Rural Electrification in Tunisia:

National Commitment, Efficient Implementation and Sound Finances

Report

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ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

PURPOSE

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FUNDING

ESMAP is a knowledge partnership supported by the World Bank, the UNDP and official donors from Belgium, Canada, Denmark, Finland, France, Germany, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. ESMAP has also enjoyed the support of private donors as well as in-kind support from a number of partners in the energy and development community.

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Table of Contents

List of Tables

List of Figures

List of Boxes

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Abbreviations and Acronyms

ADB	African Development Bank
ANER	National Agency for Renewable Energy (Agence Nationale des Energies Renouvelables)
BTJ	Basse Tension Journalière
CGDR	General Regional Development Commissariat (Commissariat Général de Développement Régional)
CNER	National Rural Electrification Commission (*Commission Nationale d'Electrification Rurale*)
CSFP	Sectoral Center for Professional Training (*Centre Sectoriel de Formation Professionnelle*)
EdF	Electricité de France
EGA	Algerian Electricity and Gas Company
EU	European Union
FSN	Fund for National Solidarity (*Fonds de Solidarité Nationale*)
GDP	gross domestic product
GNP	gross national product
GTZ	German Agency for Technical Cooperation (*Deutsche Gesellschaft für Technische Zusammenarbeit*)
HV	high-voltage
LV	low-voltage
MDE	Ministry of Economic Development (*Ministère du Développement Economique*)
MI	Ministry of Industry
NGO	nongovernmental organization
PAC	Pre-stressed Armored Concrete
PDRI	Regional Integrated Development Program (Programme de Développement Rural Intégré)
PP	Presidential Program (*Programme Presidentiel*)
PRD	Regional Development Program (Programme Régional de Développement)
PSC	Personal Services Code
PV	photovoltaic
STEG	Tunisian Electricity and Gas Company (Société Tunisienne de l'Electricité et du Gaz)
SWER	Single-Wire Earth-Return
USAID	United States Agency for International Development

Units of Measure

ha	hectare
hp	horsepower
kVA	kiloVolt Ampere
kWh	kilowatt hour
mm	millimeter
MTD	millions of Tunisian Dinars
Mtoe	million tons of oil equilavent
MV	medium-voltage
MW	megawatt
VA	Volt Ampèrev

Currency Equivalents

Tunisia's national currency is the Tunisian Dinar (TD).

The TD's evolution against the US dollar is as follows:

1975	0.366
1980	0.381
1986	0.796
1990	0.882
1995	0.946
2000	1.274

1

Summary

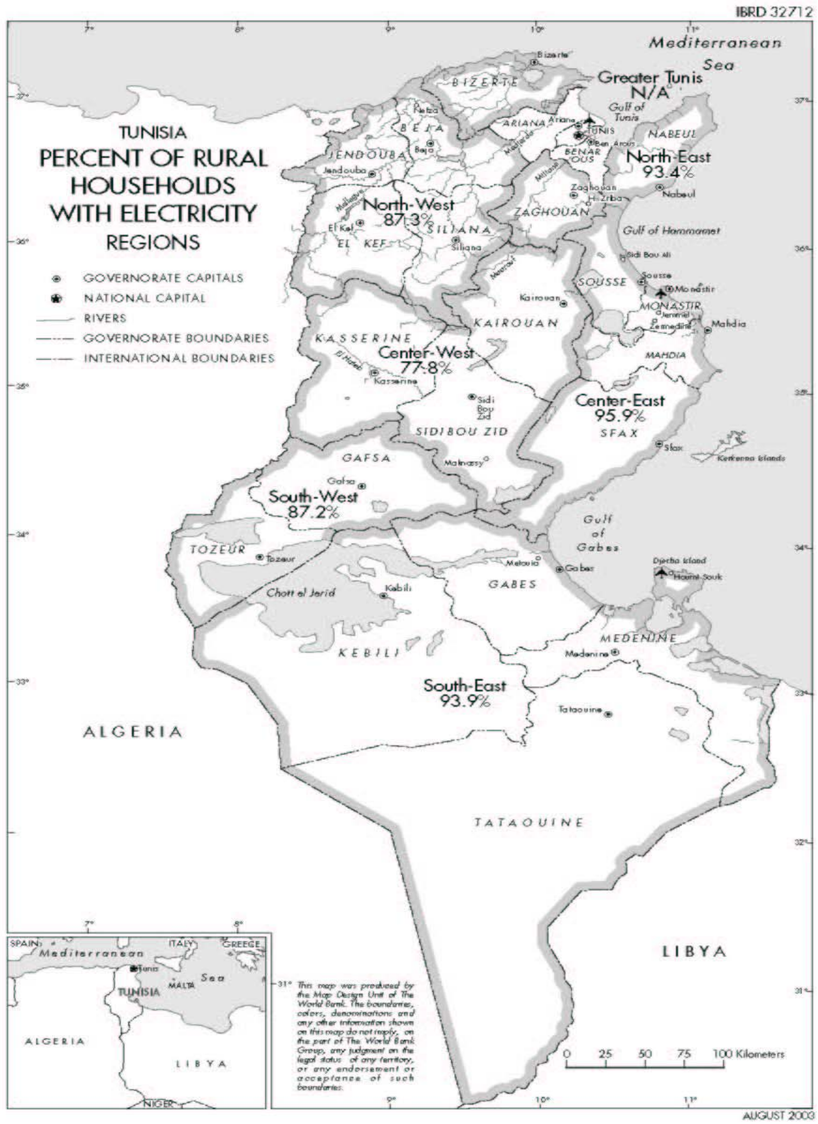
1.1 When Tunisia's rural electrification program was launched in the mid-1970s, only 30,000 (6 percent) of the country's rural households were electrified, even though half of the population lived in rural areas. At that time, rural electrification became the third pillar in an integrated rural development drive that also emphasized basic education and improved health services.

1.2 The Government of Tunisia has made rural electrification a top priority in its social and economic development plans, as evidenced by investment of more than 450 million Tunisian Dinars (MTD) between 1977 and 2000, most of it provided by the national government.

1.3 The Tunisian Electricity and Gas Company (*Société Tunisienne de l'Electricité et du Gaz*), known as STEG, has been the primary implementer of rural electrification. Considered a model enterprise, this public utility's high level of human and technical competence has allowed it to introduce efficient commercial, computer, and other technological innovations. These have included the MALT (*Mise A La Terre*) three-phase/single-phase distribution system, which has dramatically reduced costs, enabling connection targets to be exceeded repeatedly. Overall system losses of 13.4 percent (3.1 percent of them nontechnical) compare favorably with the utilities of developed countries.

1.4 Since 1975, more than 600,000 rural connections have been made, 7,700 with 50-100 watt, solar photovoltaic (PV) systems. By the end of 2000, 88 percent of rural households and nearly 95 percent of all households had been electrified (figure 1.1). The current goal is to achieve, by the year 2010, 97 percent household grid connection and 3 percent PV service.

Figure 1.1: Tunisia's Rural Electrification Coverage, 2000



Main Program Features

1.5 A unique feature of Tunisian rural electrification has been balancing a business-oriented utility operation with substantial State financing and explicit support for rural development. Regional governments' close coordination of rural development zones and infrastructure has ensured the provision, maintenance, and staffing of rural electrification, along with the establishment of schools, clinics, roads, and public lighting systems, resulting in key development synergies.

1.6 Tariff policies, negotiated with the Ministry of Industry (MI), have not diverged greatly from STEG's long-term marginal costs. Low-consumption and agricultural users have benefited from subsidized tariffs.

1.7 As Tunisia rapidly approaches total rural electrification, the following challenges have emerged:

- While rural-electrification planning, implementation, and management are highly decentralized, democratization of Tunisian society is creating pressure for greater consumer participation in electricity decision-making, including better communication between the utility and its customers.
- Although STEG's finances have remained healthy to date, future generation costs are expected to rise, reflecting higher oil prices; moreover, connection and maintenance costs will increase as residents in more remote areas are connected to the grid.
- The favorable arrangements for STEG's gas purchases, which financed electricity-sector operating deficits in the past, are changing; future contributions will rely more on revenue from electricity operations.
- The MALT distribution system, which has proven highly cost-effective and appropriate to date, may require reinforcement and conversion to meet increased rural demand and to encourage demand growth and rural development and employment.
- As the final 12 percent of Tunisia's rural population (70,000 households) is electrified, the respective roles of grid electrification and PV technologies and institutions will require better clarification and coordination.

1.8 As market saturation approaches, the question arises: How can STEG's accumulated technical expertise and external contractors and suppliers be maintained and used, perhaps through technical assistance, to assist rural electrification programs in other African nations? The many factors that contributed to STEG's success—strong government policy and financial commitment, gender and social equity, institutional esprit de corps, technical innovation, and uniquely enabling political and economic conditions—are lacking in many other African countries. Nonetheless, the STEG experience can provide useful lessons—even in unpromising situations—in terms of adaptive technology, robust finances, and an open and transparent system for selecting villages for electrification.

Country Overview

1.9 The smallest country in North Africa (164,500 sq km), Tunisia is situated at the northernmost point of the African continent. Bounded by Algeria to the west, Libya to the southeast, and the Mediterranean Sea to the north and east, the country is divided into well-watered northern and semi-arid southern regions by the Atlas Mountains. The north features lush vineyards and dense cork forests (northwest); fertile grasslands (north-central); and livestock, citrus fruits, and garden produce (northeast), from the capital city of Tunis to Cap Bon.

1.10 Toward the south, mountains give way to a central plateau, which gradually descends to date-palm oases and low-lying salt lakes, known as "chotts." In the extreme south, the chotts merge into the vast Sahara Desert, which comprises 40 percent of the country's land area. The Medjerda River, the country's only major river system, originates in Algeria, emptying into the Gulf of Tunis.

1.11 A mild Mediterranean climate dominates the north and central regions, while the Saharan south is hot and dry. Average annual precipitation varies from 420 mm in the north, to 900 mm in the Atlas Mountains, to less than 350 mm in the southern desert. Only 20 percent of land is arable; 4 to 9 percent consists of forests and woodlands; 20 percent is pasture land; and 13 percent is under permanent crops.

1.12 Nearly two-thirds of Tunisia's 9.7 million people live in urban areas. The ethnic majority is of mixed Arab-Berber origin. The major religion is Islam, and most people are bi-lingual in French and Arabic.

1.13 Tunisia's public health system provides free or highly subsidized health care to some 50 percent of its citizens. Life expectancy is 74 years, infant mortality is 29 per 1,000 live births, and primary school enrollment is 97 percent. Tunisia has good roads and telecommunications networks.

1.14 About 85 percent of water resources is used for agriculture. Nearly 350,000 hectares (ha) are irrigated, and 80 percent of rural households has access to potable water; however, studies show that, if current trends persist, water supply will be insufficient to meet growing demand by 2015.

1.15 The country has 23 regional governments or *Governorates*, which are further divided into *Delegations*. Its legal system is based on French civil law and Islamic law. Tunisia is a lower middle-income country, with a per-capita GNP of US$2,060 (1999) and a GDP of $22 million (1998). Economic growth averaged 7 percent in the 1970s, 3.5 percent in the 1980s, and 5 percent in the 1990s. Principal economic activities are tourism, industry, and agriculture. About 33 percent of the 2.5 million labor force is in agriculture, with 25 percent (including 650,000 women) in industry. Foreign trade is increasingly important, especially with the European Union (EU); exports and imports total about 43 and 46 percent, respectively, of GDP. Major exports include chemicals, crude oil, and textiles.

2

A Brief History of Electrification

2.1 Electricity generation in Tunisia began in 1902, when a French concessionaire that was already providing gas installed the first power plant to service the capital city of Tunis. Other French companies rapidly followed suit, constructing power plants in the cities of Sousse (1905), Sfax (1907), Ferryville (1909), and Bizerte (1911). On the eve of Tunisia's independence from France, in 1956, seven concessionaires controlled the country's electricity generation and distribution. The largest of these was the CTET (*Compagnie Tunisienne d'Electricité et de Transports*) established in 1952, which serviced Greater Tunis and parts of the Northwest. The concessionaires designed their own networks and produced their own electricity or subcontracted producers to maximize profitability of their concession areas and duration of their respective contracts. This resulted in companies sacrificing long-term interests for short-term profitability, making few investments in infrastructure, and alleviating shortages with uncertain solutions.

2.2 CTET owned Goulette, Tunisia's oldest and most powerful steam thermal power station (57 MW in 1952). FHET (*Forces Hydroélectriques de Tunisie*), the country's second largest concessionaire, created in 1952, was responsible for hydroelectric power plants in Ben Metir and Neber in the Northwest. Other companies, which mainly generated diesel, distributed electricity to various cities and urban areas, including Béja, Bizerte, Gabès, Gafsa, Médenine, Sousse, Sfax, Tozeur, and Zarzis. In addition, Tunisia imported electricity from the Algerian Electricity and Gas Company (EGA), which also had interests in FHET. The network consisted of the interconnection with Algeria and the connection between hydroelectric plants in the Northwest and Greater Tunis.

2.3 After independence, the Government of Tunisia initiated a general policy to nationalize key economic activities, including electricity and gas, water, railroads, and banks. In 1958, it temporarily took control of the concessionaires, replacing CTET and the other companies with management committees. On April 3, 1962, the Government nationalized electricity generation and electricity and gas transport and distribution. These activities were entrusted to the STEG, a public utility. At that time, only 26 percent of Tunisian households had access to electricity.

2.4 In the decade that followed, owing to rapid growth in domestic customers and initial extension of the grid into rural areas, electricity consumption increased at a pace of 11.5 percent. STEG concentrated its efforts on rationalizing the system it had inherited from the concessionaires. Electricity generation and transport were developed to meet the demand of new industrial projects, such as El Fouledh steelworks, and the textile industry. In 1965, Goulette 2 was installed, including four groups of 27.5 MW each. In 1972, a power plant was built in the southern city of Ghannouch, which included two groups of 30 MW each and a 15-MW gas turbine. Part of the electricity thus generated was used in Gabès' new industrial units and the rest was transported to other regions through a newly looped system. Electricity generation in Baves was favored through exploitation of flared gas in the southern region (El Borma oil field associated gas) and construction, in 1972, of a gas pipeline connecting the oil field with the Gabès area.

2.5 With assistance from the French utility, EdF, and the pro-active education policy of the Tunisian government,[1] STEG developed a cadre of highly qualified technicians and engineers. By the mid-1970s, it had established sound business practices and financial sustainability achieved through tariffs related to marginal costs. Only 37 percent of all Tunisian households had access to electricity. Although 50 percent of all households were located in rural areas, only 6 percent (30,000 households) had access.

Initial Expansion into Rural Areas

2.6 Having strengthened its electricity generation and transport capacity, the Government became increasingly concerned about the exodus from rural areas caused by lack of public services. In 1973, within the context of its mandate to electrify the nation, STEG undertook a technical audit of distribution, with assistance from Hydro-Quebec.

2.7 Taking into account the Government's ambitious goals, the country's low levels of rural energy consumption, and the State financing that would be required, the audit recommended studying a new, low-cost means of electricity distribution that used three-phase/single-phase lines. Based on the North American model, this system was known in Tunisia as the MALT. Although controversial, the recommendation was confirmed by technical and economic studies conducted for the Master Plan for Distribution in 1974–1975, which estimated savings of 18 to 24 percent using the MALT system. In 1976, the technical decision was made to begin converting to the new system, using three-phase/single-phase lines and 30 kilovolts (kV). On this basis, the Planning Ministry, together with STEG, set rural electrification goals that were incorporated into the Vth Plan (1977–81) and subsequent Five-year Plans (table 2.1).

Table 2.1: Evolution of Tunisia's Rural Electrification Program, 1972–2001

	Five-year Plan					
Factor	IVth (1972–76)	Vth (1977–81)	VIth (1982–86)	VIIth (1987–91)	VIIIth (1992–96)	IXth (1997–2001)[1]
Total investment (MTD)		29	52	105	130	134
No. of new connections	30,000	70,000	80,000	114,000	180,000	135,000
Cumulative						

[1] During the 1970s, 30 percent of Tunisia's national budget was allocated to education.

connections		100,000	180,000	294,000	474,000	609,000
Rural electrified (%)	6	16	28	48	75.7	88.1
Total electrified (%)	37	56	69	81	90.0	94.9
No. of households electrified with PV systems[2]					3,919[3]	3,838

[1] Implemented through the year 2000.

[2] PV program adds about 1 percent to rural electrification coverage.

[3] Cumulative through the VIIIth Plan.

Source: STEG reports.

2.8 The Vth Plan (1977–81) allocated Government funds for system expansion and identified villages to be electrified, based on lowest-cost criteria. STEG's main emphasis was on converting the existing distribution system into the MALT system. During this period, 70,000 rural households were connected, and investment costs were fully recovered. During the VIth Plan (1982–86), 80,000 rural households were connected. Savings from the new distribution system made it possible to connect an additional 10,000 households under the same budget, raising the rate of rural electrification to 28 percent.

Intensified Rural Electrification

2.9 For the VIIth Plan (1987–91), the Government, for the first time, mobilized external funding sources—African Development Bank (ADB), Kuwait Fund, and French Development Agency (ADF) (*Agence Française de Développement*)—with which to launch a more intensive phase of rural electrification. From 1987 to 2000 (VIIth, VIIIth, and IXth Plans), 114,000, 180,000 and 135,000 households, respectively, were connected, raising the rate of rural electrification from 28 percent in 1986 to 88 percent in 2000. Since 1977, 609,000 households have been electrified, and the current goal is to achieve total electrification of the country by 2010.

2.10 Recognizing that remaining unelectrified rural households would be scattered throughout increasingly remote areas, the National Agency for Renewable Energy (ANER), in 1990, launched a PV program, which has already electrified about 1 percent of rural households (7,750 households).

2.11 Tunisia's achievement of 100 percent urban and 88 percent rural electrification is all the more remarkable because the country strictly defines *rural electrification* as connections outside incorporated areas and *rural population* as only the population outside incorporated villages and towns). Tunisia's rural population, which represents 35% of the country's total population, is highly dispersed and isolated, with long distances between small groups of often scattered houses. By contrast, many other developing countries with high rates of electrification define many population groups as *rural* that, in Tunisia, would be considered *urban*. Moreover, in Tunisia, every household in an electrified village or hamlet receives a connection and wiring, sometimes with the assistance of other households in the village, contrary to other countries, where only a few households in an "electrified" village may be connected. The highly scattered nature of rural households, as well as the goal of all households in an area receiving a connection, have strongly influenced the country's rural electrification program—its costs and choice of institutional set up, distribution system, and technology.

3

National Commitment to Rural Electrification

3.1 Tunisia's achievement in rural electrification has been rooted in a strong national commitment to integrated rural development, gender equity, and social equality. Investment in rural electrification reflects the Government's long-standing integrated rural-development and modernization strategy, which has sought to raise the living standard of rural Tunisians, promote security in outlying regions, and moderate urban growth. These integrated investments have had a synergistic effect that has greatly benefited rural people's lives.

Three Pillars of Rural Development

3.2 Rural development was initiated under Tunisia's IVth Five-year Plan (1972–76), based on three pillars:

- basic education (including education of both girls and boys),
- improved health services (including family planning), and
- rural electrification to support the above two elements and rural development.

3.3 These goals were progressively complemented by other development programs, including roads and telephone networks, improved housing, and promotion of rural economic activities.

3.4 Underpinning these goals, since its independence from France in 1956, Tunisia has been at the vanguard of promoting human resources development in the region. This policy has included both women and men.

Basic Education

3.5 Before national independence, most Tunisian women were illiterate; even the most advantaged only had an elementary level of education. Even by the 1960s, female university graduates numbered only about 100. Nonetheless, women participated actively in the struggle for national independence. This was perhaps a factor in the keen personal interest of Tunisia's first president, Habib Bourguiba, in promoting women's rights. Immediately following independence, on August 13, 1956,[2] a Personal Services Code (PSC) was promulgate. Among its other provisions, the PSC abolished polygamy, instituted judicial divorce, gave women the right to vote, and set a minimum age of 17 for

[2] Tunisia now celebrates August 13 as National Women's Day.

girls to marry. The suppression of polygamy, in particular, had an enormous symbolic effect in Tunisia and throughout the world, even though it represented only 4% of marriages in Tunisia.

3.6 In the decades following the introduction of the PSC, the Tunisian government invested heavily in education to ensure that women could take advantage of their new legal rights. The emancipation of women, viewed as a struggle against ignorance, emphasized the education of girls. As a result, attitudes toward girls' education changed radically. The principle of co-educational schools was recognized as a fundamental means of progress and was adopted in schools run by the Ministry of Education. Today, more than 90 percent of both girls and boys are enrolled, and Tunisian women have one of the highest literacy rates in the Arab world. Female students outnumber males in universities; 5,000 women head private companies, and 12 percent of senior business executives and 35 percent of doctors.

Improved Health Services

3.7 The provision of basic health and family planning services formed the second pillar of Tunisia's rural development program. In 1956, female mortality was higher than male mortality. Subsequent improvement of women's access to basic health and family planning services—including women's right to fertility control and access to modern contraception—along with education—resulted in women's increased participation in salaried work. Today, Tunisian women have an average life expectancy of 74 years, have an average of only 2.2 children, and comprise about 33 percent of the labor force.

Rural Electrification: Raising Rural Living Standards

3.8 Rural electrification, the third pillar of Tunisia's rural development, supported both education and health. It also permitted higher penetration of the media, especially television, which introduced rural Tunisian families to various roles for women in urban areas and in other countries.

