REPUBLIC OF TUNISIA

ENERGY

SURVEY AND ACTIVITY

NOVEMBER 1979

JAPAN INTERNATIONAL COOPERATION AGENCY

ENERGY

STEG and his Activity
Load Forecast

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CHAPTER 1. NATURAL AND ECONOMIC ENVIRONMENT

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1.1 GEOGRAPHICAL CONDITIONS

1.1.1 Location

The Republic of Tunisia has a land area of 167,000 km^2 and forms the extreme northern tip of Africa at the junction of the Mediterranean's western and estern basins, lying between 33 and 38 degrees north and between 6 and 9 degrees east. Indis flanked by Algeria to the west, Libya to the south-east and by the Mediterranean to the north and east. Its coastline is 1,200 km long.

Mountain ranges running form the north-east to the south-west divide its territory into 2 regions in distinct contrast with each other.

(1) Morthern Region

In this region, the Medjerda Mountain Range, an extension of the Atlas Mountains, runs from the south-west to the north-east to reach Bezerte. To the south also, the Teboursouk Mountains run parallel to the Medjerda Range to reachhalmost to Medjez El Bab. Tunisia's largest river, the Oued Medjerda, which rises in Algeria, flows down between these two major ranges, receiving tributaries both large and small, to feed the Mediterranean Sea. From the geographical and climatic standpoints, the region is subdivided into 3 areas: the Northwest, most of which is covered by forests of cork oak; the Central, comprising fertile fields; and the Northeast, which is known for livestock, citrus and horticultural products and stretches form the city of Tunis to Cap Bon.

(2) Southern Region

The Southern region is immediately south of Dorsale, and with it comes a sudden change to a dry climate. The region is divided into the Central Plateauland the Sahara Desert areas. They have scattered oases and lakes of high salt content which dry up in summer.

1.1.2 Climate

Tunisia has a Mediterranean-type mild sunny climate with four seasons spring, summer, sutumn and winter. It is hot and dry during the period from May to September, but during the rainy period from October to April of the following year it is quite temperate. Average annual temperatures are 18°C at Tunis, Sousses and Sfax, 17°C at Bizerte and 19°C at Gabes. The Medjerda basin has the most plentiful rain, though the average annual rainfall is only 1,000 mm to 1,200 mm. That in the cities during the last several years is as follows:

Tunis-Carthage	..... 800 mm	Sfax	..... 300 mm
Nabeul	..... 800 mm	Gabes	..... 280 mm
Sousse	..... 600 mm	Kairouan	..... 300 mm

1.1.3 Population and Major Cities

According to the national census at May 8, 1975, the population of Tunisia was 5,577,000, though it was found to be only 4,533,000 in the census of 1966. Thus, the annual population grouwth rate during the same period is taken into consideration, however, the real population growth rate rises to 2.65% per year. With the total number of households at 1,009,000, there were 5.5 persons per household.

According to conservative forecasts of population growth made by the I.N.S., based on rather lower estimated birth rates, the average annual growth rate will be 2.3% in 1977-1980, 2.24% in 1980-1985, 2.10% in 1985-1990, 1.79% in 1990-1995 and 1.48% in 1995-2000.

The Country is divided into 18 administrative districts known as "Gouvernorats", which are named after the most important town in each Gouvernorat. Cities of particular importance among them and their populations are:

Tunis	.....	800,000 inhabitants (This figure passes the million mark when the population of suburban Tunis is included.)
Sfax	.....	172,000 inhabitants
Sousse	.....	70,000 inhabitants
Bizerte	.....	63,000 inhabitants
Kairouan	.....	55,000 inhabitants
Menzel Bourguiba	.....	42,000 inhabitants
Gafsa	.....	42,000 inhabitants
Gabes	.....	41,000 inhabitants

1.2 ENERGY RESOURCES AND THEIR OUTPUTS

1.2.1 General Situation

The energy resources of a coutry are clearly reflected in the annual output of each type of energy. The following table shows the production in 1976 and the production outlook for 1981.

Resources	1976		1981	
	Output	Interms of 10^3 TEP	Output	Interms of 10^3 TEP
Crude oil	3,700 Mm^3	3,700 (72.5%)	5,800 MT	5,800 (67.8%)
Refined oil	1,130 Mm^3	1,130 (22.1%)	2,540 MT	2,540 (25.3%)
Natural gas	213,000 Mm^3	234 (4.6%)	1,500,000 Mm^3	1,650 (16.4%)
City gas	22,500 Mm^3	25 (0.5%)	30,000 Mm^3	33 (0.3%)
Hydro electricity	53,000 Mm^3	17 (0.3%)	53,000 MWh	17 (0.2%)
Total		5,106 (100 %)		(100 %)

As is clarified in this bable, the greater part of present energy requirements is met by petroleum resources. It is forecast, however, that during the period of the Fifth Economic and Social Development Plan (1977-1981), the use of oil will decline from 95 % in 1976 to 83 % in 1981 as a proportion of the total energy production methods, while that of natural gas will rise from 5 % in 1976 to 17 % in 1981. Compared with these two types of energy, hydroelectric power is only of secondary importance.

1.2.2 Water Power Resources

Even in the Northwest, the area of Tunisia with the most rain, the average annual rainfall in at the level of only 1,000 mm to 1,200 min. Furthermore, with the exception of some areas flanked by Algeria, undulations are generally gentle so that very few high-head sites are found. Consequently, both the geographical and the meteorological conditions may be said to be unsuitable for hydroelectric power generation. Therefore, the maximum utilization of water power resources is one of the most important national requirements.

1.2.3 Petroleum Resources

Petroleum resources are more abundan than those for water power. Since 1964, when an oil field was first discovered at El Borma by SIEP, there have been petroleum reserves discovered in succession at El Doureb, Sfax, Asthart, etc., and as a result, the export of crude oil has exceeded that of phosphate ore and of all other goods since 1969. Thus, the increase in crude oil production in recent years has given the Tunisian national economy ..... until then troubled by enormous balance of payments deficits ..... a bright outlook. The annual output, however, has wavered around the low level of approximately 4 million tons with the exception of 1947, the peak year, when the output reached 4.6 million tons. (The annual average output in the Fourth Plan during the period 1973-1976 was 4.1 million tons.) This stagnancy, however, has been lessened by the start of production at the ISIS oil field (annual output, 0.5 million tons) and by the water injection methods being used for optimum production at El Borma Oil Field (annual output, 2.7 million tons) and Ashtart Oil Field (annual output, 2.5 million tons). The annual output of crude oil is planned to reach 5.8 million tons by 1981, as against the 3.7 million tons produced in 1976.

1.2.4 Petroleum Refining

In recent years, the Bizerte Oil Refinery has been treating oil suitable to the equipment, with the result that the production performance has been acheived over the nominal equipment capacity. Although the production capacity is an annual one million tons, however, it is far from enough to meet the increased demand for refined petroleum products.

The increase in demand for such products depends somewhat upon the available quantity of gas that can be substituted for fuel oil and gasoil. At any rate, however, should no new refinery be constructed, the oil shortage in 1981 can be expected to amount to 1.9 million tons, as against 0.5 million tons in 1976; and to reach 1 million tons even if the quantity of gas available is well secured. In the Fifth Plan, therefore, the increase of oil refining capacity is intended to raise the annual output of refined petroleum products from 1.1 million tons in 1976 to 2.5 million tons in 1981.

1.2.5 Natural Gas

The gas pipeline approximately 300 kilometers long between the El Borme oil field and the consumption center of Gabes started operation in 1972, when the original amount transported was 34,000 m^3/hr. Since it became apparent that this would not catch up with the recent demand for gas, however, a development plan has implemented to raise the amount of gas transported from 34,000 m^3/hr to 58,000 m^3/hr.

Although the natural gas deposit at El Borma is not considered very abundant, that recently discovered in Gabes Bay has caused the estimations of deposits to increase conspicuously. In fact, the result of investigations so far conducted has led to the following estimation:

Fixed deposits	..... 40 billion Nm^3
Estimated and possible deposits	..... 80 billion Nm^3

The results of the preliminary investigation in relation to the optimum development of the offshore natural gas field in Gabes Ray suggest a phased development by which the initial investment may be reduced so as to hold the gas production price down to the international price level. In the Fifth Plan, the investment in this development is estimated at 245 million dinars. When the development is completed and full production under way, an annual output of 3 billion Nm^3 is expected. However, the output planned for 1981, the starting year of production, is 1.5 billion Nm^3.

Besides the development of the Gabes gas field, plans are now under investigation by Algeria and Italy to transport gas form the Hassi Rmel natural gas field in Algeria to the northern part of Italy by laying an overland pipeline to Cap Bon, in Tunisia, and a submarine pipeline across the Mediterranean from there. According to this plan, the amount of gas to be transported to Italy is estimated at approximately 12 billion Nm^3 per year, 5.7% of which ..... approximately 600 million Nm^3 per year .. Tunisian energy situation will have been greatly improved.

As for gas consumption, out of the 1976 output of 213 million Nm^3, 196 m million Nm^3 were consumed by the Ghannouch Steam Power Station and the Ghannouch and Borchemma Gas Turbine Power Stations, while the remaining 16 million Nm^3 were used by the chemical plants ..... ICM, ICF, MAP and AL-KIMIA ..... and brickworks in the Gabes industrial area. This shows that, at present in Tunisia, natural gas is consumed exclusively as a primary energy source. Demands have been voiced that, when the Gabes gas field has been developed, its huge output should be used not only as fuel for a new thermal power station for STEG, but also as raw material for the gaschemical industry that woruld be newly established.

1.3 NATIONAL ECONOMY

1.3.1 Growth of GNP

For several years after Tunisia became independent in 1956, the economy went through a period of stagnancy, as did that of other Maghreb contries, owing to the repatriation of the European colonialists who had until then held the reins of the

economy. In the second half of the 1960s, however, as a result of successive public and private investments within the framework of the Ten-Yeay Economic Development Plan, the annual growth rate of the GNP began to increase drastically compared with those of the 1950s (by as much as 3% per year).

In the First Plan (1962-1964), the Second Plan (1965-1968) and the Third Plan (1969-1972), all of which were implemented within the framework of the Ten-Year Economic Development Plan, the planned economic growth rate was 6% per year. In the Fourth Plan which was then carried into effect, the average annual economic grouth rate was planned for 6.6%, but in fact remained at 6%. This was attributable to the repercussion of the world-wide economic crisis, in the form of, for example, short supply of construction materials and lack of skill in domestic construction contractors on the one hand, and, on the other, a rise in import prices and limited markets for major internal products. The fact that even during such a world-wide economic recession, Tunisia still recorded an economic growth rate of 6% per year, is therefore highly commendable.

1.3.2 Fifth Economic and Social Development Plan

(1) Economic growth Target and Investment Requiremets

The Fifth Plan (1977-1981), the first stage of the new long-range Economic and Social Development Plan projected for the period 1977 to 1986, consists of three main parts: the promition of industrial production to be implemented on the basis of a planned investment of 4,200 million dinars (3,400 million dinars in terms of 1976 value); the establishment of a self-sufficient food production system; and the realization of full employment of additional laborers. This plan aims at an average annual GNP growth rate of 7.5%.

The growth rate of each sector, the proportion of the GNP controlled by it, and the planned investment requirements are given in Table 1-1. As shown, the GNP is forecast to increase from 1,427.7 million dinars in 1976 to 2,022.0 million dinars (in terms of 1976 value) in 1981, and in line with this, the GNP per capita is expected to increase from 249 dinars in 1976 to 314 dinars (in terms of 1976 value) in 1981.

(2) Procuerment of Funds

Thus, with the average annual GNP growth rate set at 7.5% and the rate of increase in the total demand of the public and private sectors at an annual average of 7.1%, national savings of 3,115 million dinars are planned for the period of the Fifth Plan. (The projected ratio of national savings to GNP is 22.6%.) Accordingly, it is intended that the total investment requirements of 4,325 million dinars, the planned investment requirements of 4,200 million dinars plus increased inventories of 125 million dinars, will be raised as follows:

National savings	3,115 million dinars (71.2%)
External Finances*	1,210 million dinars (28.8%)
Total	4,325 million dinars (100 %)

(Note) The external finances are divided into total inflowed funds of 1,680 million dinars, out-flowed funds of 370 million dinars, (350 million dinars of the amount are for repayment of liabilities.) and the addition to the exchange reserve of one million dinars, with the balance of 1,210 million dinars.

