development strategy of concentrating the supply of electricity to these areas, thus improving agricultural productivity and increasing state tax revenue, then using these funds to develop the less advanced areas in the north-east of the state. The project formed the basis of this strategy.

The coverage of the ODA loan for this project was the entire amount of the foreign currency portion (10,039 million yen) for procurement of equipment and materials, and a part of the local currency portion (2,793 million yen [$20.843 million] covering part of the construction costs of substations and transmission lines and the entire cost of consulting); a total of 12,832 million yen, the plan being to contribute approximately half the overall project cost of 24,343 million yen. Of the remaining project cost, 4,811 million yen ($35.907 million) of the budget was to be furnished by the Centrais Elétricas de Goiás S.A. (executing agency for the project, more details later. Known hereunder as CELG); 4,020 million yen ($30 million) by the national irrigation program (PRONI), and 2,680 million yen ($20 million) by the Federation of Rural Electrification Associations (GEER).

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1 These were the regional divisions at the time of project appraisal, and different divisions are now used, however for the purposes of comparing project plans and results the regions used in this report will be those current at the time. In 1988 a section was detached from Goias State to create the new geographical region of Tocantins State.

2 "Cerrado" is a Portugese word meaning "closed" and is a general term for a type of landscape dotted with bushes with blackish-gray bark and twisted trunks. It is also used broadly to describe undeveloped areas.

1.2 Background

(1) The 2010 Plan and the electrification program in the State of Goias

At the time when the possibility of implementing this project was being examined (around 1988), the Ministry of Mines and Energy, DNAEE and the electricity companies in each state were formulating plans for the period between 1987 and 2010. Goias State also produced a plan at this time, for the electrification of the whole state (1988-1992). This was to involve total investment of 696 million dollars, of which approximately half was budgeted for electrification in rural areas, and this project received high priority in this master plan for the electricity sector.

(2) The low rate of electrification in rural areas

While 92.1% of urban areas in Goias State were electrified by 1990, the rate of electrification in rural areas was 31.8%. With a gap in electrification of this magnitude, the state authorities recognized that the supply of electricity to rural areas needed to be improved.

(3) Increase in electricity demand in the agricultural sector

Agriculture, with a GRDP share of 16% (1990 IPEAS resource material) and a labor population comprising 31.5% of the total working population (1993, IBGE resource material), is one of the main industries in Goias State. Goias State is one of the regions of Brazil known by the title of "cerrado" (see project location details), and a scorching dry season that lasts for 4-5 months combined with sandy soil makes the region vulnerable to water shortages for cultivation. The provision of irrigation facilities[3] is therefore essential to improving agricultural productivity, however the electricity to operate these facilities is insufficient, and some farms receiving no electricity from CELG were engaging in costly diesel generation.

It was under these severe conditions that the state set a target for annual growth in agricultural production between 1990 and 1996 of 6.3%, in an initiative to improve agricultural productivity. CELG for its part produced the demand forecasts in Table 1-1, on the assumption that it would play a role in the electricity supply aspect of any plans (also supplying electricity currently being generated by farmers themselves). These forecasts predicted that electricity demand between 1990 and 1996 would increase1.8 times in rural communities and 14.4 times for irrigation facilities, and demonstrated the need for an increase in electricity supply facilities to respond to this demand.

[3] One type of irrigation equipment used in the project location is a large-scale piece of equipment known as a center pivot, varying in size but averaging around 600m, which moves in a circular motion using one end as a pivot (in other words a circle with a 600m radius). Other smaller types of irrigation equipment used include conventional (semi-fixed sprinkler) and self –propellers (self-propelling sprinklers).

Table 1-1 Electricity Demand Forecasts by Sector in Goias State

(Unit: GWh)

	1990	1991	1992	1993	1994	1995	1996
Residential	1164	1231	1319	1414	1509	1603	1698
Industrial	1414	1444	1790	1859	1952	2023	2081
Commercial	502	532	563	596	630	663	669
Rural communities	153	163	179	202	226	250	273
Irrigation	30	37	89	194	301	366	433
Public sector	467	498	518	536	563	563	616
Other	8	5	5	5	5	5	5
Total	3738	3910	4463	4806	5186	5473	5775

Note: 1990 figures are actual results. “Irrigation” refers to electricity consumption by center pivots.

Source: CELG

Project History

1988	May	Request of ODA loan to this project by Brazilian government
	November	JBIC appraisal mission
1989	April	Prior notice by Japanese government
	November	Exchange of Notes
1990	October	Approval of Exchange of Notes by National Diet in Brazil
1991	February	Ratification of Exchange of Notes
	September	Signing of Loan Agreement
	December	Effectuation of Loan Agreement
1992	March	JBIC mission (alteration of implementation plan)
	October	Alteration of Loan Agreement in accordance with the alteration of loan disbursement method
1995	July	Approval of additional project scope
1997	October	Completion of the project

1.3 Comparison of Original Plan and Actual

(1) Project Scope

Project Scope	Plan (at the time of appraisal)	Actual (Final)	Difference
1. Construction of transmission lines			
230kv	36km	154.69km	+118.69km
138kv	210km	500.00km	+290.00km
69kv	650km	677.67km	+27.67km
34.5kv	516km	480.78km	-35.22km
Total	Total 1,412km	Total 1,813.14km	Total +401.14km
2. Substation			
230/69 kv	175MVA	200.00MVA	+25.00MVA
230/138kv	-	300.00MVA	+300.00MVA
138/69 kv	75MVA	150.00MVA	+75.00MVA
138/34.5kv	15MVA	120.00MVA	+105.00MVA
138/13.8kv	75MVA	0	-75.00MVA
69/34.5kv	94MVA	143.75MVA	+49.75MVA
69/13.8kv	71MVA	20.00MVA	-51.00MVA
34.5/13.8kv	135MVA	115.00MVA	-20.00MVA
Total	Total 640MVA	Total 1,048.75MVA	Total +408.75MVA
3. Distribution of electricity			
Matto Grosso Goiano	18,243km	8,957km	-9,286km
Planalto Goiano	5,630km	6,776km	+1,146km
Alto Araguaia Goiano	1,527km	4,641km	+3,114km
Serra Caiapo	2,531km	6,668km	+4,137km
Meia Ponte	3,905km	4,336km	+431km
Sudeste	4,274km	6,355km	+2,081km
Vertente do Paranaiba	2,744km	4,700km	+1,956km
Total	Total 38,854km	Total 42,433km	Total +3,579km
4. Rural electrification			
Matto Grosso Goiano	14,086 houses	11,483 houses	-2,603 houses
Planalto Goias	4,347 houses	6,257 houses	+1,910 houses
Alto Araguaia	1,179 houses	2,971 houses	+1,792 houses
Serra Caiapo	1,954 houses	4,561 houses	+2,607 houses
Meia Ponte	3,015 houses	6,386 houses	+3,371 houses
Sudese Goiano	3,300 houses	7,014 houses	+3,714 houses
Vertente do Paranaiba	2,119 houses	5,216 houses	+3,097 houses
Total	Total 30,000 houses	Total 43,888 houses	Total +13,888 houses
5. Consulting service			
Service			
Overseas	30M/M	55M/M	+25M/M
Domestic	3,332M/M	1,725M/M	-1,607M/M
Total	Total 3,362M/M	Total 1,780M/M	Total -1,582M/M

(2) Implementation Schedule

	Plan (at the time of appraisal)	Actual	Difference
1. Procurement of equipment and materials			
(1) Selection of contractor	Feb. 1992 — Oct. 1994 (32 months)	Nov. 1993 — Aug. 1996 (33 months)	+22 months (+1 month)
(2) Procurement	Feb. 1993 — Oct. 1995. (32 months)	Feb. 1994 — Sep. 1997 (43 months)	+23 months (+11 months)
2. Construction work			
(1) Selection of contractor	May 1992 — Jun. 1993 (13 months)	Mar. 1993 — Sep. 1996 (42 months)	+39 months (+29 months)
(2) Construction	Jul. 1993 — Feb. 1996 (31 months)	Sep. 1993 — Sep. 1997 (48 months)	+19 months (+17 months)
3. Consulting service			
(1) Foreign consultant			
- Selection	Nov. 1991 — Feb. 1992 (3 months)	Aug. 1992. — Apr. 1993 (8 months)	+14 months (5 months)
- Service	Feb. 1992 — Jun. 1996 (52 months)	Jun. 1993 — Oct. 1997 (52 months)	+16 months (0 month)
(2) Domestic consultant			
- Selection	Nov. 1991 — Feb. 1992 (3 months)	Dec. 1992 — Mar. 1993 (3 months)	+13 months (0 month)
- Service	Feb. 1992 — Jun. 1996 (52 months)	Jun. 1993 — Oct. 1997 (52 months)	+16 months (0 month)

