CHAPTER 4

EXISTING POWER SYSTEM AND EXPANSION PLANS

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4.1 Existing Power System

Electricity Supply System

The Ministry of Mines and Energy (MME) is responsible for overseeing the general development of the energy sector. The parastatal electrical utility, NamPower is responsible for electricity generation, transmission and distribution.

The distribution system is complicated (Figure 4.1). In the urban areas and a part of towns and villages, 46 entities owned by the local authorities distribute electricity received at 66kV from NamPower through their distribution system. In the rural areas, the Ministry of Regional, Local Government and Housing (MRLGH) operates 11kV level reticulations, empowered from NamPower, which were constructed by MME. Over parts of seven regions in northern Namibia, Northern Electricity, a private distributor is responsible for electricity supply.

NamPower operates as a bulk supplier to municipalities, mining, MRLGH, Northern Electricity and as a distributor to commercial farms, manufacturing and government facilities out of local authorities in the rural areas.

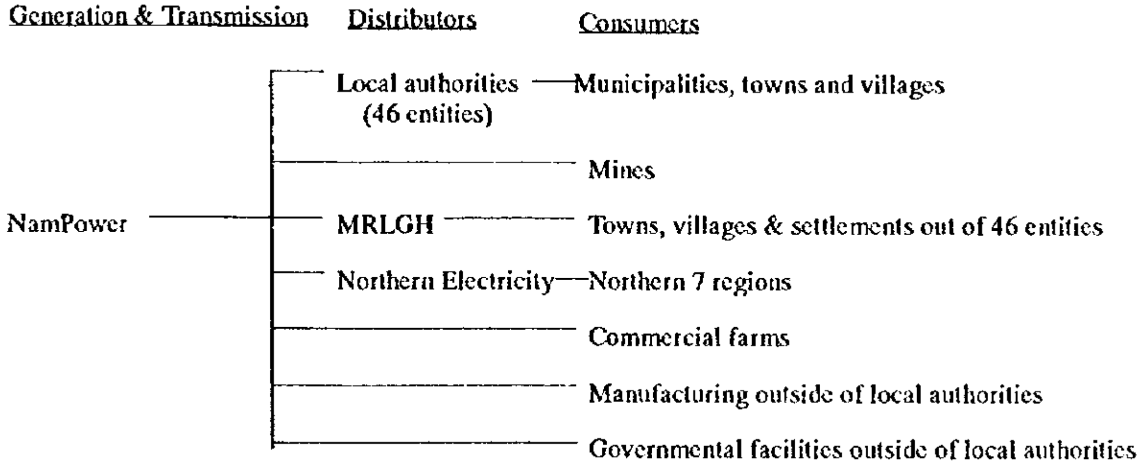


Figure 4.1 Electricity Supply System

Expansion Plans

Since Independence, there has been steady growth in electricity demand at an average annual rate of 2.3%. NamPower has catered for the increasing demand by extended import from South Africa. Based on the anticipated growth in demand, NamPower shall need extra capacity in generation. It has therefore decided to construct 400kV interconnecting line with the South African network.

Concurrently NamPower is considering various alternatives to increase its generation capacity. It announced in May 1997 that it had reached agreement in principle with Shell and Eskom to develop a 750MW combined cycle power plant making use of gas from Kudu if the technical, economic and commercial feasibility prove favourable. Its commissioning is not decided yet.

Regarding system expansion plan, NamPower only refers to that the 400kV interconnection is a certainty at the time of writing, and the Epupa hydropower project in the subject of a feasibility study in its electricity master plan.

4.1.1 Generating Capacity

The total power supply capacity of the NamPower grid at present is 584MW and is made up by the following sources of energy:

- **Ruacana hydro electric power plant** [Commissioned in 1978]
  240MW. Located on the Cunene river at Ruacana falls.

- **Van Eck thermal power plant** [Commissioned in 1972]
  120MW. Located in Windhoek

- **Paratus diesel power plant** [Commissioned in 1975]
  24MW. Located in Walvis Bay.

- **South Africa interconnector** [Commissioned in 1982]
  200MW. A 220kV double circuit line linked between Kokerboom in Namibia and Aggeneis substation on the Eskom 400kV grid with 2 x 315MVA transformers

- **Katima Mulilo diesel power plant** [Commissioned in 1980]
  3MW Located in Katima Mulilo, in an isolated system

Van Eck thermal power plant would be closed down in the end of 2003 since its technical life would have expired.

Table 4.1 shows statistics on the energy sales and generation. The system peak load on the grid was 326.6MW for July 1997, when peak load from Eskom was 259.6MW (79% of the system peak load).

Demand growth (1987 - 1996) is illustrated in Figure 4.2, Load duration of system in Figure. 4.3 and Load duration of imports from Eskom in Figure 4.4.

Table 4.1 Namibian Energy Balance

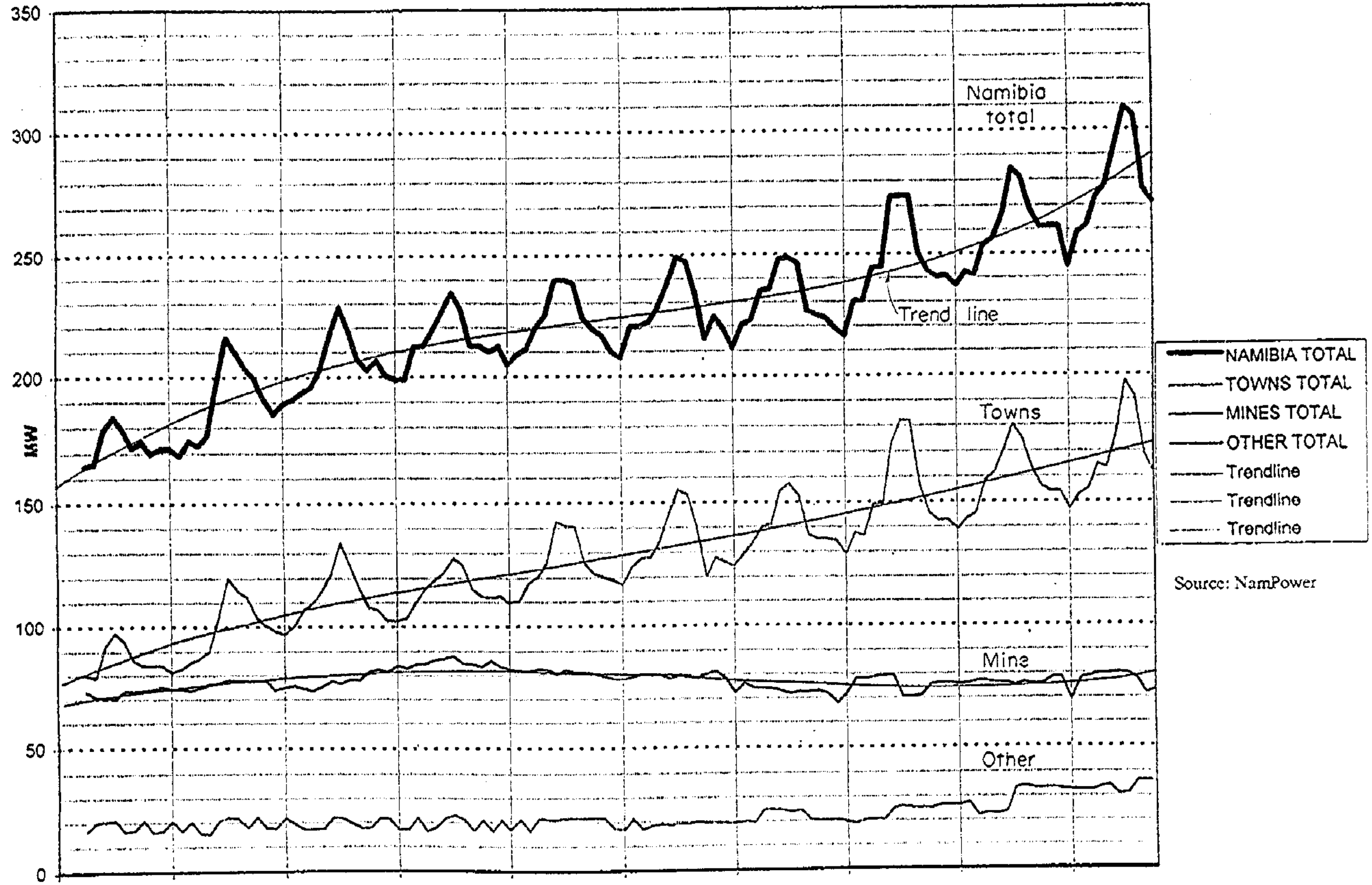
(Unit: GWh)

No.	Total Sales / Year	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97
1	Ruacana P/S	1086	1308	1053	1322	1148	967	672	1134	854	610
2	Van Eck / Paratus P/S	124	88	96	46	6	27	189	124	20	19
3	Export	(233)	(267)	(166)	(201)	(204)	(49)	(28)	(146)	(30)	(1)
4	Net Import	(320)	(290)	(475)	(350)	(589)	(703)	(846)	(618)	(1078)	(1319)
5	Exchange [Item (3) + (4)]	553	557	641	551	793	752	874	764	1108	1320
6	Total sent out	1763	1953	1790	1919	1948	1746	1735	2015	1951	1949
7	Losses	181	176	178	200	234	195	200	237	220	249
	Losses in %	(10.3)	(9.0)	(9.9)	(10.4)	(12.0)	(11.2)	(11.5)	(11.7)	(11.28)	(12.78)
8	Total sales	1582	1777	1612	1719	1714	1551	1535	1784	1731	1700
	Break Down of Total Sales										
9	Municipalities	482	584	624	658	718	750	786	868	913	963
10	Mines	702	700	742	758	691	619	629	631	656	596
11	Rural Supply	89	32	38	39	42	50	57	139	132	140
12	Water Supply	0	53	53	63	60	61	59	-	-	-
13	Total Consumption	1273	1368	1457	1519	1512	1480	1530	1638	1670	1730
14	Export to RSA	233	267	166	201	204	49	28	146	30	1
15	**Total Sales**	**1506**	**1636**	**1623**	**1720**	**1716**	**1529**	**1558**	**1785**	**1700**	**1731**
16	Errors & Omissions	76	141	-11	-1	-2	22	-23	0		
17	Losses include E & O (%)	(14.6)	(16.2)	(9.3)	(10.4)	(11.3)	(12.4)	(10.2)	(0)		
18	Peak Load (MW)	(211)	(213)	(225)	(240)	(246)	(279)	(261)	(277)	(294)	(321)
19	Load Factor (%)						(69)	(75)	(77)	(75)	(69)

Source: NamPower Annual Report

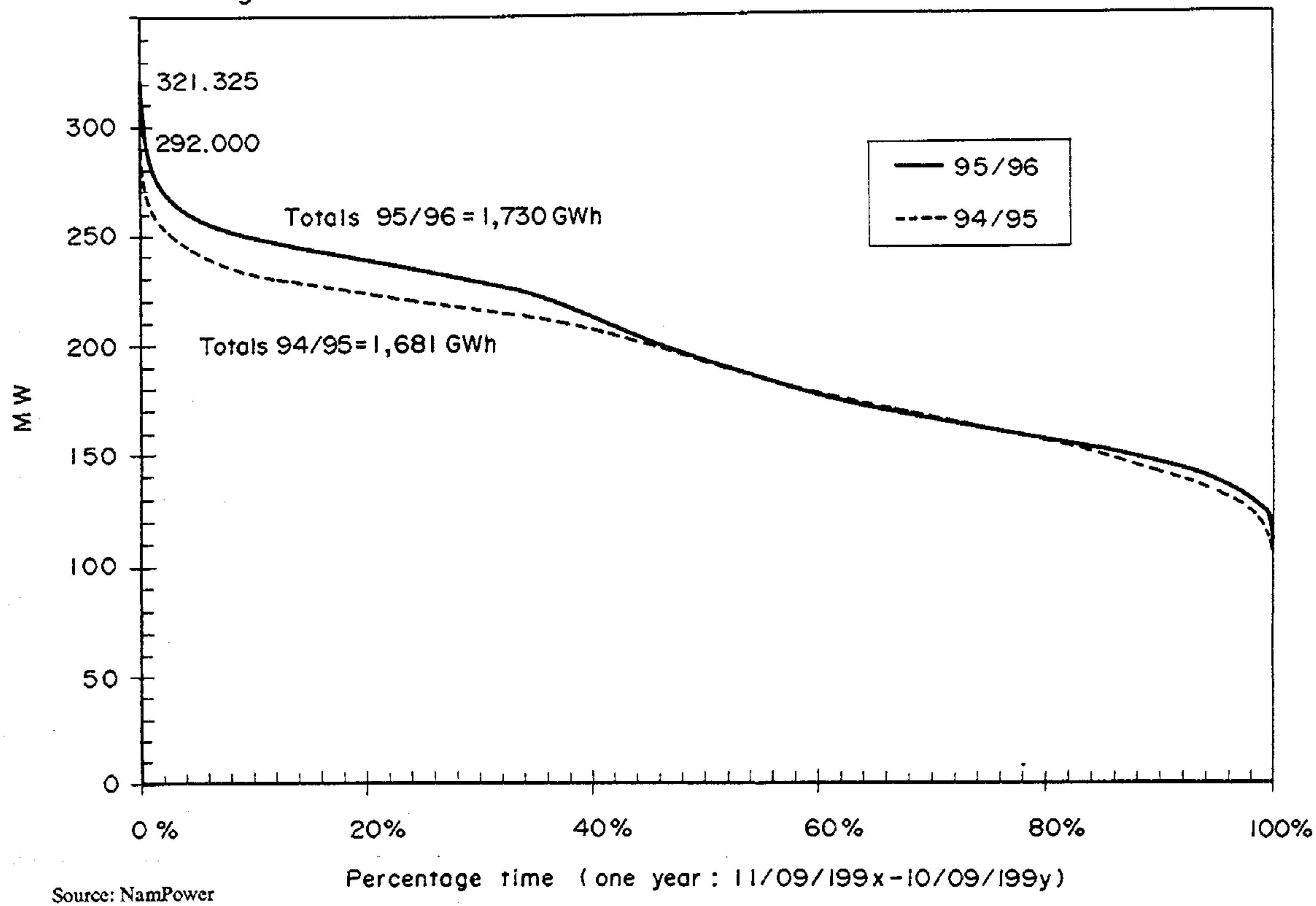
$$(19)\ \text{Load factor} = \frac{(6) - (3)}{8{,}700 \times (18)} \times 100\ (\%)$$

Fig. 4.2 DEMAND GROWTH
1987 - OCTOBER 1996



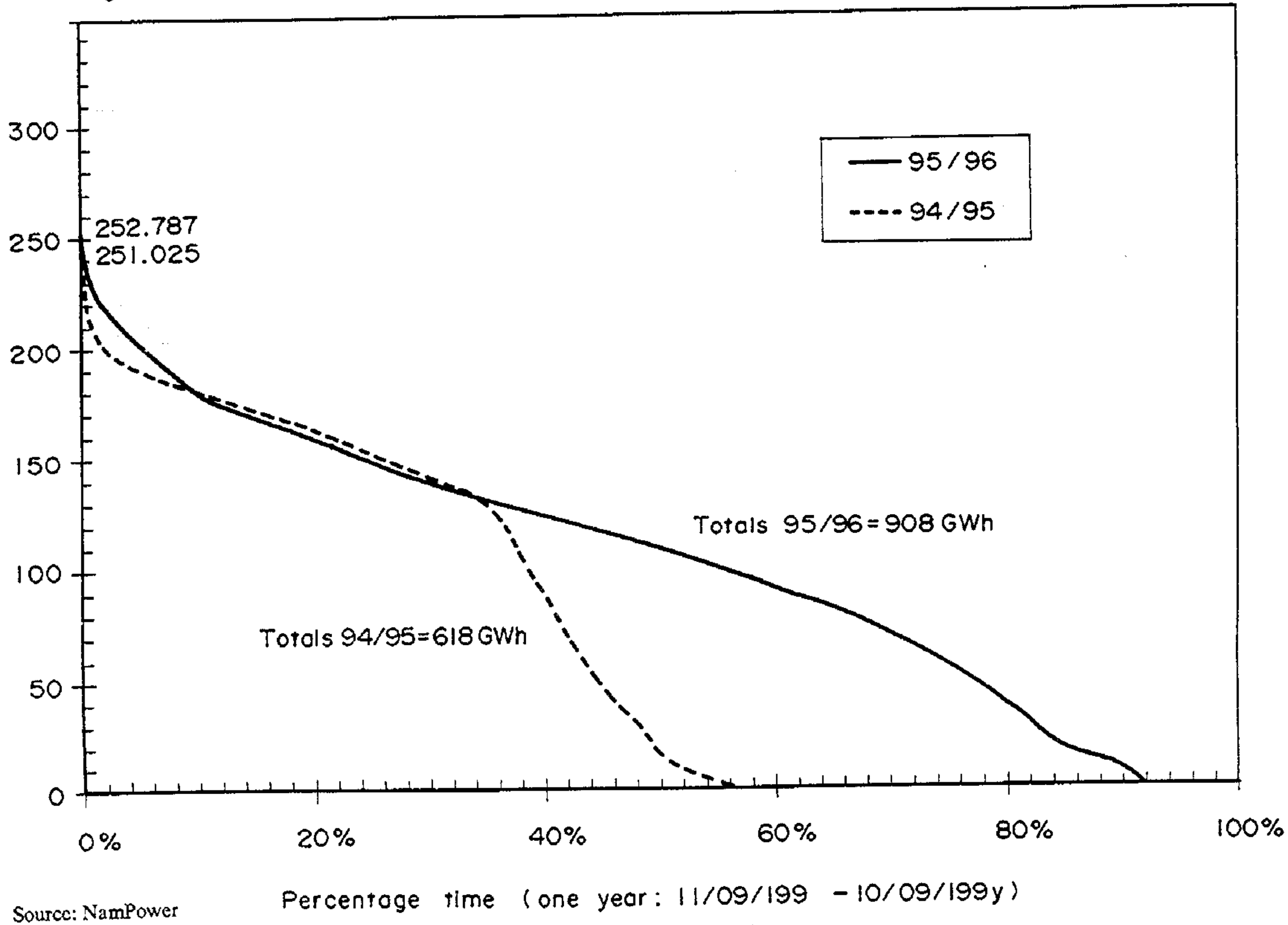
Source: NamPower

Fig. 4.3 Load Duration of System



Source: NamPower

Fig. 4.4 Load Duration of Imports from Eskom



Source: NamPower

4.1.2 Ruacana Hydro Electric Power Plant

Ruacana hydro power plant is NamPower's main source of power. The plant is located on the Cunene River. The plant was commissioned in 1978 and is in fairly good shape. It is underground power plant with 3 units of 80MW each. It is a run-of-the-river power plant with a small regulating reservoir which allows only for daily and limited weekly regulation. Long term regulation was originally planned to be provided from the Gove dam located in Angola on the upper part of Cunene River. However this has never been implemented because this storage dam is in Angolan territory and not under the control of NamPower.

The Cunene River is characterized as a typical African river with an average stream flow at Ruacana which varies from some 20m^3/sec to 500m^3/sec in the wet season and very low flow rate in the dry season for approximately 70% of the time.

The river flow is largely fluctuating by year, too. As shown by Figure 4.5 (1/4 - 4/4) and Figure 4.6. 1993 has been exceptionally dry with the total usable volume from Ruacana being only around one third the amount of the wet year of 1992. Thus, a hydro power plant, especially with a small reservoir, is not reliable in terms of firm capacity. Figure 4.7 and Figure 4.8 illustrate the Cunene River flow duration curves.

The Ruacana output capability on average for high and low flow pattern are;

240MW (100% output) = 30% of time
100MW (40% output) = 60% of time
0MW (0% output) = 10% of time

Ruacana Power Plant

Total rated plant output	240MW
Total plant maximum output	249MW
Total rated discharge at rated head	204m^3/sec
Full supply water level	El 902.7m
Normal water level	El 902.2m
Lowest water level	El 895.2m
Tailrace water level	El 760.2 ~ 764.5m
Diversion weir live volume	25.7 x 10^6 m^3

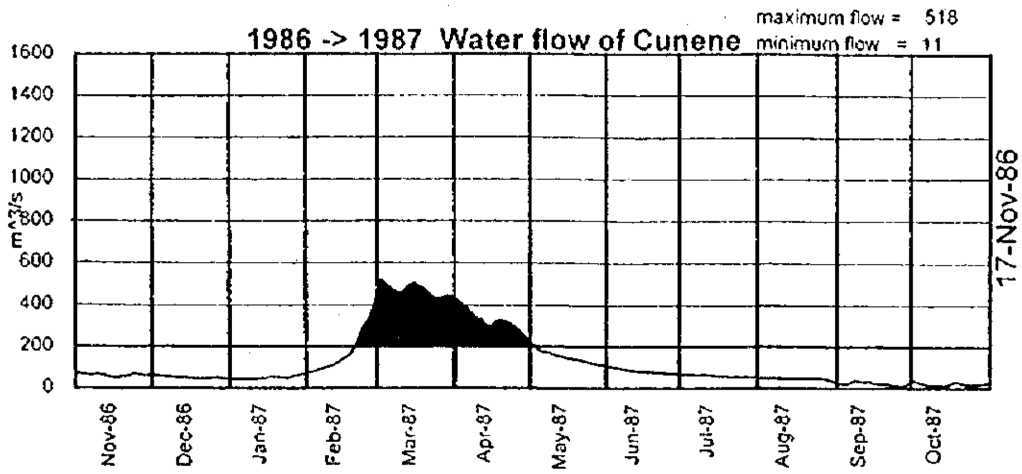
Turbine	3 x 83MW
	Vertical Francis Turbine
	H=134m, Q=68m^3/sec, N=230.8 rpm
	Vöest Alpine, Austria
Generator	3 x 88.88MVA
	Semi-umbrella, circulating air-cooled
	E=11.0kV, Pf=0.9
	Canadian Westinghouse
Main Transformer	3 x 90MVA
	Water-cooled, three phase
	E=11.0/330kV
	ASEA, Republic of South Africa

Fig. 4.5 Cunene River Flow, Summary for Each Year (1/4)

Summary for the period 1986 - 1987

Total Volume (million m^3) = 4019

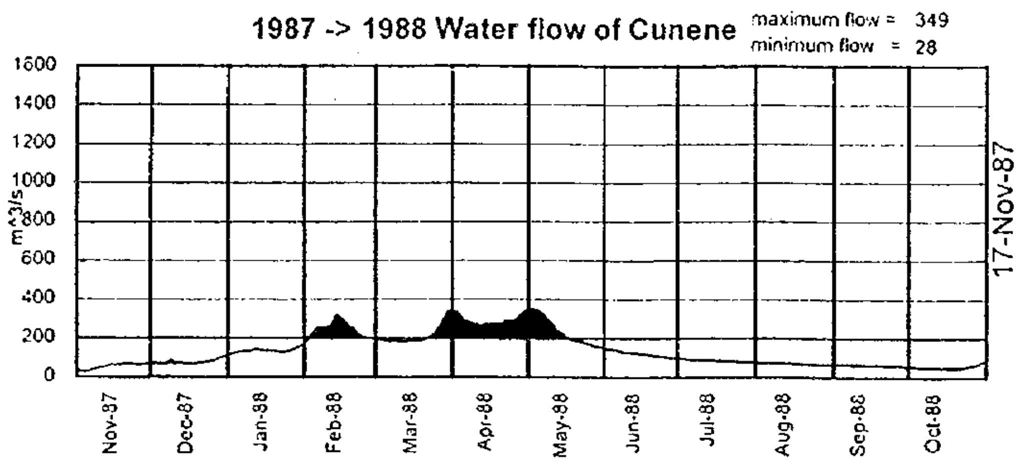
Total Usable Volume (million m^3) = 2867 Equivalent to 937 GWh



Summary for the period 1987 - 1988

Total Volume (million m^3) = 4315

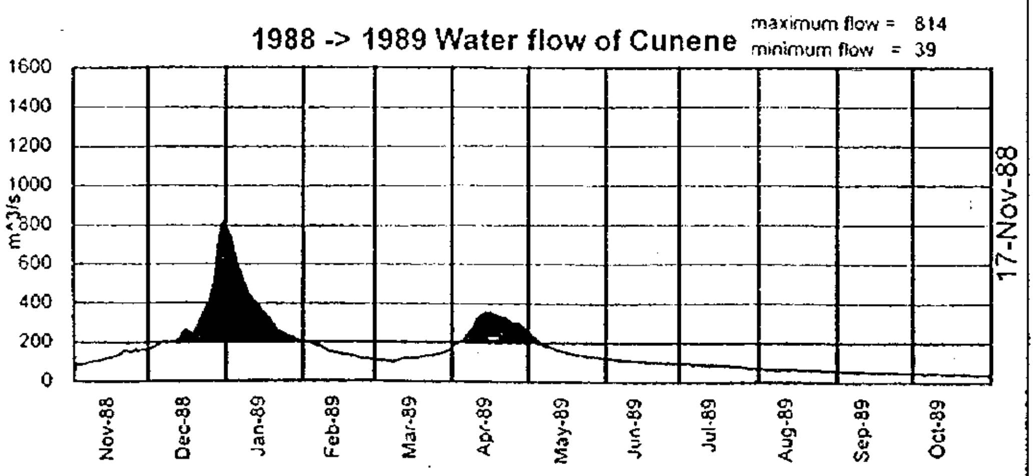
Total Usable Volume (million m^3) = 3780 Equivalent to 1235 GWh