(3) International Balance of Payments

The general situation of the international balance of payments as planned under the Fifth Plan will be as follows:

- The trade of goods will be in deficit by an average annual amount of 325 million dinars.
- The trade of services, with increased revenues from tourism, is expected to be in surplus by an average annual amount of 145 million dinars.
- There will be an average annual deficit in the balance to transfer payments of 62 million dinars.

The overall international balance of payments will show an average annual dificit of 242 million dinars, and a cumulative deficit for the period of the Five-Year Plan of 1,210.0 million dinars. This cumulative deficit, as was indicated in the preceding item 1.3.2 (2), will be covered by external and other finances. The above balances of payments are shown for each financial year in Table 1-2.

Tableau 1-1 : **PRODUIT INTERIEUR BRUT ET PROGRAMME D'INVESTISSEMENTS PREVUS AU COURS DU Ve PLAN**

(Millions de Dinars)

Secteur	Produit Intérieur Brut 1976	Produit Intérieur Brut 1981	Taux de croissance moyen annuel	Part relative en 1981	Investissements prévus dans le Ve Plan
Agriculture et pêche	253,8	303,3	2,5 %	15,0 %	500
Industries	309,7	502,6	10,6 %	24,9 %	2.035
– Mines et énergie	75,7	135,4	12,1 %	6,7 %	1.035
Mines	11,5	21,1	9,7 %		130
Produits pétroliers	41,5	76,7	14,1 %		532
Electricité	15,1	27,2	9,9 %		200
Eau	7,6	10,5	7,9 %		173
– Industries manufacturières	137,5	238,5	11,7 %	11,8 %	950
Agricole et alimentaire	48,7	59,2	2,4 %		130
Matériaux de construction	10,0	26,1	25,3 %		290
Mécanique et électrique	18,2	37,1	15,5 %		170
Chimie et caoutchouc	7,6	20,4	25,1 %		220
Textile, habillement, cuir	38,8	69,7	12,3 %		100
Bois, papier et divers	14,2	26,0	13,0 %		40
– Bâtiment et travaux publics	96,5	128,6	8,0 %	6,4 %	50
Services	512,2	722,1	6,9 %	35,7 %	1.286
Transport et télécommunic.	76,5	125,6	10,8 %		570
Tourisme	49,8	70,2	6,8 %		95
Logement	65,0	76,4	3,3 %		600
Commerce et autres services	320,9	449,9	6,7 %		24
Services administratifs	161,0	232,0	9,4 %	11,5 %	376
Droits et taxes indirects nets de subvention d'Etat	188,0	262,0	8,1 %	12,9 %	-
Total	1.424,7	2.022,0	7,5 %	100,0 %	4.200

Note: Le produit intérieur brut est évalué aux prix 1976, tandis que les investissements prévus sont évalués aux prix courants.

Tableau 1-2 BALANCE DES PLAIEMENTS
(Aux prix courants)

(Millions de Dinars)

	1977	1978	1979	1980	1981	Total
Transactions des biens						
– Exportations	386,0	450,0	558,0	642,0	725,0	2.761,0
– Importations	685,0	749,0	884,0	973,0	1.048,0	4.384,0
Solde	- 299,0	- 344,0	- 326,0	- 331,0	- 323,0	- 1.623,0
Transactions des services						
– Exportations	244,0	278,0	306,5	348,0	385,5	1.562,0
– Importations	133,0	155,0	169,5	184,0	196,5	838,0
Solde	111,0	123,0	137,0	164,0	189,0	724,0
Transferts courants						
– Recettes	85,0	89,0	93,0	97,0	101,0	465,0
– Dépenses	114,0	133,0	154,0	175,0	200,0	776,0
Solde	- 29,0	- 44,0	- 61,0	- 78,0	- 99,0	- 331,0
Opérations courantes						
– Recettes totales	715,0	817,0	957,0	1.078,0	1.211,5	4.788,0
– Dépenses totales	932,0	1.082,0	1.207,5	1.332,0	1.444,5	5.998,0
Solde courant	- 217,0	- 265,0	- 250,0	- 245,0	- 233,0	- 1.210,0

CHAPTER 2. PRESENT STATE OF ELECTRIC POWER INDUSTRY

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2.1 STEG AND ITS ORGANIZATION

2.1.1 Circumstances

Societe Tuniseienne de lElectricite et du Gaz (STEG) is a corporation that was founded by Act 62-8 dated April 3, 1962, which was then partially amended by Act 70-58 dated October 2, 1970. By these Acts, STEG was established to take over the assets and liabilities of all the seven chartered electric power companies. The corporation is a public institution of a commercial and industrial character having the entitlements and capacities of a juridical person as well as financial autonomy. Its commercial purpose is to produce and discribute electric power, and also natural and manufactured gas.

Between 1970 and 1974, the electric power supplied by STEG amounted to approximately 84 % of the nation-wide total demand, the remaining 16 % of which was supplied by private power generation facilities mainly attached to iron-works, petroleum refineries and chemical plants. In 1975-1976, however, the deceleration of industrial production led to some decline in the proportion made up by private power generation. Thus, in 1975 and 1976, the electric power supplied by STEG accounted for 88 % and 86 % of the total, respectively.

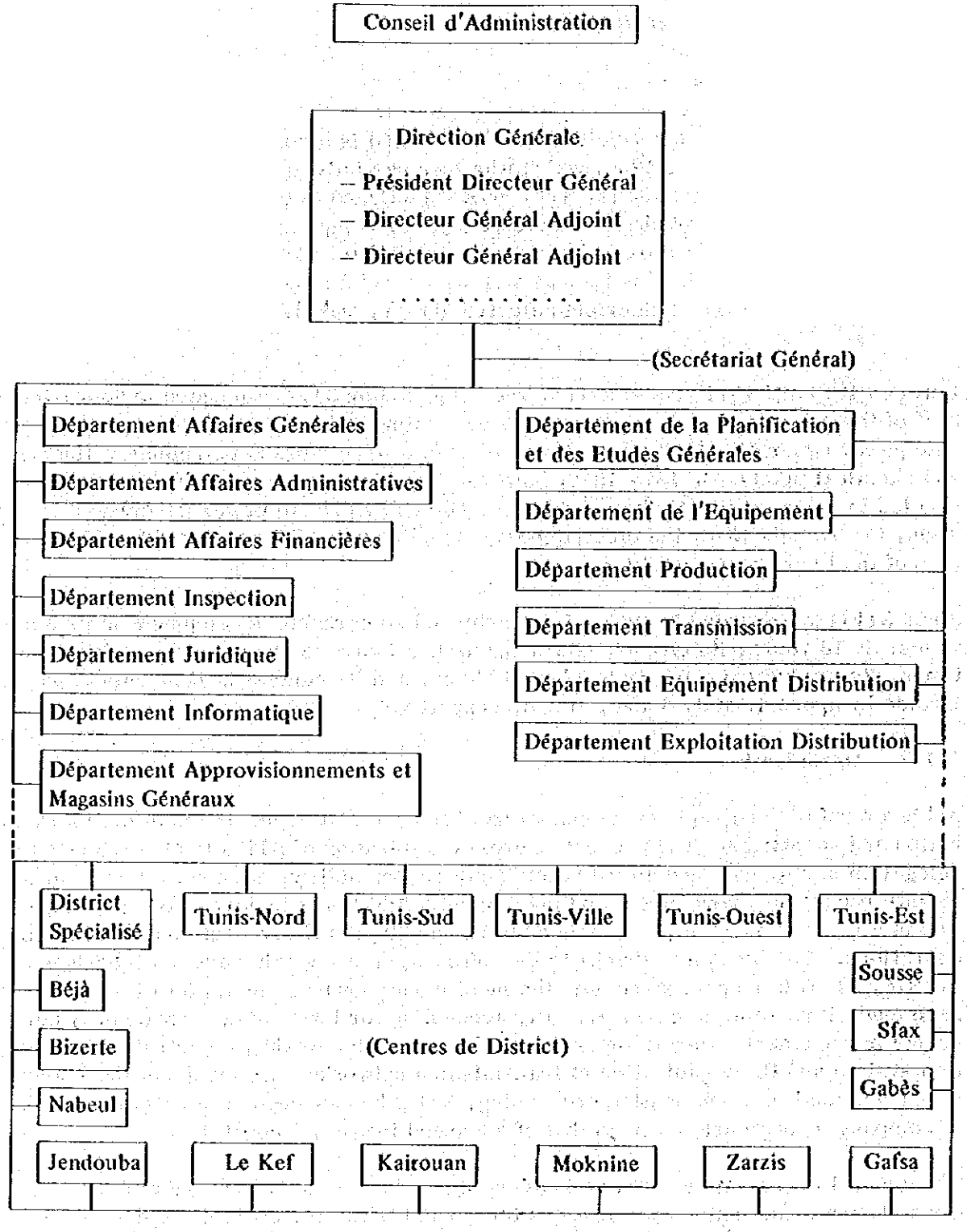
Since STEG was founded in 1962, it has achieved remarkable development in its activities: in 16 years, its electric power output has increased by approximately seven times, its production capanity by about 4 times, and its number of consumers and income by approximately 3 and 5 times, respectively.

2.1.2 Organization

Achievement of such rapid development has been a result of maximum effort in organization and adaptation. The present internal organization of STEG is characterized by delegation of authority and a clear division of responsibility, each sector controlling its own budget for management and investment. Additional features are: participation of a large number of persons in decision-making; and constant control over all operations. Furthermore, thanks to the information processing system introduced in 1976, STEG is now managed with the most modern management facilities, which have made it possible to carry out daily accounting for low-voltage consumers, personnel management, overall supervision of construction works, a controlled information system and the organization of transmission networks. By means of these system of management and information processing, STEG has succeeded in reaching a level of company management equal to that of advanced industrial countries.

The general organization chart of STEG is shown in Fig. 2-1. The Administrative Council, the most senior body responsible for deliberation, control and decision-making, is composed of seven members in total: a President, a Vice-President and three Directors; as well as one representative each from the Ministries of Finance and of Industry, Mining and Energy. The headquarters of STEG consists of one bureau and eight Divisions, and the bureau, Direction Generale, controls the

Figure 2-1 ORGANIGRAMME GENERAL



business of the Divisions and the district centers (centres de district) set up in thirteen of the Gouvernorats (local administrative districts). Maintenance and operation of power stations, transmission lines, substations and distribution networks are under the control of the various divisions responsible.

2.2 POWER GENERATION FACILITIES

Since inauguration, the capacity of the power stations belonging to STEG has increased from 116,200 KWD (70,300 kW in stream power stations, 27,900 KWD in hydroelectric power stations and 18,000 kW in Diesel power stations) in 1962 to 477,060 kW (227,500 kW in steam power stations, 209,000 kW in gas turbine stations, 28,260 kW in hydroelectric power stations and 12,300 kW in Diesel power stations) as of October, 1977. The average annual growth rate is 9.9%. Percentages for the various types of power stations are given below.

Power stations	Installed capacity (kW)	Percentage
Linked system		
Steam	227,500	44.7
Gas turbine	209,000	43.8
Hydro.	28,260	5.9
Subtotal	464,760	97.4
Isolated system		
Diesel	12,300	2.6
Total	477,060	100.0

A breakdown of the total installed capacity as of the end of March, 1978, is indicated below.

2.2.1 Capacity of Thermal Power Stations

There are three steam power stations in existence: La Goulette I (57,500 kW), La Goulette II (110,000 kW) and Ghannouch I (160,000 kW) (Total, 227,500 kW). The first two are fueled by heavy oil, and the last by natural gas. In contrast with their installed capacities, the guaranteed maximum capacities in continuous operation are 30,000 kW, 95,000 kW and 58,000 kW, respectively.