(3) Project Cost

Item	Plan (at the time of appraisal)		Actual		Difference	
	Foreign currency (¥1 million)	Local currency ($ thousand)	Foreign currency (¥1 million)	Local currency ($ thousand)	Foreign currency (¥1 million)	Local currency ($ thousand)
1. Procurement of equipment and materials	1,503	3,868	5,165	16,670	3,662	12,802
(1) Transformer substation	1,595	2,982	1,808	5,835	213	2,853
(2) Transmission lines	5,949	21,061	3,786	99,824	-2,163	-78,763
(3) Distribution lines						
2. Construction	-	7,928	-	13,628		5,700
(1) Transformer substation	-	7,310	-	18,820		11,510
(2) Transmission lines	-	31,600	-	56,967		25,367
(3) Distribution lines						
	86	8,438	202	15,026	116	6,588
3. Consultant	-	14,122		2,715		-11,407
4. Management fee	-	500		349		-151
5. Land compensation	906	8,941			-906	-8,941
6. Contingency						
Total	10,039	106,750	10,961	229,834	922	123,084
JBIC portion	10,039	20,843	8,008	40,736	-2,031	19,893

[Exchange rate] At the time of appraisal (November 1988): US$1=¥134
At the time of completion (1993 IFS yearly average): US$1=¥110

2. Analysis and Evaluation

2.1 Evaluation on Project Implementation

2.1.1 Project Content

(1) Alternation of project scope

Two alterations to the scope of the project were made, in April 1992 and July 1995, as a result of the need to respond to changes arising during project implementation such as the electricity demand situation.

The reason of the 1992 alteration to project scope was the change in the electricity demand situation in Goias State over the considerable period, (approximately three years from the time of appraisal to the conclusion of the loan agreement) between project appraisal in November 1988 through the exchange of notes and loan agreement to project implementation, as a result of the domestic situation in Brazil. This change in demand required revisions to the scope of the project. Table 2-1 Revision of Project Scope (April 1992) shows details of the revised plan. Included are elements removed from the target of the loan owing to CELG commencing work using its own funds during the delay in the signing of the loan agreement, and new additions and alterations owing to regional revisions of electricity demand.

Table 2-1 Major Alternation Contents After Original Plan (at the time of appraisal)

Project Scope	Results of review for project scope (Apr. 1992)	Addition of project scope by CELG's request (July 1995)
Construction of transmission lines		
230kv	144km	+10.69km
138kv	500km	—
69kv	677km	+0.67km
34.5kv	0km	+480.78km
Total	Total 1,321km	Total +492.14km
Substation		
230/69kv	100MVA	+100.00MVA
230/138kv	150MVA	+150.00MVA
138/69kv	150MVA	-
138/34.5kv	120MVA	-
138/13.8kv	0	-
69/34.5kv	143.8MVA	-
69/13.8kv	0	+20.00MVA
34.5/13.8kv	0	+115.00MVA
Total	Total 663.8MVA	Total +385.00MVA
Consulting service		
Foreign	30M/M	+25M/M
Domestic	2,328M/M	-
Total	Total 2,328M/M	Total +25M/M

Note: - : No alterations.

The backdrop to the 1995 change in project scope was a need to increase the absolute quantity of electricity supply owing to an increase in the number of households requiring electricity in the villages of the target region, combined with forecasts of further rapid growth in demand as a result of the increased stability of the Brazilian economy and economic recovery. A request from CELG was received and the additions to the scope of the project carried out (for details see Table 2-1 [Project scope as per CELG request (July 1995)].

In conjunction with these changes, the scope of the consulting services was revised. Compared to the original plan, additional services were required from overseas consultants, while the revisions to project scope did not entail any changes to domestic consulting services, although the content of these services was reduced later when contracts were signed.

Both sets of alterations were a response to changes in circumstances over time, and the propriety of all changes was confirmed by JBIC at the time. The project was successfully implemented with no delays to the implementation schedule as a result of these changes, therefore they are not considered to have caused any problems.

(2) Selection of electricity consumers

Meetings were held in each of the cities and districts in the target region to explain the project and recruit prospective candidates for electricity supply. CELG set the following conditions for electricity supply:

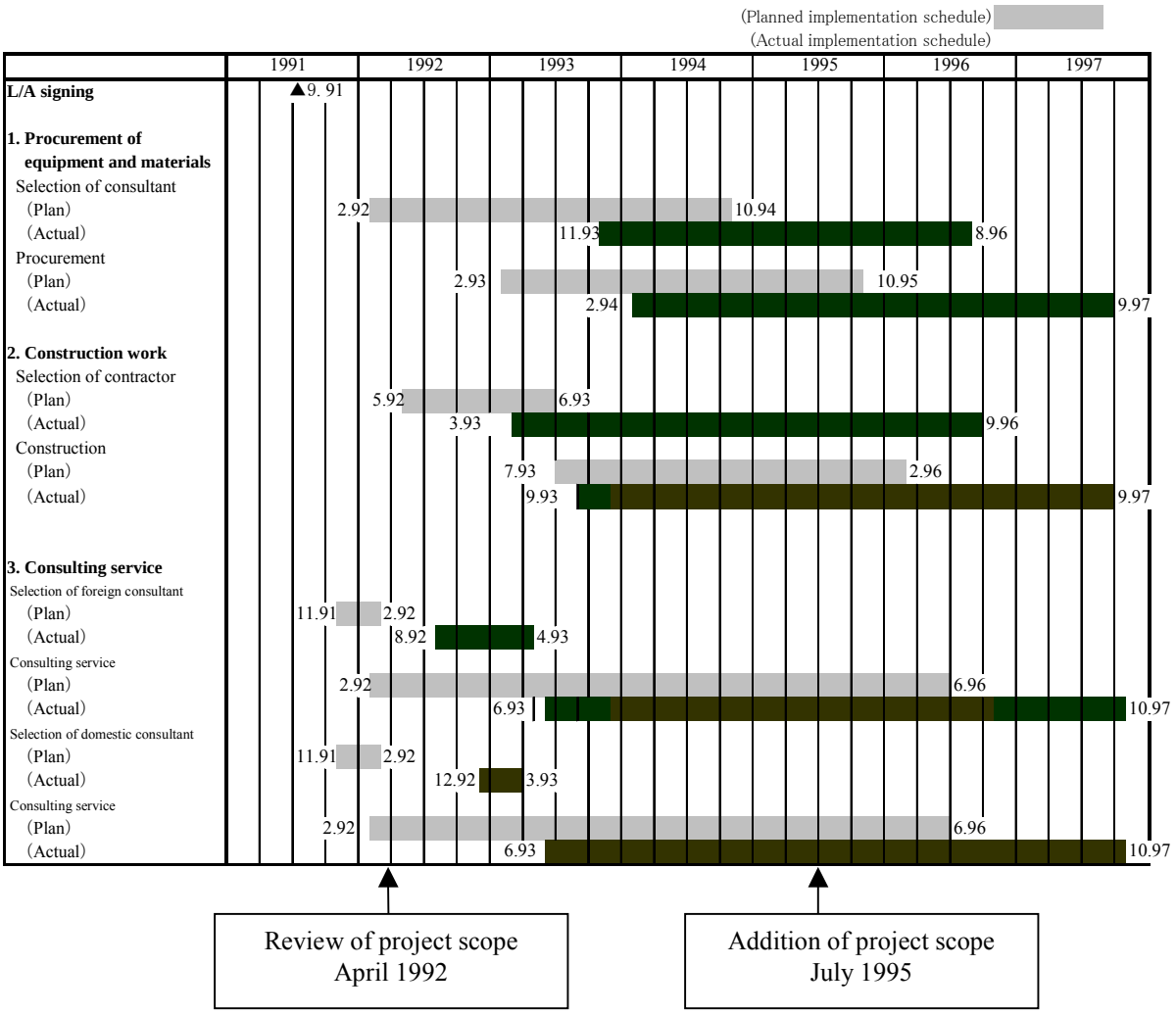
- Electricity consumers less than 1km from the electricity supply point to bear one third of the cost of installation work, and electricity consumers 1km or more from the supply point to pay in addition to this the costs of installation work in the area over 1km.
- Single phase electricity employing 5, 10, 15 or 25kVA transformers to be used.

Because decisions on electricity supply were made after the conditions had been clearly explained to potential electricity consumers, no particular problems were identified in the selection of project beneficiaries.