Summary for the period 1988 - 1989

Total Volume (million m^3) = 5034

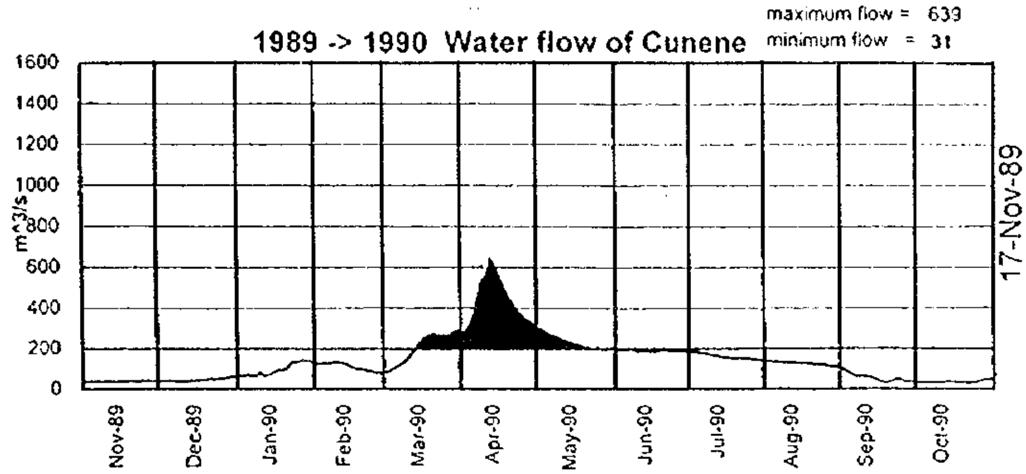
Total Usable Volume (million m^3) = 3929 Equivalent to 1284 GWh



Summary for the period 1989 - 1990

Total Volume (million m^3) = 4547

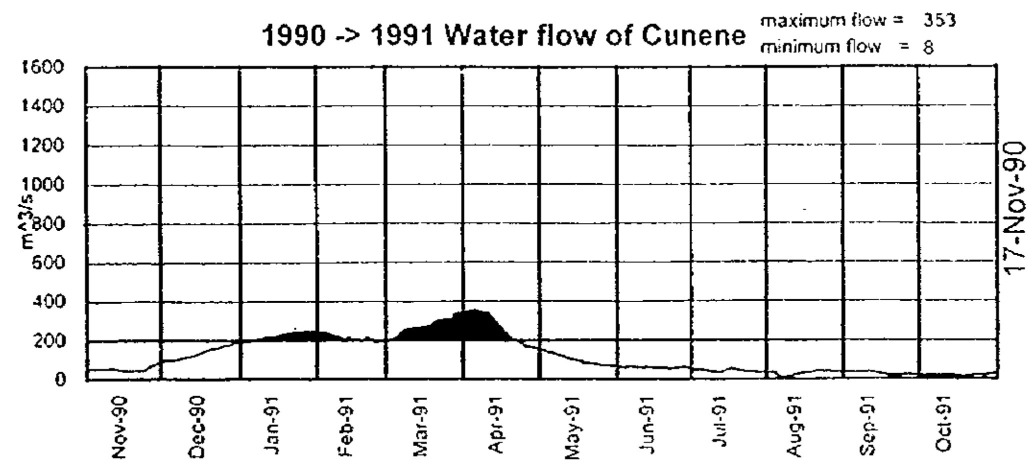
Total Usable Volume (million m^3) = 3762 Equivalent to 1229 GWh



Summary for the period 1990 - 1991

Total Volume (million m^3) = 3795

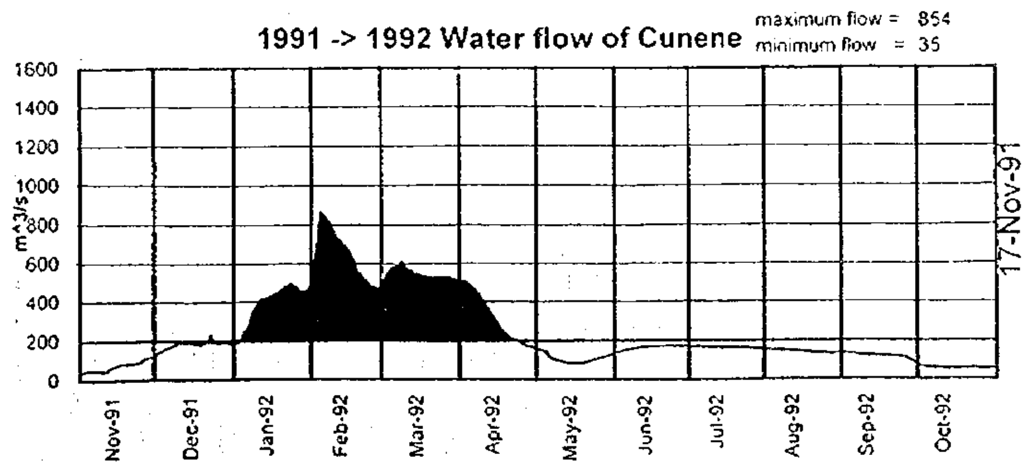
Total Usable Volume (million m^3) = 3314 Equivalent to 1083 GWh



Summary for the period 1991 - 1992

Total Volume (million m^3) = 7567

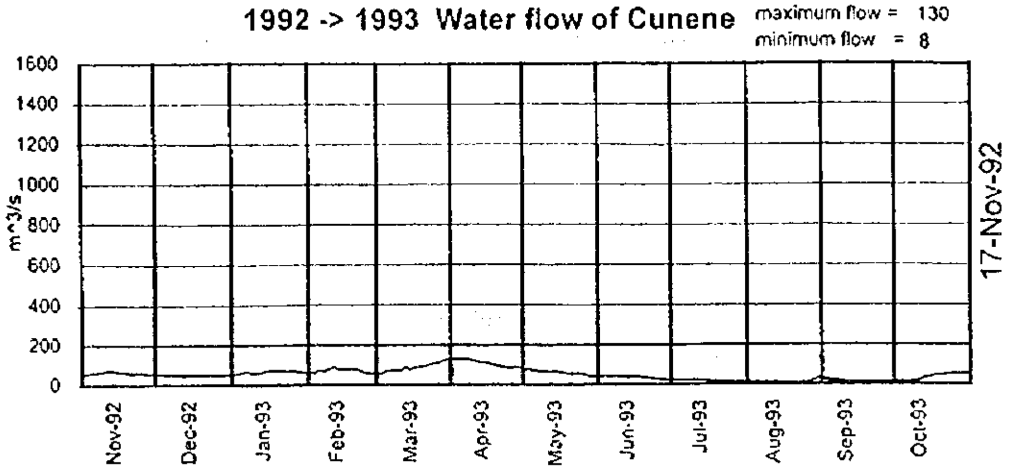
Total Usable Volume (million m^3) = 4737 Equivalent to 1548 GWh



Summary for the period 1992 - 1993

Total Volume (million m^3) = 1631

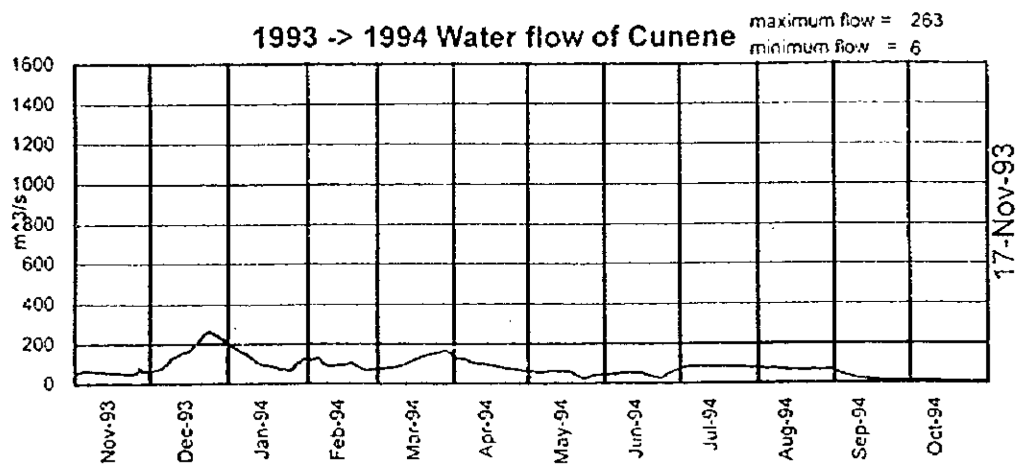
Total Usable Volume (million m^3) = 1631 Equivalent to 533 GWh



Summary for the period 1993 - 1994

Total Volume (million m^3) = 2468

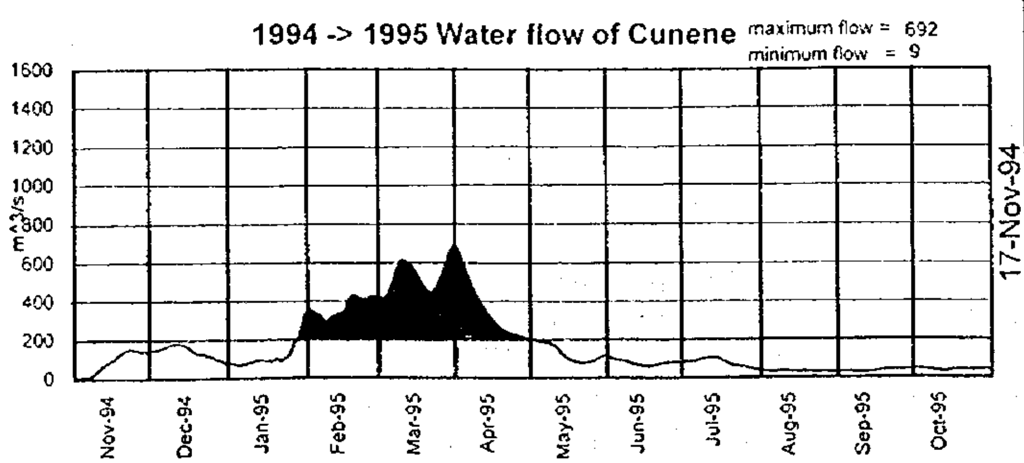
Total Usable Volume (million m^3) = 2426 Equivalent to 793 GWh



Summary for the period 1994 - 1995

Total Volume (million m^3) = 5227

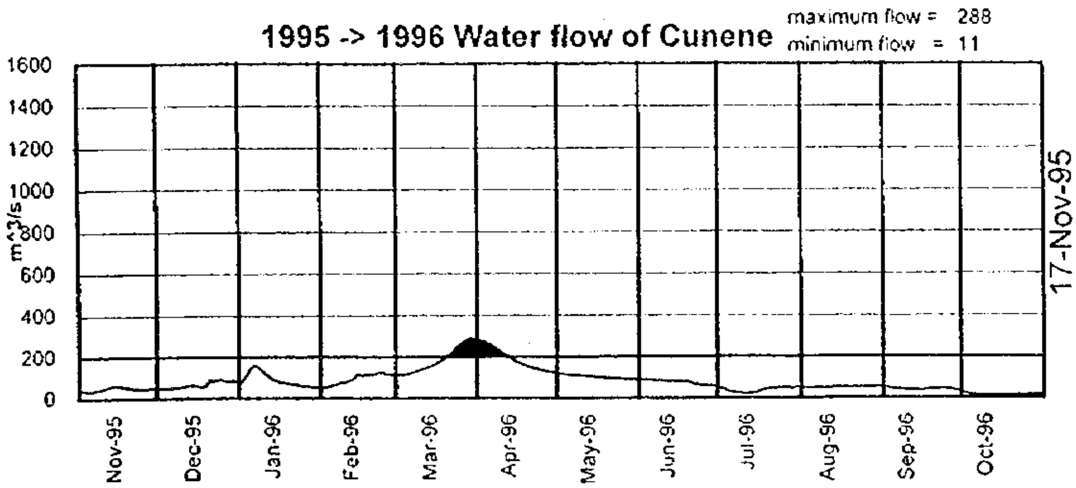
Total Usable Volume (million m^3) = 3481 Equivalent to 1138 GWh



Summary for the period 1995 - 1996

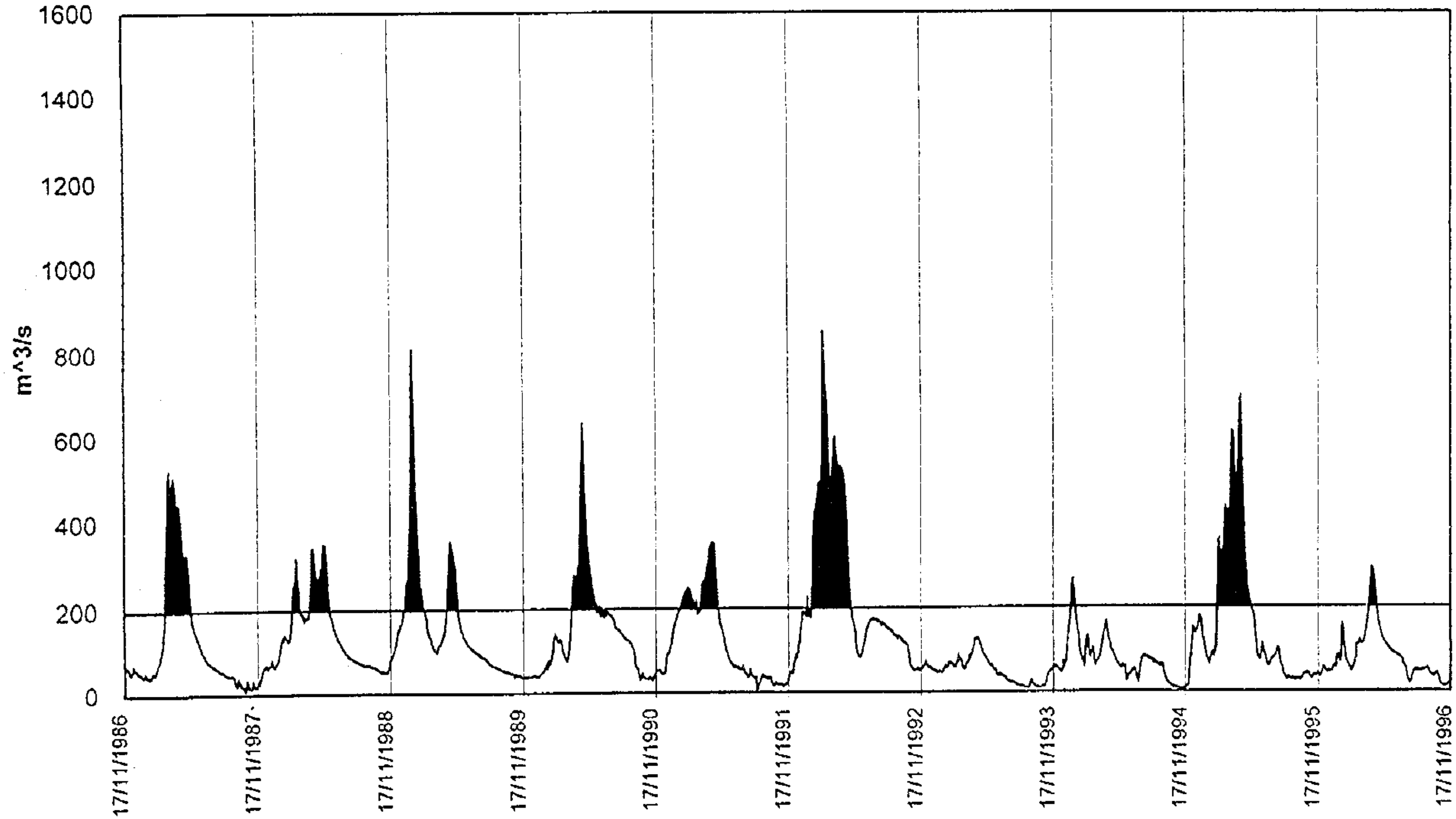
Total Volume (million m^3) = 2653

Total Usable Volume (million m^3) = 2546 Equivalent to 832 GWh

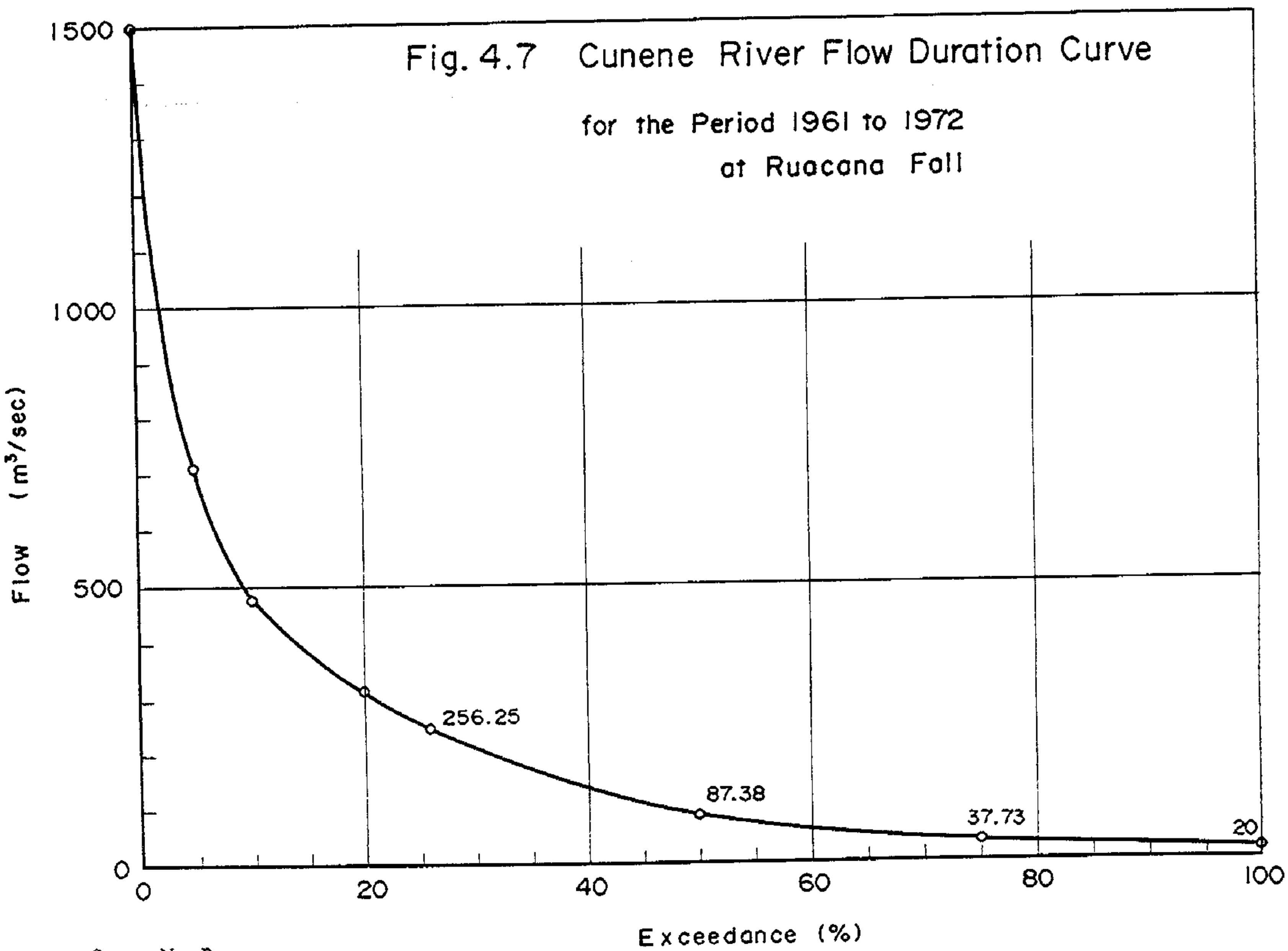


Source: NamPower

Fig. 4.6 **KUNENE RIVER FLOW (1986 - 1996)**



Source: NamPower

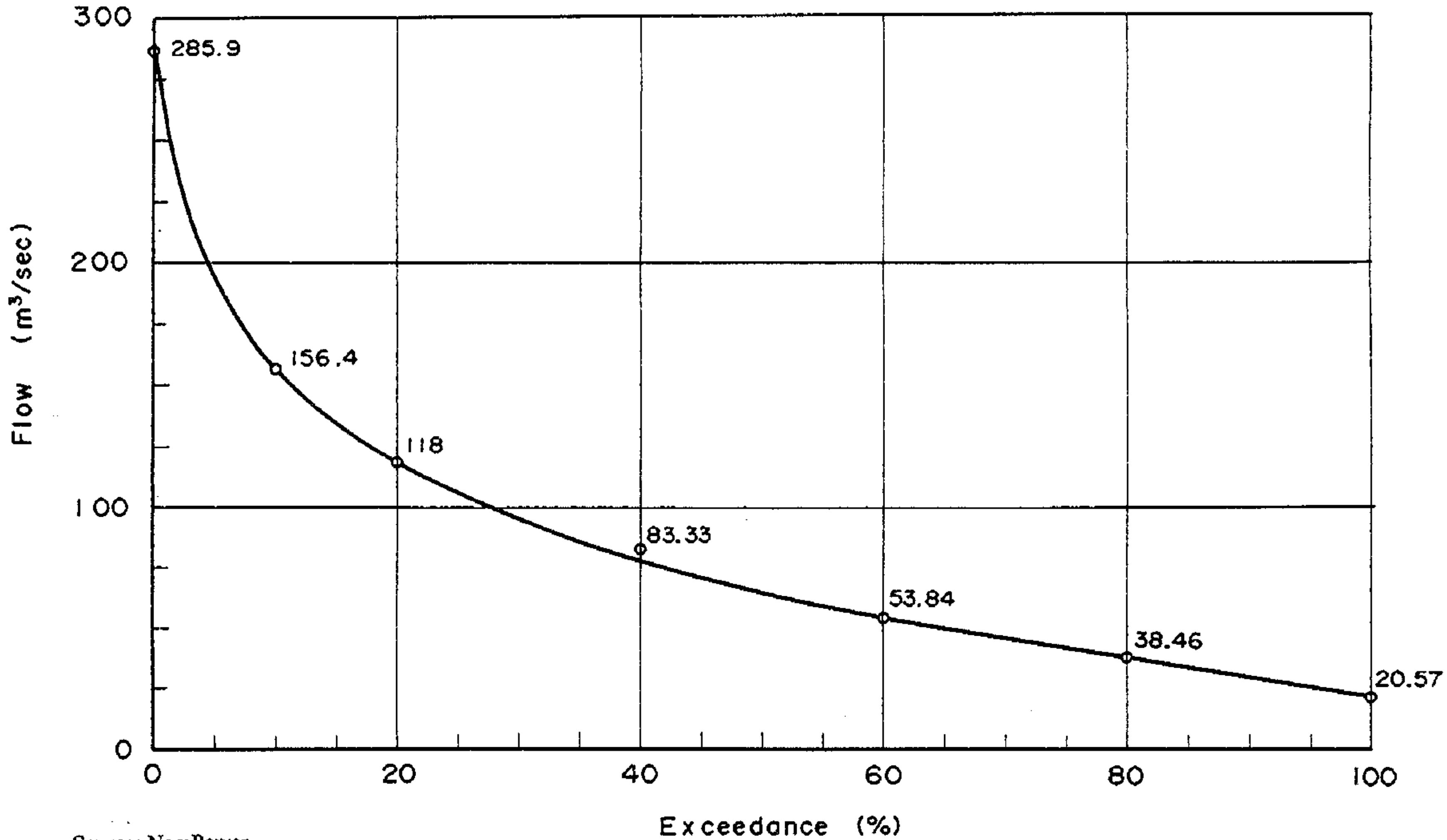


Source: NamPower

Fig. 4.8 Cunene River Flow Duration Curve

for the Period Aug.'95 to July '96

at Ruacana Fall



Source: NamPower

4.1.3 Van Eck Thermal Power Plant

Van Eck thermal power plant is located 5km north of Windhoek. The plant includes four steam turbines-generator units of 30MW each. The plant is coal-fired and air-cooled with large funs which power consumption reduces the maximum sent out power by 2 MW/unit. The plant was taken into operation in the period 1972-79.

The coal to Van Eck is obtained from South Africa by ship to Walvis Bay and then by rail. The coal is extremely expensive at N$276.50/ton (1996 term, 64.4 US$/ton) at Van Eck. Its average calorific value is 27.5MJ/kg (6,570kcal/kg). Overal thermal efficiency is approximately 23%. The specific fuel consumption is 0.57kg/kWh which results in a high fuel cost of 15.7Nc/kWh (3.65 USc/kWh). The plant is presently only used as a back-up source and could be closed down in the early part of 2000. Table 3.2 shows Van Eck plant generation records since 1972.

Capacity	Total 120MW, 4 x 30MW
Generator	35.3MVA
	Power Factor 0.85
	11kV
	3,000 rpm
	50 Hz
Boiler	Chain grate stoker
	Evaporation rate of 67.5 kg/sec
	Steam output of 63 bar and 485°C

Table 4.2 Van Eck Power Plant Generation Records

Commissioned May 1972

Year	GWh	Remarks
1972	94.75	
1973	217.84	
1974	369.21	
1975	431.72	
1976	537.34	
1977	622.22	
1978	889.74	Ruacana Plant commissioned 180MW (3 x 60MW)
1979	512.71	
1980	468.65	Ruacana Plant 231MW (3 x 77MW)
1981	467.57	
1982	288.07	Eskom grid linked
1983	164.71	
1984	97.96	
1985	136.38	
1986	101.99	Ruacana Plant 240MW (3 x 80MW)
1987	131.88	
1988	87.28	
1989	96.97	
1990	78.05	Ruacana Plant 249MW (3 x 83MW)
1991	149.74	
1992	88.86	
1993	157.22	Ruacana Plant Unit 3 Transformer repaired
1994	158.04	Ruacana Plant Unit 3 Stator repaired
1995	25.85	SAPP started
1996	13.29	

4.2 Transmission System — Existing and Future Expansion Plan

4.2.1 Transmission Line

Existing Transmission System

The network comprises approximately 14,000 km of both high and low voltage lines indicated below at the end of 1996. A distribution master plan is in the process of being implemented by NamPower in consultation with Ministry of Mines and Energy (MME).