Gas turbine power stations number four in all: Ghannouch II (59,000 kW), Bouchemma (62,000 kW), Tunis Sud (44,000 kW) and Sfax (44,000 kW) (Total, 209,000 kW). The first two are fueled by natural gas, the others by gasoil.

Tableau 2-1 **CARACTERISTIQUES GENERALES DES CENTRALES ELECTRIQUES EXISTANTES SUR LE RESEAU INTERCONNECTE EN MARS 1978**

Catégorie et Centrale	Groupe	Année de mise en service		Puissance installée (kW)	Puissance garantie (kW)	Combustible utilisé
Thermique Vapeur						
La Goulette I	GR 3	1954		17.500		
	GR 4	1950		15.000		
	GR 5	1948		15.000		
	GR 6	1931		10.000		
			Total	57.500	30.000	Bunker C
La Goulette II	TV 1	1965		27.500		
	TV 2	1965		27.500		
	TV 3	1968		27.500		
	TV 4	1968		27.500		
			Total	110.000	95.000	Bunker C
Ghannouch I	TV 1	1972		30.000		
	TV 2	1972		30.000		
			Total	60.000	58.000	Gaz naturel
Turbine à gaz						
Ghannouch II	TG 1	1971		15.000		
	TG 2	1973		22.000		
	TG 3	1973		22.000		
			Total	59.000	59.000	Gaz naturel
Bouchemma	TG 4	1977		31.000		
	TG 5	1977		31.000		
			Total	62.000	62.000	Gaz naturel
Tunis Sud	TG 1	1975		22.000		
	TG 2	1975		22.000		
			Total	44.000	44.000	Gas-oil
Sfax	TG 1	1977		22.000		
	TG 2	1977		22.000		
			Total	44.000	44.000	Gas-oil
Hydraulique						
Nebeur	GR 1	1956		6.500		
	GR 2	1956		6.500		
			Total	13.000		(Barrage Mellègue)
Fernana amont		1958		8.500		
Fernana aval		1962		1.200	20.000	
			Total	9.700		(Barrage Ben Metir)
El Aroussia	GR.PR.	1956		4.800		
	GR.AUX.	1956		100		
			Total	4.900		(Centrale au fil de l'eau)
Kasseb	GR 1	1969		660		(Barrage Kasseb)
Puissance Totale	26	-		464.760	412.000	(Arrondi)

Diesel power stations, on the other hand, whose capacity totals 12,300 kW (including a 10,240-kW power generator in reserve at Sfax), are scattered over the country in fourteen places, and are operated as isolated system.

2.2.2 Capacity of Hydroelectric Power Stations

Five dams exist: Mallegue, Ben Metir, El Aroussia, Kasseb and Bon Heurtma; and their major purpose is to supply agricultural or drinking water, so that power generation is only secondary. (Bon Heurtma Dam has no power station.)

The total capacity of the hydroelectric power stations is thus conspicuously smaller than that of the thermal power stations, but may be analyzed as follows: Nabeul, 13,000 kW; Fernana Upstream, 8,500 kW; Fernana Downstream, 1,200 kW; El Aroussia, 4,900 kW; and Kasseb, 660 kW. The total installed and guaranteed capacities are 28,260 kW and 20,000 kW, respectively.

An outline of the installations of the above hydroelectric and thermal power stations is given in Table 2-1.

2.3 POWER TRANSMISSION AND SUBSTATION FACILITIES

2.3.1 High Voltage Transmission Lines

The transmission networks of STEG as of May, 1978, have three standard voltages, 225 kV, 150 kV and 90 kV. The greater part of the networks loops the territory together. Moreover, the loop line is equipped with one antenna to transmit power to Cap Bon Area (a 90 kV line between Tunis Sud and Korba) and another to transmit power generated by Ghannouch I and II (a 225 kV line between Ghannouch and Maknassy at present in operation at 150 kV). The loop line is also equipped with still more two loops, a line connecting La Goulette with Tunis Ouest and the other connecting Tunis Sud with Tunis Ouest, Menzel Bourguiba and El Aroussia.

The construction of a new 225 kV line reaching Naassen Substation on the outskirts of Tunis City by extension of the existing 225 kV line between Ghannoch and Maknassy is expected to be completed before long.

On the other hand, there are two 90 kV international connection lines between Tunisia and Algeria. They connect Fernana Power Station and Tajerouine Substation with El Hajjar Substation and El Aouinet Substation, respectively, in Algeria. In case of an emergency requirement for electric power on either the Tunisian or the Algerian side, a power interchange of a maximum of 15 mW is carried out between the two countries.

After the new transmission line to Naassen Substation has been completed, the total distance of 225 kV lines will be 345 km (excluding 153 km international connection line), that of 150 kV lines, 90 km, and that of 90 kV lines, 475 km. The overall distance will then be 1,721 km.

Tableau 2-2 CARACTERISTIQUES GENERALES DES LIGNES DE TRANSPORT HAUTE TENSION EN MARS 1978

Ligne		Tension (kV)	Distance (km)	Terne	Conducteur	Section (mm^2)
Ligne 225 kV						
Ghannouch - Maknassy	*	225	93	1	Al-Ac	411
Maknassy - Oueslatia	**	225	140	1	Al-Ac	411
Oueslatia - Naassen	**	225	112	1	Al-Ac	411
	Total		345			
Ligne 150 kV						
La Goulette - M'Saken		150	129	1	Al-Ac	297
M'Saken - Sfax		150	102,5	1	Al-Ac	297
Sfax - Maknassy		150	104	1	Al-Ac	297
Maknassy - Metlaoui		150	116	1	Al-Ac	297
Metlaoui - Kasserine		150	106	1	Al-Ac	297
Kasserine - Tajerouine		150	83,5	1	Al-Ac	297
Ghannouch - Robbana		150	102	1	Al-Ac	297
Ghannouch - Maknassy		150	100	1	Al-Ac	297
Ghannouch - Bouchemma		150	3,5	1	Al-Ac	265
Ghannouch - Cimentrie		150	11	1	Al-Ac	297
Alimentation Hammamet		150	34	2	Al-Ac	265
Alimentation Akouda		150	9	2	Al-Ac	265
	Total		900,5			
Ligne 90 kV						
Tajerouine - Nebeur		90	59	1	Al-Ac	288
Nebeur - Jendouba		90	21	1	Al-Ac	288
Jendouba - Fernana		90	27	1	Al-Ac	288
Fernana - El Aroussia		90	100	1	Al-Ac	288
El Aroussia - Tunis Sud		90	43	1	Al-Ac	288
Tunis Sud - Tunis Ouest		90	10	1	Al-Ac	288
La Goulette - Tunis Sud		90	16	2	Al-Ac	288
La Goulette - Tunis Ouest		90	27	1	Al-Ac	288
Tunis Ouest - M. Bourguiba		90	58	1	Al-Ac	181,6
El Aroussia - M. Bourguiba		90	39	1	Al-Ac	176
Maassen - Tunis Sud		90	8	2	Al-Ac	420
Alimentation El Fouladh		90	2	1	Al-Ac	176
Tunis Sud - Korba		90	65	1	Al-Ac	176
	Total		475			
Ligne 90 kV internationale						
Tajerouine - El Aouinet		90	60	1	Al-Ac	288
Fernana - El Hajjar		90	93	1	Al-Ac	288
	Total		153			
Longueur totale du réseau de la STEG			1.873,5 km			

Note: * Une ligne de 93 km, Ghannouch - Maknassy, est construite en 225 kV mais est exploitée provisoirement en 150 kV.

** La construction de ces deux lignes 225 kV est presque terminée.

An outline of the existing transmission facilities is given in Table 2-2.

2.3.2 High-voltage Substations

The existing transmission networks are supported by fifteen high-voltage substations all over the country, all of which are provided with HT/HT or HT/MT transformers. Of these substations, those at Tunis Sud, Ghannouch, Sfax, Korba and Menzel Bourguiba are built next to the local gas turbine power stations.

The transformers in these substations total 57 and have a capacity per unit of 10 to 100 MVA. Their aggregate installed capacity is 1,350 MVA, a breakdown of which follows:

Voltage (kV)	Capacity (MVA)	Unit
225/150	100	1
150/ 33	25	6
150/ 33	15	14
96/ 33	50	1
96/ 33	40	2
90/ 30	30	4
90/ 30	20	10
90/ 30	15	8
90/ 30	10	2
90/ 11	40	3
90/ 11	30	6
	Total 1,350 MVA	57 Units

These substations are equipped with four shunt reactors of 150 kV and six MVAR, and five capacitors totaling 45.6 MVAR, as reactive power supply facilities. Furthermore, the gas turgine generator of Tunis Sud can be used for synchronous phase modification. The bank capacities of the main transformers of the substations are in Table 2-3.

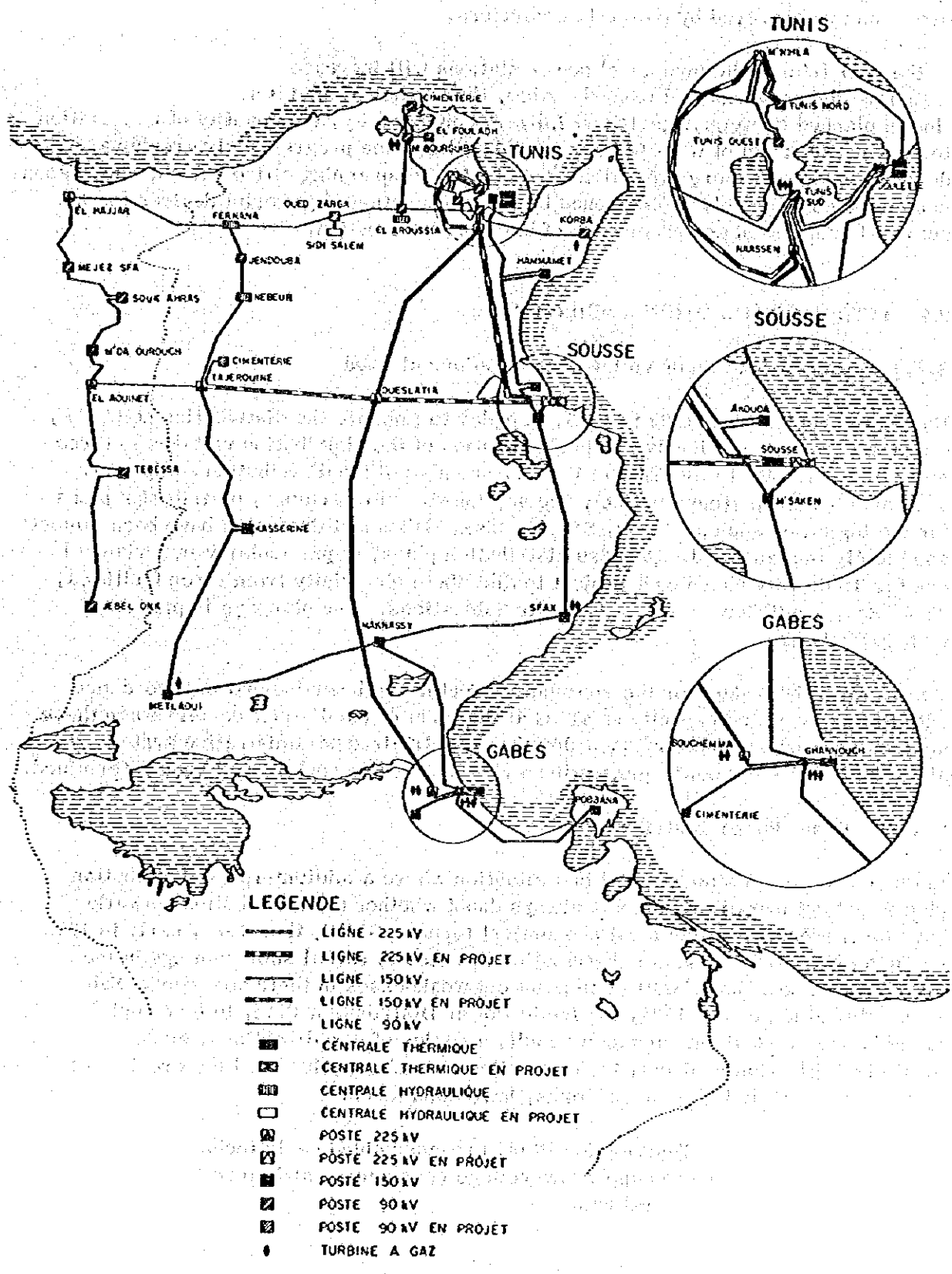
2.3.3 Load Dispatching Office

At present, the operation of the primary and secondary transmission networks is controlled by a load dispatching office located at the STEG headquarters. The office is provided with a variety of recording apparatus, measuring instruments and telesignalling equipment, but they are limited in number. Under these circumstances, the office has to deal with all necessary load dispatching work, such as regulation of

