SONEL's Demand Projection for Public Sector
(Excluding HT Consumers)

Year	Trend Method		Micro Method			
			Medium (Niveau) Forecast		Low (Moyenne) Forecast	
	GWh	MW	GWh	MW	GWh	MW
South Interconnection System						
1990/91	1,265	250	1,192	225	1,000	222
1994/95	1,467	311	1,340	253	1,129	251
1998/99	1,702	388	1,516	287	1,282	285
North Interconnection System						
1990/91	129	26	162	29	134	24
1994/95	137	31	170	31	142	28
1998/99	146	37	184	33	150	30

Notes: GWh = Energy production, MW = Peak power demand
Medium Forecast = Medium (Niveau) Growth Forecast
Low Forecast = Low (Moyenne) Growth Forecast

The above three forecasts currently prepared by SONEL indicate a relatively large difference in the projected figures varying by forecast method. Further discussion is given in succeeding Sections.

4.5.2 Basis of Demand Forecast

The SONEL's demand forecast has projected only the public sector and does not include HT consumers. Table 4.5.3 shows the contract capacity of HT consumers. All HT consumers have no plan to increase their capacity for the near future. Actually, growth rate in average for the last 8 years shows only 1.1 % per annum, as shown on Table 4.4.3 (II).

Thus, overall demand forecast is obtained in form of adding the power and energy of HT consumers to the power demand forecast for public sector in each network.

In estimation of energy loss for HT consumers, Table 4.4.4 (II) "HT Consumers" shows 2.9 % to 0.6 % in the last 5 years and therefore, in this study, 2.0 % is considered as the energy loss rate in HT production for this demand forecast.

(1) South Interconnection Network

As mentioned above, there are two methods for the demand forecasts for the public sector which was made by SONEL in 1989/90; one is the trend method for 10-year forecast (up to 1998/99) and the other is the micro method for 15-year forecast (up to 2014/15).

(a) Trend method for public sector

(a-1) Low Growth Scenario by SONEL:

In case of the trend method, both annual growth rates of energy production and peak power are considered in the SONEL's estimate to be 3.8 % and 5.6 %, which represents the trend for the last 3 years in average, as shown in Table 4.5.1 (I) "South Interconnection Network".

Usually, such average values is obtained to be 5 to 10-year average ones for long term forecast; e.g., 6.9 % for the last 5-years (1983/84 - 1988/89) or 9.7 % for the last 10-years (1978/79 - 1988/89). It seems, however, that SONEL assumed the future growth rate conservatively, taking into account the demand showing a decreasing trend at the time of forecast. This scenario assumed by SONEL is regarded herein as "Low Growth Scenario".

Regarding the forecast of peak power, annual growth rate of 5.6 % is used against 3.8 % of annual growth rate in energy production based on a trend in the last 3-year period. There will be no large change in this trend judging from a relatively small variation in annual load factor ranging from 59.1 % to 62.5 % in the past 14 years, as given in Table 4.4.2. Besides, power shift value shows 1.47 (= 5.6 / 3.8) if the growth rates for the last 3-years are adopted. While, power shift value shows only 1.02 (= 9.9 / 9.7) for the last 10-years (1978/79 - 1988/89) or 1.03 (= 7.1 / 6.9) for the last 5-years (1983/84 - 1988/89). It seems that this difference is due to a trend in a shorter horizon and therefore load factor should be adopted to be about 60 % for this horizon of the demand forecast, while SONEL uses lower figures for load factor in its power demand projection (see Table 4.5.1).

As a result of reviewing data for the two more years of 1989/90 and 1990/91, such decreasing tendency is still going on and the estimated growth rates is therefore revised to be 2.6 % instead of 3.8 %.

(a-2) High and Medium Growth Scenarios:

In a sense, the Low Growth Scenario above is deemed to be a too conservative scenario scanning particularly the trend of the last five years which is characterized as a major economic regression period.

The fall in power demand growth in five years (1985/86 - 1990/91) owes much to a reflection of setback in the country' s economic growth. This is just an economic matter due mainly to sudden and large decrease of oil price caused in mid 1980' s. It is, however, evaluated that this economic depression does not represent the long-term nor future trend of Cameroon' s economics; the high economic growth rate will be recovered in the very near future.

As stated in Chapter 2, World Bank (WB) has reported that the growth rate of GNP was -3.3 % in 1988/89 and -2.0 % in 1991/92 but estimated to recover it to 2.55 % to 4.82 % with 4 scenarios up to 1999/2000, which means fundamental infrastructures will be well arranged by that time. In such circumstances, annual growth rates will be kept low up to the end of this century and thereafter recover to normal growth.

Based on this concept, the following two alternative scenarios are examined:

	Energy Production Growth (% per year)	
Alternative Scenario	1990/91 - 99/00	2001/02 - 14/15
High Growth Scenario	2.6 %	7.2 %
Medium Growth Scenario	2.6 %	4.9 %

Notes: 7.2% = Average growth rate in last 10 years (1980/81 - 90/91)
2.6% = Average growth rate in last 5 years (1985/86 - 90/91)
4.9% = Medium value of 7.2% and 2.6%

(b) Micro method for public sector

SONEL carried out two sets of demand forecast by micro method; one of which is "Medium (Niveau) Growth Forecast" and the other is "Low (Moyenne) Growth Forecast".

This method of forecast is widely used in other countries as well; i.e., domestic demand and small industry demand are proportional to population based on a per capita consumption, and medium tension (MT) demand increases generally in relation to GDP growth rate. The parameters assumed in the SONEL's demand forecast by this method is as shown in Table 4.5.4.

Regarding annual load factor, 60.5 % is adopted as Medium forecast and 51.4 % for Low forecast, which seems reasonable if some power shift is considered for the Low forecast.

As to growth rate of population, SONEL has used 4.75% up to 1999/2000 and thereafter 2.46% up to 2014/15 for the South Interconnection Network. While, the government tentatively estimated the population in 1991, as given in Table 4.4.5, which shows that annual growth rate for the last 15 years (1975/76-1990/91) is about 3.2 % in the whole country, while the corresponding figure for the regions of the South Interconnection Network is calculated as 4.16 %. Hence, the SONEL's estimation seems reasonable, which assumes a larger figure (almost equal to the actual growth rate) for the short future and a smaller figure for the long future for a conservative estimate.

In the SONEL's estimate, MT demand is forecasted based on growth rate ranging from 1.09 % in 1999/2000 to 2.91 % in 2014/15 increasing step by step in case of the Medium forecast (see Table 4.5.4). While, the elasticity to GDP ranges yearly from 0.42 to 2.46 during the last 8 years and averages out 1.33. Therefore, SONEL's estimation seems to be somewhat conservative compared with the projected GDP growth scenarios (2.55 to 4.82 % towards 2000, see Section 2.2.2).

Elasticity between MT Consumption and GDP Growth

Year	MT consumption growth rate (%)	GDP growth rate (%)	Elasticity
1979/80	-	-	-
80/81	8.2	17.1	0.48
81/82	3.8	7.6	0.50
82/83	17.2	7.0	2.46
83/84	3.3	7.8	0.42
84/85	14.6	8.9	1.64
85/86	8.3	7.3	1.14
86/87	3.5	-5.0	-
87/88	-1.3	-7.3	-
Average for last 8 years	7.2	5.4	1.33
Average for last 5 years	5.7	2.3	2.48

Note: Information on GDP growth rate is available only for period from 1980/81 to 1987/88 (see Table 2.2)

A review of the Medium and Low growth scenarios is made herein by the Study Team without changing fundamental parameters as discussed above. However, some parameters such as percentage of energy loss, assumption of per capita energy, growth rate of MT consumption, etc. are slightly changed to meet with the past tendency, as shown in Table 4.5.13. Beside, the High scenario is prepared herein to assume per capita consumption more attractively with 1.5 % of growth rate per annum.

(2) North Interconnection Network

Same as for the South Interconnection Network, two methods of the demand forecasts for the public sector were made by SONEL in 1989/90 for the same horizon of forecast as above. HT consumers is only one consumer (CICAM, paper mill, see Table 4.5.3), to which electricity supply was started from 1989/90.

(a) Trend method

In case of the macro method by trend, annual growth rates of energy production and peak power are considered to be 1.6 % and 4.8 % respectively, which represent the trends in the last 4 years (1984/85 -1988/89) in average (see Table 4.5.1).

The last 5 year average growth rate of energy production (1983/84 - 1988/89) is 2.9 % or the last 10-year one (1978/79 - 1988/89) is 8.4 %. It seems, however, that SONEL assumed a conservative growth rate, similarly to the case of forecast for the South Interconnection Network.

Regarding the forecast of peak power, annual growth rate of 4.8 % is used by SONEL. The power shift value shows 3.1 if these growth rates is adopted (= 4.8% / 1.6%). While, a trend of power shift value shows only 0.93 for the last 10-years or 1.38 for the last 5-years. This difference seems due to a trend in a shorter horizon. Actual trend of load factor shows 57.1 % to 68.9 % up to 1984/1985 and thereafter decreasing to 61.0 %, as given in Table 4.4.2. Load factor should be, therefore adopted to be 60 to 62% in this horizon of the demand forecast. It is noted that SONEL assumes lower figures for load factor as shown in Table 4.5.1 (II).

(b) Micro method

Same as for the South Interconnection Network, there are two demand forecast of energy; one is Medium (Niveau) Growth Production and the other Low (Moyenne) Growth Production.

Table 4.5.4-(II) shows the parameters of demand forecast for the North Interconnection Network, which is slightly different from those used for the South Interconnection Network.

Regarding load factor, 62.8 % is adopted as Medium forecasts, which seems reasonable. Load factor of 57.1% is adopted as Low forecasts, which seems rather low judging from the historical load factors (see Table 4.4.2).

As to growth rate of population, SONEL estimated 2.46 % in this horizon of forecast. While, the government estimated 1990/91 population in 1991, as given in Table 4.4.5, which shows that annual growth rate for the last 15 years (1975/76 – 1990/91) is 3.2% in the whole country, where the corresponding figure for the regions of the North Interconnection Network is 0.03%.

Such being the case, the SONEL's estimation seems somewhat higher but acceptable, since the figure may still be a likely figure for the future.

MT demand is forecasted based on growth rates ranging from 0.75 % up to 1999/2000 and 5.0 % up to 2014/15 in case of the Medium forecast. The rate up to 1999/2000 is somewhat smaller than those for the South Interconnection Network in consideration of regional difference, which appears reasonable.

Load for HT consumers is added for each demand forecast, since SONEL's forecast dose not included it.

4.5.3 Results of the Forecast

(1) Forecast according to SONEL's criteria

Table 4.5.5 shows the summary of SONEL's demand forecast under "Low Growth Scenario" of trend method in which the peak power demand is based on load factors assumed by SONEL.

This output is virtually the revision of Table 4.5.1, in which the projection horizon is extended up to year 2014/15 and the demand of HT consumers is added.

Similarly, Table 4.5.6 shows the forecast by micro method. The output is virtually the revision of Table 4.5.2, in which the demand of HT consumer is added.

The tables cover the demand forecast for both of the South and North Interconnection Networks. These forecasts are presented just for reference and were not adopted in further study.

Forecast obtained for North Interconnection Network is summarized below for reference.

Demand Forecast for North Interconnection Network
(For Reference)

Year	Trend method		Micro method			
	Low Scenario		Medium (Niveau)		Low (Moyenne)	
	Energy (GWh)	Peak (MW)	Energy (GWh)	Peak (MW)	Energy (GWh)	Peak (MW)
1990/91	151.5	27.1	184.1	31.9	156.4	26.9
1994/95	159.7	28.6	194.6	33.8	163.8	30.8
1999/00	*171.0	*30.8	209.0	36.4	174.0	32.8
2004/05	*201.5	*36.6	317.8	56.2	220.9	42.2
2009/10	*238.3	*43.6	372.7	66.2	250.4	48.1
2014/15	*282.6	*52.0	439.4	78.3	284.4	54.9

(2) Forecast proposed in this Study (for South Interconnection Network)

The study attempted to work out the demand projection for the South Interconnection Network. The projection is based on both of trend method and micro method, in each of which three alternative scenarios (low, medium and high scenarios) were examined.

Table 4.5.7 shows the result of the "Low Growth Scenario" by trend method in which growth rate of energy production is set at 2.6% and the load factor at 60% as assessed by the Study Team. Similarly, Tables 4.5.8 and 4.5.9 show the results of "Medium Growth Scenario" and "High Growth Scenario", respectively, projected by trend method.

On the other hand, the results of the revised demand forecast by micro method are also shown in Tables 4.5.10 through 4.5.12. Each table shows "Low", "Medium", and "High" scenarios, respectively.

Both forecasts are summarized below in terms of total energy production and peak power demands:

Demand Forecast for South Interconnection Network by Trend Method

Year	High Scenario		Medium Scenario		Low Scenario	
	Energy (GWh)	Peak (MW)	Energy (GWh)	Peak (MW)	Energy (GWh)	Peak (MW)
1990/91	2,568	390	2,568	390	2,568	390
1994/95	2,697	418	2,697	418	2,697	418
1999/00	2,879	452	2,879	452	2,879	452
2004/05	3,504	571	3,285	529	3,084	491
2009/10	4,388	739	3,801	628	3,318	536
2014/15	5,641	978	4,456	752	3,585	586

Demand Forecast for South Interconnection Network by Micro Method

Year	High Forecast		Medium Forecast		Low Forecast	
	Energy (GWh)	Peak (MW)	Energy (GWh)	Peak (MW)	Energy (GWh)	Peak (MW)
1990/91	2,568	390	2,568	390	2,568	390
1994/95	2,797	434	2,759	427	2,742	470
1999/00	3,154	502	3,055	483	3,019	531
2004/05	3.578	582	3,400	548	3,271	587
2009/10	4,153	690	3,829	629	3,541	647
2014/15	4,890	829	4,375	732	3,849	716

As a summary of the above demand projection, the following can be recommended:

(1) North Interconnection Network will remain as a relatively small power market in a foreseeable future (52 - 78 MW in 2014/15). There will be no acute merit nor need of interconnection with the South Interconnection Network.

(2) Accordingly, the proposed Memvé Elé Project would be planned in consideration of power/energy demand of the South Interconnection Network.

(3) Demand projections of various scenarios for the South Interconnection Network are graphically shown in Fig. 4.5.1 (energy production demand and peak power demand by trend method) and Fig. 4.5.2 (energy production demand and peak power demand by micro method). In this forecasts, load factor for public sector is assumed to be 60% throughout the projected period. Looking at the projections overall, this study presumes that the "Medium Growth Scenario" of the micro method represents the most likely features of power demand growth. In the Scenario, demand growth rate of the public sector is assumed as 3.9 % in average, which roughly corresponds to the GDP growth scenario "B" or "C" mentioned in Subsection 2.2.2 herein before.

(4) Subject to further refinement of the demand projection, in future stage, the study assumes at moment that future power market will grow along with the "Medium Growth Scenario" of the micro method.

4.6 Transmission Line System for the Project

4.6.1 Proposed Route of Transmission Line

The Memvé Elé project site is situated in the south-western region of the country. The region covers such major loading centers as the capital Yaoundé, industrial center Edéa, and the trade port Douala. Those load centers are geographically separated in the western and eastern parts of the South Interconnection Network.

The bulk consumer in the South Interconnection Network is ALUCAM, an aluminum refinery operating in Edéa. Other major consumers in the region are SOCATRAL (aluminum production), CELLUCAM (paper mill) and CIMENCAM (cement factory). They consume at the present more than half of the overall energy consumption in the system. Besides those factories, there was a plan of building another aluminum factory in Kribi area, but the plan seems to be abandoned at present. Those bulk electricity consumers are situated in the western part along the gulf of Guinea, and supplied power by generating facilities being operated in their adjacent areas.

Yaoundé, Mbalmayo and Ebolowa are major demand centers in the eastern part of the South Interconnection Network, but there is only one diesel power station (Yaoundé/Mefou) operated in the area. Most of energy required in this part is supplied by the generating facilities operated in the western part through 225 kV and 90 kV transmission lines.

The Memvé Elé project is located in the southern part of eastern and western load centers and almost equal distance from both centers. The project is recommended to be directly connected with the eastern part of the system for supplementing its shortage of power sources and for promoting its regional development. The surplus power can be transmitted to the western part through the existing 225 kV line between Oyomabang and Mangombe substations.

Supposing the project would be connected directly to the western part of the system through Kribi, Edéa and Douala towns, the line should pass the forest/fauna reserve area (Campo reserve area) over about 120 km between the project site and Kribi town.

The direct route from the project to the western part should be better to avoided from the points of environmental conservation, accordingly. There is neither access road nor approach road in the section, which will require high construction, operation, and maintenance costs as well as a long construction period. Taking account of salt pollution from the gulf of Guinea, the line route on the seaside should be aligned far enough from the seashore. It makes the costs for construction and maintenance high.

From such points, the new transmission line will directly be constructed from the project to the capital Yaoundé.

4.6.2 Transmission Line Voltage

Operated voltages of the existing transmission lines in the country are 225 kV, 110 kV, 90 kV, 30 kV, and 15 kV. It is not recommended to use different line voltage from the existing system voltages for preventing complicated system operation and for standardizing operation and maintenance works.

Transmission magnitude of the project is 200 MW (100 MW in the 1st development stage and additional 100 MW in the 2nd development stage) over about 285 km.

There are several methods for selection of the suitable line voltage, i.e., transmission capacity coefficient method, surge impedance loading method, and Still's formula.

All of those methods and formula show that 90 kV or 110 kV line is not adequate for the project magnitude and 225 kV to 275 kV line is adequate for the project.

Since the 225 kV system is standard in the country, the line voltage for the project is selected at 225 kV. Another merit of 225 kV use is that connection of the new line to the existing substation is easily and economically carried out, since the existing facilities are operated under 225 kV at the present.

4.6.3 Alignment of Transmission Line

The route from the project site to Meyo Centre will be principally aligned along the existing road. The road is covered by laterite and to be widened for the construction purpose of the Memvé Elé project. There are a number of villages along the road, and accordingly the route will be selected avoiding those villages. In about 20 km section between the project site and Akom village, many tributaries of Mvila river are scattered. The route in the section should be selected meandering those tributaries on the shortest distance. Distance of the section will be approximately 88 km.

The section between Meyo Centre and Ebolowa will be aligned along the main asphalt paved road from Yaoundé city to Ambam city over about 46 km. Both sides of the road are covered by swamp. The line route should be selected keeping some distance from the swamp and houses clustered along the road. Most of the route will be on the east side of the road. There is an airport near Ebolowa. The line route in the area should be carefully selected following the standards and recommended practices of International Civil Aviation Organization.

The line route from Ebolowa to Mbalmayo is also selected along the main asphalt paved road through Mengong. Since there seems no swampy area in the section, the route is able to be aligned close to the road as much as possible in consideration of future regional plan as well as easy construction and maintenance of the line.

There are Mbalmayo and Zamakoe forest reserves in the north and south of Mbalmayo town. The line route in the area should be determined under approval of the authority concerned.

After the Zamakoe reserve, the line will run along the main road till Nkolmefou II village, then turn west to Mekoumbou village, and turn to north thereafter to the existing 225 kV Yaoundé substation (Oyomabang Substation) located the north-west of the town, detouring the densely populated areas.

Section distances of Meyo Centre to Ebolowa, Ebolowa to Mbalmayo, and Mbalmayo to Yaoundé are 46 km, 93 km and 57 km making total route length of 285 km from the project site to the existing Yaoundé substation.

4.6.4 Substations

The Oyomabang substation has a space of accommodating additional five (5) 225 kV feeder bays in the premises for future extension; one of which will be extended for Nachtigal line. And one bay will be extended for Edéa-Mangombe and one more bay for Nachtigal. The remaining two bays will be, therefore, available for double circuit incoming line from the Memvé Elé, without expansion of land space.

225 kV double bus system will be applied, to suit with the existing one. Some extension of control building or appurtenant buildings may be necessary.

4.6.5 Alternative Route of Transmission Line

(1) Introduction

In the Sub-section 4.6.3, the transmission line bound for Yaoundé is recommended. In this section, however, possibilities to choose another transmission line route are sought.

The Memvé Elé project that is planed to be connected to the South Interconnection Network is situated in the south-western region of the country. The major load centers of the network are i) the capital Yaoundé and its adjacent cities (Yaoundé area) and ii) industrial factories presently concentrated in Edéa and Douala region (Industrial area).

For the Yaoundé area, the power supply is made through the south-running 225 kV and 90 kV transmission lines. It is foreseen that the power demand will become greater than the power supply in the area mainly because of the power consumption growth of the public sector. However, a new hydropower source, the Nachtigal Project, is under consideration to strengthen the power supply for the Yaoundé area. When the plan is realized, the power deficit is hardly expected in the Yaoundé area at least in the short future; the additional power supply by the Memvé Elé Project in this case cannot be the first priority.

The industrial factories including an aluminum refinery in the Industrial area are bulk consumers of the South Interconnection Network; they consume more than a half of the overall energy generated in the network. No strict power deficit is expected in the Industrial area in a long term basis as long as the present industrial facilities are preserved. In fact, no facility expansion plan is reported from these existing factories. However, another new aluminum factory is planned in the Kribi region. Once the new aluminum factory is realized, new power source must accordingly be required. Memvé Elé plant can be the new power source concerning its closer location.

In this case, the other transmission line route of the Memvé Elé Project other than Yaoundé route could be appropriate, that is, the Kribi route running through Kribi, Edéa and Douala cities. Notice that the Kribi route is supposed to run in the Campo forest/fauna reserve. However, there presently exist wide timber roads until a point where is approximately 40 km to the project site and foot path thereafter. The route shall carefully be selected so as to utilize those roads and footpaths as much as possible to minimize environmental impacts.

(2) Alternative Route of Transmission Line (Kribi Route)

The Kribi transmission line route will be selected along footpath and the existing timber road westward from the project site to Melabe. The route length along footpath from the power station is about 45 km passing through mountainous range and skipping tributaries of Ntem river. The foot path may be required to upgrade to motorable road for construction purpose. The line will pass in the Campo forest/fauna reserve. However, its environmental impact can be minimized because the line route is able to be aligned along the existing timber road that is wide enough and bearable for heavy construction vehicles.

In the section of Melabe to Kribi town over 60 km, the line route will run on the east side of laterite surfaced motorable road up to the Kribi town, one of large sea-ports in the country. The road is closely aligned along the gulf of Guinea, and for preventing salt pollution to the line facilities the route should be selected on east side of the road to keep economically sufficient distance from the sea, although recorded wind velocity in the country is low and forest covering the area will be effective to shield the line facilities from the sea pollution.

There is 90 kV transmission line operated between Kribi and Edéa (Mangombe substation) over about 112 km along the asphalted national road. The existing line is well aligned keeping away from many water logged areas and villages located along the road, and a lake near Mangombe. The line of the Memvé Elé Project will be aligned in parallel to the 90 kV line for easy maintenance work. It will be necessary to carefully select the crossing point of the line over the wide Sanaga river and approaching route to the Mangombe substation near Ekite housing area.

Total length of the line is estimated to be approximately 240 km between the Memvé Elé power station and the Mangombe substation through Nkoadjap, Melabe, Kribi, Elon, Apou and Ndogbinan Lon.

(3) Alternative Substations in Kribi Route

The Mangombe substation reserves four 225 kV feeder bays in the premises for future extensions; one of which is reserved for Yaoundé lines, one for Douala-Logbaba and two for reserves. This reserve bays may be available for double circuit incoming line from the Memvé Elé, without expansion of land space.

Some extension of control building or appurtenant buildings may be necessary.

(4) Cost Estimate of Alternative Transmission Line along Kribi Route

The prices for tower materials, conductors and substation equipment are estimated at the CIF price in Douala excluding import duties and taxes. Civil works such as site clearance, earth work and foundation treatment are included in the transmission line cost.

The estimated costs are:

Description	Quantities	Foreign Currency (Mill. US$)	Local Currency (Mill. US$)
Transmission Lines	L.S.	20.41	4,695
Substation	L.S.	3.39	106
Total	-	23.80	4,801

Note: Construction cost for a new access road between Nkolelon and Nyabessan and maintenance cost for full section Kribi - Campo - Nkolelon - Nyabessan are not included in the above.

(5) Land Acquisition and Compensation (Kribi Route)

a) Right-of-way for the transmission line will be 40 m, 20 m on both sides of the centerline of the transmission line route. The right-of-way will be compensated for trees/bushes clearing and construction field works. The area to be compensated is estimated to be 960 *ha* (240 km long x 40 m wide).

b) Land for tower positions will be acquired for exclusive use for the transmission line. Necessary land for a tower position will be a 20 m by 20 m square in average. The total area to be compensated measures at 24 *ha* (600 towers x 20 m x 20 m).

Table 4.2.1 Existing Power Plant (1)

(As of end of 1991)

(I) South Interconnected Network

Name	Installed Capacity (MW)	Year of Commissioning
(A) Hydro Power Plants		
1. Edea		
a) No.I:	34.160	
- 2 x 11.360 MW		1953
- 1 x 11.440 MW		1958
b) No. II:	124.950	
- 6 x 20.825 MW		1973
c) No. III:	104.125	
- 2 x 20.825 MW		1973
- 2 x 20.825 MW		1975
- 1 x 20.825 MW		1976
Sub-total	263.235	
2. Song Loulou	387.600	
- 4 x 48.450 MW		1981
- 2 x 48.450 MW		1987
- 1 x 48.450 MW		1988
- 1 x 48.450 MW		1989
Total of hydro	650.835	

(B) Thermal Power Plants (Diesel only)	(Standby) (MW)	(Autonomous) (MW)
1. Littoral and South regions		
a) Bafoussam	10.000	-
b) Douala (Bassa I & II)	15.160	-
c) Kribi	0.400	-
d) Nkongsamba	1.162	-
e) Campo	-	0.136
f) Mape	-	0.716
g) Messondo	-	0.112
h) Mouanko	-	0.096
i) Nkondjock	-	0.240
Sub-total	26.722 (12.410)	1.300 (0.594)

Table 4.2.1 Existing Power Plant (2)

(As of end of 1991)

	(Standby) (MW)	(Autonomous) (MW)
2. Central, South and East regions		
a) Ebolowa	1.200	-
b) Mvomeka'a	0.495	-
c) Sangmelima	1.021	-
d) Yaounde (Mefou)	10.280	-
e) Abong-Mbang	-	0.875
f) Ambam	-	0.372
g) Batouri	-	0.729
h) Bertoua	-	2.270
i) Betare-Oya	-	0.126
j) Djoum	-	0.152
k) Edom	-	0.200
l) Yokadouma	-	0.326
Sub-total	12.996 (7.982)	5.050 (3.764)

	(Standby) (MW)	(Autonomous) (MW)
3. North-west and South-west regions		
a) Bakebe	0.025	-
b) Bamenda	0.340	-
c) Bota	2.478	-
d) Kumba	0.180	-
e) Kumbo	0.400	-
f) Nkambe	0.256	-
g) Mundemba	-	0.197
h) Wum	-	0.192
Sub-total	3.679 (2.294)	0.389 (0.368)
Total of thermal	43.397 (22.686)	6.739 (4.726)

Note:

1) Standby units in thermal (diesel) power plants mean the ones connected to the interconnected network but the autonomous units are yet to be connected to it like isolated system.