Voltage (kV)	Length (km)
330	521
220	1,645
132	946
66 kV and below	10,546
Total	13,658

A 330 kV line from Ruacana to Omburu and double circuit of 220 kV lines from Omburu to the Aggeneis in the RSA constitute the backbone transmission lines of Namibia. The lines run approximately 1,500 km and link with Eskom grid at Aggeneis. Figure 4.9 shows power system in Namibia.

The main feeders are composed of the following:

Line Section	kV	km	Conductor
Ruacana-Omburu	330	522	2x427 mm^2 Zebra
Omburu-Osona	220	104	1x325 mm^2 Goat
Osona-Van Eck	220	58	1x325 mm^2 Goat
Omburu-Van Eck	220	166	1x325 mm^2 Goat
Van Eck-Hardap	220	290	2//x158 mm^2 Wolf
Hardap-Kokerboom	220	199	2//x158 mm^2 Wolf
Kokerboom-Karas	220	163	2//x158 mm^2 Wolf
Karas-SA border	220	134	2//x158 mm^2 Wolf

A 220kV line extends westwards from Omburu to Swakopmund, and another 220kV line extends in a north-easterly direction to Gerus and Otjikoto. From Otjikoto there extend 132kV lines to Rundu north-easterly and to Okatope north-westerly. And another 132 kV line extends from Kokerboom to Namib westward. The lines are outlined below.

Line Section	kV	km	Conductor
Omburu-Khan	220	114	1x325 mm^2 Goat
Khan-Rössing	220	78	1x325 mm^2 Goat
Rössing-Walmund	220	53	1x325 mm^2 Goat
Omburu-Gerus	220	140	1x325 mm^2 Goat
Gerus-Otjikoto	220	175	1x325 mm^2 Goat
Otjikoto-Rundu	132	270	1x158 mm^2 Wolf
Otjikoto-Oshivelo	132	86	1x158 mm^2 Wolf
Oshivelo-Okatope	132	114	1x158 mm^2 Wolf
Kokerboom-Konkiep	132	119	2x105 mm^2 Hare
Konkiep-Namib Dummy	132	143	2x105 mm^2 Hare
Namib Dummy-Namib	132	47	2x63 mm^2 Cu
Gerus - Welwetschia	132	167	(1x158 mm^2 Wolf)

The role of the inter-connector – 220kV 2 cct between Van Eck Power station and Aggeneis Substation RSA – has grown bigger and bigger in these years. Nevertheless, frequent interruptions are observed as shown in Table 4.1 Fault statistics of the line for the year 1995 and 1996. This seems fairly serious situation.

Distribution lines with the voltage 66kV and below extend radially from the main substations for further dispersion of power to the consumption areas along the coast and inland. As great parts of the country is rather sparsely populated, the areas served by the distribution network covers quite a small portion of the total areas.

It must be noted that Katima Mulilio in Caprivi Corridor situated in the north-eastern border and Oranjemund and Rosh Pinah situated in the south-western border are supplied from their neighbor country Zambia and RSA respectively.

Transmission line expansion programme

Among the several alternatives for cope with the growing demand in the country, NamPower has decided the construction of 400 kV inter-connector between Auas substation near Windhoek and Aries substation near Kenhardt in RSA for the completion date by May 2000. Other expansion programs expected by 2005 are enumerated below (See Figure 4.10).

Line Section	kV	km	Conductor	Completion	
Kokerboom-RSA Border	400	270	4 x 404 mm^2 Tern	1999	
Auas-Kokerboom	400	455	4 x 404 mm^2 Tern	2000	
Auas - Gerus	400	240	4 x 404 mm^2 Tern	2005	
Epupa - Gerus	400	680	4 x 404 mm^2 Tern	2005 *	
Auas - Van Eck	220	31	2 x 158 mm^2 Wolf	1999	3cct.
Dune -Van Eck	220	232	2 x 158 mm^2 Wolf	2005	
Dune - Walmund	220	40	2 x 158 mm^2 Wolf	2005	
Okatope - Ruacana	132	235	2 x 105 mm^2 Hare	1998	
Auas -Gobabis	132	170	2 x 105 mm^2 Hare	2000	

NamPower contemplates that if 400 kV line has extended up to Gerus before the Epupa is commissioned, the lines marked * are constructed and if Epupa goes ahead of that 400 kV line, a 330 kV line between Epupa and Omburu is constructed.

4.2.2 District Substations

Existing Substations

The installed capacities of main (district) substations which composes a Namibian primary transmission system at the end of 1996 are indicated below.

The transmission system is characterized by its relatively low loading and its long distances. To cope with this situation extensive reactive compensation is installed at different locations as shown in the table below.

However due to rapidly growing demand and less rain fall in these years, the situation has changed. Especially in case of the 220 kV inter-connector, it is occasionally operated with a heavy load as big as its limit of transmission capacity.

Substation	Transformers		Reactors	Capacitors
	(kV)	(MVA)	(MVAr)	(MVAr)
Ruacana (PS)	330/66	2 x 40	2 x 60	
Omburu	330/220	2 x 315	2 x 60	
	220/66	2 x 40	2 x 15 + 30	
SVC			56	45
Osona	220/66	2 x 40		
Van Eck	220/66	1 x 90		
	220/66	2 x 60		

	220/11	1 x 35	
Hardap	220/66	2 x 40	3 x 40
Kokerboom	220/132	1 x 40	3 x 40
	220/66	2 x 40	
Karas			2 x 15
Gerus	220/66	2 x 40	2 x 15
Otojikoto	220/132	1 x 40	
	220/66	2 x 40	
Walmund	220/66	2 x 40	
Khan	220/66	1 x 40	
	220/66	1 x 24	
Rössing	220/11	2 x 40	
Rund	132/66	1 x 25	
Oshivello	132/22	1 x 10	
Okatope	132/66	1 x 25	
Konkiep	132/11	1 x 10	
Namib	132/66	1 x 25	
Walvis Bay	66/11	2 x 30	

Substation expansion programme

In relation to the short term system expansion program NamPower has following program of newly construction of substation or additional installation of transformers for the following substations to complete by the end of 1996.

Substation	Transformer		Reactor		Completion Date
	(kV)	(MVA)	(kV)	(MVA)	(year/month)
Kokerboom	400/220	2 x 315	400	5 x 100	1999/06
Auas	400/220	2 x 315	400	2 x 100	2000/06
	220/132	2 x 40			2000/06
	220/66	2 x 40			2000/06
Gerus	400/220	1 x 315			2005/06
Haib Mine	220/11	3 x 90			1998/06
Ruacana	330/132	1 x 80			1998/06
Gobabis	132/66	1 x 20			2000/06

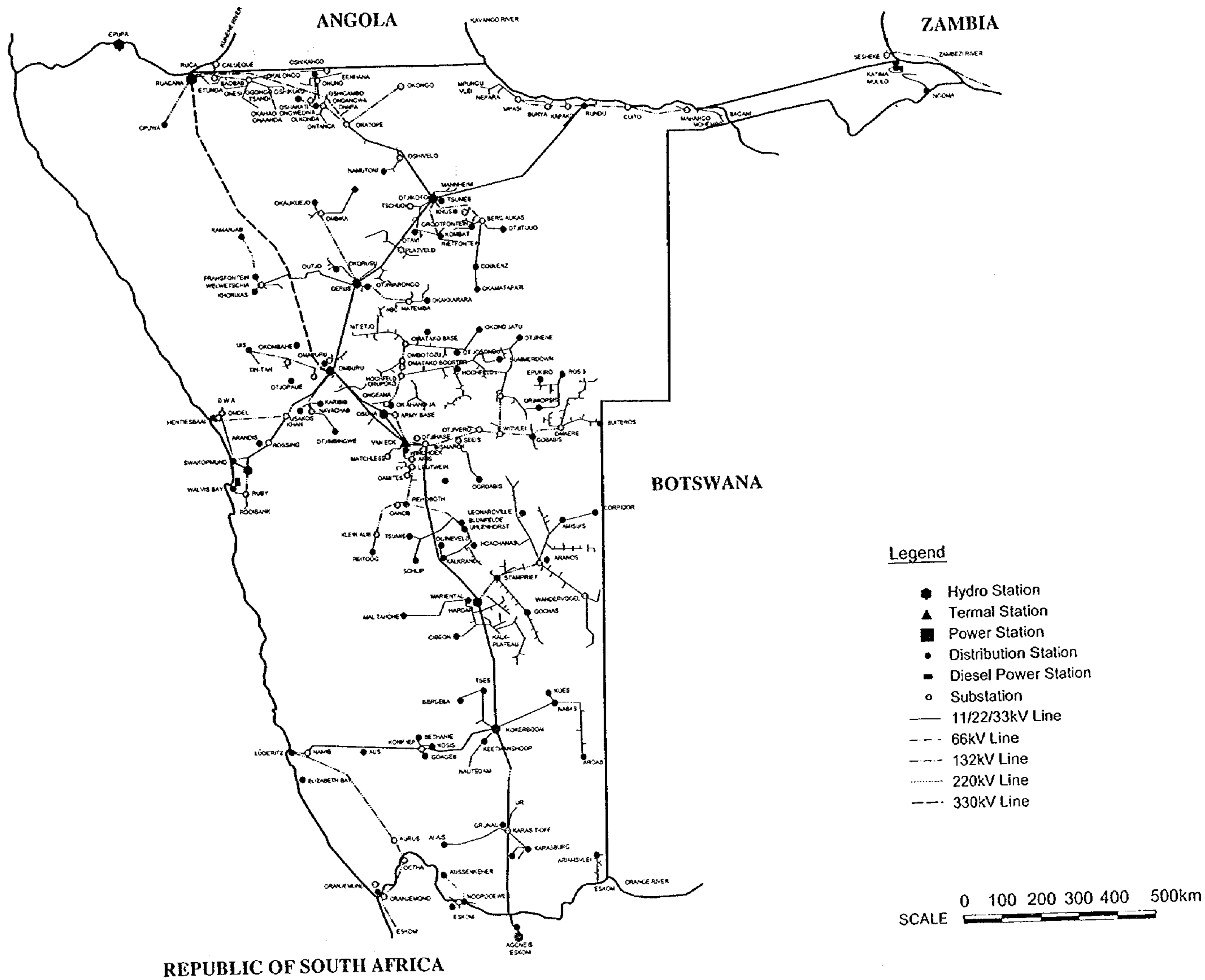


Figure 4.9 Namibian Power System

Table 4.3 Fault Statistics for the 200kV Eskom-NamPower Interconnection

Faults for the year June 1995 to July 1996

Date	Station	Circuit	Duration (min)	Remarks
07-06-96	Van Eck	Hardap 1 Hardap 2	17.00	Under frequency Load shed
21-06-96	Van Eck	Hardap 1 Hardap 2	55.00	Under frequency Load shed
05-05-96	Van Eck	Hardap 2	1.00	Broken insulator
07-05-96	Van Eck	Hardap 2	1.00	Broken insulator
12-04-96	Van Eck	Hardap 1 Hardap 2	28.00	Pole slip-Instability due to Van Eck-Omburu line fault
18-03-96	Van Eck	Hardap 1	1.00	Unknown
27-02-96	Kokerboom	Aggeneis 1	1.00	Lightning
26-02-96	Van Eck	Hardap 1	1.00	Unknown
13-01-96	Kokerboom	Aggeneis 1	ARC	Lightning
14-01-96	Kokerboom	Aggeneis 1	ARC	Lightning
14-01-96	Kokerboom	Aggeneis 2	ARC	Lightning
20-01-96	Van Eck	Hardap 1 Hardap 2	5430.00	Pylon toppled by flood water
11-12-95	Kokerboom	Aggeneis 1	25.00	Lightning
11-12-95	Van Eck	Hardap 1 Hardap 2	12.00	System collapse
15-11-95	Kokerboom	Aggeneis 2	21.00	Tree grew into line & Veld fire
15-11-95	Kokerboom	Aggeneis 1	40.00	Tree grew into line & Veld fire
15-11-95	Van Eck	Hardap 1 Hardap 2	18.00	System collapse
16-11-95	Kokerboom	Aggeneis 2	21.00	Tree grew into line & Veld fire
16-11-95	Kokerboom	Aggeneis 1	12.00	Tree grew into line & Veld fire
16-11-95	Van Eck	Hardap 1 Hardap 2	15.00	System collapse
09-06-95	Kokerboom	Busbar Hardap 1 Aggeneis 1	92.00 96.00 94.00	Bus trip

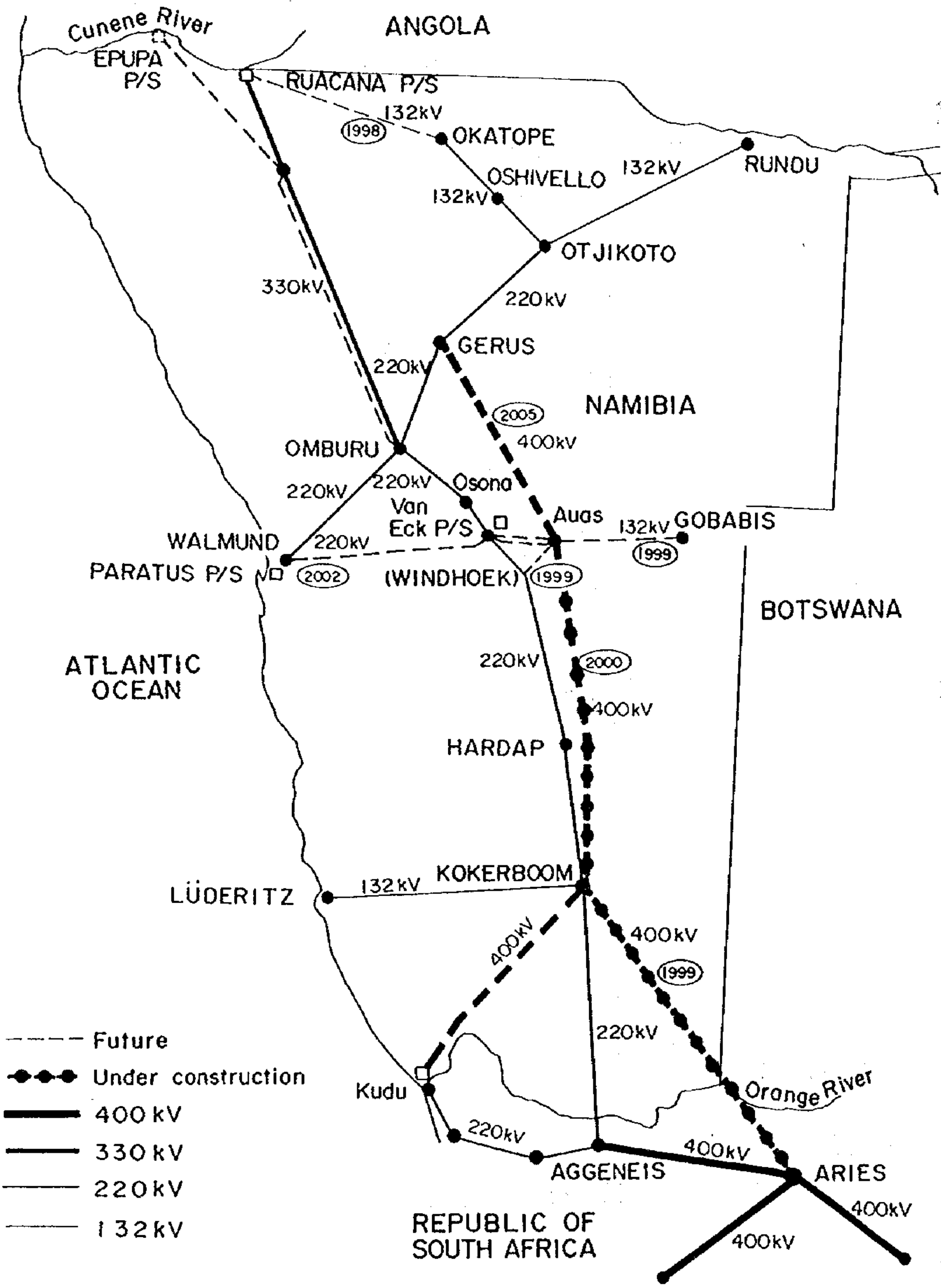


Figure 4.10 TRANSMISSION EXPANSION PLAN (1996-2010)

4.2.3 400 kV Inter-connector With RSA

To meet a rapid growing demand in the country NamPower have studied several alternatives and finally decided to construct a new 400 kV inter-connector for strengthen the trunk line of import power from RSA.

The project involves the construction of approximately 900 km of single circuit 400 kV transmission line from Aries substation near Kenhardt in South Africa to the proposed Auas substation near Windhoek. The new line will pass through the existing 220 kV Kokerboom substation, near Keetmanshoop. Which will be extended to accommodate the new 400 kV circuits, associated transformers and reactive compensation.

The transmission line design proposed and undertaken by Eskom uses an innovative compact cross-rope suspension tower (guyed chainnet structure). These structures are extremely light and less cumbersome for construction works.

The line will use quad bundle ACSR 'Tern' conductors with the phases arranged in a triangular formation to keep losses to a minimum. Composite silicon rubber insulators will be used because of the advantages they offer in terms of weight - they are extremely light - and performance in desert pollution conditions.

The line will also incorporate an optical fiber groundwire (OPGW) containing 24 fibers, some of which will be used for power system protection, control and communications. The others will be available for third party use providing scope for increased communication traffic between Namibia and South Africa. NamPower is in discussion with Telecom Namibia with regard to leasing some of these fibers to them.

The project will be handled as two separate entities. The work in South Africa which includes extension of Aries substation and construction of approximately 180 km of transmission line to the Orange River border between South Africa and Namibia will be undertaken by Eskom.

The work in Namibia - construction of approximately 720 km of transmission line, extension of Kokerboom substation and the construction of Auas substation - will be undertaken by NamPower.

The first stage of the project, incorporating construction of the line from Aries to Kokerboom and the extension of Kokerboom substation, should be completed by May

1999. Construction of Auas substation and the completion of the line to Auas which forms phase two of the overall development is expected by May 2000.

The substation work will be on the basis of supply and erect contracts for the major equipment items comprising transformers, reactors and static var compensations (SVC). Switchgear and other equipment will be purchased from South Africa and erected under a local erection contract. The substations will use outdoor SF6 switchgear in a conventional double busbar arrangement. It is envisaged that two 315 MVA 400/220 kV transformers will be installed at Kokerboom and two 315 MVA 400/220 kV transformers at Auas. Static var compensation will be required at both Kokerboom and Auas substations in order to operate the system satisfactorily.

The total project cost is estimated approximately N$ 950 million (1997 prices).

NamPower has awarded the major contract for the construction of the project to two SA-based companies on November 1997. SA-France company ABB Powertech/Cegelec Consortium won the N$ 366 million transmission line contract, while ABB Powertech Transformer Ltd of South Africa was awarded the contract for supply and installation of transformers and reactors at a value of N$ 66 million.

This new interconnection will remove the existing constrains on power imports from South Africa caused by high power losses and the limited capacity of the 220kV interconnection. The 400kV line to some extent will have a stabilising effect on the existing system. The supply from Eskom is firm and is only constraint for singular conditions and severe network incidents.

Power import capability

According to Swed Power's study, the power import from Eskom may be extended up to 800MW and above provided that the reactive power losses are adequately compensated. The necessary installations are indicated in Table 4.4. The new Static Var Control (SVC) are assumed to be located at Auas .

Table 4.4 Power Import Capability

NamPower Load (MW)	Existing SVC (Mvar)	New SVC (Mvar)	Import Auas (MW)	Import Aggeneis (MW)	Total (MW)
620	45		320	270	590
650	68		340	280	620
720	136		400	310	710
810	230		490	340	830
860.	305	140	540	370	910

Division of real power between 220kV and 400kV is determined by the network impedances, and consequently not controllable if no special components are installed.

4.3 Import and Export of Electricity

4.3.1 Power Balance

Power import from Eskom is an important complement to the indigenous power. The imported power and energy has been steadily increasing, and has been 251MW and 908GWh in 1996 (95/96). The power is considered to be the limit of the capability of the transmission system.

To supply its total electricity demand (326.6MW for July 1997) NamPower would import the power in excess of the available generation capacity for the following main reasons:

- Restrictions on the generation at Ruacana hydro-power station due to the limited and seasonal dependence on water flows of the Cunene River
- The high fuel cost of NamPower's thermal power stations.

Power is imported from Eskom when there are shortfalls in the NamPower system and power is exported to Eskom when is excess in the system. The exported power and energy has been 97.5MW and 29GWh in 1996.

The reservoir at Ruacana hydro-power station allows only for daily and limited weekly regulation. Long term regulation was planned to be provided from the Gove dam located in Angola on the upper part of Cunene River. The Cunene River is characterized as a typical African river with an annual average stream flow at Ruacana which varies from some $20m^3/sec$ to $500m^3/sec$ in the wet season and very low flow rate for approximately 70% of the time. However, this has never been implemented because this storage dam is in Angolan territory and not under the control of NamPower.

The prices of imported power varies between 4.98 Nc/kWh and 8.28 Nc/kWh depending on the amount of power import and the availability of surplus energy in the Eskom system.

4.3.2 Power Purchase Agreement

The power purchase agreement between Eskom and NamPower is a ten year contract based on South African Power Pool (SAPP) principles and has started 11 September 1995. The tariff includes the following three components: (Source: SWAWEK - System Expansion for 1996-2006 by Swed Power)

- Firm Power is paid for at 7.56 Rand/kW per week. The quantity is determined on a week basis. It is arrived at from the total system peak demand minus the amount of indigenous firm power that is considered to be available from NamPower's sources. The indigenous firm power is determined with regard to the flow at Ruacana and the available capacity from the thermal plants.

- System Energy is paid for at 4.2 cent/kWh. The System Energy is treated as the total imported energy minus the Firm Energy.

- Firm Energy is paid for at 4.02 cent/kWh. The Firm Energy is then calculated by multiplying the Firm Power by 168 hours.

The Firm Power (P_{firm}) is calculated as

$$P_{firm} = P_{peak} - P_{hydro} - P_{thermal}$$

Both hydro capacity (P_{hydro}) and thermal capacity ($P_{thermal}$) are slightly reduced due to losses and technical availability.

The hydro component is determined under the presumption that it is always possible to regulate the natural flow at Ruacana to meet the peak demand. This means that except from periods of exceptional drought, P_{hydro} will amount to about 90MW.

The thermal component includes contributions from Van Eck and Paratus. $P_{thermal}$ is currently 132MW.

With today's load level of about 270MW the firm power purchases then amounts to about 50MW during normal hydrological conditions.

270 - 90 - 132 = 48MW

The weekly fee for firm power then amounts to about N$363,000. Higher flows in the Cunene River will then further reduce or even eliminate the firm power fee.

The tariff is subject to escalation according to the Production Price Index (PPI) in South Africa (in 1995 term). Under present conditions the tariff construction is quite favourable for NamPower, since the amount of firm power is small or zero over long periods of normal flow at Ruacana. However, this situation will change in the future. This should be estimated and economic comparisons be made between alternatives.

4.3.3 Southern African Power Pool

The vision of an integrated southern African grid, shared by many utilities in the region, is now becoming a reality with the signing of the Southern African Power Pool (SAPP) agreement which was formalised at government and at utility level during 1995.

The SAPP agreement consists of four documents drawn up between April 1995 and August 1996 under the auspices of the Southern African Development Community (SADC). In order of precedence they are:

(1) Inter-governmental memorandum of understanding

This is the formal agreement between the governments of the eleven SADC countries and Zaire* setting up the Power Pool, the aim being "to reduce investments and operation costs, enhance reliability of supply and share in the other benefits resulting from the interconnected operation of their system".

It states that each government will authorise its national power utility to enter into further agreements to establish SAPP. This gives the member utilities responsibility for setting the Pool rules (always ultimately subject to the accord of their respective governments).

* The following nine countries are interconnected by the grid : Botswana, Lesotho, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe and Zaire.

(2) Inter-utility memorandum of understanding

The purpose is to establish the basic principle under which the SAPP will operate, inter alia:

a) the co-ordination of and the co-ordination in the planning and operation of the various systems to minimize costs while maintaining reliability and,
b) the full recovery of costs and the equitable sharing of the resulting benefits.

This defines the structure of SAPP, and provides for non-SAPP utilities to become members, and for privately owned generation companies to have observer status.

SAPP's board is the Executive Committee, made up of the chief executives of the participating utilities. Under this is the Management Committee, consisting of three representatives per member utility of sufficient seniority in their own organization to make all relevant decisions. The three Sub-committees, Planning, Operating and Environmental shall report to the Management committee.

(3) Agreement between operating members

The purpose of this Agreement is

a) to co-ordinate and co-operate in the operation of their systems to minimise costs while maintaining reliability:

b) to fully recover their costs, and

c) to share equitably in the resulting benefits.

Among the benefits that will be achieved are reductions in required generating capacity, reductions in regional fuels costs and improved use of hydro-electric energy. This Agreement establishes the rules under which these benefits can be realised.

The meat of this agreement is in the Service Schedules setting out the following thirteen transaction types:

Emergency Energy	Operating Reserve
System Energy	Wheeling
Economy Energy	Scheduled Outage Energy
Surplus Energy	Firm Power
Energy Banking	Participation Power
Short-Term Firm Power	Control Area Services
System Participation Power	

For any transaction the relevant rates(s) or prices shall be that which has been quoted and agreed upon before the start of the transaction.

(4) Operation guidelines

These are based on the North American Electric Reliability Council guidelines. The aim is to monitor the technical performance of the Southern African grid against an international benchmark.

Net maximum generating capacity of Sub-Saharan Africa is shown in Table 4.5 and its production and trade of electricity in Table 4.6. Figure 4.11 shows Southern African Grid.

The SAPP agreement provides the foundation for a co-operative regional approach to one of the biggest sectors in SADC's overall economy. This is just the first step.