Tableau 2-3 LOCALISATION DES PUISSANCES DE TRANSFORMATION ET DE COMPENSATION EN MARS 1978

Poste	Nombre de transformateurs	Capacité (MVA)	Tension (kV)	Capacité de compensation		
				Condensateur ou réactance	Tension (kV)	Capacité (MVAR)
La Goulette	1	50	96/33			
	2	40	96/33			
Tunis Sud	1	30	90/11			
	2	30	90/11			
	1	20	90/33	Condensateur	30	8,4 x 1
	2	20	90/33			
	3	30	90/33			
Tunis Ouest	1	15	90/33			
	2	20	90/33			
	1	30	90/11	Condensateur	10	8,4 x 1
	2	30	90/11			
	3	40	90/11			
Menzel Bourguiba	1	30	90/33			
	2	20	90/33	Condensateur	30	9,6 x 1
	3	20	90/33			
Jendouba	1	15	90/33			
	2	10	90/33			
Tajerouine	1	15	90/33			
	2	15	90/33			
Korba	1	15	90/33			
	2	15	90/33			
M'Saken	1	15	150/33			
	2	15	150/33	Condensateur	30	9,6 x 1
	3	25	150/33			
Sfax	1	25	150/33			
	2	25	150/33			
Metlaoui	1	15	150/33	Condensateur	30	9,6 x 1
	2	15	150/33	Réactance	150	6 x 1
Kaserine	1	15	150/33			
	2	15	150/33			
Ghannouch	1	15	150/33	Réactance	150	6 x 2
	2	15	150/33			
Robbana	1	15	150/33			
Maknassy	1	15	150/33	Réactance	150	6 x 1
Sous-total	56	1.250				
Bouchemma	1	100	225/150	Réactance	150	20 x 1
Grand total	57	1.350				

RESEAU DE TRANSPORT
SITUATION EN 1978



LEGENDE

- LIGNE 225 kV
- LIGNE 225 kV EN PROJET
- LIGNE 150 kV
- LIGNE 150 kV EN PROJET
- LIGNE 90 kV
- CENTRALE THERMIQUE
- CENTRALE THERMIQUE EN PROJET
- CENTRALE HYDRAULIQUE
- CENTRALE HYDRAULIQUE EN PROJET
- POSTE 225 kV
- POSTE 225 kV EN PROJET
- POSTE 150 kV
- POSTE 90 kV
- POSTE 90 kV EN PROJET
- TURBINE A GAZ

the operating conditions of the transmission networks, and directing the power stations and substations, by means of only these simple devices. The regulation and direction are conveyed by power-line carriers.

In the near future, the number of power stations will increase and the high-voltage transmission networks will expand. Also, the construction of a new interconnecting line is planned between Algeria and Libya. Consequently, the quantity of information to be processed and of work to be executed will become progressively greater and the decision made will more far-reaching. The load dispatching office will therefore soon need to be considerably strengthened by the introduction of powerful devices for the automatic collection and processing of data and information.

2.4 POWER DISTRIBUTION FACILITIES

2.4.1 Standardization of Voltages and Equipment Used

During the period from 1962 to 1973, in order to improve the distribution networks, a plan was worked out involving standardization of the distribution voltages to three steps ..... 30 kV, 15 kV and 10 kV ..... and also of the distribution equipment. This plan has been almost entirely accomplished. Furthermore, distribution plans for the big cities such as Tunis, Sousse, Sfax, Gabes and Gasfaalso have been almost completely implemented. Of these distribution plans, of particularly importance is one for Tunis City based on a project to distribute electricity from three facilities, Tunis Sud, Tunit Ouest, and La Goulette Substations. The plan was implemented with special care.

Before this, the budget for the distribution sector had been decided in accordance with the fund-raising capacity of STEG at the level of the district centers when these decided their own budgets ..... under the decentralized administrative system ..... after the budgets for power generation and transmission sectors had been determined.

2.4.2 Basic Power Distribution Plan

In the above circumstances, and in a situation where a midium-range distribution plan is not yet prepared, there is always doubt whether the distribution networks have been expanded on the most economical terms. STEG, therefore, early in 1973 set up a symposium on power distribution technics to reveal shortcomings in the distribution networks as well as to point out weaknesses in their operation. Subsequently, at the end of 1975, the Basic Power Distribution Plan, to be completed in 1981, was worked out, and as a result, a series of new directions, such as new local electrification projects, the estimation of funds required and the creation of a new concept in distribution networks, have been taken.

Under the Basic Power Distribution Plan, pre-assembled cable techniques were tentatively implemented to supply low-voltage consumers, and since 1977, these have been coming into general use.

On the other hand, in the case of medium-voltage distribution networks, the results of repeated thorough technical and economic investigations have clarified the necessity to change fundamentally past concepts of power distribution networks and adopt the M.A.L.T. System (three-phase, four-line, direct-earthing system). This shift is at present under way. In addition to the qualitative improvements in services in the power distribution sector, these new technics will made it possible to supply agricultural areas which now have a single-phase system, so that cost of agricultural electrification itself can be cut drastically.

2.5 INCREASE IN POWER GENERATION AND CONSUMPTION

2.5.1 Power Generation

As mentioned above, the 1977 output of STEG power stations accounted for approximately 86 % of the total output throughout the country, the remaining 14 % being generated by private power generation facilities. In 1963, STEG generated 287.9 GWH of electric power, of which 6.8 % was produced by hydroelectric stations, 8.6 % by Diesel stations and 84.6 % by thermal stations. In contrast with this, in 1977. the output amounted to 1,517.8 GWH, of which steam stations produced 73.2 %, gas turbine stations, 24.7 %, and hydroelectric and Diesel stations, only 2 % and 0.1 % respectively.

The output growth rate during the past four years, from 1973 to 1977, has been 12 % per year.

On the one hand, the nationwide output including that of the private power generation facilities, in particular, Magreb Chemical Industries (ICM) in the Gabes industrial area and SIAPE and NPK in the Sfax area, increased from 340.2 GWH in 1962 to 1,724.8 GWH in 1977,at an annual growth rate of 11.4% .

The above developments are tabulated below:

Power Station	1962	1973	1976	1977	Percentage
Output of STEG	(GWh)	(GWh)	(GWh)	(GWh)	(%)
Steam Power Stations	243.7		972.3	1.111.2	(73.2)
Gasturbin Power Stations	-		312.1	374.3	(24.7)
Hydroelectric P.S.	19.4		53.0	30.3	(2.0)
Diesel P.S.	24.8		2.0	2.0	(0.1)
Subtotal	287.9	960.7	1.339.4	1.517.8	(100)
Output of Private Power F.	52.3	169.3	185.0	207.0	(estimated)
Nationwide Total	340.2	1.130.0	1.524.4	1.724.8	(estimated)

2.5.2 Power Consumption

The quantity of electric power sold by STEG increased from 246.4 GWH (medium-voltage demand, 141.9 GWH; low-voltage demand, 104.5 GWH) in 1962 to 1,331.3 GWH (high- and medium-voltage demand, 882.3 GWH; low-voltage demand, 449 GWH) in 1977. During this period, the average annual growth rates of the high- and medium-voltage and the low-voltage power consumption were 12.9 % and 10.2 %, respectively.

The proportion of output to consumption, idicating the efficiency of transmission and distribution netwoeks, remains at approximately 86 %: 86.5 % in 1962, 85 % in 1973, 84.3% in 1976 and 87.7% in 1977. These changes during the past 5 years are tabulated below:

Noes	1962	1973	1976	1977	Percentage
Energy Sold by STEG					
High- and Medium-voltage Demand					
Mining Industies		106	123	132	(10.0)
Iron & Steel Industries		47	67	79	(5.9)
Chemical Industries		12	26	21	(2.3)
Construction Materials		86	106	159	(11.9)
Paper & Edition Industries		50	54	63	(4.7)
Textile and Clothes Industries		39	48	59	(4.4)
Food Industries		51	64	75	(5.6)
Various Industries		27	44	54	(4.1)
Other Sectors		150	210	230	(17.4)
Subtotal	141.9	568	742	882	(66.3)
Low-voltage Demand	104.5	253	387	449	(33.7)
Total	246.4	821	1.124	1.331	(100)
Internal Consumption by Private Power Facilities	52.3	169	185;	207	
Nationwide Total	298.7	990	1.314	1.538	

2.5.3 Maximum Power Consumption

The maximum power consumption in the interconnected system was only 62 MW in 1962, but increased to 192 MW in 1973, 272 MW in 1976 and 320 MW in 1977. During this period the load factor was almost constant: 54.8 % in 1962, 57.1 % in 1975, 56.2 % in 1976 and 54.1 % in 1977.

2.5.4 Consumers

The ceaseless efforts of STEG at electrification of rural areas as well as of urban districts led to a huge increase in the number of consumers: from 203,000 houses in 1962 to 452,000 houses in 1976. Out of the total of the consumers in 1976, 408,000 houses (90.3%) were in urban districts, and the remaining 44,000 houses being in rural areas. The average annual growth rate of the total number was 5.9%. (The total for 1977 is expected to reach 507,000 houses.)

On the basis of the STEG estimate that approximately 45% of the total estimated population in 1977 is supplied with electric power (65% in urban districts, 23% in rural areas), power consumption per capita throughout Tunisia is 259 kWH per year, and per house is 576 kWH per year (including the internal consumption of companies with private power generation facilities).

2.6 TARIFFS

2.6.1 Revision of Tariffs

Since 1971, STEG has been investigating the system of electricity charges on the theory of mariginal cost. The first-stage investigation was completed in 1975 and in April of the same year the first tariff revision was implemented. In addition, that December saw the introduction of a new supply contract for medium-voltage consumers.

The second revision of charges was made in June 1977, and showed an increase of approximately 20% over the previous charges. A third revision, siming at a further 8% increase, is planned for 1979. The purposes of these revisions have been:

- to absorb increases in fuel costs (the average unit fuel price for thermal power stations having been forecast to rise from 3.4 millimes/kWH in 1976 to 6.7% millimes/kWH in 1978).
- to carry out the intended level of investment in the electric power sector of the Fifth Plan (1977-1981) ..... 200 million dinars, an amount approximately 3 times that invested furing the Fourth Plan (68.7 million denars).

2.6.2 Structure of Tariffs

(1) Low-voltage Charges

STEG applies two types of low-voltage charges: those for lighting (1 on 2 kVA) and those for motive power (3 kVA or more). These charges consist of a fixed kVA charge (for motive power consumers only), a client charge (for lighting consumers only) and an energy charge (including taxes). These are shown below:

Fixed kVA Charge	100 millions/kVA month	
Client Charge	100 millions/consumer-month	
Energy Charge	Lighing	Motive

0 - 10 kWH/kVA	46 million	41 million
10 kWH/kVA or more	41 million	34 million

(2) Special Low-voltage Charges

The special low-voltage tariff is divided into 5 types: for consumers of electric power for agricultural purposes (supply cut off at peak hours); for water-boiling (supply cut off at peak hours); for heating and cooling (temporary tariffs); for oilpressing and milling; and for public lighting. They are composed of fixed kVA charge, charge, a client charge and an energy charge, an outline of which follows:

- Fixed kVA Charge (for oilpressing and milling only) 100 millions/kVA-month
- Client Charge (in accordance with uses) 200 - 700 million/Consumer-month
- kWH energy Charge:

To some uses, different charges of 8-25 millimes/kWH are applied in accordance wit with the time zones of a day (daytime, peak hours and nighttime), and to others, charges of 30-40 milliomes/kWH and 22-25 millimes/kWH are applied for the first-stage consumption of 0-25 or 30 kWH/kVA and for the second-stage consumption of more than 25 or 30 kWH/kVA, respectively.