3.9 The national goal of raising the living standard of rural citizens has included a considerable investment in rural electrification. The political will to invest in rural electrification has proven remarkably steady in weathering political and economic changes. From 1977 to 2000, total investment in rural electrification amounted to nearly 450 MTD; over this period, the Government's contribution increased from 45 percent to more than 80 percent of total investment (table 2.1).

Integrated Investments

3.10 Tunisia's rural electrification policy has been tightly integrated into the country's regional planning process and Five-year Plans. Since the 1970s, the Regional Development Program, known as the PRD (*Programme Régional de Développement*), has been the primary source of State funding for rural electrification. PRD allocations for each rural development sector are negotiated annually between the Ministry of Economic Development or MDE (*Ministère du Développement Economique*) and each regional government or Governorate. At various times, the regional governments have assigned rural electrification a top priority. After the sectoral allocation is negotiated, specific projects are chosen at the *Gouvernorate* level, thereby ensuring local input in project selection. During the 1997–2000 period, rural electrification represented more than 21 percent of total PRD investment, second only to drinking water (table 3.1).

Table 3.1: PRD Investments by Sector, 1997–2000

Sectoral Activity	Amount (MTD)	% of Total Investment
Drinking water	373.7	45.9
Rural electrification	172.7	21.2
Roads, bridges, and streets	150.0	18.4
Education and teaching	47.0	5.8
Post offices and telephones	32.4	4.0
Flood-protection works	19.8	2.4
Health	7.8	1.0
Youth and children	7.5	0.9
Professional training	3.7	0.5
Total investment	814.8	100.0

Source: PRD annual development report, 2000.

Integrated Rural Development Program

3.11 In 1984, the State-funded Integrated Rural Development Program or PDRI (*Programme de développement rural intégré*) was initiated to supplement the PRD. Although small compared to the PDR, the PDRI takes a more integrated approach to rural development. It offers beneficiaries integrated assistance across many areas, including agricultural production, irrigation, and electrification.

Domestic Funds and International Loans

3.12 To meet political needs and assist projects that fail to meet the usual selection criteria of the rural electrification program or other sectoral programs, Tunisia's president created two extra-budgetary funds, which comprise the Presidential Program (PP):

- Special Presidential Fund. This Fund finances projects that the president selects at regional ministry-level meetings and during visits throughout the country.
- National Solidarity Fund or FSN (*Fonds de Solidarité Nationale*). Also known by its bank account number, 2626, the FSN was created by the president in 1992 to improve Tunisian living conditions, particularly in underprivileged areas (*zones d'ombre*). Voluntary contributions are solicited from nongovernmental organizations (NGOs), public and private businesses, and Tunisian citizens. FSN use has resulted in an estimated 10-percent increase in the rate of rural electrification.

3.13 These personal initiatives of the president, supported by contributions from a broad spectrum of society, exemplify the country's strong political commitment to rural development, and to rural electrification in particular.

3.14 Total investment in rural electrification, of which the State's contribution has increased from 45% to more than 80%, has amounted to more than 450 MTD. Since 1977, the State has incurred more than 200 MTD in external debt—not always at concessional rates—with which to finance rural electrification. The ADB, the most significant source, has provided five lines of credit (82.1 percent). The ADB (1995) stated: "With four projects over the period under consideration and about 50% of the total loans granted, Tunisia is the country where ADB has intervened on a sustained basis in the area of rural electrification since 1979. This is because the country has a clearly defined welfare and national development policy where rural electrification has, since 1977, been given priority in successive development plans."

3.15 Other funding sources have included the World Bank (7.8 percent), AFD (7.5 percent), and Kuwait Fund (2.6 percent). Together with ADB support, these loans have helped to finance the connection of 376,000 rural residents, 61.7 percent of the 609,000 rural households connected over this period. Finally, national commitment to total rural electrification has been demonstrated by the development and funding of an ambitious, high-quality PV program, established in the mid-1980s to reach the most isolated households that otherwise would not meet the selection criteria. This program is financed primarily, not by beneficiary and regional-government contributions, but through supplier and World Bank credits and NGOs.

Socioeconomic Synergies

3.16 Tunisia's rural electrification policy has been tightly integrated into the country's regional planning process and five-year plans, with integrated rural development planning orchestrated by the MDE. As table 3.1 shows, investments in drinking water, transportation and communications infrastructure, health, and education have paralleled rural electrification investments in targeted districts. These integrated investments appear to have had a synergistic effect that has greatly benefited rural people's lives.

3.17 Although the socioeconomic effects of rural electrification have not been measured, a correlation exists between growth in rural electrification and national socioeconomic indicators. The increase in the rate of rural electrification—from 6 percent in 1976 to 88 percent in 2000—has been paralleled by a reduced incidence of poverty—from 40 percent in 1956 to 7 percent in 1995;[3] nearly total primary-school enrollment; increased life expectancy (from 50 to 74 years); and improved status of women, who now comprise one-third of the Tunisian labor force. Between 1975 and 1999, real GNP per capita has increased from US$770 to $2,060, while regional disparities have been reduced and income distribution has improved.

3.18 Given that one impetus for rural electrification and rural development generally was to reduce the rural exodus, it is interesting to note the stabilization of the rural population over the 1975–99 period. The rate of urban growth fell from 4.3 to 1.2 percent—despite a doubling of the total population—and population growth fell from 2.3 to 1.2 percent. Today, 35 percent of Tunisians live in rural areas.

[3] In Tunisia, poverty is highest in the mountainous Northwest and above the national average in the hilly west-central and southern deserts. In the District of Tunis and east-central region, which benefit from tourism and dynamic coastal economies, incidence of poverty is low and declining.

Education: Benefits from Better Electric Lighting

3.19 Education is the top priority for Tunisian families from all walks of life; thus, it is not surprising that in a rapid rural appraisal done for this case study, households with school-age children cited improved homework and school performance as the primary benefits of rural electrification (box 3.1). At the same time, they noted that electric lighting reduced the eye strain commonly associated with using candles and kerosene lamps. Schools asserted that the rate of female enrollment caught up with that of boys after households, schools, and public streets were electrified. Public lighting has improved safety, a key concern for families with girls. Construction of paved roads, part of a coordinated rural development effort, has helped to reduce absenteeism. Electric lighting inside schools has improved reading conditions, especially during early evening hours, when, previously, students were required to bring their own candles. Rural residents in these areas perceived that electric lighting, together with the construction of paved roads, helped to reduce absenteeism and contributed to increasing the rate of primary school graduation to 60-70 percent.

Box 3.1: Survey Reveals Tunisians' Perceived Benefits of Rural Electrification

In May and June 2000, a three-member research team (one male economist, one male engineer, and one female statistician) conducted a rapid socioeconomic appraisal of Tunisian households that had been electrified for two-to-five years. The survey was conducted in three rural areas: Bizerte (North), Siliana (West-central), and Nabeul (Northeast). The team interviewed 54 households; key informants in health, family planning, and rural development services; and agricultural and agro-processing users. Family-planning assistants, long experienced in direct relationships with rural families in larger populations, interviewed an additional 50 households. The appraisal explored not only the respondents' perceived benefits of rural electrification, but also problems in service, such as power outages.

The researchers discovered that households were well aware of the benefits of rural electrification and had quickly taken advantage of their connections. Each had an average of two lights per room; refrigerator, television, and radio ownership varied between one for every two households and one per household; and some households owned cable dishes. Households perceived multiple positive linkages between rural electrification and education, health, and quality of life. Those with school-age children perceived improved homework and school performance as the primary benefits. Other perceived benefits, especially for women and girls, were better access to education, health and family-planning services, and televised information; economic advantages; and enhanced safety.

Source: Chaib and Ounali, 2001.

Improved Access to Health and Family Planning Services

3.20 After education, the Tunisian government's most important priority is basic health and family planning, which is reflected in households' perceived benefits of rural electrification in the study areas. Rural electrification was provided at the same time as were clean water and well-equipped and staffed health clinics (for example, a nurse is permanently available even in these remote clinics; a general practitioner visits once a week; and a specialist health team regularly visits). Health clinics are equipped with electric lighting, a refrigerator, negatoscope, sterilizer, popinel, electric fans, oil heaters, radio, television, and occasionally a video. Most drinking-water points are equipped with pumping devices, and there is much demand to replace diesel with electricity.

3.21 Beneficiaries and health staff attributed the reduced birth rates in their area, at least in part, to rural electrification, which increased the effectiveness of family planning and other health programs. Clinics reported being able to expand the range of their equipment and services. For example, they can present televised and videotaped programs on public health and disease prevention in waiting rooms; instruments can be sterilized; and vaccines for infants and tetanus shots for pregnant women are more widely available. According to one nurse, refrigeration for vaccines and medicine has noticeably reduced childhood diseases, diarrhea, and poisoning.

Media and Information Access

3.22 Respondents also credited rural electrification with improving access to critical information, particularly via televised media. Women in electrified households organized their daily tasks to make time for watching television, which conveyed many messages on reproductive health and contraceptive methods; vaccines; prevention of sexually transmitted diseases; and health checks for breast and colon cancer. Family planning units used audio-visual aids, making awareness-raising campaigns more effective. Better information for girls from family planning services, but above all from television, is credited with the rapid decrease in teenage pregnancies. Clinics presented televised and videotaped programs on public health and disease prevention in waiting rooms.

3.23 Women beneficiaries and health staff perceived that rural electrification improved women's quality of life. Because of electrification, both husbands and wives spent more time at home. Installation of television sets—and even satellite dishes—have raised women's awareness (in many cases, more so than their husbands) of current political and world events. In turn, this has given women the confidence to speak up, defend themselves, and take on leadership roles. In addition, rural women and children, especially girls, became more demanding about personal hygiene and followed the latest television advertisements and fashions.

Economic Savings

3.24 Perceived benefits of rural electrification also included increased economic opportunities for women at home and in the village. Because electric lighting made evening activities possible, many girls said they preferred staying in the village to earn a living by sewing, weaving, or knitting to going to the city to work as maids. Sewing workshops and hairdressers (presumably a result of increased fashion consciousness) figured prominently among the economic activities perceived as having developed because of electrification. Various national development programs provided households equipment for such activities. Another perceived economic advantage was lighting of crop-processing activities during evening hours. In addition, refrigeration was valued for its ability to preserve food and medicine and thus save money spent on such items.

Enhanced Safety

3.25 Another cited benefit was enhanced safety resulting from widespread public and outdoor lighting (e.g., in front of houses, barns, sheds, and even orchards). External lighting prevented theft and protected citizens from dangerous snakes. Enhanced safety was a key concern for families with girls. Schools asserted that, after households, schools, and public streets were electrified, the rate of female enrollment caught up with that of boys.

Benefits to Agriculture and Livestock

3.26 Householders and rural development workers perceived that electricity benefited agricultural development. Water points multiplied, and electric motors quickly replaced diesel sets. Electric pumps were cheaper (for a surface well, a single-phase electric motor costs about 1,500 TD compared to 6,000-8,000 TD for a comparable diesel motor) and operating costs were lower. Furthermore, diesel motors required technicians (in short supply in rural areas). Hygiene was better with electric than with diesel motors, and electric pumps operated for longer periods than did diesel motors (18 versus 12 hours per day).[4]

3.27 The national government provides agricultural development various incentives to integrate with rural electrification. For example, one water conservation program provides a subsidy of 60% for electric pumps and drip irrigation pipes; a subsidy of 7-15% is provided for electric pumps alone. Drip irrigation in this area (Bizerte) has increased returns for tomatoes (from 25 to 120 tons per ha) and potatoes (from 15 to 35 tons per ha).

3.28 Animal husbandry was also perceived as having benefited from electrification in the study area. For example, cows could now be milked mechanically, and milk-storage centers reduced waste and provided supplies for more distant markets. Refrigerated centers permitted storage of eggs, cheese, fruits, and vegetables; electrically heated and ventilated henhouses stimulated commercial chicken production; and electric motors provided power for grain milling, oil pressing, and small workshop equipment.

[4] One disadvantage of electric water pumping for agricultural use is that it rapidly exhausts the water table. For this reason, it must be carefully monitored. The water authority sets maximum outputs, which farmers cannot vary according to their needs; therefore, a reservoir must be constructed.

4

Effective Institutional Structure

4.1 Tunisia's rural electrification program, in which the public sector plays a dominant role, benefits from an institutional structure that has proven highly effective in achieving rapid connection rates. An iterative five-year planning and implementation process balances economic and social criteria and imposes financial, target-driven discipline on rural development projects, including rural electrification. The system is characterized by centralized planning, with major regional and subregional inputs and initiatives, all within the framework of a comprehensive rural development program.

Characteristics of an Effective Institutional Structure

4.2 Three major features give the institutional structure unity of direction and action:

- well-defined agency roles and mandates,
- official coordinating body and supplemental agency coordination, and
- planning and implementation processes that guarantee continuous interaction between agencies.

4.3 Clear criteria govern project selection; they provide cooperating institutions unambiguous guidelines, which are instrumental in facilitating closely coordinated policymaking and implementation. Because all cooperating agencies are aware of the criteria governing the process, they can focus on efficient implementation.

Agency Roles and Mandates

4.4 That Tunisia has multiple institutions involved in developing and implementing its rural electrification program may, at first glance, appear unwieldy. However, each agency has a clearly defined role and mandate.

National Policy and Planning

4.5 The MDE, in collaboration with its specialized agencies, including the General Regional Development Commissariat or CGDR (*Commissariat Général de Développement Régional*), defines overall rural development policy, which provides the framework for rural electrification. The MDE is charged with disbursing a share of national revenue to subsidize rural electrification projects in a cost-effective, equitable way. It mobilizes finances, and divides the national budget for rural development between the regional governments and implementing agencies. Both the PDR and the PDRI are housed within the MDE.

4.6 The MI develops Tunisia's energy policy. It is responsible for supervising the various branches of the energy sector: hydrocarbon exploration and production; refining and distribution of petroleum products; and production, transport, and distribution of gas and electricity. As part of its mandate, the MI houses the National Rural Electrification Commission or CNER (*Commission Nationale d'Electrification Rurale*), has supervisory authority over STEG, and provides input into the five-year planning process.

4.7 The Special Presidential Fund and FSN (two separate funds comprising the PP), help finance rural electrification projects whose costs exceed the ceiling established under the five-year planning process.

4.8 STEG, as the national electric utility, is responsible for electricity generation, transmission, and distribution, as well as natural-gas transport and distribution. Although it falls within the MI's jurisdiction, STEG enjoys considerable autonomy in practice, especially in technical matters. However, broader social decisions, such as tariff changes, are made in consultation with the MI.

4.9 ANER, under the administrative supervision of the Ministry of Environment, promotes energy conservation and development of renewable energy.

Regional and Local Planning and Implementation

4.10 The Governorates, in their role as regional executive agencies of the Ministry of the Interior, are charged, together with their Delegations, with selecting rural development projects, including rural electrification projects, and allocating funds disbursed from the national budget, in addition to their own resources. The Governorates also oversee the timely and efficient completion of projects. Thus, they and their Delegations provide, at an official level, primary regional and local input into project selection and design. In identifying rural electrification projects in their respective jurisdictions, the Delegations also consult with *Oumdas* (leading citizens who act as spokespersons for local interests).

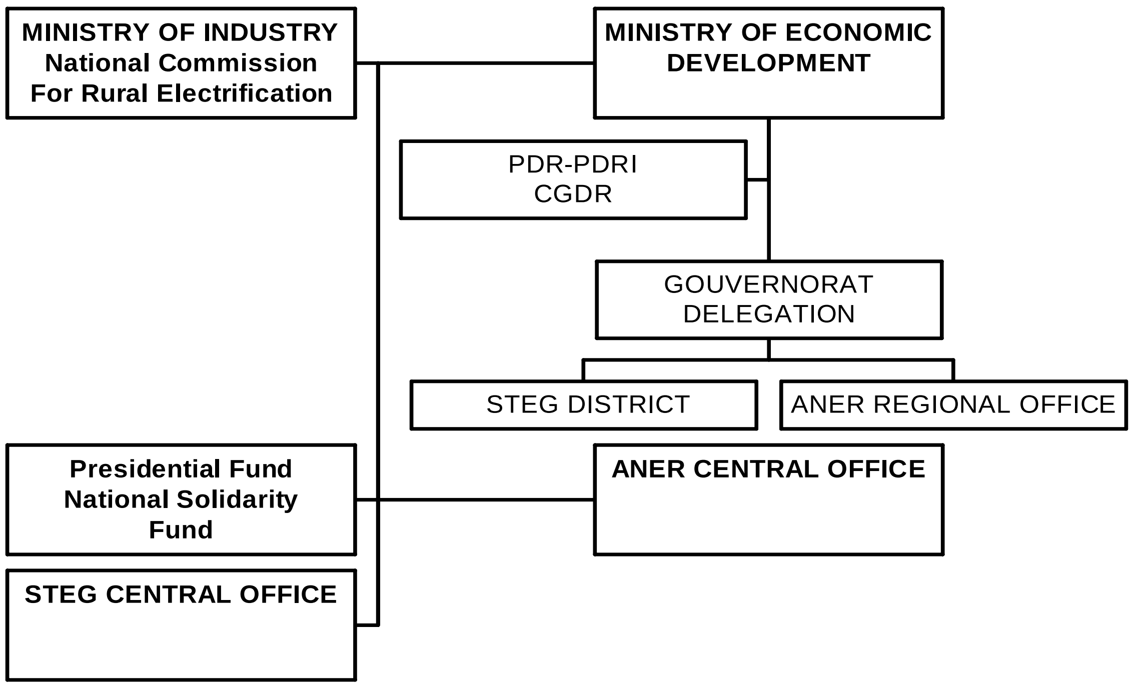
4.11 STEG is responsible for implementing the major part of the rural electrification program—that based on grid extension. It maintains a regional organization that parallels the Governorates. Thus, STEG districts largely coincide with Governorates, facilitating regular consultations between the two bodies. STEG is the direct counterpart of the Governorates in rural electrification projects. As a statutory Government corporation, established by Decree Law No. 62-8 of 1962 on nationalization, STEG is responsible not only for grid-based rural electrification projects, but for the entire electricity sector, including generation, transmission, distribution, and export, as well as distribution of gas under the MI's supervision.

4.12 ANER undertakes PV-based rural electrification projects that aim to connect households remote from the grid. Although much of its activity is centered at its Tunis headquarters, ANER has offices in the three regions where it implements the most projects: El Kef, Sidi Bouzid, and Gabès.

Agency Coordination

4.13 Recognizing the many institutions involved in rural electrification, considerable effort is made to ensure their coordination. At policy and implementation levels, coordination is achieved both institutionally and systemically (figure 4.1).

Figure 4.1: Key Institutional Relationships in Rural Electrification Planning, 2001



4.14 The CNER, a coordinating body chaired by the MI's Director of Electricity and Gas, includes representatives of STEG, ANER, MDE, Ministry of Environment, Ministry of the Interior, and FSN. Through regular meetings, CNER keeps members informed of rural electrification activities implemented throughout the country. It provides a forum where policymaking, planning, and implementing agencies can exchange views and identify problems.

4.15 Though useful, the CNER cannot handle the broad range of issues that arise during a major program's planning and implementation. Therefore, Tunisia supplements CNER's coordination work with continuous interaction—both horizontal and vertical—between agencies. For example, when the Five-year Plans are being formulated to arrive at targets consistent with available financial and technical resources, two-way communication is continuous between the MDE, MI, STEG, ANER, and CNER. Similarly, at the regional level, the Governorates interact continuously with STEG districts and ANER offices during program execution.

4.16 The program contents of the Five-year Plans are also developed iteratively through two-way communication between central and regional authorities. In fact, the first estimate of rural electrification projects within the overall rural development budget, established by the MDE, originates at the subregional (Delegation) level. Far from being entirely top-down, the process incorporates a substantial amount of bottom-up content, at least at the official level.

4.17 The dynamics of this coordination are reflected throughout the planning and implementation process, discussed below.

Planning and Implementation

4.18 During most program years, more villages or households wish to be electrified than there are funds available to do so. It is therefore important to ensure that rural electrification planning is open and objective and uses clearly-defined criteria to rank villages and households for connection. Clear criteria respond to concerns about social justice or fairness, reduce local political pressure to "jump the queue," and allow for a more rational and economic, long-term electrification program. They also facilitate project planning and implementation by eliminating potential contention between cooperating agencies.

4.19 Because Tunisia's rural electrification program is integrated into the rural development programs of the Economic and Social Development Five-year Plans, it shares many features of other rural development projects. The project-selection process underscores rural electrification's role as an agent of rural development. For example, rural electrification plans and targets are made publicly available so that progress can be monitored and assessed.

4.20 The first step in project selection is to identify and prioritize regions to be included in the rural development program. This is done in three stages: 1) choosing the zone (local district), 2) selecting the beneficiaries within the chosen zone, and 3) identifying projects for rural electrification. At all three stages, exchange of information and subsequent adjustments to plans can be observed.

STEG Site-selection Process

4.21 The STEG program, which accounts for more than 90 percent of connections, uses a two-step process for site selection. First, within the framework of the current Five-year Plan, the MDE identifies the Delegations or zones to include in the rural development program. Selection is based on such criteria as income level and other economic and social indicators, unemployment, environmental quality, gender status, expected rate of return from projects, and costs of job creation and improved living conditions. Second, potential projects are identified within the Delegations and zones selected in the first step. The Governorate asks the Delegations to list all non-electrified *agglomerations*.[5] Potential sites for electrifying agricultural pumping and water drilling in the Delegations are also identified. This list is compiled in collaboration with the local Oumdas.