2) Figures shown in parentheses mean the present guarantee of their output.

3) In the East region, Kadey HEPP is expected to be commissioned in 1995/96.

Table 4.2.1 Existing Power Plant (3)

(II) North Interconnected Network

Name	Installed Capacity (MW)	Year of Commissioning
(A) Hydro Power Plants		
1. Lagdo	72.000	
- 4 x 18.000 MW		1983
Total of hydro	72.000	
(B) Thermal Power Plants (Diesel only)	(Standby) (MW)	(Autonomous) (MW)
1. Garoua region		
a) Garoua	19.942	-
b) Guider	0.200	-
c) Yagoua	1.200	-
d) Maroua	1.900	-
e) Kousseri	-	1.424
f) Poli	-	0.236
Sub-total	23.242 (16.842)	1.670 (1.152)
	(Standby) (MW)	(Autonomous) (MW)
2. Ngaoundere region		
a) Ngaoundere	-	4.400
b) Meiganga	-	0.600
c) Touboro	-	0.184
d) Tignere	-	0.152
e) Banyo	-	0.512
f) Tibati	-	0.392
Sub-total	- (-)	6.240 (4.664)
Total of thermal	23.242 (16.842)	7.910 (5.816)

Note:

1) North network is expected to be interconnected with the South interconnected network in future, but its timing is yet unkown.

2) Stand-by units in thermal (diesel) power plants mean the ones connected to the interconnected network and the autonomous units are yet to be connected to it.

3) Figures shown in parentheses mean guarantees of their output.

Table 4.2.1 Existing Power Plant (4)

(III) Summary

Particulars	Installed Capacity (MW)
(A) Hydro Power Plants	
1) South network	650.835
2) North network	72.000
Total	722.835
(B) Thermal Power Plants	
1) South network	
a) Stand-by in the network	43.397 (22.686)
b) Autonomous	6.739 (4.726)
Sub-total	49.661 (27.412)
	26.722 (12.410)
2) North network	
a) Stand-by in the network	23.242 (16.842)
b) Autonomous	7.910 (5.816)
Sub-total	31.152 (22.658)
Total	81.288 (50.070)
Grand-total	804.123

Note:

1) Figures shown in parentheses mean guarantees of their output.

Table 4.3.1 Existing Substation Transformers (1)

(As of end of 1991)

(I) South Interconnected Network

Name	Voltage ratio (kV)	Capacity (No.) x (MVA)	Total capacity (MVA)
1. Mangombe (Edea)	225/90/15	3 x 35 (1 ph) (1 x 35)	105 (35)
2. Logbaba (Douala)	225/90/15	3 x 35 (1 ph) (1 x 35)	105 (35)
3. Oyomabang (Yaounde)	225/90/15	3 x 35 (1 ph) (1 x 35)	105 (35)
4. Bekoko	225/90/15	3 x 35 (1 ph)	105
5. Bassa	90/16.5	3 x 50	150
6. Deido	90/16.5	1 x 20	20
7. Bonaberi	90/16.5 15/31.25	1 x 20 1 x 5	25
8. Koumassi	90/16.5	2 x 50	100
9. Limbe	90/33	1 x 20	20
10. Nkongsamba	90/33 90/16.5 15/31.25	1 x 10 1 x 10 1 x 2	22
11. Bafoussam	90/33 90/16.5	1 x 10 1 x 2	12
12. BRGM	90/16.5 15/31.25	3 x 20 1 x 5 (1 x 5)	65 (5)
13. Ngousso	90/16.5 30/15	3 x 20 1 x 5 (1 x 10)	65 (10)
14. Bamenda	90/30 30/15	1 x 20 1 x 5	25
15. Ndjock-Nkong	90/33	1 x 20	20
16. Mbalmayo	90/33	1 x 20	20
TOTAL			964 (120)

Table 4.3.1 Existing Substation Transformers (2)

(As of end of 1991)

(II) North Interconnected Network

Name	Voltage ratio (kV)	Capacity (No.) x (MVA)	Total capacity (MVA)
1. Garoua	110/15	2 x 20	
	15/90	2 x 20	
	15/30	1 x 2	82
2. Guider	90/30	1 x 10	10
3. Maroua	90/30	2 x 10	
		2 x 5	30
TOTAL			122

Note:

(1) Figures in parentheses show reserve units.

(2) 1 ph. means single phase.

Table 4.3.2 Existing Transmission Lines (1)

(As of end of 1991)

(I) South Interconnected Network

No.	Section		Circuit No.	Route Length (km)	Conductors (sq.mm)
(A)	225 kV Transmission Line				
1.	Song-Loulou	- Mangombe (Edea)	2	58.0	Almelec 366
2.	Mangombe	- Logbaba (Douala)	1	61.5	Almelec 366
3.	Mangombe	- Oyomabang (Yaounde)	1	168.0	Almelec 366
4.	Logbaba	- Bekoko	1	41.5	Almelec 570
5.	Song-Loulou	- Logbaba	1	93.0	Almelec 366
	Subtotal (A)			422.0 (480.0 km-circuit)	
(B)	90 kV Transmission Line				
1.	Mangombe (Edea)	- Logbaba (Douala)	1 1	65.0 62.5	AASC 173 Almelec 366
2.	Mangombe	- Edea III	1	2.8 2.4	Almelec 228 Almelec 366
3.	Mangombe	- Cellucam	1	4.7	Almelec 228
4.	Edea III	- Ndjock-Nkong	1	88.8	AASC 228
5.	Edea III	- Alucam	1	0.7	Almelec 366
6.	Ndjock-Nkong	- Oyomabang (Yaounde)	1	76.7	AASC 228
7.	Logbaba	- Bassa	1 1	2.9 3.7	AASC 173 Almelec 366
8.	Logbaba	- Koumassi	1	6.9 1.4	Almelec 366 Cable800
9.	Bassa	- Deido	1	5.2	Almelec 228
10.	Bassa (30 kV operation at present)	- Makepe	1	5.3	Almelec 366
11.	Bekoko	- Deido - Bonaberi	1 1	20.9 -	Almelec 366 Almelec 366
12.	Bekoko	- Limbe	1	48.2	Almelec 228
13.	Bekoko	- Nkongsamba	1	113.6	Almelec 228
14.	Nkongsamba	- Bafoussam	1	93.0	Almelec 228

Table 4.3.2 Existing Transmission Lines (2)

No.	Section			Circuit No.	Route Length (km)	Conductors (sq.mm)
15.	Bonaberi	-	Cimencam	1	0.4	Almelec 240
16.						
17.	Oyomabang	-	Ngousso	1	24.0	Almelec 366
18.	Oyomabang	-	BRGM	1	4.0	Almelec 366
				1	4.0	AASC 228
19.	Oyomabang	-	Mbalmayo	1	49.0	AASC 371
20.	Mangombe (15 kV operation at present)	-	Kribi		106.0	Almelec 232
	Subtotal (B)				862.1	(866.1 km-circuit)

(II) North Interconnected Network

No.	Section			Circuit No.	Route Length (km)	Conductors (sq.mm)
(A)	110 kV Transmission Line					
1.	Lagdo	-	Garoua	2	49.8	AASC 150
	Subtotal (A)				49.8	(99.8 km-circuit)
(B)	90 kV Transmission Line					
1.	Garoua	-	Guider	1	101.9	Almelec 228
2.	Guider	-	Maroua	1	99.3	Almelec 228
	Subtotal (B)				201.2	(201.2 km-circuit)

Note:-

Alme : Almelec (HAL)

AASC : Almelec-Acier (ACSR)

Figures shown in parentheses show a line length of the line (Circuit No. x Route length).

Table 4.4.1 Historical Energy Production by Power Source

(Unit:GWh)

Year	Thermal	Hydro	Total	Annual increase rate (%)
1975/76	69.2	1,271.8	1,341.1	-
76/77	70.7	1,239.9	1,310.6	-2.3
77/78	66.2	1,209.9	1,276.1	-3.3
78/79	74.4	1,310.4	1,384.8	9.3
79/80	82.2	1,305.7	1,387.9	0.2
80/81	94.0	1,561.1	1,655.1	19.3
81/82	105.1	2,042.5	2,147.6	29.8
82/83	105.5	2,055.0	2,160.5	0.6
83/84	38.6	2,118.0	2,156.6	-0.2
84/85	64.7	2,318.6	2,383.3	10.5
85/86	40.3	2,456.6	2,496.9	4.8
86/87	51.4	2,409.6	2,461.0	-1.4
87/88	57.6	2,496.3	2,553.9	3.8
88/89	41.6	2,648.6	2,690.2	5.3
89/90	43.4	2,658.9	2,702.3	0.4
90/91	38.3	2,669.4	2,707.7	0.2
Average growth rate: (last 10 years)	-8.6%	5.5%	5.0%	(80/81-90/91)

Table 4.4.2 Energy Production for Public Sector (1)

(I) South Interconnected Network

(Unit:GWh)

Year	Energy Production (GWh)	Growth Rate (%)	Peak Power (MW)	Average Power (MW)	Load Factor (%)
1975/76	274.6	-	52.3	31.3	59.9
76/77	320.4	16.7	61.9	36.6	59.1
77/78	395.5	23.5	73.0	45.1	61.8
78/79	463.9	17.3	86.8	53.0	61.0
79/80	534.3	15.2	97.7	61.0	62.4
80/81	597.7	11.2	113.2	68.2	60.3
81/82	673.1	12.6	123.0	76.8	62.5
82/83	767.4	14.0	145.1	87.6	60.4
83/84	841.6	9.7	158.5	96.1	60.6
84/85	958.5	13.9	177.7	109.4	61.5
85/86	1,051.3	9.7	189.9	120.0	63.2
86/87	1,126.7	7.2	207.3	128.6	62.2
87/88	1,163.4	3.3	212.9	132.8	62.4
88/89	1,174.0	0.9	223.8	134.0	59.9
89/90	1,190.4	1.4	223.2	135.9	60.9
90/91	1,193.3	0.2	224.0	136.2	60.8

Average growth rate:	7.2%	7.1%	(last 10 years:1980/81 - 90/91)
	2.6%	3.4%	(last 5 years:1985/86 - 90/91)

(II) North Interconnected Network

Year	Energy Production (GWh)	Growth Rate (%)	Peak Power (MW)	Average Power (MW)	Load Factor (%)
1975/76	41.5	-	8.3	4.7	57.1
76/77	44.4	7.1	8.8	5.1	57.6
77/78	47.8	7.5	9.8	5.5	55.7
78/79	55.9	17.1	11.0	6.4	58.0
79/80	60.6	8.4	11.7	6.9	59.1
80/81	68.5	13.0	13.7	7.8	57.1
81/82	76.7	11.9	14.9	8.8	58.8
82/83	85.4	11.3	16.9	9.7	57.7
83/84	108.3	26.9	19.2	12.4	64.4
84/85	117.7	8.7	19.5	13.4	68.9
85/86	125.3	6.4	21.8	14.3	65.6
86/87	125.1	-0.1	21.4	14.3	66.7
87/88	129.1	3.2	22.4	14.7	65.8
88/89	125.1	-3.1	23.4	14.3	61.0
89/90	119.0	-4.9	21.6	13.6	62.9
90/91	116.9	-1.8	20.6	13.3	64.8

Average growth rate:	5.5%	4.2%	(last 10 years:1980/81 - 90/91)
	-1.4%	-1.1%	(last 5 years:1985/86 - 90/91)

Table 4.4.2 Energy Production for Public Sector (2)

(III) Total (South + North Network)

(Unit:GWh)

Year	Energy Production (GWh)	Growth Rate (%)	Average Power (MW)
1975/76	316.1	-	36.1
76/77	364.8	15.4	41.6
77/78	443.2	21.5	50.6
78/79	519.9	17.3	59.3
79/80	594.9	14.4	67.9
80/81	666.2	12.0	76.0
81/82	749.8	12.5	85.6
82/83	852.8	13.7	97.3
83/84	950.0	11.4	108.4
84/85	1,076.2	13.3	122.9
85/86	1,176.6	9.3	134.3
86/87	1,251.9	6.4	142.9
87/88	1,292.5	3.2	147.5
88/89	1,292.1	0.5	148.3
89/90	1,309.4	0.8	149.5
90/91	1,310.2	0.1	149.6

Average growth rate: 7.0% (last 10 years:1980/81 - 90/91)
2.2% (last 5 years:1985/86 - 90/91)

(Source : SONEL)

Table 4.4.3 Historical Energy Consumption by Consumers

(I) By Consumer Category

(Unit:GWh)

Year	HT Consumers	MT Consumers	LT Consumers	Totals	Increase Rate (%)
1975/76	985.4	164.4	148.7	1,298.5	-
76/77	909.5	188.6	166.9	1,265.0	-2.6
77/78	807.4	212.4	189.7	1,209.5	-4.4
78/79	835.8	261.2	220.8	1,317.8	9.0
79/80	759.8	279.9	255.5	1,295.2	-1.7
80/81	952.4	302.7	282.2	1,537.3	18.7
81/82	1,352.8	314.3	350.6	2,017.7	31.2
82/83	1,265.1	368.3	393.8	2,027.2	0.5
83/84	1,186.2	380.3	395.1	1,961.6	-3.2
84/85	1,285.6	435.9	439.6	2,161.1	10.2
85/86	1,296.5	472.1	478.6	2,247.2	4.0
86/87	1,174.7	488.5	533.7	2,196.9	-2.2
87/88	1,240.1	482.0	550.8	2,272.9	3.5
88/89	1,368.9	482.3	545.0	2,396.2	5.4
89/90	1,385.1	475.4	547.9	2,408.4	0.5
90/91	1,381.6	396.5	573.5	2,351.6	-2.4
Average growth: rate (last 10 years):	3.8%	2.7%	7.3%	4.3%	(80/81-90/91)

(II) By HT Consumers

Year	Alucam	Socatral	Cellu-cam	Cimen-cam	*Sonara **Cicam	Total
1979/80	736.2	14.8	8.9	-	-	759.9
80/81	861.6	14.7	72.9	-	*3.2	952.4
81/82	1,264.6	12.0	67.7	-	*8.6	1,352.8
82/83	1,174.9	12.5	53.9	17.8	*6.0	1,265.1
83/84	1,125.2	13.6	11.8	29.1	*6.4	1,186.2
84/85	1,221.9	13.2	9.9	32.5	*8.1	1,285.6
85/86	1,228.9	14.5	8.9	36.4	*7.7	1,296.5
86/87	1,113.4	14.0	4.6	35.1	*7.5	1,174.7
87/88	1,188.0	10.5	3.8	30.7	*7.1	1,240.1
88/89	1,315.5	11.4	3.4	28.1	*10.6	1,368.9
89/90	1,316.3	11.8	2.9	27.8	**26.2	1,385.1
90/91	1,317.8	12.5	2.7	26.1	**22.4	1,381.6
Share(90/91)	95.4%	0.9%	0.2%	1.9%	1.6%	100%
Average growth rate: (82/83 - 90/91)	1.4%	0.0%	-31.2%	4.9%	** -14.5%	1.1%

* South interconnected system
** North interconnected system

(Source: SONEL)

Table 4.4.4 Loss of Energy (1)

(I) LT & MT Consumers (Public Sector)

(a) South Interconnected Network

Year	Public Sector Production (GWh)	Public Sector Consumption (GWh)	Loss of Energy (GWh)	Loss of Energy (%)
1979/80	534.3	475.7	58.6	11.0
80/81	597.7	519.2	78.5	13.1
81/82	673.1	593.5	79.6	11.8
82/83	767.4	681.3	86.1	11.2
83/84	841.6	675.6	166.0	19.7
84/85	958.5	764.7	193.8	20.2
85/86	1,051.3	825.5	225.8	21.5
86/87	1,126.7	899.9	226.8	20.1
87/88	1,163.4	910.7	252.7	21.7
88/89	1,174.0	905.8	268.2	22.8
89/90	1,190.4	907.4	283.0	23.8
90/91	1,193.3	880.2	313.1	26.2

(b) North Interconnected Network

Year	Public Sector Production (GWh)	Public Sector Consumption (GWh)	Loss of Energy (GWh)	Loss of Energy (%)
1979/80	60.6	59.7	0.9	1.5
80/81	68.5	65.8	2.7	3.9
81/82	76.7	71.4	5.3	6.9
82/83	85.4	80.8	4.6	5.4
83/84	108.3	99.8	8.5	7.8
84/85	117.7	110.8	6.9	5.9
85/86	125.3	120.6	4.7	3.8
86/87	125.1	122.3	2.8	2.2
87/88	129.1	122.1	7.0	5.4
88/89	125.1	121.5	3.6	2.9
89/90	119.0	115.9	3.1	2.6
90/91	116.9	89.8	27.1	23.2*

Note: Reason of energy loss increase in 1990/91 is unkown.

Table 4.4.4 Loss of Energy (2)

(c) Total (South + North Interconnected Network)

Year	Public Sector Production (GWh)	Public Sector Consumption (GWh)	Loss of Energy (GWh)	Loss of Energy (%)
1979/80	594.9	535.4	59.5	10.0
80/81	666.2	585.0	81.2	12.2
81/82	749.8	664.9	84.9	11.3
82/83	852.8	762.1	90.7	10.6
83/84	949.9	775.4	174.5	18.4
84/85	1,076.2	875.4	200.7	18.6
85/86	1,176.6	946.1	230.5	19.6
86/87	1,251.8	1,022.2	229.6	18.3
87/88	1,292.5	1,032.8	259.7	20.1
88/89	1,299.1	1,027.3	271.8	20.9
89/90	1,309.4	1,023.3	286.1	21.8
90/91	1,310.2	970.0	340.2	26.0

(II) HT Consumers

Year	Total Production (GWh)	Public Sector Production (GWh)	*HT Production (GWh)	HT Consumption (GWh)	Loss of Energy (%)
1979/80	1,387.9	594.9	793.0	759.9	4.2
80/81	1,655.1	666.2	988.9	952.4	3.7
81/82	2,147.6	749.8	1,397.8	1,352.8	3.2
82/83	2,160.5	852.8	1,307.7	1,265.1	3.3
83/84	2,156.6	949.9	1,206.7	1,186.2	1.7
84/85	2,383.3	1,076.2	1,307.1	1,285.6	1.6
85/86	2,496.9	1,176.6	1,320.3	1,296.5	1.8
86/87	2,461.0	1,251.8	1,209.1	1,174.7	2.9
87/88	2,553.9	1,292.5	1,261.4	1,240.1	1.7
88/89	2,690.2	1,299.1	1,391.1	1,368.9	1.6
89/90	2,702.3	1,309.4	1,392.9	1,385.1	0.6
90/91	2,707.7	1,310.2	1,397.5	1,381.6	0.9

Note:- Figures marked with asterisk (*) are estimated values.
Energy loss of HT consumers is assumed to be 2.0 %, referring to the past trend.

Table 4.4.4 Loss of Energy (3)

(III) All Consumers (LT + MT + HT Consumers)

Year	Total Production (GWh)	Total Consumption (GWh)	Loss of Energy (GWh)	Loss of Energy (%)
1975/76	1,341.1	1,298.4	42.7	3.3
76/77	1,310.6	1,265.0	45.6	3.6
77/78	1,276.1	1,209.5	66.6	5.5
78/79	1,384.8	1,317.8	67.0	5.1
79/80	1,387.9	1,295.2	91.7	7.1
80/81	1,655.1	1,537.3	117.8	7.7
81/82	2,147.6	2,017.7	129.9	6.4
82/83	2,160.5	2,027.2	133.3	6.6
83/84	2,156.6	1,961.6	195.0	9.9
84/85	2,383.3	2,161.1	222.2	10.3
85/86	2,496.9	2,247.2	249.7	11.1
86/87	2,461.0	2,196.9	264.1	12.0
87/88	2,553.9	2,272.9	281.0	12.4
88/89	2,690.2	2,396.2	294.0	12.3
89/90	2,702.3	2,408.5	293.8	12.2
90/91	2,707.7	2,351.6	356.1	13.2

(Source : SONEL)

Table 4.4.5 Population in Cameroon (1)

(I) **Total Population**

Year	Total Population	Growth Rate	
		Yearly	1975/76-90/91
1975/76	7,603,924	2.47 %	-
76/77	7,793,921	2.50 %	
77/78	7,989,918	2.50 %	
78/79	8,188,916	2.50 %	
79/80	8,393,915	2.50 %	
80/81	8,603,914	2.50 %	
81/82	8,827,909	2.60 %	
82/83	9,046,000	2.47 %	
83/84	9,468,500	4.67 %	
84/85	9,933,823	4.91 %	
85/86	10,306,447	3.75 %	
86/87	10,821,746	5.00 %	
87/88	11,181,035	3.33 %	
88/89	-	-	
89/90	-	-	
90/91	12,243,700	3.07 %	3.22 % ≈ 3.2%

Source: (1)Data for 1975/76 to 1980/81 - Annuaire Statistique du Cameroun 1983
(2)Data for 1981/82 to 1987/88 - Cameroun in Figure 1984, 1987, 1988
(3)Data for 1990/91 - Perspective de ;l'Economie Camerounaise a l'Horizon 1991

Table 4.4.5 Population in Cameroon (2)

(II) Region-wise Population

	Provincial Region	1975/76	1990/91	Growth rate
1.	Centre	1,177,125	2,979,500	6.39 %
2.	South	315,297	451,200	2.42 %
3.	East	366,562	530,400	2.49 %
4.	Littoral	935,457	2,255,200	6.04 %
5.	West	1,035,920	1,490,400	2.45 %
6.	South-west	620,709	942,500	2.82 %
7.	North-west	978,030	1,351,800	2.18 %
South Network		5,429,100	10,001,000	4.16 %
8.	North	479,306	672,900	2.29 %
9.	Far-North	1,395,194	1,098,600	- 1.58 %
10.	Adamaoua	359,445	471,200	1.02 %
North Network		2,233,945	2,242,700	0.03 %
TOTAL		7,663,045	12,243,700	3.17 % ≈ 3.20 %

Source: (3) Data for 1990/91 - Perspective de ;l'Economie Camerounaise a l'Horizon 1991

(4) Data for 1986/87 - Situation et Perspectives Demographiques du Cameroun (Resume), September 1990

Note: There is slight difference in 1975/76 population between data sources (1) and (4), but the difference is minor in terms of assessing the population growth ratio.

Table 4.4.6 Estimation of Electrification

Provincal Region	1986/87 No. of consu-mers	No. of popula-tion	No. of House-hold	Share of Electri-fication	1990/91 No. of consu-mers	No. of popula-tion	No. of House-hold	Share of Electri-fication
1) Centre	63,225	1,651,600	217,316	29.1 %	82,142	2,979,500	392,039	21.0 %
2) South	6,505	373,798	49,184	13.2 %	9,333	451,200	59,368	15.7 %
3) East	5,595	517,198	68,052	8.2 %	5,738	530,400	69,789	8.2 %
DRCSE	75,325	2,542,596	334,552	22.5 %	97,213	3,961,100	521,197	18.6 %
4) Littoral	91,636	1,352,833	178,004	51.5 %	113,670	2,255,200	296,737	38.3 %
5) West	28,481	1,339,791	176,288	16.2 %	37,939	1,490,400	196,105	19.3 %
DRLO	120,117	2,692,624	354,293	33.9 %	151,609	3,745,600	492,842	30.8 %
6) South-west	14,326	838,042	110,269	13.0 %	22,048	942,500	124,013	17.8 %
DRSO	14,326	838,042	110,269	13.0 %	22,048	942,500	124,013	17.8 %
7) North-west	14,187	1,237,348	162,809	8.7 %	20,022	1,351,800	177,868	11.3 %
DRNO	14,187	1,237,348	162,809	8.7 %	20,022	1,351,800	177,868	11.3 %
South Network	223,955	7,310,610	961,922	23.3 %	290,892	10,001,000	1,315,921	22.1 %
8) North	8,739	832,165	109,495	8.0 %	10,895	672,900	88,539	12.3 %
9) Far-North	8,968	1,855,695	244,170	3.7 %	12,030	1,098,600	144,553	8.3 %
10) Ada-maoua	6,067	485,185	65,156	9.3 %	7,414	471,200e	62,000	12.0 %
DRNEA	23,744	3,173,045	418,822	5.7 %	30,339	2,242,700	295,092	10.3 %
North Network	23,744	3,173,045	418,822	5.7 %	30,339	2,242,700	295,092	10.3 %
TOTAL	247,729	10,483,655	1,379,428	18.0 %	321,231	12,243,700	1,611,013	19.9 %

Note: (1) Domestic consumer is composed of FC, UD and UDG consumesrs in terms of tariff category.

(2) Number of person per household is assumed to be 7.6 persons for tentative estimation of electrification ratio, as referred to Clause 2.2.

(3) Number of population is quoted from "DNR, DENO87" for 1986/87 and "Perspective de l'Economie Camerounaise l'Horizon 1991" for 1990/91.

Table 4.4.7 Number of Consumers (1)

(I) LT Consumers by Regions

Provincial Region	Number of Consumers 1979/80	1984/85	1989/90	1990/91	Per capita Consumption (kWh)
1) Centre	32,211	50,496	84,074	85,815.(25.4%)	50.0
2) South	3,419	5,379	9,554	9,738 (2.9%)	29.6
3) East	2,237	4,774	6,907	6,055 (1.8%)	13.4
DRCSE	37,867	60,649	100,535	101,608 (30.1%)	42.8
4) Littoral	49,859	81,214	116,095	121,025 (35.8%)	128.1
5) West	9,814	18,984	38,341	39,836 (11.8%)	20.1
DRLO	59,673	100,198	154,436	160,861 (47.6%)	85.1
6) South-west	7,412	11,326	18,800	22,505 (6.7%)	25.6
DRSO	7,412	11,326	18,800	22,505 (6.7%)	25.6
7) North-west	3,858	8,945	20,899	20,580 (6.1%)	9.0
DRNO	3,858	8,945	20,899	20,580 (6.1%)	9.0
South Network	108,810	181,118	294,670	305,554 (90.5%)	52.5
8) North	3,494	6,887	11,492	11,819 (3.5%)	34.7
9) Far-north	3,375	6,361	12,286	12,562 (3.7%)	14.6
10) Adamaoua	2,358	5,026	7,779	7,915 (2.3%)	20.2
DRNEA	9,227	18,274	31,557	32,296 (9.5%)	21.8
North Network	9,227	18,274	31,557	32,296 (9.5%)	21.8
TOTAL	118,037	199,392	326,227	337,850 (100%)	46.8

Note:- DRCSE : Regional Delegation of Centre, South and East.

DRLO : Regional Delegation of Littoral and West.

DRSO : Regional Delegation of South-west.