(3) Medium-voltage Charges

Two types of charges are applied to medium-voltage consumers: time-zone and graduated. Each type consists of a fixed kW charge, a client charge and a special energy charge, as shown below:

	Time zone Charge	Graduated Charge
Fixed kW Charge	1.5 DT/kW-month	0.1 DT/kVA-month
Client Charge	1.5 DT/Consmer-month	2.5 DT/Consumer-month
Special Energy Charge		

In the case of the time-zone chrges, 16 millimes/kWH, 26 millimes/kWH and 7 millimes/kWH are applied to day-time, peak hours and nighttime, respectively. In the case of the graduated charges, 27 millimes/kWH and 22 millimes/kWH are applied to the first stage of monthly consumption of 0-50kVA and the second stage of monthly consumption more than 50 kWA, respectively.

(4) Medium-voltage Special Charges

The medium-voltage special charges are divided into two types: charges for electric for agriculture (supply cut offlat peak hours) and for emergencies. The structure of these charges is as follows:

	Agriculture	Emergency
Fixed kW charge	1.5 DT/kW-month	0.2 DT/kW-month
Client Charge	2.5 DT/Consumer-month	15 DT/Consumer-month
Special Energy Charge:		

To the daytime consumption, charges of 16 millimes/kWH and 24 millimes/kWH are applied for agricultural and energency used, respectively. To the mighttime consumption, charges of 7 millimes/kWH and 14 millimes/kWH are applied for agricultural and emergency uses, respectively. Furthermore, to the peak hour consumption for emergency use, a charge of 47 millimes/kWH is applied.

(5) High-voltage Charges

To high-voltage consumers, two types of charges are applied: for general use and for emergency use. The structure of these charges is as follows:

	General	Emegency
Fixed kW Charge	0.5 DT/kW-month	0.1 DT/kW-month
Client Charge	-	30 DT/Consumer-month
Special Energy Charge:		

Both the two types of charges for general and emergency uses are time-zone charges: 15 and 21 millimes/kWH in daytime, 22 and 37 millimes/kWH in peak hours and 6 and 3 millimes/kWH in nighttime.

2.6.3 Average Selling Prides of Energy per Unit

The following table compares the average selling prices per unit to high-and medium-voltage and to low-voltage consumers before and after the charge revision in June, 1977:

Item	High and Medium V.	Low V.	Total
Charges Revised in April, 1975 (Based on the Power Consumption in 1976)			
Power-selling Proceeds (1000 DT)	10,413	12,342	22,755
Consumption (GWh)	746	399	1,145
Selling Prices/per unit (millimes/kWH)	14.0	30.9	19.9
Charges Revised in June, 1977 (Based on the Power Consumption 1976)			
Charge Growth Rates	24.8%	16.0%	20.0%
Selling Prices per Unit	17.4	35.9	23.9

CHAPTER 3. LOAD FORECAST

CHAPTER 3 LOAD FORECAST

3.1 ENERGY DEMAND FORECAST

3.1.1 Power Consumption

As was stated in sub-section 2.5.2, the nationwide power consumption of Tunisia increased from 990 GWh in 1973 to 1,527 GWh in 1977. During this period, the average annual growth rate was 11.5%, very high, even when compared with the growth rate of any other country, advanced or developing.

Within these five years, the consumption of electric power supplied by STEG increased by STEG increased from 821 GWh to 1,309 GWh -- an average annual growth rate of 12.4%. An analysis by type of consumer of the increases in power consumption indecates that the growth rate of high- and medium-voltage consumption is 10.6%, as against 16.0% for low-voltage.

3.1.2 Forecast by STEG

In Tunisia, the Fifth Economic and Social Development Plan was carried into effect in 1977. The Fifth Plan aims, between 1977 and 1981, at promotion of industrial production, establishment of a self-sufficient food system and realization of fullemployment of the additional labor force, as well as an average annual GNP growth rate of 7.5%. As a load forecast attached to this plan, "Le Marche de l'Electricite à moyen et long terme" was worked out in December, 1977, by STEG.

This refers to the period 1977 to 1986 in its medium-range projections and to that ending in 2003 for the long-range. It gives values estimated by various methods, of which the following method was adopted as the most likely to produce a correct forecast.

(a) The medium-range forecast (1977-1986) estimates the high- and medium-voltage demand taking into account the production development plan of the industrial sector; and the low-voltage demand in view of the outlook for the local power distribution promotion plan.

(b) The long-range forecast (1987-2003) gives a number of comprehensive projections that are based on consumption curves and past Trends of the GNP, and by extrapolation from these, presents three estimates, maximum, average and minimum.

The demand-end power consumption and its average annual growth rates every five years in the STEG power system forecast by this method are indicated in the following table.

Item	1977	1981	1986	1991	1996
Consumption (GWh)					
Maximum	1,340	2,280	4,340	7,200	4,500
Average	1,340	2,280	4,340	6,500	9,000
Minimum	1,340	2,280	3,970	5,800	7,600
Average Annual Grouth Rates					
Maximum		14.2	13.7	10.6	7.8
Average		14.2	13.7	2.4	6.7
Minimum		14.2	11.7	7.8	5.5

As this table shows, the maximum, average and minimum forecasts during the period of the Fifth Plan, from 1977 to 1981, are all the same. As for the period in and after 1982, however, while the maximum and average forecasts make allowance for the construction of the iron and steel complex, the chemical complex and the No. 6 cement mill, the minimum one does not take these into consideration. By 1086 there is a difference of about 10%.

Furthermore, if these average forecast are regarded as typical, the obsetvation of demand growth rate reveals that, compared with the average annual growth rate of approximately 14% during the period 1977 to 1986, the rate in and after 1986 will decline drastically, and in and after 1991 will fall below the so-called "10-year-double rate" (7.2%) of the semi-advanced and advanced countries.

3.1.3 Forecast by Macroscopic Method

The above load forecasts of STEG, faithfully reflecting the future economic development plan of the Tunisian Government, are the most detailed. The actual achievement, however, will not necessary be consistent with the intended target. (As compared with the target of the Fourth Plan, the rate of performance was 91%). The conclusion reached here is that judgements of future load forecasts should be formed on the basis on the comparison of estimated values obtained by the following macroscopic method with those of STEG mentioned above.

The best index of the economic activities of a nation is the GNP. Power consumption, since it adheres to the production and consumption of goods and services, has an extremely good correlation with the GNP. Macroscopic load forecasting is a method of estimating the long-range nationwide power requirement by correlating the GNP per citizen, or per capita GNP, with energy consumption per citizen, or per capita kWh. The EPDC, having investigated and analyzed the statistics on many countries, which were prepared by the International Bank for Reconstruction and Development (IBRD), and having confirmed this correlation on a worldwide basis, has adopted the macroscopic method as a powerful tool in long-range forecasting. The parameters that must be known, and the correlation to be confirmed are as follows:

(1) Required Parameters

(a) Average per capita GNP growth rate at the present.

(b) Present GNP per capita.

(c) Present kWh per capita.

(d) Degree of variation in growth rate compared with variation of GNP per capita.

(e) Degree of variation in kWh per capita compared with variation in GNP per capita.

(g) Population increase forecast

The above basic economic indexes for Tunisia taken from the Fourth Plan (1973-1976) and the Fifth Plan are listed in Table 3-1, from which the following required parameters are obtained.

GNP/capita in Standard Year (1976)	US (The 1968 price)
kWh/capita in Standard Year (1976)	232 kWh
Present Average Annual Growth Rate of GNP/capita	5.2%
Average Annual Growth Rate of kWh/capita	8.1%

(2) Correlation between GNP per capita and Growth Rate

The statistical investigations spoken of above indicate, as Fig. 3-1 shows, a rough correlation between the GNP per capita and the corresponding growth rate, a gradual rise in the rate of growth until the GNP per capita reaches US$ 500 to $ 1,000 (the 1968 figure), and then a gradual decline. Such correlations differ between countries but, from the worldwide standpoint, can be classified into three groups, high, low and average. The typical curves of correlation are shown in Fig. 3-1.

In this figure, by drawing a curve starting from the GNP per citizen (US$ 415) and the present Tunisian average annual growth rate (5.20%) to find out whether correlation exists between the GNP per capita and the growth rate, the numerical values given in Fig. 3-1 are obtained.

(3) Correlation between GNP per capita and kWh per capita

In the same way, statistical investigation confirms that there is a rough correlation between the GNP per capita and kWh per capita, which is classified into three groups, high, low and average, and their typical curves are as drawn in Fig. 3-2. In this figure, drawing a curve on the basis of the GNP per capita and kWh per capita of Tunisia in the past five years indicates the power consumption per citizen corresponding to the future GNP per capita.

(4) Population Forecast

The real annual population growth rate of Tunisia in and after 1965 was an average of 2.65% and the national census in 1975 indicated a total population of 5,577,300. For forecasting future populations, the report of the Fifth Plan laid down two methods: one based on the hypothesis that population growth rates will remain constant and the other on the hypothesis that future birth rates will gradually decline, on the basis of comparison of the birth rates in 1965 and 1966 with that in 1976. The forecast for power consumption shown in this report is based on the values given by the latter method, as shown below.

Tableau 3-1 PRINCIPAUX INDICES ECONOMIQUES POUR LA PREVISION DE LA CONSOMMATION D'ELECTRICITE

Description	1972	1973	1974	1975	1976
1. Population (1.000)	5.200	5.330	5.450	5.577	5.737
2. P.I.B. aux prix 1972 (Million de DT)	1.077,6	1.082,4	1.185,8	1.301,7	1.424,7
3. P.I.B. par habitant (Dinars)	202,7	203,0	217,6	233,4	248,3
4. P.I.B. par habitant évalué aux prix 1968:					
(Dinars)	176,6	176,9	189,7	203,4	216,4
(Converti en $E.U.)	339	340	364	390	415
5. Consommation nationale (GWh)	882	988	1.078	1.152	1.330
6. Consommation par habitant (kWh)	170	185	198	207	232

Note: (1) Les indices des prix de gros sont les suivants:

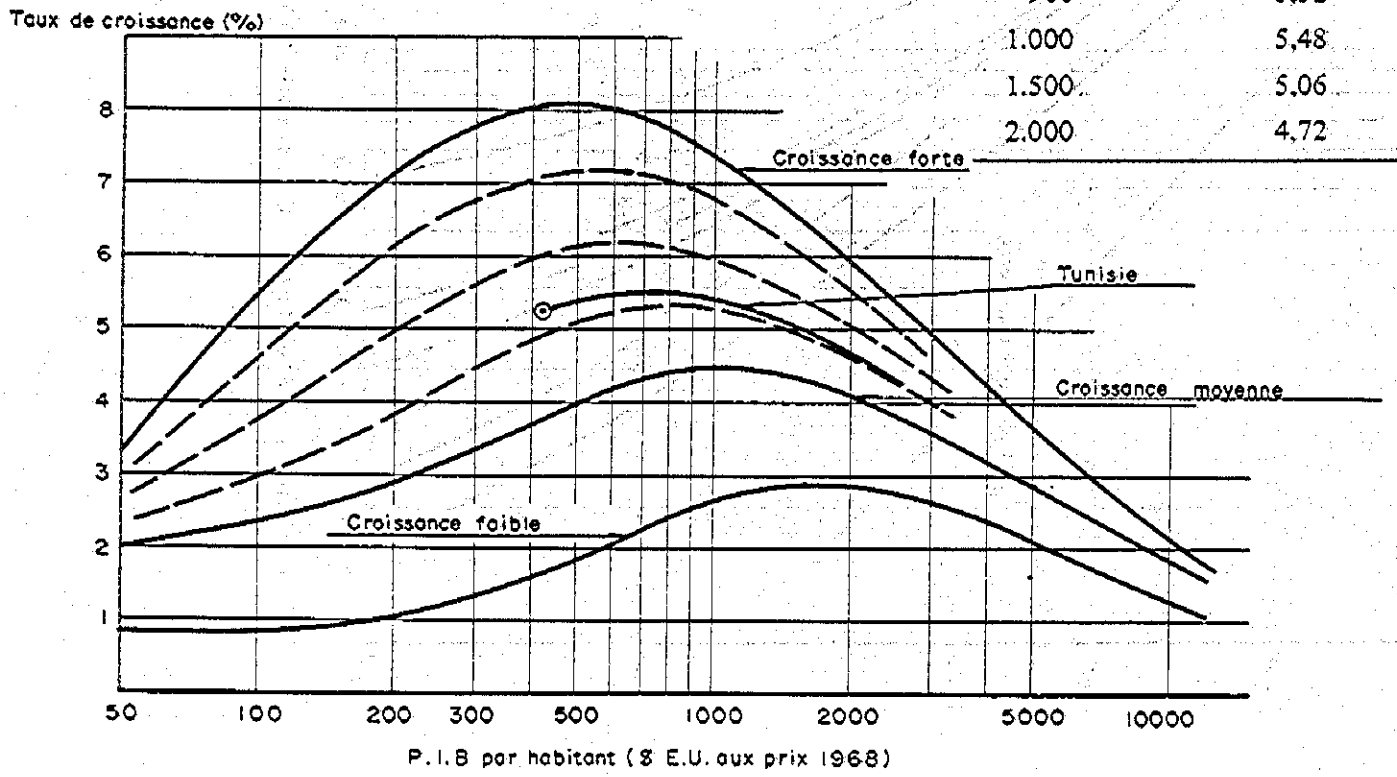
1968 95
1969 96
1970 100
1971 107
1972 109

(2) Le taux de change avec le dollar E.U. au cours de la période 1968 ~ 1970 était le suivant:

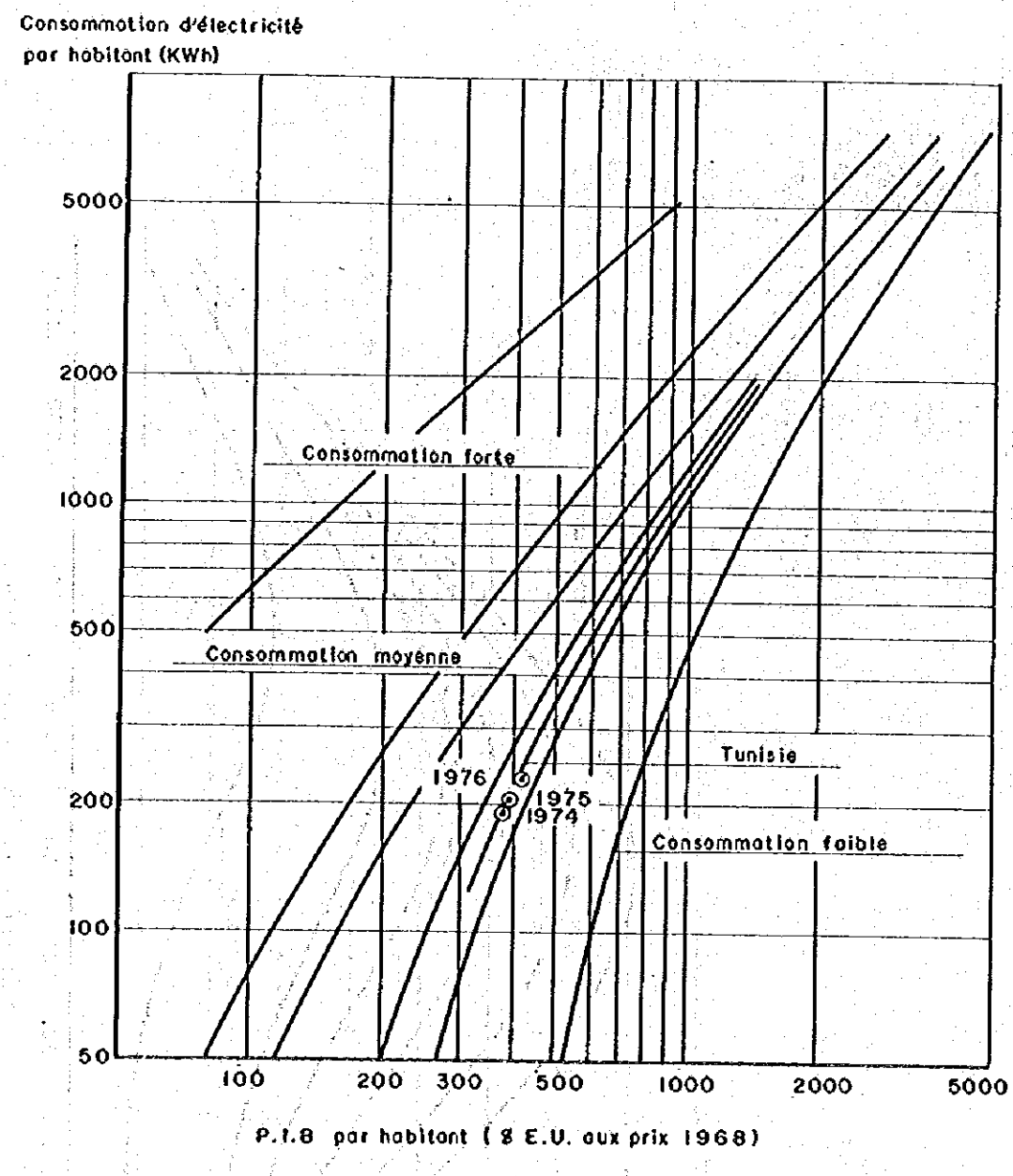
1 $E.U. = 0,521 Dinars

Graphique 3-1 CORRELATION ENTRE P.I.B. PAR HABITANT ET SON TAUX ANNUEL DE CROISSANCE

P.I.B. par habitant (S.E.U.)	Taux annuel de croissance (%)	Taux moyen de croissance (%)
415	5,20	
500	5,37	5,29
600	5,49	5,43
700	5,62	5,56
800	5,57	5,59
900	5,52	5,55
1.000	5,48	5,50
1.500	5,06	5,27
2.000	4,72	4,89



Graphique 3-2 **CORRELATION ENTRE P.I.B. PAR HABITANT ET LA CONSOMMATION D'ELECTRICITE PAR HABITANT**



Year	Population	Average Annual Growth Rate
1976	5,737,300	
1981	6,437,000	2.36 %
1986	7,177,000	2.24 %
1991	7,939,000	2.10 %
1996	8,675,000	1.79 %

(5) Forecast Results

The nationwide power consumption of Tunisia and that part of it supplied by the electric power system of STEG, both forecast macroscopically on the casis of the above parameters, are indicated in Table 3-2. The power supplied by the STEG system is forecast as a constant 85 % of the nationwide consumption. (The actual rates were 84 %, 88 % and 86 % in 1970 to 1974, in 1975 and in 1976, respectively.

3.1.4 Comparison and Conclusion

The load forecast obtained by the macroscopic method indicates, as is shown in Fig. 3-3, that the average annual growth rates every five years starting from 1976 will slowly decline: 13.8 % in 1976 to 1981, 12.6 % in 1981 to 1986, 11.2 % in 1986 to 1991 and 10.4 % in 1991 to 1996. In contrast with this, the mean annual growth rates according to the average forecasts considered as typical of those of STEG are, for the above periods, 14.2 %, 13.7 %, 8.4 % and 6.7 %, respectively. In other words, the growth rates according to the STEG forecast begin to show a rather redical decline in and after 1986.

However, the difference between the EPDC forecast and that of STEG is as much as 4.1 % in 1981, but increases up to 6.4 % in 1985 and 9.3 % in 1986. The difference diminishes greatly after 1986 and is eliminated by 1989 and 1990. Then, on the other hand, the EPDC forecast exceeds the STEG forecast, the difference amounting to 16 % as of 1996.

To make allowances for the STEG forecasts through 1986 being based on the hypothesis that all economic conditions will have been met and that the growth rates in and after 1986 will fall below the mean international level, this study has adopted values between the two forecasts, on the basis of which the maximum load is forecast as follows.

Tableau 3-2 PREVISION DE LA CONSOMMATION D'ELECTRICITE ETABLIE PAR LA METHODE MACROSCOPIQUE

Année	Taux de croissance du P.I.B. par habitant	P.I.B. par habitant aux prix 1968	Consommation d'électricité par habitant	Population estimée	Consommation nationale	Consommation fournie par la STEG
	(%)	($E.U.)	(kWh)	(1.000)	(GWh)	(GWh)
1976	5,20	415	232	5.737	1.330	1.145
1977	5,29	437	260	5.872	1.530	1.300
1978	5,29	460	290	6.037	1.750	1.490
1979	5,29	484	330	6.175	2.040	1.730
1980	5,43	510	360	6.307	2.270	1.930
1981	5,43	538	400	6.437	2.570	2.190
1982	5,43	567	450	6.581	2.960	2.520
1983	5,43	598	500	6.728	3.360	2.860
1984	5,56	631	550	6.879	3.780	3.220
1985	5,56	666	600	7.033	4.220	3.590
1986	5,56	708	650	7.177	4.670	3.970
1987	5,59	742	720	7.331	5.280	4.490
1988	5,59	784	780	7.485	5,840	4.960
1989	5,59	827	850	7.642	6.500	5.520
1990	5,55	873	920	7.803	7.180	6.100
1991	5,55	922	1.000	7.939	7.940	6.750
1992	5,50	973	1.100	8.085	8.890	7.560
1993	5,50	1.020	1.200	8.229	9.879	8.390
1994	5,27	1.080	1.290	8.377	10.820	9.200
1995	5,27	1.130	1.400	8.527	11.940	10.150
1996	5,27	1.197	1.500	8.675	13.010	11.060

Note: Les taux de croissance annuels moyens sont les suivants:

De 1976 à 1981 . . . . . 13,8 %

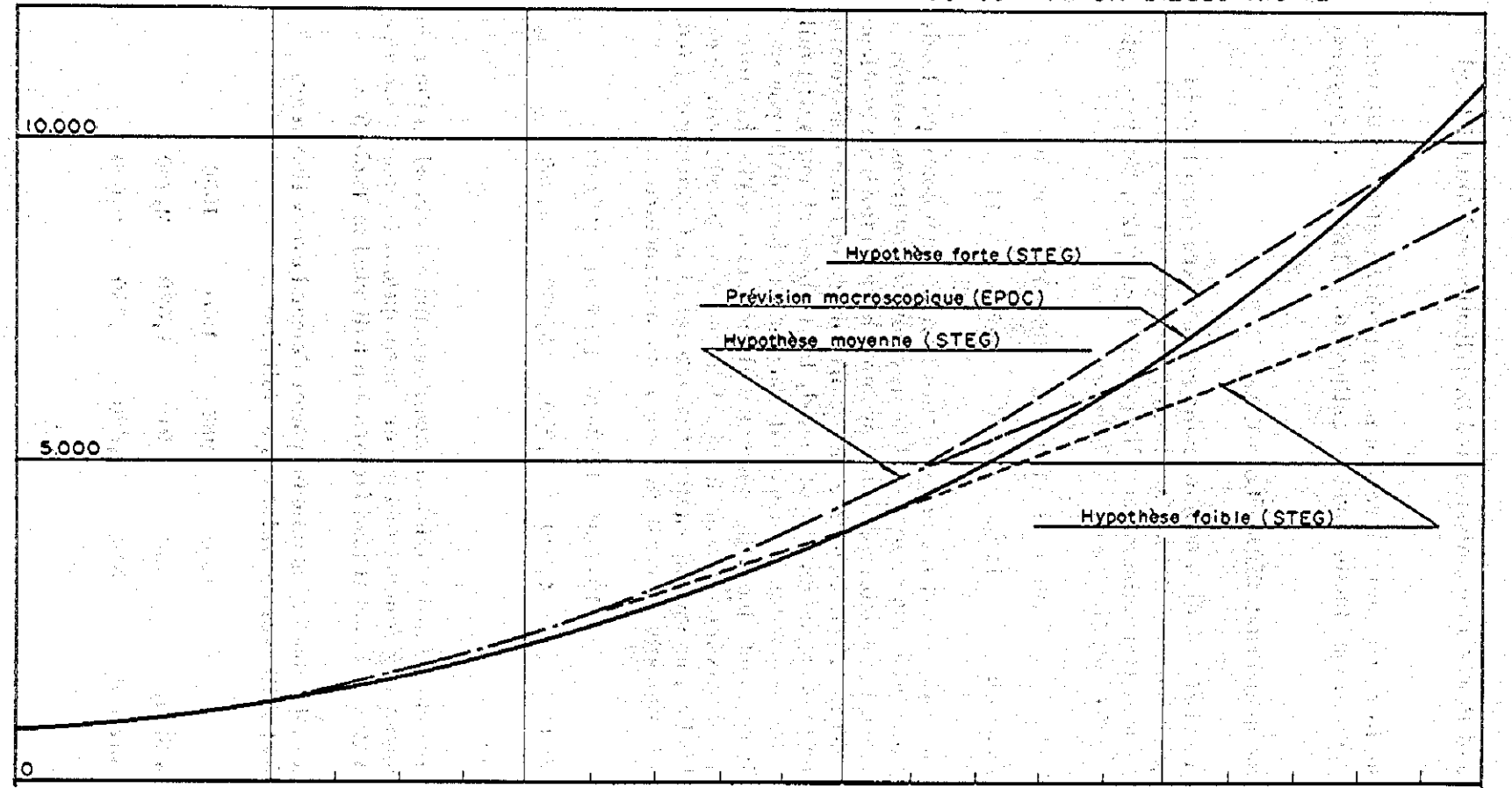
De 1981 à 1986 . . . . . 12,6 %

De 1986 à 1991 . . . . . 11,2 %

De 1991 à 1996 . . . . . 10,4 %

La moyenne de 1976 à 1996 . . . . . 12,0 %

(GWh) Graphique 3-3 COMPARAISON DES PREVISIONS DE LA CONSOMMATION D'ELECTRICITE



Ecart des prévisions (%)												
Hypothèse moyenne / Macroscopique	4.1		4.2	5.3	6.4	9.3	4.7	2.8	1.4	-1.6	-3.7	-10.6	-16.

Taux moyen de croissance (%)				
STEG (Moyenne)	14.2 %	13.7 %	8.4 %	6.7 %
EPDC	13.8 %	12.6 %	11.2 %	10.4 %

3.2 MAXIMUM LOAD FORECAST

3.2.1 kWh Loss Rate of Power Transmission and Distribution and Annual Load Factor

To forecast the maximum load, the future levels of power transmission and distribution loss rate and of the annual load factor must be estimated. STEG has approached this as follows:

(1) Power Transmission and Distribution Loss Rate

The power transmission and distribution loss over the seven years from 1970 to 1976, was at the average annual rate of 18.5 %. Taking into account the gradual future completion of the power transmission and distribution networks, the loss rate will gradually decline by 1 % every five years as follows:

Period	1977-81	1982-86	1987-91	1992-96
Power Loss/Consumption	17 %	16 %	15 %	14 %

According to statistical investigations, the annual hours of maximum continued load, which are calculated by dividing transmission-end energy demand by transmission-end maximum power demand in the interconnected system, have so far been confirmed at an almost constant 4,800 to 4,900. With the rising proportion of home consumers whose power consumption is centered on a peak period, the number of hours will fall, but at the same time, as the proportion of industrial consumers whose daily power consumption is relatively constant rises, the number will increase. STEG has forecast that the annual hours of maximum power demand will increase by 50 hours every five years, as indicated below, on the expectation that the relative importance of indu industrial consumers will gradually increase in the consumer structure.

	1977-81	1982-86	1987-91	1991-96
Continued Peak Hours	4,900	4,950	5,000	5,050

3.2.2 Forecast Results

Transmission-end energy demand and maximum power demand calculated on the basis of the above premises concerning demand-end power consumption, transmission and distribution power loss rates and annual load factors are indicated in Table 3-3.

A comparison of the forecast values of maximum power demand every five years given in the table with the STEG average values is as follows:

	1981	1986	1991	1996
Forecast by This Study	530	910	1,520	2,260
STEG Average Forecast	540	1,020	1,380	2,050

Further, a comparison of the STEG forecasts, high, average and low, with the values adopted by this study is made in Fig. 3-4, from which the following conclusions can be drawn:

(a) All the corresponding forecast values are equal until 1980.

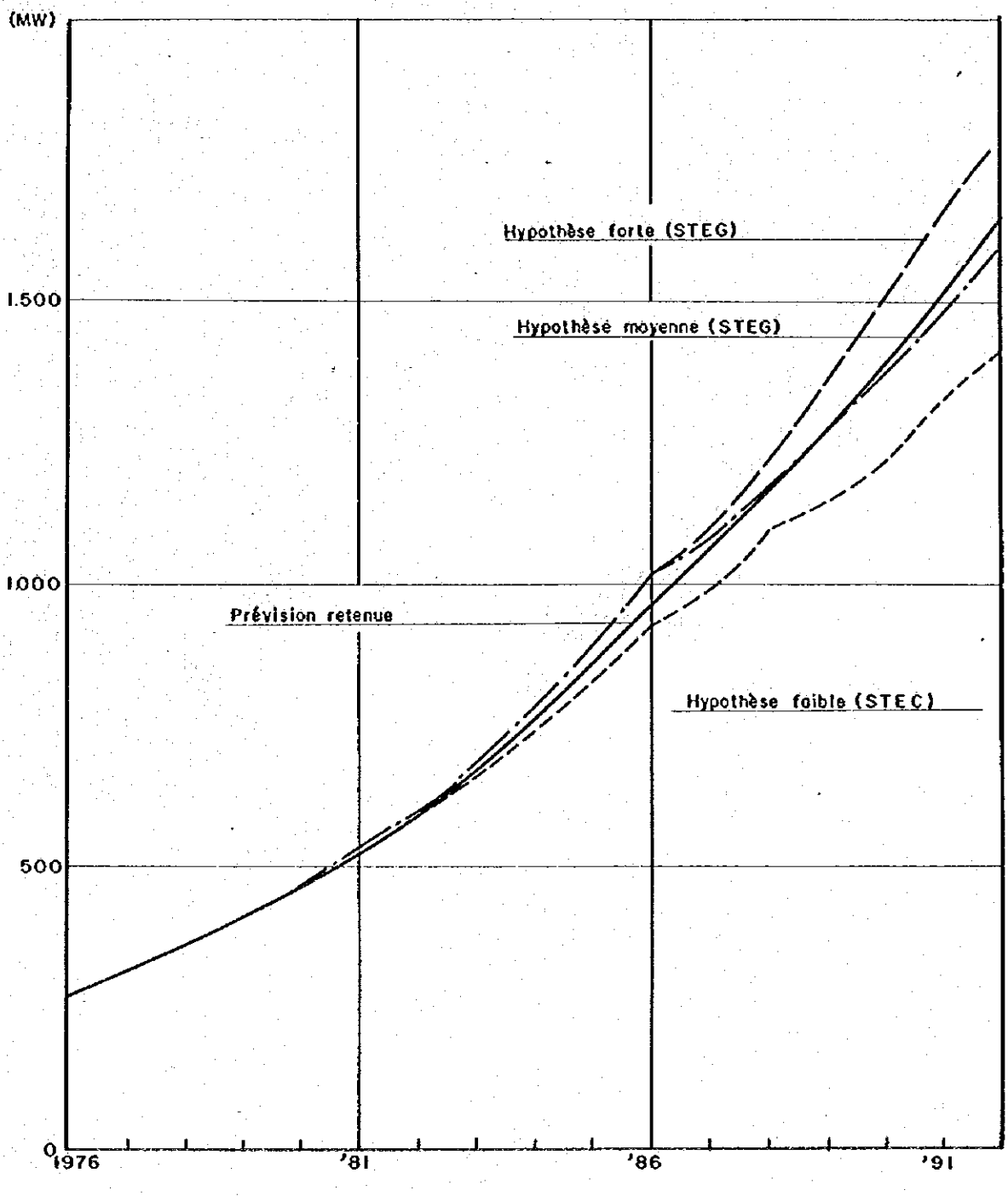
(b) The values adopted as of 1986 by the EPDC rank midway between the high and average forecasts and the low forecast.

(c) Although each STEG forecast fhows a curve of considerable irregularity with 1986 as a turning point, the forecast curve adopted by the EPDC is regular and is an average of the STEG forecasts.

Tableau 3-3 PREVISION DE LA PUISSANCE MAXIMUM APPELEE SUR LE RESEAU INTERCONNECTE DE LA STEG

Année	Consommation fournie par la STEG			Production aux bornes centrales	Puissance maximum appelée
	Prévision macroscopique par l'EPDC	Prévision par la STEG (Hypothèse moyenne)	Prévision retenue dans ce rapport		
	(GWh)	(GWh)	(GWh)	(GWh)	(MW)
1976	1.145	1.145	1.145	1.339,4	272
1977	1.330	1.340	1.335	1.560	320
1978	1.490	1.570	1.530	1.790	370
1979	1.730	1.750	1.740	2.040	420
1980	1.930	1.990	1.960	2.290	470
1981	2.190	2.280	2.235	2.610	530
1982	2.520	2.590	2.555	2.960	600
1983	2.860	2.980	2.920	3.390	680
1984	3.220	3.390	3.305	3.830	770
1985	3.590	3.820	3.705	4.300	870
1986	3.970	4.340	4.155	4.820	970
1987	4.490	4.700	4.595	5.280	1.060
1988	4.960	5.100	5.030	5.780	1.160
1989	5.520	5.600	5.560	6.390	1.280
1990	6.100	6.000	6.050	6.960	1.390
1991	6.750	6.500	6.625	7.620	1.520
1992	7.560	7.000	7.280	8.300	1.640
1993	8.390	7.500	7.945	9.060	1.790
1994	9.200	8.000	8.600	9.800	1.940
1995	10.150	8.500	9.325	10.630	2.110
1996	11.060	9.000	10.030	11.430	2.260

Graphique 3-4 COMPARAISON DES PREVISIONS DE LA PUISSANCE MAXIMUM APPELEE



CHAPTER 4. FACILITY DEVELOPMENT PROJECTS IN THE FIFTH PLAN

CHAPTER 4 FACILITY DEVELOPMENT PROJECTS IN THE FIFTH PLAN

4.1 FACILITY DEVELOPMENT PROJECTS

With the aim of qualitative improvement of electric power supply by meeting the increase in dimand in urban districts and agricultural areas and, at the same time, by reducing transmission troubles, drop-outs,etc., development projects are being implemented for power generation facilities, transmissionk and substation facilities, distribution facilities and building and operation facilities, covered by the investment of 200 million dinars for the period 1977 to 1981.

4.1.1 Development of Power generation Facilities

(1) Thermal Power Stations

Development plans for the thermal power sector conclude Sousse Steam Power Station (150 MW × 2) and seven gas turbines of 22 MW each--totalling 154 MW-- which will be located at Sfax (2 units), Mengel Bourgiba (2 units) , Tunis Sud (1 unit), Korba (1 unit) and Metlaoui (1 unit).

The two gas turgines at Sfax started operation in 1977 and the remaining five also are plenned are planned to be in operation by the end of 1987. The first steam generator at Sousse should start operating in April 1980, and the second in September of that year.

(2) Hydroelectric Power Stations

The construction site of the Sidi Salem Multi-purpose Profect was established in 1977. Although Sidi Salem Dam mainly aims at supplying potable and agricultural water, a hydroelectric station with an installed capacity of 26 MW (guaranteed capacity: 20 MW) will be constructed for the secondary purpose of electric generation. Sidi Salem Hydroelectric Power Station, STEG's sixth, is scheduled to start operation in November 1982.