4.22 Next, STEG district offices in each Governorate review this list in detail. They make site visits to verify the information provided by the Governorates and collect additional data, including length of needed medium voltage (MV) and low-voltage (LV)

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[5] The term *agglomeration* is defined as a minimum of 10 households or adjacent households no more than 200 m apart, built with walls and roofs of permanent materials.

lines available, as well as number of transformers and housing units suitable for electrification. This information is then mapped onto the existing grid.

4.23 In this way, a database of economic and technical information is constructed for each STEG district. This information is processed in STEG's computer-driven economic feasibility model in order to evaluate the investments per project or *grappe* (several projects served by the same medium-tension [MT] line). STEG headquarters then estimates costs, based on STEG unit costs, of electrifying the various households, agglomerations, and pumping and drilling sites. Based on this estimate, a table is prepared, showing the number of households that can be electrified at various cost levels and the estimated total costs of electrifying the number of households at each cost level.

4.24 This process permits STEG to provide the MDE with scenarios for electrification. Each scenario gives, for each Governorate, the number of beneficiaries, cost of projects, and rates of electrification. Once the rural development objectives of the Five-year Plan are fixed, these scenarios are used to establish project costs. For example, in the IXth Plan (1997–2001), the MDE fixed the ceiling at 2,200 TD (of which beneficiaries pay 200, STEG pays 200, and the State pays 1,800). Thus, all projects that cost less than this ceiling are selected for inclusion in the provisional Five-year Plan, based on grid extension; however, projects that cost more than 2,200 TD may be included in supplementary PP funding.

4.25 The regional Governorate, in collaboration with STEG's district office, adopts these projects and the funds the MDE allocates for rural electrification. The CNER then checks for inconsistencies between the adopted Governorate projects and those in other programs (e.g., PDR, PDRI, Special Presidential Fund, and FSN). Finally—through meetings between the MDE, Governorate, STEG, and ANER—the Governorate program is confirmed at the national level. The Five-year Plan is thus the consolidation of the various regional plans.

ANER Site-selection Process

4.26 Under the ANER program, the number of households that could benefit from PV systems is based on census data, as well as results of STEG inquiries and a 1995 renewable-energy study that concluded 70,000 households would not be served by the grid. Based on these findings, ANER planned to install 10,000 systems in the VIIIth and IXth Five-year Plans (7,700 have been installed to date).

4.27 ANER's site-selection process is determined largely by the advance of the grid-connected system. Historically, because of the time lag between ANER project definition and installation (as long as two or three years), PV projects were sometimes overtaken by arrival of the grid. In other cases, the grid arrived shortly after the PV systems had been installed, thereby duplicating efforts and wasting resources.[6]

4.28 Today, tighter coordination between ANER, STEG, and the Governorates helps to avoid such duplication. ANER now asks each Governorate to provide a list of potential

[6] In 20 percent of cases, the grid arrived within three months to a year after PV equipment had been installed.

beneficiaries of PV systems. The list is based on rural development needs, present and projected distance from the grid, and householder interest. Increasingly, efforts are made to ensure that projects are located well beyond anticipated grid extension. Thus, the list is reviewed by STEG before implementation.

Achievements and Challenges

4.29 Rural electrification experience throughout the world suggests no single institutional structure or process for success. Regardless of the structure adopted, however, several characteristics are essential: clarity of purpose, well-defined roles for all agencies involved, and established procedures that ensure equitable agency coordination. As noted above, Tunisia scores well on all counts.

4.30 Nonetheless, Tunisia's rural electrification program has its shortcomings. Coordination has sometimes broken down—as the above example of duplicating PV systems and grid extension projects illustrates—resulting in wasted resources. Moreover, while the project-selection process (at least on paper) appears admirably clear and transparent, it may be criticized, in practice, for verging on the mechanical, especially in cases where local costs diverge from the national averages used to estimate total costs of rural electrification. Finally, although the selection process is initiated at the community level, in consultation with the local Oumda, this input is considered official rather than at the citizenry level, and could therefore be incomplete.

4.31 On balance, however, Tunisia's track record reflects its efficient, well-coordinated institutional processes, as well as its perceived fairness. These factors, in turn, have reinforced a national commitment to improving rural living conditions by making rural electrification an integral part of the country's broader rural development program.

5

Effective and Efficient Operations and Practices

5.1 The STEG's long record as an effective, efficient utility has earned it an international reputation as one of the best developing-country power utilities in the world (Hicks et al. 1993; ESMAP 1992a. Insulated from unwarranted political influences through its mandate, STEG has been a key partner in Tunisia's rural development. It is viewed as a model enterprise in the Tunisian government and economy,[7] having attracted the best and brightest Tunisian engineers and economists to implement the nation's rural development mission during the 1970s. In hindsight, the high level of confidence vested in STEG's technical assessments played an important role in the successful adoption of cutting-edge technology.

Operational Characteristics for Success

5.2 Three major operational factors contributed to STEG's success:

- clear mandate and effective management structure,
- early computerization and development of software applications adapted to the Tunisian system, and
- transparent norms and guidelines.

Mandate and Management Structure

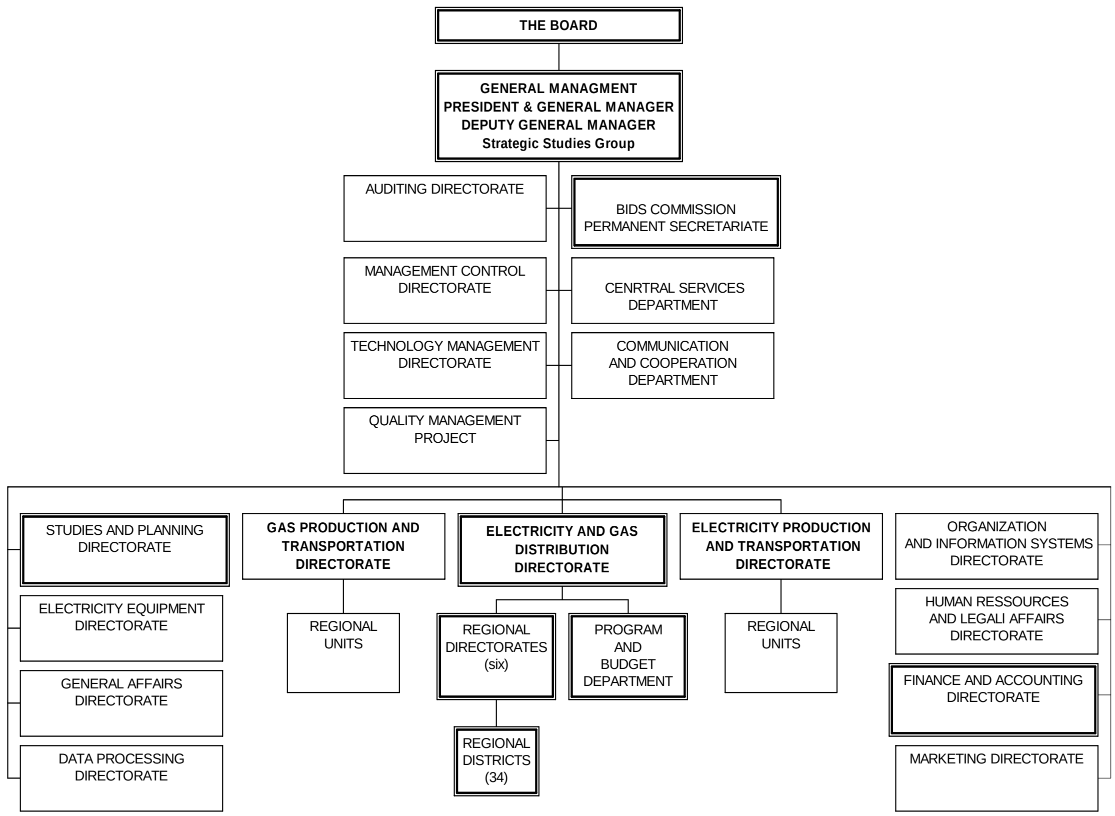
5.3 STEG is a statutory Government corporation, of a commercial and industrial nature. Established by Decree Law No. 62-8 of April 3, 1962 under the Ministry of Industry's supervision, STEG is responsible for the generation, transmission, distribution, import, and export of electricity and natural gas. The utility's three departments and 15 directorates, which report to the chairman and managing director, are responsible for operating the electricity and gas systems and managing the utility (figure 5.1).

5.4 The Directorate for Electricity and Gas Distribution has primary responsibility for rural electrification, through its Department of Program and Budget, Logistical Directorate, five Regional Directorates, and 34 District branch offices. This Directorate is supported directly, however, by the General Management, which approves plans and budgets, and by central administrative STEG units, including the Directorate for Finance

[7] While a discussion of the reasons for STEG's development as a model enterprise is beyond the scope of this report, it should be noted that the strong leadership role of its founding chairman at critical junctures was a significant factor.

and Accounts, Directorate for Studies and Planning (which sets tariffs), and Directorate for Human Resources and Legal Affairs (which trains external contractors).

Figure 5.1: STEG Organizational Chart



5.5 STEG's 14-member Board of Directors includes a Chairman and Managing Director, Assistant Managing Director, nine members representing the State (including a representative of the Ministry of Environment), two members representing employers, and one financial controller. STEG also has a cooperative agreement with the Association of Consumer Protection to provide consumer input through regular meetings with STEG headquarters, as well as with field offices and the newly implemented call centers.

5.6 STEG's organizational structure reveals two key reasons for its success in rural electrification. First, the utility has enjoyed the backing of highly professional, experienced administrative units within a large corporation with well-established operating and customer-management procedures. Second, it has benefited from a highly decentralized implementation structure since 1977, when the decision was made to establish district offices in each Gouvernorate. Today, in fact, many Gouvernorates have more than one STEG district office, which facilitates coordination with rural development planning through the local selection of STEG projects in close cooperation with the regional administration.

Early Computerization and Development of Software Applications

5.7 Another key to STEG's success has been the computerization of operations and development of software applications, which have been adapted to the utility's specific needs. STEG was the first major Tunisian corporation to computerize operations; this occurred in the early 1970s, the same time that the country's rural electrification drive was launched. By the late 1970s, nearly all departments had been computerized, which permitted a sophisticated level of data collection, analysis, and management that contributed greatly to STEG's ability to monitor and improve its performance in all areas, including rural electrification.

5.8 During the mid-1970s, various software applications fundamental to the day-to-day operations of STEG were designed and adopted. These included:

- personnel and salary management (pay chain),
- daily accounts, billing, and receivables of LV subscribers, known as BTJ (*Basse Tension Journalière*),
- billing of MV subscribers,
- inventory management of network supplies,
- integrated management system, and
- integrated management of construction works.

5.9 During this initial period, STEG emphasized software development as an operational and business management tool. Engineers and software technicians were recruited to design and put in place these software applications. To strengthen data handling, a more powerful mainframe computer was purchased, and access terminals were installed in users' offices. Software applications were also developed to facilitate the design of rural electrification systems. These included the Tanouir software for sizing MV lines and the BTJ software for daily accounting records of LV customers (Appendix 1).

Transparent Norms and Guidelines

5.10 STEG's operational norms and guidelines, updated regularly, are used by both STEG technicians and outside contractors to ensure a standardized approach and adherence to contracts. These guidelines include:

- *Section on Specific Administrative Clauses* or CCAP (Cahier des Clauses Administratives Particulières)—Covers all administrative details, including the costs that can be included in bids, those for which STEG is responsible, escalating factors for unit costs, terms of payment to contractors, general billing conditions, applicable taxes, penalties, insurance requirements, construction supervision, and project acceptance by STEG.
- *Section on Specific Technical Clauses* or CCTP (Cahier des Clauses Techniques Particulières)—Includes all general specifications for project construction, including tolerances when laying out lines, transport and handling procedures for various components, specifications for preparing concrete, appropriate

installation of line hardware and stringing of conductors, and preparation of grounds.

- *Technical Guide to STEG Electricity Distribution* (Guide Technique de la Distribution Electricité de la STEG—Includes all specifications for the design and construction of rural electrification projects and is supplemented by a series of documents detailing Tunisian standards.
- *Uniform Cost Evaluation Reference* (Mercuriale, Etat Synthétique)—Prepared by STEG every 12-18 months based on its nationwide rural-electrification cost history, permits standardized cost evaluation by all units. Costs are prepared for each assembly that a rural electrification project uses; they include supply and storage fees, overhead, in-country transport from central storage to job site, and installation. The Mercuriale facilitates preparation of customer invoices for construction, equipment, and services rendered by STEG for its customers, as well as calculation of project costs, regardless of financing source.
- *Unit Cost Contract* (Contrat-tariff)—Contains unit costs for each task undertaken during project construction as a basis for payment to small enterprises. This document is revised every three years for each zone on the basis of unit costs bid by the large enterprise that is the lowest bidder for large projects in that specific zone (minus the transport costs from central storage to the district, which is STEG's responsibility for small jobs).

5.11 Taken together, these guidelines have provided an implementation framework for rural electrification that has reduced costs and raised efficiency considerably through standardization.

Successful Project Implementation and Construction

5.12 STEG's successful implementation and construction of rural electrification projects are based on four major factors:

- encouragement of private-sector participation during the construction phase,
- promotion of local industry to supply equipment and materials,
- computerized inventory management system, and
- rigorous commercial practices, including control of non-technical losses and effective billing and connection payment procedures.

Private-sector Participation in Construction

5.13 Most rural electrification projects are constructed by outside contractors, not STEG. STEG's role more often involves project planning and design, contractor selection and training, procuring and managing grid supplies, development of detailed construction standards and guidelines, and monitoring and evaluation of completed projects. This approach has succeeded in maintaining low costs and ensuring quality construction, as well as supporting the development of local expertise and enterprises.

5.14 Both large national enterprises and small local firms participate in project construction. Projects whose labor costs exceed 30,000 TD are bid on. A verification committee, composed of independent evaluators, uses a technically and financially rigorous process through which to evaluate the bids. For projects whose labor costs are less than 30,000 TD, STEG's district office selects small local firms, based on their availability and technical capacity. In 1992, large enterprises handled 36 percent of construction, small firms were responsible for 56 percent, and STEG undertook the remaining 8 percent.

5.15 In the early 1970s when the drive toward rural electrification first began, Tunisia's few local enterprises lacked the skills needed to construct medium-voltage/low-voltage (MV/LV) substations and lines. STEG encouraged these firms to increase their competence through training provided by the Sectoral Center for Professional Training (CSFP) (part of the Tunisian Agency for Professional Training). The CSFP training program helped to establish a qualified cadre of rural electrification contractors in all regions. In 1999–2000 for example, the CSFP trained 30 foremen and 63 linemen, who represented firms from throughout Tunisia.

5.16 As projects progress, STEG technicians regularly check their adherence to the utility's technical distribution guidelines. STEG prepares regular project status reports, which are submitted to the regional Gouvernorates, the MI, and financing organizations.

5.17 A STEG team inspects completed projects to ensure they conform to the terms of the contract and relevant construction norms. Since STEG assumes all financial responsibility for subsequent use of the system, the inspections are quite rigorous, and the contractor must remedy any inadequacies before payment is made.

Participation of Local Supply Industry

5.18 Tunisia's rural electrification program has encouraged the development of national industries to supply its needs. In externally-funded projects, local and international suppliers compete directly, which has pushed local suppliers to improve their product quality and adjust prices to the international market. Initially, local suppliers enjoyed a 15-percent preference over the lowest international bid; this preference decreased by 5 percent per year until it was eliminated in 2004, at which time local suppliers were placed on the same footing as international ones.. Currently, the average share of Tunisian suppliers of grid materials is 64 percent (it varies between 40 and 100 percent, depending on the item supplied) (Appendix 2).

5.19 The bidding process for grid supplies is meticulous. Pre-defined rules are followed for deadlines, method of evaluating technical bids independent of price bids, and method of submitting bids for specialized commissions' approval. These rules guarantee maximum transparency and give suppliers the confidence to make their best offers.

5.20 Now that Tunisia's electrification market is nearly saturated, suppliers are turning toward export markets. According to the World Bank (2000a), export of electrical machinery is a booming industry, having grown from 1.2 percent in 1980 to 7.5 percent in 1997 and poised for continued grow. Thus, STEG's strategy of using local suppliers appears to have not only reduced its own costs, but to have also encouraged growth of a national export industry.

Computerized Inventory Management System

5.21 STEG's sophisticated inventory management system has been a major factor in the utility's ability to cut costs. The supply system allows for disruptions, thereby avoiding storage costs. Through regional grouping, larger quantities can be ordered, thereby reducing supply costs.

5.22 The Logistics Department is responsible for determining global supply needs, launching calls for bids, and placing orders. This was the first STEG department to obtain the ISO-9002 quality certification, which assures suppliers and bidders that procedures follow international standards.

5.23 Inventory management occurs within an ongoing cycle of document circulation, data analysis, and database updates. Four key features of the cycle are:

- *Annual calls for bids and placing orders*—Conducted according to a well-defined, independently reviewed process.
- *Monthly updating of current inventories* (at both central and district-level warehouses)—Permits timely transfers between districts, thereby reducing the need for storage. This system has been computerized since the early 1970s, and each item has a code and STEG end price.
- *Monitoring supply consumption* (using the same computer software)—Provides information on supply flows, inventory stocks and changes, and system performance (e.g., how close current inventories are to average monthly consumption and average monthly stocks). All supplies are divided into three classes: A, B, and C. Class A, which represents 80 percent of supplies by value, has an inventory of 4-to-6 months; Class B represents 15 percent, with a 12-to-18 month inventory; and Class C, represents the remaining 5 percent, with a 12-to-24 month inventory.
- *Forecasting needed purchases*—Made for the following year, based on the above data on current use and five-year averages, for each of the some 400 items in the inventory.

Rigorous Commercial Practices

Non-technical Losses

5.24 Tunisia's non-technical losses—the financial losses the utility incurs when the power it supplies is consumed but not paid for—are comparable to those of developed-country utilities. STEG's distribution system has minimized its non-technical losses largely as a result of a customer management improvement program introduced in the 1980s. For the entire distribution network, ESMAP (1992a) estimated non-technical losses at only 3.1 percent (technical losses, mainly in transformation, were estimated at 10.3 percent and total systemwide losses at 13.4 percent).

5.25 In rural areas, fraud and meter tampering are minimal. One major reason is that rural customers respect the electricity utility more than urban consumers do. Meters in rural areas, installed more recently than in urban areas, are damaged less often , and unrecorded losses caused by blocked or damaged meters are rare. Another deterrent is STEG's policy on illegal connections: it includes frequent monitoring and inspection campaigns, rotating meter readers among districts, printing meter cards for disconnected customers, and generating computerized lists of low-consumption users. Bonuses are given for identifying cases of fraud;strict legal action is taken in such cases. And hard-to-hook-up-to, insulated cables are used for networks and supply lines.

Customer Billing

5.26 Customers are automatically billed from two computer centers: 1) Tunis and 2) Sfax. In the early 1970s, STEG set up an integrated billing software program, whose effectiveness has been proven through thorough testing. The first customer who requests a connection activates the system. Each customer file is followed closely through the cycle of connection, cash payment, hook-up, and finally metering and billing of consumption. This system allows for daily monitoring of consumption and regular monitoring of installed meters to avoid unaccounted for consumption.

5.27 The software used can monitor meter reading and signal any deviation in athe bi-monthly reading regarding a customer's historic consumption pattern. This allows the detection of index errors and signals any potential cases of fraud as soon as any unexplained changes in consumption levels occur.

5.28 Although LV customers are billed bi-monthly, meters in rural areas are read only once every six months (compared to once every four months in urban areas and every other month for Government offices and water pumping). Thus, between meter readings for rural customers, two bills are estimated based on the average bi-monthly consumption over the last three rolling years. When the meter is read, the actual consumption is calculated, and the amount paid in intermediate bills is deducted.

5.29 Large customers are metered and billed on a monthly basis. Billing is spread out over time in order to better divide the handling of customer files and cash flow during the month.

Payment Collection

5.30 Although STEG agents deliver statements to customers' business addresses or residences within three-to-five days; however, this method is expensive. Postal service is also considered unreliable, expensive, and faces delivery problems similar to those of STEG. Both the postal service and STEG drops off the bills of more isolated rural customers at the local general store, which serves as an informal post office. This can result in payment delays and cutting off of service for rural customers.

5.31 Electronic pre-payment meters, whose cost is falling, are under consideration. This approach would allow customers to manage their own consumption and avoid being cut off. STEG would make eight fewer trips to the village per year, resulting in considerable cost savings, in addition to savings in managing billing and checking meters. It would also eliminate sources of customer conflict, such as errors in metering or cut-offs caused by payment delays. Other alternatives under consideration are using portable terminals for meter reading and immediate delivery of bills to customers for actual consumption; however, these alternatives remain expensive.

Debt Recovery and Connection Payment Facilities

5.32 In most rural areas, customers give top priority to paying their electricity bills. Most unpaid bills originate in the public sector, but, as Table 5.1 shows, payment has improved in recent years. In 1997–98, unpaid bills for LV customers—both rural and urban—represented less than 5 percent of STEG's total unpaid bills.

Table 5.1: Comparison of STEG's Unpaid Bills, 1990 and 1997–98

	1990		1997	1998	1998
Unpaid Bills	MTD	%	MTD	MTD	%
Total public sector	21.3	81	60.9	48.1	79.6
Total private sector	5.0	19	17.3	12.3	20.4
LV customers (rural and urban)	3.2	12	9.6	2.9	4.8
Total	26.3	100	78.2	60.4	100

5.33 Payment facilities for connection costs are extremely generous, as STEG has learned from experience that rural households can maintain only low monthly payments. When the rural electrification program was first launched, customers had to pay their connection fees over a 10-month period. When even this payment arrangement proved unaffordable for many rural customers, the amount was progressively spread out over 40 months in 20 bi-monthly payments, and later extended to 72 months in 36 bi-monthly payments, where it remains today. This policy of spreading out payments has greatly reduced the monthly bills of connecting households; as a result, non-payment is rare.