2.1.2 Implementation Schedule

As Fig. 2-1 indicates, there was an overall delay in the implementation schedule. This was owing to postponement of the start of project implementation (start of consultant selection), which then delayed the start of subsequent stages in implementation. The cause of this postponement was the revision of implementation plans (see above) after the conclusion of the loan agreement. The reason for procurement of materials and equipment, contractor selection and the implementation schedule running respectively nine, 29 and 17 months behind schedule was not only revisions to the original implementation plan, but also the addition to the scope of the project. There were also delays in some aspects of procurement, contracts and construction work with tenders and delivery of materials, and a suspension of work due to adverse weather conditions during the wet season (September – February), however these delays had only a very minimal impact on the overall implementation schedule.

Figure 2-1 Comparison of Original Plan and Actual for Implementation Schedule



The number of contracts involved in the project was considerable: 55 for the procurement of materials and equipment, and 33 for construction work; a total of 88. The JBIC project team at CELG therefore drew up a schedule indicating how much time was required for the production of each piece of equipment; identified clearly the priorities among the large quantity of equipment, and managed the schedule carefully so that equipment was supplied in the order of that which was most urgently needed. As a result, all construction work including the additional work was completed within the disbursement period of the loan agreement.

With regard to consulting services, arranging contracts with overseas consultants took considerable time, and there were changes to the contents of contracts owing to revisions to the project plans etc. Both overseas and domestic consulting services however were completed on schedule.

Despite delays in the furnishing of the loan, changes in demand over time, and the necessity to revise various procedures for changes, the fact that all work including additional work was completed within the loan disbursement period demonstrates that management of the implementation schedule by the executing agency was more than adequate.

2.1.3 Project Cost

The calculations in yen in Table 2-2 (1) of the difference between planned and actual project cost indicate that while overall project cost ran approximately 50% over budget, the contribution from JBIC funds remained virtually unchanged from that planned. The overall cost over-run was a result of the additions to project content outlined in 2.1.1, combined with inflation and currency fluctuations during the project implementation period.

Table 2-2 (1) shows a reduction in the JBIC funding amounts for equipment and materials procurement costs and consulting costs, and an increase in funding of construction costs. Separation of JBIC funds in Table 2-2 (2) into foreign and local currency portion[4] shows that the amount for procurement of equipment and materials calculated as part of the foreign currency component declined as a result of such factors as a reduction in work targeted by the loan and the effects of currency fluctuations. The construction costs included in the local currency portion on the other hand increased, the main reason being the increased amount of work required for additional construction. JBIC responded to the discrepancy between estimates of the cost of construction and actual costs by drawing on its reserve fund, and by redirecting funds allocated to procurement to construction costs. The cost of consulting by overseas firms increased as the additional work called for additional services and changes in consulting contracts, while the services and unit cost of labor of local consultants were reduced when contracts were signed, resulting in lower costs than originally planned.

Comparing the planned and actual shares of the various funding sources in the overall project cost (See Fig. 2-2), the ODA loan amount remained unchanged despite an increase in overall project cost, resulting in an actual share of overall project costs of 34% versus the 52% originally envisaged. CELG funding on the other hand increased from 20% to 53%, and it is apparent therefore that a large portion of the increase in overall project cost was supplied from CELG funds.

[4] Local currency portion calculations at the time of appraisal were conducted in US dollars.

Table 2-2 Comparison of Original Plan and Actual for Project Cost

(1) Planned/actual results for overall project cost in yen

(Unit: ¥1 million)

Item	Plan		Actual		Difference	
	Overall	JBIC	Overall	JBIC	Overall	JBIC
1. Procurement of equipment and materials	12,787	9,047	24,216	7,806	11,429	-1,241
2. Construction	6,276	1,512	9,835	3,705	3,559	2,193
3. Consultant	1,217	1,217	1,855	978	638	-239
4. Management fee	1,892	0	299	0	-1,593	0
5. Land compensation	67	0	38	0	-29	0
6. Reserve fund	2,104	1,056			-2,104	-1,056
Total	24,343	12,832	36,243	12,489	11,900	-343

Source: JBIC, CELG

(2) Planned/actual results for JBIC funding by foreign and local currency portion

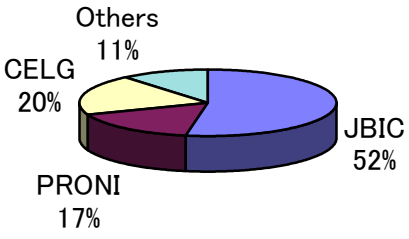
Item	Plan (at the time of appraisal)		Actual (final)		Difference	
	Foreign currency (¥1 million)	Local currency ($ thousand)	Foreign currency (¥1 million)	Local currency ($ thousand)	Foreign currency (¥1 million)	Local currency ($ thousand)
1. Procurement of equipment and materials	9,047		7,806	0	-1,241	0
2. Construction	0	11,280	0	33,681	0	22,401
3. Consultant	86	8,438	202	7,055	116	-1,383
4. Management fee	0	0	0	0	0	0
5. Land compensation	0	0	0	0	0	0
6. Reserve fund	906	1,125			-906	-1,125
Total	10,039	20,843	8,008	40,736	-2,031	19,893

Source: JBIC, CELG

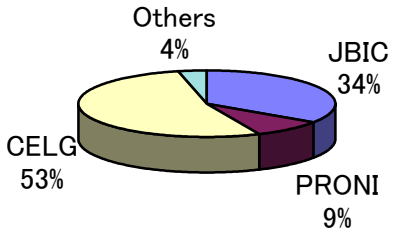
Note: Planned value rate US$1 = ¥134 (at the time of appraisal in 1988)
Actual value rate US$1 = ¥110 (unified by 1993 average rate at the time of project implementation)

Figure 2-2 Project Funding Sources

Plan



Actual



2.1.4 Implementation Scheme

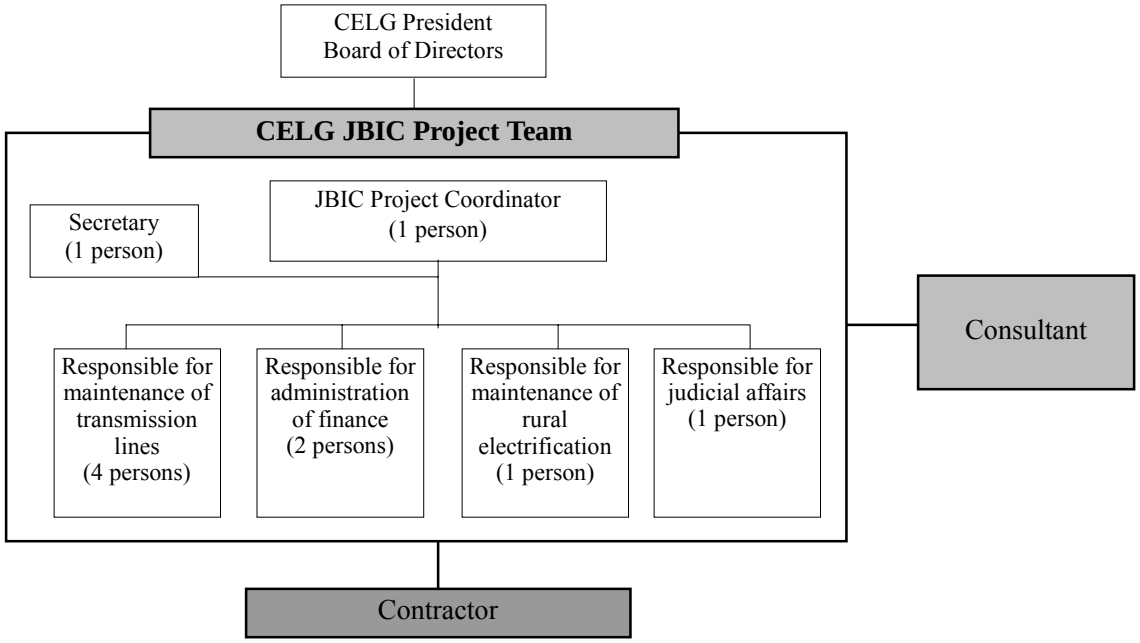
(1) Executing Agency

CELG, the executing agency for the project, is the electricity corporation of Goias State, established in August 1955 for the purposes of supplying electricity in the state. Approximately 80% of CELG shares are held by the state government. CELG operations involve the generation, conversion at substations, transmission and distribution of electricity, and cover a supply area of 330,000 km² (99% of Goias State) divided into 234 local authorities and 329 regions, with a total population of approximately 4.3 million as of 1997.