DRNO : Regional Delegation of North-west.

DRNEA : Regional Delegation of North, Far-North and Adamaoua.

Table 4.4.7 Number of Consumers (2)

(II) MT Consumers

(a) By Regions

Provincial Region	Number of Consumers				Per capita Consumption
	1979/80	1984/85	1989/90	1990/91	(kWh)
1) Centre	84	140	189	199 (17.5%)	32.4
2) South	15	16	32	36 (3.2%)	23.1
3) East	7	12	21	18 (1.6%))	4.2
DRCSE	106	168	242	253 (22.3%)	27.6
4) Littoral	308	464	563	561 (49.4%)	89.8
5) West	54	75	108	100 (8.8%)	12.2
DRLO	362	539	671	661 (58.2%)	58.9
6) South-west	43	56	67	67 (5.9%)	23.8
DRSO	43	56	67	67 (5.9%)	23.8
7) North-west	10	19	34	31 (2.7%)	2.4
DRNO	10	19	34	31 (2.7%)	2.4
South Network	521	782	1014	1012 (89.1%)	35.5
8) North	21	42	54	55 (4.8%)	40.6
9) Far-North	18	25	44	47 (4.1%)	8.6
10) Adamaoua	12	19	22	22 (2.0%)	8.9
DRNEA	51	86	120	124 (10.9%)	18.3
North Network	51	86	120	124 (10.9%)	18.3
TOTAL	572	868	1,134	1,136 (100%)	32.4

Table 4.4.7 Number of Consumers (3)

(b) By Load Centers

(As of 1990/91)

Center No.	Name of Center	No. of M.T. Consumers	Consumption (MWh)	Revenue from Consumption (Mil. FCFA)	Total Revenue (Mil. FCFA)
11	Sect Urban de Douala	-	-	-	-
	Total Exploitation (Sect Urban de Douala)	-	-	-	-
12	Sect Urban de Yaounde	171	6,025.9	206.50	278.81
	Total Exploitation (Sect Urban de Yaounde)		6,025.9	206.50	278.81
146	Bertoua	9	94.2	3.12	3.77
155	Batouri	3	26.0	0.91	1.12
156	Nanga Eboko	2	15.7	0.55	0.65
159	Abong Mbang	6	21.4	0.75	1.14
181	Betare-Oya	-	-	-	-
188	Yokadouma	1	4.1	0.15	0.18
193	Belamo	-	-	-	-
203	Mbandjock	1	2.4	0.08	0.11
	Total Exploitation (Sect Interdepart Est)	22	163.8	5.56	6.97
108	Yaounde Rural	3	13.1	0.46	1.72
109	Makak	3	13.2	0.46	0.62
145	Eseka	4	60.8	2.12	2.40
147	Akonolinga	3	15.4	0.54	0.24
153	Bafia	4	32.6	1.14	1.41
160	Obala	3	23.2	0.78	0.87
172	Monatele	1	5.5	0.19	0.22
	Total Exploitation (Sect Interdepart Yaounde Ext.)	21	163.8	5.69	7.48
120	Ambam	1	3.4	0.12	0.16
121	Djoum	-	-	-	-
125	Mbalmayo	6	654.4	22.11	24.38
137	Sangmelina	9	95.8	3.34	4.99
138	Ebolowa	8	101.9	3.34	4.23
	Total Exploitation (Sect Interdepart Sud)	24	855.5	28.91	33.76
	Total Delegation (DRCSE)		7,209.0	246.66	327.02
105	Ngambe	-	-	-	-
123	Kribi	15	905.5	30.58	33.23
124	Edea	-	-	-	-
154	Yabassi	-	-	-	-
	Total Exploitation (Sect Interdepart Littoral)	-	-	-	-
114	Dshang	9	91.6	3.18	6.32
115	Foumban	7	26.4	0.92	1.42
116	B'Fssam Ville	30	975.5	33.41	38.41
117	Bafang	23	74.3	2.59	3.82
122	B'Fssam Rural	8	133.9	4.43	5.23
135	Foumbot	3	31.3	1.09	1.73
136	Mbouda	3	40.2	1.40	1.68
148	Bangante	8	98.9	3.22	3.68
201	Ndikinimeki	2	3.5	0.12	0.32
	Total Exploitation (Sect Interdepart Ouest)	93	1,475.6	50.36	62.61

Table 4.4.7 Number of Consumers (4)

Center No.	Name of Center	No. of M.T. Consumers	Consumption (MWh)	Revenue from Consumption (Mil. FCFA)	Total Revenue (Mil. FCFA)
113	Nkongsame	-	-	-	-
127	Mbanga	-	-	-	-
128	Loum	-	-	-	-
134	Manjo	-	-	-	-
140	Souza	-	-	-	-
	Total Exploitation (Sect Depart Moungo)		-	-	-
	Total Delegation (DRLO)		-	-	-
118	Maroua	27	406.1	13.97	16.68
139	Yagoua	5	105.9	3.56	5.23
144	Mokolo	3	20.8	0.73	0.85
157	Kousseri	4	40	1.38	1.64
158	Mora	1	3.5	0.12	0.21
192	Kaele	2	5.4	0.19	0.69
	Total Exploitation (Sect Interdepart Ext. Nord)		581.7	19.95	25.3
126	Ngaoundere	18	232.1	8.00	9.51
131	Meiganga	2	7	0.24	0.84
150	Banyo	1	3.7	0.13	0.76
170	Tibati	-	-	-	-
191	Tignere	-	-	-	-
	Total Exploitation (Sect Depart Adamaoua)		242.8	8.37	11.11
102	Tcholire	4	12.3	0.43	0.39
103	Touboro				
119	Garoua	41	3,324.6	89.53	98.25
143	Guider	6	40.7	1.42	2.01
153	Poli				
	Total Exploitation (Sect Interdepart Garoua)		3,377.6	91.38	100.65
	Total Delegation (DRN)		4,202.1	119.70	137.06
173	Limbe	17	687.3	23.76	27.17
174	Tiko	12	512.7	17.46	19.88
175	Buea	14	164.6	5.55	6.46
176	Kumba	10	117.2	4.01	4.82
178	Muyuka	10	119.3	4.10	4.71
179	Mamfe	3	32.6	1.13	1.34
190	Mumdemba	-	-	-	-
	Total Exploitation (Sect Interdep. Sud Ouest)		1,633.7	56.01	64.38
177	Bamenda	18	206.0	6.99	8.57
180	Nkambe	3	38.3	1.34	1.57
183	Kumbo				
184	Wum	3	14.6	0.51	0.82
202	Ndop	1	10.1	0.36	0.45
	Total Exploitation (Sect Interdep. Nord Ouest)		269.0	9.20	11.41
	Total Siege		10,214.1	325.66	416.71

* Calculation results of the case excluding "A" Sect Interdept. Sud Ouest.

Table 4.4.7 Number of Consumers (5)

(III) HT Consumers

(A) Outline

	Name of manufacturer	Kind of manufacture	Location	Province	Contract capacity (MW)
1)	Alucam	Aluminium refinery	Edea	Littoral	145
2)	Socatral	Aluminium product	do.	do.	3.15
3)	Cellucam	Paper mill	do.	do.	2.5
4)	Cimencam	Cement factory	Douala	do.	6.7
5)	Cicam	Textile factory	Garoua	North	2.5
	Total				158.85
6)	Cimenterie (not yet start for operation)	Cement factory	Yaounde	Centre	-

(B) Historical Peak Power and Consumption of Alucam and Socatral at Edea

Year	Alucam (GWh)	Socatral (GWh)	Total (GWh)	Average Power (MW)	Peak Power (MW)	Load Factor (%)
1979/80	736.2	14.8	751.0	85.7	110.2	77.8
80/81	861.6	14.7	876.3	100.0	168.5	59.3
81/82	1,264.6	12.0	1,276.6	145.7	190.5	76.5
82/83	1,174.9	12.5	1,187.4	135.5	172.6	78.5
83/84	1,125.2	13.6	1,138.8	130.0	161.6	80.4
84/85	1,221.9	13.2	1,235.1	141.0	160.6	87.8
85/86	1,228.9	14.5	1,243.4	141.9	161.1	88.1
86/87	1,113.4	14.0	1,127.4	128.7	150.0	85.8
87/88	1,188.0	10.5	1,198.5	136.8	169.0	80.9
88/89	1,315.5	11.4	1,326.9	151.5	166.0	91.3
89/90	1,316.3	11.8	1,328.1	151.6	168.0	90.2
90/91	1,317.8	12.5	1,330.3	151.9	166.0	91.5

Note:-

1) Both Alucam and Socatral are supplied directly from Edea No. II power station.

2) The above peak power are recorded for Alucam and the other consumers than the above seem to be considered in peak power for public sector owing to direct connection to the network.

Table 4.4.8 Sales Amount and Number of Customers in Cameroon

Year	Income (F.CFA million)						Number of Consumers		
	HT	MT	LT	Subtotal	Other revenue	Total	HT	MT	LT
1975	1,291	2,206	3,323	6,820	832	7,652	2	334	57,792
1976	1,267	2,515	3,867	7,649	925	8,574	2	386	70,497
1977	1,332	6,304	5,483	10,346	1,599	11,945	2	410	78,427
1978	1,326	8,224	6,304	11,608	1,629	13,237	2	471	91,385*
1979	1,384	5,146	8,224	14,754	1,950	16,704	3	503	103,572*
1980	1,509	5,852	9,561	16,922	1,997	18,919	4	570	118,037*
1981	2,565	6,265	10,614	19,444	3,629	23,073	4	620	132,822*
1982	4,103	6,717	13,285	24,105	3,898	28,003	4	708	148,028*
1983	4,248	9,523	16,142	29,913	4,738	34,651	5	822	175,622*
1984	4,851	10,032	17,611	32,494	5,589	38,083	5	811	181,510*
1985	5,118	11,505	19841	36,464	5,861	42,325	5	878	199,392*
1986	5,320	13,771	23,009	42,100	5,901	48,001	5	941	234,816*
1987	5,569	14,393	26,156	46,118	6,869	52,987	5	1,013	260,791*
1988	5,661	14,589	27,596	47,846	5,667	53,515	5	1,121	282,923*
1989	6,125	14,449	26,889	47,463	4,233	51,696	5	1,127	302,291*
1990	7,399	17,542	29,695	54,636	-	-	5	1,134	326,227
1991	7,624	15,679	32,393	55,696	-	-	5	1,136	337,850

Sources: Compte Rendu de Gestion, 1971/72, 1973/74, 1975/76, 1976/77, 1977/78, 1978/79, 1979/80, 1980/81, 1981/82, 1983/84, 1984/85, 1986/87, 1988/89, 1989/90

(*) : Compte Rendu de Gestion - Statistique Analytique-, 1977/78 - 1988/89

Note: Other revenue includes connecting services, supplies of material and sundry services.

H.T.: High tension,

M.T.: Medium tension

L.T.: Low tension

Table 4.4.9 Tariff System (1)

(As of May 1993)

I. LOW VOLTAGE POWER CONSUMERS

The following tariffs are applied in the whole territory of Cameroon:

1. *Lighting*

- Requested capacity lower or equal to 0.66 kVA:	47.70 F/kWh
- Requested capacity over 0.66 kVA:	56.70 F/kWh

2. *Domestic Use*

Power supply for air conditioning, water-heaters, electric cookers and washing machines, according to the quantity of energy consumed as measured by a special meter: 42.30 F/kWh.

3. *Power for Engines*

For all purposes: 42.30 F/kWh.

4. *Public Lighting*

Tarrifs applied to all power consumed between 6:30 pm and 6:00 am: 28.80 F/kWh.

II. MDIUM VOLTAGE POWER CONSUMERS

1. *Fixed rate:*

7,900 CFAF for each kW of requested capacity.

2. *Proportional tax per kW consumed*

By portions of monthly utilization hours of requested capacity:

- 1st portion:	from 0 to 200 hours	35.00 F
- 2nd portion:	from 201 to 325 hours	32.00 F
- 3rd portion:	from 326 to 450 hours	29.00 F
- 4th portion:	more than 450 hours	27.00 F

Source: Decree of the Ministry of Industrial and Commercial Development (May 10, 1993)

Table 4.4.9 Tariff System (2)

(As of May 1993)

III. HIGH VOLTAGE POWER CONSUMERS

1. Fixed rate:

The rate is determined in acordance with the number of hours of utilization of requested capacity per year as follows:

- from 0 to 3,900 hours: 13,517 F/kWh
- from 3,901 to 5,400 hours: 9,412 F/kWh
- from 5,401 to 6,600 hours: 4,707 F/kWh
- over 6,600 hours: no charge

2. Proportional tax per kW consumed

The tax is determined in accordance with the number of hours of utilisation of requested capacity per month as follows:

- from 0 to 200 hours: 23.53 F/kWh
- from 201 to 325 hours: 21.18 F/kWh
- from 326 to 450 hours: 16.47 F/kWh
- over 450 hours: 11.95 F/kWh

Source: Decree of the Ministry of Industrial and Commercial Development (May 10, 1993)

Table 4.5.1 Energy and Power Forecast for Public Sector (1)

(Trend Method; As per Projected by SONEL in 1989/90)

(I) South Interconnected Network

Year	Energy Production (GWh)	Growth Rate (%)	Peak Power (MW)	Average Power (MW)	Load Factor (%)
1989/90	1,218.4	3.8	236.5	139.1	58.8
90/91	1,264.5	do.	249.9	144.3	57.8
91/92	1,312.3	do.	264.0	149.8	56.7
92/93	1,361.9	do.	278.9	155.5	55.7
93/94	1,413.4	do.	294.7	161.3	54.7
94/95	1,466.9	do.	311.4	167.5	53.8
95/96	1,522.4	do.	329.1	173.8	52.8
96/97	1,579.9	do.	347.7	180.3	51.9
97/98	1,639.7	do.	367.4	187.2	50.9
98/99	1,701.7	do.	388.2	194.3	50.0
Average annual growth:	3.8%		5.6%	(last 3 years: 1985/86 - 88/89)	

Note:- Figures for public sector do not include HT consumers.

(II) North Interconnected Network

Year	Energy Production (GWh)	Growth Rate (%)	Peak Power (MW)	Average Power (MW)	Load Factor (%)
1989/90	127.0	1.6	24.5	14.5	59.2
90/91	129.1	do.	25.7	14.7	57.3
91/92	131.1	do.	26.9	15.0	55.6
92/93	133.2	do.	28.2	15.2	53.9
93/94	135.3	do.	29.2	15.4	52.8
94/95	137.4	do.	31.0	15.6	50.6
95/96	139.6	do.	32.4	15.9	49.2
96/97	141.8	do.	34.0	16.2	47.6
97/98	144.1	do.	35.6	16.4	46.2
98/99	146.4	do.	37.3	16.7	44.8
Average annual growth :	1.6%		4.8%	(last 4 years: 1984/85 - 88/89)	

Note:- Figures for public sector do not include HT consumers since no HT consumers has been supplied in North network up to 1988/89.

(Source : SONEL, DE)

Table 4.5.1 Energy and Power Forecast for Public Sector (2)

(Trend Method; As per Projected by SONEL in 1989/90)

(III) Total Demand (South + North Network)

Year	Energy Production (GWh)	Growth Rate (%)	Average Power (MW)
1989/90	1,345.5	4.1	153.6
90/91	1,393.5	3.6	159.1
91/92	1,443.4	3.6	164.8
92/93	1,495.1	3.6	170.7
93/94	1,548.7	3.6	183.1
94/95	1,604.3	3.6	183.1
95/96	1,662.0	3.6	189.7
96/97	1,721.7	3.6	196.5
97/98	1,783.7	3.6	203.6
98/99	1,848.0	3.6	211.0

Average annual growth : 3.6%

(Source : SONEL, DE)

Table 4.5.2 Energy and Power Demand Forecast for Public Sector (1)

(Micro Method; As per Projected by SONEL in 1989/90))

(I) South Interconnected Network

(A) Medium (Niveau) Growth Forecast

Year	Energy Production			Growth Rate	Average Power	Peak Power
	LT (GWh)	MT (GWh)	TOTAL (GWH)	(%)	(MW)	(MW)
1990/91	589.2	603.0	1,192.2	-	136.1	224.8
91/92	617.2	609.5	1,226.7	2.90	140.0	231.5
92/93	646.5	616.3	1,262.8	2.94	144.2	238.3
93/94	677.2	623.3	1,300.5	2.99	148.5	245.4
94/95	709.4	630.5	1,339.9	3.03	153.0	252.8
95/96	743.1	638.0	1,381.1	3.07	157.7	260.6
96/97	778.4	645.7	1,424.1	3.11	162.6	268.7
97/98	815.4	653.7	1,469.0	3.16	167.7	277.2
98/99	854.1	661.9	1,516.0	3.20	173.1	286.7
99/00	894.7	687.4	1,582.1	4.36	180.6	298.5
2000/01	1,032.5	707.0	1,739.5	9.95	198.6	328.2
01/02	1,057.9	727.1	1,785.0	2.62	203.8	336.6
02/03	1,083.9	747.9	1,831.8	2.62	209.1	345.6
03/04	1,110.6	769.2	1,879.8	2.62	214.6	354.7
04/05	1,137.9	791.3	1,929.2	2.63	220.2	364.0
05/06	1,165.9	814.0	1,979.9	2.63	226.0	373.6
06/07	1,194.6	837.4	2,032.0	2.63	232.0	383.4
07/08	1,224.0	861.5	2,085.5	2.63	238.1	393.5
08/09	1,254.1	886.4	2,140.5	2.64	244.3	403.9
09/10	1,284.9	912.0	2,197.0	2.64	250.8	414.5
10/11	1,316.5	938.4	2,255.0	2.64	257.4	425.5
11/12	1,348.9	965.7	2,314.6	2.64	264.2	436.7
12/13	1,382.1	993.7	2,375.8	2.65	271.2	448.3
13/14	1,416.1	1,022.6	2,438.8	2.65	278.4	460.1
14/15	1,450.9	1,052.5	2,503.4	2.65	285.8	472.3

Note:- Figures of MT demand include 3 HT consumers, Cimencam, Cellucam and Sonara (now, MT consumer).

(Source: SONEL, DSG)

Table 4.5.2 Energy and Power Demand Forecast for Public Sector (2)

(Micro Method; As per Projected by SONEL in 1989/90))

(B) Low (Moyenne) Growth Forecast

Year	Energy Production			Growth Rate	Average Power	Peak Power
	LT (GWh)	MT (GWh)	TOTAL (GWH)	(%)	(MW)	(MW)
1990/91	589.2	410.9	1,000.2	-	114.2	222.3
91/92	617.2	413.0	1,030.2	3.00	117.6	228.9
92/93	646.5	415.1	1,061.6	3.05	121.2	235.9
93/94	677.2	417.1	1,094.4	3.09	124.9	243.2
94/95	709.4	419.2	1,128.6	3.13	128.8	250.8
95/96	743.1	421.3	1,164.4	3.17	132.9	258.8
96/97	778.4	423.4	1,201.8	3.21	137.2	267.1
97/98	815.4	425.5	1,240.9	3.25	141.7	275.8
98/99	854.1	427.7	1,281.8	3.29	146.3	284.8
99/00	894.7	429.8	1,324.5	3.33	151.2	294.3
2000/01	1,032.5	443.6	1,476.1	11.45	168.5	328.0
01/02	1,057.9	457.8	1,515.7	2.68	173.0	336.8
02/03	1,083.9	472.4	1,556.3	2.68	177.7	345.9
03/04	1,110.6	487.5	1,598.1	2.68	182.4	355.1
04/05	1,137.9	503.1	1,641.0	2.69	187.3	364.7
05/06	1,165.9	519.2	1,685.1	2.69	192.4	374.5
06/07	1,194.6	535.8	1,730.4	2.69	197.5	384.5
07/08	1,224.0	553.0	1,777.0	2.69	202.8	394.9
08/09	1,254.1	570.7	1,824.8	2.69	208.3	405.5
09/10	1,284.9	588.9	1,873.9	2.69	213.9	416.4
10/11	1,316.5	607.8	1,924.3	2.69	219.7	427.6
11/12	1,348.9	627.2	1,976.2	2.69	225.6	439.1
12/13	1,382.1	647.3	2,029.4	2.69	231.7	451.0
13/14	1,416.1	668.0	2,084.1	2.70	237.9	463.1
14/15	1,450.9	689.4	2,140.3	2.70	244.3	475.6

Note:- Figures of MT demand include 3 HT consumers, Cimencam, Cellucam and Sonara (now, MT consumer).

(Source: SONEL, DSG)

Table 4.5.2 Energy and Power Demand Forecast for Public Sector (3)

(Micro Method; As per Projected by SONEL in 1989/90)

(II) North Interconnected Network

(A) Medium (Niveau) Growth Forecast

Year	Energy Production			Growth Rate	Average Power	Peak Power
	LT	MT	TOTAL			
	(GWh)	(GWh)	(GWH)	(%)	(MW)	(MW)
1990/91	78.1	83.6	161.7	-	18.5	29.4
91/92	80.0	84.3	164.3	1.58	18.8	29.9
92/93	82.0	84.9	166.9	1.58	19.1	30.3
93/94	84.0	85.5	169.5	1.59	19.4	30.8
94/95	86.1	86.2	172.3	1.60	19.7	31.3
95/96	88.2	86.8	175.0	1.60	20.0	31.8
96/97	90.4	87.5	177.8	1.61	20.3	32.3
97/98	92.6	88.1	180.7	1.62	20.6	32.9
98/99	94.9	88.8	183.7	1.63	21.0	33.4
99/00	97.2	89.5	186.7	1.63	21.3	33.9
2000/01	164.5	93.9	258.4	38.45	29.5	47.0
01/02	168.5	98.6	267.2	3.38	30.5	48.6
02/03	172.7	103.6	276.2	3.40	31.5	50.2
03/04	176.9	108.7	285.7	3.41	32.6	51.9
04/05	181.3	114.2	295.5	3.43	33.7	53.7
05/06	185.7	119.9	305.6	3.44	34.9	55.6
06/07	190.3	125.9	316.2	3.46	36.1	57.5
07/08	195.0	132.2	327.2	3.47	37.3	59.5
08/09	199.8	138.8	338.6	3.49	38.6	61.6
09/10	204.7	145.7	350.4	3.50	40.0	63.7
10/11	209.7	153.0	362.7	3.52	41.4	66.0
11/12	214.9	160.7	375.6	3.53	42.9	68.3
12/13	220.2	168.7	388.9	3.55	44.4	70.7
13/14	225.6	177.1	402.7	3.56	46.0	73.2
14/15	231.1	186.0	417.1	3.58	47.6	75.8

(Source: SONEL, DSG)

Table 4.5.2 Energy and Power Demand Forecast for Public Sector (4)

(Micro Method; As per Projected by SONEL in 1989/90)

(B) Low (Moyenne) Growth Forecast

Year	Energy Production			Growth Rate	Average Power	Peak Power
	LT	MT	TOTAL			
	(GWh)	(GWh)	(GWH)	(%)	(MW)	(MW)
1990/91	58.3	75.7	134.0	–	15.3	24.4
91/92	59.8	76.0	135.8	1.35	15.5	27.2
92/93	61.2	76.4	137.6	1.36	15.7	27.5
93/94	62.7	76.8	139.5	1.37	15.9	27.9
94/95	64.3	77.2	141.5	1.38	16.1	28.3
95/96	65.9	77.6	143.4	1.39	16.4	28.7
96/97	67.5	78.0	145.4	1.40	16.6	29.1
97/98	69.1	78.4	147.5	1.41	16.8	29.5
98/99	70.8	78.7	149.6	1.42	17.1	29.9
99/00	72.6	79.1	151.7	1.43	17.3	30.3
2000/01	96.2	81.7	177.9	17.23	20.3	35.6
01/02	98.6	84.3	182.8	2.80	20.9	36.6
02/03	101.0	87.0	188.0	2.80	21.5	37.6
03/04	103.5	89.8	193.2	2.80	22.1	38.6
04/05	106.0	92.6	198.6	2.80	22.7	39.7
05/06	108.6	95.6	204.2	2.81	23.3	40.8
06/07	111.3	98.7	209.9	2.81	24.0	42.0
07/08	114.0	101.8	215.8	2.81	24.6	43.2
08/09	116.8	105.1	221.9	2.81	25.3	44.4
09/10	119.7	108.4	228.1	2.81	26.0	45.6
10/11	122.6	111.9	234.6	2.81	26.8	46.9
11/12	125.7	115.5	241.2	2.81	27.5	48.2
12/13	128.8	119.2	247.9	2.81	28.3	49.6
13/14	131.9	123.0	254.9	2.82	29.1	51.0
14/15	135.2	126.9	262.1	2.82	29.9	52.4

(Source : SONEL, DSG)

Table 4.5.3 - Energy and Demand Forecast for HT Consumers

(I) South Interconnected Network

Name of Factory	Contract capacity (MW)	*1 Plant Factor (%)	*2 Required energy production (GWh)	Peak Power (MW)	Remarks
1) Alucam	145.0	100	1,296.1	145.0	
2) Socatral	3.15	50	14.1	3.15	
Sub-total (1)	148.15	-	1,310.2	148.15	For Micro method
3) Cellucam	2.5	20	4.5	2.5	
4) Cimencam	6.7	50	29.9	6.7	
Sub-total (2)	9.2	-	34.4	9.2	
TOTAL	157.35	-	1,344.6 (1375.1)	157.35 (166.0)	For Trend method

(II) North Interconnected Network

Name of Factory	Contract capacity (MW)	*1 Plant Factor (%)	*2 Required energy production (GWh)	Peak Power (MW)	Remarks
5) Cicam	2.5	100	22.3	2.5	
TOTAL	2.5	-	22.3	2.5	For both methods

Note: - 1) Each plant factor based on the contract capacity is assumed from the present trend.

2) Required energy for production includes loss of energy, assuming 2% .

3) Peak power is assumed to be summation of each contract capacity as maximum.

4) The values in the parentheses shows actual ones for South interconnected system achieved in 1990/91, which will be used for the revised demand forecast as HT consumers.

Table 4.5.4 Situation of Demand Forecast by Microscopic Method (1)

Following parameters are summarized for the demand forecast by SONEL:

(I) South Interconnected Network

	Description	Medium Forecast (Niveau)	Low Forecast (Moyenne)	Remarks
1)	Population growth	4.75 % up to 1999/00 and 2.46 % thereafter (*1)	- same as left -	4.67 % in average for past 15 years
2)	Domestic demand per capita	56.2 kWh up to 1999/00 and 63.9 kWh thereafter	- same as left -	57.3 kWh in 1986/87
3)	Average professional demand per capita (M.F. demand)	4.4 kWh	- same as left -	5.1 kWh in 1986/87
4)	MT demand (as per GDP growth)	1.09 % in 1990/91 to 2.91 % in 2014/15 (*1)	0.5 % up to 1999/00 and 3.2 % up to 2014/15.	
5)	Average load factor for public sector (LT & MT)	60.5 % (5,300 Hours)	51.4 % (4,500 Hours)	
6)	Loss of distribution	15 %	- same as left -	
7)	Others	Demand for 3 consumers (Cimencam, Cellucam & Sonara) is included in that of MT.	- same as left -	
8)	Service rate (*2)	22 % up to 1999/00 and 25 % up to 2014/15.	- same as left -	

Note:- (1) The figures quoted from SONEL's Data prevail over that of parameters owing to some discrepancy between them. Some of parameters are revised accordingly.