Analysis of Customer Service : Problems and Solutions

5.34 Historically, STEG has sought technical responses to customer-service problems (e.g., innovative billing practices and the MALT system), while monitoring of customer satisfaction with service quality has been largely ignored. It has been assumed that the economic cost of an undistributed kilowatt hour in a rural area—characterized by low electricity demand—is much less than one in an urban area, that daytime power outages often go unnoticed by customers, and hence that economic losses are insignificant. The informal field work conducted for this study identified several common problems reported by the consumers interviewed, described below.

Power Outages and Lack of Communication

5.35 According to the informal field work conducted for this study, power outages, though infrequent, did occur in the villages studied. Some were programmed (as part of works in progress), while others were unanticipated (due to natural causes, such as violent weather). Lack of communication has exacerbated the problem. For example, health clinics complained of not having been informed of prolonged outages, and having to contend with spoiled refrigerated vaccines. To protect against such damages, some clinics have had to reduce vaccine inventories or maintain emergency coolers. In addition, rural customers experienced difficulty contacting STEG because of out-of-order or inaccessible telephone booths or because they believed the utility would be informed about their problem automatically.

Voltage Fluctuations

5.36 Voltage fluctuations have damaged domestic appliances and television sets. Regional development authorities and agricultural and agro-processing customers interviewed for this study reported that voltage fluctuations had damaged electric motors used for water pumping.[8,] In the future, such fluctuations could increase as coverage is extended to houses located remotely from MT/LT substations.

Lack of Access to Three-phase Power

5.37 Agro-processing customers in the areas studied expressed concern about lack of access to three-phase power (single-phase power prevails in rural areas). Private silos, usually located near grain fields, require three-phase power because they are fed by electrogenes groups. Refrigerated collection centers (financed by a Luxembourg project) require a power of 15-22 kW and three-phase power. Rural development authorities also mentioned projects that companies are prepared to invest in that are located in areas where water is available; however, power is limited to the single-phase grid (e.g., an ostrich-raising project in Sidi Bourouis, where electric heaters would be used).

Billing

Some farmers and water associations also complained about bi-monthly billing (they would prefer monthly bills), inconvenience of peak-load management periods, power-factor penalties, and taxes on electricity bills.

Call for Monitoring

5.38 Today, STEG employs customer service representatives in its branch offices to handle customer billing problems and complaints. Moreover, pilot call centers have been set up in certain districts to handle customer inquiries. Even so, rural areas still lack sufficient monitoring of customer needs and service levels. Such monitoring could perhaps lead to educational campaigns for customers and alternative utility approaches.

STEG's Customer-service Response

5.39 Over the past two years, STEG has launched a high-priority effort (*ecoute client*) to improve how customer problems are resolved. Customer service representatives are employed in branch offices to handle customer billing problems and complaints. Moreover, pilot call centers have been set up in certain districts to handle customer inquiries. Additional monitoring of customer needs and service levels is needed in rural areas, which perhaps could lead to educational campaigns for customers and to alternative approaches by the utility.

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[8] One disadvantage of electric water pumping for agricultural use is that it rapidly exhausts the water table. For this reason, it must be carefully monitored. The water authority sets maximum outputs, which farmers cannot vary according to their needs; therefore, a reservoir must be constructed.

6

Robust Financial Arrangements

6.1 Unlike many developing countries, Tunisia has implemented its rural electrification program without undue stress on Government or implementing-agency finances. Four major factors have contributed to this achievement. First, during much of the period of rapid rural electrification, Tunisia's economy grew briskly (4-5 percent), thereby generating adequate budgetary support. Second, declining investment in electricity generation during the 1980s released funds for rural electrification. Third, rural consumption represented only 4 percent of total consumption, which minimized the effects of subsidies on operating costs. Fourth, Tunisia had access to loans and grants from a wide range of international donors and agencies.

6.2 Rural electrification involves both capital costs and subsidies. Capital costs are needed for system expansion, as the grid is extended into new areas. Once in place, some type of subsidy is typically needed to offset the high costs of servicing remote communities.

Financing Grid Expansion

6.3 STEG, rural electrification beneficiaries, and State resources were all mobilized effectively to achieve grid expansion. The State bore the largest share, either through domestic budgetary resources or borrowing from various international organizations. Since 1977, the formula described below has been used to define the contributions of each funding source.

STEG's Contribution

6.4 A cost ceiling per average connection has been established for STEG. This simple, workable formula sets a limit on STEG financial participation and provides incentives to undertake economically justified investments. From 1977 to 1986 (the Vth and VIth Five-year Plans) STEG contributed up to 100 TD per household connection and 250 TD for agricultural pumping, thereby providing an additional incentive for the more immediately economically productive activity. However, since 1989, STEG's participation in household connections increased to 200 TD, reflecting higher costs and a special national effort to improve the quality of rural life.

Role of Beneficiaries

6.5 Beneficiaries' participation in connection costs is fixed at 200 TD. This amount is calculated so that electricity costs less than alternative energy sources (e.g., candles, kerosene, or batteries). In certain regions, beneficiaries have agreed to contribute more than the required 200 TD to expedite household connection (e.g., Bizerte's level is 273 TD, Nabeul's is 400-600, and Sfax's is 400).

State Participation

6.6 The State, through its various programs, assumes the balance of investment costs not covered by the STEG or beneficiaries. Over the past 25 years, the State's participation has risen from 400 TD per connection during the Vth Plan (1977–81) to 1,800 TD during the IXth Plan (1997–2001). The chief reasons for the 1,400 TD increase were inflation (the cost in real terms might have risen from 400 TD to about 1,500 TD) and the higher costs associated with connecting more dispersed, remote communities. Excluding contributions from the Special Presidential Fund and FSN for those projects that exceed the specified ceiling, the State's contribution now accounts for up to 85 percent of total connection charges (compared to 45 percent in the program's early years).

6.7 For each project, an average cost of electrification is calculated in terms of an upper and lower limit. The lower limit equals the maximum STEG connection contribution (200 TD) and the beneficiary's fixed contribution (200 TD). Thus, projects costing less than 400 TD are considered feasible, and are financed by STEG.

6.8 For projects costing more than 400 TD, a maximum or ceiling is defined every five years in the Economic and Social Development Plan. For the IXth Plan, this ceiling was set at 2,200 TD. Projects costing between the lower (400 TD) and upper (2,200 TD) limits are co-financed by the State under such programs as the PRD and PDRI. Projects costing more than 2,200 TD can draw on the PP funds or voluntary citizens' rural development fund.

Sustainable Financial and Tariff Strategies

6.9 For long-term sustainability, any rural electrification program must establish a system of tariffs and charges that are self-financing and do not depend on increasingly larger subsidies from State revenues. In this respect, Tunisia's tariff policy has avoided many of the pitfalls encountered in other developing countries. STEG prices power close to its long-term marginal cost, and makes considerable efforts to keep rates in line with the cost of providing electricity.

6.10 The tariff structure, negotiated between STEG and the MI, reflects the differing costs in providing electricity supplies to broad customer groups (table 6.1). Thus, tariffs are lower for high-voltage (HV), industrial customers with high consumption levels and higher for LV customers, typically households with low consumption levels. Currently, tariffs do not reflect the locational cost differences in delivering energy; that is, nationwide tariffs are established without accounting for the considerable cost differences in supplying rural and urban households. In this regard, rural household tariffs benefit from a significant cross-subsidy since each new connection costs significantly more than the STEG bills.

6.11 According to a STEG-requested tariff study conducted in 1996, high- and medium-voltage tariffs, on average, reflect marginal costs of supply. However, LV tariffs were about 10 percent lower than their long-term marginal costs of supply, despite their being generally higher than high- and medium-voltage tariffs.

Table 6.1: Average Electricity Price (Excluding Taxes) by Consumer Group, 1994–99 (millimes* per kWh)

	Year					
Voltage Group	1994	1995	1996	1997	1998	1999
High	42.3	43.9	43.4	43.7	44.0	44.2
Medium	56.7	58.5	58.7	58.7	58.5	58.6
Low	74.0	76.2	77.1	76.9	76.9	76.7
Average price	61.1	63.1	63.7	64.0	64.1	64.5

* 1,000 millimes = 1 TD.

Source: STEG

6.12 A second characteristic of the tariff structure is the distinction between peak and off-peak usage in all electricity markets (high-, medium, and low-voltage levels) (table 6.2). In many cases, peak-hour tariffs are nearly twice as high as off-peak tariffs.

6.13 The low-voltage supply, of which rural users account for 11 percent, has various tariffs designed to promote social equity and rural development. For example, a low lifeline tariff applies to consumers who use less than 50 kWh per month. These consumers pay 63 millimes per kWh for the first tranche, which rises to 90 millimes per kWh for consumption of more than 50 kWh per month. The progressive nature of these tariffs encourages consumers to manage their consumption in order to reduce consumption in the next higher tranche. Public lighting, which ensures greater public security, benefits from a special tariff.

6.14 STEG tariffs are also designed to promote rural development, especially agriculture. Thus, irrigation benefits from the lowest tariffs (table 6.2). A low off-peak tariff (35 millimes per kWh compared to 45 millimes per kWh) encourages farmers to irrigate at night. Since the early days of rural electrification, tariff policies have particularly encouraged oil pressing and milling/grinding. Until 1978, each of these activities benefited from its own tariff, which was substantially lower than the average low-tension tariff. Between 1979 and 1993, the two tariffs were combined into one, which was still lower than the average. In 1994, however, in an effort to simplify, this tariff was aligned with the average low-tension tariff. These advantageous agricultural tariffs are part of a broader program to stimulate rural development, which also includes low-interest loans and subsidies to such projects as irrigation, storage centers for agricultural products, milk-collection centers, and rural industries (including repair shops, bakeries, hair salons, and weaving sheds).

6.15 Unlike many other developing countries, Tunisia increases its tariffs frequently in order to preserve the utility's financial balance. Since 1992, five increases have occurred (7 percent in 1992, 3 percent in 1993, 5.9 percent in 1994, 4.6 percent in 2000, and 2.4 percent in 2001), yielding an average annual increase of more than 2 percent. However, this percentage is less than half of the 4.6-percent cost-of-living increase and therefore represents, in real terms, a decline in overall tariff level. Tariffs for domestic consumers, including rural consumers, have declined more sharply than the average (by about 16 percent over the past five years). From 1991 to 2001, the price of the lifeline segment (less than 50 kWh) rose only 6 millimes per kWh, while tariffs for consumption above 50 kWh rose 20 millimes per kWh (table 6.3).

Table 6.2: Electricity Tariffs (Excluding Taxes), 2001

Voltage Level	Tariff	Fixed Charges[1]		Energy Price (mill/kWh)[1,2]			
		Subscription (mill/customer/month)	Power (mill/kW/month)	Day	Peak	Evening	Night
High tension	4 times a day	-	2,500	42	82	63	29
	3 times a day	-	2,500	44	80	NA	30
	Back-up	-	1,000	53	95	68	31
Medium tension	Uniform	-	300[3]	65			
	Time of day	-	3,000	50	94		
	Water pumping	-	3,000	51	93		
	Agricultural use	-	-	50	Out		
	Pumping for irrigation	-	-	50	Out		
	Back-up	-	1,500	63	102		
Low tension	Economic tranche[4] (1 and 2 kVA)	-	100[3]	63			
	Normal tranche (> 2 VA)	-	100[3]	90			
	Public lighting	-	200[3]	77			
	Water heating	400	-	66	Out	66	
	Heating and cooling	300	-	98			
	Irrigation						
	Uniform	300	100[3]	61			
	Time of day	700	-	45	Out	NA	35

[1] A value added tax is applied at the following rates: 18 percent on all fixed charges and the energy price (taxes excluded) for all uses except domestic and irrigation; 10 percent on the energy price (taxes excluded) for domestic and irrigation uses.

[2] A municipal tax is applied at the rate of 3 millimes per kWh.

[3] millimes per kVA per month.

[4] Below 50 kWh per month; above this, the normal tranche applies.

NA = not applicable.

Note: mill. = millimes

Source: STEG

Table 6.3: Trends in Low-voltage Household Tariff, 1991–2001 (millimes/kWh)

	Year										
Tariff Level	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Less than 50 kWh	57	59	59	61	61	61	61	61	61	62	63
More than 50kWh	70	76	79	83	83	83	83	83	83	87	90

Source: STEG

6.16 Although STEG does not provide sectoral accounts, it is believed that, over the past decade, the gap between electricity-sector costs and prices has been modest. During the mid-1990s, the costs of supplying electricity may have been somewhat higher than revenues. Falling fuel prices in subsequent years probably brought STEG costs and sales revenue back into balance.

6.17 Overall, STEG's finances are healthy, with only moderate debt. However, in its accounts, STEG does not distinguish between net profitability of its electricity and gas activities. In the mid-1990s, it is probable that gas profits compensated for deficits in the overall electricity account. Although the electricity sector was in balance in the late-1990s, costs subsequently rose. The price of oil, which accounts for a substantial share of generation capacity, increased sharply, and the cost of connecting households remote from the grid continues to rise. At the same time, tariff increases have not kept pace with inflation.

6.18 Financing electricity deficits through surpluses in the gas account may be practicable for a limited period, particularly when gas prices are high. However, the process is vulnerable to changing conditions in the gas market, masking the true financial position of the electricity sector. This, in turn, distorts electricity-sector planning and adds to the political difficulty of raising tariffs.

Economics and Financing of PV Systems

6.19 The primary rationale for PV-based rural electrification is to benefit households considered beyond the feasible extension of the grid. Other justifications for PV installation include fuelwood shortages and the increasing hydrocarbon deficit.

6.20 The cost of installing PV systems for rural households is estimated at about 1,900 TD. This amount is in line with STEG connection costs, currently estimated at 1,500-2,200 TD and even reaching 2,500 TD for connection charges financed by supplementary PP programs. However, these PV cost estimates do not cover replacement and maintenance. While the PV module can last 20-30 years, the other component parts (which together account for one half of the installed system) must be replaced after 5-10 years.

6.21 Furthermore, the lower yield of PV systems means that kWh costs are in the range of 1-2 TD per kWh , more than 10 times the cost of grid-delivered electricity. Such high costs for low-income customers means that the State bears a major share of installation costs. In the current ANER system, the beneficiary pays 100 TD, a token of the beneficiary's interest and capacity to accept maintenance costs or the costs of replacing used equipment.

6.22 The regional council of the Governorate contributes 200 TD, while the State, through the ANER budget, supplementary funds, and supplier credits, contributes the balance of about 1,600 TD. In most cases, the State, through its various programs, contributes more than 90 percent of system costs. Contrary to expectations, Beneficiaries do not accept responsibility for maintenance or replacement, and typically assume that the system belongs to the State, which they hold responsible for repairs. If ANER does not repair the PV systems, they remain broken. As a result, ANER has been obligated to establish a separate budget for maintenance.

6.23 Clearly, the PV program is expensive in terms of delivered energy. However, the relatively modest program size (only 7,700 families to date) means that total budget exposure is relatively small, and the high costs could be considered a necessary humanitarian and developmental contribution to improve the quality of rural life.

6.24 Even so, there is concern about rising costs and poor performance, especially as the PV program plays an increasingly greater role in electrifying Tunisia's remaining unelectrified households beyond the reach of the grid (expected to number in the tens of thousands). Reflecting this concern, various policy changes are being discussed. In the near future, these will center on increased beneficiary contributions. In the longer term, a completely new system could be envisaged in which the beneficiary would contact the PV equipment supplier directly to arrange for system installation. ANER's role would then be to provide subsidies, act as a national coordinator for PV systems, and provide technical assistance to regional authorities and beneficiaries.

7

Cost-cutting Technical Innovations

7.1 From the outset of rural electrification, STEG recognized that the program's ambitious goals could only be met by keeping investment costs at a minimum. Thus, early on, vigorous efforts were made to cut costs. In addition pursuing efficient operational and commercial practices, STEG's engineers have continuously developed and adapted technical innovations to Tunisian conditions, thereby reducing the costs of both implementation and maintenance.

7.2 While it is not possible to determine what proportion of Tunisia's rural electrification program has resulted from these cost-cutting innovations, the repeated overshooting of ADB loan targets from 1979 to 1989 suggests their remarkable effect (table 7.1). In all four ADB loans over this decade, the length of 30-kV and LV lines, number of substations, and, most importantly, number of new connections far exceeded specified targets. In 1979, devaluation of the TD accounted for a portion of the 72 percent more connections; however, the 78 and 52 percent overshooting of 1982 and 1989 targets, respectively, resulted from ongoing, successful cost reductions.

Table 7.1: ADB Tunisian Loan Targets and Achievements, 1979–89

Major ADB Loans	30-kV Lines (km)	Sub-stations	LV Lines (km)	New Connections
1979				
Target	500	175	280	17,400
Achievement	910	574	1,375	29,900
Percent difference	54	330	391	72
1982				
Target	860	616	605	16,110
Achievement	1,293	1,114	1,531	28,640
Percent difference	50	81	150	78
1984*				
Target	250	400	1,600	200,000
Achievement	332	460	2,269	214,767
Percent difference	33	15	42	7
1989				

Target	2,810	2,800	3,900	61,000
Achievement	3,715	3,976	6,590	92,557
Percent difference	32	42	69	52

* Urban electrification only.

Commitment to Customized Solutions

7.3 One key reason for these cost reductions was Tunisia's early adoption, in the mid-1970s, of a low-cost, three-phase/single-phase distribution system, known as MALT. Unlike most African countries and many other developing countries, Tunisia chose not to adopt the technical standards it had inherited from Europe, which included a three-phase, LV distribution system, suited to densely populated areas and heavy loads. Many developing countries that adopted this system, following the advice of European utilities, ended up with a high-cost-per-km distribution infrastructure that was poorly suited to their scattered settlements and low demand levels.

7.4 Tunisia's decision to adapt the lower-cost, three-phase/single-phase distribution technology used in North America and Australia to its unique environment is arguably the single most important reason for the country's later success in rural electrification (box 7.1). Wider use of single-phase distribution not only reduced costs dramatically, enabling electrification of far more households within the same budget. It also fostered in STEG a unique esprit de corps that grew out of this courageous technical decision. Though much criticized at the outset, the utility's decision was later proven correct and supported by the political establishment. Moreover, STEG gained confidence through solving numerous technical and related problems involved in setting up the new system. As a result, it was motivated to continuously develop and implement vigorous cost-cutting efforts and innovative technical approaches over the following decades.

Box 7.1: Adopting the MALT System: Key Technical Decisions

The three-phase/one-phase MALT distribution system adopted in Tunisia consists of major arteries of overhead lines in three-phase, 30-kV, line-to-line voltage, with four conductors (three phases and one neutral wire) and secondary, single-phase, 17.32-kV, line-to-neutral voltage rural distribution overhead lines (two wires: one phase and one neutral).

If heavy loads are to be fed, then three-phase lines with four conductors are used. Fuse cutouts protect MV lines. Single-phase transformers give a secondary, phase-to-neutral voltage of 230 V (single-phase, LV lines), which is used by most rural customers. The distribution system is composed of robust materials and equipment that are easy to use and maintain.

When Tunisia adopted the MALT system, it made a second key technical decision: opting for a relatively high, single-phase 17.32-kV voltage, rather than the weak 3 or 5 kV of the North American model. The higher voltage was selected for the single-phase rural electrification overhead lines because of the long distances between villages and the nearest three-phase artery and to provide for future demand growth over the 30-year lifetime of the lines.

Steps Toward MALT: Technical and Economic Decision-making

7.5 When Tunisia's need to accelerate rural electrification became evident in the early 1970s, STEG undertook a technical audit of distribution to assess existing distribution methods, of which there were only two: 1) North American approach (characterized by widespread use of lines, combined with a three-phase backbone) and 2) European approach (with extended three-phase lines throughout the service zone). This audit concluded that the predominant European three-phase system was not well adapted to Tunisia's ambitious program of low-cost rural electrification. Given the features of Tunisia's targeted population—low rural incomes, dispersed households, and consumption limited to lighting and basic appliances (mainly refrigerators and television sets)—it was clear that the cost of rural electrification could not be financed solely through tariffs and that limited resources should be invested wisely. This led the technical audit to recommend considering a new means of distribution, using single-phase lines.

7.6 According to one Tunisian engineer who participated in the program, "Never had a technical recommendation raised as many debates and exchanges of points of view in STEG" (Essebaa 1994). The environment at that time was hostile to the changeover (ADB 1995a) with opposition from both system operators and European partners. . However, a technical study for the Master Plan for Distribution confirmed the audit's recommendations. To avoid pitting the European and North American systems against each other, the Tunisians called the new three-phase/single-phase distribution system *Mise A La Terre*, referring to MALT's grounding of the fourth neutral wire.

7.7 After several more studies that confirmed the audit's recommendations, and despite voices of opposition, STEG engineers were confident of the technical feasibility of the changeover and also of the MALT system's superior level of service quality, given that it allowed automatic isolation of lines that fault from the rest of grid. Having established technical confidence, the decision to change over became an economic question. Thus, during 1974–75, economic studies were carried out in several stages. First, a comparative study of distribution systems was carried out in seven typical villages, with positive results for the MALT system, which resulted in 30-percent savings.