As shown in Fig. 2-3, for the purposes of project implementation, an JBIC project team was set up directly linked to the CELG President and Board of Directors. Included in the team were personnel with expertise in the areas of responsibility of the various divisions of CELG, who became JBIC project leaders and managed all areas of the project. The personnel in the diagram represent the main numbers involved during the project, however there was also a separate team of 7-8 personnel responsible for tenders and a team involved in technical appraisals. The ranking of the project by the Goias State government from the time of appraisal as a priority project and the top priority given the project within CELG itself were factors that enabled this comprehensive implementation structure to be put into place.

Because this project team had wide-ranging powers of decision-making on all aspects of project implementation (the project team was charged with the responsibility for all policy decisions involving the project, and the content of decisions reported directly by the team to the board of directors) there were no delays in internal procedural matters. In addition, employment of the bare minimum of management personnel necessary made for clarity and speed in the issuing and carrying out of instructions.

Figure 2-3 JBIC Project Implementation Scheme



The staff on the project team that was central to implementation of the project were involved from the first studies in the formative stages right through to project completion, and the continuous involvement of staff familiar with all aspects of the project undoubtedly contributed to the efficiency with which it was carried out. Although for CELG this project was its first involving an ODA loan, CELG staff demonstrated an impressive willingness to learn in terms of the loan arrangements etc., and recognition of the extent of CELG's commitment to the project was also an important factor in its efficient implementation. In sum, CELG supervision of the project can be described as outstanding.

CELG methods of monitoring the project furthermore have even become a model for ODA loan projects, with the company arranging for its project coordinators to speak directly to personnel involved in ODA loan projects in other states (specifically Bahia and Ceara) and share their experiences.

(2) Consultant

Overseas (Japanese) and local consultants were chosen separately using a system of short-lists. The TOR of the overseas consultants was to review documents submitted by CELG to JBIC; generally facilitate communication between CELG and JBIC, and provide CELG and the local consultants with the necessary support and advice on project implementation matters such as detailed plans and the preparation and evaluation of tender documents. The role of the local consultants was to assist CELG with matters such as detailed plans, technical evaluation of proposals, inspection of materials and equipment and inspection of construction work. CELG rated the overall performance of both overseas and local consultants as excellent, and both can be said to have adequately fulfilled their roles as per the TOR without any problems.

(3) Contractor

Contractors for the procurement of equipment and materials were chosen by international competitive bidding, and for the construction work by competitive bidding within Brazil. The nature of the project required a large number of contracts, and consequently a large number of contractors were employed. CELG evaluation of contractors, while noting some differences in quality, concluded that on the whole work had been carried out satisfactorily. The local survey conducted as part of this evaluation did not identify any contractor-based problems of note either, and it may be concluded that contracting work on the project was carried out without any especial difficulties.

2.2 Evaluation on Operations and Maintenance

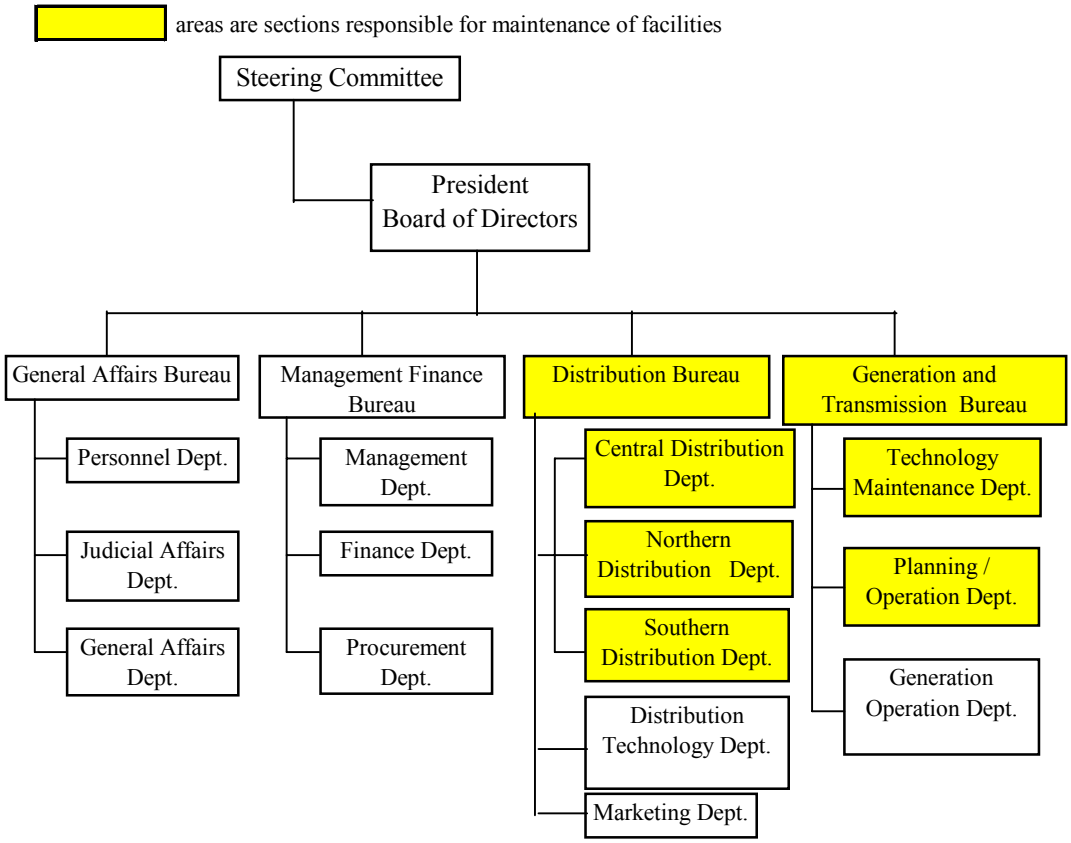
This project does not cover electricity distribution over the whole of Goias State, however the nature of electricity distribution makes it extremely difficult to specifically evaluate the operations and maintenance only of the area targeted by the project. This section will therefore examine and analyze operations and maintenance over the whole of the CELG distribution network.

2.2.1 Operations and Maintenance Scheme

(1) CELG organizational structure

Fig. 2-3 shows the current CELG organizational structure. In 1992 before the project commenced CELG employed a total of 4,018 staff, however by 1998 this number had declined by almost 40% to 2,494. A major factor in this reduction was pressure from the federal government from 1995 onward on the Goias State government to cut excess staff from state institutions as a means of tackling the state's budget deficit and heavy debt burden. From July 1995 CELG began gradually downsizing, starting with staff who had joined the company without taking any formal competitive examinations. The main targets of staff cuts were staff not belonging to any particular section; secretaries; welfare-related staff, and staff at manned substations converted to unmanned facilities via capital investment in communications, and there were no

Figure 2-3 CELG Overall Organization Chart



major cuts involving essential operations and maintenance staff.

(2) Operations policy

CELG operations policy consists first of all of guidelines based on state plans, formulated by a steering committee of the major CELG investors.[5] The board of directors then devises a strategy based on the policies of the steering committee, and makes decisions on medium and long-term plans. Each section of the corporation implements these plans in their various operations, and review meetings are held every quarter to check on performance, with objectives being reset if required. CELG also makes use of surveys to assess customer satisfaction. Decisions concerning investment and staff appointments are the responsibility of the board of directors.

Finances and the setting of electricity charges, procurement and marketing follow regulations laid down by the federal government. Electricity charges are divided broadly by federal regulations into two types. These are defined in detail according to peak and non-peak use of the electricity system and the quantity of electricity consumed, and all administration is carried out by computer. Most payments from electricity consumers are made through banks and accounts can also be paid at locations such as lottery ticket outlets, which are open until relatively late. Furthermore, while still in the trial stage, in a limited number of areas, a pilot scheme is being conducted involving payment of electricity charges by prepaid card, and efforts are being made to improve the percentage of electricity charges collected.

Policy and planning for the maintenance of facilities are the responsibility of the relevant divisions at CELG main office, and are the basis on which each branch carries out the operation and maintenance of equipment. Most equipment at substations is operated in accordance with the manuals produced by the manufacturer of the equipment. Representatives from each branch receive training on maintenance of distribution lines to form the core staff involved in operations at their individual workplaces.