(2) It seems that "Service rate" means share of electrification.

Table 4.5.4 Situation of Demand Forecast by Microscopic Method (2)

(II) North Interconnected Network

	Description	Medium Forecast (Niveau)	Low Forecast (Moyenne)	Remarks
1)	Population growth	2.46 % up to 2014/15	- same as left -	0.47 % in average for past 15 years
2)	Domestic demand per capita	22.9 kWh up to 1999/00 and 37.8 kWh thereafter	16.7 kWh up to 1999/00 and 20.6 kWh thereafter	12.1 kWh in 1986/87
3)	Average professional demand per capita (M.F. demand)	2.8 kWh up to 1999/00 and 4.6 kWh thereafter	2.5 kWh up to 1999/00 and 4.2 kWh thereafter	1.0 kWh in 1986/87
4)	MT demand (as per GDP growth)	0.75 % up to 1999/00 and 5.0 % up to 2014/15.	0.5 % up to 1999/00 and 3.2 % up to 2014/15.	
5)	Average load factor for public sector (LT & MT)	62.8 % (5,000 Hours) (*1)	57.1 % (4,500 hrs)	
6)	Loss of distribution	10 % for MT and 3 % for LT	- same as left -	
7)	Service rate (*2)	8 % up to 1999/00 and 9 % up to 2014/15.	- same as left -	

Note:- (1) The figures quoted from SONEL's Data prevail over that of parameters owing to some discrepancy between them. Some of parameters are revised accordingly.

(2) It seems that "Service rate" means share of electrification.

Table 4.5.5 Forecast of Energy and Peak Power (1)

(By Trend Method: Load factor as per assumed by SONEL)

(I) South Network

Year	Public sector (*1)			HT consumers (*3)		Total		
	Energy Production (GWh)	Peak Power (MW)	Load Factor (%)	Energy Production (GWh)	Peak Power (MW)	Energy Production (GWh)	Peak Power (MW)	Load Factor (%)
88/89	1,174.0	223.8	59.9	1,368.8	166.0	2,542.8	389.8	74.5
1989/90	1,218.4	236.5	58.8	1,344.6	157.4	2,563.0	393.9	74.3
90/91	1,264.5	249.9	57.8	1,344.6	157.4	2,609.1	407.3	73.1
91/92	1,312.3	264.0	56.7	1,344.6	157.4	2,656.9	421.4	72.0
92/93	1,361.9	278.9	55.7	1,344.6	157.4	2,706.5	436.3	70.8
93/94	1,413.4	294.7	54.7	1,344.6	157.4	2,758.0	452.1	69.6
94/95	1,466.9	311.4	53.8	1,344.6	157.4	2,811.5	468.8	68.5
95/96	1,522.4	329.1	52.8	1,344.6	157.4	2,867.0	486.5	67.3
96/97	1,579.9	347.7	51.9	1,344.6	157.4	2,924.5	505.1	66.1
97/98	1,639.7	367.4	50.9	1,344.6	157.4	2,984.3	524.8	64.9
98/99	1,701.7	388.2	50.0	1,344.6	157.4	3,046.3	545.6	63.7
(*2)								
1999/00	1,766.4	403.0	50.0	1,344.6	157.4	3,111.0	560.3	63.4
2000/01	1,833.5	418.3	50.0	1,344.6	157.4	3,178.1	575.6	63.0
01/02	1,903.2	434.2	50.0	1,344.6	157.4	3,247.8	591.5	62.7
02/03	1,975.5	450.7	50.0	1,344.6	157.4	3,320.1	608.0	62.3
03/04	2,050.5	467.8	50.0	1,344.6	157.4	3,395.1	625.1	62.0
04/05	2,128.5	485.6	50.0	1,344.6	157.4	3,473.1	642.9	61.7
05/06	2,209.3	504.0	50.0	1,344.6	157.4	3,553.9	661.4	61.3
06/07	2,293.3	523.2	50.0	1,344.6	157.4	3,637.9	680.5	61.0
07/08	2,380.5	543.0	50.0	1,344.6	157.4	3,725.1	700.4	60.7
08/09	2,470.9	563.7	50.0	1,344.6	157.4	3,815.5	721.0	60.4
09/10	2,564.8	585.1	50.0	1,344.6	157.4	3,909.4	742.4	60.1
10/11	2,662.3	607.3	50.0	1,344.6	157.4	4,006.9	764.7	59.8
2014/15	3,090.6	705.0	50.0	1,344.6	157.4	4,435.2	862.4	58.7

Note: 1) SONEL has forecasted upto 1998/1999 according as annual load factor decreasing year by year from 59% to 50%, since increase rate of peak power is assumed as 5.7%.

2) Just for reference, same load factor in 1998/99 (50%) is used thereafter, along with the same growth rate of energy production up to 2014/15.

3) Peak power of HT consumers are assumed to be total of the contract capacities (Refer to Table 4.5.3).

Table 4.5.5 Forecast of Energy and Peak Power (2)

(By Trend Method: Load factor as per assumed by SONEL)

(II) North Network

Year	Public sector (*1)			HT consumers (*3)		Total		
	Energy Production (GWh)	Peak Power (MW)	Load Factor (%)	Energy Production (GWh)	Peak Power (MW)	Energy Production (GWh)	Peak Power (MW)	Load Factor (%)
88/89	125.1	23.4	61.0	22.3	2.5	147.4	25.9	65.0
1989/90	127.0	24.5	59.2	26.2	2.5	153.2	27.0	64.8
90/91	129.1	25.7	57.3	22.4	2.5	151.5	28.2	61.3
91/92	131.1	26.9	55.6	22.3	2.5	153.4	29.4	59.6
92/93	133.2	28.2	53.9	22.3	2.5	155.5	30.7	57.8
93/94	135.3	29.2	52.9	22.3	2.5	157.6	31.7	56.8
94/95	137.4	31.0	50.6	22.3	2.5	159.7	33.5	54.4
95/96	139.6	32.4	49.2	22.3	2.5	161.9	34.9	53.0
96/97	141.8	34.0	47.6	22.3	2.5	164.1	36.5	51.3
97/98	144.1	35.6	46.2	22.3	2.5	166.4	38.1	49.9
98/99	146.4	37.3	44.8	22.3	2.5	168.7	39.8	48.4
(*2)								
1999/00	148.7	37.9	44.8	22.3	2.5	171.0	40.4	48.3
2000/01	154.4	39.3	44.8	22.3	2.5	176.7	41.8	48.2
01/02	160.3	40.8	44.8	22.3	2.5	182.6	43.3	48.1
02/03	166.4	42.4	44.8	22.3	2.5	188.7	44.9	48.0
03/04	172.7	44.0	44.8	22.3	2.5	195.0	46.5	47.9
04/05	179.2	45.7	44.8	22.3	2.5	201.5	48.2	47.8
05/06	186.0	47.4	44.8	22.3	2.5	208.3	49.9	47.7
06/07	193.1	49.2	44.8	22.3	2.5	215.4	51.7	47.6
07/08	200.5	51.1	44.8	22.3	2.5	222.8	53.6	47.5
08/09	208.1	53.0	44.8	22.3	2.5	230.4	55.5	47.4
09/10	216.0	55.0	44.8	22.3	2.5	238.3	57.5	47.3
10/11	224.2	57.1	44.8	22.3	2.5	246.5	59.6	47.2
2014/15	260.3	66.3	44.8	22.3	2.5	282.6	68.8	46.9

Note: 1) SONEL has forecasted upto 1998/1999 according as annual load factor decreasing year by year from 59.2% to 44.8%, since increase rate of peakpower is assumed as 4.8%.

2) Just for reference, same load factor in 1998/99 (44.8%) is used thereafter, along with the same growth rate of energy production up to 2014/15.

3) Peak power of HT consumers are assumed to be total of the contract capacities (Refer to Table 4.5.3).

Table 4.5.5 - FORECAST OF ENERGY AND PEAK POWER (3)

(By Trend Method; Load factor as per assumed by SONEL)

(III) Total Demand (South+ North Network)

Year	Public sector							HT consumers						Total		
	Energy Production			Peak Power			Load Factor	Energy Production			Peak Power			Energy Production	Peak Power	Load Factor
	South (GWh)	North (GWh)	Total (GWh)	South (MW)	North (MW)	Total (MW)	(%)	South (GWh)	North (GWh)	Total (GWh)	South (MW)	North (MW)	Total (MW)	(GWh)	(MW)	(%)
88/89	1,174.0	125.1	1,299.1	223.8	23.4	247.2	60.0	1,315.5	-	1,315.5	166.0	-	166.0	2,489.5	389.8	72.9
1989/90	1,218.4	127.0	1,345.4	236.5	24.5	261.0	58.8	1,344.6	26.2	1,370.8	157.4	2.5	159.9	2,716.2	420.9	73.7
90/91	1,264.5	129.1	1,393.6	249.9	25.7	275.6	57.7	1,344.6	22.4	1,367.0	157.4	2.5	159.9	2,760.6	435.5	72.4
91/92	1,312.3	131.1	1,443.4	264.0	26.9	290.9	56.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	2,810.3	450.8	71.2
92/93	1,361.9	133.2	1,495.1	278.9	28.2	307.1	55.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	2,862.0	467.0	70.0
93/94	1,413.4	135.3	1,548.7	294.7	29.2	323.9	54.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	2,915.6	483.8	68.8
94/95	1,466.9	137.4	1,604.3	311.4	31.0	342.4	53.5	1,344.6	22.3	1,366.9	157.4	2.5	159.9	2,971.2	502.3	67.5
95/96	1,522.4	139.6	1,662.0	329.1	32.4	361.5	52.5	1,344.6	22.3	1,366.9	157.4	2.5	159.9	3,028.9	521.4	66.3
96/97	1,579.9	141.8	1,721.7	347.7	34.0	381.7	51.5	1,344.6	22.3	1,366.9	157.4	2.5	159.9	3,088.6	541.6	65.1
97/98	1,639.7	144.1	1,783.8	367.4	35.6	403.0	50.5	1,344.6	22.3	1,366.9	157.4	2.5	159.9	3,150.7	562.9	63.9
98/99	1,701.7	146.4	1,848.1	388.2	37.3	425.5	49.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	3,215.0	585.4	62.7
1999/00	1,766.4	148.7	1,915.1	403.0	37.9	440.8	49.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	3,282.0	600.7	62.4
2000/01	1,833.5	154.4	1,987.9	418.3	39.3	457.6	49.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	3,354.8	617.5	62.0
'01/02	1,903.2	160.3	2,063.4	434.2	40.8	475.0	49.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	3,430.3	634.8	61.7
'02/03	1,975.5	166.4	2,141.8	450.7	42.4	493.0	49.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	3,508.7	652.9	61.3
'03/04	2,050.5	172.7	2,223.2	467.8	44.0	511.8	49.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	3,590.1	671.6	61.0
'04/05	2,128.5	179.2	2,307.7	485.6	45.7	531.2	49.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	3,674.6	691.1	60.7
'05/06	2,209.3	186.0	2,395.4	504.0	47.4	551.4	49.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	3,762.3	711.3	60.4
'06/07	2,293.3	193.1	2,486.4	523.2	49.2	572.4	49.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	3,853.3	732.2	60.1
'07/08	2,380.5	200.5	2,580.9	543.0	51.1	594.1	49.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	3,947.8	754.0	59.8
'08/09	2,470.9	208.1	2,679.0	563.7	53.0	616.7	49.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	4,045.9	776.5	59.5
'09/10	2,564.8	216.0	2,780.8	585.1	55.0	640.1	49.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	4,147.7	800.0	59.2
'10/11	2,662.3	224.2	2,886.4	607.3	57.1	664.4	49.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	4,253.3	824.3	58.9
2014/15	3,090.6	260.3	3,350.8	705.0	66.3	771.3	49.6	1,344.6	22.3	1,366.9	157.4	2.5	159.9	4,717.7	931.2	57.8

Table 4.5.6 Forecast of Energy Production and Peak Power (1)

(By Micro Method: as per assumed by SONEL)

(I) South Network - (a) Medium (Niveau) Growth Production

Year	Public Sector Energy Production (GWh)	Public Sector Peak Power (MW)	Public Sector Load Factor (%)	HT Consumers Energy Production (GWh)	HT Consumers Peak Power (MW)	Total Energy Production (GWh)	Total Peak Power (MW)	Total Load Factor (%)
1988/89	1,174.0	223.8	59.9	1,391.1	166.0	2,565.1	389.8	75.1
89/90	1,190.4	223.2	60.9	1,366.7	168.0	2,557.1	391.2	74.6
1990/91	1,192.2	225.0	60.5	1,310.2	148.2	2,502.4	373.1	76.6
91/92	1,226.7	231.5	60.5	1,310.2	148.2	2,536.9	379.6	76.3
92/93	1,262.8	238.3	60.5	1,310.2	148.2	2,573.0	386.4	76.0
93/94	1,300.5	245.4	60.5	1,310.2	148.2	2,610.7	393.5	75.7
94/95	1,339.9	252.8	60.5	1,310.2	148.2	2,650.1	401.0	75.4
95/96	1,381.1	260.6	60.5	1,310.2	148.2	2,691.3	408.7	75.2
96/97	1,424.1	268.7	60.5	1,310.2	148.2	2,734.3	416.9	74.9
97/98	1,469.0	277.2	60.5	1,310.2	148.2	2,779.2	425.3	74.6
98/99	1,516.0	286.0	60.5	1,310.2	148.2	2,826.2	434.2	74.3
99/00	1,582.1	298.5	60.5	1,310.2	148.2	2,892.3	446.7	73.9
2000/01	1,739.5	328.2	60.5	1,310.2	148.2	3,049.7	476.4	73.1
01/02	1,785.0	336.8	60.5	1,310.2	148.2	3,095.2	485.0	72.9
02/03	1,831.8	345.6	60.5	1,310.2	148.2	3,142.0	493.8	72.6
03/04	1,879.8	354.7	60.5	1,310.2	148.2	3,190.0	502.8	72.4
04/05	1,929.2	364.0	60.5	1,310.2	148.2	3,239.4	512.2	72.2
05/06	1,979.9	373.6	60.5	1,310.2	148.2	3,290.1	521.7	72.0
06/07	2,032.0	383.4	60.5	1,310.2	148.2	3,342.2	531.6	71.8
07/08	2,085.5	393.5	60.5	1,310.2	148.2	3,395.7	541.7	71.6
08/09	2,140.5	403.9	60.5	1,310.2	148.2	3,450.7	552.0	71.4
09/10	2,197.0	414.5	60.5	1,310.2	148.2	3,507.2	562.7	71.2
10/11	2,255.0	425.5	60.5	1,310.2	148.2	3,565.2	573.6	70.9
11/12	2,314.6	436.7	60.5	1,310.2	148.2	3,624.8	584.9	70.7
12/13	2,375.8	448.3	60.5	1,310.2	148.2	3,686.0	596.4	70.5
13/14	2,438.8	460.2	60.5	1,310.2	148.2	3,749.0	608.3	70.4
2014/15	2,503.4	472.4	60.5	1,310.2	148.2	3,813.6	620.5	70.2

Note: Regarding energy production and peak power for HT consumers, please refer to Table 4.5.3.

Table 4.5.6 Forecast of Energy Production and Peak Power (2)

(By Micro Method: as per assumed by SONEL)

(I) South Network - (b) Low (Moyenne) Growth Production

Year	Public Sector			HT Consumers		Total		
	Energy Production (GWh)	Peak Power (MW)	Load Factor (%)	Energy Production (GWh)	Peak Power (MW)	Energy Production (GWh)	Peak Power (MW)	Load Factor (%)
1988/89	1,174.0	223.8	59.9	1,391.1	166.0	2,565.1	389.8	75.1
89/90	1,190.4	223.2	60.9	1,366.7	168.0	2,557.1	391.2	74.6
1990/91	1,000.2	222.3	51.4	1,310.2	148.2	2,310.4	370.4	71.2
91/92	1,030.4	229.0	51.4	1,310.2	148.2	2,340.6	377.1	70.8
92/93	1,061.4	235.9	51.4	1,310.2	148.2	2,371.6	384.0	70.5
93/94	1,094.4	243.2	51.4	1,310.2	148.2	2,404.6	391.4	70.1
94/95	1,128.6	250.8	51.4	1,310.2	148.2	2,438.8	399.0	69.8
95/96	1,164.4	258.8	51.4	1,310.2	148.2	2,474.6	406.9	69.4
96/97	1,201.8	267.1	51.4	1,310.2	148.2	2,512.0	415.2	69.1
97/98	1,240.9	275.8	51.4	1,310.2	148.2	2,551.1	423.9	68.7
98/99	1,281.8	284.8	51.4	1,310.2	148.2	2,592.0	433.0	68.3
99/00	1,324.5	294.3	51.4	1,310.2	148.2	2,634.7	442.5	68.0
2000/01	1,476.1	328.0	51.4	1,310.2	148.2	2,786.3	476.2	66.8
01/02	1,515.7	336.8	51.4	1,310.2	148.2	2,825.9	485.0	66.5
02/03	1,556.3	345.8	51.4	1,310.2	148.2	2,866.5	494.0	66.2
03/04	1,598.1	355.1	51.4	1,310.2	148.2	2,908.3	503.3	66.0
04/05	1,641.0	364.7	51.4	1,310.2	148.2	2,951.2	512.8	65.7
05/06	1,658.1	368.5	51.4	1,310.2	148.2	2,968.3	516.6	65.6
06/07	1,730.4	384.5	51.4	1,310.2	148.2	3,040.6	532.7	65.2
07/08	1,777.0	394.9	51.4	1,310.2	148.2	3,087.2	543.0	64.9
08/09	1,824.8	405.5	51.4	1,310.2	148.2	3,135.0	553.7	64.6
09/10	1,873.9	416.4	51.4	1,310.2	148.2	3,184.1	564.6	64.4
10/11	1,924.3	427.6	51.4	1,310.2	148.2	3,234.5	575.8	64.1
11/12	1,976.2	439.2	51.4	1,310.2	148.2	3,286.4	587.3	63.9
12/13	2,029.4	451.0	51.4	1,310.2	148.2	3,339.6	599.1	63.6
13/14	2,084.1	463.1	51.4	1,310.2	148.2	3,394.3	611.3	63.4
2014/15	2,140.3	475.6	51.4	1,310.2	148.2	3,450.5	623.8	63.1

Note: Regarding energy production and peak power for HT consumers, please refer to Table 4.5.3.

Table 4.5.6 Forecast of Energy Production and Peak Power (3)

(By Micro Method: as per assumed by SONEL)

(II) North Network - (a) Medium (Niveau) Growth Production

Year	Public Sector			HT Consumers		Total		
	Energy Production (GWh)	Peak Power (MW)	Load Factor (%)	Energy Production (GWh)	Peak Power (MW)	Energy Production (GWh)	Peak Power (MW)	Load Factor (%)
1988/89	125.1	23.4	61.0	22.3	2.5	147.4	25.9	65.0
89/90	118.4	21.6	62.6	26.2	2.5	144.6	24.1	68.5
1990/91	161.7	29.4	62.8	22.4	2.5	184.1	31.9	65.9
91/92	164.3	29.9	62.8	22.3	2.5	186.6	32.4	65.8
92/93	166.9	30.3	62.8	22.3	2.5	189.2	32.8	65.8
93/94	169.5	30.8	62.8	22.3	2.5	191.8	33.3	65.7
94/95	172.3	31.3	62.8	22.3	2.5	194.6	33.8	65.7
95/96	175.0	31.8	62.8	22.3	2.5	197.3	34.3	65.6
96/97	177.8	32.3	62.8	22.3	2.5	200.1	34.8	65.6
97/98	180.7	32.9	62.8	22.3	2.5	203.0	35.4	65.5
98/99	183.7	33.4	62.8	22.3	2.5	206.0	35.9	65.5
99/00	186.7	33.9	62.8	22.3	2.5	209.0	36.4	65.5
2000/01	258.4	47.0	62.8	22.3	2.5	280.7	49.5	64.8
01/02	267.2	48.6	62.8	22.3	2.5	289.5	51.1	64.7
02/03	276.2	50.2	62.8	22.3	2.5	298.5	52.7	64.6
03/04	285.7	51.9	62.8	22.3	2.5	308.0	54.4	64.6
04/05	295.5	53.7	62.8	22.3	2.5	317.8	56.2	64.5
05/06	305.6	55.6	62.8	22.3	2.5	327.9	58.1	64.5
06/07	316.2	57.5	62.8	22.3	2.5	338.5	60.0	64.4
07/08	327.2	59.5	62.8	22.3	2.5	349.5	62.0	64.4
08/09	338.6	61.6	62.8	22.3	2.5	360.9	64.1	64.3
09/10	350.4	63.7	62.8	22.3	2.5	372.7	66.2	64.3
10/11	362.7	66.0	62.8	22.3	2.5	385.0	68.5	64.2
11/12	375.6	68.3	62.8	22.3	2.5	397.9	70.8	64.2
12/13	388.9	70.7	62.8	22.3	2.5	411.2	73.2	64.1
13/14	402.7	73.2	62.8	22.3	2.5	425.0	75.7	64.1
2014/15	417.1	75.8	62.8	22.3	2.5	439.4	78.3	64.0

Note: Regarding energy production and peak power for HT consumers, please refer to Table 4.5.3.

Table 4.5.6 Forecast of Energy Production and Peak Power (4)

(By Micro Method: as per assumed by SONEL)

(II) North Network - (b) Low (Moyenne) Growth Production

Year	Public Sector			HT Consumers		Total		
	Energy Production (GWh)	Peak Power (MW)	Load Factor (%)	Energy Production (GWh)	Peak Power (MW)	Energy Production (GWh)	Peak Power (MW)	Load Factor (%)
1988/89	125.1	23.4	61.0	22.3	2.5	147.4	25.9	65.0
89/90	118.4	21.6	62.6	26.2	2.5	144.6	24.1	68.5
1990/91	134.0	24.4	62.8	22.4	2.5	156.4	26.9	66.5
91/92	135.8	27.2	57.1	22.3	2.5	158.1	29.7	60.8
92/93	137.6	27.5	57.1	22.3	2.5	159.9	30.0	60.8
93/94	139.5	27.9	57.1	22.3	2.5	161.8	30.4	60.8
94/95	141.5	28.3	57.1	22.3	2.5	163.8	30.8	60.7
95/96	143.4	28.7	57.1	22.3	2.5	165.7	31.2	60.7
96/97	145.4	29.1	57.1	22.3	2.5	167.7	31.6	60.6
97/98	147.5	29.5	57.1	22.3	2.5	169.8	32.0	60.6
98/99	149.6	29.9	57.1	22.3	2.5	171.9	32.4	60.5
99/00	151.7	30.3	57.1	22.3	2.5	174.0	32.8	60.5
2000/01	177.9	35.6	57.1	22.3	2.5	200.2	38.1	60.0
01/02	182.8	36.6	57.1	22.3	2.5	205.1	39.1	59.9
02/03	188.0	37.6	57.1	22.3	2.5	210.3	40.1	59.9
03/04	193.2	38.6	57.1	22.3	2.5	215.5	41.1	59.8
04/05	198.6	39.7	57.1	22.3	2.5	220.9	42.2	59.7
05/06	204.2	40.8	57.1	22.3	2.5	226.5	43.3	59.7
06/07	209.9	42.0	57.1	22.3	2.5	232.2	44.5	59.6
07/08	215.8	43.2	57.1	22.3	2.5	238.1	45.7	59.5
08/09	221.9	44.4	57.1	22.3	2.5	244.2	46.9	59.5
09/10	228.1	45.6	57.1	22.3	2.5	250.4	48.1	59.4
10/11	234.6	46.9	57.1	22.3	2.5	256.9	49.4	59.3
11/12	241.2	48.2	57.1	22.3	2.5	263.5	50.7	59.3
12/13	247.9	49.6	57.1	22.3	2.5	270.2	52.1	59.2
13/14	254.9	51.0	57.1	22.3	2.5	277.2	53.5	59.2
2014/15	262.1	52.4	57.1	22.3	2.5	284.4	54.9	59.1

Note: Regarding energy production and peak power for HT consumers, please refer to Table 4.5.3.

Table 4.5.6 Forecast of Energy Production and Peak Power (5)

(By Micro Method: as per assumed by SONEL)

(III) Total Demand - (a) Medium (Niveau) Growth Production

Year	Public sector							HT consumers						Total		
	Energy Production			Peak Power			Load Factor	Energy Production			Peak Power			Energy Production	Peak Power	Load Factor
	South (GWh)	North (GWh)	Total (GWh)	South (MW)	North (MW)	Total (MW)	(%)	South (GWh)	North (GWh)	Total (GWh)	South (MW)	North (MW)	Total (MW)	(GWh)	(MW)	(%)
1988/89	1,174.0	125.1	1,299.1	223.8	23.4	247.2	60.0	1,368.8	22.3	1,391.1	166.0	2.5	168.5	2,690.2	415.7	73.9
89/90	1,190.4	118.4	1,308.8	223.2	21.6	244.8	61.0	1,366.7	26.2	1,392.9	168.0	2.5	170.5	2,701.7	415.3	74.3
1990/91	1,192.2	161.7	1,353.9	224.9	29.4	254.4	60.8	1,310.2	22.4	1,332.6	148.2	2.5	150.7	2,686.5	405.0	75.7
91/92	1,226.7	164.3	1,391.0	231.5	29.9	261.3	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,723.5	412.0	75.5
92/93	1,262.8	166.9	1,429.7	238.3	30.3	268.6	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,762.2	419.3	75.2
93/94	1,300.5	169.5	1,470.1	245.4	30.8	276.2	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,802.6	426.9	74.9
94/95	1,339.9	172.3	1,512.2	252.8	31.3	284.1	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,844.7	434.8	74.7
95/96	1,381.1	175.0	1,556.1	260.6	31.8	292.4	60.7	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,888.6	443.1	74.4
96/97	1,424.1	177.8	1,601.9	268.7	32.3	301.0	60.7	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,934.4	451.7	74.2
97/98	1,469.0	180.7	1,649.7	277.2	32.9	310.0	60.7	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,982.2	460.7	73.9
98/99	1,516.0	183.7	1,699.7	286.1	33.4	319.4	60.7	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,032.2	470.1	73.6
99/00	1,582.1	186.7	1,768.7	298.5	33.9	332.5	60.7	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,101.2	483.1	73.3
2000/01	1,739.5	258.4	1,997.9	328.2	47.0	375.2	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,330.4	525.9	72.3
01/02	1,785.0	267.2	2,052.2	336.8	48.6	385.4	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,384.7	536.0	72.1
02/03	1,831.8	276.2	2,108.0	345.6	50.2	395.9	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,440.5	546.5	71.9
03/04	1,879.8	285.7	2,165.5	354.7	51.9	406.6	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,498.0	557.3	71.7
04/05	1,929.2	295.5	2,224.6	364.0	53.7	417.7	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,557.1	568.4	71.4
05/06	1,979.9	305.6	2,285.5	373.6	55.6	429.1	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,618.0	579.8	71.2
06/07	2,032.0	316.2	2,348.2	383.4	57.5	440.9	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,680.7	591.5	71.0
07/08	2,085.5	327.2	2,412.7	393.5	59.5	453.0	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,745.2	603.6	70.8
08/09	2,140.5	338.6	2,479.1	403.9	61.6	465.4	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,811.6	616.1	70.6
09/10	2,197.0	350.4	2,547.4	414.5	63.7	478.2	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,879.9	628.9	70.4
10/11	2,255.0	362.7	2,617.7	425.5	66.0	491.4	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,950.2	642.1	70.2
11/12	2,314.6	375.6	2,690.2	436.7	68.3	505.0	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	4,022.7	655.7	70.0
12/13	2,375.8	388.9	2,764.7	448.3	70.7	519.0	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	4,097.2	669.6	69.8
13/14	2,438.8	402.7	2,841.5	460.2	73.2	533.4	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	4,174.0	684.0	69.7
2014/15	2,503.4	417.1	2,920.5	472.4	75.8	548.2	60.8	1,310.2	22.3	1,332.5	148.2	2.5	150.7	4,253.0	698.9	69.5

Note: Regarding energy productiion and peak power for HT consumers, please refer to Table 4.5.3.