7.8 To extend these comparisons to more villages, STEG developed a computerized model—an innovation at that time—capable of comparing system costs in 300 projects randomly chosen from those selected for the Vth Five-year Plan (1977–81). STEG staff gathered basic field data on electricity consumption, length of needed medium- and LV lines, and estimated future number of customers (five years after electrification) for specific end-uses (e.g., lighting and pumping). Technical assumptions were made about installed power and voltage drops. After gathering the most realistic prices of electrical equipment, these assumptions were used to design and cost various scenarios to provide a range of results for both distribution systems.

7.9 Results of the model, using data from the 300 randomly selected villages, highly favored the MALT system, which projected overall savings of 18-24 percent. As table 7.2 shows, the largest savings was at the MV network level. Soon after these results were made known, in January 1976, the decision was made to switch to the MALT system.

Table 7.2: Estimated Savings of MALT System, Compared to Three-phase Distribution System, 1975

Network Level	Cost Reduction (%)
MV network	30-40
MV/LV substations	15-20
LV network	5-10
Overall	18-24

Source: Essebaa, 1994.

Rapid System Conversion

7.10 Once this decision was made, the changeover to the MALT system occurred rapidly, testifying to STEG's analytical, planning, and logistical abilities. To the extent possible, existing equipment and materials (circuit breakers, spark gaps, three-phase underground cables, auxiliary relays of protection, 30-kV three-phase transformers, and switching devices) were kept and integrated into the new system to save costs.

7.11 System conversion consisted of two major steps:

- Changeover from the existing 4,000 km of 30-kV grid, consisting of
- - Installing neutral point coils in HV/30kV substations,
- - Laying the fourth neutral wire on the main 30-kV feeder lines, and
- - Replacing the constant time protections (relays and current transformers) with reciprocal time protections in HV/MV and ring main unit (RMU) substations.
- Planning, designing, and monitoring installation of new construction (lines and single- and three-phase substations) in the MALT system.

Resolution of Technical Problems

7.12 Both steps posed important questions of technical adaptation, organization, implementation capacity, and customer relations, given the repeated interruptions in supply, which inevitably occurred during the changeover. Table 7.3 gives examples of the types of obstacles that STEG encountered during the conversion and how it overcame them.

Table 7.3: STEG's Switch to the MALT System: Typical Obstacles and Solutions

Changeover from the 30-kV network	
Obstacle	Solution
Laying a neutral, fourth wire had not been foreseen during construction of the European three-phase network; thus, difficulties were encountered in installing the neutral wire on existing poles while maintaining the required height above ground.	For each type of crossing, considerable imagination and numerous trials and attempts were required to place the fourth wire accurately.

The neutral wire was attached to the LV spool insulator, which was later judged inadequate, especially where excessively long spans between poles caused the wires to break.	The LV spool insulator was later replaced by a suspension insulator.
Wires snapped in some spans where the neutral wire had been incorrectly placed, with flashovers occurring between the neutral and one of the three live wires.	These anomalies were quickly corrected without significant damages.
Changing the protections in HV/MV and switching substations	
Obstacle	Solution
The existing, fully saturated current transformers were not well adapted to MALT.	These were replaced with higher performance current transformers.
Difficulties were encountered that were linked to necessary power cuts in order to replace and adjust protections.	The tripping-reclosing cycles and the automates associated with the new protections were studied, identified, wired, and tested in the laboratory prior to installation. Field interventions were reduced to installation and connection of a fully equipped panel, wired and tested in the laboratory.
Taking the resistant earth protection out of service created much apprehension.	With more experience, it was demonstrated that the resistant earth protection was not indispensable.
Specifications of equipment and installations for the new system	
Obstacle	Solution
The new three-phase (Ynyn) transformers created problems of tank overheating in cases of outages in one live wire.	These were replaced by four-column, magnetic transformers.
The first fuse cutouts and the cabin substation crossing insulators were not suited to the humid climate of the coastal zones or the salinity of Chott El Jérid.	Technical specifications were modified to reinforce insulation of equipment installed in these geographic areas.
Disturbances were encountered in local telephone lines running along long-distance electric lines.	Capacity disturbances were resolved by using filters on the telephone lines; inductive disturbances were eliminated by improving line groundings.

7.13 ydro-Quebec engineers provided technical advice on the three-phase/single-phase system. Beginning in 1976, short-term technical visits to Canada were organized for district chiefs and system operators and engineers. However, STEG staff had sole responsibility for system planning of the new system and resolution of the problems encountered throughout the course of switching to the new system were entirely the work of STEG staff. The changeover, which was completed in 1980, laid the foundation for launching a vast program of rural electrification in single-phase overhead branch lines.

7.14 Length of single-phase lines rose from 0 km in 1976 to nearly 19,000 km in 2000 (table 7.4). As the Five-year Plans were implemented, the number of kilometers of single-phase lines increased more rapidly than the number of kilometers of three-phase lines, and the single-phase investment grew increasingly dominant. Today, single-phase lines account for 51 percent of the total network, compared to only 16 percent in 1981.

Table 7.4: Length of Three-phase and Single-phase MV Overhead Lines, by Planning Period

Five-year Plannning Period	*Three-phase Lines*		*Single-phase Lines*		*% Single-phase of Total*
	km	Growth (%)	km	Growth(%)	
1977–81	9,488	7.1	1,830	16.3	16.2
1982–86	12,312	5.3	3,318	12.6	21.0
1987–91	13,412	1.7	7,008	16.1	34.3
1992–96	15,551	3.0	13,920	14.7	47.2
1997–2001	17,538	3.1	18,563	7.5	51.4

Note: All figures were recorded at the end of the respective Five-year Planning Periods.

7.15 Similarly, the number of single-phase substations rose from 0 in 1976 to more than 22,000 in 2000. Today, single-phase substations dedicated to rural electrification now account for 70 percent of all STEG substations.

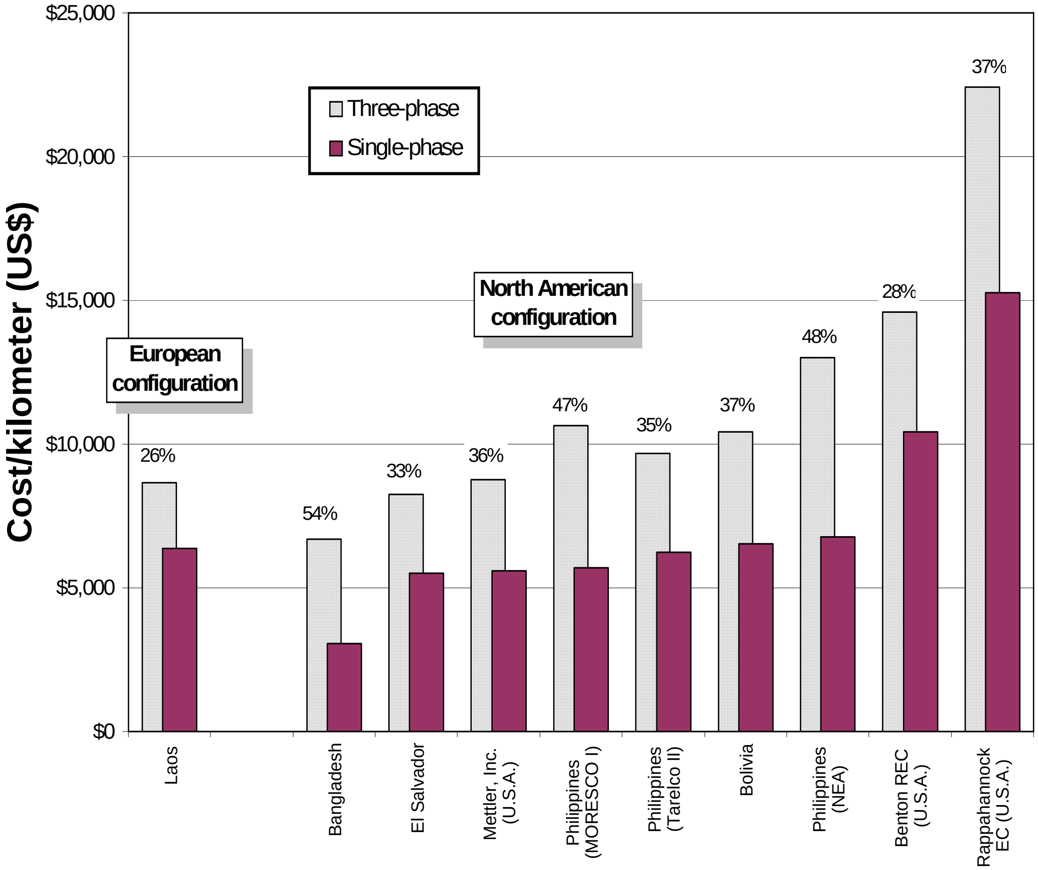
The MALT Advantage

7.16 As it has evolved, the MALT system has proven its reliability and safety. Its two major advantages are:

- its reduced cost permits service to be provided to more households for a given investment and
- improved quality of service, resulting from its ability to isolate a damaged area automatically.

7.17 The originally estimated cost savings of 18-24 percent was later surpassed by gains calculated at 34-40 percent, which is consistent with recent comparisons of the three-phase/single-phase system with the conventional, three-phase configuration (figure 7.1).

Figure 7.1: Total Line Cost (Materials and Labor) and Cost Savings for Three-phase and Single-phase Configuration in Various Countries



Source: NRECA International, 1999.

7.18 For this study, STEG calculated cost reduction on a typical 1.44-km long rural electrification line in 54.6 mm^2 Almelec, using its in-house, Tanouir software design of MV lines (Appendix 3). This resulted in a cost estimate of US$6,665 per km, a 37-percent reduction. The principal savings were in poles and line accessories, with a negligible cost increase for grounding. That this change was made early in the development of the Tunisian grid meant that its associated costs did not weigh too heavily on profitability, and the resulting high returns have been a significant factor in the country's high rate of rural electrification.

7.19 The MALT system improves service quality by automatically isolating a damaged area. The branch line affected by the failure is isolated by a fuse placed at the head of each branch line so that the other feeder lines and the principal artery continue to function normally. As a result, fewer rural customers are affected, failures are more quickly identified, and repairs are made more promptly and at lower cost.

Solutions for Large-motor Productive Uses

7.20 As the MALT system has advanced and proven its reliability and safety, criticism has diminished, but challenges are still raised. For example, while single-phase lines present no difficulties for use of household appliances (e.g., refrigerators or color televisions) or small motors (e.g., electric pumps or manual tools), adaptations and conversions must be made to serve large-motor (above 7.5 horsepower [hp]), agro-industrial, and deep-borehole irrigation loads. This limitation creates a potential problem for larger-scale industrial development in more remote areas, where rural customers must bear the additional costs.

7.21 Most industrial development occurs in industrial zones and incorporated villages, which are supplied with three-phase, 30-kV lines. Outside these areas, conversion from single-phase to three-phase lines can be made later, if justified by the load. However, in practice, this has seldom happened in Tunisia.

7.22 Technical solutions—widely marketed and practiced in North America—consist of special, more expensive motors, which, for 100-hp loads, can cost an additional US$2,000-15,000. Experts at the United States Agency for International Development (USAID) have pointed out that these costs are minor compared to the cost of installing three-phase lines; they have recommended even wider use of single-phase lines, even in areas with high loads from agro-industry and pumping (Hicks 1993). In Tunisia, however, early experience with single-phase, 7.5-hp electric pumps was unsatisfactory, which created suspicion among consumers that single-phase lines were somehow inferior.

7.23 STEG has offered several solutions for rural customers who own large motors:

- For motors with 7.5-15 hp, a parallel assembly of two 7.5-hp motors can be constructed at twice the price of a single motor;
- For motors above 7.5 hp, a locally made, static converter can be used at a cost of between 3,500 TD (corresponding to a 25-kVA converter) and 6,500 TD (corresponding to a 50-kVA converter); this will depend on the motor horsepower, voltage input, and whether a three-phase auto-transformer 230/400 is needed;
- A single-phase line can be converted into a three-phase line, at a cost of 12,400 TD per km.

7.24 For smaller motors, installing a static converter is cheaper than converting even one-half of a kilometer of single-phase line into a three-phase line, especially if only one motor is involved. Still, these solutions are not widely practiced. In all cases, however, the customer must bear the extra costs.

7.25 It is difficult to determine to what extent unavailability of three-phase power lines has prevented establishment of productive, large-motor uses in Tunisia's more remote rural areas. Today, prosperous retirees often return to their rural homes to establish economic activities. Two such examples were encountered in this study's informal rural appraisal: a vineyard and winery under construction had only single-phase connections and would incur considerable costs to purchase motors for both large-scale irrigation and pressing; and a proposed ostrich-raising project would require numerous electric heaters.

Continuing Tradition of Cost- reducing Technical Innovation

7.26 Successful adoption of the MALT system fostered STEG's aggressive approach to cost-cutting, technical innovations. Throughout the 1980s and 1990s, technical and economic studies and pilot projects were undertaken to further reduce distribution-system costs, which resulted in a number of changes and cost savings. The examples given below are prioritized roughly according to their cost-savings importance:

- *Aluminum alloy wiring.* In 1991, an aluminum alloy (ASTER) replaced copper wiring for constructing MV lines after a study showed that international copper prices were continuing to rise and that the estimated annual savings of using ASTER was 500,000 TD.
- *Pin insulators.* In the 1990s, pin insulators replaced suspension chains on MV lines. In the new design, the conductor is held higher on the pole so that shorter supports can be used to achieve the same ground clearance. The resulting cost savings were significant. For example, the district of Kasserine achieved 20 percent savings for single- and three-phase lines.
- *Round-iron poles.* Round-iron poles, which are cheaper, lighter and sturdier, have gradually replaced more expensive prestressed armored concrete (PAC) poles. The range of PAC poles has been reduced to three classes of 9-m poles (9/150, 9/300, and 9/600), while 18 class and length combinations of round-iron poles are in stock (8/150, 8/500, 9/180, 9/500, 10/180, 10/500, 10/1,000, 12/300, 12/500, 12/925, 13/450, 143/900, 13/1,700, 13/3,400, 15/450, 15/800, 15/1,600, and 15/3,200).
- *Cheaper protections*. Expensive, LV circuit breakers at MV/LV substations have been replaced by much cheaper, yet adequate, fuses.
- *Cheaper meters*. Three-phase meters have been limited to large consumers, while the power range of less expensive, single-phase meters has been increased.
- *Pole fastenings*. To secure weak poles, cement foundations (8/150, 9/150, and 9/180 m/daN) have been replaced by backfilling around poles with stone to reduce line-construction costs.
- *Mixed MV and LV network.* MV network poles have been used, where possible, to carry part of the LV network as underbuilt lines were constructed so that fewer LV poles would be needed.

7.27 Although the cost advantage of any single innovation may be relatively modest, the cumulative savings is considerable, testifying to the importance of STEG's culture of continuous improvement.

Variations on the MALT System

7.28 STEG has continued its ongoing commitment to reducing distribution-system costs through technical innovation. In 1990, for example, it introduced the Single-Wire Earth-Return (SWER), a variation on the MALT system. SWER has only one live wire and no neutral wire. The return current passes through at a grounding point at the end of the line (MV/LV substations). This technique allows for an additional savings of 26-30 percent, compared to single-phase MALT.[9] SWER was introduced with a number of precautions, however, because of the returning current's potential risk to humans and animals if lines are not carefully installed and monitored.[10] By late 1996, the feeder lines implemented using SWER as pilot projects supplied 425 villages through 1,148 MV/LV substations. District chiefs have the freedom to decide whether to use SWER in specific rural electrification projects.

7.29 Another STEG innovation is the MALT 4.16-kV, single-phase line, which can reduce the cost of electrifying rural villages where houses are widely dispersed. As the rate of rural electrification increases, the number of locations with clusters of houses decreases; the remaining unelectrified households are more scattered, and the average cost per customer increases. This situation requires an increasingly long, LV network. In 1996, pilot projects illustrated that a cost reduction of 7-14 percent can be obtained for houses with an average dispersal, and an even greater reduction (31-33 percent) can be achieved for extremely dispersed houses. This technique, however, is suitable only for the relatively few projects at the end of the network, where no further extensions will occur. Hence, the gains are relatively small and usually unjustified by the increased management needs of introducing another level of voltage and range of network materials. Nonetheless, district chiefs can opt to use the 4.16-kv, single-phase line for projects with widely scattered households at the end of the grid.

Standardized Equipment and Procedures

7.30 STEG makes efforts to reduce stock inventory by standardizing components where possible. For many years, an internal standardization commission worked on an ongoing, part-time basis to improve service quality, reduce network losses, and research technical specifications for network materials better adapted to Tunisia's climate. While the main emphasis was on improving service quality and inventory management, many of the changes adopted contributed to reductions in maintenance and management costs. In terms of cost savings, key changes were:

- *Replacement of spark gap by lightning arresters* to better protect pole-mounted MV/LV substation transformers and decrease the frequency of transformers breaking down.
- *Introduction of three-phase transformers (*Ynyn *with four magnetic columns)*, where the fourth column absorbs imbalances in the two other phases caused by overheating of the transformer tank in the original three-column, star-connection transformers.

[9] According to a 1996 study on STEG pricing, involving electrification of some five rural villages using MV lines of 2.7-10.6 km length.

[10] SWER's disadvantage is that a more extensive and costly grounding network is necessary at every point where the line is grounded since the voltage drop at the grounding points could be sufficiently high to shock humans or livestock. In Tunisia, SWER is used in more remote areas, where loads are usually low; hence, the voltage is low and less dangerous. Nonetheless, given that loads are increasing in remote areas, grounding must be carefully monitored.

- *Development of a distribution-system construction guide* (with state-of-the-art technical rules and guidelines) for use by the utility's planning office and work and maintenance units.

7.31 Other standardization efforts to reduce costs included:

- *Hot galvanization*, a small-cost way to avoid corrosion that prolongs the life of metal constituents of the grid.
- *Installation of capacitor banks* on MV branch lines and in large consumer substations to increase the power factor, reducing both voltage drops and level of losses in the MV and LV network, without having to reinforce the grid. This was accomplished through an educational campaign that informed large consumers of the cost-effectiveness of purchasing the capacity banks, rather than paying the penalties caused by their power factors falling below 0.8.
- *Development of in-house (Tanouir) software* adapted to the Tunisian MV network for sizing MV lines. This software has considerably reduced the length of studies and has permitted studying design variations for a specific agglomeration and choosing the lowest-cost solution.
- Standardization of both pole-mounted and cabin MV/LV substations (structure, protection, and grounding).
- *Coordination of protections* (circuit breakers, reclosers, and fuses) in a selectivity cascade, permitting the automatic isolation of the affected line from the grid and considerably reducing the undistributed energy. With each grid extension or major modification in the operating diagram, coordination of protections must be re-studied to guarantee effectiveness of the selectivity cascade.

8

Photovoltaics: Complementary Strategy for Isolated Users

8.1 Tunisia's national PV program underscores the country's commitment to provide at least a minimal level of electrification service to even its most remote rural households, which otherwise would remain unconnected. Currently, 7,750 households (about 1 percent of total electrified rural households), 200 schools, and a few clinics and forest/border posts have PV installations.

8.2 The grid and PV programs are complementary, and, in some cases, PV has become an interesting alternative to the grid. At a connection cost of 1,900 TD per household, PV compares favorably with grid-connection ceiling costs of 1,500-2,200 TD, or even 2,500 TD for FSN projects.

8.3 Tunisia's PV program aims to contribute to the national goal of 100 percent electrification by 2010, by which time 97 percent of households are expected to have grid electrification and 3 percent PV systems. Nonetheless, only 71,500 rural households remain unelectrified. During the last Five-year Plan alone, 200,000 households were connected to the grid.

8.4 To date, factors contributing to the success of the national PV program include:

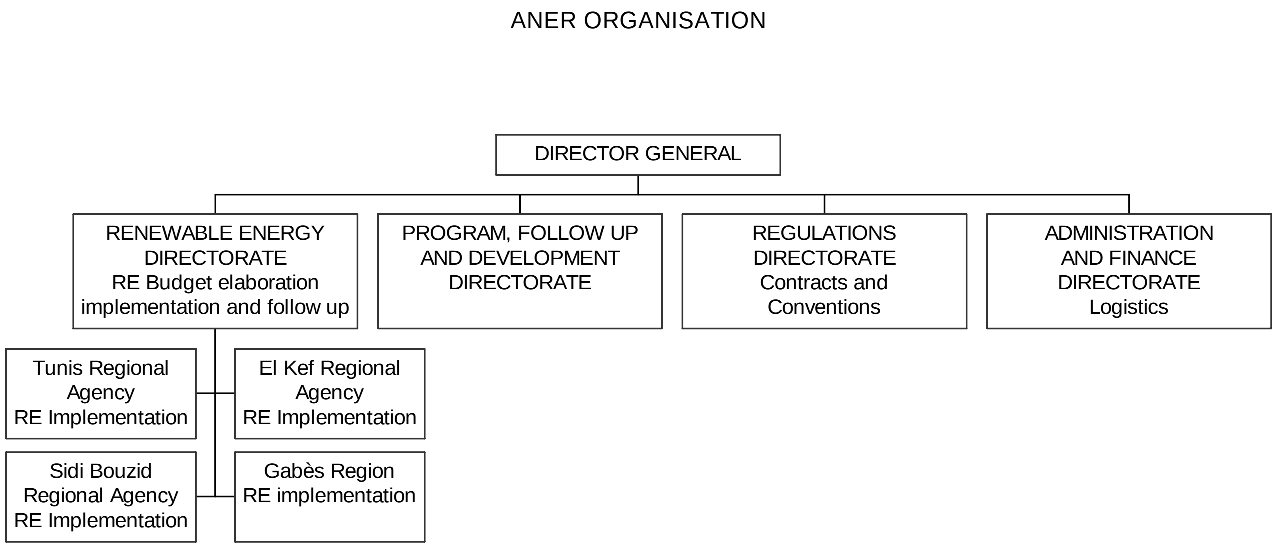
- coordination with grid systems and institutions,
- demonstration and pilot dissemination projects to test feasibility and adapt components,
- financing through State and international subsidies as a minimum public service,
- focus on user needs and training, and
- emphasis on maintenance and after-sales support.