(3) Maintenance system

Of the facilities completed in the project, operations and maintenance of substations and transmission lines of 69kV or over are managed by the maintenance section of the Generation and Transmission Bureau in Figure 2-3. The section employs 187 systems operation staff and 403 maintenance staff involved in transmission lines (both figures March 1998). Transmission lines, substations and distribution networks up to 69kV are the responsibility of the Distribution Bureau in Figure 2-3, and three sections within the Department carry out maintenance in the three separate regions of North, South and Central. 1,128 staff are involved in the operations and maintenance of electricity transmission and distribution (the staff in the shaded areas of the diagram), and with total CELG staff numbering 2,494 this equates to an approximately 50% staff allocation to operations and maintenance.

On the other hand, CELG is increasingly contracting maintenance-related activities out to operators in the private sector. While at the time of appraisal for this project (1988), 50% of maintenance on transmission

[5] Major investors as of March 1998 are: the Goias state government with 80%, the Sao Paulo Stock Exchange (15.2%) and ELETROBRAS (1.6%).

lines, 80% on substations and 87% of maintenance on distribution networks were carried out by private companies, the current figures for ordinary maintenance are 80% for transmission lines, 20% for substations, 90% for distribution substations, and 90% for distribution, and 100%, 0%, 75% and 75% respectively for emergency maintenance. Most maintenance then in actual fact is contracted out. CELG chooses contractors carefully in accordance with a specific set of criteria, and supervises and directs all work including that on live power lines. Recently there has been an upsurge in the amount of work being contracted out to private operators, and with a consequent increase in the number of new contractors, CELG will be required to monitor the capabilities of its contractors carefully for some time.

(4) Training

CELG conducts various types of training both internally and externally with the aim of improving the average technical and administrative skills of its staff. Fourteen staff technical courses and eight computer courses are held within CELG annually; seven outside technical and ten computer courses within the state of Goias, and four office skills, three technical and three management-related courses in other states. In 1997 approximately 160,000 Reals were spent on internal training for 1,851 staff, and approximately 100,000 Reals on training outside the company for 1,238 staff.

Each CELG division provides coaching for contracted staff in their respective areas of responsibility. Furthermore, as facilities expand in CELG, bearing in mind the current increase in outsourcing of work, the possibility of setting up a training center for staff involved in facility maintenance is being considered.

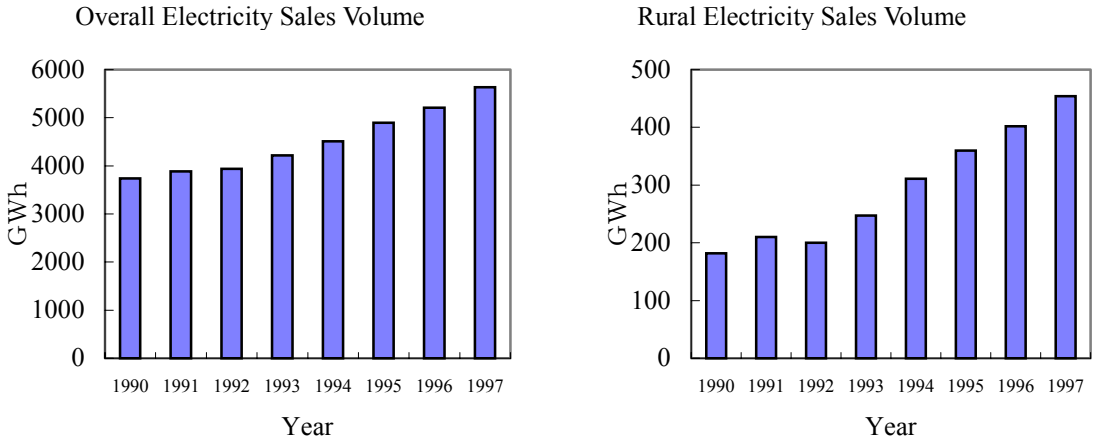
2.2.2 Operations and Maintenance

(1) Operation Status

(i) Changes in the volume of electricity sales/ revenue from electricity sales

As Figure 2-5 shows, since 1990 electricity sales over the whole of the region under CELG jurisdiction have risen annually at a steady pace, with 1997 electricity sales 40% higher than those of 1990. In particular, the sales of electricity to the rural sector which is the aim of the project increased by approximately 150% over the same period, which is a proof that the facilities constructed in the project are being operated effectively. This rise in electricity sales has also seen a rise in CELG revenue from electricity sales (Table 2-3), and behind this success there is a relatively high collection rate for electricity charges, as may be seen in Table 2-4.

Figure 2-5 Changes in the Electricity Sales Volume of CELG



Source: CELG

Table 2-3 CELG Revenue from Electricity Sales

(Unit: thousand Reals)

Year	1995	1996	1997
Total electricity sales revenue	408,850	576,799	687,833
Revenue from rural electricity sales	23,829	32,141	37,181

Source: CELG

Table 2-4 Collection Rate for Electricity Charges

Year	1996	1997
Housing	88%	98%
Industry	91%	99%
Commerce	91%	98%
Rural	90%	97%
Public Sector	72%	95%

Source: CELG

Collection rate = *Amount collected in the fiscal year [Note] / Amounts invoiced in the fiscal year) %

(Note) Amount collected in the fiscal year includes not only amounts invoiced in that year but amounts collected that was invoiced in the previous year.

(ii) Power outages

CELG power outages in 1997 are calculated below in accordance with federal government[6] definitions.[7]

FEC (Number of outages annually per customer household, average of total)	**29.52 outages**
DEC (Hours of outages annually per customer household, average of total)	**24.39 hours**

According to CELG reports, most power outages are the result of natural disasters or malfunction of older equipment. There is every possibility of outages increasing with future increases in demand, and it is imperative, therefore, that CELG starts investigating and analyzing in detail the causes of power outages now, and deals with them starting with the most urgent, or puts in place measures to deal with problems when they do arise.

In the adjacent state of Minas Gerais, where electrification is further advanced than in Goias, fire damage to lines resulting from burning-off of hillsides and fields[8] is reported to be one cause of power outages. The same activity is carried out in Goias and the likelihood of damage of this type occurring as the distribution network grows is high. CELG may be required to pre-empt this by stepping up its publicity campaigns to make residents aware of the consequences of lighting fires near facilities such as power lines.

(iii)Transmission and distribution loss

A glance at the annual figures for CELG power transmission and distribution loss reveals a relatively high 13-15% loss per year in the period since 1990 (transmission and distribution loss over the whole of Japan was 5% in 1995, and around 9.9% in Thailand in 1994). While there has been improvement in the past two years; from 15% in 1996 to 12.79% on a monthly basis for June 1998, the figures remain high. Factors in these levels of loss are the relatively long transmission lines, technical loss and electricity theft. Of the 12.79% loss in June 1998, distribution loss (including theft) at 10.2% was higher than transmission loss at 2.67%. CELG further estimates that approximately 3% of distribution loss can be attributed to theft. As shall be discussed in the next section, there is ample scope from a technical point of view to improve

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6 FEC (Freqüência equivalente de interrupção por consumidor do conjunto considerado)= $\left(\sum_{i=1}^{n} Ca\,(i)\right) / Cs$

DEC(Duração equivalente de interrupção por consumidores do conjunto considerado)= $\left(\sum_{i=1}^{n} Ca(i) \times t(i)\right) / Cs$

i = number of outages
t(i) = outage time
Ca(i) = number of electricity consumers affected
Cs= total number of electricity consumers

7 (Ref) Examples of average number of power outages and average outage times: Thailand 9.72 outages and approx.10 hours; Korea 2.29 outages and approx. 4.5 hours.

8 From a report on a national forest fire seminar organized in April 1992 by the Institute of the Environment and Renewable Natural Resources of the Brazilian Ministry of the Environment

these loss figures.

(2) Operation and maintenance

As explained, the capacity of CELG facilities and electricity sales increased dramatically following implementation of the project. Maintenance, how it is carried out and with what degree of reliability, will therefore be an important issue in the future. Furthermore, as described in the section on operational performance, power outages and transmission and distribution losses are both at high levels. The next section discusses current measures for tackling these problems and some points to consider for the future.

(i) Facility inspections

At present, checks on distribution equipment and site inspections are only conducted within the confines of substations. The following checks are carried out on substation facilities.

1. Transformers
   - 1-1 Chemical analysis of insulating oil
     Insulating oil is collected from transformers, and analyzed and measured for water content, acidity, color, resistance etc.
   - 1-2 Polymerization tests
     Degree of polymerization of organic components of insulating oil is analyzed and an estimate made of life span.
   - 1-3 Analysis of degree of sediment
   - 1-4 Tap change control and operations test
     A control order is issued to see if taps have been changed as ordered, and confirmed on-site.
2. Circuit breakers, oil switches for reshutting-off of circuit
   Maintenance of circuit breakers is carried out after calculating the amount of current passing though in a specified period. Checks include analysis of SF6 gas in the arc and careful inspection of electrode surfaces. Temperature measurements are also conducted using thermography.
3. Arresters, power cables etc.
   Stationary equipment with no moving parts is tested for irregularities by measuring temperature via thermography at regular intervals.