Table 4.5.6 Forecast of Energy Production and Peak Power (6)

(By Micro Method: as per assumed by SONEL)

(III) Total Demand - (b) Low (Moyenne) Growth Production

Year	Public sector							HT consumers						Total		
	Energy Production			Peak Power			Load Factor	Energy Production			Peak Power			Energy Production	Peak Power	Load Factor
	South (GWh)	North (GWh)	Total (GWh)	South (MW)	North (MW)	Total (MW)	(%)	South (GWh)	North (GWh)	Total (GWh)	South (MW)	North (MW)	Total (MW)	(GWh)	(MW)	(%)
1988/89	1,174.0	125.1	1,299.1	223.8	23.4	247.2	60.0	1,368.8	22.3	1,391.1	166.0	2.5	168.5	2,690.2	415.7	73.9
89/90	1,190.4	118.4	1,308.8	223.2	21.6	244.8	61.0	1,366.7	26.2	1,392.9	168.0	2.5	170.5	2,701.7	415.3	74.3
1990/91	1,000.2	134.0	1,134.1	222.3	24.4	246.6	52.5	1,310.2	22.4	1,332.6	148.2	2.5	150.7	2,466.7	397.3	70.9
91/92	1,030.2	135.8	1,166.0	228.9	27.2	256.1	52.0	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,498.5	406.7	70.1
92/93	1,061.6	137.6	1,199.2	235.9	27.5	263.4	52.0	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,531.7	414.1	69.8
93/94	1,094.4	139.5	1,233.9	243.2	27.9	271.1	52.0	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,566.4	421.7	69.5
94/95	1,128.6	141.5	1,270.1	250.8	28.3	279.1	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,602.6	429.7	69.1
95/96	1,164.4	143.4	1,307.8	258.8	28.7	287.4	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,640.3	438.1	68.8
96/97	1,201.8	145.4	1,347.2	267.1	29.1	296.2	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,679.7	446.8	68.5
97/98	1,240.9	147.5	1,388.4	275.8	29.5	305.3	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,720.9	455.9	68.1
98/99	1,281.8	149.6	1,431.3	284.8	29.9	314.8	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,763.8	465.4	67.8
99/00	1,324.5	151.7	1,476.2	294.3	30.3	324.7	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,808.7	475.3	67.5
2000/01	1,476.1	177.9	1,653.9	328.0	35.6	363.6	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	2,986.4	514.2	66.3
01/02	1,515.7	182.8	1,698.5	336.8	36.6	373.4	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,031.0	524.0	66.0
02/03	1,556.3	188.0	1,744.3	345.9	37.6	383.4	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,076.8	534.1	65.8
03/04	1,598.1	193.2	1,791.3	355.1	38.6	393.8	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,123.8	544.4	65.5
04/05	1,641.0	198.6	1,839.7	364.7	39.7	404.4	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,172.2	555.1	65.2
05/06	1,685.1	204.2	1,889.3	374.5	40.8	415.3	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,221.8	566.0	65.0
06/07	1,730.4	209.9	1,940.4	384.5	42.0	426.5	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,272.9	577.2	64.7
07/08	1,777.0	215.8	1,992.8	394.9	43.2	438.0	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,325.3	588.7	64.5
08/09	1,824.8	221.9	2,046.7	405.5	44.4	449.9	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,379.2	600.5	64.2
09/10	1,873.9	228.1	2,102.0	416.4	45.6	462.0	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,434.5	612.7	64.0
10/11	1,924.3	234.6	2,158.9	427.6	46.9	474.5	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,491.4	625.2	63.8
11/12	1,976.2	241.2	2,217.3	439.1	48.2	487.4	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,549.8	638.0	63.5
12/13	2,029.4	247.9	2,277.4	451.0	49.6	500.6	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,609.9	651.2	63.3
13/14	2,084.1	254.9	2,339.1	463.1	51.0	514.1	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,671.6	664.8	63.0
2014/15	2,140.3	262.1	2,402.5	475.6	52.4	528.1	51.9	1,310.2	22.3	1,332.5	148.2	2.5	150.7	3,735.0	678.7	62.8

Note: 1) Regarding energy productiion and peak power for HT consumers, please refer to Table 4.5.3.

Table 4.5.7 Forecast of Energy Production and Peak Power

(Low Forecast Scenario by Trend Method; Load Factor at 60%)

South Interconnected Network

Year	Public Sector: Energy Production (GWh)	Growth Rate (%)	Average Power (MW)	Load Factor (%)	Peak Power (MW)	Industrial Sector: Energy Production (GWh)	Peak Power (MW)	Total: Energy Production (GWh)	Peak Power (MW)
1988/89	1,174.0	0.9	134.0	59.9	223.8	1,391.1	166.0	2,565.1	389.8
89/90	1,190.4	1.4	135.9	60.9	223.2	1,366.7	168.0	2,557.1	391.2
90/91	1,193.3	0.2	136.2	60.8	224.0	1,375.1	166.0	2,568.4	390.0
1991/92	1,224.3	2.6	139.8	60.0	232.9	1,375.1	166.0	2,599.4	398.9
92/93	1,256.2	2.6	143.4	60.0	239.0	1,375.1	166.0	2,631.3	405.0
93/94	1,288.8	2.6	147.1	60.0	245.2	1,375.1	166.0	2,663.9	411.2
94/95	1,322.3	2.6	151.0	60.0	251.6	1,375.1	166.0	2,697.4	417.6
95/96	1,356.7	2.6	154.9	60.0	258.1	1,375.1	166.0	2,731.8	424.1
96/97	1,392.0	2.6	158.9	60.0	264.8	1,375.1	166.0	2,767.1	430.8
97/98	1,428.2	2.6	163.0	60.0	271.7	1,375.1	166.0	2,803.3	437.7
98/99	1,465.3	2.6	167.3	60.0	278.8	1,375.1	166.0	2,840.4	444.8
99/00	1,503.4	2.6	171.6	60.0	286.0	1,375.1	166.0	2,878.5	452.0
2000/01	1,542.5	2.6	176.1	60.0	293.5	1,375.1	166.0	2,917.6	459.5
01/02	1,582.6	2.6	180.7	60.0	301.1	1,375.1	166.0	2,957.7	467.1
02/03	1,623.7	2.6	185.4	60.0	308.9	1,375.1	166.0	2,998.8	474.9
03/04	1,666.0	2.6	190.2	60.0	317.0	1,375.1	166.0	3,041.1	483.0
04/05	1,709.3	2.6	195.1	60.0	325.2	1,375.1	166.0	3,084.4	491.2
05/06	1,753.7	2.6	200.2	60.0	333.7	1,375.1	166.0	3,128.8	499.7
06/07	1,799.3	2.6	205.4	60.0	342.3	1,375.1	166.0	3,174.4	508.3
07/08	1,846.1	2.6	210.7	60.0	351.2	1,375.1	166.0	3,221.2	517.2
08/09	1,894.1	2.6	216.2	60.0	360.4	1,375.1	166.0	3,269.2	526.4
09/10	1,943.3	2.6	221.8	60.0	369.7	1,375.1	166.0	3,318.4	535.7
10/11	1,993.9	2.6	227.6	60.0	379.4	1,375.1	166.0	3,369.0	545.4
11/12	2,045.7	2.6	233.5	60.0	389.2	1,375.1	166.0	3,420.8	555.2
12/13	2,098.9	2.6	239.6	60.0	399.3	1,375.1	166.0	3,474.0	565.3
13/14	2,153.5	2.6	245.8	60.0	409.7	1,375.1	166.0	3,528.6	575.7
14/15	2,209.5	2.6	252.2	60.0	420.4	1,375.1	166.0	3,584.6	586.4

Note: 1) A revised load factor (60%) is used for Public Sector as constant in consideration of past tendency.

2) Energy and peak power for Industrial Sector is quoted from those of 1991/92 (See table 4.5.3), to meet with past tendency.

Table 4.5.8 Forecast of Energy Production and Peak Power

(Medium Forecast Scenario by Trend Method; Load Factor at 60%)

South Interconnected Network

Year	Public Sector					Industrial Sector		Total	
	Energy Production (GWh)	Growth Rate (%)	Average Power (MW)	Load Factor (%)	Peak Power (MW)	Energy Production (GWh)	Peak Power (MW)	Energy Production (GWh)	Peak Power (MW)
1988/89	1,174.0	0.9	134.0	59.9	223.8	1,391.1	166.0	2,565.1	389.8
89/90	1,190.4	1.4	135.9	60.9	223.2	1,366.7	168.0	2,557.1	391.2
90/91	1,193.3	0.2	136.2	60.8	224.0	1,375.1	166.0	2,568.4	390.0
1991/92	1,224.3	2.6	139.8	60.0	232.9	1,375.1	166.0	2,599.4	398.9
92/93	1,256.2	2.6	143.4	60.0	239.0	1,375.1	166.0	2,631.3	405.0
93/94	1,288.8	2.6	147.1	60.0	245.2	1,375.1	166.0	2,663.9	411.2
94/95	1,322.3	2.6	151.0	60.0	251.6	1,375.1	166.0	2,697.4	417.6
95/96	1,356.7	2.6	154.9	60.0	258.1	1,375.1	166.0	2,731.8	424.1
96/97	1,392.0	2.6	158.9	60.0	264.8	1,375.1	166.0	2,767.1	430.8
97/98	1,428.2	2.6	163.0	60.0	271.7	1,375.1	166.0	2,803.3	437.7
98/99	1,465.3	2.6	167.3	60.0	278.8	1,375.1	166.0	2,840.4	444.8
99/00	1,503.4	2.6	171.6	60.0	286.0	1,375.1	166.0	2,878.5	452.0
2000/01	1,577.1	4.9	180.0	60.0	300.1	1,375.1	166.0	2,952.2	466.1
01/02	1,654.3	4.9	188.9	60.0	314.8	1,375.1	166.0	3,029.4	480.8
02/03	1,735.4	4.9	198.1	60.0	330.2	1,375.1	166.0	3,110.5	496.2
03/04	1,820.4	4.9	207.8	60.0	346.4	1,375.1	166.0	3,195.5	512.4
04/05	1,909.6	4.9	218.0	60.0	363.3	1,375.1	166.0	3,284.7	529.3
05/06	2,003.2	4.9	228.7	60.0	381.1	1,375.1	166.0	3,378.3	547.1
06/07	2,101.4	4.9	239.9	60.0	399.8	1,375.1	166.0	3,476.5	565.8
07/08	2,204.3	4.9	251.6	60.0	419.4	1,375.1	166.0	3,579.4	585.4
08/09	2,312.4	4.9	264.0	60.0	439.9	1,375.1	166.0	3,687.5	605.9
09/10	2,425.7	4.9	276.9	60.0	461.5	1,375.1	166.0	3,800.8	627.5
10/11	2,544.5	4.9	290.5	60.0	484.1	1,375.1	166.0	3,919.6	650.1
11/12	2,669.2	4.9	304.7	60.0	507.8	1,375.1	166.0	4,044.3	673.8
12/13	2,800.0	4.9	319.6	60.0	532.7	1,375.1	166.0	4,175.1	698.7
13/14	2,937.2	4.9	335.3	60.0	558.8	1,375.1	166.0	4,312.3	724.8
14/15	3,081.1	4.9	351.7	60.0	586.2	1,375.1	166.0	4,456.2	752.2

Note:
1) A revised load factor (60%) is used for Public Sector as constant in consideration of past tendency.
2) Energy and peak power for Industrial Sector is quoted from those of 1991/92 (See table 4.5.3), to meet with past tendency.

Table 4.5.9 Forecast of Energy Production and Peak Power

(High Forecast Scenario by Trend Method; Load Factor at 60%)

South Interconnected Network

Year	Public Sector					Industrial Sector		Total	
	Energy Production (GWh)	Growth Rate (%)	Average Power (MW)	Load Factor (%)	Peak Power (MW)	Energy Production (GWh)	Peak Power (MW)	Energy Production (GWh)	Peak Power (MW)
1988/89	1,174.0	0.9	134.0	59.9	223.8	1,391.1	166.0	2,565.1	389.8
89/90	1,190.4	1.4	135.9	60.9	223.2	1,366.7	168.0	2,557.1	391.2
90/91	1,193.3	0.2	136.2	60.8	224.0	1,375.1	166.0	2,568.4	390.0
1991/92	1,224.3	2.6	139.8	60.0	232.9	1,375.1	166.0	2,599.4	398.9
92/93	1,256.2	2.6	143.4	60.0	239.0	1,375.1	166.0	2,631.3	405.0
93/94	1,288.8	2.6	147.1	60.0	245.2	1,375.1	166.0	2,663.9	411.2
94/95	1,322.3	2.6	151.0	60.0	251.6	1,375.1	166.0	2,697.4	417.6
95/96	1,356.7	2.6	154.9	60.0	258.1	1,375.1	166.0	2,731.8	424.1
96/97	1,392.0	2.6	158.9	60.0	264.8	1,375.1	166.0	2,767.1	430.8
97/98	1,428.2	2.6	163.0	60.0	271.7	1,375.1	166.0	2,803.3	437.7
98/99	1,465.3	2.6	167.3	60.0	278.8	1,375.1	166.0	2,840.4	444.8
99/00	1,503.4	2.6	171.6	60.0	286.0	1,375.1	166.0	2,878.5	452.0
2000/01	1,611.6	7.2	184.0	60.0	306.6	1,375.1	166.0	2,986.7	472.6
01/02	1,727.7	7.2	197.2	60.0	328.7	1,375.1	166.0	3,102.8	494.7
02/03	1,852.1	7.2	211.4	60.0	352.4	1,375.1	166.0	3,227.2	518.4
03/04	1,985.4	7.2	226.6	60.0	377.7	1,375.1	166.0	3,360.5	543.7
04/05	2,128.4	7.2	243.0	60.0	404.9	1,375.1	166.0	3,503.5	570.9
05/06	2,281.6	7.2	260.5	60.0	434.1	1,375.1	166.0	3,656.7	600.1
06/07	2,445.9	7.2	279.2	60.0	465.4	1,375.1	166.0	3,821.0	631.4
07/08	2,622.0	7.2	299.3	60.0	498.9	1,375.1	166.0	3,997.1	664.9
08/09	2,810.8	7.2	320.9	60.0	534.8	1,375.1	166.0	4,185.9	700.8
09/10	3,013.2	7.2	344.0	60.0	573.3	1,375.1	166.0	4,388.3	739.3
10/11	3,230.1	7.2	368.7	60.0	614.6	1,375.1	166.0	4,605.2	780.6
11/12	3,462.7	7.2	395.3	60.0	658.8	1,375.1	166.0	4,837.8	824.8
12/13	3,712.0	7.2	423.7	60.0	706.2	1,375.1	166.0	5,087.1	872.2
13/14	3,979.3	7.2	454.3	60.0	757.1	1,375.1	166.0	5,354.4	923.1
14/15	4,265.8	7.2	487.0	60.0	811.6	1,375.1	166.0	5,640.9	977.6

Note: 1) A revised load factor (60%) is used for Public Sector as constant in consideration of past tendency.

2) Energy and peak power for Industrial Sector is quoted from those of 1991/92 (See table 4.5.3).

Table 4.5.10 Revised Forecast of Energy Production and Peak Power

(Low Forecast Scenario by Micro Method)

South Interconnected Network

Year	Public Sector				Industrial Sector		Total		
	Energy Production (GWh)	Average Power (MW)	Load Factor (%)	Peak Power (MW)	Energy Production (GWh)	Peak Power (MW)	Energy Production (GWh)	Peak Power (MW)	Load Factor (%)
1988/89	1,174.0	134.0	59.9	223.8	1,391.1	166.0	2,565.1	389.8	75.1
89/90	1,190.4	135.9	60.9	223.2	1,366.7	168.0	2,557.1	391.2	74.6
90/91	1,193.3	136.2	60.8	224.0	1,375.1	166.0	2,568.4	390.0	75.2
1991/92	1,231.4	140.6	51.4	273.6	1,375.1	166.0	2,606.5	439.6	67.7
92/93	1,274.5	145.5	51.4	283.2	1,375.1	166.0	2,649.6	449.2	67.3
93/94	1,319.8	150.7	51.4	293.3	1,375.1	166.0	2,694.9	459.3	67.0
94/95	1,367.4	156.1	51.4	303.9	1,375.1	166.0	2,742.5	469.9	66.6
95/96	1,417.3	161.8	51.4	315.0	1,375.1	166.0	2,792.4	481.0	66.3
96/97	1,469.7	167.8	51.4	326.6	1,375.1	166.0	2,844.8	492.6	65.9
97/98	1,524.8	174.1	51.4	338.8	1,375.1	166.0	2,899.9	504.8	65.6
98/99	1,582.6	180.7	51.4	351.7	1,375.1	166.0	2,957.7	517.7	65.2
99/00	1,643.4	187.6	51.4	365.2	1,375.1	166.0	3,018.5	531.2	64.9
2000/01	1,705.4	194.7	51.4	379.0	1,375.1	166.0	3,080.5	545.0	64.5
01/02	1,751.2	199.9	51.4	389.2	1,375.1	166.0	3,126.3	555.2	64.3
02/03	1,798.3	205.3	51.4	399.6	1,375.1	166.0	3,173.4	565.6	64.0
03/04	1,846.6	210.8	51.4	410.4	1,375.1	166.0	3,221.7	576.4	63.8
04/05	1,896.2	216.5	51.4	421.4	1,375.1	166.0	3,271.3	587.4	63.6
05/06	1,947.2	222.3	51.4	432.7	1,375.1	166.0	3,322.3	598.7	63.3
06/07	1,999.6	228.3	51.4	444.4	1,375.1	166.0	3,374.7	610.4	63.1
07/08	2,053.5	234.4	51.4	456.3	1,375.1	166.0	3,428.6	622.3	62.9
08/09	2,108.8	240.7	51.4	468.6	1,375.1	166.0	3,483.9	634.6	62.7
09/10	2,165.6	247.2	51.4	481.2	1,375.1	166.0	3,540.7	647.2	62.4
10/11	2,224.0	253.9	51.4	494.2	1,375.1	166.0	3,599.1	660.2	62.2
11/12	2,283.9	260.7	51.4	507.5	1,375.1	166.0	3,659.0	673.5	62.0
12/13	2,345.5	267.8	51.4	521.2	1,375.1	166.0	3,720.6	687.2	61.8
13/14	2,408.8	275.0	51.4	535.3	1,375.1	166.0	3,783.9	701.3	61.6
14/15	2,473.9	282.4	51.4	549.7	1,375.1	166.0	3,849.0	715.7	61.4

Note: 1) A revised load factor (60%) is used for Public Sector as constant in consideration of past tendency.

2) Actual data of 1990/91 for Industrial Sector is quoted for (See table 4.5.3).

Table 4.5.11 Revised Forecast of Energy Production and Peak Power

(Medium Forecast Scenario by Micro Method)

South Interconnected Network

Year	Public Sector				Industrial Sector		Total		
	Energy Production (GWh)	Average Power (MW)	Load Factor (%)	Peak Power (MW)	Energy Production (GWh)	Peak Power (MW)	Energy Production (GWh)	Peak Power (MW)	Load Factor (%)
1988/89	1,174.0	134.0	59.9	223.8	1,391.1	166.0	2,565.1	389.8	75.1
89/90	1,190.4	135.9	60.9	223.2	1,366.7	168.0	2,557.1	391.2	74.6
90/91	1,193.3	136.2	60.8	224.0	1,375.1	166.0	2,568.4	390.0	75.2
91/92	1,237.2	141.2	60.5	233.4	1,375.1	166.0	2,612.3	399.4	74.7
92/93	1,283.9	146.6	60.5	242.3	1,375.1	166.0	2,659.0	408.3	74.4
93/94	1,332.8	152.2	60.5	251.5	1,375.1	166.0	2,707.9	417.5	74.0
94/95	1,384.1	158.0	60.5	261.2	1,375.1	166.0	2,759.2	427.2	73.7
95/96	1,437.8	164.1	60.5	271.3	1,375.1	166.0	2,812.9	437.3	73.4
96/97	1,494.1	170.6	60.5	281.9	1,375.1	166.0	2,869.2	447.9	73.1
97/98	1,553.0	177.3	60.5	293.0	1,375.1	166.0	2,928.1	459.0	72.8
98/99	1,614.9	184.3	60.5	304.7	1,375.1	166.0	2,990.0	470.7	72.5
99/00	1,679.7	191.7	60.5	316.9	1,375.1	166.0	3,054.8	482.9	72.2
2000/01	1,745.9	199.3	60.5	329.4	1,375.1	166.0	3,121.0	495.4	71.9
01/02	1,810.9	206.7	60.5	341.7	1,375.1	166.0	3,186.0	507.7	71.6
02/03	1,878.9	214.5	60.5	354.5	1,375.1	166.0	3,254.0	520.5	71.4
03/04	1,950.1	222.6	60.5	368.0	1,375.1	166.0	3,325.2	534.0	71.1
04/05	2,024.6	231.1	60.5	382.0	1,375.1	166.0	3,399.7	548.0	70.8
05/06	2,102.6	240.0	60.5	396.7	1,375.1	166.0	3,477.7	562.7	70.5
06/07	2,184.4	249.4	60.5	412.2	1,375.1	166.0	3,559.5	578.2	70.3
07/08	2,270.1	259.1	60.5	428.3	1,375.1	166.0	3,645.2	594.3	70.0
08/09	2,359.9	269.4	60.5	445.3	1,375.1	166.0	3,735.0	611.3	69.8
29/10	2,454.2	280.2	60.5	463.1	1,375.1	166.0	3,829.3	629.1	69.5
10/11	2,553.0	291.4	60.5	481.7	1,375.1	166.0	3,928.1	647.7	69.2
11/12	2,656.8	303.3	60.5	501.3	1,375.1	166.0	4,031.9	667.3	69.0
12/13	2,765.8	315.7	60.5	521.9	1,375.1	166.0	4,140.9	687.9	68.7
13/14	2,880.2	328.8	60.5	543.4	1,375.1	166.0	4,255.3	709.4	68.5
14/15	3,000.4	342.5	60.5	566.1	1,375.1	166.0	4,375.5	732.1	68.2

Note: 1) In this table, a revised load factor (60%) is used for Public Sector as constantin consideration of past tendency.

2) Actual data of 1990/91 for Industrial Sector is quoted (See table 4.5.3).

Table 4.5.12 Revised Forecast of Energy Production and Peak Power

(High Forecast Scenario by Micro Method)

South Interconnected Network

Year	Public Sector				Industrial Sector		Total		
	Energy Production (GWh)	Average Power (MW)	Load Factor (%)	Peak Power (MW)	Energy Production (GWh)	Peak Power (MW)	Energy Production (GWh)	Peak Power (MW)	Load Factor (%)
1988/89	1,174.0	134.0	59.9	223.8	1,391.1	166.0	2,565.1	389.8	75.1
89/90	1,190.4	135.9	60.9	223.2	1,366.7	168.0	2,557.1	391.2	74.6
90/91	1,193.3	136.2	60.8	224.0	1,375.1	166.0	2,568.4	390.0	75.2
1991/92	1,249.9	142.7	60.5	235.8	1,375.1	166.0	2,625.0	401.8	74.6
92/93	1,303.9	148.9	60.5	246.0	1,375.1	166.0	2,679.0	412.0	74.2
93/94	1,361.1	155.4	60.5	256.8	1,375.1	166.0	2,736.2	422.8	73.9
94/95	1,421.4	162.3	60.5	268.2	1,375.1	166.0	2,796.5	434.2	73.5
95/96	1,485.2	169.5	60.5	280.2	1,375.1	166.0	2,860.3	446.2	73.2
96/97	1,552.6	177.2	60.5	293.0	1,375.1	166.0	2,927.7	459.0	72.8
97/98	1,623.8	185.4	60.5	306.4	1,375.1	166.0	2,998.9	472.4	72.5
98/99	1,699.1	194.0	60.5	320.6	1,375.1	166.0	3,074.2	486.6	72.1
99/00	1,778.8	203.1	60.5	335.6	1,375.1	166.0	3,153.9	501.6	71.8
2000/01	1,834.6	209.4	60.5	346.2	1,375.1	166.0	3,209.7	512.2	71.5
01/02	1,920.1	219.2	60.5	362.3	1,375.1	166.0	3,295.2	528.3	71.2
02/03	2,009.9	229.4	60.5	379.2	1,375.1	166.0	3,385.0	545.2	70.9
03/04	2,104.2	240.2	60.5	397.0	1,375.1	166.0	3,479.3	563.0	70.5
04/05	2,203.2	251.5	60.5	415.7	1,375.1	166.0	3,578.3	581.7	70.2
05/06	2,307.2	263.4	60.5	435.3	1,375.1	166.0	3,682.3	601.3	69.9
06/07	2,416.4	275.8	60.5	455.9	1,375.1	166.0	3,791.5	621.9	69.6
07/08	2,531.0	288.9	60.5	477.6	1,375.1	166.0	3,906.1	643.6	69.3
08/09	2,651.5	302.7	60.5	500.3	1,375.1	166.0	4,026.6	666.3	69.0
09/10	2,778.1	317.1	60.5	524.2	1,375.1	166.0	4,153.2	690.2	68.7
10/11	2,911.1	332.3	60.5	549.3	1,375.1	166.0	4,286.2	715.3	68.4
11/12	3,050.9	348.3	60.5	575.7	1,375.1	166.0	4,426.0	741.7	68.1
12/13	3,197.9	365.1	60.5	603.4	1,375.1	166.0	4,573.0	769.4	67.8
13/14	3,352.4	382.7	60.5	632.6	1,375.1	166.0	4,727.5	798.6	67.6
14/15	3,514.8	401.2	60.5	663.2	1,375.1	166.0	4,889.9	829.2	67.3

Note: 1) In this table, a revised load factor (60%) is used for Public Sector as constantin consideration of past tendency.