Table 4.5 Net Maximum Generating Capacity of Sub-Saharan Africa

(MW)

Country		Year ended	Thermal	Hydro	Nuclear	Geo-thermal	Total	% of total
Angola	a c	12/95	125.22	200.80	-	-	326.02	0.74
Botswana	a b	3/96	172.00	-	-	-	172.00	0.39
Congo		12/95	18.20	89.00	-	-	107.20	0.24
Kenya	d	6/95	100.48	569.50	-	45.35 e	715.33	1.62
Lesotho	a b	3/96	1.56	3.27	-	-	4.83	0.01
Malawi	a	3/95	24.56	164.60	-	-	189.16	0.43
Mauritius	a	12/95	277.70	54.20	-	-	331.90	0.75
Mozambique	a	12/95	97.39	491.19 f	-	-	588.58	1.34
Namibia	a b	6/95	147.00	240.00	-	-	387.00	0.88
South Africa	a b	12/95	30,612.00 g	2,248.80 h	1,840.00	-	34,700.80	78.75
Swaziland	a b	3/95	9.50	40.50	-	-	50.00	0.11
Tanzania	a	12/95	139.15	375.00	-	-	514.15	1.17
Zaire		12/94	37.80	2,442.16	-	-	2,479.96	5.63
Zambia	a	3/95	84.00	1,670.00	-	20.00	1,774.00	4.03
Zimbabwe	a	6/95	1,056.00	666.00	-	-	1,722.00	3.91
Total			32,902.56	9,255.02	1,840.00	65.35	44,062.93	100.00
SADC			32,746.08	6,154.36	1,840.00	20.00	40,760.44	92.51
South African Customs Union			30,942.06	2,532.57	1,840.00	0	35,314.63	80.15

Thermal electricity comprises conventional plants of all types, whether or not equipped for the combined generation of heat and electric energy. Accordingly, they include steam-operated generating plants, with condensation (with or without extraction) or with back-pressure turbines and plants using internal combustion engines or gas turbines whether or not these are equipped for the recovery.

Remarks:

a. Member of the Southern African Development Community (SADC)
b. Member of the South African Customs Union
c. Available capacity
d. Effective capacity = sent-out capacity + own use capacity
e. Includes wind turbine capacity of 0.35 MW
f. Includes Cahora Bassa
g. Excludes Eskom's 4,531 MW in reserve storage
h. Includes pumped storage

Source: Information obtained from electricity utilities and South Africa's National Electricity Regulator

Table 4.6 Production and Trade of Electricity of Sub-Saharan Africa

(GWh)

Country		Year ended	Gross production	Imports	Exports	Total available	% of total	kWh per capita
Angola	a	12/95	1,042.0	-	-	1,042.0	0.50	99
Botswana	a b	3/96	1,017.0	382.0	-	1,399.0	0.67	999
Congo		12/95	353.9	166.2	-	520.1	0.25	226
Kenya		6/95	3,678.3	187.2	-	3,865.5	1.86	148
Lesotho	a b	3/96	434.5	434.5	-	434.5	0.21	217
Malawi	a	3/95	860.5	-	1.0	859.5	0.41	108
Mauritius	a	12/95	1,047.4	-	-	1,047.4	0.50	952
Mozambique	a c	12/95	364.5	608.0	-	972.5	0.47	56
Namibia	a b	6/95	1,268.7	766.9	-	2,025.6	0.97	1,447
South Africa	a b	12/95	174,715.0	172.0	3,047.0	171,840.0	82.70	4,373
Swaziland	a b	3/95	109.8	597.0	-	706.8	0.34	862
Tanzania	a	12/95	1,791.0	11.4	-	1,802.4	0.87	68
Zaire	d	12/94	5,379.0	52.5	1,278.3	4,153.2	2.00	110
Zambia	a	3/95	8,116.0	-	1,067.0	7,049.0	3.39	766
Zimbabwe	a	6/94	7,811.0	2,312.4	45.5	10,077.9	4.85	969
Total			207,544.1	5,690.1	5,438.8	207,795.4	100.00	1,070
SADC			198,132.9	5,284.2	4,160.5	199,256.6	95.89	2,277
South African Customs Union			177,100.5	2,352.4	3,047.0	176,405.9	84.89	3,927

Remarks:

a. Member of the Southern African Development Community (SADC)

b. Member of the South African Customs Union

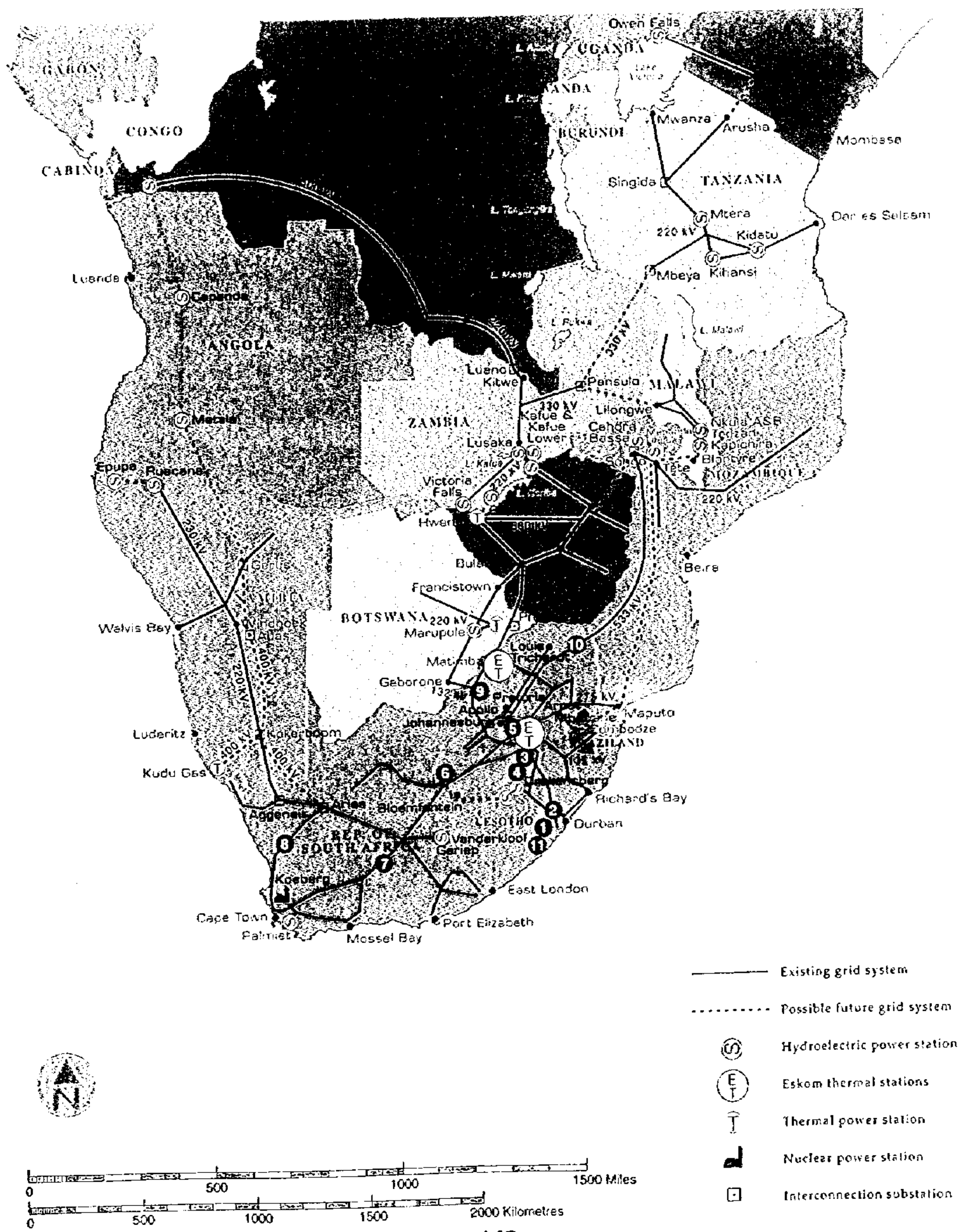
c. Includes Cahora Bassa

d. Statistics for year ended 31 December 1994 not available at time of publication.

Source: Information obtained from electricity utilities and South Africa's National Electricity Regulator

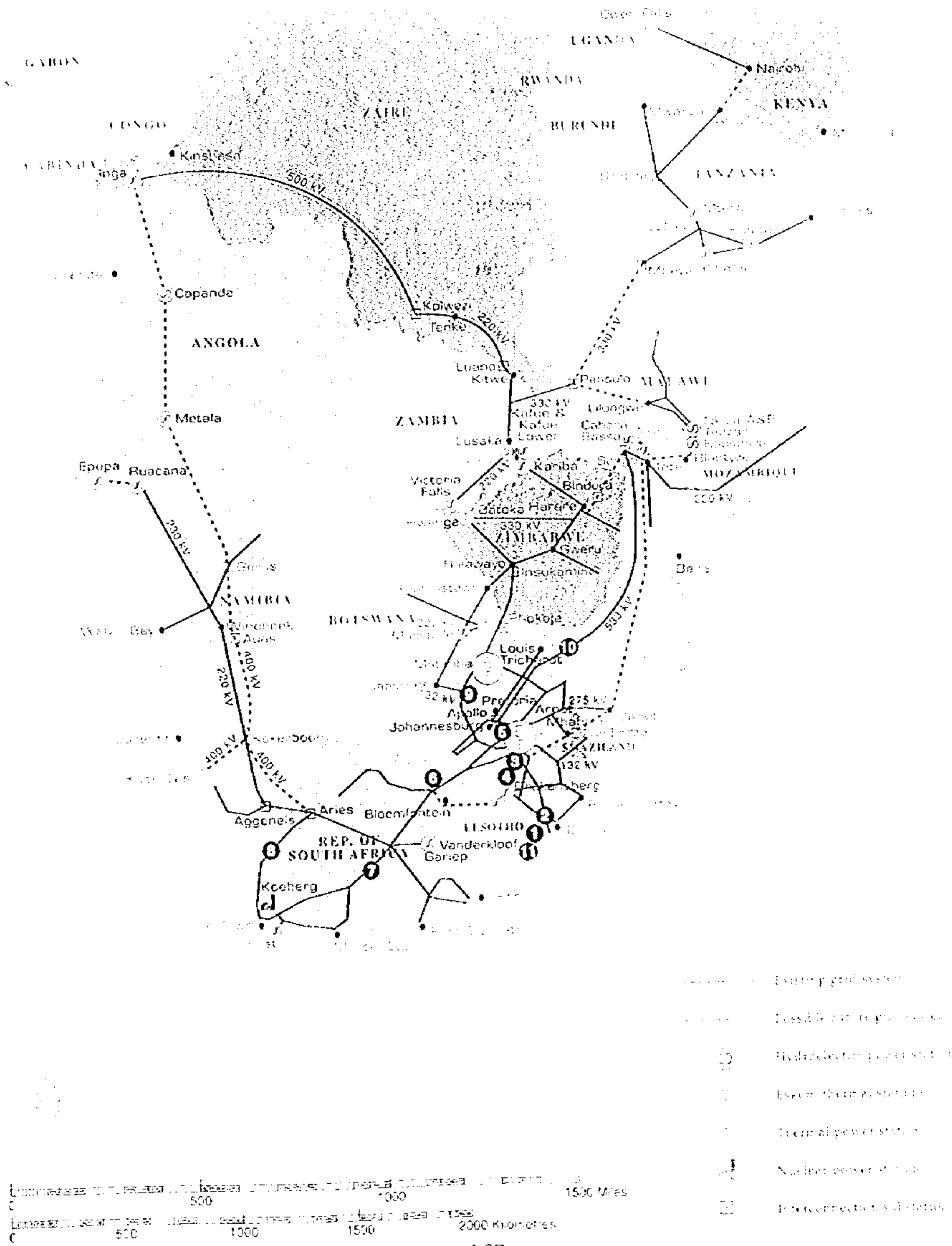
as at end 1996

Fig. 4.11 SOUTHERN AFRICAN GRID



as at end 1996

Fig. 4.11



4.3.4 Eskom's Integrated Electricity Plans

Eskom has a vision to provide the world's lowest-cost electricity for growth and prosperity. The Integrated Electricity Planning (IEP) process to achieve its vision IEP in Eskom is defined as the process which selects, from a fully array of demand- and supply-side options, that combination of actions, risks and investments which satisfies its customers' electricity needs, achieves optimal value for the customer and is financially viable for Eskom. IEP includes to provide signals to the Southern and South African power pool, regarding long-term resource requirements for the stakeholders and the market.

Table 4.7 gives the key information outlining Eskom's electricity plan to meet a moderate annual 3% growth in demand for electricity over a planning horizon form 1996 to 2015. The Table shows that Eskom now has an excess capacity over 5,000MW, which is gradually digested to the year 2008.

It is based on a selection of long-term planning assumptions considered by the IEP process as being conservative and realistic. It assumes an 87% plant availability being sustained over the planning horizon and 75% penetration of the Distribution Group's proposed demand-side initiatives.

As future supply options, recommissioning of mothballed plants of Camceden, Grootvllei and Komati has been planned. Recommissioning costs for these plants are reviewed on an ongoing basis. However, they must be much cheaper than newly built plants.

Besides short- and mid-term options for power imported from neighbouring countries include the following:

- 350MW from Zambia Electricity Supply Commission via power wheeling arrangement with the Zimbabwe Electricity Supply Authority, targeted for 1998
- 600MW from Capanda hydro plant in Angola, targeted for the year 20000
- 500MW from Inga 1 and 2 hydro plants in Zaire

Eskom's Major Data (1996 Annual Report)

Total electricity sold	165,370GWh
Coal burnt in power stations	85.4Mt
Peak demand on integrated system	27,967MW
Nominal capacity	38,497MW
Net maximum capacity	36,563MW
Average price per kWh	11.3 Rc
Average total cost per kWh	9.46 Rc

Sales to other countries in southern Africa, GWh

Botswana	685
Lesotho	335
Mozambique	596
Namibia	1,100
Swaziland	571
Zimbabwe	2,267
Total	5,554

Table 4.7 Integrated Electricity Plan recommended for the 1997 to 2001 business planning cycle - based on the moderated load forecast

ENERGY FORECAST (GWh)	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Energy sent out	173,186	177,885	183,315	190,302	196,113	202,041	207,799	213,268	218,884	224,973	231,130	237,322	243,838	250,412	257,006	263,420	269,928	276,319	282,594	288,981
Less DSM initiatives	171	338	672	1,172	2,006	2,795	3,675	4,509	4,468	6,177	6,844	7,345	8,012	8,679	9,180	9,847	10,515	11,015	11,682	12,349
Energy sent out (after DSM initiatives)	173,015	177,547	182,643	189,130	194,107	199,246	204,124	208,759	214,416	218,796	224,286	229,977	235,826	241,733	247,826	253,573	259,413	265,304	270,912	276,632
Year-on-year growth (%)	.	2.62	2.87	3.55	2.63	2.65	2.45	2.27	2.71	2.04	2.51	2.54	2.54	2.50	2.52	2.32	2.30	2.27	2.11	2.11
PEAK DEMAND FORECAST (MW)																				
Annual peak	26,436	27,172	28,060	29,173	30,140	31,197	32,240	33,263	34,298	35,396	36,481	37,558	38,674	39,795	40,911	42,002	43,100	44,187	45,253	46,336
Year-on-year growth (%)		2.78	3.27	3.97	3.31	3.51	3.34	3.17	3.11	3.20	3.07	2.95	2.97	2.90	2.80	2.67	2.61	2.52	2.41	2.39
System load factor before DSM (%)	74.8	74.7	74.6	74.5	74.3	73.9	73.6	73.2	72.9	72.6	72.3	72.1	72.0	71.8	71.7	71.6	71.5	71.4	71.3	71.2
Reductions from DSM initiatives:																				
- Load shifting	21	42	84	147	252	357	462	566	671	774	852	929	1,007	1,084	1,161	1,239	1,316	1,394	1,471	1,549
- Strategic load																				
- Energy efficiency	33	67	133	233	399	565	732	898	1,064	1,228	1,350	1,473	1,596	1,719	1,841	1,964	2,087	2,210	2,332	2,455
- Cogen potential																				
Annual peak after DSM	26,382	27,063	27,843	28,793	29,489	30,275	31,046	31,799	32,563	33,394	34,279	35,156	36,071	36,992	37,909	38,799	39,697	40,583	41,450	42,332
System load factor after DSM (%)	74.9	74.9	74.9	75.0	75.1	75.1	75.1	74.9	75.2	74.8	74.7	74.7	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6
GENERATION CAPACITY (MWSO)	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1.0 EXISTING SYSTEM	31,030	Up to and including Palmiet/Kenda (including deratings and stored plant)																		
2.0 EXISTING DSM AGREEMENTS																				
Interruptible load	1,430	370	370	370	370															
3.0 COMMITTED NEW CAPACITY																				
Majuba (3x612 dry & 3x667 wet)	612	612	612	667	667	667														
4.0 IMPORT OPTIONS																				
Cahora Bassa firm (950/1,450)		950							500											
Other imports (ZESCO)	350																			
5.0 RECOMMISSIONING STORED UNIT																				
Arnot (4 x 330)	330	330	330	330																
Camden (8 x 190)														190	570	570	190			
Grootvlei (180 + 5 x 190)													570	560						
Komati (5 x 90 + 4 x 114)													294	408		204				
6.0 NEW GENERATION PLANT																				
Coal-fired dry cooled (6 x 350)																				325
Pumped storage 1 (3 x 333)															333	333	333			
Pumped storage 2 (9 x 333)																	333	999	1,332	333
CAPACITY ADDED (MW)	2,722	2,262	1,312	1,367	1,037	667			500				864	1,158	903	1,107	356	999	1,332	658
System sent-out capacity (MW)	33,752	36,014	37,326	38,693	39,730	40,397	40,397	40,397	40,897	40,897	40,897	40,897	41,761	42,919	43,822	44,929	45,785	46,784	48,116	48,774
Gross plant margin (GPM) (%)	27.9	33.1	34.1	34.4	34.7	33.4	30.1	27.0	25.6	22.5	19.3	16.3	15.8	16.0	15.6	15.8	15.3	15.3	16.1	15.2
Excess above 15.2% GPM (MW)	3,355	4,833	5,246	5,518	5,753	5,515	4,626	3,759	3,379	2,421	1,401	391	201	298	144	226	47	25	358	

Source: Synopsis of the Integrated Electricity Plan for Eskom's 1997 - 2001 Business Cycle

CHAPTER 5

POLICY, SYSTEM AND ORGANIZATION

CHAPTER 5 POLICY, SYSTEM AND ORGANIZATION

5.1 Introduction

As was mentioned earlier, the power supply system in Namibia is divided into the separate organization, (i) generation and transmission and (ii) distribution. Generation and transmission are undertaken NamPower (Namibia Power Company) which is a 100% government-owned company and which conducts independent operation as the sole operator.

As for distribution, although NamPower directly distributes power to some large users such as mining companies, commercial farm, etc., other organizations are operating the distribution of power to consumers in municipalities and rural area. In 16 municipalities, the municipal authorities have their own municipal distribution networks and at the same time are responsible for maintenance. In rural villages, or settlements, however, NamPower supplies power to a substation near each area, while the MME is responsible for the construction of distribution facilities within the area boundaries, and maintenance of the distribution system are conducted by the MRLGH. Since the achievement of national independence, the government has been implementing the Rural Electrification Programme, for which the MME acts as the direct promoter, in the northern part of Namibia (former Owambo region), near the border with Angola, where the density of the population, mainly consisting of low income people, is very high, but has found it difficult to achieve the expected results. Consequently, the government made a contract with a private company called Northern Electricity in December 1996 and transferred (leased) all local distribution facilities to the company to carry out consigned trial operation for a period of five years. If this trial produces favorable results, the MME plans to apply the same method to other areas.

5.2 Organization Structure Related to Power Supply

The Government of Namibia consists of 20 ministries and two offices under the President, and the ministries directly involved in power supply are the MME and MRLGH (see Figure 5.1).

(1) MME (Ministry of Mines and Energy)

The MME is in charge of natural resources and energy and is responsible for advancing formulation of the Power Development Master Plan which covers power self-sufficiency and rural electrification, proclaimed in the First National

Development Plan (NDP-1). Organization of the MME is composed of four directorates, and the compilation, coordination and regulation of power policy is carried out by the Electricity Division which belongs to the Directorate of Energy. Now the MME is run by a small number of staff, however, reinforcement of the staff is needed to keep its efficiency and proper function for forthcoming abundant tasks (see Figures 5.2 and 5.3).

(2) MRLGH (Ministry of Regional, Local Government and Housing)

This ministry is responsible for carrying out coordination with, and controlling and supervising local administrative Organizations, and is deeply involved in the rural village and settlement development plans. As for rural electrification, the MRLGH is responsible for maintenance of distribution facilities and collection of electricity charges following completion of electrification of distribution facilities works by the MME, and it also carries out additional installation of distribution lines within the villages as the necessity arises. The MRLGH itself is the supervisory organization of the central government, and actual work is carried out by subordinate organizations within respective rural administrative bodies (see Figures 5.1 and 5.4).

(3) NamPower

NamPower is a 100% government-owned power company and acts as the sole operator responsible for the work concerned with generation and transmission. NamPower operates under a self-supporting accounting system.

The main source of power generation is the Ruacana Hydropower Plant (240 MW) located close to the northern border with Angola. The Van Eck Thermal Power Plant (120 MW) and the Paratus Diesel Power Plant (24 MW) are used for backup purposes because of their high operating cost resulting from a high fuel cost, which resulting to reduce the operation rate of these plants. In addition to the above plants, power is purchased via the linkage line (220 V) with Eskom which was completed in 1980, and power from this source is mainly consumed in the central and southern regions of Namibia. Further, in preparation of an expected increase in the power demand in the future, NamPower has commenced the construction of a new linkage line (400 kV) with Eskom of South Africa, and this is targeted for completion in 2000.

NamPower is composed of seven sections and employs some 817 people (as of October 1997). Currently, it possesses a regional office in the capital, Windhoek, and another regional office is being built in Tsumeb in the north, and it strives to provide thorough customer service via these offices and also district offices in Otiwarongo, Ondangwa and Keetmanshoop.

The Republic of Namibia is internationally a member of the SAPP (consisting of 11 member countries including South Africa), and NamPower also acts as the implementing agency of this organization.

NamPower concluded technical support contracts with Eskom and EDF of France in 1996 and is opening ways for participation in seminars and technical training programs, etc. via the overseas training system. In this way, it aims to acquire the latest technology.

NamPower served approximately 2,100 customers in 1997, representing an 8.6% increase over the previous year. This was largely the result of its promotion of electrification plans targeting rural communes and commercial farmers, and it has increased the combined extension of transmission and distribution lines by 673 km in the past year.

Meanwhile, income from the sale of power is on the increase, up by 17.5% in 1997 over the previous year, and the business standing of the company is generally sound and healthy (see Figure 5.5).

(4) Northern Electricity

Northern Electricity is a private company which was established in December 1996 based on a contract with the government and is responsible for power distribution in seven regions in the north of Namibia (Okavango, Caprivi, Ohangwena, Oshikoto, Oshana, Omusati and Kunene). It has assumed the existing distribution facilities by lease and commenced full-scale independent operation in March 1997.

The period of the contract with the government is five years and the contract is renewable thereafter on an annual basis. Northern Electricity has been licensed to supply electricity over wide-ranging areas to some 750,000 people, however, its electrification rate in the subject areas is currently low at approximately 6-7% and the distribution load capacity is only approximately 33 MVA.

There are seven members on the Board of Northern Electricity, and the company has 56 employees (as of January 1998) and five service centers for customer services. Since it is unable to provide a full range of customer services using only these employees, Northern Electricity employs 37 vendors by separate contract, consisting of five engineers (one at each service center) and 32 service men, to compensate for this lack of capacity. Moreover, in August 1997, it established a Fault Reporting Center providing 24 hour service in Tsumeb, and in this way is striving to improve its service setup to enable it to respond immediately to accidents and troubles (see Figure 5.6).

Northern Electricity submits monthly reports to EMC (Evaluation Monitoring Committee, consisting of the representatives from MME, MRLGH and Local Authorities). As of January 1998, it serves 6,697 customers and sells 4,360 MWh of power in January, representing increases of approximately 16% and 5% respectively over the same period last year. As of January 1998, approx 70% customers are using pre-paid cards.

Furthermore, in a pioneering move, Northern Electricity has applied for and received government permission to establish a 1 Nc/kWh Electrification Surcharge for the promotion of electrification in this region, and a 1.1 Nc/kWh Community Development Fund (total 2.1 Nc/kWh) for contributing to local infrastructure development , and to collect these on top of its normal electricity tariff. In January 1998, approximately N$ 50,000 was returned to the community via the Community Development Fund in that month.

(5) Municipalities

Although municipalities purchase 100% of electric power from NamPower each municipality possesses a section in charge of distribution and employs engineers and other staff members. However, except for in large cities, numbers of engineers and staff are small and functions tend to be inadequate in terms of organizational structure and technical capability.

In contrast, the Windhoek Municipality (the capital city) is an exception since its population is approximately 10 times larger than that of other municipalities. The power distribution department in Windhoek Municipality is composed of the Planning Section, Distribution Section, Systems Section, Administration Section and Secretary under the City Electrical Engineer. The total number of engineers and other staffs is approximately 200 in 1997, and some 160 of these staff members are assigned to the Distribution Section and carry out construction, operation, maintenance and control of the distribution network in the city.

There are approximately 40,000 power users, 90% of which are general households and 5% are commercial users. There are seven load centers throughout the city, the total capacity of distribution facilities is approximately 200 MVA, the peak power demand is approximately 100 MW, and 80% of power consumption (kWh) is for domestic and commercial purposes (figures in 1995).

The technical level of staff is also relatively high and Windhoek Municipality carries out maintenance, inspections and repairs by itself. Except for cases of major accidents, the municipality hardly relies on NamPower and is run in an organized manner.