CELG's implementation of these checks is reliable, and certainly inspections within substations are conducted to a largely satisfactory level. However, inspections of emergency equipment, such as test operation of emergency diesel motors, which is not currently a required inspection procedure, are also important, and it is hoped that in future, they will be included (the smooth running of emergency equipment being vital from the point of view of reducing the time taken to restore power after outages).

Furthermore it is not only inspections within sub-stations that are important, but in terms of preventing outages, site inspections of transmission lines and distribution lines etc. are important as well. At present

CELG conducts only minimal site inspections of these facilities, however such inspections should be conducted regularly starting with those lines which are most vital in terms of electricity supply.

(ii) Safety measures

Table 2-5 shows the number of work accidents within the CELG supply area (this includes all accidents and the number involving electricity is unclear). Accidents have remained at a constant level each year, but when the increase in work associated with the increase in facilities is taken into account, the accident rate may be viewed as having fallen. Nevertheless, as long as there are fatalities, urgent steps are required to ensure preventing similar accidents.

Furthermore if we consider that this is a new electrification project, and the target area of the project being a vast rural area, sparsely populated and difficult to access in a hurry, the safety awareness of consumers unaccustomed to using electricity also becomes an important issue. CELG is dealing with this concern by distributing new electricity consumers a leaflet containing easily understable information in a cartoon style, and its PR activities regarding electricity use have been very thorough to date.

Table 2-5 Work Accidents Among CELG Staff

Year	Accidents	Fatalities
1990	101	0
1991	84	0
1992	105	1
1993	84	3
1994	82	0
1995	109	3
1996	114	1
1997	86	0

Source: CELG

(iii) Response to power outages

Power outages causes the largest problems for electricity consumers, and when they occur, CELG takes the following steps to restore services. First, a resident in the area of the outage will report it by telephone to the electricity customer service center (CELG main office). The telephone service center operates 24 hours, and the staff member who received the report contacts the person responsible for restoring power in the area of the outage. Depending on the fault situation, this person conducts an inspection of facilities from the power source to the loading side of the distribution lines, i.e. distribution transformers and fuse, and low-tension distribution lines etc., with the aim of finding the source of the problem, eliminating it and restoring power. CELG's free calling service set up for reporting power outages is widely advertised among customers via leaflets. CELG's attention to the consumer point of view in operating this type of service is praiseworthy.

Even though the number of the sample was extremely limited to five, the electricity consumers interviewed during the local survey (see annex) expressed their general satisfaction with CELG response to faults.

(vi) Transmission and distribution loss countermeasures

According to CELG, it is working diligently on the following two means of controlling loss of electricity during transmission and distribution.

1. Improvements to line connection points to control transmission and distribution loss.
   Because of major heat loss at connection points, improvements are gradually being made to connection methods, taking into account the area of contact points.
2. Increased inspections to prevent electricity theft.
   At the same time as the regular monthly meter checks, with the aim also of checking on maintenance required on electricity supply facilities, CELG has begun to inspect wiring on electricity consumers' property for any signs of electricity theft.

At present, trials are also underway on the use of special stickers to seal electricity meters as a means of preventing electricity theft. The stickers leave a mark if removed, and are made in such a way that once removed, they cannot be stuck on again. It is hoped this will be an effective method of preventing loss via electricity theft involving tampering with meters.

2.2.3 CELG Financial Status

Tables 2-6 and 2-7 show major CELG financial results and financial indicators for the past three years. Because at the end of the 1995 financial year Brazil abolished inflation price adjustments, comparisons cannot be made for the whole of the year, so the indicators used here are those for 1996 and 1997.

Firstly, a look at the statements of income in Table 2-6 reveals that between 1996 and 1997 operating profit climbed out of the negative and took a major turn for the better. A significant factor in this was major growth in sales. (An increase of 17.9% between 1996 and 1997). Overall CELG electricity charges

during this period rose an average of 1.9%, and the number of electricity consumers 6.4%. The increase in sales chiefly due to a rise in the number of customers, as opposed to a rise in prices.

In terms of cost-cutting, since 1995 efforts to reduce labor costs as explained in section 2.2.1 on operations and maintenance systems have resulted in the ratio of labor costs to turnover falling from 22.6% in 1996 to 16.2% in 1997. On the other hand, because of the amount of equipment maintenance etc. now being carried out by private contractors, as the statements of income in Table 2-6 shows, outsourcing costs are rising. However, because revision of contract prices for the outsourcing of maintenance was carried out between 1996 and 1997, the ratio of the combined amount of labor costs and outsourcing costs to turnover fell from 34.8% in 1996 to 28.7% in 1997. In terms of cost reductions, as in other areas, CELG is therefore reaping the rewards of its efforts. The underwriting of CELG debts held with the federal government by the state government was also a major factor contributing to CELG's success in reducing costs.

Of the financial indicators in Table 2-7, total asset turnover is little different to the average figure of 37% for the Japanese electricity industry. Improvements may be observed in rate of return, current ratio and capital adequacy between 1996 and 1997, however the figures for current ratio and capital adequacy are still low. Capital adequacy in particular is lower than the case would be in Japan. As indicated in the balance sheet in Table 2-6, CELG has a considerable debt burden in the form of long term loans and unpaid taxes and charges. A look at Table 2-8 showing the composition of long term loans reveals that the ODA loan is CELG's next largest after loans from the Bank of Brazil, but repayment of the principal will commence from the 1998 fiscal year. From a position in which net profit has finally moved into the black in FY 1997, some difficulties can be envisaged in making loan repayments using only equity capital. Nevertheless as explained earlier, CELG is beginning to see the results of its efforts in improving management, and by continuing to improve charge collection, reduce transmission and distribution loss further and work toward greater efficiency in operation of its facilities, it will be possible for CELG to pay back its loans starting with that from JBIC, without too much trouble.

(Note: Owing to depreciation of the Real by the Central Bank of Brazil on January 13 1999, and the switch on the 18th to a floating rate, as of the beginning of February the Real has fallen to around 1.7 to the US dollar (from around 0.8reals to the dollar before depreciation). Loan repayments involved in this project will not be able to escape the effects of this currency fluctuation either, and it is imperative for JBIC keep a close watch on the repayment situation in the future (the next payment for this project L/A incidentally is due on March 20 1999).

Table 2-6 Financial Achievements (Unit: thousand Reals)

Statement of Income

	1996	1997
Operating Income		
Turnover	590,570	696,408
Discount on sales	-186,913	-204,337
Total	403,657	492,071
Business Expenses		
Personnel expenses	-91,120	-79,783
Material costs	-5,294	-4,079
Consignment costs	-49,497	-61,393
Electricity generation costs (water, fuel)	-2,939	-1,809
Purchase of electricity for resale Note1	-82,720	-132,089
Deprecations Note2	-66,841	-32,123
Others	-19,639	-53,539
Financial expenditure, income		
Receiving interest	53,857	9,272
Paying interest	-178,972	-123,072
Others	13,538	1,890
Total	-429,627	-476,725
Ordinary profit	**-25,970**	**15,346**
After-tax net profit	-45,801	9,443

Note 1: CELG-owned generating facilities were sold to a private company at the end of 1996. Because CELG then began to purchase electricity from this company in 1997, the amount of nationally-owned electricity available for resale increased.

Note 2: Depreciation costs show a major reduction in 1997 due to the establishing of the Cachoeira Dourada electricity generation company by CELG at the end of 1996 and the subsequent detachment of the Cachoeira Dourada power stations from CELG control.

Balance Sheet

	1996	1997
Assets		
Liquid Assets		
Current deposit	9,138	15,147
Sales credit	166,995	206,106
Accounts receivable	19,480	17,996
Raw material	6,744	6,331
Reserve for uncorrectable account	-452	-25
Prepaid expenses	337	294
Sub-total	202,242	245,849
Long-term Assets		
Tangible fixed assets	922,115	969,529
Other investment	117,050	117,999
Deferred asset	337	248
Sub-total	1,039,502	1,087,776
Total	1,241,744	1,333,625

	1996	1997
Liabilities		
Liquid Liabilities		
Current liabilities	53,162	46,922
Payment arrears	7,892	3,495
Tax payable Note1	145,667	139,078
Short-term borrowing	78,521	45,417
Other reserve Note2	106,667	39,680
Others	12,542	22,910
Sub-total	404,451	297,502
Fixed Liabilities		
Long-term borrowing Note5	524,271	584,240
Tax payable Note 3	100,106	98,402
Other reserve Note 4	182,954	253,128
Sub-total	807,331	935,770
Total of debts	1,211,782	1,233,272
Capital		
Capital	143,059	143,059
Capital surplus	8,952	58,952
Profit reserve	-122,049	-101,658
Total of capital	29,962	100,353
Total	1,241,744	1,333,625

Source: CELG

Note 1: Product distribution tax (ICMS), social security levies (COFIN), social insurance (INSS) etc.