Coordination with Grid Systems and Institutions

8.5 Since 1985, ANER has implemented the PV program, while the STEG has implemented the grid extension program. Although ANER has principal responsibility for Tunisia's renewable energy policy and promotion, the Ministry of Economy, in 1993, designated ANER to play the lead role in PV rural electrification (particularly in executing pilot dissemination projects, such as a project funded by the German Agency for Technical Cooperation [GTZ] to electrify 1,000 households in Kef). Since then, ANER's implementation role has continued. Though the roles of STEG and ANER differ, their work is closely coordinated by CNER, under the aegis of the General Directorate of Energy, which includes representatives of the Ministries of the Interior, Economic Development, and Environment; FSN; as well as STEG and ANER.

8.6 Headquartered in Tunis, ANER has four rural electrification directorates and regional representatives in the three regions (excluding Tunis, ANER headquaters) where most PV systems have been installed (figure 8.1).

Figure 8.1: ANER Organization Chart



8.7 PV electrification emphasizes:

- Pre-electrification of isolated and dispersed households and public services; a limited supply (50-100 W) is offered to those who must wait at least five years for the grid and
- Electrification of households and public services unlikely to ever receive grid connection.

8.8 At the regional level, the process of household selection aims to avoid overlap between PV electrification and grid extension areas. The regional council prepares lists of potential beneficiaries based on their distance from LV and MV lines and the cost of connecting to the national grid. Next, ANER verifies these door-to-door, in close collaboration with regional and local authorities. Finally, the regional council collects household contributions and transfers them to ANER, which can then begin work.

8.9 In practice, however, there is often a long delay (largely caused by the time needed to seek PV systems financing) between the date of defining PV zones and actual installation. Meanwhile, the grid advances without attempting to avoid PV areas. Despite improvements in the selection process, in about 20 percent of cases, the grid still arrives three months to one year after PV installation. To avoid such duplication of State investment, as well as user disillusionment, priority is now being given to households that do not expect to be connected to the grid. It has also been proposed (based on Quebec's experience) that a rural electrification agency be established—to include representatives of STEG, ANER, and the regional government—to closely coordinate around the country's mission of total rural electrification.

Well-tested Technical and Social Feasibility

8.10 Interest in PV developed during the early 1980s, based on environmental and social grounds. Several demonstration projects were followed by pilot dissemination projects, which showed that the technology could contribute to meeting the basic electricity needs of isolated rural households and that individual PV systems were better adapted to isolated households than centralized systems, biogas, or grid extension.[11]

8.11 A key facet of the pilot projects was to evaluate the technical performance of PV systems. Field experience revealed:

- Need for adopting 100-W systems since outages have frequently been experienced during winter months using 50-W systems.
- Confirmation of the sound performance of silicium monocrystalline and polycrystalline modules; systems that had manufacturing defects were returned under the 10+ years guarantee.
- Extension of storage battery life through studies and trials conducted in cooperation with local manufacturers and the Mechanical and Electrical Industry Technical Center (CETIME); the outcome was a decision to use more expensive, tubular-plate batteries that better tolerate the charge/discharge cycle.
- Technical-performance testing of various brands of other components, whose manufacturing quality and international standards have improved over the years; components include regulators; bulbs; and voltage adaptors for radios, cables and installation accessories.
- Continued need for improvement in installation quality of connections, equipment placement, and wiring.

8.12 The national rural electrification program has implemented these recommendations. The installed systems used have the following minimum specifications:

- crystalline PV panels, with a minimum power of 100 Watt peak (Wp);
- tubular-plate batteries, with a minimum capacity of 200 Ampere hour (Ah);
- 12V/15A charge/discharge regulator;
- three lighting fluorescent bulbs (12/18 W);
- radio voltage transformer (12 V/9, 7.5 and 6 V); and
- 12-V electrical outlet for television set.

[11] Major projects included the GTZ-funded project in Kef and a State-financed rural schools program.

National and International Financing

8.13 In Tunisia, electricity is viewed as a minimum public service to which every household has a social right. More than 90 percent of the country's PV rural electrification program is subsidized. The largest funding sources are PV-module exporting countries, which have provided supplier credits for some 50 percent of the PV systems installed to date. The World Bank has provided loan credits for another 25 percent of installed systems; while national development funds, NGOs, and beneficiaries have contributed the remainder (table 8.1).

Table 8.1: Financing Tunisia's PV Rural Electrification Program

Funding Source	No. of Households Electrified
FSN)[1]	950
PRD[2]	330
PDRI	20
World Bank	2,250
Supplier Credits[2]	5,000
NGOs	350
Total	8,900

[1] FSN has also financed some 1,000 households that are co-financed by other donors included in this table.

[2] Low-interest and commercial supplier credits supplemented PRD (200 TD/system) and beneficiary (100 TD/system) contributions to finance a total of 5,000 households.

8.14 Beneficiaries are required to pay 100 TD per system, with 200 TD financed by the regional government, and the remaining 1,600 TD financed by State sources. Currently, consideration is being given to increasing the amount beneficiaries pay since 20 percent of system costs today would equal 500 TD.[12]

8.15 Spread over the 20-30 year lifetime of system modules, and including replacement costs of other components, a financial cost of 1-2 TD per kWh can be calculated, compared with the national electricity price of 0.100 TD per kWh (table 8.2). Clearly, the success of national PV rural electrification depends heavily on the availability of credits and subsidies.

Table 8.2: Cost And Lifetime of PV System Components, 2000

Component	Cost (TD/Unit)	Lifetime (Years)
PV panels, 100 Wp	800-900	20-30
Charge/discharge regulator	100-200	5-10
Tubular battery, 200 Ah	300-350	5-7
Fluorescent bulbs (3)	120-200	5-10

[12] In 1990, 20 percent equaled 100 TD.

Accessories	100-150
Installation and quality control	150-250
Maintenance visits (2)	40-80
Total cost	1,610-2,130

User Needs and Training

8.16 Tunisia's PV rural electrification program has sought to meet user needs in several ways. First, system sizes have been increased, initially from 50 W to 70 W, with the present standard now at 100 W, in recognition of greater power needs and less insolation during winter. This equipment feeds a continuous 12-volt current: three light bulbs, one black-and-white television, and one radio-cassette player. Still, surveys have shown that the daily consumption level—up to six hours per day for lighting and television viewing, and three hours for radio-cassette player use—is 300 Wh. Households regularly overload their systems, sometimes leading to regulator-induced outages to protect the accumulator battery. To avoid such outages, users connect their televisions directly to the battery, resulting in further damage.

8.17 Second, because of lack of familiarity with PV systems, ANER organizes training workshops for regional administrators and beneficiaries to explain how the systems work. Even so, many households lack complete understanding of their systems' limitations, as illustrated above.

8.18 Third, ANER has striven to meet an increasing demand for refrigeration, which present PV systems cannot accommodate without costly supplementary equipment. However, users have been reluctant to contribute, even partially, to cover these costs. For example, ANER launched a program to disseminate 40 refrigerators (100 W, 100 liters) to households that already had PV systems, at a cost of 2,500 TD to ANER and 500 TD to users; no interested users were found for three years, even though the refrigerator alone costs 900 TD.

Maintenance and After-sales Service

8.19 ANER has had an ongoing emphasis on maintenance and after-sales service. Originally, it was hoped that the beneficiary contribution would serve as both evidence of and motivation for financial interest in continued maintenance; however, two problems have emerged. Users have believed that responsibility for maintenance lies with the State. Moreover, Tunisia's few suppliers (only 2-5) are unable to offer a national maintenance network profitably because of the small number of dispersed installations; thus, spare parts are not easily available, despite a two-year guarantee.

8.20 ANER has variously handled this problem through:

- rehabilitation of systems that deteriorated for lack of replacement parts;
- subsidy (up to 65 percent**)** of spare parts, beyond the guarantee; and
- training of local technicians in installation and after-sales service (thus far, 200 technicians have been trained).

Electrifying Villages in Siliana Governorate: A Case Study

8.21 In 1997, a PV project initiated in several remote villages of Siliana Gouvernorate brought electricity to some 200 rural homes, a primary school, and a health center. The project was implemented by the Tunisian Agency for Energy Management (AME)[13] and the Spanish Cooperation Agency (IPADE) within a framework of Tunisian and Spanish cooperation.

Site Selection and Visits

8.22 AME and IPADE, with the help of local authorities, selected three villages in the delegation of Bouarada for PV electrification: Ftiss, Rmill, and Henchir Romen. Selection was based on number of residents, distance to the STEG grid, and distance to asphalt and dirt roads.

8.23 Next, local authorities established an initial list of 195 homes, a clinic, a primary school, and shrines (*marabouts*). Project staff then visited these sites and established a file for each that included information on location (distance to the grid and accessibility by vehicle); household (head of household, number of persons, professions, social status); house construction (number of rooms and construction type); and audio-visual appliances.

8.24 Although electrification of a mosque and public lighting had been envisioned, visits to the sites showed that there was no mosque in the area or potential sites for public lighting. On the other hand, electrification of a primary school and a health clinic were needed. Together with the local authorities, AME and IPADE decided to electrify both the school and the clinic.

8.25 Visits to household sites showed that some households either refused PV electrification (fearing it would prevent them from receiving grid electrification) or could not afford their contribution of 100 TD per system. Thus, a waiting list of beneficiaries was compiled.

Technician Training

8.26 PV system installation was entrusted to local enterprises, while beneficiaries financed accessories for installation. Two local companies were selected: SINES (installation) and Solar Energy Systems (acquisition of accessories).

8.27 To ensure better follow-up and maintenance of the PV systems installed, the project undertook training of six local technicians in the three villages, who were employed by SINES and Solar Energy Systems. Training began with a one-week course on the theory of PV-system functioning, particularly the role of each component (e.g., module, regulator, battery), held at AME's regional services laboratory in Kef. This course was followed by one week of practical training on the principles of PV installation. As part of the course, technicians in the selected villages carried out four trial installations. Trainees who passed a theoretical exam received certificates for having participated in the course.

[13] In 1993, AME became ANER.

Users' Association and Contribution

8.28 Together with the local authorities, a users' association was created, whose objectives were to:

- ensure proper use of PV equipment and materials through sound maintenance and repair practices, in collaboration with AME,
- ensure system maintenance beyond expiration of the warranty period,
- organize participation of trained local technicians in installation work, and
- collect funds needed for minor maintenance and repair and association management.

8.29 User contributions, set at 100 TD per beneficiary, covered the expenses of acquiring accessories and small parts for installing 202 PV systems (including those for the primary school and health clinic). Before collecting these funds, AME confirmed with STEG that registered households (those on the list) were not connected to the grid and were not scheduled to receive grid connection over the next five years. During the collection phase, some beneficiaries stated that they could not afford their contribution and requested credit facilities. Twenty-three beneficiaries did not wish to receive PV electrification and were replaced by others on the waiting list.

Installation and Maintenance

8.30 On June 13, 1998, the systems were inaugurated. SINES established a file card for each PV installation, which the company and beneficiary co-signed. Table 8.3 shows the components and user types for the systems installed. The first maintenance check of all systems occurred four months after installation was completed.

Table 8.3: Installed PV Systems, by Component and User Type

Component	Home	Elementary school	Health center
PV module	2	4	8
Battery	2	6	12
Regulator	1	1	1
Onduleur	-	1	1
Bulbs	3	9	4

Source: ANER, 1998.

9

Lessons in Integrated Rural Development and Social Equity

9.1 Tunisia's achievement of 100 percent urban and 88 percent rural electrification is remarkable, all the more so because the country's definition of rural electrification is restricted to connections made outside incorporated areas. Compared to rural populations in other developing countries with high rates of electrification, Tunisia's rural population—although only 35 percent of the total population—is highly dispersed and isolated, with long distances between small groups of often scattered houses. This characteristic, combined with the Government's social commitment to connecting all households, has highly influenced program costs and choice of institutional set-up, distribution system, and technology.

9.2 Major factors key to the success of Tunisia's rural electrification program are:

- national commitment to rural electrification as part of a broader, integrated rural development program emphasizing social equity;
- effective institutional structure and coordination of project planning and selection;
- utility's sound management and continuing process of technical innovation;
- robust financial arrangements; and
- complementary PV strategy to serve isolated users.

National Commitment in a Multisector Development Context

9.3 Tunisia's rural electrification achievement has been motivated by continuing national commitment as part of a broader, integrated rural development program that has emphasized social equality. Since its independence from France in 1956, the country has been at the vanguard in promoting human resources development, including gender equity. This is evidenced by the PSC that was promulgated immediately after independence and the IVth Development Plan, implemented in 1972, whose three pillars were basic education (for girls and boys), improved health services (with an emphasis on family planning), and rural electrification (whose socioeconomic criteria included gender equity).

9.4 National commitment to rural electrification is also reflected in the personal initiatives of each president and strong societal support in using domestic resources to fund rural electrification. Since 1977, the State's investment has increased from 45% to 85% of the total, amounting to more than 450 MTD. In response to Tunisia's clearly defined national development and social welfare policies, which have emphasized the importance of rural electrification, the country has received enthusiastic international donor support, of which the ADB has been the most significant source.

9.5 Regional planning processes and successive five-year plans, which have tightly incorporated rural electrification into broader objectives of integrated rural development, have produced synergistic effects. Indeed, growth in rural electrification and national socioeconomic indicators are strongly correlated. Informal surveys conducted in several rural areas attest to rural electrification's multiple benefits—as perceived by rural householders, especially women—in education, health and family planning, economic opportunities, and enhanced security. Integrating gender equity into the socioeconomic criteria for rural electrification has been an ongoing aspect of State support for and subsequent success of rural electrification.

Effective Institutional Structure and Coordination

9.6 Regardless of the structure or process a country adopts for rural electrification, certain principles are essential to success. To reiterate, these include well-defined, coordinated roles for all agencies concerned and established procedures that ensure agency cooperation is perceived as fair. The Tunisian system scores well on both counts.

9.7 All agencies that participate in Tunisia's rural electrification program have well-defined roles. Coordination is ensured through an agency with a specific mandate for coordination. Equally important, policymaking and implementation agencies at both regional and national levels collaborate closely. Agency cooperation is facilitated through a project-selection process that is meticulous, orderly, and transparent. Through this process, concerns about social justice are addressed, thereby reducing political pressure in identifying projects, allowing for a more rational and economic long-term program.

Utility Transparency and Innovation

9.8 STEG's effectiveness and efficiency have earned it both political and popular support. Much of the utility's success can be attributed to a clear mandate and a management structure that combines the benefits of centralized planning and design with decentralized operations. Published norms, guidelines, and standard contracts contribute to operational transparency.

Benefits of Unleashing Technical Innovations

9.9 STEG has demonstrated a high-level capacity for adapting technology to meet Tunisia's clearly-defined, rural electrification objectives. Early on, the utility computerized its management systems and developed customized software applications, including a sophisticated inventory management system.

9.10 Introduction of the MALT three-phase/single-phase distribution system has dramatically demonstrated STEG's high level of innovative technical expertise. Indeed, the utility's switch to the MALT system has been the single largest change introduced into the Tunisian program, permitting rapid expansion of rural electrification. In addition, the MALT system has provided a high level of service by reducing the rate and duration of outages.

9.11 That Tunisian engineers, with little international support, implemented the MALT system and solved its technical problems is testimony to the country's commitment to developing a well-educated cadre of professionals. As the utility's staff succeeded in problem-solving, they gradually developed an esprit de corps that gave them the confidence to propose and implement additional innovative, cost-cutting solutions.

9.12 Although the overall cost-cutting effects of the program's technical innovations have not been studied, they clearly have permitted the electrification of significantly more households within the same budget. The MALT distribution system alone is estimated to have saved 37 percent of costs, compared with the conventional three-phase system.

Exemplary Commercial and Construction Practices

9.13 STEG's implementation of commercial practices—including control of non-technical losses, billing, and collection practices—has been outstanding. Overall system losses are only 13.4 percent (3.1 percent non-technical). Despite difficulties in delivering bills to isolated communities and their limited means of payment, rural consumers have an excellent payment record. Success factors include a customer management improvement program that has focused on sound meter-reading policies and practices, development of an integrated billing software program, and spreading out connection-cost payments.

9.14 Successful construction and implementation of rural electrification projects owes much to encouraging private-sector participation in construction and promoting local-industry efforts to supply equipment and materials.

Effective Tariff Policy

9.15 Tariffs broadly reflect the varying costs of supplying HV, MV, and LV customers. All markets distinguish between off-peak and peak usage to encourage more efficient capacity use. LV supply, of which rural users account for 11 percent, has various tariffs designed to promote social equity and rural development. These include a lifeline tariff for those who consume less than 50 kWh per month, subsidized public lighting, and low tariffs for irrigation. Such tariffs benefit from a significant, yet apparently manageable, cross-subsidy. Although STEG does not publish detailed power-sector finances, it is believed that, over the last decade, there has been only a modest gap between electricity-sector costs and prices.

Complementary PV Strategy

9.16 Tunisia's high-profile PV program—with its goal of providing a minimum 100-W level of electricity service to all households by 2010—reflects a commitment to including even the most remote rural areas in national development. Although PV currently represents only 1 percent of total electrified rural households, that percentage could climb to 3 percent over the next five years.

9.17 The PV program features the high-quality technical support and robust finances that have characterized the country's rapidly expanding grid program. Success factors have included close institutional coordination with STEG; careful selection and adaptation of equipment; strong domestic and international donor support; and an emphasis on user needs, maintenance, and after-sales support.

Challenges Ahead

9.18 As total rural electrification rapidly approaches, Tunisia faces new challenges. While rural electrification planning, implementation, and management are highly decentralized, these are largely limited to State channels. Changes toward democratizing Tunisian society may create pressures for greater consumer participation in sectoral decision-making and the need for better communication between STEG and its customers. Findings from an informal field study point to the need to monitor rural customer needs and service levels, leading perhaps to both consumer educational campaigns and new utility approaches.

9.19 While in theory, Tunisia's project-selection process is transparent and minimizes political pressure, in practice, it may be criticized for verging on the mechanical. This is especially so in cases where local costs diverge from the national averages used to estimate the total costs of rural electrification.

9.20 To date, STEG's finances have remained healthy; however, the future may pose challenges that will demand closer attention to both costs and revenues. Generation costs are expected to rise, reflecting higher oil prices. Connection and maintenance costs will continue to increase as more remote communities are connected to the grid. As loads develop in rural areas, expensive system upgrades may well be required. Moreover, a more rapid expansion of PV systems will add to these cost pressures.

9.21 As the final 12 percent of the rural population (70,000 households) is electrified, the respective roles of PV and grid electrification and institutions will require greater clarification and improved coordination in terms of user expectations, training, and maintenance.

9.22 Despite frequent increases, tariff levels lag behind inflation. The real costs of electricity, particularly to LV customers, have fallen sharply. Though efforts have been made to restructure tariffs to reflect the higher costs of supplying LV to rural consumers, a significant cross-subsidy remains in the current tariff structure. The share of rural electrification, as defined in this report, is as yet small and may not significantly affect system-wide finances; however, any changes in overall tariff policy designed to increase STEG revenues are likely to affect rural, as well as other, consumers.

9.23 The favorable arrangements for STEG's gas purchases, which, in the past, have financed electricity-sector deficits, are changing. In the future, the utility's contributions to rural electrification will depend more on revenues from its electricity operations.

9.24 Given the current administration's concerns about employment, one question is whether the MALT system needs to be adapted and reinforced to better support rural industrial development. Research may be needed to determine whether a more aggressive customer education campaign is required on technical alternatives or new incentive measures introduced to amortize the costs of electrifying high-power motors to encourage rural industrial development.

9.25 Finally, the question arises: Can the considerable technical expertise of STEG and its external contractors and suppliers be shared with rural electrification programs in other African countries? The enabling political and socioeconomic conditions that contributed to STEG's success may not be replicated in other countries. Nonetheless, STEG can provide useful lessons—even in unpromising situations—from its experience in adaptive technology, robust finances, and transparent project selection.

9.26 The MALT system has attracted the attention of various African countries. Both Senegal and Mali have sent their technicians to STEG for training or to obtain information they can potentially apply in their countries. At the request of Madagascar's Ministry of Energy, STEG carried out a study for a pilot project in that country, and technicians from Madagascar's utility have participated in STEG training courses. In 1993, an evaluation by the Nordic Consulting Group recommended to the ADB that STEG's experience be disseminated on a broader scale. Indeed, encouraging STEG's technical assistance to rural electrification programs throughout Africa and other developing countries worldwide—through both bilateral and multilateral programs—is an interesting option.

Appendix 1

Daily Accounts, Billing, and Receivables of Low-voltage Customers: BTJ Software Application

A1-1 The Basse Tension Journalière (BTJ) software application integrates the management and follow-up of each phase preceding billing, from formulation of a request for a new connection through meter installation and hook-up. During this phase, the computerized software application facilitates following the progress of customers' connection requests and verifying or re-starting execution to ensure that all meters paid and installed pass through the billing chain to integrate the normal cycle of accounting and billing of use. The automatic follow-up minimizes unbilled energy consumption caused by not registering meters put into service.