5.3 Electricity Act

In Namibia a new Electricity Act has been proclaimed and preparations for its enforcement are being done.

The main objective of this Act is establishment of the Electricity Control Board consisting of nine Board Members, including representatives of the MME, NamPower and ALAN (Representatives of chamber of mines, Local Authorities and Agriculture Unions.), to supervise and coordinate power supply operations (generation, transmission and distribution) and secure the efficient supply of power.

The Act also includes a provision that enables the Electricity Control Board to propose the establishment of a Rural Electrification Fund for promoting rural electrification conditional upon approval by the Minister of Mines and Energy. This implies an intention to implement the same type of fund on national wide basis as is currently implemented by Northern Electricity (the rate will be set by Electricity Control Board).

5.4 Electricity Pricing

The existing electricity tariff rates are as indicated below.

(1) Power Sale Price of NamPower

NamPower currently sells power to municipalities, local authorities, businesses, commercial farms and some regional settlements, and reviews the tariff every year. In the last few years, the tariff has been increased with each annual review.

Tariff revisions are decided by a board meeting of NamPower and are introduced after getting approval by the government (MME). The following gives a comparison of the current tariff (as revised in July 1997) with the pre-revision tariff. The unit charge has been raised by approximately 8% and the basic charge has been raised by more than 30%.

	Before Revision	After Revision
1) Large Power Users (75 kVA or more)		
• Demand Charge (Max. Power Charge)	42.30 N$/M/kVA	41.44 N$/M/kVA
• Unit Charge (Per kWh of power use)	7.40 Nc/kWh	8.00 Nc/kWh
• Basic Charge (Fixed Charge)	75.00 N$/M	100.00 N$/M
2) Small Power Users		
• Unit Charge	16.60 Nc/kWh	17.93 Nc/kWh
• Basic Charge		
up to 25 kVA TR	25.00 N$/M	30.00 N$/M
up to 50 kVA TR	50.00 N$/M	85.00 N$/M
up to 75 kVA TR	75.00 N$/M	100.000 N$/M
(TR: Transformer Capacity)		

(2) Purchase Price from South African Eskom

The purchase price from Eskom in 1997 was 6.73 Nc/kWh on average, a 4.8% reduction from the previous year's level due to increased purchase (approximately 20% over the previous year) by NamPower based on the revised power supply agreement between NamPower and Eskom using the price determination method adopted by the SAPP.

(3) Electricity Tariff Rate of Municipalities

Each municipality determines its own electricity tariff (power sales cost) upon obtaining approval from the Ministry of Finance via the MME, and tariffs vary among municipalities.

The electricity tariff consists of a basic charge and an energy charge, the basic charge being a monthly fixed charge classified according to the size of power use (Amp, kVA, etc.) and the category of user, and the energy charge being a rate per unit of power used (kWh) determined according to the size of power use and category of user. The energy charge is multiplied by the amount of power used (kWh) to obtain the amount to be paid.

There are some municipalities where the basic charge is included in the energy charge. Regarding the category of general domestic user, the basic charge is around N$ 18.00-100.00 per month, the energy charge is 13.00-23.00 Nc/kWh, and in cases where the basic charge is included in the energy charge, the absence of the basic charge is offset by a higher energy charge of between 28.00-37.00 Nc/kWh.

As for other categories, for example, large commercial and industrial users, there are numerous cases where the basic charge is large and the kWh tariff rate is slightly reduced.

In the case of the largest municipality of Windhoek, there is a finely classified system of charges, and the special discount (40%) that is applied to elderly households is worthy of attention. The pre-paid card system is partially adopted in Windhoek and in this case there is no basic charge nor category classification but the energy charge is set at a uniform rate of 29.00 Nc/kWh.

The electricity tariff in Windhoek is determined by taking into account the setting elements of purchase cost from NamPower, general administrative costs and profit. The composition of the electricity tariff in the past is as shown below.

	94/95	95/96	96/97 (November 96)
Purchase cost	60.7%	59.1%	63.4%
General administrative costs	17.8%	16.1%	15.6%
Ordinary profit	21.5%	24.8%	20.9%

This indicates that the ratio occupied by profit is very large (the Council target for this is 25%).

The reason for this is that, because the electricity tariff is one of the few sure sources of income available to the city, part of the cost of other infrastructure construction and maintenance is added to the electricity tariff. This is one of the issues currently under debate within the municipality and there are some voices calling for this additional charge to be lowered in order to have incentive to larger power consumption.

The above-mentioned excess addition on charge is not only adopted in Windhoek but can be seen in other municipalities and local authorities, too.

The average rate of electricity charge collection is 60~100% in municipalities, and 80% in Windhoek. The collection rate becomes worse in Northern Area.

(4) Electricity Tariff Rate of MRLGH in Rural Area

The electricity tariff in rural towns, villages and settlements, etc. is set as a common charge by the MRLGH based on the results of separate discussions between the MRLGH and local authorities and is decided upon receiving the approval of the Ministry of Finance via the MME.

The electricity tariff applied for in July 1997 for general households excluding large users is as indicated below.

	Small Customer (Residential)	Other Customer [Business, School Hospital, Church etc.]
Deposit	N$ 130.00	N$ 230.00 (1 phase) N$ 690.00 (3 phase)
Basic charge Per Month	N$ 0.80/A (up to 60A)	N$ 0.85/A (1 phase) (up to 60A) N$ 4.50/A (3 phase) (up to 60A)
Energy charge Per kWh	Nc 27.00	Nc 29.00 (1 phase) Nc 29.00 (3 phase)

In the case of the pre-payment system (up to 60 A), there is no deposit nor basic charge, but the energy charge is a uniform 34.00 Nc.

Looking at the figures, the electricity tariff charged by the MRLGH is certainly not low compared to the tariffs charged by municipalities and indeed are higher. Compared with the case of Windhoek, the energy charge for small customer and pre-payment charge are both approximately 17% high.

(5) Electricity Tariff Rate of Northern Electricity

The electricity tariff of Northern Electricity is determined following the approval by the Ministry of Finance applied for by the Northern Electricity via the EMC (Evaluation Monitoring Committee) and the MRLGH. The electricity tariff adopted in July 1997 is generally the same as the tariff charged by the MRLGH in rural areas as mentioned in (4) above. This is because MRLGH decided to apply the revised tariff of Northern Electricity as the government common tariff to local authorities administrated by MRLGH.

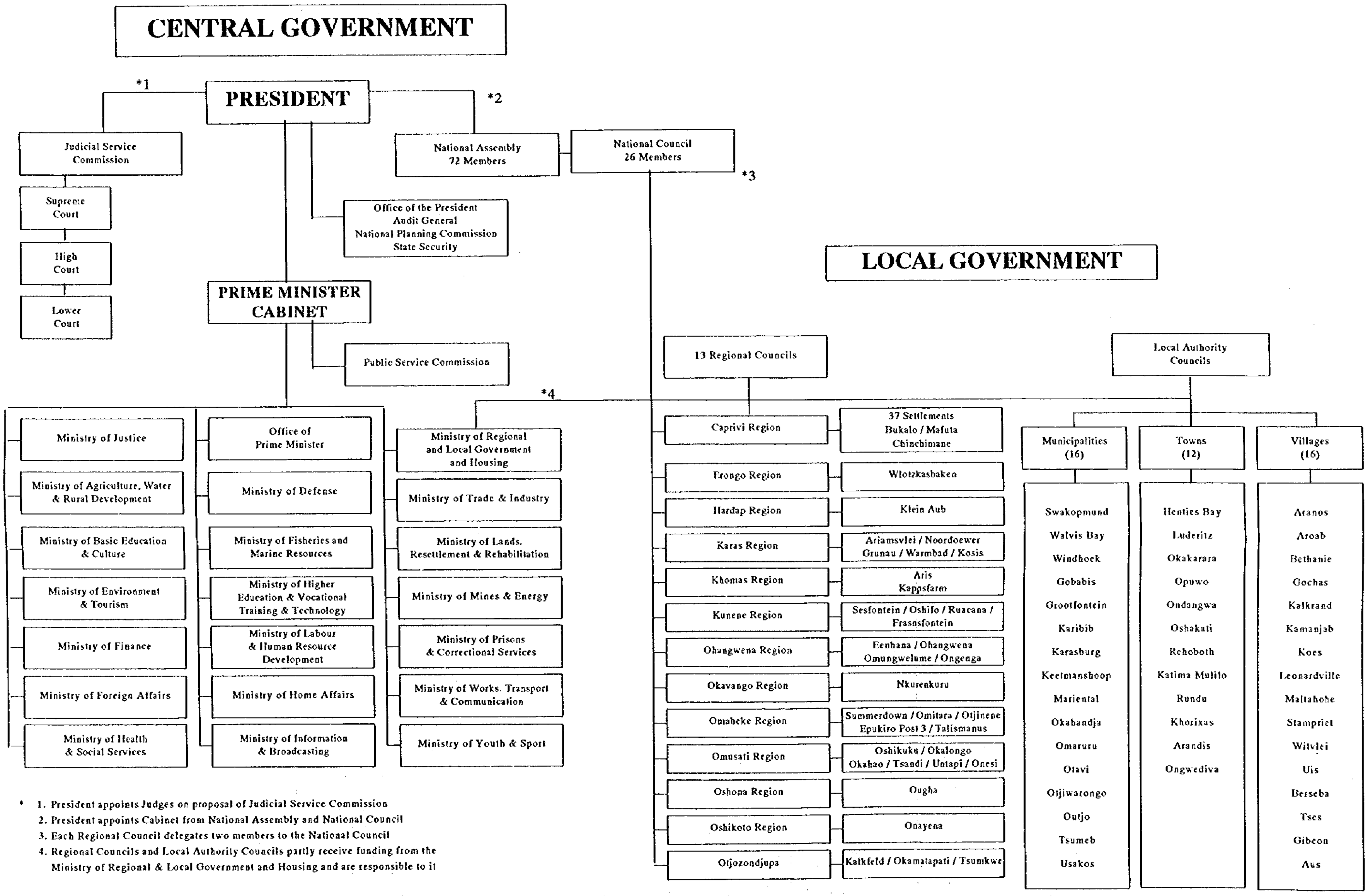


Figure 5.1 GOVERNMENT OF THE REPUBLIC OF NAMIBIA

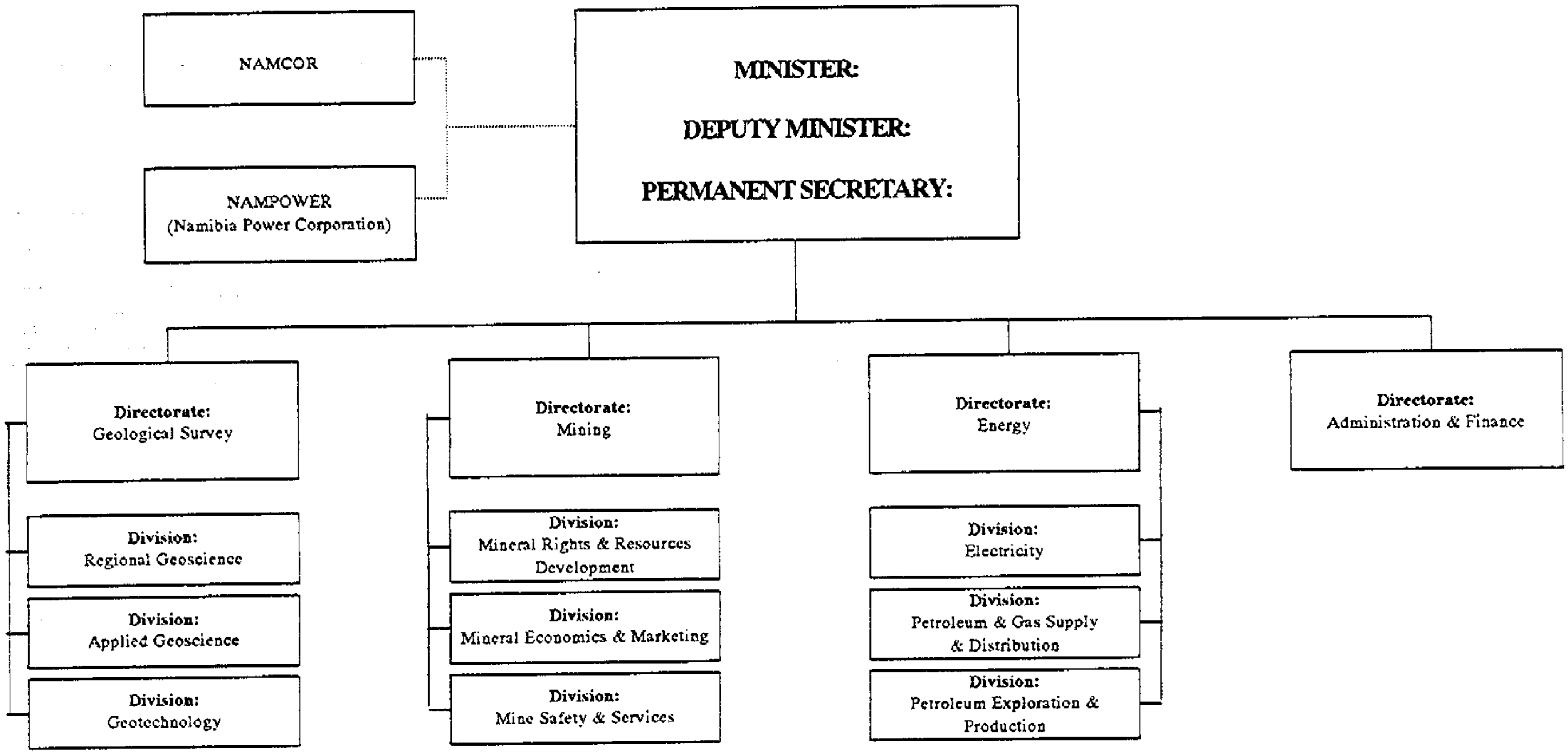


Figure 5.2 MINISTRY OF MINES AND ENERGY

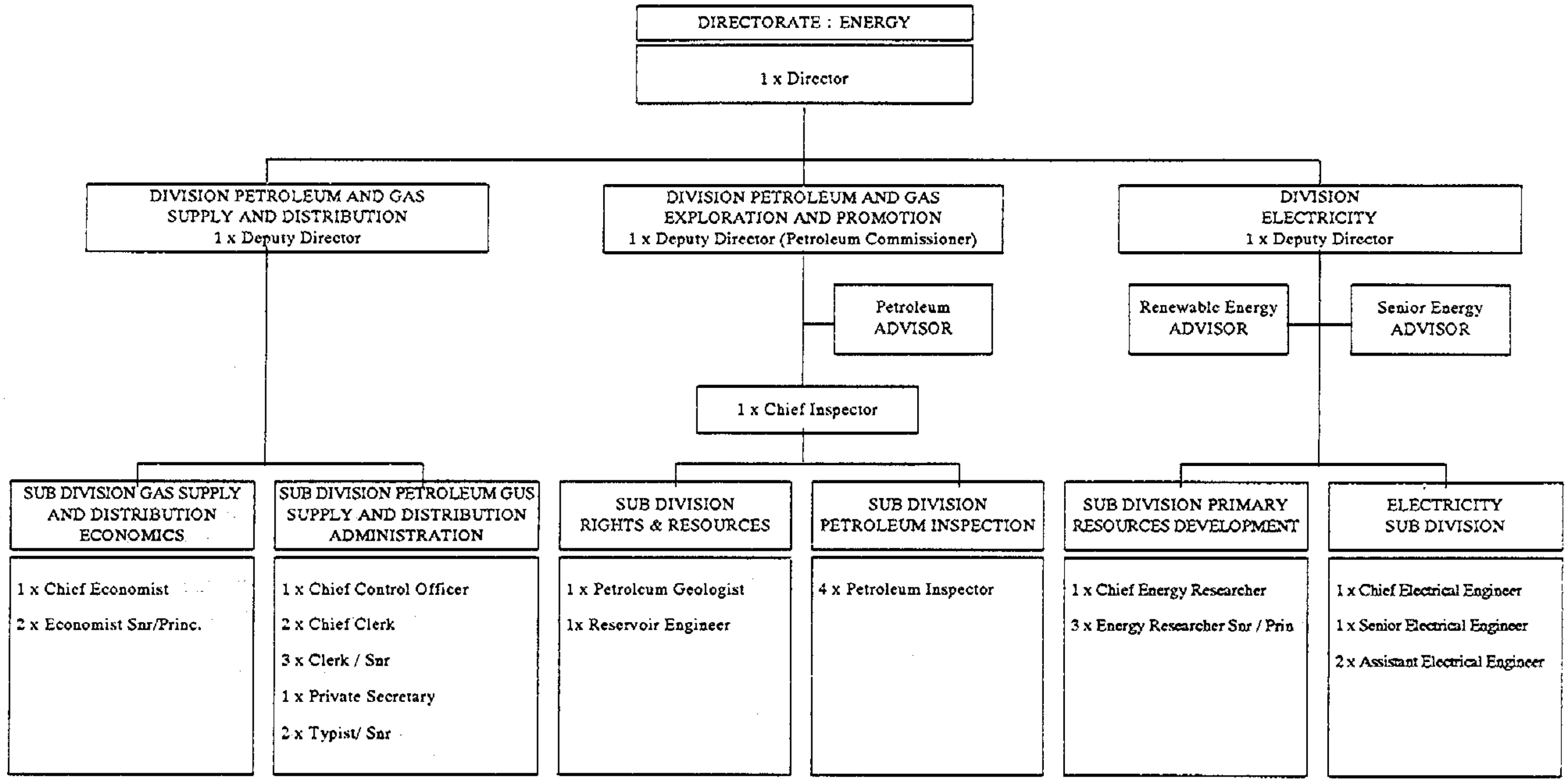


Figure 5.3 ORGANIZATION STRUCTURE OF THE DIRECTORATE : ENERGY

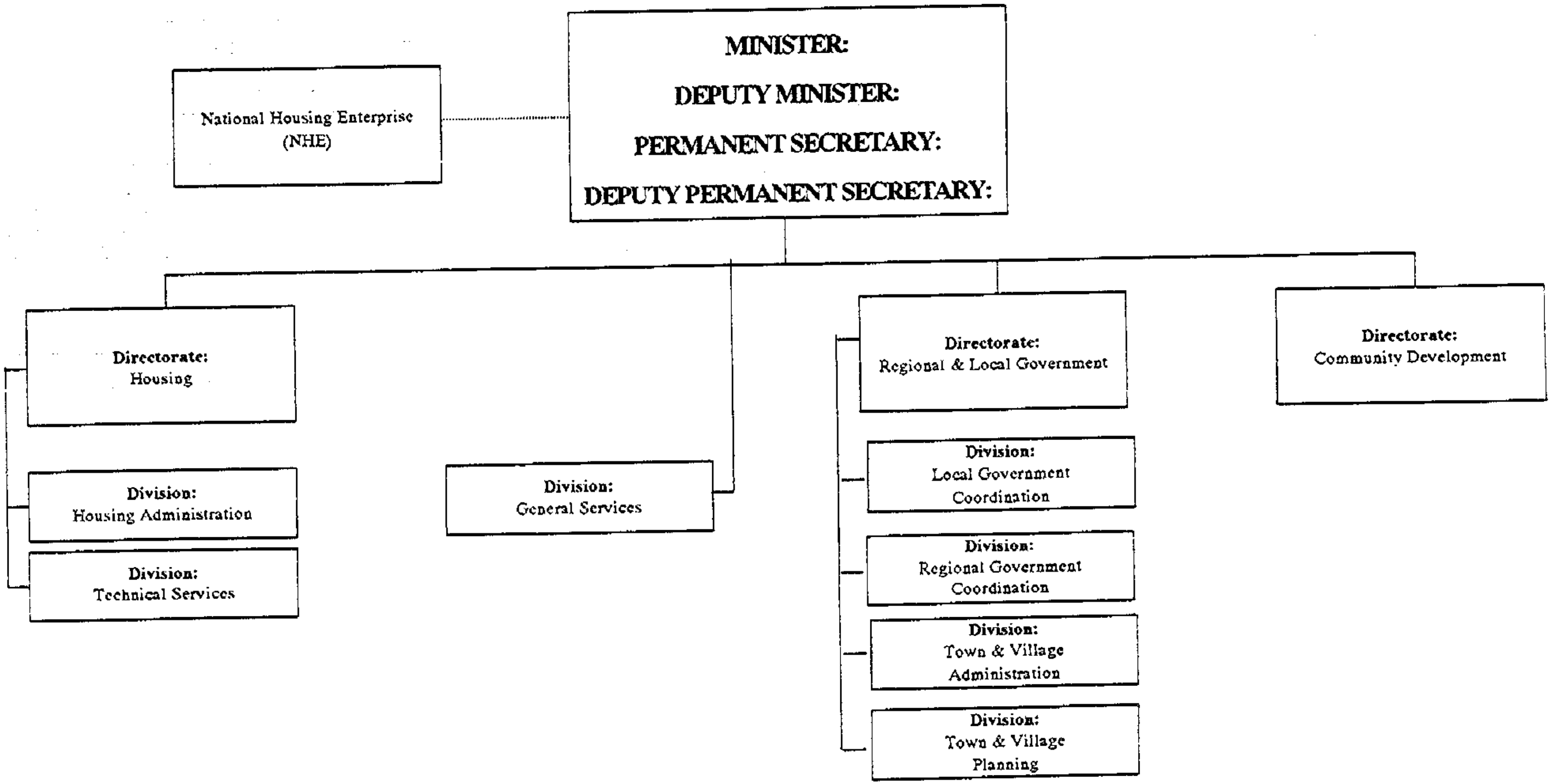


Figure 5.4 MINISTRY OF REGIONAL AND LOCAL GOVERNMENT AND HOUSING

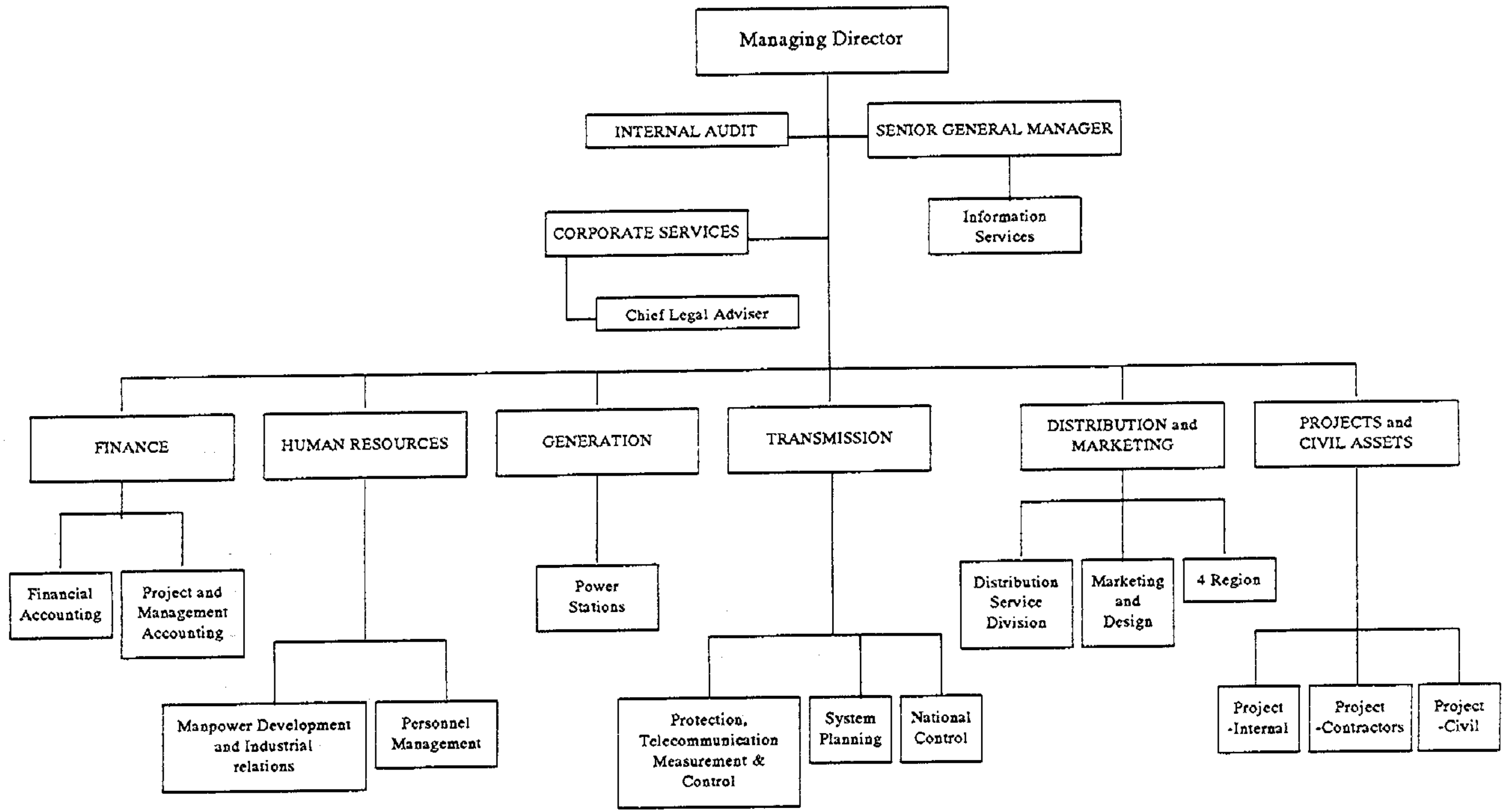


Figure 5.5 NAMPOWER ORGANISATIONAL STRUCTURE

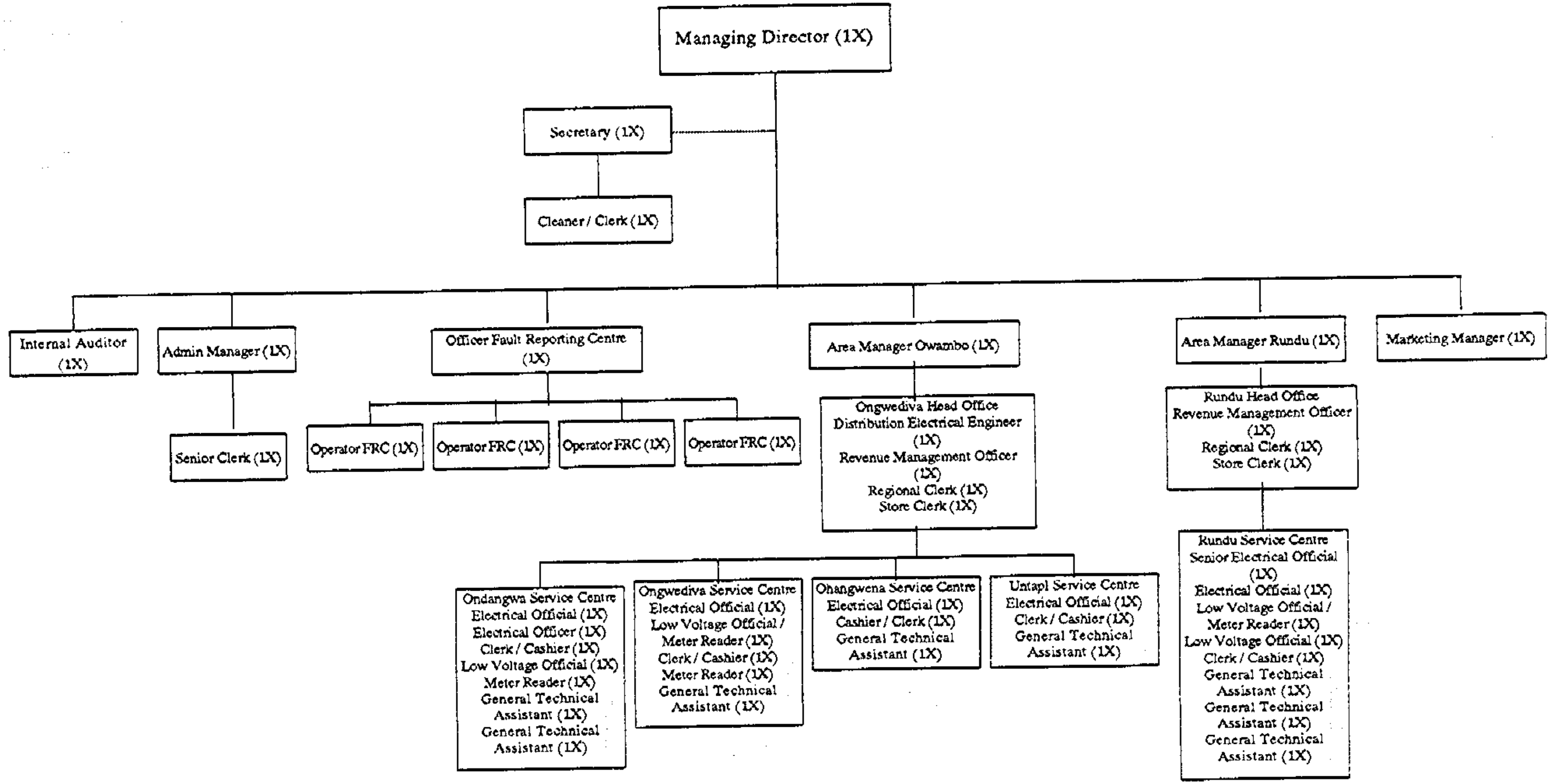


Figure 5.6 NORTHERN ELECTRICITY

CHAPTER 6

ELECTRICITY DEMAND FORECAST

CHAPTER 6 ELECTRICITY DEMAND FORECAST

6.1 The Energy Situation in Namibia

Like the economy, energy consumption was very much influenced by Namibia's history, as set out above. There was no real stability during the decades before it got its independence. Sanctions also played a major role until 1990.