Note 2: CELG pension fund, litigation costs etc.

Note 3: Of Note 1, amounts with limit for principal repayments extended to April 2013.

Note 4: Related to project approval, ultimately dealt with as directed by the project approval entity (i.e. currently the federal government), and not included in analysis.

Note 5: The long term loan amount for 1997 includes the 153.321 million reals underwritten by the Goias state government at the end of the financial year.

Table 2-7 Financial Index

Unit: %

			Reference
	1996	1997	Electric business in Japan[Note1]
Ratio of current profits for net worth	-2.1	1.1	1.7
Ratio of current profits to turnover	-6.4	3.1	4.6
Turnover ratio of total liabilities and net worth[Note2]	31.9	36.4	38.0
Current ratio	50.0	82.6	21.2
Ratio of net worth	2.4	7.4	14.8

Note 1: Figures in 1997. Source: Finance and Banking Statistics Monthly Bulletin 1998.8 No.556

Note 2: Turnover × Total assets × 100

Source: Calculated from CELG material

Table 2-8 Breakdown of CELG Long-term Borrowing in FY 1997

(Unit: thousand Real)

Borrowed from	Amount	(%)
Bank of Brazil	214,433	(49.8%)
JBIC	104,188	(24.1%)
PRONI	29,879	(6.9%)
ELETROBRAS	10,241	(2.4%)
Others	72,178	(16.7%)
Total	430,919	(100.0%)

Source: Calculated from CELG material by the author

2.3 Project Effects and Impacts

The objective of this project was to facilitate improved production of agricultural produce by improving the rate of electrification in rural areas and supplying electricity to irrigation facilities.

The electrification rate, firstly, has increased dramatically in comparison with the rate before the project began. During the project implementation period, no other new electrification projects were taking place in the target area, therefore the improvement in electrification in these regions can be viewed largely as a result of this project, and one of the objectives of the project considered fulfilled. Looking at the other objective of improved productivity of agricultural produce, a number of factors can influence changes in productivity, making it impossible to specify precisely what part has been played by electrification. However, by examining the figures for agricultural production before and after the project, it is possible to make some observations regarding aspects that may be considered effects and impacts of the project.

In terms of qualitative effects and impacts, as well as improvement in the quality of life resulting from electrification, it is worth paying particular attention to verifying the secondary effects of the project on environmental conservation, as included in the report of the executing agency.

2.3.1 Quantitative Effects and Impacts

(1) Rise in the rate of electrification in rural areas

Table 2-9 shows electrification rates of rural regions in the project target area. Over the entire project, electrification increased 35 percentage points from the 1990 pre-project figure of 32%, to 67% in 1997. The increase in individual regions ranged from 30 to 50 percentage points.

Table 2-9 Electrification Rates of Rural Areas by Region

Unit: %

Name of region	Year							
	1990	1991	1992	1993	1994	1995	1996	1997
354 Mato Grosso de Goias	34.4	38.4	41.5	44.6	50.2	56.4	59.8	62.9
355 Planalto Goiano	18.1	22.3	25.6	28.7	35.8	49.7	56.3	61.8
356 Alto Araguaia Goiano	13.9	17.1	19.9	21.7	27.8	47.0	52.7	55.9
357 Serra do Caiapo	37.0	42.0	46.9	50.3	60.6	72.4	78.4	82.3
358 Meia Ponte	54.8	64.0	68.0	71.0	83.9	91.8	95.6	98.9
359 Sudeste Goiano	7.6	9.3	10.9	46.5	15.2	25.7	28.8	30.6
360 Vertente Paranaiba	45.8	51.4	55.4	58.5	67.9	76.2	79.9	82.7
Overall	31.8	36.3	39.7	46.3	49.7	59.2	63.5	66.8

Source: CELG

In terms of households, the number of homes in the project area connected to the electricity system increased from 23,932 in December 1988 to 70,590 after the implementation of the project (December 1997), an improvement of 195%.

Of these households, the number supplied with electricity as a result of this project was 43,888, and it can

safely be said that the project made a major contribution to electrification.

Comparing growth in the number of total consumers supplied with electricity by CELG with the growth from among this number in electricity consumers in rural areas (Table 2-10), it may be observed that while between 1991 and 1997 the overall number of electricity consumers increased by 47.7%, the increase in rural areas was 90.6%. This figure is a manifestation of the concentrated electrification of rural areas implemented under the project.

Table 2-10 Movements in the Number of Consumers Supplied with Electricity

	1991	1992	1993	1994	1995	1996	1997	Growth rate between 1991 and 1997
Overall	883,876	937,792	1,001,808	1,074,308	1,149,901	1,226,236	1,305,681	47.7%
For rural area	42,567	45,206	49,927	58,754	70,807	76,679	81,151	90.6%

Source: CELG

(2) Development in the produce and stock-raising industries

The number of irrigation facilities (center pivots) supplied with electricity by CELG increased from 427 in 1991 to 769 in December 1997 following completion of the project. The result, as can be seen in Table 2-11, was a dramatic increase in land under irrigation in the project area.

Table 2-11 Movements in the Land Area under Irrigation

(Unit: ha)

Water resources (name of river)	1991	1992	1993	1994	1995	1996
Araguaia	2,301	2,555	4,344	4,469	5,502	5,883
Tocantins	8,236	9,666	9,882	10,551	11,223	11,240
Paranaiba	27,625	34,608	40,380	47,045	51,986	53,644
Total	38,162	46,829	54,607	62,066	68,710	70,767

Source: CELG

Because rises and falls in agricultural production are influenced not only by the increase in irrigated land area owing to electrification but by other factors such as expansion of the area of cultivated land itself, weather, government policies and the production plans of individual farmers depending on their own demand predictions, it is not possible to conclude that the electrification carried out in this project was linked to an immediate rise in agricultural productivity. If we turn to improvements in productivity based on farmers being able to harvest two or three crops a year owing to access to irrigation facilities at a lower cost[9], we find that as indicated in Table 2-12, harvests of the major crops in Goias are increasing, and that productivity is growing every year. Here we can find proof that concentrated electrification via this project of rural areas and the consequent increase in use of irrigation facilities has resulted in significant growth in

[9] For example, the electricity cost for irrigation needed to produce 1ha of beans is 245 reals using diesel generation, and approximately half that at 122 reals using CELG-supplied electricity.

production. Wheat-growing in particular is an activity that the provision of irrigation facilities has made feasible in Goias, therefore in this sense the project can be said to have improved wheat productivity.

Table 2-12 Unit Yield of Major Agricultural Products in Goias State

(Unit: kg/ha)

Agricultural products	1992	1993	1994	1995	1996
Beans*	770	874	950	988	1,369
Maize	3,473	3,537	3,476	3,911	3,964
Sugar cane	72,869	73,273	74,756	73,594	75,955
Wheat	1,596	2,434	3,149	4,019	3,684

* Generally called as Feijão (= beans) in Portuguese

Other than soy beans

Source: Brazilian National Geographic Statistical Institute material

In terms of stock-raising also, as may be observed from Table 2-13, production of milk and dairy cattle has improved in Goias in recent years. This is related to the project enabling refrigeration to be employed in rural areas for the storage of milk by producers for a specified period of time. As indicated in Table 2-14, the number of commercial refrigeration and storage units used in agro-industries and the electricity consumption of these types of equipment have increased in recent years. The use of this equipment, particularly in rural areas, is something made feasible by the project, and without electrification would have been impossible.

This project therefore can be said to have made a considerable contribution to development in agriculture and agriculture-related industries in Goias State.