A1-2 BTJ involves a daily routine. Each day, the following are published: bills, meter readings, state of control and follow-up in meter reading errors and possible fraud, state of execution, orders for cut-offs of customers who have exceeded their payment period, orders to install meters, and state of subscription cancellations or disputes. Management of these daily tasks uses full-time, specialized teams throughout each two-month billing cycle and permits fluidity in STEG's cash flow. The former software application published all bills for an entire cycle at the same time, and all customers had approximately the same payment date. Thus, cash flow during this one period was massive, but poor during others. Numerous bill distributors and meter readers were required in order to visit all customers within a minimum amount of time; however, at other times during the cycle, they had little to do and were not used profitably.

A1-3 When a customer's meter is read, s/he receives a bill within one-two days. The bill includes all details, including deadline for payment and date of the next meter reading so that the customer can plan for someone to be at home to give the meter reader access to the meter, which is installed inside the house. Customers away from home on the day of meter reading can record and call in the reading themselves in order to receive a bill corresponding to their exact consumption.

A1-4 BTJ automatically allows for keeping current accounts specific to the management of LV subscribers (payment of connection costs, payment of bills, expenses of reconnection after cut-offs, and corrections to bills following meter-reading errors).

A1-5 BTJ memorizes a history of consumption for a rolling year (six bills) for each LV subscriber. In case a customer is not at home or the meter is not read, consumption can be estimated based on the history of the last six bi-monthly bills.

A1-6 BTJ introduces codes that, in theory, can facilitate later analysis of consumption, by providing statistics on electricity use and category of subscriber. Unfortunately, this coding is difficult to check, errors go uncorrected, and agents who input codes for electricity use often fail to check them, knowing that no one will reproach them; thus, this coding is unreliable.

A1-7 Terminals linked to the central computer have been installed in the customer service windows of branch offices so that customer service representatives can directly consult the BTJ database to obtain information directly on customers' accounts.

A1-8 With increased numbers of customers and saturation of the mainframe computer, the BTJ application has been decentralized to the regional office level.

Appendix 2

Average Rate of National Value-added, By Item of Local Electrical System Equipment

Item Group	*Item*	*Supplier*	*Average (%)*	
Cables	Electric cable	Câbles Chakira	63.0	
		Tunisie Câbles	63.0	
	Lighting set	SIME	44.0	
	Transformers	SACEM	51.0	
Switchboards	SM6 distribution switchboard	TET		> or = 40%
	MV & LV distribution switchboard	ELECTRO-CONDUCTEUR		> or = 40%
	Single-phase, meter-mounting board	SIAME	70.0	
	MV distribution switchboard	COMPTO		> or = 40%
	Switch cupboard	SIME	54.0	
Switches	Section switch	ELECTRO-CONDUCTEUR	65.7	
	Three-pole section switch	COPEL	63.0	
	Fuse cutout	ALPHA G.T.I		> or = 40%
	Circuit-breaker isolator	SMEE		> or = 40%
		COMPTO		> or = 40%
	MV circuit breaker	META	39.3	
		ELECTRO-CONDUCTEUR	65.0	
	Power circuit breaker	SOMELEC		> or = 40%
	Cutout	ELECTRO-CONDUCTEUR	85.6	
	Single-pole cutout	COPEL	61.9	
	Contactor	TTE	57.0	
	Single-pole breaker	TTI	66.0	

	Breaker	SIAME	51.5	

Item Group	*Item*	*Supplier*	*Average (%)*	
MV and LV line accessories	Branch anchoring clip	ARELEC	49.5	
	Anchoring clip	SIAME		> or = 40%
	Anchoring clip for carrying neutral wire	ARELEC	46.4	
	Connector	SIAME	61.0	
	Branch connector	PRECIMECA	64.0	
		ARELEC	70.2	
	Derivation circuit connector	ARELEC	67.0	
	Grip with parallel grooves	ARELEC	59.9	
	Aluminum wire connector	ARELEC	66.2	
	Bimetal wire connector	ARELEC	68.9	
	LV suspension set for twisted cables	ARELEC	53.9	
	Wall hanging accessory for LV cable	ARELEC	89.0	
	Branch isolated support	ARELEC	46.1	
	Mounting bracket	ARELEC	41.7	
	Wire end ferrule	ARELEC	84.3	
	Alarm device	PLYMOUTH Tunisie	84.0	
Earthing	Earth rod	INDELEC		> or = 40%
		SIDU	62.6	
Pipes	Galvanized welded pipe	PAF	57.0	
	Bendy duct	MTMP	50.3	
	PVC duct	UNBOPLAST	55.0	
Boxes	Junction box	SMEE	51.5	
	Sealing-end pothead	SMEE	47.5	
Line poles	Round-iron pole	El Fouledh	100.0	
	Pre-stressed, armed concrete pole	BMS	100.0	
		KANAOUET	100.0	
		BONA	100.0	
Overall Average			64.4	

Appendix 3

Example of MALT Cost Reduction, Based on STEG Prices

A3-1 To illustrate the cost reduction achieved, in current prices, using the single-phase MALT lines (versus the conventional European three-phase lines), a line representative of those that had already been studied was chosen from the rural network. The selected line was 1.44 km in length in ASTER 54.6 mm², a typical section used in rural electrification.

A3-2 The study method consisted of using the Tanouir MV, line-design software to 1) analyze the cost of the line as a three-phase MALT line (three wires for phases + neutral) and 2) suppress two phase conductors and add a neutral wire in order to study the same 1.44-km line in MALT single-phase (one phase + one neutral). The simulation was further analyzed by comparing suspended-type and pin insulator-type lines. The comparison allowed for estimating the cost reduction per kilometer resulting from introducing the pin-insulator technique.

A3-3 Results of the study showed that, for the suspended string insulator line, 1 km of MALT single-phase line achieved a 35 percent reduction in cost over the MALT three-phase line and 27 percent over the European three-phase line; for the pin insulator line, 1 km of MALT single-phase line achieved a 42 percent reduction in cost over the MALT three-phase line and 37 percent over the European three-phase line (table A3.1).

Table A3.1: Summary of Cost-comparison Study Results

Cost or Cost-savings Item	*Suspended String Insulator*	*Pin Insulator*	*Cost-cutting Achieved with Pin Insulator (%)*
Cost of 1 km of European MV, three-phase overhead line (US$)*	12,496	11,543	5.67
Cost of 1 km of MALT MV, single-phase overhead line (US$)*	8,146	6,665	18.00
Cost savings of 1 km, single-phase, 2-wire line/MALT type, 4-wire line (%)	35	42	
Cost savings of 1 km, single-phase, 2-wire line/European type, 33-wire line (%)	27	37	

* 1 US$ = 1.45 TD (September 2001 exchange rate).

A3-4 Further, results showed that estimated cost reduction achieved using the pin insulator, single-phase line—versus the suspended insulator, single-phase line—was 18 percent, which approximates the 20 percent estimated by Essebaa (1994). Clearly, the more single-phase lines that are constructed, the more profitable the MALT three-phase/single-phase system becomes. As figure 7.1 illustrates (NRECA 1999), Tunisia's 42-percent cost reduction (total line cost of US$6,665/km) places the country between Bolivia (37 percent) and the Philippines (48 percent).

A3-5 In general, the changeover to single-phase lines, at an additional cost of only 2 percent in the neutral grounding, allows for a considerable reduction in costs of wires, line accessories, and poles. The cost reduction in poles becomes even more important with the pin insulator technique, which allows an additional 10 percent reduction, compared to the European three-phase line (table A3.2).

Table A3.2: Summary of Cost-cutting Distribution, by Item Groups

	Cost Reduction (%) of MALT Single-phase versus Overall Cost of European Three-phase Lines	
Item Group	*Suspended String Insulator or Suspension Chain Line*	*Pin Insulator Line*
Conductors	6.6	7.0
Line accessories	13.5	11.5
Earthing (or grounding)	-2.0	-2.2
Poles	7.2	17.3
Crossings (guy wires and anchors), galvanized cross-arms	1.7	3.1
Overall	27.0	36.7

A3-6 One should note that these estimates refer only to the particular lines studied here. A line having more slopes (due to uneven soil) or more curves will cost more. To estimate a valid average cost for all of Tunisia, it would be necessary to study several dozen lines, performing the above-described simulation for each. That time-consuming process would fail to yield exact results because of Tunisia's saturation of rural electrification; that is, the terrain and curves of the lines not yet constructed may differ from existing ones. Thus, costs may differ.

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LIST OF REPORTS ON COMPLETED ACTIVITIES

Region/Country	*Activity/Report Title*	*Date*	*Number*
	SUB-SAHARAN AFRICA (AFR)		
Africa Regional	Anglophone Africa Household Energy Workshop (English)	07/88	085/88
	Regional Power Seminar on Reducing Electric Power System Losses in Africa (English)	08/88	087/88
	Institutional Evaluation of EGL (English)	02/89	098/89
	Biomass Mapping Regional Workshops (English)	05/89	--
	Francophone Household Energy Workshop (French)	08/89	--
	Interafrican Electrical Engineering College: Proposals for Short- and Long-Term Development (English)	03/90	112/90
	Biomass Assessment and Mapping (English)	03/90	--
	Symposium on Power Sector Reform and Efficiency Improvement in Sub-Saharan Africa (English)	06/96	182/96
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	Africa Gas Initiative – Main Report: Volume I	02/01	240/01
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	Ministerial Workshop on Women in Energy	10/01	250/01
	Energy and Poverty Reduction: Proceedings from a Multi-Sector And Multi-Stakeholder Workshop Addis Ababa, Ethiopia, October 23-25, 2002.	03/03	266/03
	Opportunities for Power Trade in the Nile Basin: Final Scoping Study	01/04	277/04
	Énergies modernes et réduction de la pauvreté: Un atelier multi-sectoriel. Actes de l'atelier régional. Dakar, Sénégal, du 4 au 6 février 2003 (French Only)	01/04	278/04
	Énergies modernes et réduction de la pauvreté: Un atelier multi-sectoriel. Actes de l'atelier régional. Douala, Cameroun du 16-18 juillet 2003. (French Only)	09/04	286/04
	Energy and Poverty Reduction: Proceedings from the Global Village Energy Partnership (GVEP) Workshops held in Africa	01/05	298/05
	Power Sector Reform in Africa: Assessing the Impact on Poor People	08/05	306/05
Angola	Energy Assessment (English and Portuguese)	05/89	4708-ANG
	Power Rehabilitation and Technical Assistance (English)	10/91	142/91
	Africa Gas Initiative – Angola: Volume II	02/01	240/01
Benin	Energy Assessment (English and French)	06/85	5222-BEN
Botswana	Energy Assessment (English)	09/84	4998-BT
	Pump Electrification Prefeasibility Study (English)	01/86	047/86
	Review of Electricity Service Connection Policy (English)	07/87	071/87
	Tuli Block Farms Electrification Study (English)	07/87	072/87
	Household Energy Issues Study (English)	02/88	--
	Urban Household Energy Strategy Study (English)	05/91	132/91
Burkina Faso	Energy Assessment (English and French)	01/86	5730-BUR
	Technical Assistance Program (English)	03/86	052/86
	Urban Household Energy Strategy Study (English and French)	06/91	134/91
Burundi	Energy Assessment (English)	06/82	3778-BU
	Petroleum Supply Management (English)	01/84	012/84
	Status Report (English and French)	02/84	011/84

Region/Country	Activity/Report Title	Date	Number
Burundi	Presentation of Energy Projects for the Fourth Five-Year Plan (1983-1987) (English and French)	05/85	036/85
	Improved Charcoal Cookstove Strategy (English and French)	09/85	042/85
	Peat Utilization Project (English)	11/85	046/85
	Energy Assessment (English and French)	01/92	9215-BU
Cameroon	Africa Gas Initiative – Cameroon: Volume III	02/01	240/01
Cape Verde	Energy Assessment (English and Portuguese)	08/84	5073-CV
	Household Energy Strategy Study (English)	02/90	110/90
Central African Republic	Energy Assessment (French)	08/92	9898-CAR
Chad	Elements of Strategy for Urban Household Energy The Case of N'djamena (French)	12/93	160/94
Comoros	Energy Assessment (English and French)	01/88	7104-COM
	In Search of Better Ways to Develop Solar Markets: The Case of Comoros	05/00	230/00
Congo	Energy Assessment (English)	01/88	6420-COB
	Power Development Plan (English and French)	03/90	106/90
	Africa Gas Initiative – Congo: Volume IV	02/01	240/01
Côte d'Ivoire	Energy Assessment (English and French)	04/85	5250-IVC
	Improved Biomass Utilization (English and French)	04/87	069/87
	Power System Efficiency Study (English)	12/87	--
	Power Sector Efficiency Study (French)	02/92	140/91
	Project of Energy Efficiency in Buildings (English)	09/95	175/95
	Africa Gas Initiative – Côte d'Ivoire: Volume V	02/01	240/01
Ethiopia	Energy Assessment (English)	07/84	4741-ET
	Power System Efficiency Study (English)	10/85	045/85
	Agricultural Residue Briquetting Pilot Project (English)	12/86	062/86
	Bagasse Study (English)	12/86	063/86
	Cooking Efficiency Project (English)	12/87	--
	Energy Assessment (English)	02/96	179/96
Gabon	Energy Assessment (English)	07/88	6915-GA
	Africa Gas Initiative – Gabon: Volume VI	02/01	240/01
The Gambia	Energy Assessment (English)	11/83	4743-GM
	Solar Water Heating Retrofit Project (English)	02/85	030/85
	Solar Photovoltaic Applications (English)	03/85	032/85
	Petroleum Supply Management Assistance (English)	04/85	035/85
Ghana	Energy Assessment (English)	11/86	6234-GH
	Energy Rationalization in the Industrial Sector (English)	06/88	084/88
	Sawmill Residues Utilization Study (English)	11/88	074/87
	Industrial Energy Efficiency (English)	11/92	148/92
	Corporatization of Distribution Concessions through Capitalization	12/03	272/03
Guinea	Energy Assessment (English)	11/86	6137-GUI
	Household Energy Strategy (English and French)	01/94	163/94
Guinea-Bissau	Energy Assessment (English and Portuguese)	08/84	5083-GUB
	Recommended Technical Assistance Projects (English & Portuguese)	04/85	033/85
	Management Options for the Electric Power and Water Supply Subsectors (English)	02/90	100/90
	Power and Water Institutional Restructuring (French)	04/91	118/91
Kenya	Energy Assessment (English)	05/82	3800-KE
	Power System Efficiency Study (English)	03/84	014/84
	Status Report (English)	05/84	016/84
	Coal Conversion Action Plan (English)	02/87	--

Region/Country	Activity/Report Title	Date	Number
	Solar Water Heating Study (English)	02/87	066/87
Kenya	Peri-Urban Woodfuel Development (English)	10/87	076/87
	Power Master Plan (English)	11/87	--
	Power Loss Reduction Study (English)	09/96	186/96
	Implementation Manual: Financing Mechanisms for Solar Electric Equipment	07/00	231/00
Lesotho	Energy Assessment (English)	01/84	4676-LSO
Liberia	Energy Assessment (English)	12/84	5279-LBR
	Recommended Technical Assistance Projects (English)	06/85	038/85
	Power System Efficiency Study (English)	12/87	081/87
Madagascar	Energy Assessment (English)	01/87	5700-MAG
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	Environmental Impact of Woodfuels (French)	10/95	176/95
Malawi	Energy Assessment (English)	08/82	3903-MAL
	Technical Assistance to Improve the Efficiency of Fuelwood Use in the Tobacco Industry (English)	11/83	009/83
	Status Report (English)	01/84	013/84
Mali	Energy Assessment (English and French)	11/91	8423-MLI
	Household Energy Strategy (English and French)	03/92	147/92
Islamic Republic of Mauritania	Energy Assessment (English and French)	04/85	5224-MAU
	Household Energy Strategy Study (English and French)	07/90	123/90
Mauritius	Energy Assessment (English)	12/81	3510-MAS
	Status Report (English)	10/83	008/83
	Power System Efficiency Audit (English)	05/87	070/87
	Bagasse Power Potential (English)	10/87	077/87
	Energy Sector Review (English)	12/94	3643-MAS
Mozambique	Energy Assessment (English)	01/87	6128-MOZ
	Household Electricity Utilization Study (English)	03/90	113/90
	Electricity Tariffs Study (English)	06/96	181/96
	Sample Survey of Low Voltage Electricity Customers	06/97	195/97
Namibia	Energy Assessment (English)	03/93	11320-NAM
Niger	Energy Assessment (French)	05/84	4642-NIR
	Status Report (English and French)	02/86	051/86
	Improved Stoves Project (English and French)	12/87	080/87
	Household Energy Conservation and Substitution (English and French)	01/88	082/88
Nigeria	Energy Assessment (English)	08/83	4440-UNI
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Rwanda	Energy Assessment (English)	06/82	3779-RW
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	Improved Charcoal Production Techniques (English and French)	02/87	065/87
	Energy Assessment (English and French)	07/91	8017-RW
	Commercialization of Improved Charcoal Stoves and Carbonization Techniques Mid-Term Progress Report (English and French)	12/91	141/91
SADC	SADC Regional Power Interconnection Study, Vols. I-IV (English)	12/93	-
SADCC	SADCC Regional Sector: Regional Capacity-Building Program for Energy Surveys and Policy Analysis (English)	11/91	-
Sao Tome and Principe	Energy Assessment (English)	10/85	5803-STP
Senegal	Energy Assessment (English)	07/83	4182-SE
	Status Report (English and French)	10/84	025/84

Region/Country	Activity/Report Title	Date	Number
	Industrial Energy Conservation Study (English)	05/85	037/85
Senegal	Preparatory Assistance for Donor Meeting (English and French)	04/86	056/86
	Urban Household Energy Strategy (English)	02/89	096/89
	Industrial Energy Conservation Program (English)	05/94	165/94
Seychelles	Energy Assessment (English)	01/84	4693-SEY
	Electric Power System Efficiency Study (English)	08/84	021/84
Sierra Leone	Energy Assessment (English)	10/87	6597-SL
Somalia	Energy Assessment (English)	12/85	5796-SO
Republic of South Africa	Options for the Structure and Regulation of Natural Gas Industry (English)	05/95	172/95
Sudan	Management Assistance to the Ministry of Energy and Mining	05/83	003/83
	Energy Assessment (English)	07/83	4511-SU
	Power System Efficiency Study (English)	06/84	018/84
	Status Report (English)	11/84	026/84
	Wood Energy/Forestry Feasibility (English)	07/87	073/87
Swaziland	Energy Assessment (English)	02/87	6262-SW
	Household Energy Strategy Study	10/97	198/97
Tanzania	Energy Assessment (English)	11/84	4969-TA
	Peri-Urban Woodfuels Feasibility Study (English)	08/88	086/88
	Tobacco Curing Efficiency Study (English)	05/89	102/89
	Remote Sensing and Mapping of Woodlands (English)	06/90	--
	Industrial Energy Efficiency Technical Assistance (English)	08/90	122/90
	Power Loss Reduction Volume 1: Transmission and Distribution System Technical Loss Reduction and Network Development (English)	06/98	204A/98
	Power Loss Reduction Volume 2: Reduction of Non-Technical Losses (English)	06/98	204B/98
Togo	Energy Assessment (English)	06/85	5221-TO
	Wood Recovery in the Nangbeto Lake (English and French)	04/86	055/86
	Power Efficiency Improvement (English and French)	12/87	078/87
Uganda	Energy Assessment (English)	07/83	4453-UG
	Status Report (English)	08/84	020/84
	Institutional Review of the Energy Sector (English)	01/85	029/85
	Energy Efficiency in Tobacco Curing Industry (English)	02/86	049/86
	Fuelwood/Forestry Feasibility Study (English)	03/86	053/86
	Power System Efficiency Study (English)	12/88	092/88
	Energy Efficiency Improvement in the Brick and Tile Industry (English)	02/89	097/89
	Tobacco Curing Pilot Project (English)	03/89	UNDP Terminal Report
	Energy Assessment (English)	12/96	193/96
	Rural Electrification Strategy Study	09/99	221/99
Zaire	Energy Assessment (English)	05/86	5837-ZR
Zambia	Energy Assessment (English)	01/83	4110-ZA
	Status Report (English)	08/85	039/85
	Energy Sector Institutional Review (English)	11/86	060/86
	Power Subsector Efficiency Study (English)	02/89	093/88
	Energy Strategy Study (English)	02/89	094/88
	Urban Household Energy Strategy Study (English)	08/90	121/90
Zimbabwe	Energy Assessment (English)	06/82	3765-ZIM
	Power System Efficiency Study (English)	06/83	005/83
	Status Report (English)	08/84	019/84
	Power Sector Management Assistance Project (English)	04/85	034/85

	Power Sector Management Institution Building (English)	09/89	--
Zimbabwe	Petroleum Management Assistance (English)	12/89	109/89
	Charcoal Utilization Pre-feasibility Study (English)	06/90	119/90
	Integrated Energy Strategy Evaluation (English)	01/92	8768-ZIM
	Energy Efficiency Technical Assistance Project: Strategic Framework for a National Energy Efficiency Improvement Program (English)	04/94	--
	Capacity Building for the National Energy Efficiency Improvement Programme (NEEIP) (English)	12/94	--
	Rural Electrification Study	03/00	228/00

EAST ASIA AND PACIFIC (EAP)