Other than water from the Kunene river, biomass (mostly woodfuel) and small amounts of solar power, Namibia is dependent on importing all its energy.

Water supply to NamPower's Ruacana Power Station varies substantially as there is no proper control of the river flow due to the damage of the Gove dam higher up in the Kunene river, situated in Angola.

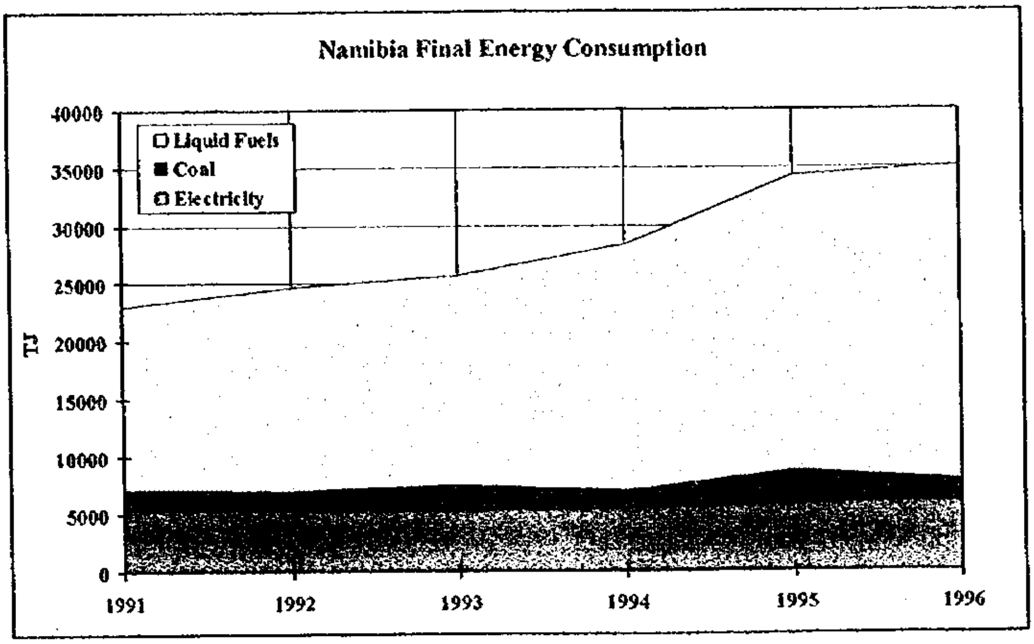
Namibia currently has no exploitable coal reserves. NamPower imports coal for its Van Eck Power Station located in Windhoek through Walvis Bay harbour. The unexploited Aranos coal basin north east of Mariental, which contains in situ resources of about 350 million ton of high-quality metallurgical coal at a depth of 200 to 300 metres, is the largest coal deposit in Namibia. The feasibility of the mining deposit could be reassessed in terms of present market conditions.

Prospecting for oil continues. No petroleum refineries currently exist, and all refined liquid fuels are imported through Walvis Bay harbour. All uranium is exported. Offshore natural gas reserves have not yet been developed, but they have a big potential. Utilisation of these gas reserves is currently being investigated.

Historical time series data for liquid fuels and coal consumption were only available for the past six years. No time series data was available for traditional fuels.

Total final commercial energy consumption in 1996, according to current statistics, was 35 113TJ (i.e. excluding traditional energy). See figure 6.1 below.

Figure 6.1 - Namibia Final Energy Consumption



Source: MME

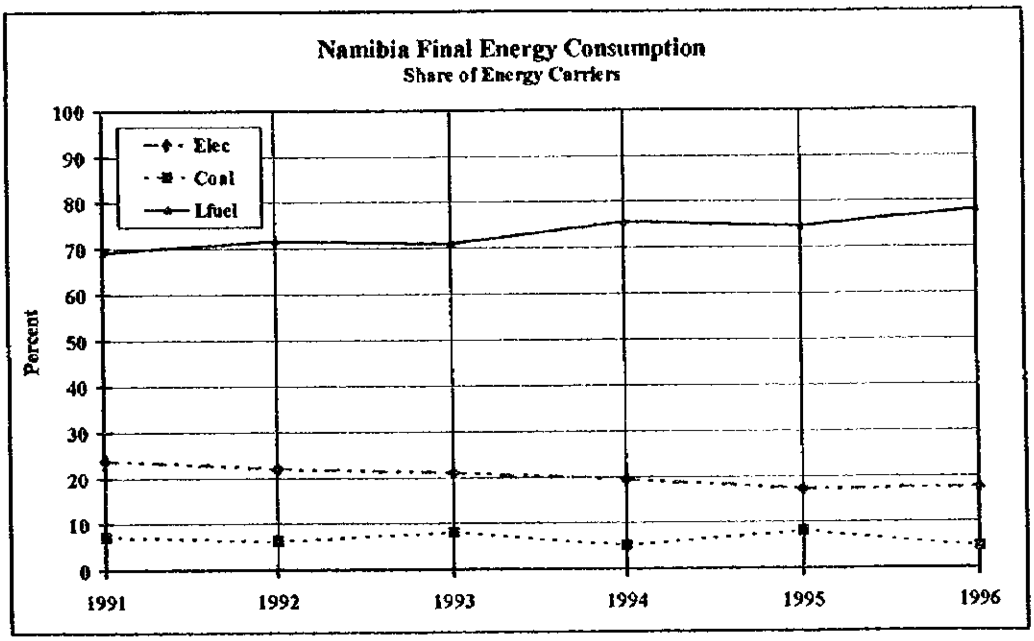
Commercial energy intensity in Namibia increased from 3.4MJ/N$ in 1991 to 4.3MJ/N$ in 1996 (using GDP at constant 1990 prices), mainly due to the high growth in liquid fuels consumption. Including traditional energy, the intensity rose to 5.3MJ/N$ for 1996. Most developed economies in the world have shown a steady decline in energy intensity as the structure of their economies has shifted away from heavy resource based industry.

Energy consumption per capita is often used as a measure for the living standard of a country. Commercial energy consumption per capita in Namibia increased from 16.3GJ in 1991 to 21.4GJ in 1996. If traditional fuels are included, the 1996 consumption per capita becomes 26.7GJ. Energy consumption per capita for the twenty four Organisation for Economic Co-operation and Development(OECD) countries in 1990 ranged from 30.1GJ for Turkey to 370.5GJ for Luxembourg, with an average of 137.7GJ for all these countries. The average of the forecast for the OECD countries for the year 2000 is 147.8GJ. It is clear that as Namibia develops further, its energy consumption per capita will increase.

Average annual growth in total energy consumption between 1991 and 1996 was 8.8% while the growth in GDP averaged 4% over the same period. This gives an energy-income elasticity of over two.

Liquid fuels average annual growth was 11.4% from 1991 to 1996. This high growth lead to liquid fuels increasing its market share from 69% in 1991 to 78% in 1996, as can be seen in figure 6.2 below.

Figure 6.2 - Namibia Final Energy Market Share



Source: MME

Electrical energy growth was only 2.3% over the same period and lost share from 24% in 1991 to 17% in 1996. When biomass is also considered, the share of 17% drops to 14%. Of total electricity consumption about 60% was imported in 1996. Average annual growth in electricity consumption over the last sixteen years was 2.9% compared to GDP growth of 1.9% over the same period.

The figure of 78% drops to 62% when biomass is taken into account. The share of coal decreased from 7% in 1991 to just under 5% in 1996. With biomass included, the share is just under 4% for 1996.

Liquid fuels are predominantly used in transport(road, rail, air and sea), mining and agriculture. Smaller quantities are used in manufacturing and households. Diesel is used to generate electricity and to pump water in off-grid remote areas. Of the 1996 liquid fuels consumption, almost 50% was diesel and about 34% petrol. Rural communities use LPG for cooking, and paraffin and candles for lighting.

The market for liquid fuels is not expected to capture much, if any, of the electricity market. In fact it is expected that electricity will replace diesel-electric generators in some cases. Petrol and diesel prices are set by the government, and the real price for both fuels has decreased since 1989.

Coal, as final energy, is used mainly in smelters at mines (e.g. copper) and manufacturing (e.g. cement). Namibia phased out their steam locomotives in the sixties. Coal is very expensive, and is not used extensively. It is also not expected that coal will have any significant influence on the use of electricity.

Natural gas is not available on a commercial basis yet, and it has been assumed that, should gas fields be further developed, the gas will mainly be used as a primary source for electricity generation for Namibia.

Large amounts of traditional woodfuel are used, mostly in the rural areas either directly or as charcoal. The majority of households in these areas depend on wood fuel. Wood fuel is used mostly for cooking and heating. In the short to medium term, wood resources will continue to be an important energy source. The share of traditional fuel is currently estimated at about 20% of total final energy. This amounts to about 8 778TJ for 1996.

Electricity is used by mining, manufacturing, commerce, households, water pumping, irrigation, government and parastatals, etc. Electricity consumption per capita was 1 030kWh in 1996, compared to around 13 000kWh per capita in so-called Developed Countries.

There is a large disparity in access to adequate energy between urban and rural areas. It is estimated that only about 8% to 9% of the rural homes have access to grid electricity. If urban areas are included, the figure is around 25%.

Electricity prices in Nambia are in general relatively low by RSA and international standards. Local real electricity prices are about 50% to 60% of what they were in 1980. NamPower's real price in 1996 was just above that of the price in 1988.

It has been assumed that affordable energy prices will prevail during the forecasting period. Most of the electricity consumed in Namibia is imported from Eskom. Eskom had made two separate compacts with its customers. In 1991, the organisation committed itself to reducing the real price of electricity by 20% between 1992 and 1996. The actual price reduction achieved over this period amounts to 16.8% in real terms. In 1994 Eskom entered into a second compact to reduce the real price of electricity by 15% by the year 2000.

Electricity growth in the household sector will be mainly driven by urbanisation in the urban areas and by the electrification drive in the rural areas, together with the concomitant increase in living standards. People in the rural areas have expressed a strong desire to have electricity. The draft energy policy also considers affordable energy services necessary for social development.

Another factor which will also have an influence, is tax concessions in the EPZ areas which will positively influence manufacturing costs. Improved technologies and efficiencies will further contribute towards affordable prices.

6.2 Large Power User Electrical Energy Forecast

This description summarises the electrical energy forecast, and the results.

A forecast is usually the best estimate of what is expected to happen in future at that particular point in time. It can be updated daily, weekly, monthly or annually depending on the changes in the environment. This forecast has been based on data and information received up to about August/September 1997.

Information in the forecast should be treated with the necessary confidence.

The Large Power User Forecast should be read in conjunction with the Sectoral Model in Excel format.

6.2.1 Large Power User Data

The historical time series data obtained for electricity consumption during February and March in 1997, as measured in units sold, is accounting data and not statistical data. As such, it is subject to errors and adjustments normally found in such records.

Data categorisation, grouping and quality is such that it would not be possible to develop a highly sophisticated computerised econometric or mathematical model for forecasting electricity consumption. Historical time series sales by all municipalities are not readily available in the categories laid down by the Standard Industrial Classification(SIC) codes or by economic sectors. Electricity sales of Nampower to some municipalities are included in that of other sectors e.g. sales to Tsumeb municipality, Rosh Pinah village and Oranjemund village are included in sales to specific the mines. Electricity consumption by the Uis town is also included under that of the mine until the mine closed. Some power for large scale water pumping which was previously supplied by municipalities, is now classified under water pumping which falls under the government and parastatals category. A few municipalities had their own generation in the past, and the electricity consumption for those early years is missing. Some mines also had their own generation in the past.

Furthermore, electricity consumed by smelters and refineries is all included under that of the mines, instead of manufacturing.

Historical monthly time series data and information were obtained from NamPower for electricity sales for their different categories and individual customers back to 1988. This data was then converted to annual data, on a calender year basis. Annual data for the period 1988 back to 1980 was extracted from NamPower's accounts by hand. The data was arranged into more detailed categories, sectors or sub-sectors. Within the larger categories or sectors major individual customers were singled out.

It was not considered necessary to create a separate data base. The data forms part of the sectoral energy forecast model, and the data can be updated in the model as and when necessary.

6.2.2 Methodology of Large Power User Forecast

The large power users include the proclaimed municipalities, mining, industry, government and parastatals and bulk water pumping. Small users in rural areas such as unproclaimed municipalities, towns and villages together with so-called commercial farming were handled under Small Power Users below.

Time series data for sixteen years have been considered. Although history usually does not repeat itself, a sound knowledge of the history is still very important in estimating future trends.

The model used, disaggregated or decomposed the electricity market into different end-use sectors, sub-sectors and even major customers. A forecast was done for each one of these sectors, sub-sectors or individual customers, as they have divergent characteristics, and eventually aggregated again. The small consumers in each category or sector were grouped together and a forecast was done for them together. These small consumers are usually between 1% to 15% of the total consumption of that sector or category.

As much information as possible was collected on each one of the major customers or sectors. This information was obtained through site visits, meetings and interviews with people of those organisations. Questionnaires were left with the major customers for completion and return to the Ministry of Mines and Energy. Information was also obtained from NamPower staff, reports, publications, documents and magazines. The news papers were also scanned daily and reports were followed up where necessary.

The forecast basically centres around knowledge of and understanding the behaviour of each one of the different electricity market sectors, sub-sectors and major customers. An analysis was done for most of the end-use categories, sectors, sub-sectors and major customers in terms of past growth patterns and trends, reasons for these trends, possible future expansions and developments, correlation with some exogenous variables such as GDP, etc. Historical time series data was graphically displayed to form a better idea of the historical trends. Use was also made of judgemental forecasting. The inputs for this technique are generally historical data together with contextual information. Contextual information is information which helps in the explanation, interpretation and anticipation of time series behaviour.

Opinions and forecasts of major consumers have also been taken into account. The method for each one of these categories or sectors is not exactly the same. Forecasts for major individual mines were mainly based on past performance, the opinions of mine management and the life expectancy of the mines.

Sales data for the major categories, customers and sectors for the first six months of 1997 was also obtained from NamPower during August 1997. From this the performance for the first six months of 1997 was assessed when compared to the first six months of 1996, etc.

The Sectoral Model is a more simplified, manageable and user friendly method, than costly and extremely complex mathematical models which require the highly specialised, experienced and scarce skilled human resources. The Sectoral Model is also not too difficult to maintain and update. Another strong point of the

Sectoral Model is the fact that it handles the changes in the structure and mix in the market quite easily, and also caters for the discontinuities in time series data.

Finally energy intensity and energy per capita were also calculated to assess the forecast results.

More detailed information on how the forecasts were done, is given under each of the individual sectors, sub-sectors or major customers below.

The high- and low forecasts were not done to the same level of detail as the middle forecast. The middle forecast was used as the base and, except for mining and manufacturing, the growth rates for the different major categories or sectors were adjusted in proportion to inter alia the economic growth rates. In the case of mining and manufacturing, various possible future projects were included in the high forecast, or left out of the low forecast. For more details refer to the Sectoral Model.

Regional forecasts were derived from the abovementioned forecasts. The method which was used was one of allocating the major customers to their particular regions. This accounted for about 85% of the total consumption. The rest was devided amongst all the regions. It should be noted that this is not a very accurate method, but an approximation. A more accurate method will need much more time, and it was also not considered to be worth the effort. Sales to other countries are excluded from the regional forecasts.

6.2.3 The Large Power User Electricity Market Forecast

The large power user market has been divided into the following main categories namely Local Authorities, Mining, Industry (manufacturing), Water Pumping, Government and Parastatals, and Rural. These categories or sectors have again been sub-divided.

The forecast covers the total Namibian demand for electrical energy, i.e. it also includes the sales directly from Eskom to some Namibian consumers. Sales to foreign countries were also included under large power users.

Rail traction currently uses exclusively liquid fuels, and it was assumed that no electrification of rail transport will take place within the timeframe of this forecast.

(1) Local Authorities

Local authorities consumed about 56% of total electricity consumption in Namibia during 1996, and is currently the biggest category. This excludes sales to Tsumeb municipality, and sales to Oranjemund and Rosh Pinah townships, which receives its power via the particular mines. Although an official breakdown of historical sales by municipalities is not available, it is estimated that about 50% of the sales go to residential users, while the rest goes to industry, commerce and government buildings.

Population growth, urbanisation, electrification of homes and the establishment of industries are the main drivers of electricity consumption. It is estimated that, where just over 30% of the population was urbanised in 1996, the figure will be about 50% by the year 2020. This will have a significant influence on the demand for electricity. As the standard of living increases, some people will also buy more appliances which use electricity.

This category has been divided into major individual municipalities and towns, the rest of municipalities and towns and proclaimed villages. Each one or group was considered separately in the forecast.

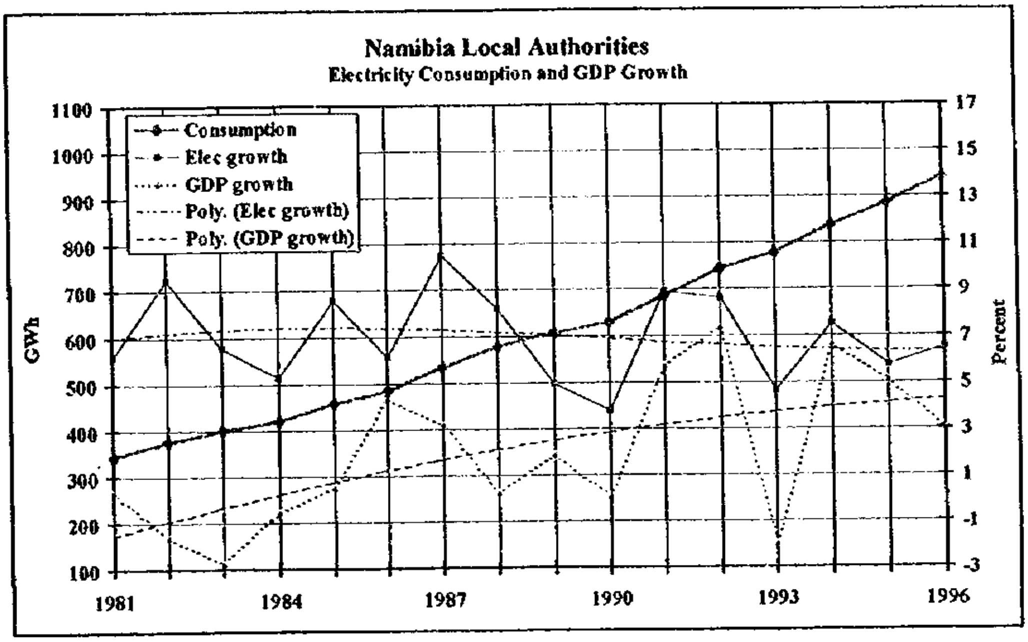
Major individual municipalities and towns were visited and discussions were held with senior officials with regard to the present situation and future prospects, in particular expected electricity consumption.

Electricity consumption of Local Authorities increased at an annual rate of 6.9% over the past sixteen years - an exponential curve fit indicates a downward trend

from just over 7% in 1981 decreasing to just under 7% in 1996. See figure 6.3 below on the next page.

The population growth rate in the country was about 3.2% over the same period, but the growth rate experienced in the municipalities and towns is around 5% to 6% per annum. This is a clear indication that urbanisation and its concomitant needs are major drivers of electricity consumption in local authorities.

Figure 6.3 - Namibia Local Authorities Electricity Consumption



Source: NamPower

a) Windhoek Municipality.

Windhoek is the capital of Namibia and it is the largest single municipality. Its population was close to 200 000 people in 1996, or about 12% of the total Namibian population.

Electricity consumption of Windhoek was about 50% of the total consumption of Local Authorities in 1996.

Historical growth of electricity consumption increased from 4% per annum in 1981 to 12% in 1986, and thereafter declined gradually to a rate of 6% in

1996. The average for the past sixteen years was 6.3%. This high growth rate in the last few years is mainly due to the growth in urbanisation - the average growth rate of the city's population over the last five years was about 5% to 6% per annum. It is estimated that 60% of the electricity consumption of Windhoek is used by domestic consumers, while the rest is consumed by commerce, hotels, light industry and government. Typical large customers are the breweries and hospitals.

Future growth of electricity consumption of Windhoek is expected to remain high for a number of years. Apart from the fact that it is the capital, there are also the Windhoek and Eros airports which will support the development of the city. The city is also popular for tourism, and hotels are widely used by businessmen. Afrox planned to build a N$4million liquid oxygen and nitrogen gas production plant which will be capable of meeting the needs of the entire Namibian market and supplying gas for export to neighbouring countries, but the project has been shelved for the time being. Plans have also been announced to build a five star hotel with a casino and conference facilities in Windhoek.

The influx of people from the rural areas to the city had created a huge demand for housing with the concomitant demand for electricity. This influx is expected to continue, and the population growth rate of the city is estimated to stay around 5% per annum up to the year 2020.

Although the trend of electricity consumption was somewhat downward, it seems to have levelled out to just above 5%. It is well above the GDP growth rate and about the same as the growth rate of the population of the city. The margin between the electricity growth rate and the GDP growth rate shows a definite narrowing over time.

Electricity consumption for the first six months of 1997, when compared to the first six months of last year, shows a growth of 6%.

The municipality forecasts an average growth in electricity consumption of about 5% to 6% per annum over the medium term. This growth is expected to be maintained for some time, due to continuing urbanisation and development, but it is expected that growth will decrease in later years to about 4% to 5% mainly as a result of a decrease in electricity intensity.

b) Walvis Bay Municipality

When Namibia became independent in 1990, Walvis Bay remained under the government of South Africa. The town was only re-incorporated into Namibia four years later, on 1 March 1994. Walvis Bay is the main harbour of Namibia. The town is also known for its fish processing industry.

Walvis Bay was is the second biggest consumer of electricity in this category and was responsible for 12% of the electricity consumption of total Local Authorities in 1996.

Electricity sales to Walvis Bay were influenced by inter alia the political situation, urbanisation, trade, as well as the unpredictable variations in the fish industry caused by oceanic factors.

There was a significant expansion of the fishing industry, especially in the white fish lines, since independence. About 28% of the municipality's electricity is currently consumed by the fishing industry.