2) Actual data of 1990/91 for Industrial Sector is quoted for (See table 4.5.3).

Table 4.5.13 Situation of Revised Demand Forecast by Micro Method

(Parameters used are summarized herein for the revised demand forecast.)

South Interconnected Network

	Description	Medium Forecast (Niveau)	Low Forecast (Moyenne)	High Forecast
1)	Population growth	4.75 % up to 1999/00 and 2.46 % thereafter	- same as left -	- same as left -
2)	Domestic demand per capita	47.8 kWh up to 1999/00 and 54.3 kWh thereafter in terms of consumption	- same as left -	50.5 kWh in 1990/91 with annual growth rate of 1.5%
3)	Average professional demand per capita (M.F. demand)	3.8 kWh in terms of consumption	- same as left -	- same as left -
4)	MT demand (as per GDP growth)	1.0 % in 1990/91 to 6.4% in 2014/15 (*1)	0.5 % up to 1999/00 and 3.2 % up to 2014/15.	1.0 % in 1990/91 to 6.4% in 2014/15 (*1)
5)	Average load factor for public sector (LT & MT)	60.5 % (5,300 Hours)	51.4 % (4,500 Hours)	60.5 % (5,300 Hours)
6)	Loss of distribution	26 %	- same as left -	- same as left -
7)	Service rate	22 % up to 1999/00 and 25 % up tp 2014/15	- same as left -	-

Note: The figures quoted herein are are almost same with Table 4.5.4, except that some parameters are rivised; to To meet the psat data at starting point, i.e., domestic demand per capita, growth rate of MT demannd and loss of distribution as above.

Fig. 4.1.1 Organization Chart of The Republic of Cameroon

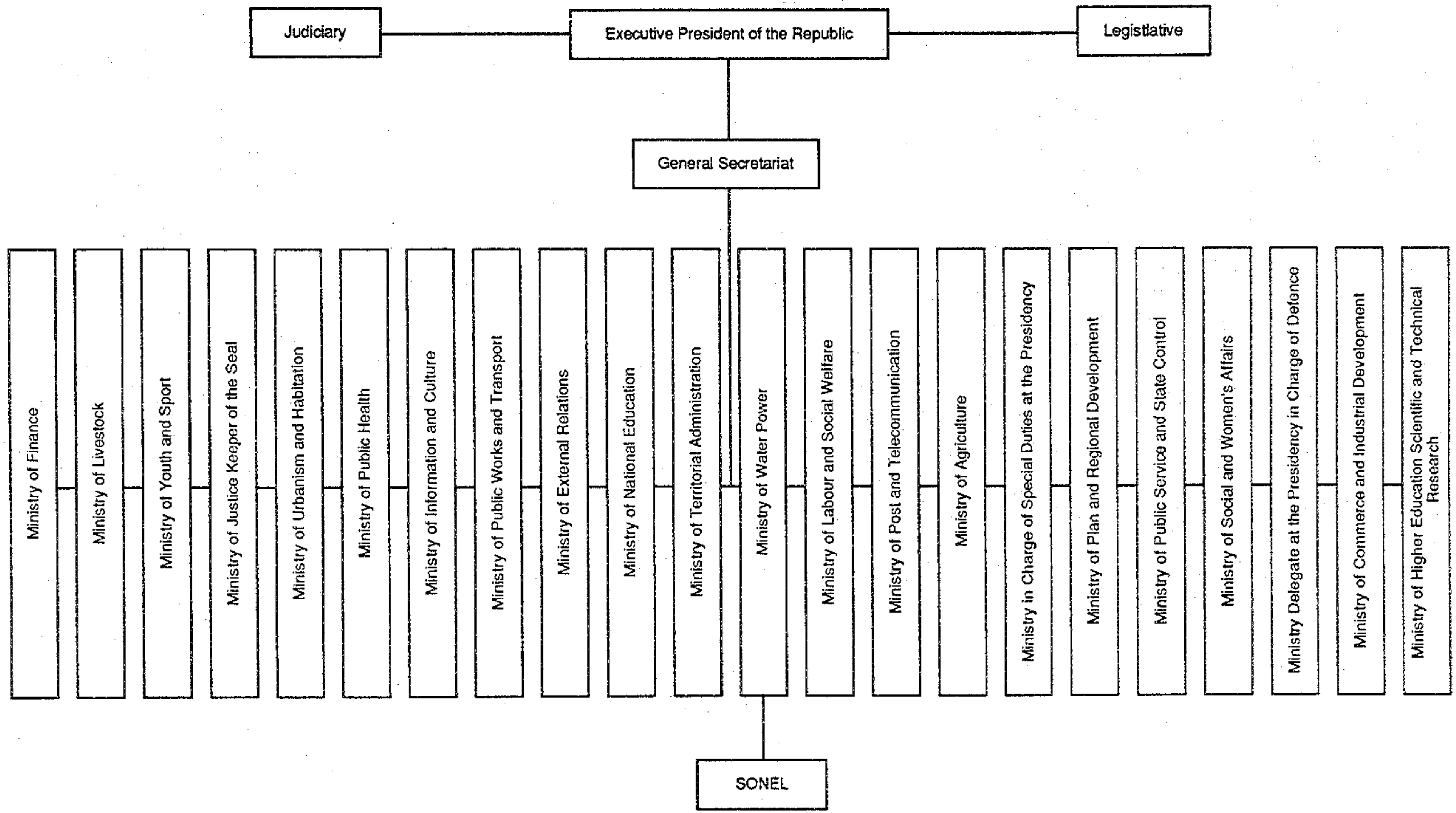
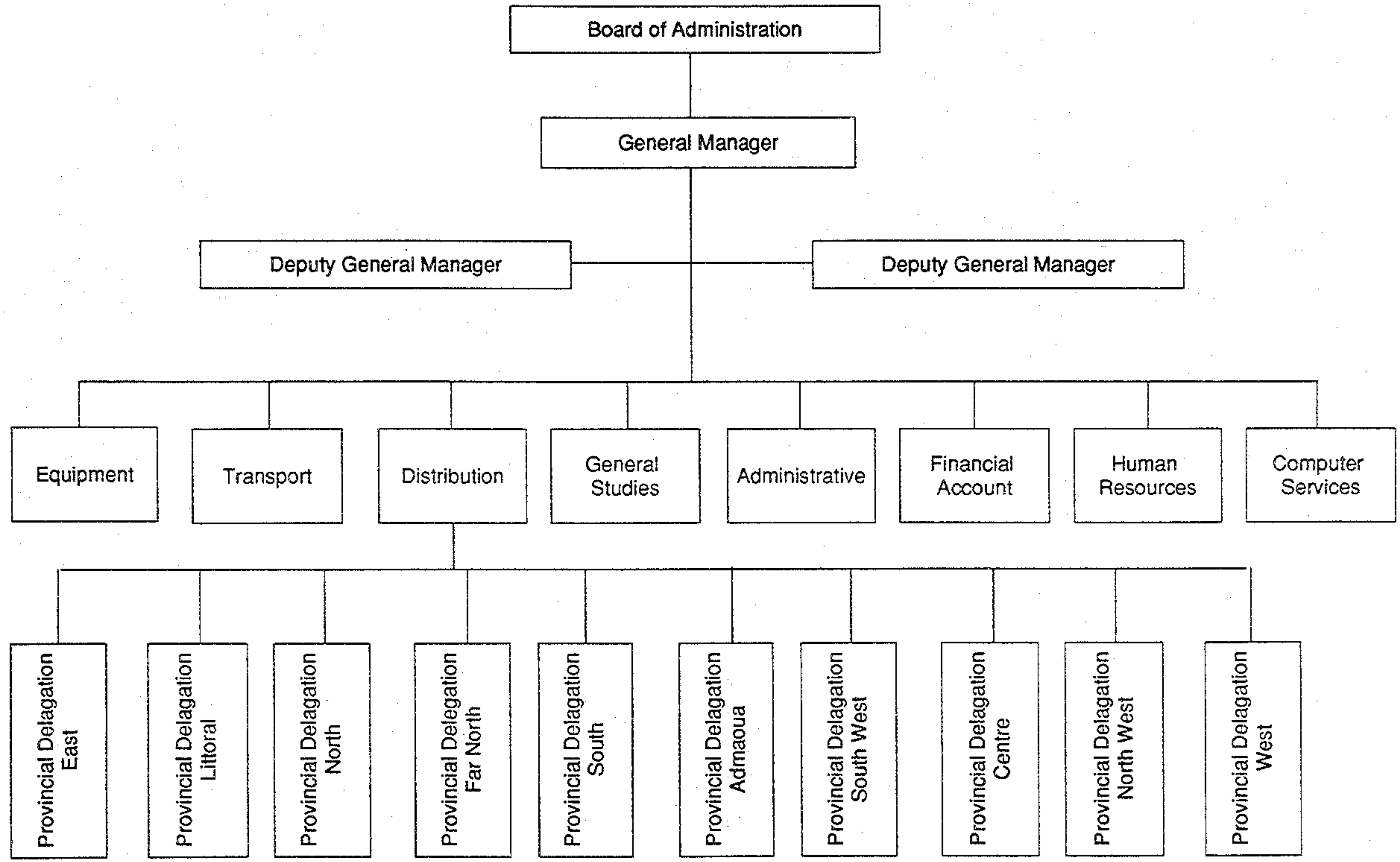


Fig. 4.1.2 Organization of SONEL (As of June 1990)



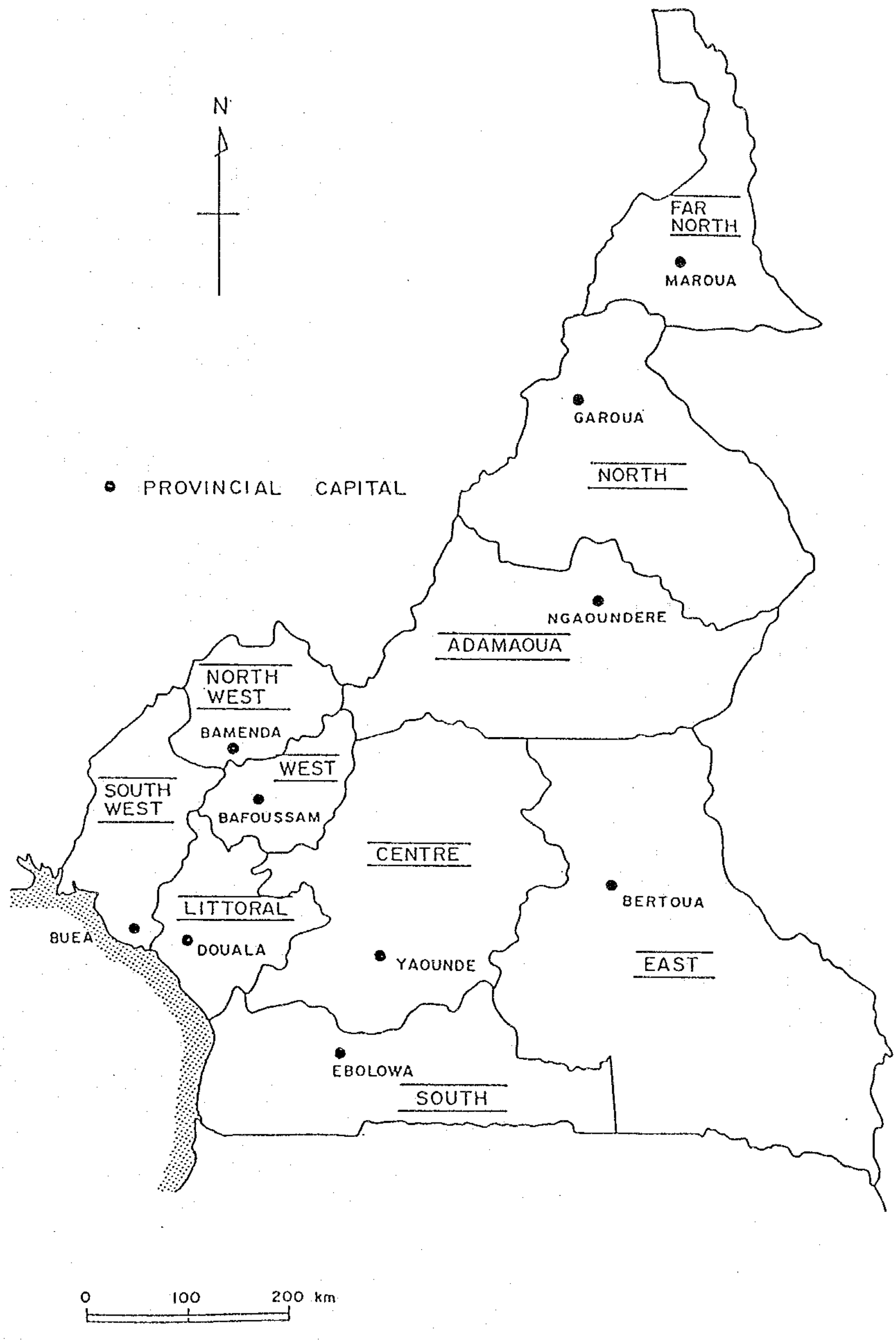


Fig. 4.1.3 Location of Administrative Provinces

Fig. 4.1.4 Transmission Line Networks

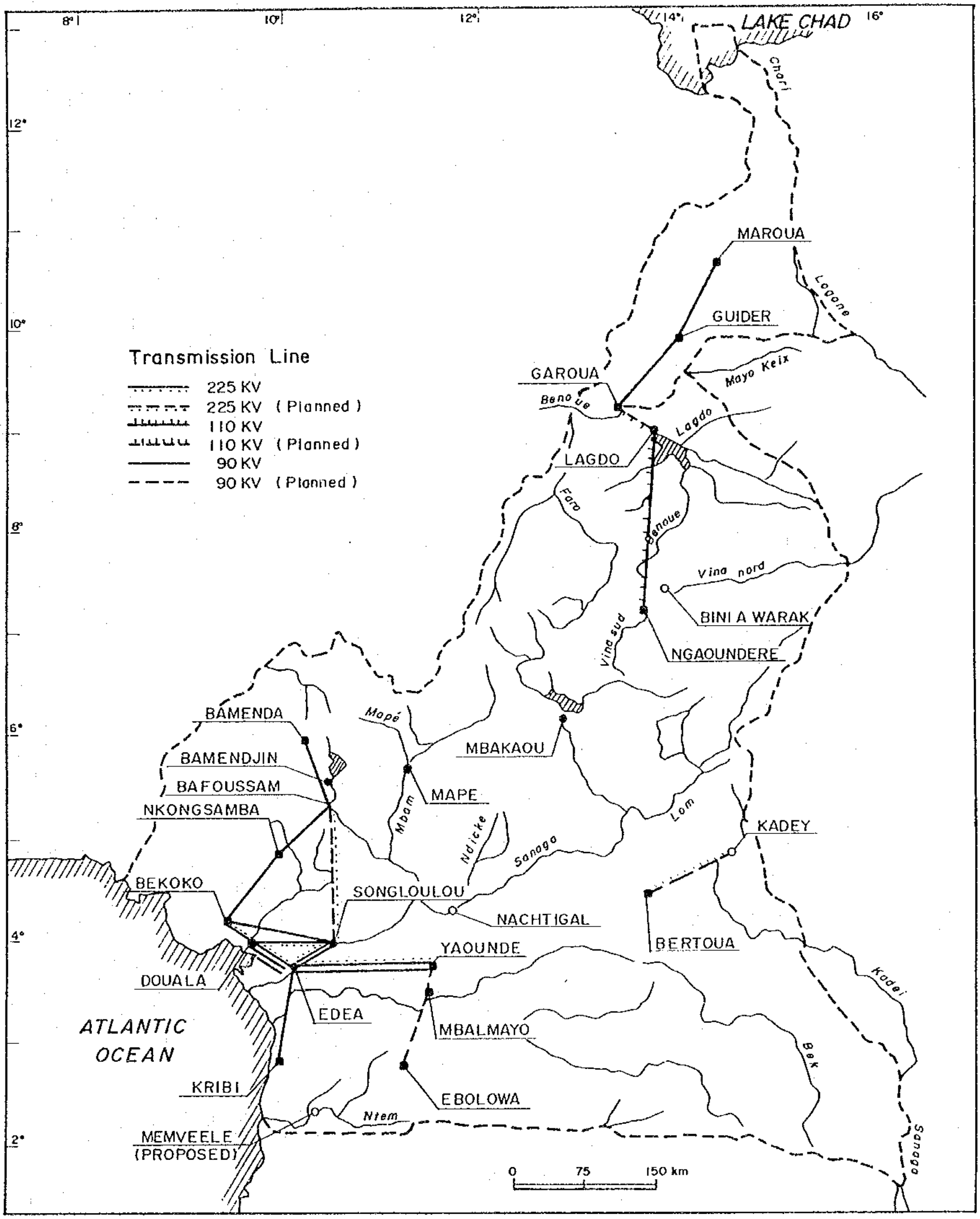
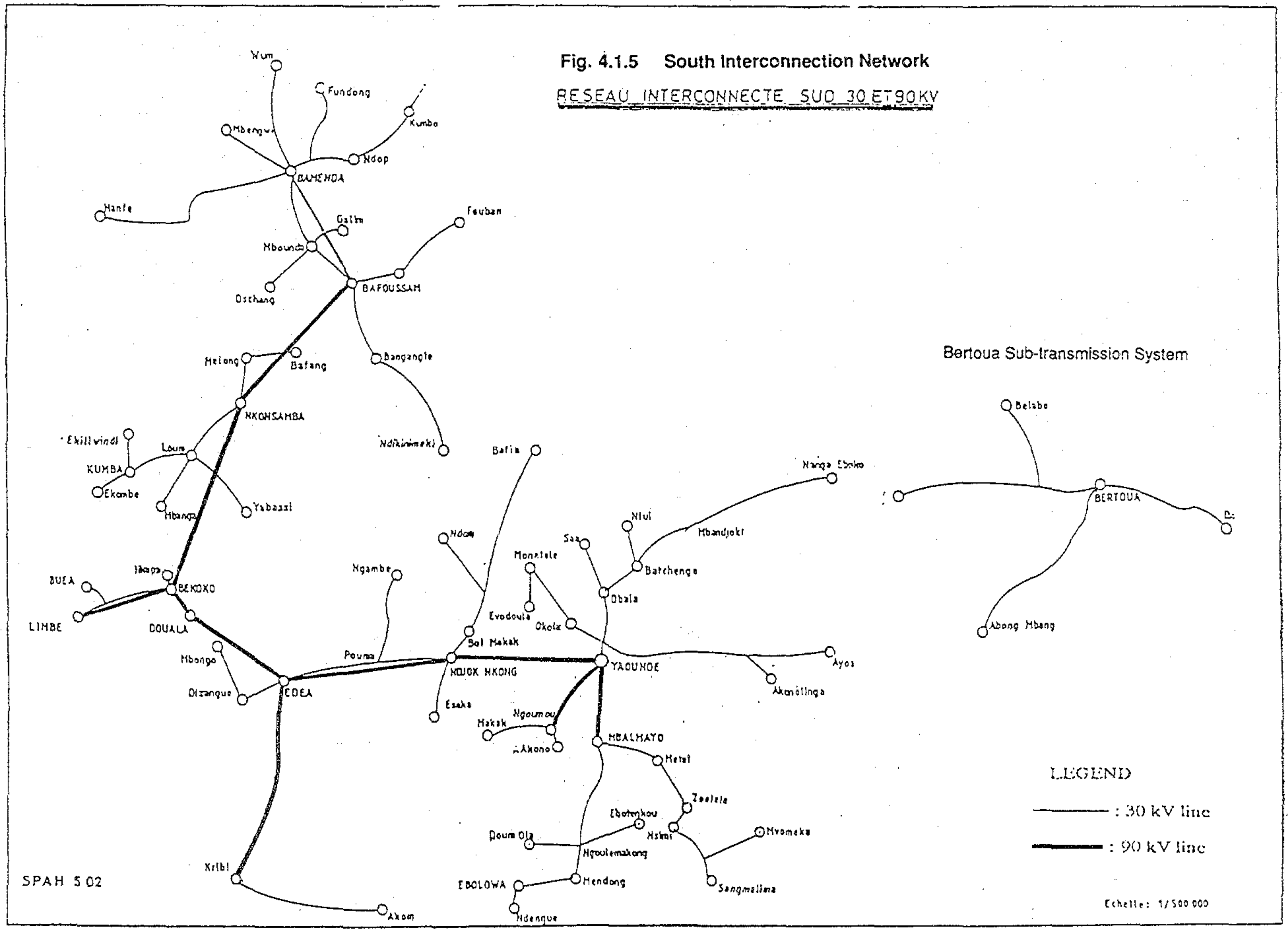
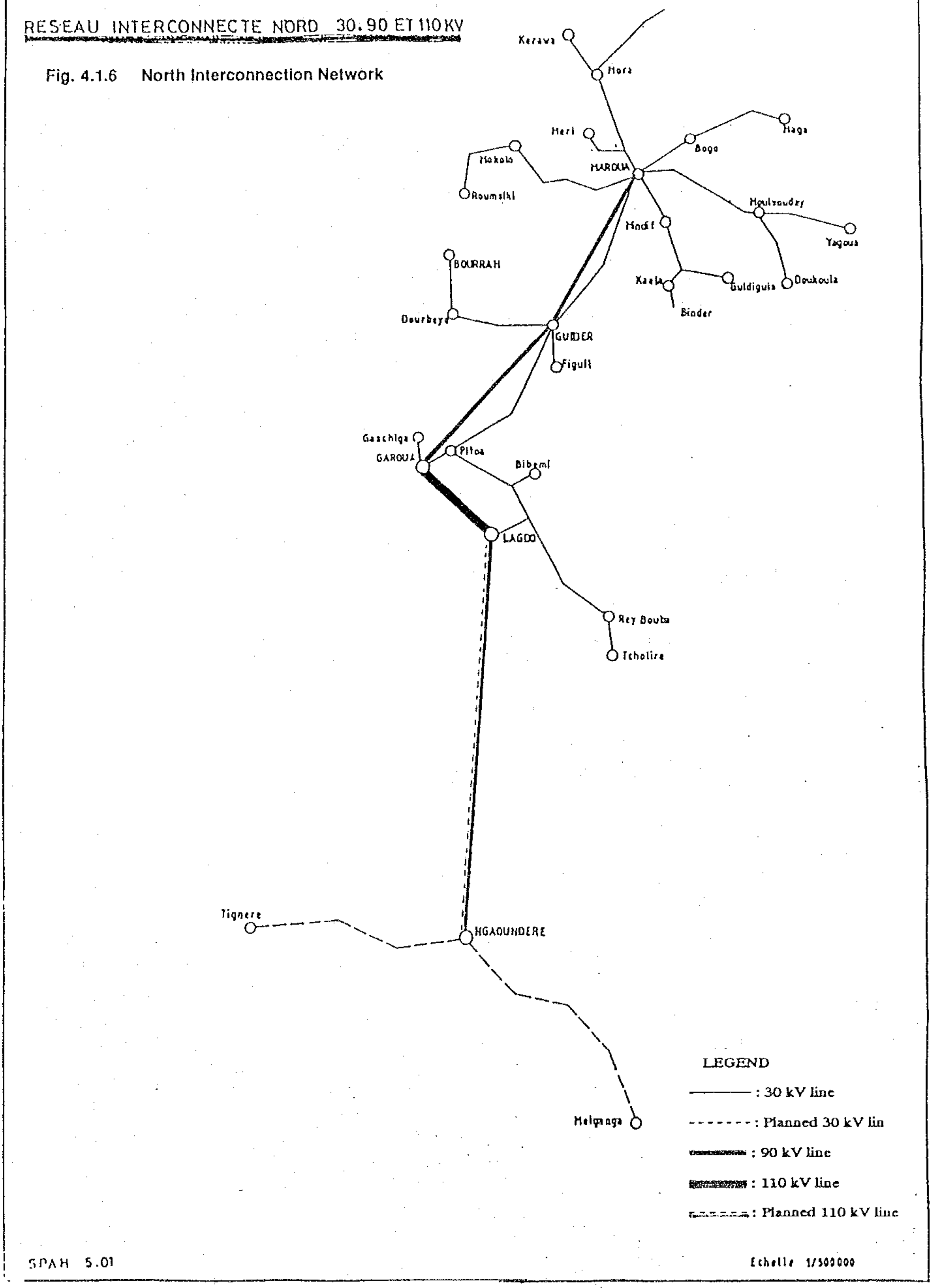