Asia Regional	Pacific Household and Rural Energy Seminar (English)	11/90	--
China	County-Level Rural Energy Assessments (English)	05/89	101/89
	Fuelwood Forestry Preinvestment Study (English)	12/89	105/89
	Strategic Options for Power Sector Reform in China (English)	07/93	156/93
	Energy Efficiency and Pollution Control in Township and Village Enterprises (TVE) Industry (English)	11/94	168/94
	Energy for Rural Development in China: An Assessment Based on a Joint Chinese/ESMAP Study in Six Counties (English)	06/96	183/96
	Improving the Technical Efficiency of Decentralized Power Companies	09/99	222/99
	Air Pollution and Acid Rain Control: The Case of Shijiazhuang City and the Changsha Triangle Area	10/03	267/03
	Toward a Sustainable Coal Sector In China	07/04	287/04
Fiji	Energy Assessment (English)	06/83	4462-FIJ
Indonesia	Energy Assessment (English)	11/81	3543-IND
	Status Report (English)	09/84	022/84
	Power Generation Efficiency Study (English)	02/86	050/86
	Energy Efficiency in the Brick, Tile and Lime Industries (English)	04/87	067/87
	Diesel Generating Plant Efficiency Study (English)	12/88	095/88
	Urban Household Energy Strategy Study (English)	02/90	107/90
	Biomass Gasifier Preinvestment Study Vols. I & II (English)	12/90	124/90
	Prospects for Biomass Power Generation with Emphasis on Palm Oil, Sugar, Rubberwood and Plywood Residues (English)	11/94	167/94
Lao PDR	Urban Electricity Demand Assessment Study (English)	03/93	154/93
	Institutional Development for Off-Grid Electrification	06/99	215/99
Malaysia	Sabah Power System Efficiency Study (English)	03/87	068/87
	Gas Utilization Study (English)	09/91	9645-MA
Mongolia	Energy Efficiency in the Electricity and District Heating Sectors	10/01	247/01
	Improved Space Heating Stoves for Ulaanbaatar	03/02	254/02
Myanmar	Energy Assessment (English)	06/85	5416-BA
Papua New Guinea	Energy Assessment (English)	06/82	3882-PNG
	Status Report (English)	07/83	006/83
	Institutional Review in the Energy Sector (English)	10/84	023/84
	Power Tariff Study (English)	10/84	024/84
Philippines	Commercial Potential for Power Production from Agricultural Residues (English)	12/93	157/93
	Energy Conservation Study (English)	08/94	--

Region/Country	Activity/Report Title	Date	Number
Philippines	Strengthening the Non-Conventional and Rural Energy Development Program in the Philippines: A Policy Framework and Action Plan	08/01	243/01
	Rural Electrification and Development in the Philippines: Measuring the Social and Economic Benefits	05/02	255/02
Solomon Islands	Energy Assessment (English)	06/83	4404-SOL
	Energy Assessment (English)	01/92	979-SOL
South Pacific	Petroleum Transport in the South Pacific (English)	05/86	--
Thailand	Energy Assessment (English)	09/85	5793-TH
	Rural Energy Issues and Options (English)	09/85	044/85
	Accelerated Dissemination of Improved Stoves and Charcoal Kilns (English)	09/87	079/87
	Northeast Region Village Forestry and Woodfuels Preinvestment Study (English)	02/88	083/88
	Impact of Lower Oil Prices (English)	08/88	--
	Coal Development and Utilization Study (English)	10/89	--
	Why Liberalization May Stall in a Mature Power Market: A Review of the Technical and Political Economy Factors that Constrained the Electricity Sector Reform in Thailand 1998-2002	12/03	270/03
	Reducing Emissions from Motorcycles in Bangkok	10/03	275/03
Tonga	Energy Assessment (English)	06/85	5498-TON
Vanuatu	Energy Assessment (English)	06/85	5577-VA
Vietnam	Rural and Household Energy-Issues and Options (English)	01/94	161/94
	Power Sector Reform and Restructuring in Vietnam: Final Report to the Steering Committee (English and Vietnamese)	09/95	174/95
	Household Energy Technical Assistance: Improved Coal Briquetting and Commercialized Dissemination of Higher Efficiency Biomass and Coal Stoves (English)	01/96	178/96
	Petroleum Fiscal Issues and Policies for Fluctuating Oil Prices In Vietnam	02/01	236/01
	An Overnight Success: Vietnam's Switch to Unleaded Gasoline	08/02	257/02
	The Electricity Law for Vietnam—Status and Policy Issues—The Socialist Republic of Vietnam	08/02	259/02
	Petroleum Sector Technical Assistance for the Revision of the Existing Legal and Regulatory Framework	12/03	269/03
Western Samoa	Energy Assessment (English)	06/85	5497-WSO

SOUTH ASIA (SAS)

Region/Country	Activity/Report Title	Date	Number
Bangladesh	Energy Assessment (English)	10/82	3873-BD
	Priority Investment Program (English)	05/83	002/83
	Status Report (English)	04/84	015/84
	Power System Efficiency Study (English)	02/85	031/85
	Small Scale Uses of Gas Pre-feasibility Study (English)	12/88	--
	Reducing Emissions from Baby-Taxis in Dhaka	01/02	253/02
India	Opportunities for Commercialization of Non-conventional Energy Systems (English)	11/88	091/88
	Maharashtra Bagasse Energy Efficiency Project (English)	07/90	120/90
	Mini-Hydro Development on Irrigation Dams and Canal Drops Vols. I, II and III (English)	07/91	139/91
	WindFarm Pre-Investment Study (English)	12/92	150/92
	Power Sector Reform Seminar (English)	04/94	166/94

Region/Country	Activity/Report Title	Date	Number
	Environmental Issues in the Power Sector (English)	06/98	205/98
India	Environmental Issues in the Power Sector: Manual for Environmental Decision Making (English)	06/99	213/99
	Household Energy Strategies for Urban India: The Case of Hyderabad	06/99	214/99
	Greenhouse Gas Mitigation In the Power Sector: Case Studies From India	02/01	237/01
	Energy Strategies for Rural India: Evidence from Six States	08/02	258/02
	Household Energy, Indoor Air Pollution, and Health	11/02	261/02
	Access of the Poor to Clean Household Fuels	07/03	263/03
	The Impact of Energy on Women's Lives in Rural India	01/04	276/04
	Environmental Issues in the Power Sector: Long-Term Impacts And Policy Options for Rajasthan	10/04	292/04
	Environmental Issues in the Power Sector: Long-Term Impacts And Policy Options for Karnataka	10/04	293/04
Nepal	Energy Assessment (English)	08/83	4474-NEP
	Status Report (English)	01/85	028/84
	Energy Efficiency & Fuel Substitution in Industries (English)	06/93	158/93
Pakistan	Household Energy Assessment (English)	05/88	--
	Assessment of Photovoltaic Programs, Applications, and Markets (English)	10/89	103/89
Pakistan	National Household Energy Survey and Strategy Formulation Study: Project Terminal Report (English)	03/94	--
	Managing the Energy Transition (English)	10/94	--
	Lighting Efficiency Improvement Program Phase 1: Commercial Buildings Five Year Plan (English)	10/94	--
	Clean Fuels	10/01	246/01
Regional	Toward Cleaner Urban Air in South Asia: Tackling Transport Pollution, Understanding Sources.	03/04	281/04
Sri Lanka	Energy Assessment (English)	05/82	3792-CE
	Power System Loss Reduction Study (English)	07/83	007/83
	Status Report (English)	01/84	010/84
	Industrial Energy Conservation Study (English)	03/86	054/86
	Sustainable Transport Options for Sri Lanka: Vol. I	02/03	262/03
	Greenhouse Gas Mitigation Options in the Sri Lanka Power Sector: Vol. II	02/03	262/03
	Sri Lanka Electric Power Technology Assessment (SLEPTA): Vol. III	02/03	262/03
	Energy and Poverty Reduction: Proceedings from South Asia Practitioners Workshop How Can Modern Energy Services Contribute to Poverty Reduction? Colombo, Sri Lanka, June 2-4, 2003	11/03	268/03

EUROPE AND CENTRAL ASIA (ECA)

Region/Country	Activity/Report Title	Date	Number
Armenia	Development of Heat Strategies for Urban Areas of Low-income Transition Economies. Urban Heating Strategy for the Republic Of Armenia. *Including a Summary of a Heating Strategy for the Kyrgyz Republic*	04/04	282/04
Bulgaria	Natural Gas Policies and Issues (English)	10/96	188/96
	Energy Environment Review	10/02	260/02
Central Asia and The Caucasus	Cleaner Transport Fuels in Central Asia and the Caucasus	08/01	242/01
Central and Eastern Europe	Power Sector Reform in Selected Countries	07/97	196/97

Region/Country	Activity/Report Title	Date	Number
	Increasing the Efficiency of Heating Systems in Central and Eastern Europe and the Former Soviet Union (English and Russian)	08/00	234/00
	The Future of Natural Gas in Eastern Europe (English)	08/92	149/92
Kazakhstan	Natural Gas Investment Study, Volumes 1, 2 & 3	12/97	199/97
Kazakhstan & Kyrgyzstan	Opportunities for Renewable Energy Development	11/97	16855-KAZ
Poland	Energy Sector Restructuring Program Vols. I-V (English)	01/93	153/93
	Natural Gas Upstream Policy (English and Polish)	08/98	206/98
	Energy Sector Restructuring Program: Establishing the Energy Regulation Authority	10/98	208/98
Portugal	Energy Assessment (English)	04/84	4824-PO
Romania	Natural Gas Development Strategy (English)	12/96	192/96
	Private Sector Participation in Market-Based Energy-Efficiency Financing Schemes: Lessons Learned from Romania and International Experiences.	11/03	274/03
Slovenia	Workshop on Private Participation in the Power Sector (English)	02/99	211/99
Turkey	Energy Assessment (English)	03/83	3877-TU
	Energy and the Environment: Issues and Options Paper	04/00	229/00
	Energy and Environment Review: Synthesis Report	12/03	273/03

MIDDLE EAST AND NORTH AFRICA (MNA)

Region/Country	Activity/Report Title	Date	Number
Arab Republic of Egypt	Energy Assessment (English)	10/96	189/96
	Energy Assessment (English and French)	03/84	4157-MOR
	Status Report (English and French)	01/86	048/86
Morocco	Energy Sector Institutional Development Study (English and French)	07/95	173/95
	Natural Gas Pricing Study (French)	10/98	209/98
	Gas Development Plan Phase II (French)	02/99	210/99
Syria	Energy Assessment (English)	05/86	5822-SYR
	Electric Power Efficiency Study (English)	09/88	089/88
	Energy Efficiency Improvement in the Cement Sector (English)	04/89	099/89
	Energy Efficiency Improvement in the Fertilizer Sector (English)	06/90	115/90
Tunisia	Fuel Substitution (English and French)	03/90	--
	Power Efficiency Study (English and French)	02/92	136/91
	Energy Management Strategy in the Residential and Tertiary Sectors (English)	04/92	146/92
	Renewable Energy Strategy Study, Volume I (French)	11/96	190A/96
	Renewable Energy Strategy Study, Volume II (French)	11/96	190B/96
	Rural Electrification in Tunisia: National Commitment, Efficient Implementation and Sound Finances	08/05	307/05
Yemen	Energy Assessment (English)	12/84	4892-YAR
	Energy Investment Priorities (English)	02/87	6376-YAR
	Household Energy Strategy Study Phase I (English)	03/91	126/91

LATIN AMERICA AND THE CARIBBEAN REGION (LCR)

Region/Country	Activity/Report Title	Date	Number
LCR Regional	Regional Seminar on Electric Power System Loss Reduction in the Caribbean (English)	07/89	--
	Elimination of Lead in Gasoline in Latin America and the Caribbean (English and Spanish)	04/97	194/97

Region/Country	Activity/Report Title	Date	Number
LCR Regional	Elimination of Lead in Gasoline in Latin America and the Caribbean - Status Report (English and Spanish)	12/97	200/97
	Harmonization of Fuels Specifications in Latin America and the Caribbean (English and Spanish)	06/98	203/98
	Energy and Poverty Reduction: Proceedings from the Global Village Energy Partnership (GVEP) Workshop held in Bolivia	06/05	202/05
	Power Sector Reform and the Rural Poor in Central America	12/04	297/04
	Estudio Comparativo Sobre la Distribución de la Renta Petrolera en Bolivia, Colombia, Ecuador y Perú	08/05	304/05
Bolivia	Energy Assessment (English)	04/83	4213-BO
	National Energy Plan (English)	12/87	--
	La Paz Private Power Technical Assistance (English)	11/90	111/90
	Pre-feasibility Evaluation Rural Electrification and Demand Assessment (English and Spanish)	04/91	129/91
	National Energy Plan (Spanish)	08/91	131/91
	Private Power Generation and Transmission (English)	01/92	137/91
	Natural Gas Distribution: Economics and Regulation (English)	03/92	125/92
	Natural Gas Sector Policies and Issues (English and Spanish)	12/93	164/93
	Household Rural Energy Strategy (English and Spanish)	01/94	162/94
	Preparation of Capitalization of the Hydrocarbon Sector	12/96	191/96
	Introducing Competition into the Electricity Supply Industry in Developing Countries: Lessons from Bolivia	08/00	233/00
	Final Report on Operational Activities Rural Energy and Energy Efficiency	08/00	235/00
	Oil Industry Training for Indigenous People: The Bolivian Experience (English and Spanish)	09/01	244/01
	Capacitación de Pueblos Indígenas en la Actividad Petrolera. Fase II	07/04	290/04
	Estudio Sobre Aplicaciones en Pequeña Escala de Gas Natural	07/04	291/04
Brazil	Energy Efficiency & Conservation: Strategic Partnership for Energy Efficiency in Brazil (English)	01/95	170/95
	Hydro and Thermal Power Sector Study	09/97	197/97
	Rural Electrification with Renewable Energy Systems in the Northeast: A Preinvestment Study	07/00	232/00
	Reducing Energy Costs in Municipal Water Supply Operations "Learning-while-doing" Energy M&T on the Brazilian Frontlines	07/03	265/03
Chile	Energy Sector Review (English)	08/88	7129-CH
Colombia	Energy Strategy Paper (English)	12/86	--
	Power Sector Restructuring (English)	11/94	169/94
Colombia	Energy Efficiency Report for the Commercial and Public Sector (English)	06/96	184/96
Costa Rica	Energy Assessment (English and Spanish)	01/84	4655-CR
	Recommended Technical Assistance Projects (English)	11/84	027/84
	Forest Residues Utilization Study (English and Spanish)	02/90	108/90
Dominican Republic	Energy Assessment (English)	05/91	8234-DO
Ecuador	Energy Assessment (Spanish)	12/85	5865-EC
	Energy Strategy Phase I (Spanish)	07/88	--
	Energy Strategy (English)	04/91	--
	Private Mini-hydropower Development Study (English)	11/92	--
	Energy Pricing Subsidies and Interfuel Substitution (English)	08/94	11798-EC
	Energy Pricing, Poverty and Social Mitigation (English)	08/94	12831-EC
Guatemala	Issues and Options in the Energy Sector (English)	09/93	12160-GU
	Health Impacts of Traditional Fuel Use	08/04	284/04

Region/Country	*Activity/Report Title*	*Date*	*Number*
Haiti	Energy Assessment (English and French)	06/82	3672-HA
	Status Report (English and French)	08/85	041/85
	Household Energy Strategy (English and French)	12/91	143/91
Honduras	Energy Assessment (English)	08/87	6476-HO
	Petroleum Supply Management (English)	03/91	128/91
Jamaica	Energy Assessment (English)	04/85	5466-JM
	Petroleum Procurement, Refining, and Distribution Study (English)	11/86	061/86
	Energy Efficiency Building Code Phase I (English)	03/88	--
	Energy Efficiency Standards and Labels Phase I (English)	03/88	--
Jamaica	Management Information System Phase I (English)	03/88	--
	Charcoal Production Project (English)	09/88	090/88
	FIDCO Sawmill Residues Utilization Study (English)	09/88	088/88
	Energy Sector Strategy and Investment Planning Study (English)	07/92	135/92
Mexico	Improved Charcoal Production Within Forest Management for the State of Veracruz (English and Spanish)	08/91	138/91
	Energy Efficiency Management Technical Assistance to the Comisión Nacional para el Ahorro de Energía (CONAE) (English)	04/96	180/96
	Energy Environment Review	05/01	241/01
Nicaragua	Modernizing the Fuelwood Sector in Managua and León	12/01	252/01
Panama	Power System Efficiency Study (English)	06/83	004/83
Paraguay	Energy Assessment (English)	10/84	5145-PA
	Recommended Technical Assistance Projects (English)	09/85	--
	Status Report (English and Spanish)	09/85	043/85
Peru	Energy Assessment (English)	01/84	4677-PE
	Status Report (English)	08/85	040/85
	Proposal for a Stove Dissemination Program in the Sierra (English and Spanish)	02/87	064/87
	Energy Strategy (English and Spanish)	12/90	--
	Study of Energy Taxation and Liberalization of the Hydrocarbons Sector (English and Spanish)	120/93	159/93
	Reform and Privatization in the Hydrocarbon Sector (English and Spanish)	07/99	216/99
	Rural Electrification	02/01	238/01
Saint Lucia	Energy Assessment (English)	09/84	5111-SLU
St. Vincent and the Grenadines	Energy Assessment (English)	09/84	5103-STV
Sub Andean	Environmental and Social Regulation of Oil and Gas Operations in Sensitive Areas of the Sub-Andean Basin (English and Spanish)	07/99	217/99
Trinidad and Tobago	Energy Assessment (English)	12/85	5930-TR

GLOBAL

	Energy End Use Efficiency: Research and Strategy (English)	11/89	--
	Women and Energy--A Resource Guide The International Network: Policies and Experience (English)	04/90	--
	Guidelines for Utility Customer Management and Metering (English and Spanish)	07/91	--
	Assessment of Personal Computer Models for Energy Planning in Developing Countries (English)	10/91	--
	Long-Term Gas Contracts Principles and Applications (English)	02/93	152/93

	Comparative Behavior of Firms Under Public and Private Ownership (English)	05/93	155/93
	Development of Regional Electric Power Networks (English)	10/94	--
	Roundtable on Energy Efficiency (English)	02/95	171/95
	Assessing Pollution Abatement Policies with a Case Study of Ankara (English)	11/95	177/95
	A Synopsis of the Third Annual Roundtable on Independent Power Projects: Rhetoric and Reality (English)	08/96	187/96
	Rural Energy and Development Roundtable (English)	05/98	202/98
	A Synopsis of the Second Roundtable on Energy Efficiency: Institutional and Financial Delivery Mechanisms (English)	09/98	207/98
	The Effect of a Shadow Price on Carbon Emission in the Energy Portfolio of the World Bank: A Carbon Backcasting Exercise (English)	02/99	212/99
	Increasing the Efficiency of Gas Distribution Phase 1: Case Studies and Thematic Data Sheets	07/99	218/99
	Global Energy Sector Reform in Developing Countries: A Scorecard	07/99	219/99
	Global Lighting Services for the Poor Phase II: Text Marketing of Small “Solar” Batteries for Rural Electrification Purposes	08/99	220/99
	A Review of the Renewable Energy Activities of the UNDP/ World Bank Energy Sector Management Assistance Programme 1993 to 1998	11/99	223/99
	Energy, Transportation and Environment: Policy Options for Environmental Improvement	12/99	224/99
	Privatization, Competition and Regulation in the British Electricity Industry, With Implications for Developing Countries	02/00	226/00
	Reducing the Cost of Grid Extension for Rural Electrification	02/00	227/00
	Undeveloped Oil and Gas Fields in the Industrializing World	02/01	239/01
	Best Practice Manual: Promoting Decentralized Electrification Investment	10/01	248/01
	Peri-Urban Electricity Consumers—A Forgotten but Important Group: What Can We Do to Electrify Them?	10/01	249/01
	Village Power 2000: Empowering People and Transforming Markets	10/01	251/01
	Private Financing for Community Infrastructure	05/02	256/02
	Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook	07/03	264/03
	A Review of ESMAP’s Energy Efficiency Portfolio	11/03	271/03
	A Review of ESMAP’s Rural Energy and Renewable Energy Portfolio	04/04	280/04
	ESMAP Renewable Energy and Energy Efficiency Reports 1998-2004 (CD Only)	05/04	283/04
	Regulation of Associated Gas Flaring and Venting: *A Global Overview and Lessons Learned from International Experience*	08/04	285/04
	ESMAP Gender in Energy Reports and Other related Information (CD Only)	11/04	288/04
	ESMAP Indoor Air Pollution Reports and Other related Information (CD Only)	11/04	289/04

	Energy and Poverty Reduction: Proceedings from the Global Village Energy Partnership (GVEP) Workshop on the Pre-Investment Funding. Berlin, Germany, April 23-24, 2003.	11/04	294/04
	Global Village Energy Partnership (GVEP) Annual Report 2003	12/04	295/04
	Energy and Poverty Reduction: Proceedings from the Global Village Energy Partnership (GVEP) Workshop on Consumer Lending and Microfinance to Expand Access to Energy Services, Manila, Philippines, May 19-21, 2004	12/04	296/04
	The Impact of Higher Oil Prices on Low Income Countries And on the Poor	03/05	299/05
	Advancing Bioenergy for Sustainable Development: Guideline For Policymakers and Investors	04/05	300/05
	ESMAP Rural Energy Reports 1999-2005	03/05	301/05
	Renewable Energy and Energy Efficiency Financing and Policy Network: Options Study and Proceedings of the International Forum	07/05	303/05
	Implementing Power Rationing in a Sensible Way: Lessons Learned and International Best Practices	08/05	305/05

Last report added to this list: ESMAP Formal Report 307/05