The trend of electricity consumption growth of Walvis Bay municipality, shows a slight increase over the sixteen year period. Average annual growth in electricity consumption over the past sixteen years was 5.5%, compared to average national GDP growth of 1.9% over the same period.

The town's population increased from about 30 000 in 1994 to an estimated figure of 50 000 in 1996. This rate is not expected to continue for long.

Government has established an export processing zone (EPZ) in Walvis Bay, where there are very attractive incentives for those setting up various kinds of light industries. The second phase is currently under investigation and is scheduled to be operational within two years. Phase two will be developed with the assistance of the World Bank.

The harbour will be further upgraded and expanded to handle the increased trade. The new container terminal is expected to be completed by April 1998. It is planned to deepen the channel from -10.2m to -12.8m. Exports through the harbour will also benefit from exports from Southern African states. The so-called Trans-Kalahari Highway will allow exports, currently going through Durban and Cape Town harbours, to go through Walvis Bay. The port is also expected to serve Botswana, Zimbabwe, Zambia and southern Zaire. Exports should also benefit from the completion of the Trans-Caprivi Highway. The increase in industrial activities will in turn have an impact on commercial activities in Walvis Bay. An oil refining industry in Walvis Bay is also not a remote possibility.

The development described above, together with urbanisation will be the major drivers of electricity consumption in future. Walvis Bay is seen as a major growth point in future.

The past trend of electricity consumption growth shows a positive correlation with the trend of GDP growth, with a margin of about 4%. In view of the future development as explained above, growth in electricity consumption is expected to remain above that of GDP growth for the whole of the period under consideration.

The margin is however expected to decrease gradually in the later years as electricity intensity starts to decrease slightly.

Growth for the six months ending June 1997 was 5.9% when compared to the same period last year. This indicates a strong growth for 1997.

The municipality estimates that electricity consumption will increase at an average rate of about 5.3% over the next eight years. This is significantly lower than the average growth of 7.7% since 1990. A growth rate of at least 5% to 6% is forecast over the period up to about 2010/2015, whereafter growth is expected to be lower at about 4% to 5% per annum(excluding the forecast for the desalination plant).

A desalination plant is planned by Namwater to be operational from the year 2000. The ultimate power requirement for a plant using the mechanical vapour compression process is 10.3MW by 2015, while that for a plant using the reverse osmosis process is 4.7MW. It was decided to make allowance for the former process in the forecast. The plant, which will be the responsibility of Namwater, will be in the Walvis Bay municipal area and its power requirement has been added to that of the municipality mentioned above.

c) Swakopmund Municipality

When Britain annexed Walvis Bay in 1878, the Germans were forced to find an alternative harbour at that stage. This led to the birth of Swakopmund. There are no more harbour activities. In the 1970's the development of the Rössing uranium mine, about 70 km to the east of the town, had a major impact on all facets of life in Swakopmund. It currently has a population of about 25 000 people.

The town is a very popular tourist attraction and has also become a famous holiday town with many holiday flats. It is also favoured by many people as a place for retirement. A brewery is currently the biggest industrial consumer of electricity. Swakopmund is currently the third biggest consumer of electricity in the category of Local Authorities.

Average annual growth in electricity consumption was 5.9% over the past sixteen years compared to average real GDP growth for the country of only

1.9% over the same period. The trend of electricity consumption growth shows a positive correlation with the trend of GDP growth over the last number years, and is about 3% above that of the GDP trend at present.

Future growth in electricity consumption is expected to come from the residential sector, commercial activities and increased tourism and holiday activities.

Growth in 1996 was 3% and growth for the first six months of this year was only 1.4%. This low growth is due to the fact that the cold weather came later than last year. Furthermore building development(mainly new flats) peaked in 1994 and 1995, and the bottom of that cycle is now being experienced.

The municipality forecasts an average annual growth in electricity consumption of 5.7% over the next eight years for the town which is in line with the trend over the last few years. An average growth of 5% to 6% was allowed after 1998 for a number of years, and decreasing to about 3.5% per annum over the longer term.

d) Otjiwarongo Municipality

The town of Otjiwarongo is situated some 250km north of Windhoek with a population of about 25 000 people. Population growth of the town is estimated at about 5% per annum. The Okorusu fluorspar mine is located north of Otjiwarongo.

Major reasons for growth of the town are urbanisation, the establishment of a cement factory, and the fact that it is situated on the main route between north and south. Water is currently a constraint for growth.

The whole town had been electrified except for a number of houses which have recently been built and which will soon be electrified. The current cement factory will be transformed into a modern factory and expanded. It is expected that this step will be completed in 1998, and the new plant will require about 10MW of additional power. There are big lime deposits in Otjiwarongo. Apart from industry, urbanisation will be a major driver of electricity consumption.

Growth in electricity consumption shows big variations, and a straight line curve fit was done. The trend of electricity growth was about 5% to 6% above that of GDP growth, and is currently well above the estimated urbanisation rate of 5% per annum.

Growth in electricity consumption for the first six months of the year 1997 compared to the same period last year was 2.7%. This low growth is seen as a temporary situation by the municipality which was caused by the cut-off of consumers who did not pay their accounts, as well as a slowdown in building activities.

Information on development and expansions to the cement factory, have been included in the forecast over the medium term with a slight delay in construction. Considering the rate of urbanisation and GDP growth, an average growth of about 5% is forecast over the later years, dropping to about 3% to 4% by 2020. Urbanisation, especially in the smaller municipalities, will not lead to high consumption per household, as many houses will be small, and many will be of the squatter type.

e) Oshakati Town

Oshakati is located in the northern part of the country, which has a low GDP per capita. It lies on the main route to Ruacana. Time series data for electricity consumption was only available as far back as 1984. Prior to that, Oshakati had its own generation. Attempts were made to get the historical data back to 1980, but the actual data is no longer available. The South African Defence Force (SADF) had a major base in Oshakati in the late seventies and eighties which included quite a number of houses and large bungalows.

Electricity consumption by this town increased at an average annual rate of 7% over the past twelve years. In 1987 and 1988 the growth was zero, while it was a negative 5% in 1989 and 1990. This dip in the growth was due to Ondangwa being supplied and billed independently as from 1988. The withdrawal of the SADF also had an impact. Since independence the average growth rate of electricity consumption of 10.7% per annum, was significantly higher than the average annual GDP growth rate of 4.2% for the country as a whole over this period. Since independence some homes, schools, clinics were also electrified.

The University of Namibia has indicated that it plans to open a new campus in Oshakati in early 1998.

As the growth varied substantially in the past for various reasons it will not be of any benefit to do any curve fitting or to find any correlation.

Year-to-date growth for the first six months of 1997 was 7% for Oshakati town, which indicates strong growth.

No forecast was received from the town. It is expected that a high growth of about 7% will continue for some time as a result of urbanisation and a major effort to develop the northern regions. Further electrification within the boundaries of the town, as well as increased use by those who have been provided with electricity, is foreseen. The growth is expected to gradually decrease after 2000 to an average rate of about 5% per annum and to about 4% in the later years.

f) Okahandja Municipality

Okahandja is about seventy kilometres north of Windhoek on the main route to the north. The population of the town is about 20 000. Meatco is their largest single consumer of electricity with a power requirement of 1.85MVA, or about 35% of the municipality's maximum demand of 5MVA. There is also a furniture factory and a steel factory doing welding. The average monthly system load factor of the municipality is 60%.

Electricity consumption by this municipality increased at an annual rate of 7.2% over the past sixteen years. Excluding the high growth in the early eighties, electricity consumption has grown at a rate slightly above that of GDP.

Negative growth in 1993 was due to the major drought in the country and the scaling down of activities by major customers such as Meatco.

A diamond cutting and polishing factory is scheduled to open in 1998 in Okahandja, which will require about 250kVA. The probability for a manganese smelter at Okahandja is increasing, but it has been assumed that the power will be supplied directly from NamPower. It is however expected that the town will indirectly benefit from the spin-offs from this undertaking. The impact of this is difficult to quantify. The smelter is discussed under Industry below.

Growth in electricity consumption by Okahandja municipality for the six months ending June 1997 was 12.3% negative. This drop is mainly due to the lower activity level at Meatco as a result of low supplies of meat, which resulted in a decrease in refrigeration required. This is a temporary situation and has been taken into account in doing the forecast. A forecast for the short term was also received from a consultant to municipality.

As long as there is a meat processing plant electricity consumption will be very much influenced by droughts. Developments are expected to be dominated by residential and commercial growth, at not a very high level, which is also not as electricity intensive as industrial development. Future electricity consumption is expected to grow at about 4% to 5% per annum after 1998 for a few years, but is expected to decrease to about 3.5% in the later years.

g) Lüderitz Town

Lüderitz is a harbour town in the south western part of Namibia, and is the centre of the country's rock lobster industry. It exports mainly processed fish.

Electricity consumption time series data was only available from 1985 as the town, prior to that, had its own generation. It was not possible to find the missing data.

Average annual growth in electricity consumption was 12.7% over the past 11 years compared to average GDP growth of 3.2% per annum over the same period. It was particularly high since independence mainly as a result of urbanisation and the upgrading of fish processing plants. Electricity consumption, like in the case of Walvis Bay, is also very much subject to the performance of the fish industry, which in turn depends on oceanic conditions.

The construction of a new hotel will be completed during 1998. A feasibility study was completed at the end of February 1997, and found the waterfront development project to be viable provided some critical success factors be addressed.

Money had been earmarked to upgrade the harbour - it is the intention to increase its depth from 6m to 8m. About 1MW additional power will be needed for the port development during 1997 to 1998. Upgrading and improvement of the Aus-Lüderitz railway line within the next three years has also been approved. Business development between 1997 and 1998 will require another 1MW.

The port could also benefit from the development of the new Haib copper mine in the south, and also from the proposed new zinc mine, also known as the Scorpion project.

According to the municipality, the high rate of urbanisation is expected to drop significantly after 1998.

Growth for the six months to June was 2%. The low growth is attributed to the upgrading of the fish processing plants a year or two ago, which has now saturated.

The expansions mentioned have been built into the forecast for the next two to three years. This results in a growth rate of about 6% to 7% over the medium term. The possible merging of some fish processing plants could lead to a decrease in consumption at the time when it happens. As a result of this, an average annual growth rate of about 3% to 4% per annum had been allowed for, which is equal to the average GDP growth.

h) Keetmanshoop Municipality

The town is a major road, rail and air link in the south of the country, with a population of about 18 000 people. Major consumers of electricity are Namibia Dolorite Crushers, the hospital and the Canyon Hotel.

The town had its own generation until the beginning of the eighties. Electricity consumption averaged 4.6% over the past sixteen years. It is not known why there was a big fall in growth from 1983 to 1984. The major dip in growth in 1992 and 1993 was as a result of the fact that power for pumping from the Naute Dam was no longer supplied by Keetmanshoop municipality, but by NamPower.

A sleeper manufacturing plant for producing sleepers for the upgrading of the Aus-Lüderitz railway line is planned in Keetmanshoop. Houses which are without electricity are currently being electrified.

Year-to-date growth for the six months ending June was only 1.5%. The reason for the lower than 1996 growth of 6.7% is mainly due to the lower level of activities of Dolorite Crushers. The upgrading of the national road which was mostly done last year, has been completed.

The municipality expects an average annual growth of about 3% over the next eight years, which is more or less in line with the growth over the last few years. Based on past growth and no major developments, growth over the long term is also forecast at 3% per annum.

i) Mariental Municipality

Mariental is located 270km south of Windhoek on the main route to the south. The Hardap dam, the biggest in Namibia, is about ten kilometres north of the town. The water is used for irrigation of lucerne, wheat, maize and cotton. The district also provides about 50% of Namibia's fresh milk.

Growth in electricity consumption averaged 9.4% over the sixteen years against an average GDP growth of 1.9%. The high growth was caused by increased agricultural activities of the Hardap scheme, ostrich farming and abattoirs.

Urbanisation has led to the population increasing to 14 000 at present. Tourism will be developed and a clay tile and pipe factory is planned about two years from now. A feasibility study is also being done for a cheese factory.

Growth for the six months ending June 1997 was only 2.2%. This lower growth is seen by the municipality as consolidation in the growth cycle, with higher growth to follow again within the near future.

The municipality of Mariental expects a growth of about 9% per annum up to the year 2005, which is in line with the average growth over the last ten years. This growth appears to be on the high side and a figure of about 7% was allowed for after 1998, dropping to about 3% to 4% per annum by 2015/2020.

j) Tsumeb Municipality

This is a mining town in the northern part of Namibia, and is located adjacent to the Tsumeb copper mine. The municipality receives its power via the mine, and its electricity consumption time series data is therefore included under that of the Tsumeb mine. Electricity consumption of the town was about 19 GWh in 1996.

The forecast for the town has also been included under that of the mine.

k) Rest of municipalities and towns

This group consist of the smaller municipalities and towns, and represents about 15% of the total local authorities electricity consumption. They are also considered to be large power users. Some of these towns were still unproclaimed in 1992. Electricity consumed by Katimu Mulilo and the Caprivi is included in this group, although it is not supplied by NamPower.

Ondangwa, like Oshakati, was a major military base of the South African Defence force from the late seventies until the early nineties. There were big diesel-electric generator sets in Ondangwa which supplied power to the Defence Force quarters. This consumption is not known. Grootfontein was also a military base. These diesel generator sets were apparently used elsewhere after withdrawal of the SADF.

Average annual growth of this group was 10.3% over the past sixteen years, and 7.1% since 1990. Growth however, shows a downward trend over the period, with a levelling out over the last number of years. The trend of growth in electricity consumption and that of GDP growth have moved closer together over the period.

Future growth is expected to be about 5% per annum and dropping to about 4% in later years, which is slightly above the GDP growth rate.

The estimated consumption for the unproclaimed towns has been subtracted from the total of this category and has been dealt with under Rural.

l) Proclaimed Villages

These are villages with a village council. They are considered to be small power users and customers of NamPower, but get reimbursed by the government for what they pay. No allowance was made for any reclassification ("transfer") of proclaimed villages or unproclaimed villages and settlements to proclaimed municipalities or towns in this forecast.

This category consists of homes, clinics, schools, small shops and businesses, and has been dealt with under Rural.

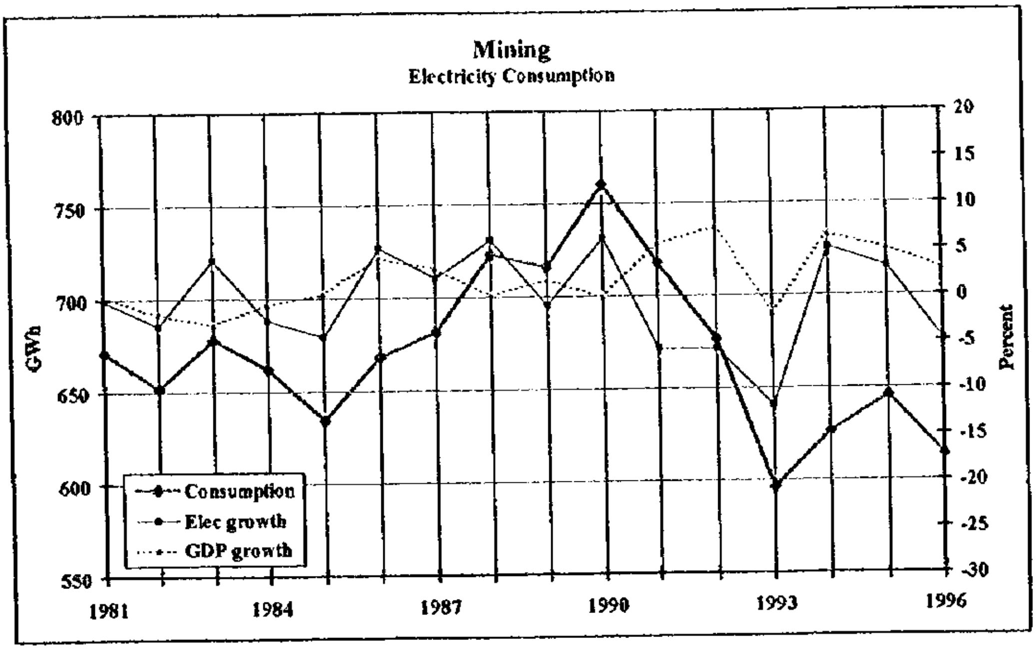
(2) Mining

Electricity consumption of the mining sector was 36% of Namibia's total consumption in 1996. Mining is currently the second largest category, and consist of a few big consumers who have a significant impact on electricity usage. Average annual growth in electricity consumption by the mining sector was a negative 0.6% over the past sixteen years. Figure 6.4 below displays electricity consumption of total mining over the past fifteen years.

Government is determined to foster small-scale mining. It is however difficult to assess the magnitude of small mining.

Mining is operating in volatile world markets for minerals. Mines, usually do not close every time when the price of the mineral drops and open again when the price increases. If there is a substantial drop in the price the output of the mine is sometimes scaled down, usually in the case of open pit ones. Once the price recovers, production returns to normal levels again. Mines usually operates fairly constantly. They close when ore reserves are totally exhausted. After closure they sometimes continue by reworking old dumps until these dumps are exhausted.

Figure 6.4 - Namibia Mining Electricity Consumption



Source: NamPower

Various mines were visited, and meetings were held with mine management regarding the situation at each mine and its future prospects. Questionnaires were left for them to complete on, for example, the expected life of the mine and the projected electricity consumption over the long term. Information was also obtained from the Chamber of Mines, various companies who are investigating or planning new mining developments, consultants and various reports on mining.

Each mining sub-sector has been handled individually from a forecast point of view.

a) Uranium Mining

The Rössing uranium mine started producing in 1976, and is one of the largest uranium mines in the world. It is located some 70km north east of Swakopmund. Namibia is ranked amongst the five biggest producers of uranium (U_3O_8) in the world. Uranium is sold to Western and Far Eastern nuclear utilities. There is a trend to move away from buying uranium on the spot market, to long term contracts in order to secure future supply.

The uranium price declined from a high of US$17 per pound in 1986 to a low of about US$8.5 per pound in 1992. It has recovered to just over US$12 per pound in 1995 and US$14 per pound during the first half of 1997. Spot prices plunged to as low as US$9 per pound during September 1997 due to massive supplies from civil and military inventories.

Uranium production by Rössing decreased from around 4000 metric ton in 1988 to about 1950 ton in 1993, due to difficult market conditions caused by increased supply from East European Countries, and in particular the former Soviet Union. Production has since increased to about 2900 ton in 1996, which was about 9% of total world production. A further increase is expected during 1997.

Western World demand is currently about 56 000 ton per annum, while world production is only about 26 000 ton per annum. The rest is supplied from stock piles. It is expected that by about the year 2005, stocks would be depleted to such an extent that they will no longer have an influence on the market.

Nuclear fuel's share of total world electricity consumption increased from 2% in 1971 to 17% in 1994. It is predicted that world-wide installed nuclear generating capacity will increase from about 345GW at the end of 1995 to just below 400GW in the year 2005, which represents a growth of 1.5% per annum.

Capacity of the Rössing mine is 5000 ton of U_3O_8 per annum. Remaining ore reserves are estimated at over 114 000 ton, and the expected life of the mine is around 25 years. The mine is currently 250 metres deep, which is about half of its ultimate depth.

Diesel-electric trolleys, which transport the ore from the bottom of the mine, were introduced in September 1986.

Electricity consumption followed the production trend of the Rössing mine, and increased again since the recovery in 1993.

Growth in electricity consumption for the first six months of 1997 was 16.4% which is indicative of the increased production at the mine.

A forecast based on the latest long term production plans of the mine, has been received and was used. It indicates a slight increase in consumption up to the year 2010, and constant thereafter. In view of a long term ovesupply of uranium a drop in power requirement was allowed for under the low forecast, starting in 1998 and staying at the 1996 levels. This amounts to a drop of about 6MW.

b) Diamond mining

Namibia was ranked number eight in the world in 1995 in terms of rough diamond production measured in carats. This represented 1.2% of total world production in 1995.

There are three players in Namibia operating in the diamond market namely Namdeb Diamond Corporation (Proprietary) Limited (Namdeb), Ocean Diamond Mining (ODM) and Namibian Minerals Corporation (Namco). North Bank Diamonds have recently obtained a concession, but is not active in the market yet - pilot operations are planned for 1998.

Consolidated Diamond Mining (CDM) was formed in 1920, and was reconstructed as Namdeb in November 1994 and is now jointly owned by De Beers Centenary and the Namibian government. It is currently the largest player in Namibia. Namdeb has three opencast mines over nearly 130 kilometres of the coastal strip northwards of the Orange river. It also operates a satellite mine further north at Elizabeth Bay, and another one in the south at Auchas, situated some 40 kilometres north east of Oranjemund.

Namdeb offshore recoveries increased during 1995. Offshore production of diamonds is about 35% of total production. There are seven vessels in operation, of which three are being used in offshore production and four for exploration.

Cape Town-based ODM, a relatively small diamond mining company, entered the market in 1995. They have secured rights to mine offshore, in the waters surrounding twelve islands near Lüderitz, through the use of an ocean-going mining vessel. The second vessel was planned for the end of 1998, but according to the latest reports they may be able to increase production through new technology without deploying another mining vessel.

In February 1996, Namco, a UK-based firm listed on the Vancouver and Namibian stock exchanges announced plans to start commercial mining during 1997. They have been granted a license to mine in the Koichab area near Lüderitz. A sub-sea crawler system will be used. Namco is also considering setting up a diamond cutting and polishing factory in Namibia.

All diamonds produced by Namibia are marketed by the central selling organisation(CSO) of the De Beers group from its London headquarters. De Beers and the Russian government have early in 1997 signed an agreement which makes De Beers the sole and exclusive buyer of all Russia's rough diamonds

Diamond production in Namibia rose by 5% to 1.382 mega carats (Mct) in 1995 from the 1.314 Mct in 1994. Of the total, 1.34 Mct were produced by Namdeb.

Rough diamond sales in 1996 have reflected continuing strength in world demand for diamond jewellery. Apart from strong demand from the USA, sales in East Asia show continuing strong growth.

Although the main onshore reserves are dwindling, offshore mining and exploration are expanding rapidly. Seabed resources in deep waters are becoming more accessible due to improved technology.

The Namdeb mine at Oranjemund, is the biggest consumer of electricity. The mine receives its power directly from Eskom. Its maximum demand was about 26MW in 1996. Consumption by the village of Oranjemund is also included in the consumption of the mine. The life of the mine is estimated at twenty five years.

Forecasts were received from Namdeb for their three mines, which included expansions. Additional dredging facilities of 10MW will lead to an increase in power consumption from 1997 at the mine at Oranjemund. Growth in electricity consumption for the first six months of 1997 was 13.2% for the Oranjemund mine. This was taken into account when doing the 1997 projection.

In the low forecast a reduction of about 10MW was phased in over the period 2006 to 2020 due to the dwindling of onshore reserves.

c) Copper Mining

Tsumeb Copper Limited (TCL) has four major mines in Namibia. It belongs to Gold Fields Namibia (GFN) who took it over in 1987.

The biggest mine is currently the one in Tsumeb. It is an underground mine with two shafts, and is about 1600 meters deep. Apart from blister copper (99% pure copper), it also produces refined lead and small quantities of arsenic, germanium and zinc.

In 1995 Namibia produced about 0.3% of world copper production, 1% of world lead production and 0.4% of world silver production.

The Tsumeb mine has come to the end of its life. The De Wet shaft was closed in June 1996. A major industrial action during August to October 1996 resulted in closure of the open pit and upper level mining operations. About 7MW of the 17MW was used for water pumping. The copper reverberatory furnace which was badly damaged, was repaired and production commenced in December 1996. The new Ausmelt lead furnace has also been commissioned.

Copper prices were drastically affected by the so-called Sumitomo trading irregularities in the second quarter of 1996. The average annual copper price fell by about US$1000 in the middle of 1996, from US$2800 per ton in 1995, and only recovered towards the end of the year. The weakening of the exchange rate of the Namibian dollar against the US dollar provided some cushioning. The price is not expected to increase significantly due to new production and expansions in other parts of the world.

News about a planned strike by some workers at Chile's Escondida mine helped lift the LME three month copper contract price recently to about US$2 300 per ton. During the last three months prices have slid to just under US$2100 per ton.

Average world lead prices improved substantially and world silver prices were steady during 1996.

Electricity consumption of the mine includes sales to the smelters as well as sales to the town of Tsumeb.

Although mining came to a halt at the mine, smelting will continue in the newly rebuilt copper smelter. Water pumping will be much less, but the loss in power of about 5MW due to this, will be made up through the additional power required by the new lead smelter. Water pumping will only require about 0.5MW in future.

The second biggest copper mine is the Kombat mine outside Tsumeb. It is also an underground mine with a life of another twenty years. Production at the Kombat mine was also negatively influenced by industrial action last year, as well by ingress of water early in 1997.

The Otjihase mine outside Windhoek is also an underground mine. Tons milled during 1996 fell by 31% due to difficult mining conditions.

The mine at Khusib Springs outside Tsumeb is a small mine with a relatively short life, and started production in June 1996.

GFN's own blister copper production had decreased from 25 515 ton in 1995, to 18 915 ton in 1996 as a result of the problems mentioned above. Silver production fell from 44 061 kg to 23 282 kg in 1996, while lead production fell from 8 114 ton to 7 269 ton in 1996, according to the GFN 1996 annual report.

Apart from 1996, when major problems were experienced as already explained above, electricity consumption varied around a figure of about 230GWh per annum over the past fifteen years.

Prospecting for copper currently continues in the Tsumeb area, and it is estimated that there are still substantial reserves.

Analysts and producers have predicted that world demand for copper in the Western World will grow at an annual rate of 2.5% to 3% per year.

The Tsumeb copper mine's electricity growth for the first six months of 1997 was a negative 54%. They are experiencing problems with the new lead smelter. This has been taken into account when the projection for 1997 was done. It was assumed for purposes of forecasting, that these problems will be solved by about the middle of 1998.