Fig. 4.1.5 South Interconnection Network



RESEAU INTERCONNECTE NORD 30.90 ET 110 KV

Fig. 4.1.6 North Interconnection Network



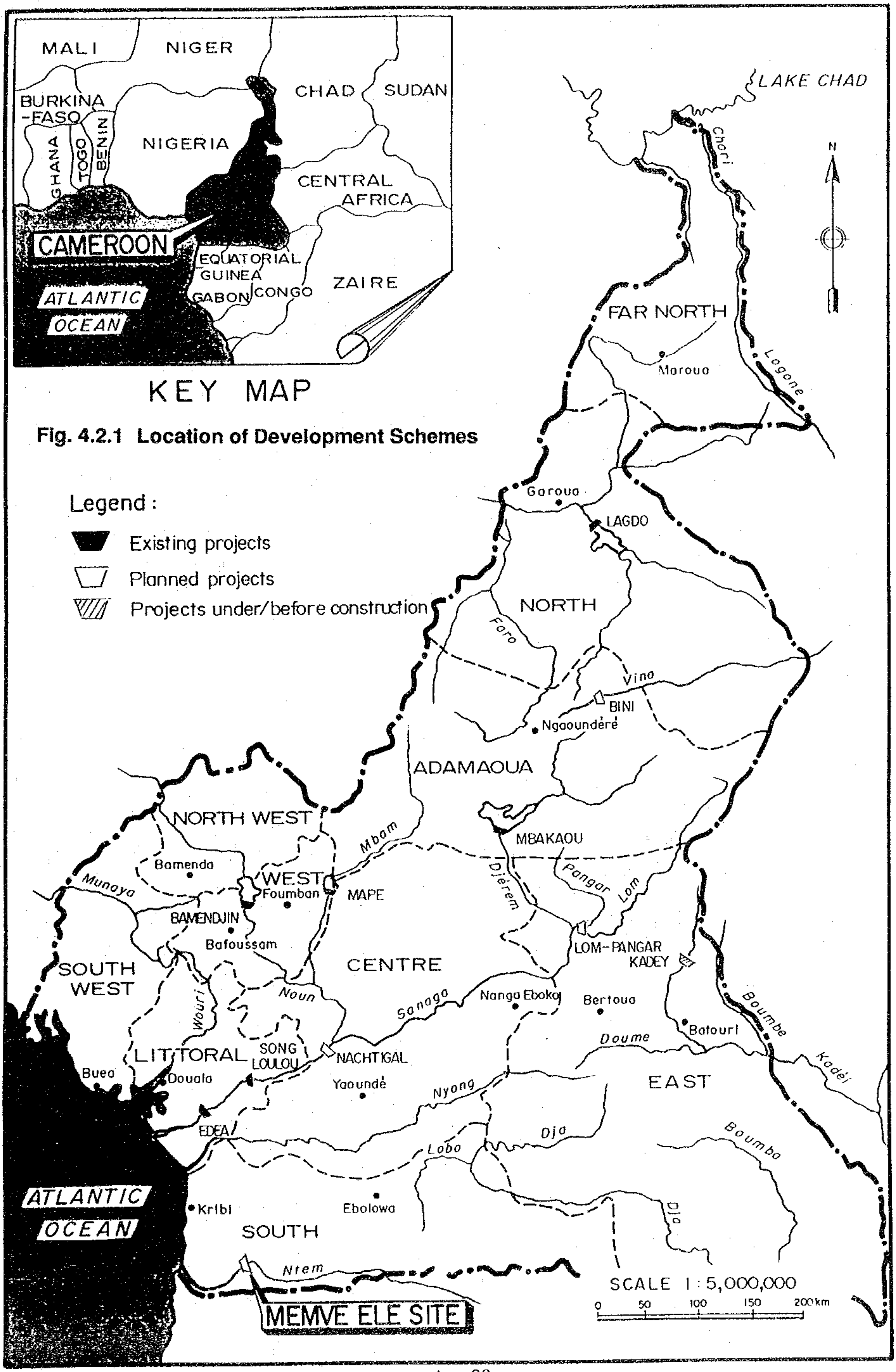


Fig. 4.2.1 Location of Development Schemes

SOUTH INTERCONNECTION NETWORK

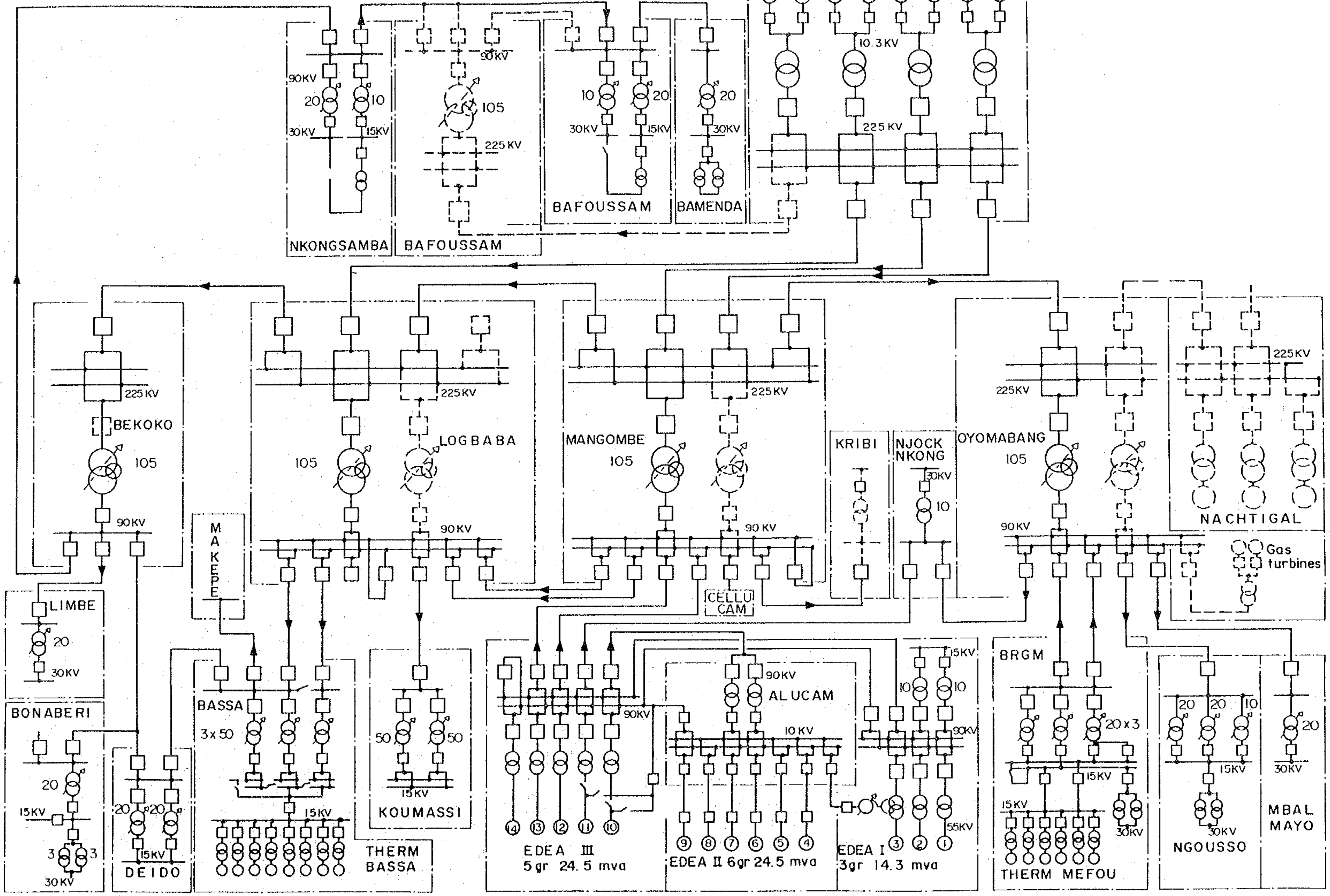


Fig. 4.3.1 Interconnection Networks (1/2)

NORTH INTERCONNECTION NETWORK

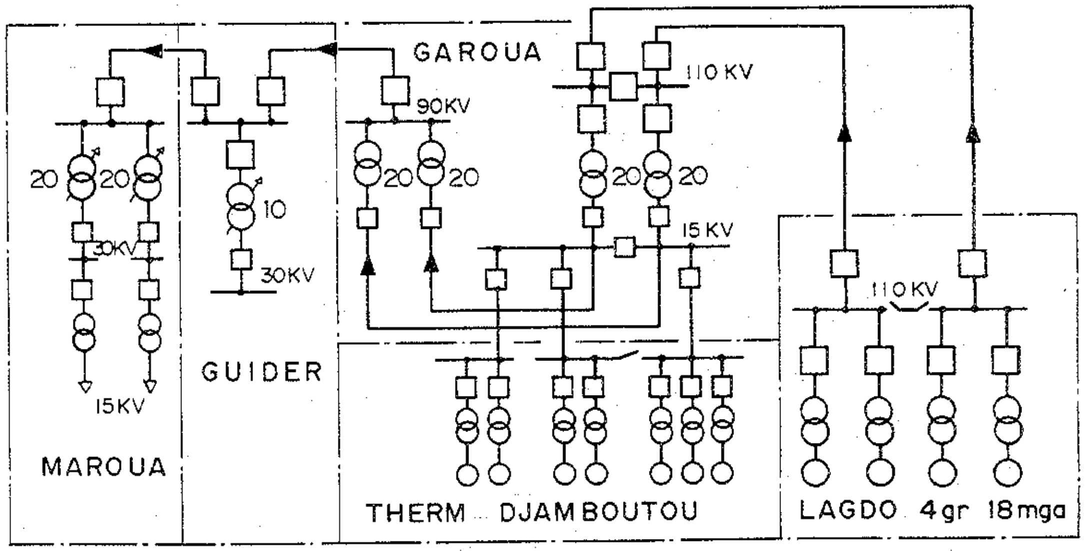
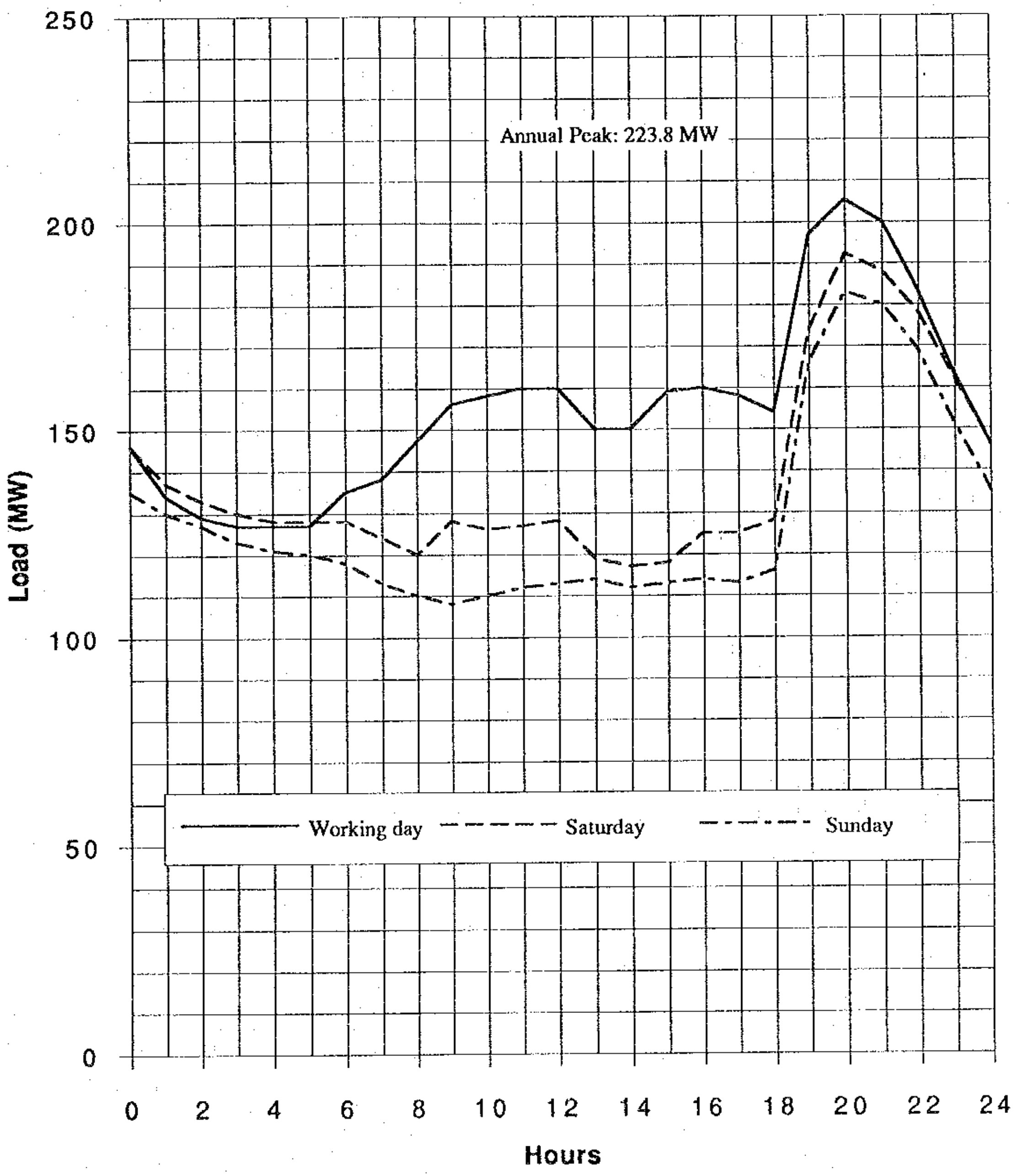


Fig. 4.3.1 Interconnection Networks (2/2)

Fig. 4.4.1 Load Curve for Public Sector in South Interconnected Network

(Fiscal Year 1988/89)



Note: 1. Working day (Load factor: 75.5%, Peak time: 4.43 hrs, 205.3 MW max., 155.7 MW average)
2. Saturday (Load factor: 71.5%, Peak time: 4.89 hrs, 192.3 MW max., 137.6 MW average)
3. Sunday & Holiday (Load factor: 69.9%, Peak time: 5.05 hrs, 183.0 MW max., 128.0 MW average)

Fig. 4.4.2 Historical Daily Load Curve (Working Days)

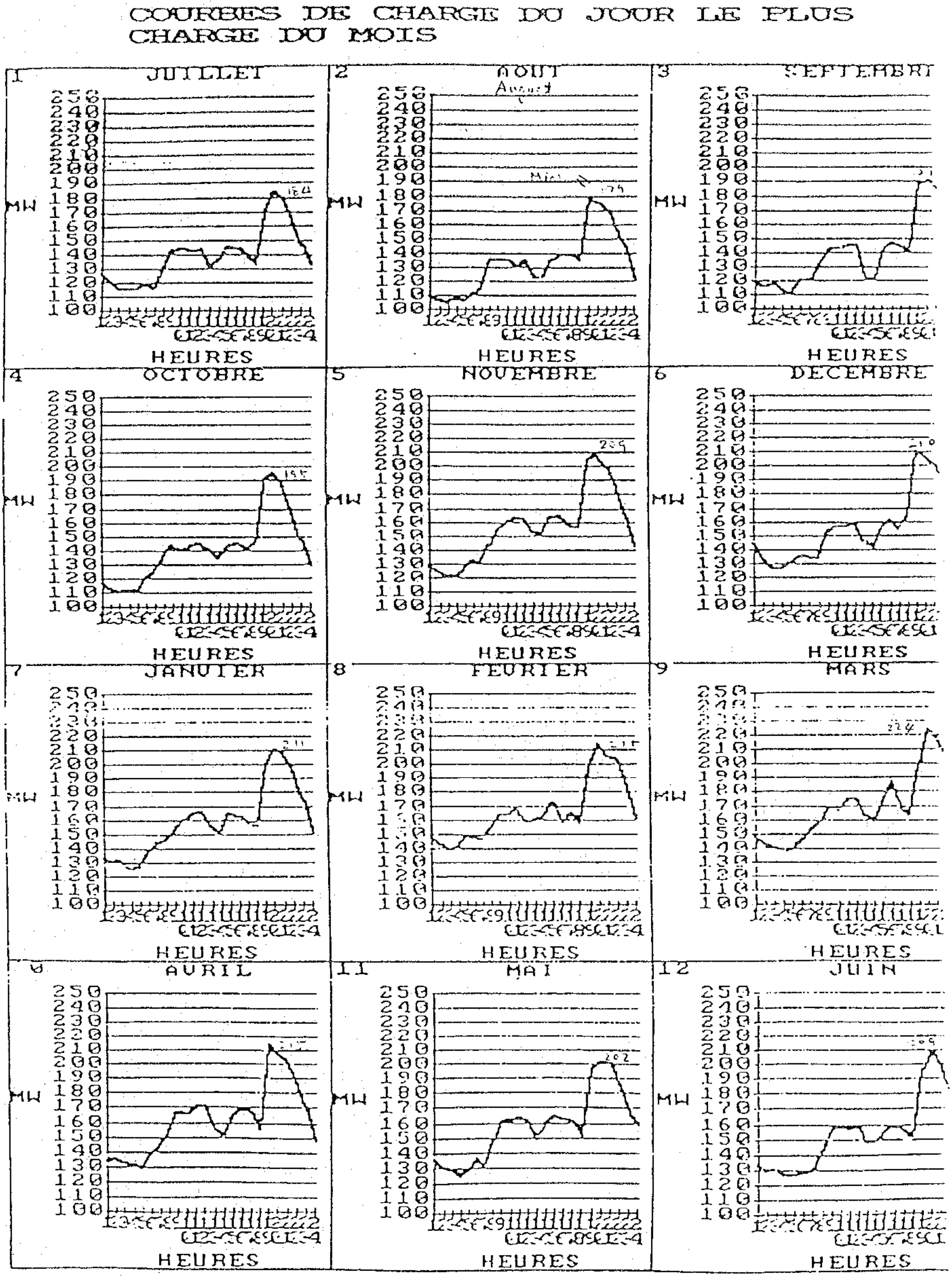


Fig. 4.4.3 Historical Daily Load Curve (Monthly Average)

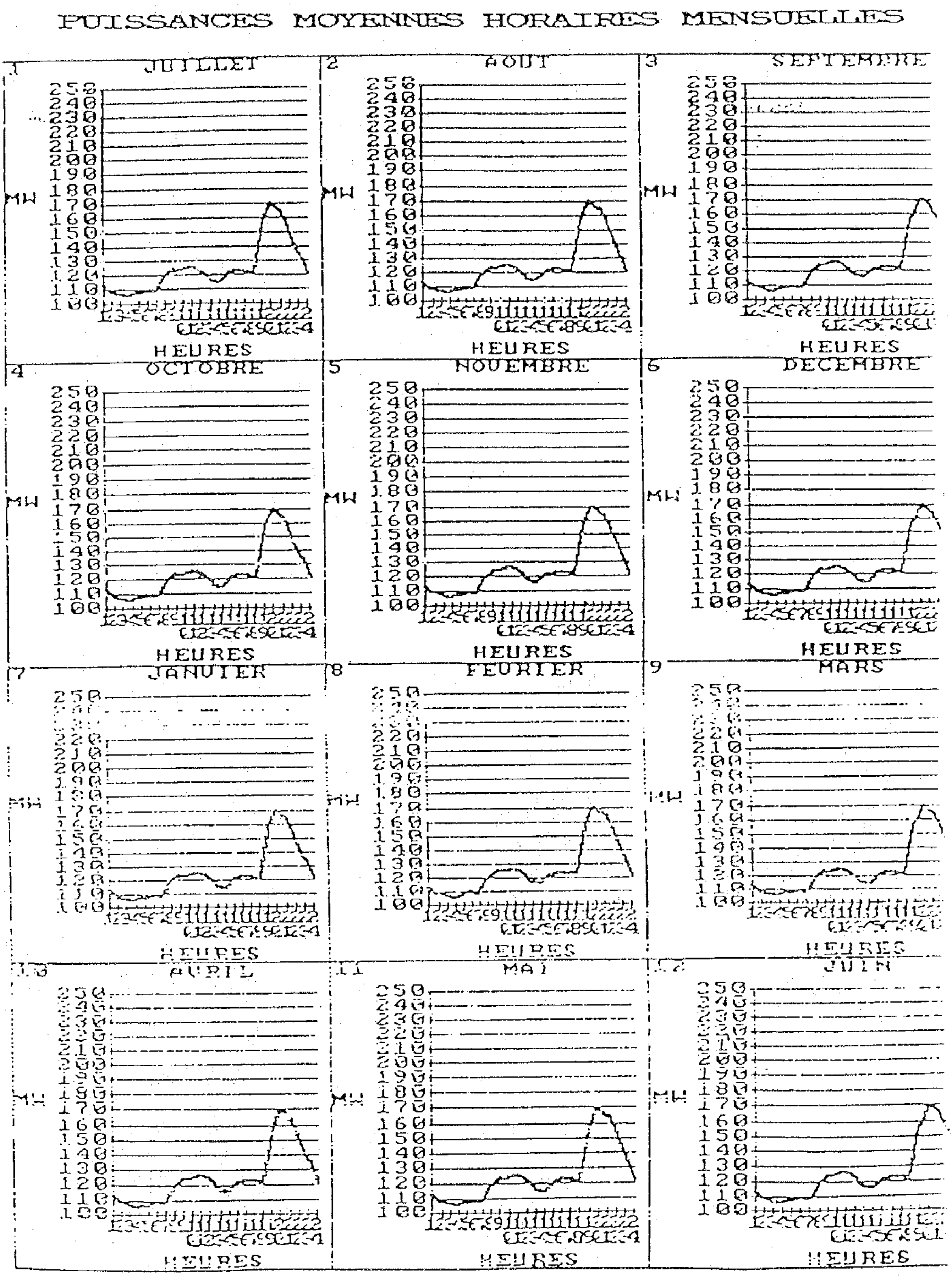


Fig. 4.5.1 Forecast of Peak Power Demand

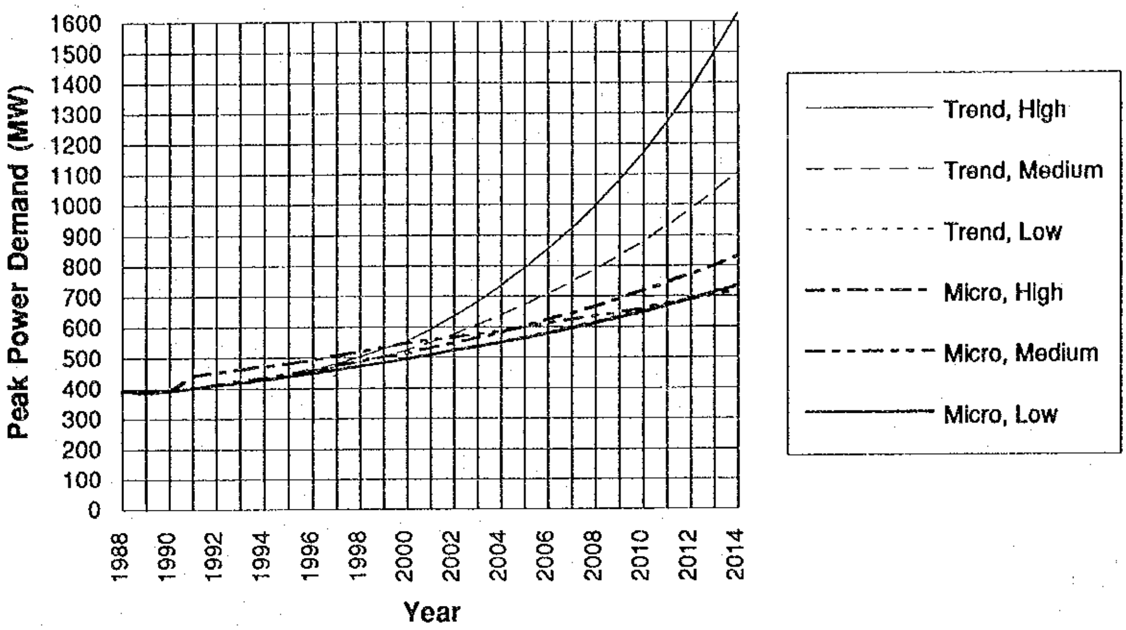
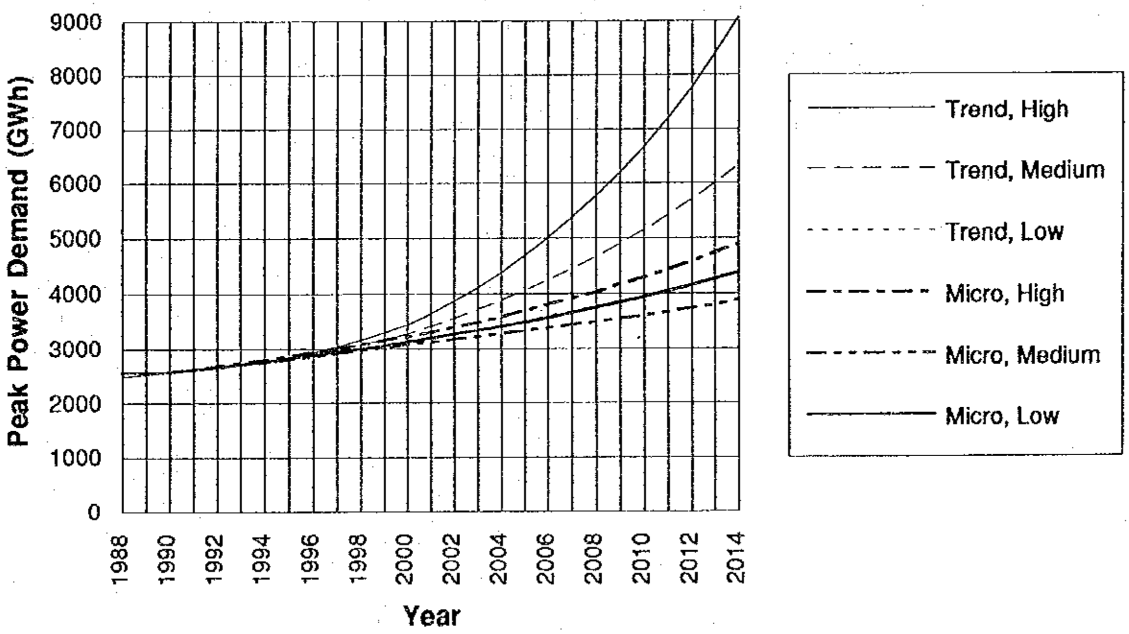


Fig. 4.5.2 Forecast of Energy Demand



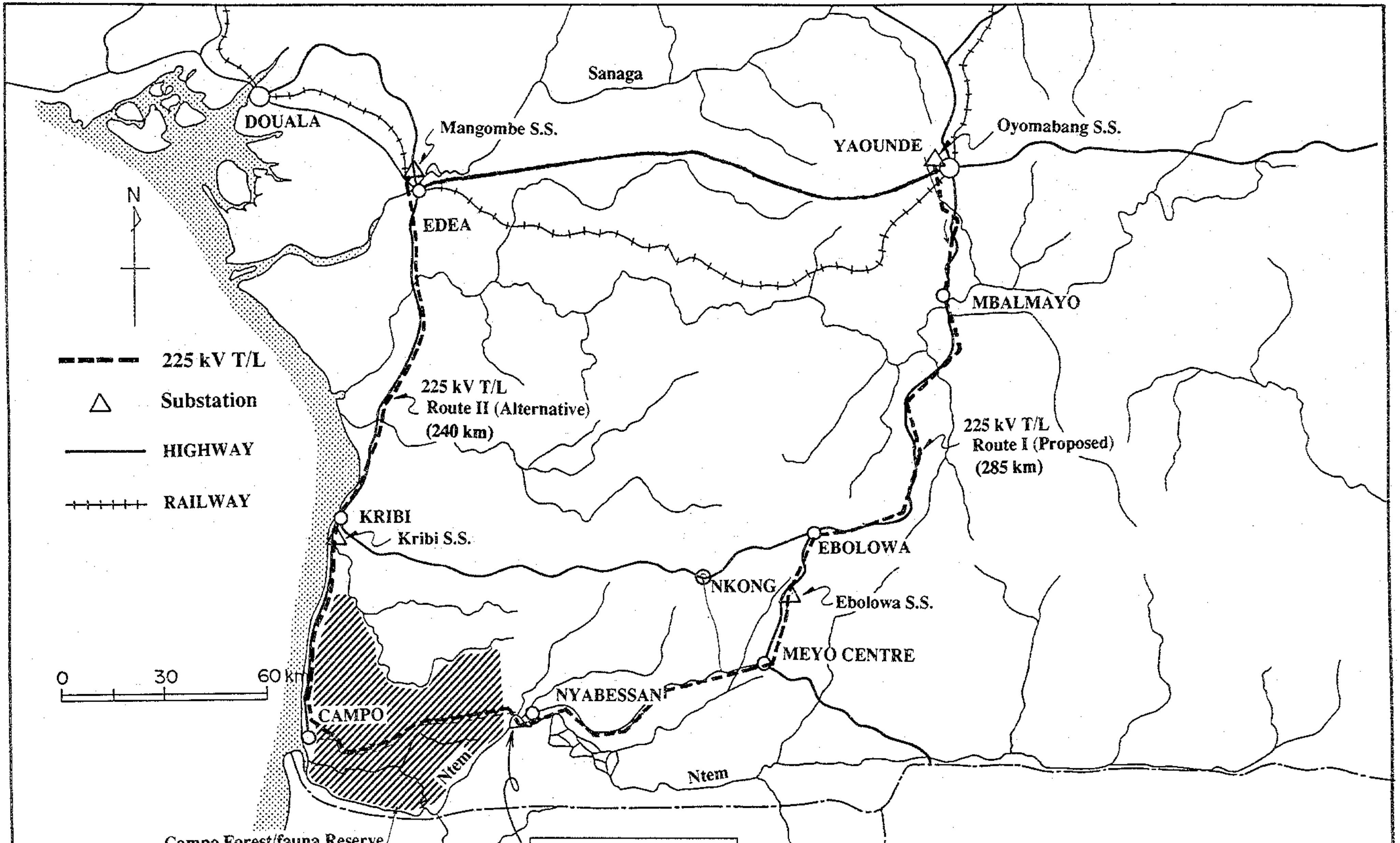


Fig. 4.6.1 Plan of Transmission Line Routes

V. PLAN FORMULATION

5.1 General

A number of development alternatives can theoretically be hypothesized even after the project location is limited to the Memvé Elé waterfall area. Careful discussions are, therefore, required based on engineering comparisons. The first and most important discussion is which development type should be most appropriate:

- *i)* reservoir type development which has a long-term runoff-regulating reservoir (say seasonal regulating reservoir or greater),
- *ii)* regulating dam type development which has a short-term runoff-regulating storage (say daily or weekly regulating storage), or
- *iii)* run-of-river type development which virtually has no runoff-regulating storage.