Table 2-13 Number of Dairy Cattle and Production of Milk in Goias State

	No. of cows and milk production volume	
Year	Dairy cattle	Milk production volume (liter)
1990	2,340,950	1,071,966
1991	2,464,525	1,166,181
1992	2,550,140	1,276,464
1993	2,659,826	1,410,500
1994	2,636,546	1,409,351
1995	2,648,938	1,469,953

Source: CELG

Table 2-14 Agroindustries Related Electricity Consumption in Goias State

Year	Commercial refrigerators		Commercial storage chamber	
	No.	Electricity consumption volume（MWh)	No.	Electricity consumption volume（MWh)
1993	37	19,568	253	29,348
1994	41	31,074	267	47,664
1995	38	36,684	271	52,673
1996	42	51,098	279	52,617
1997	50	68,845	289	54,392

Source: CELG

(3) Financial internal rate of return

Project FIRR calculations were conducted based on actual project costs and benefits known at this point in time, giving a figure of 14.4%. Costs used for the calculations were actual project cost, maintenance costs and the cost of purchasing and generating electricity, while the extra revenue from the sale of electricity made possible by the project was calculated as a benefit, for a project life of 30 years.

2.3.2 Qualitative (secondary) Effects

Although a lack of data precluded any precise quantitative verification, from the information gleaned from reports of the executing agency, interviews with beneficiaries and information from Brazilian researchers etc., it was concluded that the following are the secondary effects of rural electrification in the target regions.

(1) Improvement of everyday quality of life

Electricity supply stimulated an increase in the use of household appliances such as irons, televisions, refrigerators and washing machines and improved the quality of life of residents of rural areas. The supply of electricity to schools in rural areas furthermore enabled laborers working during the day to attend lessons at night.

(2) Reduction in burning-off of land[10] and conservation of the environment

The area in which the project was implemented is one where the use of fire after the clearing of land is a common aspect of crop and livestock production activity. If mistakes are made in burning-off and it is overdone, flying sparks can cause forest fires which damage the environment by increasing carbon dioxide, making the ground infertile, and destroying the ecology of the area. CELG cites a reduction in this burning-off (see box for details on the assumed relationship between electrification of rural areas and a

[10] A task involved in opening up land for cultivation, in which the stubble remaining following land clearance is burned after it has dried.

decline in burning-off activity), and heightened awareness of forest fire prevention among residents in the project area (as a result of the electrification, the number of televisions increases, and this rends a successful television campaign on fire prevention by the state government), as examples of good (secondary) effects on the environment as a result of the project.

In Brazil, forest fires (burning-off of fields and hillsides) are common in the area extending from the north of the country to the mid-west, and are the source of serious environmental destruction. The causes of these fires are complex and varied, but one culprit cited is the activities of man, i.e. sparks from cigarette butts etc. and burning-off activities involved in the production of crops and livestock, combined with natural conditions caused by the dry climate.

The Brazilian Institute of the Environment and Renewable Resources (IBAMA) therefore conducts surveys and provides education and monitoring of correct methods of burning-off, in an effort to reduce the number of forest fires. According to the IBAMA data in Table 2-15, since the project commenced in 1993 the incidences of fire in both Brazil as a whole and Goias have declined.

Naturally, as explained earlier there are several factors involved in fires, and although fires may be decreasing it is impossible to specify with any certainty to what extent this is a result of the project. However it is worth noting that according to IBAMA, even though there is no quantitative proof of a cause and effect relationship between electrification in rural areas and reduction in forest fires, it is generally accepted in Brazil that when electrification in rural areas brings mechanization of agriculture, leading to improved productivity, there is a reduction in the burning-off of land. At the very least, as explained in the box, if a relationship can be identified between electrification in rural areas and a reduction in burning-off, this may be linked to conservation of the environment. If we consider that the project covered a wide area encompassing all the rural regions of Goias State, then it is not difficult to imagine that as a secondary result of the project there was a decline in burning-off, and therefore the project has made some contribution to the conservation of the environment.

Table 2-15 Number of Places Where Forest Fires Occurred in Brazil

	Year						
Region	1991	1992	1993	1994	1995	1996	1997
Goias State	16,428	37,445	9,963	16,665	8,195	5,928	2,058
Other State	267,429	402,635	169,078	181,225	89,703	100,007	-
Overall Brazil	283,857	440,080	179,041	197,890	97,898	105,935	-

Source: IBAMA

3. Lessons Learned

The appointment of a project manager (or team, unit etc.) with the authority to make decisions on a wide range of matters is an effective stratagem for smooth project implementation.

In the case of this project, the project team set up inside the executing agency was allocated broad decision-making powers in matters involving project implementation, and the majority of decisions and arrangements essential to project implementation was managed within the team. This system facilitates clarity in the chain of command and speed in procedural matters, and it is identified as a major contribution to the smooth implementation of a project.

For this reason, the placement of a project manager (or team, unit etc.) with wide-ranging authority to make decisions is an effective stratagem for ensuring the smooth implementation of a project. The point is not simply appointing a project manager, but whether or not they have the authority to make decisions.

Estimated relationship between rural electrification and reduction in burning-off of land

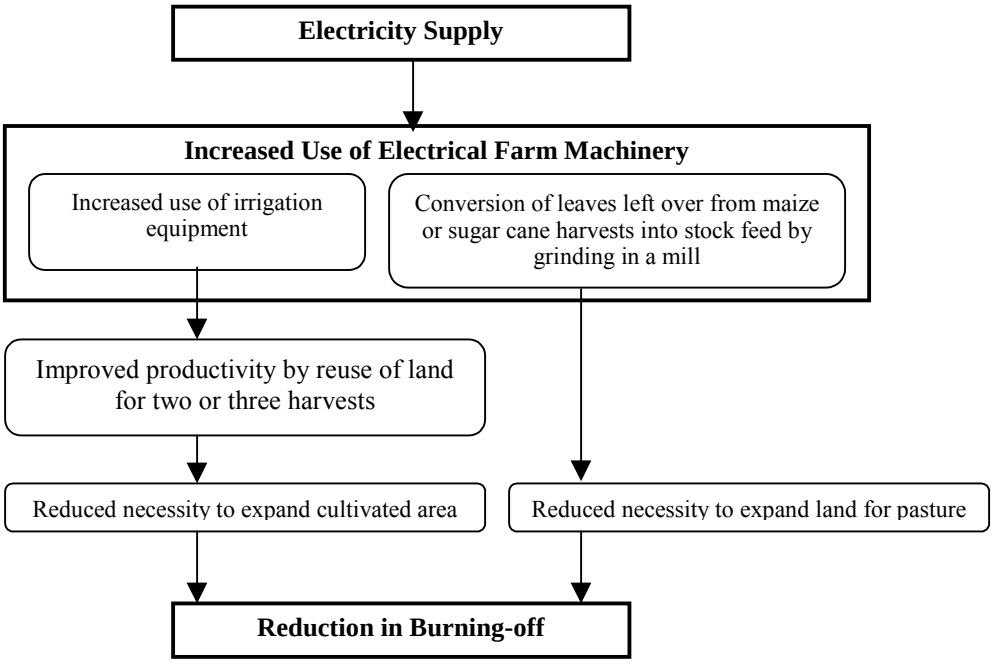
The diagram below summarizes the estimated relationship between the electrification of rural areas and reduction in the burning-off of land.

Firstly, burning-off in stock-raising areas was being carried out due to the dying-off of grass in the dry season (March – August), either to burn off forest and open up new areas for pasture to replace this grass or to encourage early growth of new grass shoots by burning off the dry grass. Electrification, however, allows the introduction of pulverizing machinery, therefore the sugar cane leaves etc. that were previously burned can be harvested by machine and ground up finely for use as feed (even dry leaves can be cut and ground by machine and mixed with the juice from sugar cane etc. to be used as feed). Consequently the need to burn off pastureland or cut down forests to open up new areas of land is reduced.

Next, burning-off for the cultivation of crops was commonly carried out to extend areas available for cultivation, because a shortage of electricity meant that use of irrigation equipment was limited and farmers therefore had to produce as much as possible in the wet season. Electrification makes possible the use of irrigation equipment at a low cost, and increases in agricultural production are achieved by harvesting two or even three crops a year from the same land, reducing the expansion of land for cultivation and consequently burn-off activity.

One other use of burning-off was for the speedy removal of grass etc. following a harvest of sugar cane or maize, in preparation for the next working of the land (doing this by hand takes time and can involve cuts to the skin, making burning-off an easier option). Here also, if leaves which have been cut and gathered are able to be crushed in a mill they can be utilized as feed, and burning-off is reduced. It follows that farming households without machinery will burn off fields for the sake of convenience to clear grass and the remains from harvesting, but it is said that the more tasks a farmer carries out by mechanical means as a result of electrification, the less burning-off he will do.

Figure The estimated cause and effect relationship between rural electrification and reduction in the burning-off of land.



① A center pivot in tomato farm

② Constructed transmission lines

③ Sugarcanes crushed in an electrical grinder