The Kombat and Otjihase mines had negative growth of 6% and 9% respectively for the same six months due to problems experienced at the mines. It was assumed that the problems will be gradually solved over the short to medium term.

Forecasts from the major GFN mines have been received from mine management, and have been used in the forecast. Consumption will be fairly constant over the period up to 2020. Under **the low forecast** however, a gradual decrease was taken into account from 2010, assuming that the output of the mines will start to drop. This decrease amounts to about 6MW by 2020.

The proposed new Haib copper mine by the Australian group Great Fitzroy, eight kilometres north of the Orange River, will be an open pit operation. They bought the mining rights in 1995. The mineable resource comprises 650Mt of ore at a grade of 0.37% Cu. This is considered as a conservative estimate. It had been the subject of drilling by UK-based RTZ during the 1970's, but the project was ditched. RTZ has been mining copper at Phalaborwa in South Africa at grades of 0.5%.

The planned output of the mine is 115 000 ton of fully beneficiated cathode copper (99.99% pure copper) per annum, along with small quantities of gold and molybdenium. The mine will have a life of at least 25 years. The process will make use of solvent extraction together with electrowinning during phase one. During phase two, heap leaching of low grade ore will by added to the process. During phase three the milling capacity will be increased by 50%. The capital cost is estimated at about N$3 billion.

Large 2.5MW electricity driven dumper trucks will be used to transport the ore from the pit. During phases one and two, the plant will have four mills.

The mine will have a big impact on development in the south. About 600 people will benefit directly from the project in the form of jobs. Export of the finished product is likely to be through Lüderitz or Walvis Bay.

For phase one, about 208MW of power will be required at a load factor of about 85%. Phase two will require about 30MW to 40MW additional, while phase three will require 340MW six years after phase two. These figures include 14.5MW of power ultimately required for water pumping. The power requirement for water pumping has been included under the Water Pumping category below.

According to the investigations sofar, the project is seen as technically feasible and viable. The final bankable feasibility study is expected to be completed by about March 1998. If it is then decided to proceed with the project, production will start by about the first quarter of the year 2000.

The probability of the project going ahead at this stage is estimated at about 50%. Power requirements of this mine were only included in the **high forecast**.

d) Tin Mining

The Uis tin mine which belonged to Iskor closed in 1991 after the collapse of international tin prices, due to the break-up of the international tin cartel in 1985, and the only power which is consumed is by the town. Electricity consumption of the town now falls under government - towns and villages not proclaimed. A study was carried out on the reclamation of mine dump material but the project was not yet taken further. Micro-scale mining is now taking place at Uis.

e) Gold Mining

Namibia has one major gold producer by the name of Navachab, near Karibib. The shareholders are Erongo Mining and Exploration Company (Anglo American) with 70%, Canada's Metal Mining Corp with 20% and Rand

Mines Windhoek Exploration with 10%. It is an open pit mine with a planned depth of 160 metres. Underground mining has been shelved for the present.

Gold is also produced as a by-product in small quantities by inter alia copper mines.

The Navachab gold deposit was discovered in 1984 and the mining started in 1988. Diesel trucks are used to transport the ore from the mine.

Namibian gold production increased from 1893 kg in 1995 to 2015 kg during 1996. This was about 0.1% of total world production in 1995.

The average monthly gold price has been continuously dropping since the US$405 in February 1996. In July 1997 it slumped to US$314, its lowest level in twelve years. The gold price has been varying around the US$385 mark for the last fourteen years. The average monthly price for July 1997 as well as August 1997 was US$324 per oz. The latest fall in prices was triggered by the Australian central bank's disclosure that it had sold two-thirds of its gold reserves. Central banks in the Netherlands, Belgium and Switzerland have also sold reserves last year. Investor and speculator perceptions are playing a big role in the gold market. World demand for gold however continues to grow in the developing markets of the Middle and Far East. Weakening of the Namibian dollar also cushioned the decline. To forecast the gold price, is almost impossible, but it is not believed at this stage that the current reassessment by the banks will continue.

The life of the Navachab mine is still another seven years, with the possibility of a further six to eight years. With additional information, as a result of drilling, it is quite possible that the life of the mine will be extended beyond 2004. As mining continues, more ore is usually found and better mining methods are also being developed, which usually extend the life of a mine.

An extended life of the mine has been allowed for in the forecast for Navachab, but no underground operations.

Exploration for gold in Namibia is also continuing. There are several deposits of gold in the north of the country, but the magnitude of these deposits is not known.

Since 1990 electricity consumption of Navachab gold mine has increased at an average rate of 3.8% per annum.

A forecast for electricity consumption was received from the mine. Increased activities from 1997 will require an additional 600kW. No further expansions are foreseen for the immediate future, and the forecast is a constant figure for the rest of the period. Growth in consumption for the first six months of 1997 was 12%.

The gradual closure of the Navachab gold mine was included under the low forecast from the year 2006, to finally close by about 2012.

f) Zinc mining

Namibia's total zinc production was close to 0.5% of total world production of zinc metal.

The underground zinc mine at Rosh Pinah, run by Imcor Zinc, is situated about 20 kilometres north of the Orange river and was brought on-stream in 1969. Iskor South Africa (who has a 51% shareholding in Imcor Zinc) currently owns the assets of the mine. The mineral rights belong to a Namibian firm PE Minerals with Malaysian partners. Iskor, PE Minerals and Namibian Mining Ventures have after prolonged negotiations signed a Memorandum of Understanding which would result in a new operating company for the mine.

The zinc concentrate (about 55% to 57% zinc) which is recovered, is exported to Zincor at Vereeniging in South Africa for refining. The mine also produces some lead which is sent to Tsumeb mine for refining and recovery of the silver. When the Tsumeb smelter is not operating, the lead is directly exported through Walvis Bay harbour. Despite the continued problems and uncertainties at Rosh Pinah, Namibian zinc concentrate production showed an increase of some 18% from 30 218 ton to 35 873 ton in 1996.

Zinc is also produced as a by-product in the processes at other mines like for example Tsumeb copper mine.

The zinc price decreased from a peak of US$1600 in 1989 to about US$1000 in 1993, and stayed constant. It is expected to rise to about US$1100 during 1997.

The Rosh Pinah mine's life has continually been extended. The latest estimate for known reserves is 13,5 Mt at a grade of 6.5%. This should last until about 2008. Exploration is being carried out and as the area is rich in zinc deposits, it was assumed that through better technologies and the discovery of more zinc ore, the life of the mine will be extended until the year 2020.

Power for the mine comes directly from Eskom. The mine also generated its own power. Electricity consumption of the Rosh Pinah mine includes that required for pumping of water to the mine, as well as the power for the town of Rosh Pinah. Electricity consumption increased from 1984 to 1987 and started to decrease again from 1991 to level out at about 31GWh per year (or about 5MW). A forecast was received from the mine which shows constant consumption over the long term. Growth in consumption for the first six months of 1997 was 1.6%.

No allowance was made for the increase of Rosh Pinah's production or for establishing their own refinery at Rosh Pinah ore somewhere else.

The Skorpion zinc deposit, twenty kilometres north west of Rosh Pinah, discovered by Anglo-American in the 1980's, has an open pittable resource of about 10 Mt at 10.3% Zn (or 1 000 000 ton of metal), about ten to fifteen metres below the surface. The zinc oxide deposit was discovered in 1976 by Erongo Mining and Exploration Ltd, an Anglo American Group Company. It is a joint venture between Reunion (60%) and Anglo American (40%).

The life expectancy of the mine is about fifteen years. However with improved technology and the discovery of more reserves, its life could be extended significantly. It is intended to make use of acid heap leaching in the process.

The feasibility study is expected to be completed by about January 1998 for the on site production of between 75 000 and 100 000 ton of cathode zinc (99.95% pure zinc), per year. Drilling is being carried out at present. With a construction period of eighteen months, starting by say the middle of 1999, production could be a reality during the first half of the year 2001. The cost of the project will be between US$100 million and US$200 million.

Export of the finished product will probably be through the Lüderitz harbour. It is expected that the current Rosh Pinah village will be developed to accommodate the 250 to 300 employees.

The water pumping for the mine from the Orange river, have been handled under Water pumping below. Total electricity power requirements for the mine are estimated at 60MW with a load factor approximately 80%.

The probability of this project happening is currently estimated at about 50%, and provision was made for this mine in the **high forecast**.

There is also the possibility that the proposed new zinc plant could do the refining of the Rosh Pinah zinc concentrate. No provision was however made for this or any expansions to the Skorpion mine after 2001/2.

g) Manganese mining

The opencast manganese mine at Otjosondu is owned by Purity Manganese and Cranford Namibia, and it achieved production of 150 000 ton at mineral grade of 44% manganese in 1996. The company is planning the construction of a manganese smelter as an export zone enterprise. This is dealt with under manufacturing.

There were reports that the intention is to eventually mine underground. According to the latest information it does not look as though this will happen. The company does not foresee any major increase in the electricity consumption by the mine when the manganese smelters are operating. In 1996 the mine consumed less than 1GWh of electricity. Even if the current output doubles, the impact will not be significant.

h) Titanium mining

The mining of sand dunes between Swakopmund and Walvis Bay is being researched by the Caledonean Mining Corporation. The key product is titanium dioxide which is found in heavy minerals like rutile and ilmenite, which in Southern Africa are usually found in beach sand-type deposits. The mining and in particular the smelting are very electricity intensive. Smelting through the use of furnaces should actually be classified under Industry below.

This project is at its early stages of exploration. Current techniques seem to be unsuitable for the satisfactory extraction of the mineral. No prefeasibility study has even been done. Nothing has been allowed for in the forecast for this specific project during the forecast period.

i) Other Mining

This group currently forms only 1% of total mining. Electricity consumption decreased significantly from 1982 to 1986, due to the closure of Berg Aukas vanadium pentoxide/lead/zinc mine. Average annual growth over the last seven years was 5%.

The Okorusu open pit fluorspar mine has plans to double its production in the near future. The mine is situated north of Otjiwarongo.

A growth of 5% per annum has been allowed for on the present consumption which should cater for small developments.

There were plans for a so-called Sand Piper plant at Walvis Bay, to produce agricultural and chemicals products from the seabed. It was however shelved some three to five years ago. The deposit is apparently an enormous one with great potential. At the initial stage about 30 MW would be required. Phase two power requirements, about six years later, would be about 108MW(including phase one). A total of about 195MW would be required in total, once phase three is completed some six years after phase two.

As the Sand Piper project has great potential, it was included in the high forecast from about 2007, or ten years from now.

Nothing has been included for silicon mining in the forecast. For silicon production refer to Industry below.

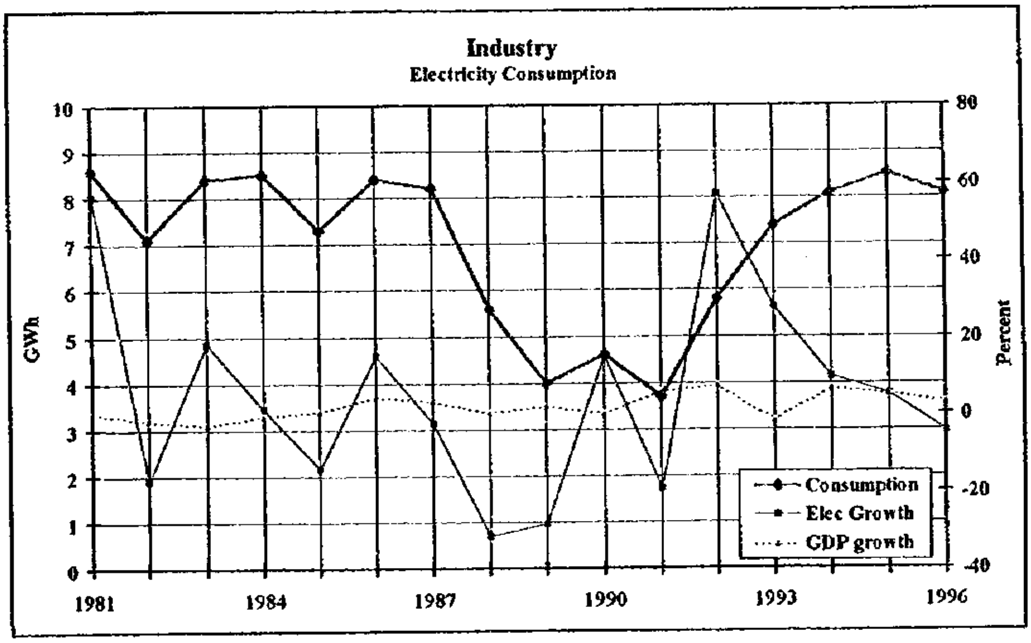
(3) Industry (Manufacturing)

This category is very small, and constitutes only 0.5% of the total electricity consumption of the country. It includes crushers, tanneries, meat processing, etc. As mentioned above, sales to the Tsumeb mine includes consumption of the copper- and lead smelters. Electricity consumed by municipal consumers is included under the consumption of that particular municipality or town. A separate exercise will have to be carried out to categorise municipal sales according to the SIC codes. With all these included under industry, the percentage share will be much higher than the 0.5%.

Electricity consumption in 1996 was almost the same as that in 1981, with a dip between 1987 and 1992. See figure 6.5 below. It is not certain as to what caused this. Average annual growth since 1990 was 9.9%.

To forecast this small category is difficult. Small industries are expected to show good growth. A growth of 6% was assumed for the medium term, with a growth of 4% to 5% in later years.

Figure 6.5 - Namibia Industry Electricity Consumption



Source: NamPower

Nothing has been included in the forecast for the production of titanium dioxide. Refer to titanium mining under mining above.

An aluminium refinery, to the immediate north of Walvis bay, was investigated at the beginning of the nineties, but was shelved. Aluminum refineries are very electricity intensive and the first pot line usually requires about 450MW, with an

additional 400MW for the second potline. No provision has been made for this particular project in the forecast.

The probability of a manganese smelter in an EPZ area has increased to 70%. A feasibility study has been carried out, and the plans are to erect the smelters at Okahandja. Ore from the Otjosondu managnese mine will be used. A total of 40MW (2x15MW smelters plus other infrastructure) at a load factor of about 85% will be required, and has been included in the forecast from the year 2000. An additional 40MW has been allowed for, about 5 years later.

According to information obtained to date, the production of a silicon type metal seems to be a rather remote possibility at this stage. Nothing has been allowed for in the forecast for any smelters as there is currently too much uncertainty about the project.

There is a possibility that the zinc smelter, planned by Gencor in South Africa, could be located at Walvis Bay. The probability that it will be located at Port Elizabeth or East Londen, is however much greater at this stage. No allowance for this particular project was made in the forecast.

(4) Water pumping

Namibia has a semi-arid climate with limited water resources. Furthermore, the country has to share the main rivers with its immediate neighbours. Water could one day even be pumped through a pipeline of close to a thousand kilometres from the Congo river to Namibia.

The newly formed Namibia Water Company (Namwater) is responsible for supplying water in bulk, while the Department of Water Affairs (DWA) will be responsible for looking after the water needs of small consumers and the rural areas, as a customer of Namwater.

Extensive pumping of water is required from underground for domestic and irrigation purposes. The Tsumeb area has a lot of under ground water trapped in dolomitic formation.

Water is pumped from the Calueque dam in the Kunene river into a canal which supplies water to the northern parts of Namibia. The dam is situated about fourty kilometres into Angola.

Apart from the Kunene system, there are a few other major systems such as the Von Bach-, Swakoppoort-, Ogongo-, Naute Dam-, Central Namib-, Omaruru Delta- and Omataku Base pumping systems or stations. Some mines in the south, e.g. the Rosh Pinah zinc mine, pump their own water from the Orange river. The power used by this pumping is estimated to be about 750kVA.

Historical annual water consumption figures for the period 1984/5 to 1996/7 were obtained from Namwater and analysed. Figures further back were taken from the NDP1 document, volume 1. Namwater's financial year runs from April to March. These water consumption figures represent about 90% of Namibia's total consumption. The other 10% is private pumping or pumping by municipalities from own sources or boreholes.

Average annual growth in water supplied by Namwater was 2% between 1980 (1980/1) to 1996 (1996/7). In 1980 domestic consumption was about 40% of total consumption, in 1995 it was close to 60% while it dropped to 52% in 1996. Irrigation was in second place with about 30% of total consumption in 1995 and 38% in 1996. It is clear that domestic consumption will be a main driver in future.

Namibia's water consumption is about 60 cubic meter per capita per annum. About 63% of the population had access to potable water (i.e. within 2.5 km from home) in 1992.

Demand for water in the central area of the country is growing due to urbanisation and development.

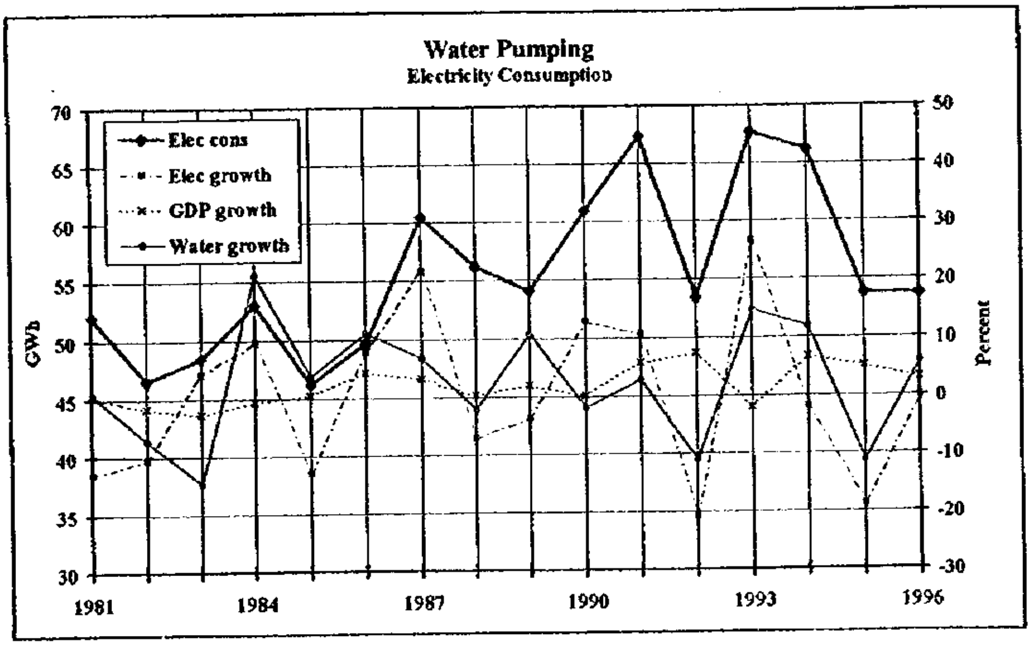
The existing water category has been broken down into the different major systems in an attempt to understand the water pumping system.

Electricity consumption of this category constituted about 3% of the country's total electricity consumption in 1996. Consumption excludes pumping by municipalities, residential consumers and farming.

To obtain exogenous variables to forecast water consumption or electricity consumption for the category is difficult as conservation, more efficient pumping, droughts, good rains, water restrictions, etc. makes it virtually impossible. During droughts a lot of local pumping from boreholes is done by consumers. Use is also made of canals which do not require pumping. Furthermore, as already mentioned, the time series for electricity consumption used in water pumping is incomplete and has some discontinuities in it, like most time series.

Electricity growth shows big variations, -20% in some years to almost +30% in some years. See figure 6.6 below.

Figure 6.6 - Namibia Water Pumping Electricity Consumption



Source: NamPower

Average annual growth in electricity consumption over the sixteen years was close to zero, against a growth in water consumption of 2%. The average annual growth in electricity consumption over the ten year period 1986 to 1996 was about 0.8%, compared to a growth in water consumption of 2.1% per annum, and GDP growth of about 3% over the same period. Some mine's water usage has decreased significantly over the last number of years due the increased re-use of the water for industrial purposes.

Water consumption in Namibia will increase further due to expected economic growth and the high rate of urbanisation. The more efficient use of water, due to its scarcity, will however continue.

As far as the existing system is concerned, a growth of 2.5% was assumed for the growth in bulk water consumption over the long term. Electricity consumption for water pumping is forecast to increase at about 1.5% per annum over the period, based on the above analysis.

Discussions were held with Namwater to obtain information on any new major pumping projects. The power for these new projects have been added to the forecast of the existing system.

Power for the desalination plant at Walvis Bay, has already been dealt with under the municipality of Walvis Bay above.

Pumping from the Tsumeb aquifers will require about 6MW by the year 2000, and was included in the forecast.

Another major future project is the proposed 250 km pipeline from the Okavango river, at Rundu, to Grootfontein to complete the so-called Eastern Water Carrier. About 17.3 million cubic metres of water are estimated to be pumped annually to Grootfontein. The water will flow via a canal from Grootfontein to the Omatako dam, from where it will be pumped to the Von Bach dam which supplies Windhoek with water. A feasibility study for the project has been completed. 5MW was included in the forecast from the year 2005. Another 5MW was allowed for this line by about 2010/15. An additional 25MW was allowed under the **high forecast** for the Eastern Water Carrier from 2010/15.

Bulk water pumping for future agricultural schemes has aslo been included in the forecast. The figures were supplied by the Ministry of Agriculture, Water and Rural Development. For the north east, from the Kavango river, 11GWh (or 6MW at a load factor of about 20%) has been phased over the long term after 1998. Another 12GWh (or 7MW at a load factor of about 20%) has been phased in over the same period for the southern part of the country along the Orange river. Pumping by farmers from these canals, has been allowed for in the Small Power User Forecast.

A desalination plant at Lüderitz is a remote possibility at this stage. This would require between 1.3MW and 2.9MW of power. This has not been included in the forecast.

Plans to build a pipeline to supply water to rural communities in the Oshivelo-Omutsewonime-Okankolo area in the north have reached an advanced stage. This will require only 0.1MW.

Water for the Haib copper mine will be pumped from the Orange river and will ultimately require an estimated 14.5MW. This was included in the **high forecast** only.

A new pipeline will also be required for the proposed new zinc mine pumping water from the Orange river. The pipeline for Rosh Pinah and the pumps are already operating at full capacity. The power requirement for pumping of water for this new mine is estimated at 1.2MW and has been included in the **high forecast.**

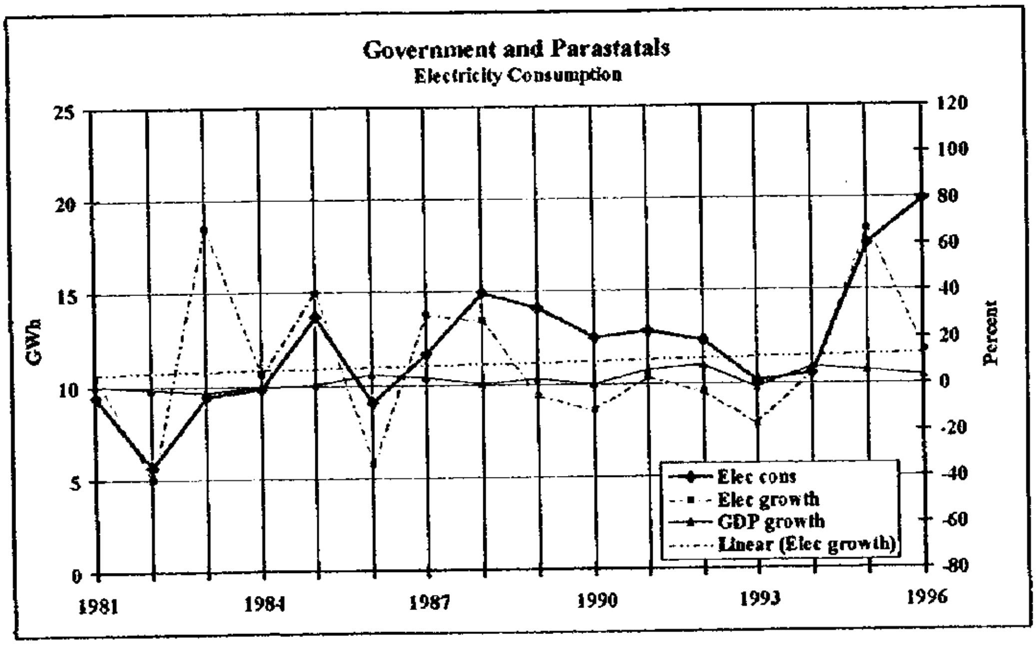
The power required for the Rundu-Grootfontein pipe line, pumping from the Tsumeb aquifers and bulk pumping for agricultural purposes from the Okavango and Orange rivers was scaled down substantially in the low forecast.

(5) Government and Parastatals

The power is mainly used for government buildings, broadcasting, government works, military bases, airports, pleasure resorts, telecommunications, border posts, etc. As in the case of Industry, there are also customers within this category who fall within municipal or town boundaries, and which are being supplied by municipalities. Some of these consumers in the north were probably also supplied by diesel generator sets during the eighties.

This is also a small sector. Electricity consumption was only 1% of the country's total consumption. Growth in electricity consumption over the period show some major variations, -40% to +70% at times. See figure 6.7.

Figure 6.7 - Government and Parastatals Electricity Consumption



Source: NamPower

Electricity consumption was influenced by the activities of the SADF in the northern regions. There is an airfield in Ondangwa which falls under this sector.

Consumption declined again after 1988 until 1993. During the last two years, consumption showed high growth due to increased tourist camp consumption and government buildings consumption. Average growth over the period was 5% per annum, or more than double that of GDP growth of 1.9%. Growth in electricity consumption for the first six months of this year compared to the same period of last year was 3.5%.

A growth of 5% was allowed for over the medium term allowing for development in this area. After that it is expected that the growth will gradually decline to be equal to that of GDP of 3.5% in later years.

(6) Sales to Foreign Countries

No sales to foreign countries have been included in the forecast. The forecast deals with the demand for electricity in the Republic of Namibia only.