The completion of the construction of this hydroelectric power station will bring the gross installed capacity of the power stations operated by STEG to approximately 911 MW (guaranteed capacity: 842 MW).

An outline of the installations of these power stations, projected in the Fifth Plan, is given in Table 4-1.

4.1.2 Development of Transmission and Substations

(1) High-voltage Transmission Lines

Planning the cinstruction of transmission lines always necessitates technical and economic investigations in order to avoid unsatisfactory operation of the transmission networks which might lead to unsound expenses for an undertaking or to deterioration

in services. STEG therefore carried out thorough investigations on a variety of altrenatives before working out the transmission development project to be implemented in the Fifth Plan. This development project was selected because it would minimize, in terms of value in hand, the gross cost, which would be the sum of the investment in the construction of transmission lines, the cost of operation and maintenamce, and the outlays accompanying troubles and drop-outs.

An outline of the installation of these new transmission lines, covered by the Fifth Plan, is shown Table 4-2.

The 225kV line from Maknassy to Oueslatia and Naassen is expected to start operation in 1978; and the 150kV lines supplying the cement mills at Hammamet, Akonda and Gabes, and the 90kV line between El Aroussia and Menzel Bourgiba have already been completed. The coming into operation in 1979 or 1980 of the main 225kV power transmission lines and, in particular, of the 225kV line looping the Tunis area will markedly improve the reliability of the transmission networks of STEG. In fact, their completion will make the power transmission system of STEG a powerful grid structure; and by the operation of loops at all times along with improvements in the protection system, it is thought that virtually no substation will ever fail because of a fault in a section of transmission line. Furthermore, it is thought that the grid meshes are small enough (approximately 100km) to maintain fairly high reliability if if reclosing is done at high speed.

In addition, the international power transmission lines connecting Algeria and Libya due to start operation in 1980 and 1982, respectively, should be mentioned:

- Interconnection Line with Algeria

  Between Metlaoui and Teble Ouk 150kV single circuit, 1980
  Between Tajerouine and El Aouinet 225kV single circuit, 1980

- Interconnection Line with Libya

  Bouchemm-Zouara 225kV two circuits, 1982

These lines aim at supporting and supplying power in a moment in case of troubles and drop-outs, in particular of 15 MW-capacity single unit or multiple units at Sousse Steam Power Station; and at then maintaining this supply until the original supply required has been restored by the other power stations of STEG. These interconnecting transmission lines will also save investment in additional power stations and give great economic benefit through planned power transmission, and so on.

The completion of thses new power transmission lines will mean that the overall distance covered by STEG transmission lines will reach approximately 2,543 km, if the international connection lines with Algeria and Libya are excluded.

(2) Substations

In parallel with the development of power generation facilities and power transmission lines, new substations are planned for the period of the Fifth Plan in eight cites:

Tunis Nord, Sousse, Naassen, M'Nihla, Akouda, Hammamet, Oueslatia and Oued Zarga. Besides, transformers will be increased at six existing subststions. The following two planned substations are particularly noteworthy.

- 90kV Tunis Nord Substaion: This will handle the power supply to new housing complexes to be established at El Nenzah, Ariana and Ras Tabia, and to a new industrial zone at Charguia. This station, situated midway between La Goulette Power Station and Tunis Ouest Power Station, will entirely take over the 30kV load supply which Tunis Ouest Substation has so far dealt with.
- 90kV Oued Zarga Substation: This substation will be established half-way along the 90kV power transmission line connecting El Aroussia Poer Station with Fernana Power Station and ensure stable electric power supply to the north-western area of Tunisia. Electric power will be transmitted to this substation through a 10kW power transmission line from the new-established Sidi Salem Hydroelectric Power Station.

As is indicated in Table 4-3, during the period of the Fifth Plan, the gross capacity of substations of STEG will double, the total substation capacity reaching 2,590MVA at the end of 1981.

4.1.3 Development of Power Distribution Networks

Compared with the development plans for power generation facilities, power transmi mission facilities and substations, that of power distribution networks is characterized by a large variety of restrictions. Some of these restrictions are listed here: those concerning third persons-- that is, consumers-- who must bear part of investment requirement for the power disdribution facilities at the same time as desiring a power supply; those obstacles to the execution of work that are related to the procuerment of appropriate construction materials; the physical capacity of technical experts of STEG and local subcontract companies of electric construction; as well as those attached to STEG fund raising which must cover a great part of the investment requirements.

As was described in sub-section 2.4.2, however, the "Basic Power Distribution Plan" definitely provided measures for carrying out electrification in urban districts and rural areas, such as the employment of technics of pre-assembled cables and the shirt to the M.A.L.T System (three-phase, four wire, direct-earthing system). With the adoption of these, the development target for the distribution sector be attained during the period of the Fifth Plan.

- Electrification Promotion in Urban Districts: The planned increase in the number of consumers during the period of the Fifth Plan is from a approximately 408,000 houses in 1976 to a total of 640,000 (an increase of 232,000). The average annual growth rate is equal to 9.4%; and the ratio of urban electrification in 1981 is forecast at 85%.
- Electrfication of Rural Areas: In the same way, the number of consumers is expected to increase by 74,000 houses, from 44,000 houses in 1976 to 118,000 houses within the duration of the Fifth Plan. The average annual growth rate is equal to 22%; and the ratio of rural electrification in 1981 is forecast to rise to 57%.

Throughout Tunisia, STEG plans to increase the length of its medium-voltage power distribution lines and the aggregate power distribution capacity of its substations according to the Fifth Plan as follws:

- Total Length of Power Distribution Lines

  Medium-voltage Supply 5,276kW
  Low-voltage Supply 3,311kW

- Power Distribution Capacity of Substations 99,577kVA

4.2 INVESTMENT PLAN

Gross investments required for implementation of the Fifth Plan amount to approxima mately 212 million dinars, of which 37% are related to power generation, 11.5% to power transmission, 38% to power distribution, and 9.5% to buildings and operation facilities. The gross investments amount to approximately 4 times those of the Fourth Plan (68,7 million dinars).

Investments planned between 1977 and 1981 for the Fifth Plan are indicated by sector in the following table.

(Milliers de Dinars)

Désignation	1977	1978	1979	1980	1981	Total
Production	16.342	18.845	22.435	14.680	6.200	78.502
Transport	7.220	7.350	8.150	7,600	2.400	32.720
Distribution	11.800	13.000	15.800	18.700	21.200	80.500
Logistique	2.858	4.915	4.480	4.030	3.670	19.953
Sous-total	38.220	44.110	50.865	45.010	33.470	211.675
Taxes et douanes	4.100	6.340	7.850	4.490	1.220	24.000
Grand total	42.320	50.450	58.715	49.500	34.690	235.675

The investments in the power generation sector will increase the installed capacity from 358,760kW in 1976 (in 1977, 464,760kW) to 874,760kW by the end of 1981 and 910,760kW at the end of 1982.

The investments in the power transmission and substation sectors will lengthen the overall distance from 1,550km at the ind of 1976 to 2,254km at the end of 1981 and will enlarge the gross substation capacity from 1,175MVA to 2,590MVA during the same period.

Furthermore, the investment plan for the power distribution sector aims at raising, between 1976 and 1981, the number of consumers from 452,000 houses to 758,000 houses, and the electrfication ratio from 65% to 85% in urban districts, from 23% to 57% in rural areas, and from 40% to 60% on a national average. It should be noted in this connection that part of the funds raised for power distribution investments will usually be covered by private consumers and local bodies, etc, and the remainder by STEG. The fund raising section of the Fifth Plan projects that 56% of the gross funds required, that is, 49.9 million dinads, will be covered by these third persons (the consumers) and the remaining 44%, or 35.6 million dinars, by STEG.

To investments in these basic infrastructure sectors of STEG must be added inves ments in buildings and operation facilities, such as the central load dispatching station (Dispatching National), various sorts of buildings and movables, special equipment, vehicles and so on. of thses facilities, the construction plan of the central load dispatching station is particularly noteworthy. The utilization of investments in this station was decided with the realization that as the number of power stations of STEG continues to increase, and, particularly when the power transmission lines interconnecting with Algeria and Libya will start operation, more efficient control and closer operation surveillance of these dynamic power generation and transmission facilites will be needed in terms of the structure of the system.

Tableau 4.1 RENFORCEMENT DU PARC DE PRODUCTION AU COURS DU Ve PLAN (1977 ~ 1981)

Catégorie et Centrale	Groupe	Année de mise en service	Puissance installée (kW)	Puissance garantie (kW)	Combustible utilisé
Thermique Vapeur					
Sousse	TV 1	1980	150.000		
	TV 2	1980	150.000		
		Total	300.000	300.000	Bunker C et gaz naturel
Turbine à gaz					
Sfax	TG 1	1977	22.000		
	TG 2	1977	22.000		
		Total	44.000	44.000	Gas-oil
Menzel Bourguiba	TG 1	1978	22.000		
	TG 2	1978	22.000		
		Total	44.000	44.000	Gas-oil
Tunis Sud	TG 3	1978	22.000	22.000	Gas oil
Korba	TG 1	1978	22.000	22.000	Gas-oil
Metlaoui	TG 1	1978	22.000	22.000	Gas-oil
		Total des turbines à gaz	154.000		
Hydraulique					
Sidi Salem	GR 1	1982	36.000	20.000	(Barrage Sidi Salem)
		Grand Total	490.000	474.000	
Puissance totale du parc de production à la fin de l'année 1982			910.760	842.000	

Tableau 4.2 **RENFORCEMENT DU RESEAU DE TRANSPORT AU COURS DU Ve PLAN (1977 ~ 1981)**

Ligne	Tension (kV)	Longueur (km)	Terne	Conducteur	Section (mm^2)
Ligne 225 kV					
Maknassy - Oueslatia	225	140	1	Al-Ac	411
Oueslatia - Naassen	225	112	1	Al-Ac	411
Oueslatia - Tajerouine	225	100	1	Al-Ac	411
Oueslatia - Sousse	225	105	1	Al-Ac	411
Sousse - Naassen	225	112	1	Al-Ac	411
Naassen - M'Nihila	225	40	1	Al-Ac	411
Total		609			
Ligne 150 kV					
Alimentation Hammamet	150	34	2	Al-Ac	265
Alimentation de la Cimentrie à Gabès	150	11	1	Al-Ac	297
Alimentation de Akouda	150	9	2	Al-Ac	265
Sousse - M'Saken	150	13	1	Al-Ac	297
Total		67			
Ligne 90 kV					
El Aroussia - M. Bourguiba	90	39	1	Al-Ac	176
Alimentation de El Fouladh	90	3	1	Al-Ac	176
Tunis Sud - Naassen	90	8	2	Al-Ac	420
Sidi Salem - Oued Zarga	90	10	1	Al-Ac	288
Total		60			
Grand Total		736 km			
Longueur totale du réseau à la fin du Ve Plan (fin 1981)		2.253,5 km			

Tableau 4.3 RENFORCEMENT DES POSTES DE TRANSPORT AU COURS DU Ve PLAN (1977 ~ 1981)

Poste	Nombre de transformateurs	Capacité (MVA)	Tension (kV)	Capacité de compensation		
				Condensateur ou réactance	Tension (kV)	Capacité (MVAR)
Sousse	1	100	225/150			
Tajerouine	1	100	225/150			
Bouchemma	1	100	225/90			
Naassen	2	100	225/90			
M'Nihila	2	100	225/90			
Hammamet	2	30	150/33			
Akouda	2	30	150/33			
Tunis Nord	1	40	90/33			
	1	30	90/33			
	1	40	90/11			
	1	30	90/11			
Menzel Bourguiba	2	40				
M'Saken	2	40				
Metlaoui	3	40				
Sfax	1	40				
Oueslatia	2	30		Réactance		
Sous-total	25	1.340				
Capacité totale à la fin du Ve Plan (fin 1981)		2.590				

Note: Non compris l'augmentation de capacité par le transfert des transformateurs à partir des autres postes.

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