Reservoir type hydro plants should deal with peak power generation with very large water storage. Contrarily, run-of-river type plants deal with mostly base power generation with no water storage. Regulating dam types are recognized intermediate ones between those two. In a broad sense, with rather small runoff-regulating capacity (a week or less) a regulating dam type is sometimes categorized in a run-of-river type with runoff-regulating function.

If the Memvé Elé Project had a huge water storage enabling seasonal or yearly runoff regulation, a reservoir type must be the most appropriate development style, and the project should generate peak power for hours a day throughout a year. Now, our concern is how huge the Memvé Elé storage can be. The definition of reservoir type generally applied to hydropower engineering is as:

Regulating factor F_r shall be greater than 0.2 or, $$F_r = \frac{V}{R} \geq 0.2,$$

Supply factor F_s shall be greater than 1.5 or, $$F_s = \frac{Q}{\frac{R}{365}} \geq 1.5, \text{ and}$$

Supply days D shall be greater than 30 days or, $$D = \frac{V}{Q} \geq 30 \text{ days.}$$

Where V: Effective storage (m3/sec·day)

R: Annual runoff (m3/sec·day)

Q: Maximum plant discharge·(m3/s)

For the Memvé Elé Project, the above expressions become:

F_r = 0.0039 to 0.0062 < 0.2,

F_S = 1.1 to 0.9 < 1.5, and

D = 1.2 to 2.4 days < 30 days.

where V = 560 to 1,100 m3/sec·day (48 to 95 million m3 equivalent)[1],

R = 145,000 to 177,000 m3/sec·day (12.6 to 15.2 billion m3/year equivalent), and

Q = 450 m3/s (14.2 billion m3/year equivalent)[2].

All of three conditions above are not satisfied. Therefore, the project scheme cannot be a reservoir type, and resultantly be either of a regulating dam or run-of-river type as far as the above indices change dramatically.

More important aspect particular at the Memvé Elé site is the difficulty of building a high dam due to topographical, geological and socio-environmental constraints. Furthermore, cost comparison study revealed that a low dam scheme is the optimum development plan at the site.

5.2 Plan Formulation Procedure

To obtain a successful plan formulation, three-step screening or optimization is considered. They are *i)* rough screening as the first step, *ii)* fine screening as the second, and *iii)* the development scale and timing (DST) optimization as the last.

The rough screening is a sort of project optimization based on cost/kWh (total project cost divided by annual energy production). Main concern in the screening is the dam alignment and waterway route. Since the identified Memvé Elé Project can be categorized in a run-of-river type in a broad sense, it is quite reasonable to use a cost/kWh barometer for the first screening. Runoff regulation effect raising downstream project's firm energy is also

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1 Water fluctuation between EL. 392 m and EL. 390 m is assumed.

2 The optimal plant discharge was determined to be 450 m3/s by the optimization study. See following sections for details.

examined, although the regulation effect is foreseen small. The first screening considers only Memvé Elé Project.

The fine screening as the second step is also project optimization. Main concern in the fine screening is the full supply level (FSL) and maximum plant discharge (Q_{max}). The criterion applied is the net benefit (present value of total project benefit minus present value of total project cost) that clearly illustrates project performance. The alternative thermal plant defining project benefit is diesel generators for both of the primary energy and the secondary energy. The second screening is supposed to choose a couple of Memvé Elé schemes having best features. The second screening does not refer to Cameroon's electricity network but concentrates on the Memvé Elé Project itself.

The DST optimization as the last step selects the best scheme of the Memvé Elé Project. Its concern is which scheme is the most attractive or most advantageous and when the selected scheme should be put into the Cameroon's South Interconnection Network which is represented by present load characteristics as shown in Fig. 5.1. The basics of the DST optimization are to select best project set to put into the system in the future under the condition that total electricity supply is greater than the demand. The criteria applied are the least development cost and the maximum net benefit of the whole South Interconnection Network in the future. The DST optimization tells us the best development order of all of future projects for the network. The future projects concerned for the DST optimization are the selected Memvé Elé schemes in the first and second screening and the Nachtigal Project proposed in the *Aménagement Hydroélectrique de Nachtigal Amont*, February 1989 (Hydro-Quebec and Lavalin with SONEL).

In the DST optimization, Memvé Elé Project is assumed as tow-stage development (Memvé Elé 1 and 2) and Nachtigal Project is as three-stage development (Nachtigal I, II, and III). Allocation of the project costs for the Memvé Elé Project is assumed such as 73 % for the first development and 27 % for the second development. The cost allocation for the Nachtigal Project is referred to the *Aménagement Hydroélectrique de Nachtigal Amont*. The project formulation procedure is summarized in Fig. 5.2.

5.3 Mathematical Models for Project Optimizations

5.3.1 Cost/kWh Optimization Model (First Screening Model)

The cost/kWh optimization problem can mathematically be expressed as:

Minimize $Z(C_o, E_o) = C_o / E_o$

Subject to $C_o = C(A, Q, H, W)$
$E_o = E(A, Q, H, W)$

where
- Z: cost/kWh (F.CFA/kWh) (the objective function)
- C_o: total project cost (F.CFA)
- E_o: annual energy production (kWh)
- A: alternatives of dam alignment
- Q: alternatives of maximum plant discharge
- H: alternatives of dam height
- W: alternatives of waterway alignment

5.3.2 Net Benefit Optimization Model (Second Screening Model)

The net benefit optimization is possible by solving a nonlinear problem that can mathematically be expressed as:

Maximize $Z = (B_o - C_o)$

Subject to $B_o = B(E, P)$
$C_o = C(A, Q, H, W)$

where
- Z: net benefit (the objective function)
- B_o: total project benefit (F.CFA)
- C_o: total project cost (F.CFA)
- E: annual energy production (kWh)
- P: dependable power output (kW)
- A: alternatives of dam alignment
- Q: alternatives of maximum plant discharge
- H: alternatives of dam height
- W: alternatives of waterway alignment

5.3.3 Development Scale and Timing (DST) Optimization Model

If the Memvé Elé Project (Memvé Elé 1 and 2) and the Nachtigal Project (Nachtigal I, II and III) are the only future hydropower plants to be developed in South Interconnection Network, the DST problem can mathematically be:

Minimize $Z = C_k(t_1, t_2, t_3, t_4, t_5)$ or Maximize $Z = B_k(t_1, t_2, t_3, t_4, t_5)$

Subject to $C_k(t_1, t_2, t_3, t_4, t_5) = C_1(t_1) + C_2(t_2) + C_3(t_3) + C_4(t_4) + C_5(t_5)$

$B_k(t_1, t_2, t_3, t_4, t_5) = B_1(t_1) + B_2(t_2) + B_3(t_3) + B_4(t_4) + B_5(t_5)$

$P_d(t, m) \leq P_s(t, m)$

$E_d(t) \leq E_s(t)$

$t_1 \leq t_2$

$t_3 \leq t_4 \leq t_5$

$t = 1993, 1994, \cdots, t_{\text{last}}$

m = January, February, $\cdots$, December

where
Z: objective function
C_k: project development cost ($k = 1, 2, 3, 4, 5$)
B_k: net benefit ($k = 1, 2, 3, 4, 5$)
P_d: power demand (MW)
P_s: power supply (MW)
E_d: energy demand (GWh)
E_s: energy supply (GWh)
t: fiscal years
m: months
t_k: developing year ($k = 1, 2, 3, 4, 5$) (variables)
$k = 1$ for 1st stage of Memvé Elé Project
$k = 2$ for 2nd stage of Memvé Elé Project
$k = 3$ for 1st stage of Nachtigal Project
$k = 4$ for 2nd stage of Nachtigal Project
$k = 5$ for 3rd stage of Nachtigal Project

The objective function represents total project cost or total net benefit of the five schemes that is defined by the first constraint. While when the total project cost is taken the objective function is minimized, when the net benefit is done it is maximized. The second and third constraints are to guarantee the electricity satisfaction in the future in up to the last year (t_{last})[3]. The electricity satisfaction is examined in terms of both gigawatt-hour (GWh) and megawatt (MW). The electricity demand up to the year of 2014 is referred to the medium growth scenario of the microscopic method. (See Figs. 4.5.1 and 4.5.2 for details.) The electricity demand after 2015 is based on expansion of the medium growth scenario assuming that the demand increase tendency is preserved. The forth and fifth define the development order; Memvé Elé 1 must precede Memvé Elé 2, etc. The last two constraint sets represent years and months the problem concerns; the beginning year associates with the present year of 1993 while the last year t_{last} does with the electricity satisfaction end in the case of putting both of full Memvé Elé and full Nachtigal Projects into the South Interconnection Network.

The optimization assumes following:

(a) The comparison is based on present value of the net benefit or total project cost associated with future projects.

(b) Cash flow is based on 1993 price (no interest during the construction period is included).

(c) Alternative thermal plant is diesel generators for the primary and secondary energy.

5.4 Development Alternatives

A number of development alternatives can be identified for the Memvé Elé Project. Points to select appropriate alternatives should be *i)* dam alignment determining how and which water resources should advantageously be used, *ii)* waterway route characterizing head for power generation, *iii)* full supply level influencing water storage volume as well as dam height, and *iv)* plant discharge defining magnitude of electric energy output.

The alternatives examined in this report finally come up 252 cases in total as summarized in Table 5.1; they are of two dam alignments, three waterway routes, six full supply levels, and seven plant discharge series. The following passages describe those four selecting points for the development alternatives.

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[3] The energy deficit will appear in 2022 or 2023 even if full development of the Memvé Elé and Nachtigal are made. The energy deficit year t_{last} depends on the Memvé Elé's development scale.

(1) Alternatives for Dam Alignment

There exist two dam alignments applicable. They are Dam Alignment 1 (*A(1)*) representing the Small Scale Development utilizing runoff from only Ntem river, and Dam Alignment 2 (*A(2)*) for the Large Scale Development using runoff from all of three rivers (Ntem, Biwome, and Ndjo'o rivers). On one hand, despite the advantage of the greater usable volume of water, the alternative *A(2)* has very long dam crest length simply yielding the greater dam volume. It measures about 3.8 km including spillway length. On the other hand, the *A(1)* has the shorter crest length. It roughly measures 1.8 km and accordingly needs smaller construction volume for the dam.

Fig. 6.1 shows those two dam alignment alternatives. Section 3.3 states the discussions on choosing those two dam alignments from view points of geology.

(2) Alternatives for Waterway Route

Six waterway routes were originally identified. As mentioned in the *Interim Report*, however, only three waterway routes remained as alternatives. Other three waterway routes identified at and before the *Progress Report* 2 turned in September 1992 had been excluded from the alternative set for the project optimization. This is because these three excluded waterways ran in the swampy areas, which were found in the field investigations to involve construction difficulty as well as project cost increase.

The present three alternatives of the waterway route are *W(1)* representing the high head scheme of the headpond and tailrace tunnels, *W(2)* denoting the low head scheme of the headpond and tailrace tunnels, and *W(3)* for the other high head scheme of tailrace tunnel without headpond. Note that all of alternatives include open headrace channel. The waterway alternatives are illustrated in Fig. 6.1.

(3) Alternatives for Full Supply Level

The applicable elevation range of full supply level (FSL) is limited. On one hand, the topography suggests that the full supply level be no below EL. 388 m because the present typical river runoff has a flow surface approximately at EL. 388 m. On the other hand, the geology warns that the water level above EL. 392 m need some countermeasure against water leakage through dam abutments. This is because no impervious zones such as hard rock above EL. 392 m are found in the right-hand-most areas where the dam abutments would be.

It is predictable, therefore, that the optimal full supply level is in the range between EL. 388 m and EL. 392 m; the *Interim Report* turned in January 1993 limits the discussions with only three alternatives in that range. To make much deeper discussions on the optimal full supply level, however, discussion range is now expanded such as from EL. 388 m to EL. 398 m.

The FSL optimization finally treats the full supply level as a continuous variable, not discrete one. However, six discrete alternatives are symbolically taken for easy understanding of the optimization study. They are $H(k)$ = {398, 396, 394, 392, 390, 388 m}; k = -2, -1, 0, 1, 2, 3[4]. Applying the three-meter freeboard to the earthfill dam, the corresponding dam crest elevations are accordingly from EL. 401 m to EL. 391 m with a two-meter interval.

(4) Alternatives for Plant Discharge

Plant discharge is one of the very important variables for hydropower plants. For the Project, maximum plant discharge ranging from 350 m3/s to 650 m3/s is examined. Although the optimization finally refers to continuous variable in that range, seven discrete discharge series are selectively discussed in the following section. The discharge series are $Q(j)$ = {*350, 400, 450, 500, 550, 600, 650* m3/s}; j = *1* to *7*. The range boundaries of the maximum plant discharge can be translated to approximately 90% and 170% of the mean runoff of the project site.

5.5 Project Optimization

5.5.1 Estimate of Project Cost and Electricity Production

(1) Estimate of project cost

Estimate of the project costs for all of 252 cases was based on cost curves which were derived from cost estimate on unit price basis (partly on lump-sum basis, i.e., the preparatory civil works) for representative alternative schemes. The tendency of the project cost in terms of the full supply level (***H(k)***) and maximum plant discharge (***Q(j)***) is straightforward. The greater those values are, the more costly is the project cost.

As expected, the Small Scale Development (***A(1)***) is less expensive by 10 to 20% than the Large Scale Development (***A(2)***). The cheapest waterway alternative is ***W(2)*** owing to its

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[4] The suffix starts with -2 (minus two) for the symbol ***H*** to meet that of the *Interim Report*.

shortest waterway length. The most expensive one is ***W(3)*** mainly because of its long headrace tunnels. The cost range is roughly F.CFA 90 to 140 billion or US $330 million to US $520 million when the maximum plant discharge is 400 m3/s to 500 m3/s.

Selected project costs are summarized in Table 5.2 and Fig. 5.3.

(2) Estimate of power output and annual possible energy production

The annual possible energy production can be defined by:

$$E = C \times 365 \text{ [days/year]} \times 24 \text{ [hours/day]} \times P \text{ [kW]}$$

$$P = \eta\, g\, H_e\, Q \text{ [kW]}$$

where C: coefficient

E: annual energy production (GWh/year)

P: power output (kW)

g: gravity acceleration (9.8 m/sec2)

η: combined efficiency (0.872)

H_e: effective head (m)

Q: plant discharge (m3/s)

The power output ***P*** and annual energy production ***E*** greatly depend on the project alternatives, especially on the maximum plant discharge ***Q***.

When a run-of-river type is assumed, in the range of ***Q*** from 400 m3/s to 500 m3/s, the power output varies roughly 150 MW to 240 MW while the energy production does 850 to 1,350 GWh a year.

In general, when a reservoir has some runoff-regulation function, usable water volume and annual possible energy can theoretically be increased. In the Memvé Elé' s case, however, increase of the usable water volume was found very small and negligible. The increase rate is only 1 % even when effective water storage volume is as large as 300 m3 billion that is regarded as the Memvé Elé' s maximum water storage with the full supply level at EL. 400 m. This is owing chiefly to a relatively small storage capacity compared to annual total runoff volume (2.4 % even in case of 300 billion m3 storage). The runoff regulating effect owing to water storage is summarized in Fig. 5.4.

Nevertheless, the reservoir will contribute to some extent to improving flow regime in terms of increasing the dry season discharges (say, 95 % discharge). Representative cases appearing in Fig. 5.4 are shown below.

Case (Fig. 5.4)	Effective Storage	Dead Storage*	Gross Storage	FSL	95 % Discharge (Outflow)	
					Discharge	Increase
ROR	-	122 mil m3	130 mil m3	392 m	82 m3/s	-
RD-1	50 mil m3	122 mil m3	172 mil m3	394 m	102 m3/s	22 m3/s
RD-2	100 mil m3	122 mil m3	222 mil m3	395 m	125 m3/s	45 m3/s
RD-3	300 mil m3	122 mil m3	422 mil m3	400 m	172 m3/s	92 m3/s

* at MOL 391.5 m (100-year sediment level 388 m plus 3.5 m for extra water intake depth).
Where Q = 450 m3/s is assumed as a maximum plant discharge

ROR: Run-of-river, RD: Regulating Dam

This will bring about the following effects and consequences:

(a) Increase of primary energy output at Memvé Elé site (secondary energy replaces or is upgraded to primary energy)

(b) Similar firming-up of primary energy is expected at the future downstream schemes, where a total head of 80 m (raised to 140 m later) may be exploitable according to SONEL's potential study (1983). This is regarded as the benefit attributable to the Memvé Elé scheme.

However, this benefit will arise only in the long future (not known at present) once the downstream scheme are realized and is not substantial in terms of present value. Hence, net-present-value raise due to the future downstream projects is disregarded from the present evaluation.

(c) Raise of FSL above EL. 392 m will involve an extensive saddle dam/water leakage prevention work both along the south western low ridges and at the right abutment of the dam (near Nyabessan).

Comparison of the above four plans is based on net present value, where the benefit is assumed to be saving in alternative thermal cost (see Section 5.5.3 below for kW and kWh values estimated for alternative thermal and Chapter 8 for further details). Taking into account these benefit and cost aspects, net present value is compared as follows:

Case	Installed Capacity (MW)	Energy (GWh) Primary	Secondary	Construction Cost (Mill. US$)	Net Present Value (Mill. US$)
ROR	201.2	338	816	416.5	153.7
RD-1	208.0	423	757	473.0	141.8
RD-2	211.6	516	690	504.1	138.2
RD-3	228.4	703	600	721.7	107.1

Case "ROR" is favorably compared, although the difference is marginal. Another merit is that the Case "ROR" requires the least cost investment. Hence, Case "ROR" is examined in further study.

The summary of the energy production simulations is shown in Figs. 5.5 and 5.6.

5.5.2 Optimal Cost/kWh by First Screening

The optimization study shows better (cheaper) cost/kWh in case of the Small Scale Development ***A(1)*** as summarized in Fig. 5.7. The cost/kWh difference between the Small and Large Scale Development cases is roughly 4% or 4 F.CFA/kWh in respective local optimal points. From the view point of waterway alternatives the Waterway Case 1 ***W(1)*** can be recognized as the superior case.

In those optimal selections, that is, ***A(1)*** and ***W(1)***, the cases of full supply level at EL. 392 m ***H(1)*** show the most advantageous scheme for the Project. The optimum value is found at 97.7 F.CFA/kWh when the maximum plant discharge is 450 m3/s ***Q(3)***.

The cost/kWh of 97.7 F.CFA/kWh can be evaluated very attractive compared with that of hydropower projects worldwide. Fig. 5.8 illustrates the cost/kWh optima. Table 5.2 includes the project cost associated with the optimal project scheme. The optimized project features are:

Dam Alignment:	Alignment, ***A(1)*** that is the small scale development using runoff only from Ntem river,
Waterway route:	Waterway Case 1, ***W(1)*** equipped with the 2.5 km long headrace channel, headpond, and two lanes of 1.5 km long tailrace tunnels (The Waterway Case 1 yields the averaged tail water level at EL. 336.0 m and gross head of 56.0 m),
Full supply level:	EL. 392.0 m, ***H(1)*** tentatively, and

Maximum plant discharge: Q = 450 m3/s, $Q(3)$ tentatively.

Recall that these are cost/kWh based screening results assuming a run-of-river type.

5.5.3 Optimal Net Benefit by Second Screening

From the first screening results, the combination of Small Scale Development (or Dam Alignment $A(1)$) and Waterway Case 1 (or $W(1)$) is assumed for the second screening on net benefit basis.

The second screening showed the almost same tendency of the project optimization results as the first screening reached. The optimum scheme obtained is that the maximum plant discharge (Q_{max}) is 450 m3/s and the full supply level (FSL) is at EL. 392 m. This is exactly same as the first screening results. The associated net benefit is US $153.7 million.

However, the above solution might change if our concern shifts to the whole South Interconnection Network from the Memvé Elé Project. The final solution shall, therefore, be obtained from the Development Scale and Timing (DST) optimization or the third screening. As the conclusion of the second screening, five development plans are taken for the DST optimization as follows:

Full Supply Level	Maximum Plant Discharge		
	Q = 400 m3/s	Q = 450 m3/s	Q = 500 m3/s
FSL. 390 m	-	Plan 1	-
FSL. 392 m	Plan 2	Plan 3	Plan 4
FSL. 394 m	-	Plan 5	-

The net benefit from those five plans are as:

Plan 1: US $139.6 million or F.CFA 37.8 billion,
Plan 2: US $135.9 million or F.CFA 36.8 billion,
Plan 3: US $153.7 million or F.CFA 41.6 billion,
Plan 4: US $137.6 million or F.CFA 37.2 billion, and
Plan 5: US $145.3 million or F.CFA 39.3 billion.

To compute the Project's net benefit, the following assumptions are taken:

i) 50 years of evaluation period from the present year of 1993,

ii) 10% of the discount rate,

iii) US $ 1,131/kW of the economic construction cost for the gas turbine generators as alternative thermal, and

iv) The energy value is estimated as US $0.0769/kWh (gas-turbine) for primary energy and US $0.0340/kWh (oil-fired) for secondary energy, which is based on international fuel price.

See Chapter 8 for other assumptions. The results of the net benefit optimization is illustrated in Fig. 5.9.

5.5.4 Development Scale and Timing (DST) Optimization

(1) Least Cost Optimization

Applying a 50-year evaluation time-line, a DTS optimization was carried out based on the least cost of the entire South Interconnection Network. The beginning year of the evaluation is the present year of 1993.

Each plan out of Memvé Elé's **Plans 1** to **5** shows that the development of the Nachtigal Project precedent to that of the Memvé Elé Project makes the network have least cost in the future. In this case, the Nachtigal Project should be developed in 2001, and the Memvé Elé Project be in 2015. The analysis summary is illustrated in Fig. 5.10 and as follows:

Memvé Elé Scheme		Total Cost	
	Plan 1	Bill. F. CFA 377.5 or	Mill. US $1,395
	Plan 2	Bill. F. CFA 430.5 or	Mill. US $1,591
(Optimal)	Plan 3	Bill. F. CFA 369.4 or	Mill. US $1,365
	Plan 4	Bill. F. CFA 462.7 or	Mill. US $1,710
	Plan 5	Bill. F. CFA 463.1 or	Mill. US $1,712

Note: Total cost is a present value composed of development costs of the full Nachtigal and the full Memvé Elé.

The DST optimization based on system's least cost concludes that **Plan 3** as the Memvé Elé's scheme should be realized after the Nachtigal Project, if the least investment is sought.

Note that the above conclusion does not always yield the most beneficial plan of the South Interconnection Network in the future, if the evaluation in (2) below is taken into account.

(2) Net Benefit Optimization

When the invest amount for the future South Interconnection Network is not strictly limited, the maximum net benefit from the Network can naturally be sought regarding the Network's components as one unit. In this situation, it is quite reasonable to try the DST optimization on maximum net benefit basis.

The net-benefit based DST optimization is carried out under the conditions shown in Table 5.3. The project candidates are Memvé Elé 1, Memvé Elé 2, Nachtigal I, Nachtigal II, and Nachtigal III. With **Plan 3** as the Memvé Elé's scheme, the DST optimization concludes the following net benefit from the future Network:

	Net Benefit (Mill. US $)	Development Order (Development Year)
	1,243.0	M1 (2001) - M2 (2008) - N1 (2013) - N2 (2019) - N3 (2021)
	1,314.7	M1 (2001) - N1 (2008) - M2 (2015) - N2 (2019) - N3 (2021)
	1,315.1	M1 (2001) - N1 (2008) - N2 (2013) - M2 (2018) - N3 (2021)
	1,314.6	M1 (2001) - N1 (2008) - N2 (2015) - N3 (2018) - M2 (2020)
	1,351.5	N1 (2001) - M1 (2010) - M2 (2015) - N2 (2019) - N3 (2021)
(Optimal)	1,351.8	N1 (2001) - M1 (2010) - N2 (2015) - M2 (2018) - N3 (2021)
	1,351.4	N1 (2001) - M1 (2010) - N2 (2015) - N3 (2018) - M2 (2020)
	1,324.9	N1 (2001) - N2 (2010) - M1 (2013) - M2 (2018) - N3 (2021)
	1,323.9	N1 (2001) - N2 (2010) - M1 (2013) - N3 (2018) - M2 (2020)
	1,303.9	N1 (2001) - N2 (2010) - N3 (2013) - M1 (2016) - M2 (2020)

Note: M1 and M2 for Memvé Elé 1 and 2
N1, N2 and N3 for Nachtigal I, II and III.

It is found that if the maximum net benefit is sought the series development in the order of Nachtigal I, Memvé Elé 1, Nachtigal II, Memvé Elé 2, and Nachtigal III is the most advantageous, when **Plan 3** (Q_{max} = 450 m3/s with FSL = 392 m) is realized. The net benefit of whole the South Interconnection Network in this case is F. CFA 365.8 billion or US $1,351.8 million, and the developing years are again: