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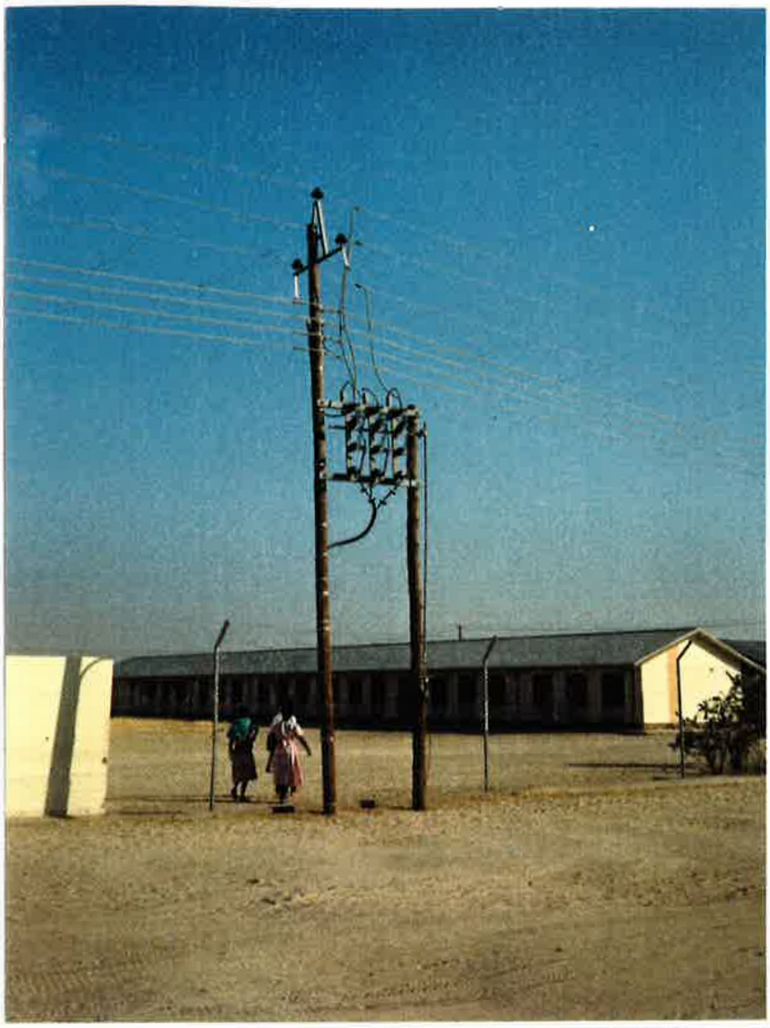
NVE
NORWEGIAN
WATER RESOURCES AND
ENERGY ADMINISTRATION

NORAD MISSION TO NAMIBIA IN CONNECTION WITH NORWEGIAN TECHNICAL ASSISTANCE TO THE ELECTRICITY SUB-SECTOR



NVE
NORWEGIAN
WATER RESOURCES AND
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Division of Development
Assistance

NORAD
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COOPERATION

Title	***No***
NORAD MISSION TO NAMIBIA IN CONNECTION WITH NORWEGIAN TECHNICAL ASSISTANCE TO THE ELECTRICITY SUB-SECTOR	*03-91*
Executive Officer(s)	***Date***
Steinar Grongstad, NVE	*February -91*

Abstract

The report presents a general description of the electricity sub-sector in Namibia with specific emphasis on rural electrification in the northern part of the country.

Development of the Cunene water resources is also discussed.

Other options for Norwegian technical assistance to the electricity sub-sector are indicated.

Subject Terms

Namibia electricity sub-sector, rural electrification, Cumene water resource

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ABBREVIATIONS

BPC	-	Botswana Power Corporation
FMDC	-	First National Development Corporation
GNP	-	Gross National Product
MEP	-	Ministry of Energy and Petroleum, Angola
MME	-	Ministry of Mines and Energy, Namibia
NORAD	-	Norwegian Agency for Development Cooperation
NPC	-	National Planning Commission
NVE	-	Norwegian Water Resources and Energy Administration
SADCC	-	Southern African Development Conference Committee
SWAWEK	-	South West Africa Water and Electricity Corporation
ZESA	-	Zimbabwe Electricity Supply Authority
ZESCO	-	Zambia Electricity Supply Corporation

CURRENCY

1 South African Rand (ZAR) = 2.53 Norwegian Kroner (NOK)

CHAPTER 1. SUMMARY

1.1 SCOPE OF WORK

On the basis of previous meetings and correspondence, the Norwegian Government represented by the Norwegian Agency for Development Cooperation (NORAD), and the Namibian Government, represented by the Ministry of Mines and Energy (MME), have expressed mutual interest with regard to Norwegian support to the energy sector in Namibia.

On this background NORAD sent a mission to Namibia during weeks 32 and 33 to specifically concentrate on the electricity sub-sector. The team composed as follows:

Mr. S. Grongstad	- NVE/NORAD:	Power system engineer/team leader
Mr. T. Westeren	- Norpower:	Power Engineer/consultant team leader
Mr. E. Nordrik	- Norpower:	Transmission engineer
Mr. K. Endresen	- Fountain:	Socio-economist
Mr. B. Sebetela	- Fountain:	Energy engineer

The objectives of the mission were defined as follows:

1. Define priorities with regard to rural electrification in collaboration with relevant Namibian authorities. Specific emphasis should be given to northern Namibia, but other areas should also be considered.

2. Evaluate existing plans and define future needs for technical assistance with regard to the joint Angolan/Namibian development of the Cunene water resources.

3. Be prepared to discuss, evaluate and give advice to the general development of the electricity subsector in Namibia.

The complete Terms of Reference for the mission are given in Appendix 1.1.

A draft report was submitted in October 1990 prior to a visit of a Namibian delegation to Oslo in November. This Namibian delegation also gave SWAWEK's comments regarding the draft report to NORAD. These comments are included in Appendix 8 along with some remarks by the Norwegian team.

1.2 SUMMARY AND CONCLUSIONS

1.2.1 The Electricity Subsector

SWAWEK is responsible for power generation and transmission in areas covered by the national grid. They supply bulk power to major industries and towns and also to individual consumers, mainly farmers in rural areas. Distribution in urban areas is the responsibility of the municipalities. Power supply to isolated areas, outside reach of the national grid, is undertaken by provincial authorities or individuals.

SWAWEK is technically operating efficiently and has a strong financial position as compared to other power utilities in the region.

Power supply outside SWAWEK's area of responsibility face constraints both with regard to qualified staff and financial support.

1.2.2 Rural Electrification in Northern Namibia

1.2.2.1 General Priorities of the Government

As expressed by officials from MME the general priorities of the Namibian Government can be expressed as follows:

- Reconciliation
- Equal distribution of resources
- Uplift of socio economic conditions
- Create basic conditions for economic development

Rural electrification in former black homelands is considered to be a prerequisite to achieve these priorities.

The mission visited the three provinces of Owambo, Kavango and Caprivi in northern Namibia together with high ranking officials from MME. In addition to the capitals of the three provinces more than 30 rural centres were visited. This indicates that the Government gives priority to northern Namibia and reasons for this are listed below:

- This region has the highest concentration of rural people.

- Development of the regions potential will avoid mass move of people to central towns.

- A considerable number of rural centres can be electrified at comparatively low costs.

Among the three provinces the Government wanted to commence with Owambo province for the same reasons as listed above. An assessment and evaluation of the socio economic setting in northern Namibia, given in Chapter 4 of this report, confirms that this priority is appropriate.

1.2.2.2 Rural Electrification Project Presented by MME

A project concept was presented by the MME to the mission. This included a map with 28 rural centres in the Owambo province proposed to be electrified as well as load flow analysis of the proposed transmission network.

Demand analysis or cost estimates were not presented to the mission.

It was, however, emphasized that the electrification programme had been defined by evaluating needs of various sectors such as education, health, industries, etc. There had been several consultations between various ministries and SWAWEK had also been involved. The programme had finally been approved by the Cabinet.

For these reasons the MME desired no significant changes with regard to rural centres included or the proposed staging of the implementation.

1.2.2.3 Project Definition and Evaluation

On basis of the socio economic setting and development plans for the various sectors, demand analysis for the three provinces have been established at the level of rural centres. Locations in addition to the 28 centres proposed by MME have also been included and evaluated. An evaluation on basis of technical and economic consideration indicates that a few more centres should be included in the project. The concept as presented by MME should, however, not be significantly changed.

On the basis of above demand forecasts and existing power facilities a project (or programme) comprising 8 stages has been defined. Due to the comparatively long distances 33 kV has been chosen as the main distribution voltage. This involves cost of NOK 110 million of which 20 percent is local currency costs. Two or more of the proposed stages can be implemented simultaneously, depending on funds available and mode of implementation.

Investments in the main transmission network have also been assessed. These will, however, not be required for the first years of operation, and have hence not been incorporated in the costs for this project.

Assessment of costs and evaluation of alternative energy resources, such as biomass, woodfuel, solar energy, wind energy, etc., have been undertaken. On the basis of unit cost of energy it appears that these are not competitive and economic evaluation versus electricity provided by isolated dieselgenerators have been performed. This show that rural electrification, by extension of the national grid as defined in this project, is economically viable on the basis of assumptions given in this report with regard to future demand and opportunity cost of capital in Namibia.

1.2.2.4 Project Implementation

SWAWEK is capable of undertaking power transmission and distribution projects with voltage levels up to 132 kV. These domestic resources should, of course be fully utilized. Their practice is, however, based on equipment purchase at suppliers in RSA.

We have understood that Norwegian (or Scandinavian) suppliers shall have the opportunity to participate in the bid process, and it is therefore recommended that a donor's representative/ consultant should be involved in the process of preparation of tender documents, tender evaluation and project follow up.

1.2.2.5 Project Operation

The present staff for technical operation and financial management in the project area is not adequate. Details with regard to training of new and reorganization of existing resources should therefore be concluded at an early stage of the project. SWAWEK is continuously training personnel for maintaining and operating its expanding network and these resources should be fully utilized. Elements of training could also be incorporated in contract with foreign supplier.

1.2.2.6 Rural Electrification Kavango

A similar concept for a rural electrification project in the Kavango province has also been worked out in this report. This concept will, of course, need to be discussed and concluded between relevant authorities in Namibia. The concept given should, however, give a realistic demonstration of scope and costs of rural electrification for the province.

1.2.2.7 Rural Electrification Caprivi

Locations apart from the capital of Katima Mulilo were not visited in Kavango. The demand as shown in the report is rather weak and should be further studied prior to concluding a project. Further interconnections with Zambia and Botswana are also important due to the geographic setting of the province and should be further investigated.

A tentative project concept is, however, presented in this report, but it should be emphasized that further studies are required.

1.2.3 Development of Cunene Water Resources

The Namibian power market is at present supplied with about 600 GWh per year, or about 40 % of the domestic demand with power import from RSA or thermal power based on coal imported from RSA.

Hydrological studies undertaken by SWAWEK conclude that the additional amount of firm power available at Ruacana when the Gove dam has been rehabilitated will be approximately 200 GWh. This is somewhat disappointing, but can be explained by the size of the catchment area affecting inflow to the Gove reservoir.

On this basis it is obvious that Namibia needs additional firm hydropower to reduce dependence on energy import, and that project planning should commence as soon as possible.

SWAWEK has also undertaken mapping of potentials downstream of Ruacana and concluded that Epupa is the most promising site. The project envisaged comprises a 130 m high dam, an annual power production of 1,600 GWh and installed capacity in the order of 400-500 MW. The engineering undertaken is at a preliminary level and a complete feasibility study is needed. Norwegian assistance should be most suitable for this.

Such a study will, however, require a bilateral agreement with the Angolan Government who up to now has been reluctant to enter into such agreement. During contacts between the two Governments on this matter, Angola has raised the question of export of surplus power to Namibia from the Capanda power plant when commissioned. Due to the long distance from Capanda to the border of Namibia this option will require transmission facilities for which both technical feasibility and economic viability are not clarified.

Obviously there is required an objective and independent assessment of technical and economic characteristics related to power transmission from Capanda and compare with power from Epupa.

1.2.4 Options for Norwegian Technical Assistance

Here below are listed certain issues for which Norwegian technical assistance could be appropriate. These are further elaborated in Chapter 9.

- Legislation
- Tariffs
- Urban electrification
- Socio economic data base
- Coordination and preparation of projects
- General technical assistance to MME

1.3 RECOMMENDATIONS

1.3.1 Rural Electrification in the Owambo Province

With regard to the project, as defined and evaluated in this report, further extensive studies should not be required. We would therefore recommend that the observations and possible changes with regard to villages to be electrified, staging, design criteria, etc., to be discussed and concluded in a meeting between the donor(s), Namibian authorities and the consultant. Possible changes could then be incorporated in a revised version of this report in a few weeks. Preparation of tender documents could start immediately thereafter.

The said meeting could also conclude details with regard to the tender process, project implementation and follow up.

1.3.2 Development of Cunene Water Resources

As additional firm hydropower is needed for the Namibian power market, the planning process should also commence as soon as possible. A feasibility study for Epupa hydropower project is desired and recommended. Terms of Reference should be worked out in cooperation with SWAWEK.

As a feasibility study for the Epupa hydropower project will require a bilateral agreement with Angola, which so far has not been achieved, it might be appropriate to assess technical and economic characteristics for the option of power transmission from Capanda. This may help a locked situation.

1.3.3 Options for Norwegian Technical Assistance

Details for these should be discussed and concluded between NORAD and MME.

CHAPTER 2. THE MISSION

2.1 GENERAL

The mission arrived in Windhoek 5 August, 1990. Prior to the arrival MME had worked out a tentative itinerary for visits to the Owambo, Kavango and Caprivi provinces in Northern Namibia. This itinerary is given in Appendix 2.1. For reference a map of Namibia is given in Appendix 2.2.

2.2 THE OWAMBO PROVINCE

The mission, headed by the Deputy Minister of Mines and Energy, Mr. Helmut Angula, departed from Windhoek 6 August and arrived at Oshivelo in the Owambo province the same day. Here the mission met with officials from the administration in Owambo, i.e. education, works and transport, health and social services, agriculture etc. Representatives from the National Planning Commission (NPC) and South West Africa Water and Electricity Corporation (SWAWEK) did also participate.

The mission spent five days in the Owambo province. All centres which are potential energy consumers were visited. Considerable time was also spent with various ministries at the province administration in Ondangwa and Oshakati.

The locations visited were Oshivelo, King Kauloma Resettlement Camp, Okatope, Onyaanya, Okankolo, Onanyena, Okahao, Tsandi, Onesi, Outape, Nakayale, Anamulenge, Elim, Oshikuku, Okalonga, Omugwelume, Ongenga, Endola, Okatana, Ongha, Ohalushu, Onekwaya, Engela, Odibo, Endunja, Okatope, Okaku, Eheke, Ondope, Ondangwa, Oshigabo, Onandjokwe, Onipa (Lutheran office), Olukonda, Ontananga, Enhana and Ogongo (regional water depot). In these locations the mission met with representatives for local administration, church leaders, schools, clinics and hospitals. The following major issues were discussed:

- Population distribution
- Commercial, industrial and public sectors
- General information on energy uses

- Information on existing isolated dieselgenerators and related consumption pattern, where relevant
- Planned development projects

A summary description of each loaction is given in Appendix 2.3.

At the Owambo province administration in Ondangwa/Oshakati, the mission met with the following authorities:

- Ministry of Health, i.e. hospital leaders in Ondangwa and in Oshakati
- Ministry of Education
- Accounting Department
- Ministry of Works, technical section
- Ministry of Works, commercial section
- Lutheran Church

The mission was given detailed information, most relevant to rural electrification from all authorities visited. This is basically used in connection with sector descriptions and demand forecasting in Chapter 4.

2.3 THE KAVANGO PROVINCE

On 10 - 12 August the mission visited the Kavango province. The locations visited were Mpungu, Nkurenkuru, Kandjimi, Tondoro and Mashari as well as some agricultural projects. The issues discussed were the same as for locations in Owambo.

Various authorities at the province administration in Rundu were also visited. These were:

- Provincial commissioner
- Ministry of Education
- Ministry of Works
- Ministry of Health

On 12 August the mission returned to Windhoek. A press release related to the visits of Owambo and Kavango provinces was then issued by MME. This is presented in Appendix 2.4.

2.4 THE CAPRIVI PROVINCE

Due to time constraints the whole delegation was not able to visit the Caprivi province as originally scheduled. A smaller team, comprising Mr. P. Shilamba, MME and Mr. T. Westeren, Norpower, did, however, visit the province capital of Katima Mulilo on 16 - 17 August and had meetings with the following authorities there:

- Provincial commissioner
- Ministry of Health
- Ministry of Education
- Ministry of Agriculture
- Ministry of Works
- Church leaders from four different churches

Locations outside Katima Mulilo in the Caprivi province were not visited.

2.5 WINDHOEK

During 13 - 17 August the mission met with the following institutions and organizations in Windhoek:

- Ministry of Mines and Energy (MME)
- South West Africa Water and Electricity Corporation (SWAWEK)
- National Planning Commission (NPC)
- Ministry of Works
- Ministry of Agriculture, Fisheries, Water and Development
- Department of Water Affairs
- Ministry of Local Government and Housing
- Ministry of Education
- Ministry of Trade and Industry
- Ministry of Health
- Elwiwa, Wind and Solar Company

2.6 ZAMBIA

During 19 - 21 August Mr. T. Westeren visited Zambia to obtain information with regard to the power supply of the Caprivi province. The relevant information is given in Chapter 7.

2.7 ANGOLA

During week 37 Mr. K. Endresen visited Angola with the following purposes:

- Collect information on power demands for the locations of Xagongo and Ondgiva in Southern Angola, which may be supplied from Northern Namibia. The relevant information is given in Chapter 5.

- Assess the position of Angolan authorities in connection with future joint Angolan/Namibian development of the Cunene water resources. The relevant information is given in Chapter 8.

2.8 PEOPLE MET

A complete list of people met at the province capitals and locations in Owambo, Kavango and Caprivi will not be given here. Central persons of the national administration in Windhoek are, however, listed below:

MME:	Mr. H. Angula, Deputy Minister Mr. S. Hangala, Permanent Secretary Mr. P. Shilamba, Electrical Engineer
SWAWEK:	Mr. P. Hoogenhout, General Manager Technical Services Mr. Mustler, Transmission Engineer
NPC:	M. J. de Kok
Ministry of Works:	Mr. van der Merwe
Ministry of Education:	Mr. B. Wenthworth
Ministry of Trade and Industry:	Mr. Deon Gous, Permanent Secretary
Ministry of Agriculture, Fisheries, Water and Development:	Mr. V. Ngipondoka

Department of Water Affairs: Mr. P. Heyns

Ministry of Health: Mr. L. Erasmus

Meeting in Lusaka with Zambia Electricity Supply Coorporation (ZESCO):

- Mr. J. T. Kaluzi, General Manager
- Mr. E. Z. Mulonda, Administrative Manager
- Mr. J. Wright, Manager Generation and Transmission
- Mr. V. C. Kayombo, Dep. Director Engineering Services

Meetings in Luanda with Ministry of Energy and Petroleum (MEP):

- Mr. C. Amaral, Vice Minister
- Mr. Meireles, Dep. Technical Manager and SADCC contact point

CHAPTER 3. THE ELECTRICITY SUBSECTOR

3.1 LEGISLATION

Power supply in Namibia is presently administered in accordance with powers of:

- "Electric Power Proclamation, 1922" (Proclamation no. 4), gazetted 15th of February 1922, regulating in general the conditions of supply of electricity for public purposes.

- "S.W.A. Water and Electricity Corporation Act, 1980", (Act no. 14), gazetted 15th of July 1989, with amendments of 1987 (Electricity Amendment Act, no. 41 of 1987) and 1989 (Electricity Amendment Act, no. 58 of 1989), regulating the tariffs levied and the conditions imposed by the S.W.A. Water and Electricity Corporation (SWAWEK).

The Government has already initiated redrafting of a suitable and modernized legislation for the electricity subsector.

The present legislation, shows apparent needs of defining borderlines for responsilities between the new political and bureaucratic structures, the local or municipal utilities, and SWAWEK. A future organizational structure of the electricity sector has to be decided. The priorities of the development of service, production and social sectors have to be built into the new legislation. Principles on tariffs, levies, expropriation of property, concessionary provisions etc., and Regulations deemed necessary, have to be reconsidered in the context of a new legislation.

3.2 ORGANIZATION

The South-West Africa Water and Electricity Corporation (SWAWEK) is responsible for generation and transmission of electricity in all areas of Namibia covered by the national grid. See also map in Appendix 3.1. In these areas SWAWEK operates as bulk supplier to towns, major industries and individual subscribers. The operation of local distribution networks in towns, normally at 11 kV and 380/220 Volt, is the responsibility of municipal authorities. Operation of isolated dieselgenerators in rural areas is undertaken by local authorities or private subscribers and is not under the responsibility of SWAWEK.

SWAWEK is a shareholders' company with all shares being owned by the government. The Managing Director is also Chairman of the Board. The present staff includes 764 employees and has been rather stable during recent years.

The staff is organised in two divisions; one for technical and one for commercial and administrative services.

The technical division is divided into departments as follows:

- Generation
- Distribution, design
- Operation
- Construction

SWAWEK undertakes planning, design and construction of transmission lines up to 132 kV with its own staff. About 800 kilometres of such H.T. (High Tension) lines have annually been constructed in Namibia during recent years of which about 50 % have been undertaken with SWAWEK's permanent staff.

Transmission lines for higher voltages, i.e. lines on steel lattice towers, are contracted.

3.3 EXISTING FACILITIES

3.3.1 General

In this section the facilities related to the national grid and operated by SWAWEK are described. Other facilities in the Owambo, Kavango and Caprivi provinces are described in Chapter 4.

3.3.2 Generation

The following generating facilities are connected to the national grid:

Ruacana Hydropower Plant - 240 MW
Van Eck Thermal Power Plant - 120 MW
Walvis Bay Thermal Power Plant - 46 MW

Ruacana Hydropower Plant, commissioned in 1978/79, comprises 3 units of 80 MW each (Francis turbines). It is an underground power station with a head of 134 m.

Van Eck Thermal Power Station includes 4 units of 30 MW each. These are conventional steam turbines. The basis is coal from RSA. Three units were commissioned in 1972, the fourth in 1978.

Walvis Bay includes various thermal generating facilities, diesel and gas, with an aggregate capacity of 46 MW. It is, however, possible that the Walvis Bay plants also in the future will be under RSA's jurisdiction as RSA intends to hold on to the Walvis Bay enclave.

The interconnector between Namibia and RSA (ESCOM) is also important with regard to supply of the SWAWEK grid. Its peak capacity is approximately 200 MW, and the economic continuous rating is about 130 MW.

SWAWEC has computerized the coordination of ESCOM contract conditions and its own production units.

The location of above generating facilities are given on the map in Appendix 3.1

3.3.3 Transmission

A single line diagram showing transmission facilities of the national interconnected network is given in Appendix 3.2.

Power transmission is undertaken at 330 kV, 220 kV, 132 kV, 66 kV, 33 kV , 22 kV and 11 kV levels.

The transmission line lengths at various voltage levels are given in table 3.1 here below:

Table 3.1
Transmission lines of the national grid

Voltage level	Transmission line lengths				
	1989	1988	1987	1986	1985
330 kV	521	521	521	521	521
220 kV	1,495	1,495	1,495	1,495	1,495
132 kV	790	635	471	471	471
66 kV	4,387	3,770	3,446	3,112	2,886

There are 64 major substations in the national grid with an aggregate installed capacity of about 1,600 MVA.

3.3.4 Distribution

As already indicated, power distribution in urban areas is the responsibility of local authorities. This will be described for the Owambo, Kavango and Caprivi provinces in Chapter 4.

3.4 POWER PRODUCTION AND CONSUMPTION

Key figures for power production are given in Table 3.2 here below.

Table 3.2
Power Production and Consumption

Item		1989	1988	1987	1986	1985
Energy produced	(GWh)	1,835	1,763	1,601	1,556	1,785
Energy sold	(GWh)	1,659	1,582	1,441	1,407	1,596
Peak demand	(MW)	213	211	205	181	178
Losses	(%)	10.6	11.4	11.1	10.6	11.8

The comparatively low losses indicate that both technical standard and operation is satisfactory.

The production and sale figures do also include import and export of power to RSA. This is illustrated by the following figures from 1989 and 1988 as given in tables 3.3 and 3.4.

Table 3.3
Power Production in 1989 and 1988

	1989		1988	
Power Station	Energy (GWh)	%	Energy (GWh)	%
Ruacana	1,308	71	1,086	62
Van Eck	90	5	124	7
Import RSA	437	24	553	31

Table 3.4
Power Sales in 1989 and 1988

	1989		1988	
Country	Energy (GWh)	%	Energy (GWh)	%
Namibia	1,392	84	1,349	85
RSA	267	16	233	15

The average production cost covers a significant variation. The Ruacana hydropower scheme reports an average production cost (materials, spares, transport, insurance and depreciation) of 0.0036 ZAR per kWh. The other extreme is the coal fired Van Eck plant, where the cost (coal, salaries, depreciation, materials, spares, and "rest") amounts to 0.1710 ZAR per kWh; or nearly 50 times as much as in the hydropower plant (The Van Eck figure is probably based on a low capacity utilisation; at full blast (120 MW) the unit cost will be less than half of the low capacity figure).

The import cost for electricity from South Africa was in 1989 0.0584 ZAR per kWh; net import amounted to approximately 10 % of the units sold by SWAWEK.

Ruacana is at present being operated as a run-of-the river power plant. This is due to the fact that the Gove dam, in Angola, is out of order. Consequently the minimum flow at Ruacana during dry season is frequently down to 30 m^3/s. However, in the dry season 1972-73 the river actually stopped flowing. This is further elaborated in Chapter 8, Development of the Cunene Water Resources.

3.5 FINANCIAL INFORMATION

3.5.1 Financial Performance

3.5.1.1 Overview

SWAWEK's annual report paints the picture of a well performing utility. The 1989 annual revenue was ZAR 135 million; the expenditure (including depreciation and interests) amounted to ZAR 65 million; giving an annual surplus of ZAR 70 million which is 52 % of sales, 14 % of total assets and 16.2 % of equity capital (total capital minus short- and long-term liabilities). SWAWEK paid a 10 % dividend on its ordinary share capital (ZAR 65 million).

The Balance Sheet illustrates a solid financial position. The share capital is 13 % of the total capital; share capital and non-distributable reserves together make up 84 % of the total capital. I.e. debts and loans only comprise 16 % of the total capital.

Current assets (ZAR 42 million) form 8 % of total assets; and exceed current liabilities (ZAR 27 million) with 56 %.

The non-distributable reserves amounting to ZAR 366 million, comprise a Reserve fund of ZAR 135 million, Development fund of ZAR 61 million, and a Capital reserve of ZAR 171 million. ZAR 196 million out of the ZAR 366 million are placed in financial assets; mainly in the form of RSA stocks (largely in ESKOM), and as an Investment plan in an insurance company and fixed bank deposits.

SWAWEK's financial assets (ZAR 196 million) are 72 % compared to the fixed assets (ZAR 271 million) of the utility.

3.5.1.2 Comments

The operating results above do not reflect the real resource efficiency of the SWAWEK utility.

The depreciation is based on historic costs. A major share of the fixed assets are several years old (Ruacana, Van Eck, etc.). The annual inflation has been in the order of magnitude of 10 - 15 % per year the last 15 years. A historic cost based depreciation rate does therefore obviously not reflect the resource cost of using the fixed assets in electricity generation, transmission and distribution.

A number of other utilities have started to calculate their annual return on revalued fixed assets (the World Bank opts for this method) in order to get a more correct expression for use of resources by the utility, and thus to view the overall tariff level in a more appropriate cost context.

SWAWEK's loans carry low interest rates; 4 - 5 % p.a. Again; with an annual inflation rate of 2-3 times the level of their interest rates, SWAWEK in fact receives a financial subsidy from the economy.

At the same time SWAWEK's fund Investments of ZAR 195 million, in 1989 gave the utility an interest revenue of ZAR 30 million; i.e. approximately a 15 % return on financial assets. Actually, SWAWEK earns 24 % of its revenue from other sources than sale of electricity.

By eliminating the financial revenue; one sees that sale of electricity amounted to ZAR 104 million, and the associated costs in generation, administration and transmission was ZAR 66 million. I.e. the operating result was ZAR 38 million; which is a result margin of 36 % on sales, and a 12 % return on total capital.

SWAWEK generated ZAR 76 million in cash. Fourty percent of this was <u>sourced</u> from other than sales of electricity (i.e. interest revenue). The cash <u>employed</u> was 40 % in capital investments, and nearly 30 % invested in external financial assets.

It is of interest to compare SWAWEK with utilities in neighbouring Botswana; the Botswana Power Corporation - BPC, and Zimbabwe; Zimbabwe Electrical Supply Authority - ZESA. Namibia and Botswana are similar in many respects; they are of the same size, have similar geographical and physical features, and both countries have a large poor rural population not supplied with electricity.

One major difference is, however, that BPC (and ZESA) also operate the distribution network down to the level of the individual household/small consumer; whilst SWAWEK is mainly a bulk supplier to major consumers and municipalities.

	SWAWEK	BPC	ZESA
Units sold 1989 (of which imported from RSA)	1659 GWh 170 GWh	861 GWh 58 GWh	8551 GWh
Peak demand	213 MW	137.5 MW	
Operating revenue 1989 Operating result 1989	104 mill. ZAR 39 mill. ZAR	138 mill. ZAR 31 mill. ZAR	610 mill. ZAR
Operating result/revenue	37 %	23 %	37 %
Average sales revenue/kWh	6.28 cents 4.67 thebe	16.93 cents 11.8 thebe	6.57 cents
Interests paid	0.77 mill. ZAR	39.6 mill. ZAR	114 mill. ZAR
Interest/oper. revenue	0.74 %	28.9 %	18.8 %
Fixed assets - historic cost - revalued	271 mill. ZAR 201 mill. Pula	 844 mill. ZAR	1043 mill. ZAR
Total assets/GWh - historic cost - revalued	0.31 ZAR/GWh 0.23 Pula/GWh	 1.03 ZAR/GWh	
Debt/total assets	11 %	48 %	55 %
Depreciation	11 mill. ZAR	39.7 mill. ZAR	70 mill. ZAR
Depreciation/fixed assets Depreciation/oper. rev.	4.1 % 10.5 %	4.7 % 28.9 %	6.7 % 11.5 %
Lines; 66 KV and lower	4387 km	1594 km	
Employees	764	1529	

3.5.2 Tariffs

As already indicated SWAWEK is responsible for power generation and transmission and supplies bulk power to towns and major industries as well as to isolated consumers, basically farmers, in rural areas. The present tariffs for these supplies are:

Consumer	Demand charge	Energy charge
Large	19.00 ZAR/kW per month	0.0425 ZAR/kWh
Small (less than 75 kW)	0	0.08 ZAR/kWh

The consumers pay monthly. In case of unsettled bills subscribers are disconnected after two weeks without further warnings.

New subscribers normally pay for their connections according to the real cost of connecting. This can either be done up-front or through periodical payments as agreed with SWAWEK.

By dividing the electricity sales revenue (1989) by the amount of energy sold, the average revenue is 0.0628 ZAR per kWh.

The average production cost (generation, transmission, management, administration, interest and historic cost depreciation) amounts to ZAR 65.7 million; or 0.0396 ZAR per kWh.

The overall average operating result is thus approximately 0.023 ZAR per kWh; or 36 % of the average revenue per unit.

The SWAWEK tariff is neither related to revalued asset costs, nor to Long Run Marginal Cost.

A depreciation based on revalued fixed assets would probably at least triple the current depreciation figure. Accounted depreciation in 1989 was 17 % of total production costs; a tripling of the depreciation would still result in a production cost well below the average sales price; the result margin would drop from its current 36 % to maybe around 15 %.

If SWAWEK was also to pay market interest rates on its financial obligations, the 1989 electricity sales price would still bring in an operating result of about 10 % compared to sales revenue. (SWAWEK does not have major external loans, and is therefore not very sensitive to changes in the borrowing interest rate).

The SWAWEK tariff per average per unit sold does not reflect what a number of consumers have to pay. The reason is that SWAWEK is a producer and bulk supplier. The municipalities are responsible for the local distribution and revenue collection of the energy sold. Under the current set up the regional authorities will need to get central Government approval before they implement their suggested local tariff schedule.

In Owambo the current tariffs are:

Consumer	**Demand charge**	**Energy charge**
Households	12.50 ZAR/month	0.16 ZAR/kWh
Business establishments		
< 25 kVA	38.00 ZAR/month	0.16 ZAR/kWh
> 25 kVA	kVA factor x 2/1000	0.16 ZAR/kWh

All other: As for businesses. However, the factor varies between the various consumer categories.

In Kavango the 1990 tariffs are:

Consumer	Demand charge	Energy charge
All	11.00 ZAR/month	0.15 ZAR/kWh

In Caprivi the present tariffs are as follows:

Consumer	Demand charge	Energy charge
Domestic	10 ZAR/month	0.20 ZAR/kWh
Industry	25 ZAR/month	0.20 ZAR/kWh

The tariff at the consumer level in northern Namibia is thus twice as high as the general SWAWEK schedule for small consumers indicate.

We have not received information as to the costs of operating the local distribution networks in Owambo, Kavango and Caprivi. At first glance one tends to assume that the margin between the SWAWEK selling price, and the local tariff level, is significant. However, the local consumption volumes are relatively small (average monthly sales in Kavango is less than 385 MWh), possibly too small to reach full economics of scale in terms of manpower/administration/organisation costs or viz distribution grid related to consumer density.

It was indicated to us that central Government (Ministry of Local Government and Housing) actually subsidises the electricity consumption in Owambo and Kavango; the local tariff revenues would then not be adequate to cover the purchase cost from SWAWEK plus the local operation. But it was not possible to have this confirmed.

3.5.3 Conclusions

From the figures contained in the 1989 annual report the following conclusions can be drawn:

a) SWAWEK holds significant financial assets that in principle could be redeployed to pay for increased generation/ transmission/distribution capacity. I.e. SWAWEK's financial means are substantial; SWAWEK could itself partfinance new developments. Two thirds of its financial revenue is currently reinvested in financial assets, rather than in physical capacity expansion.

b) The financial assets give SWAWEK a high annual net interest revenue (30 million ZAR). If the current financial structure was not changed, the resultant revenue could for example

   i) help service new debts associated with loans to finance additional generation/transmission/ distribution capacity (particularly if SWAWEK could continue to borrow as cheaply as in the past whilst at the same time be able to earn a high return on its financial assets);

   ii) partly be used to cross subsidise the poorer areas/ consumer groups in the north to be served by the national grid expansion into rural communities.

c) The current operational result of SWAWEK is good. A downward adjustment is needed to reflect the use of the assets employed in the SWAWEK generation and transmission operations. But still SWAWEK's financial requirements from an operational point of view will be met; under the current demand and distribution level and pattern. But in view of a growing demand (both among current, but also with new consumers), a tariff increase is likely in view of a LRMC probably largely in excess of the historic cost basis reflected in the formal SWAWEK accounts.

3.6 INSTALLATION CONTROL

SWAWEK has its own inspectors who undertake control of the installations beyond the point of SWAWEK supply prior to connecting new subscribers. Electricians undertaking such installations are also registered and approved by SWAWEK.

This implies that follow-up of existing facilities and control of expansions in urban areas, which SWAWEK supplies in bulk, depend on local authorities. Their present capacity in Owambo, Kavango and Caprivi are somewhat limited and reinforcement is needed when activities will increase.

CHAPTER 4. BACKGROUND FOR RURAL ELECTRIFICATION

4.1 GENERAL PRIORITIES OF THE GOVERNMENT

As expressed by officials from MME the general priorities of the Namibian Government can be expressed as follows:

- Reconciliation
- Equal distribution of resources
- Uplift of socio economic conditions
- Create basic conditions for economic development

Rural electrification in former black homelands is considered to be a prerequisite to achieve these priorities.

As indicated in Chapter 2, MME had outlined an itinerary comprising the Owambo, Kavango and Caprivi provinces prior to the arrival of the mission to Namibia. This indicates that the Namibian Government gives to priority to the northern part of Namibia. Their reasons for this priority are listed below as follows:

- This region has the highest concentration of rural people.

- Development of the regions potential will avoid mass move of people to central towns.

- A considerable number of rural centres can be electrified at comparatively low costs.

4.2 TECHNICAL CONSIDERATIONS OF MME

Officials from the MME also expressed their views with regard to basic technical criteria as follows:

- Basic design should be consistent with long-term development. High voltage lines should be designed for loads of at least 10 years.

- The best possible utilization of existing technical resources in Namibia, i.e. SWAWEK, should be achieved, also for projects financed by external financing institutions.

- Technical compatibility with existing facilities should be kept in mind when designing new projects.

4.3 RURAL ELECTRIFICATION PROJECT PRESENTED BY MME

Among the provinces of Owambo, Kavango and Caprivi in the northern region, the Namibian Government gives priority to commence the rural electrification project in the Owambo province. The same reasons as listed in Section 4.1 were applied also with regard to giving priorities among the three provinces in question.

A project concept was presented by the MME to the mission. This included a map with 28 rural centres in the Owambo province proposed to be electrified. This project or programme is divided into three phases and phase 1 is again divided into three stages. The project concept is showed in Appendix 4.1. The rural centres included in the proposed project/programme are listed in Table 4.1 below:

Table 4.1
Centres Proposed for Electrification

Centre No.	Centre Name	Phase
1 2	Onayena Okaukolo	1 A
3 4	Oniipa Oshigambo	1 B
5 6 7 8 9 10 11 12 13 14 15	Onekwayo Engela Onenga Oshikango Odibo Endunja Ohangwena Okatope Ondobe Eenhana Epinga	2
16 17 18 19 20 21 22 23 24 25	Oshikuku Elim Ogongo Nakayale Ombalantu Onamulenga Okalongo Onesi Tsandi Ondanjera	3
26	Olifa	1 C
27 28	Olukonda Ontananga	

Demand analysis, preliminary engineering or cost estimates were not presented to the mission.

It was, however, emphasized that the electrification programme had been defined by evaluating needs of various sectors such as education, health, industries, etc. There had been several consultations between various ministries and SWAWEK had also been involved. The programme had finally been approved by the Cabinet.

For these reasons the MME desired no significant changes with regard to rural centres included or the proposed staging of the implementation.

4.4 THE OWAMBO REGION

4.4.1 Socio Economic Setting

4.4.1.1 General

The Owambo province was grossly neglected by the previous regime. One proof of this is the lack of information about the people living there, and their living conditions and general environment. There does not even exist a near accurate count of the population in the area.

It is therefore not possible, so few months after independence to give a full and precise socio economic picture. However, some assessments have been made over the last few months, by various institutions (1). It should be stressed that these studies aspire neither to be comprehensive nor entirely precise in their description. They do though serve as a reasonably good general description of the region.

(1) The information in this chapter is largely based on the IDC report from the "Food Studies Group" (1990), UNICEF Namibia's Summary of Main Results of the "Household Health and Nutrition Survey (Owambo and Katutura)" (1990), Namibia's "World Summit for Children Briefing Kit" (1990), UNICEF/Morgan's "Household Food Security and Women Producers in Namibia" (1990), The World Bank's "Namibia - Preliminary Economic Review" (1990); together with own observations from the field visit in August 1990.

4.4.1.2 Population and Housing

Recent estimates indicate a population of 700,000 in the entire Owambo province.

The rate of population growth has been estimated to be 3.8 % in rural areas, and 4.2 % in peri-urban areas.

In the UNICEF survey of Owambo (peri-urban areas consisting of Oshakati - Ondangwa - Oluno, and the rural centres of Tsandi, Engela and Onyaana), 40-49 % of the households were headed by women.

300,000 of the Owambo population live in the few towns and in the vicinity of Ondangwa and Oshakati. Maybe 100,000 of the 300,000 live in permanent housing; the rest in substandard accommodation under appalling social conditions. In the rural areas the vast majority live in huts, mainly made of grass and wooden poles.

In general, the existing rural housing is not suited for electrification.

A major part of the rural population in Owambo does not live concentrated in villages. Rather, the individual household is located in "lands areas" where the house/hut is surrounded by their agricultural fields, grazing land, etc. This means the housing is scattered over large areas. One effect of this is longer walking distances to schools and health facilities. From the electrification point of view the housing pattern will cause possible distribution networks to be more extensive and expensive than if the housing was clustered.

In most cases the rural household does not own the land on which they live; they only have a right to use it; a right conferred to the male head of the household. This could be a disincentive to invest in better housing standards (and electrical reticulation), as the right to inherit the house and right of abode is by no means guaranteed for the widow or offsprings of the family father.

4.4.1.3 Employment and Income

The UNICEF survey indicates that 26 % of the household heads are self-employed, and 18 % absolutely unemployed. The unemployment figure is probably higher, as the head of the household was probably more frequently in a job situation than other members of the household.

22 % of the households received income from a Government job, and 12 % from a non-Government job. 80 % received income from a family farm. 55 % of households received remittances and 30 % pensions.

One estimate puts the public sector employment in the Owambo region at 10,000; with an average income per month of ZAR 969 per employee.

There are hardly any manufacturing or industrial activities in the region. The private sector mainly consists of smaller shops, commercial services and agricultural activities. A large number of people were employed in commercial services resulting from the local demands of the South African Defence Force (SADF); people that lost their jobs as the South Africans withdrew from the country. (One source indicates that the SADF infused ZAR 25 million per month into the local economy in northern Namibia by purchasing a variety of commercial services and goods).

Presently only 10,000 are estimated to work in the private sector; many of which at very low wages (ZAR 200 per month have been suggested as a representative/low figure).

The majority of the population live from the lands; either through crop cultivation or cattle rearing (the herd possibly consist of 330,000 cattle; another estimate sets the figure as an average of 2.2 cattle per household).

The agriculture is carried out under deteriorating semi-arid conditions.

The IDC study has guestimated (stressing the word guess) that the average rural household income is around ZAR 300 per month; of which nearly 50 % is remittences (from family members in employment elsewhere in the country) and pensions. The remaining part of the income (ZAR 154) consists of one third crop and cattle income, and two third wage employment.

The UNICEF study found that the average rural household income in the Owambo region was reported at ZAR 1,547 per year. In peri-urban Owambo the reported average household income was ZAR 4,336 per year.

The income figures in the IDC and the UNICEF studies do not quite tally (there are possibly different definitions as to what to include and how to estimate the various components; both are based on a weak data base). However, even the highest of the two imply that the average rural household have an income level more or less corresponding to the minimum of survival.

It has been estimated that a household income of ZAR 150-200 per month reflects the "food insecurity boundary". It seems impossible that an average household could possibly survive on less than ZAR 120-150 per month. I.e. the average rural household is on the verge of absolute poverty. A large number of the rural population clearly lives under subsistence conditions.

This is also confirmed by health statistics; the number of acute malnutrition cases seen at the Oshakati hospital rose to 531 in 1988.

The amount of money available for the average rural household for non-food items, such as commercial energy, is therefore currently very limited indeed. This is reflected in the fuel consumption patterns; most rural households depend on collecting firewood and cow dung to meet their energy needs. Less than 5 % of the population surveyed by UNICEF had electricity; even in the peri-urban areas 85 % used wood for cooking.

Rural families in Owambo have to walk an estimated average of 1 hour and 42 minutes per day to get water (11 minutes in the peri-urban areas). 95 % of the families had no toilet.

4.4.1.4 Education

In rural Owambo, 49 % of women and 26 % of male heads of households had no formal training at all.

The region is grossly undersupplied in terms of social services. Only 60 % of children go to school, and 60 % of the teachers are unqualified (national figures). According to the Deputy Minister of Education, there are approximately 50,000 school aged children in the north that do not attend school at all.

The pupil to teacher ratio is 39.1 in Owambo; in most other regions the figure is 20-25.

The classes are large; an average of 40 pupils in a class (32 being the national average; 23.3 in the Windhoek area). Since a number of schools are without proper buildings, the average figure is 73.3 pupils per permanent classroom.

The school facilities are generally of a very low standard (with various exceptions); in addition to lacking proper buildings, there are shortages of desks, teaching material, etc.

Children in the Katatura area (itself undersupplied with facilities) are four times more likely to be at a secondary school than children in the Owambo region.

In 1986/87 the previous Government spent on average ZAR 329 per pupil in Owambo; whilst the national average was twice as high, and ZAR 3,213 for white pupils.

4.4.1.5 Health

Modern health facilities, extension services and health education is in equally short supply. A significant part of the population does not have any real access to such services. And a number of the facilities in operation have inadequate capacity and only a low level of services to offer.

35 % of the children were suffering from malnutrition, and 8 % severely malnourished. Around 10 % of the children born alive die before their 5th birthday.

The central Oshakati medical district covers 243,000 people within a radius of 25 km, and can offer about 900 hospital beds and 8 clinics. The Engela district covers 55,000 people within a radius of 40 km; and offers 1 hospital with 200 beds and 7 small clinics. Tsandi's 32,000 people (within 100 km west, 40 km east and 30 km north) have 1 hospital with 60 beds, and 2 small clinics.

The number of people per hospital and clinic bed is twice as high in Owambo as in Windhoek.

4.4.2 Development Plans

4.4.2.1 General

Government is determined to alleviate a number of the grave shortcomings in the education and health sectors in the north of Namibia. The ambitious housing policy also seeks to rectify part of the current situation.

This is mainly reflected in the "General Policy Statement of the Namibian Government".

The welfare of the people will be promoted through policies that:

a) Insure that every citizen has access to public facilities and services

b) Raise standards and maintain the level of nutrition and public health, and raise the standard of living

c) Guarantee equality of opportunity for women

d) Protect and maintain the ecosystem and living natural resources.

The Policy Statement points at employment as the key variable against which economic performance should be assessed in Namibia.

Four priority sectors have been identified:

i) Agriculture and rural development; on which the livelihood of the majority of the people depends

ii) Education and training, to give an opportunity to all Namibians to participate fully in the development process

iii) Health care for the neglected majority of the population

iv) Housing, especially for the less advantaged

4.4.2.2 The Health Sector

It is too early for the new Government to have defined detailed economic development strategies and plans for the Owambo region. For a number of sectors the work has not reached a stage where concrete and specific programmes and projects have started emerging.

However, the authorities have progressed well in drawing up policies and programmes for the health sector. A policy document on "Restructuring and development of health care and social services in the Republic of Namibia" has been drawn up; based on a strong Government commitment of reaching the goal "health for all Namibians by the year 2000".

More concrete programmes have been prepared for the "District Hospital Project", where two of the Owambo hospitals (Eenhana and Engela) are included. This project describes the equipment, facilities, staffing etc. that will be required to reach a defined level of services and capacity. ZAR 6.1 and 8.7 million will be spent on the two hospital upgradings; which have 150 and 200 beds respectively.

A primary health care project has been drawn up; defing a hierarchy and standards of services to rural areas. This is based on a system of hospitals, health centres and clinics. It has been defined which village shall have what level of facilities and services (a number of villages will for the foreseeable future have no facilities). The capacities have thus been defined at the level of each village.

One problem, from our planning point of view, is that there is no time axis on the health development programme. I.e. it is currently not possible to say when the individual facility upgrading/construction will take place. But it appears most likely that the highest priority will be given to as quick an implementation as possible.

4.4.2.3 The Education Sector

The education authorities are in the process of specifying an infrastructural development programme; this is expected to be ready for presentation by March 1991.

Some of the features are, however, known. Current infrastructure will in general be upgraded and expanded. I.e. the current school distribution pattern will most likely be dominating for a number of year.

New secondary schools will be added to a number of primary schools.

Government wants to reduce the number of students per class, and also provide additional classrooms to cater for children currently not admitted to the school system. 4,500 classrooms are needed only for those children in the relevant age groups that do not attend school. This is a national figure, but Owambo represents approximately 50 % of the population, and has a higher than average school non-attendance rate.

An unknown number of vocational training centres will be constructed; presumably at places where there are already some educational facilities.

The large "youth-problem" will prompt the Government to establish centres for training "survival skills" to the younger people. I.e. basic skills for improved self-employment agriculture etc.

Teacher Training Colleges, Polytechnics, and In-service Teacher Training centres will be constructed in each province. The aim is to arrive at "reasonable regional educational self-sufficiency".

Government wants to avoid having too many boarding schools; they are too expensive to run. Instead secondary school facilities should be constructed closer to where people live; attached to existing primary schools.

Education's construction programme will include Teachers Quarters; Government will offer housing in order to attract people to the profession with postings in rural areas.

The Education Authorities consider electrification of the teaching facilities as very important. Not only will that make it possible to use appropriate teaching and administrative aids. It will also make it possible to use the facilities for aducalt education outside working hours. Evening classes for illiterates in a population where 60 % do not know how to read and write is an obvious necessity.

Schools will also, through the use of electricity, have more efficient and wider functions as community centres, and locations for i.e. environmental education and information programmes.

As most households do not have light, electrification of schools will be a major asset also if children may go there in the evenings to do their homework etc.

4.4.2.4 Housing

The living conditions for the rural population is poor; adequate housing is in critical shortage. Affordable housing has been established as one of the top four development priorities in the country.

The Ministry of Local Government and Housing has drawn up a National Housing Policy. This has not yet been reflected in a concrete housing programme. One cannot therefore at this stage foresee how and when the housing policy will have practical implications in the Owambo province.

The following features will characterize Government's housing programme:

- It will focus at meeting the needs of the lowest income groups that cannot afford to participate in other established formal housing delivery programmes.

- The projects shall be carried out throughout the country on a sustained basis, and must emphasize areas which have sofar been neglected (such as the communal areas in the north).

- In order to be able to build more housing units for the overall budget, each unit will be kept small. However, care will be taken to avoid standards and levels that are unacceptable to people.

- The encouragement of using local building materials.

The policy document states that the national investment in housing should be at least 5 % of Namibia's GNP. (The amount would therefore be approx. ZAR 200 million for 1990). Of this amount, at least 25 % should be provided through the national capital budget in support of public programmes for low-income housing.

This means that the National Housing Policy indicates an expenditure through Government budgets of approximately ZAR 500 million, which should be sufficient for around 20,000 houses.

As the Owambo province qualifies both though being a neglected area and though its disadvantaged population, it is fair to expect a significant number of the Government sponsored houses to crop up in peri-urban and rural Owambo.

Again, the details and the time frame for this programme have not yet been developed.

In talks with the Minister it was made clear that Governments contribution would also cover wiring/reticulation of the approved houses.

4.4.2.5 Economic Development

Future economic development will have to be based on agriculture.

For the average household an improvement in earning capacity will most likely have to come from training in improved farming methods, better tools and equipment, extension services, the establishment of functioning markets and distribution mechanisms both on the in- and output side.

The women represent the backbone of the rural economy. They carry out the bulk of the work in agriculture; as well as collecting the firewood and water used by the households. For a rural development programme to become efficient, the importance of women must be recognised, and the training and support activities must therefore adequately focus on this group.

Self-employment in the form of small scale cottage industry and repair activities will probably also have to be an important part of a development programme giving higher incomes and more job opportunities.

Some few major irrigation schemes are on the drawing board. These will probably offer job opportunities, but equally important will be their effect on the food balance.

No major industries exists; but manufacturing activities might be created as the market grows through expanded purchasing power in the region. Government is aiming at creating a favourable investment climate; giving proper incentives to foster economic growth. Detailed policies and programmes for the rural areas have, however, not yet been formulated.

4.4.3 The Energy Sector

4.4.3.1 Energy Sources

a) Biomass

The bio-mass sub-sector in Namibia is characterised by many unknowns which makes it difficult to give a precise description of the supply situation.

Information on standing stocks, annual increments and the distribution of biomass nationally and locally is not available. But in overall terms it is clear that the current energy use pattern with its limited supply in the Owambo region, has grave environmental implications.

Most of the Owambo region is barren. Trees are hard to come by in most places. The settlements of Onayena, Okangola, Oudobe and Eenhana toward Kavango are the only ones with substantial grass and tree cover. The rest of Owambo is just sand and isolated palm trees and shrubs.

It is possible that Namibia on a national scale has surplus woodfuel resources. But the impression is that the current set up where wood is transported from rural areas that still have some wood resources to peri-urban areas in the acute shortage, does not have any positive effect. Rather, the needs and purchasing power of the peri-urban areas tend to have a depleting effect on the said rural areas.

It is possible to buy woodfuel, significant demand exists in and around towns and major villages. The commercial element is limited to the collection of rural firewood and transport to more densely populated areas. Neither commercial nor cooperative woodlots exists; at least not on any noticeable scale. The supply side is thus limited to natural growth.

The probable depletion of woodfuel resources cannot only be attributed to the energy side. Significant environmental degregation also takes place as a consequence of overgrazing in communal lands, the use of wood for fencing poles and house construction, and other infrastructural developments.

Based on the general socio economic information from Owambo and on own observation, it seems unlikely that the majority of people currently using firewood for energy will be in a situation to rapidly switch to electricity as a source of alternative energy. Most of the population live under severe poverty conditions, and their current energy use is outside the money economy. Only a minority, possibly more in the peri-urban areas, will have the financial opportunity to switch from fuelwood to electricity. These are probably the groups currently depending on buying their fuelwood commercially.

Energy related actions geared at having an impact on the overall biomass situation should probably be more related to organizing the supply side through proper woodlots ensuring an adequate replenishment of resources being consumed, and measures having an impact on the efficiency in the use of biomass energy such as improved woodstoves etc.

b) Solar energy

The Owambo, Kavango and Caprivi provinces are endowed with vast resources of solar energy. Insolation values vary between 4 and 8 kWh/m^2 per day for areas north of Tsumeb with measurements based on the months of June, September and December. The annual average duration of sunshine per day for Tsumeb, Ondangwa and Rundu is 8 hours.

The technical potential to convert this resource into useful energy is vast given the state of solar technology application. This could be relevant for a variety of uses in water heating, refrigeration, lighting and water pumping for isolated areas out of economical reach of the electricity grid. Several companies in Namibia are active in making and supplying equipment in these fields.

A major limitation is, however, the high initial investment cost per kW for this type of equipment. Due to the weak socio economic conditions in the relevant areas, the use of such equipment would normally only be relevant for institutional users and some very few commercial and private establishments. Their alternatives would normally be the installation of generators, and the financial decision be based on comparative prices coupled with the feasibility of regular and adequate supply of diesel.

c) Wind energy

The average wind velocity in the north is about 2-4 m/s, with a percentage calm of over 50 %. The application of this energy source for water pumping for large communities is very limited. There are some installations at smaller farms.

d) Bio-gas

The whole of the north is rich in small stock cattle and Mahango cultivation. All these activities produce organic waste which can be used to produce bio-gas for cooking, lighting and refrigeration. In Owambo, the household structure particularly favour biogas production in that each household is located at the centre of the family's property with livestock rearing and crop production taking place in the same piece of land. This would in principle facilitate waste collection for the production of bio-gas. One significant problem is the non-availability of water which is an important input in bio-gas production

4.4.3.2 The Users of Energy

a) Domestic

Energy for cooking is provided by Mahango (millet) straws, woodfuel, cowdung, palm kernels, gas and paraffin. Based on impressions from non-electrified villages visited, it looks like the domestic energy for cooking is distributed as follows:

Mahango straw	30 %
Firewood	60 %
Cowdung, palm kernels, paraffin, gas	10 %

Lighting is predominantly paraffin and candles; with very few households using gas and generators.

A rough guestimate indicates an overall average wood energy consumption of 1.25 kg/person/day.

b) Institutions

The clinics use mainly gas for refrigeration for vaccines and some cooking. The main pattern though seems to be that fuelwood, organised or bought commercially, is the main cooking fuel. This is also being used for water heating.

The clinics are generally most inadequate in terms of equipment, staffing, and the level and volume of staffing they offer. It appears that their current gas consumption is in the order of 100 kg per month.

Some very few places have generators installed. These mainly provide electricity for lights and refrigeration. The running hours per day are few; with reported frequent breakdowns and or disruptions in the supply of diesel.

The hospital have a similar but more intensive usage pattern. Most hospitals have generators, some even use electricity for cooking.

Some of the health facilities used solar heaters for water heating. Several of these are not functioning at all. In a number of cases water heating is non-existing.

c) Schools

The secondary schools all have boarding facilities, and they have generators installed. Their electricity usage pattern is similar to that of the hospitals.

The main source of energy for cooking is gas, with woodfuel as a back-up. In eastern Owambo and Kavango, wood is the main fuel for cooking for institutions. Most kitchens are even equipped with coal/wood stoves.

4.4.4 The Electricity Subsector

4.4.4.1 Existing Facilities

Existing facilities in the Owambo province can broadly be grouped as follows:

- Facilities connected to the national grid.
- Small isolated networks/installations fed by diesel-generators.

<u>Facilities connected to the national grid</u>

With reference to the single line diagram in Appendix 3.2 it is showed four 66 kV substations in the Owambo province, all operated by SWAWEK. These are:

- Oshivelo 66 kV/22 kV, transf. capacity 2.5 MVA
- Okatope 66 kV/22 kV, transf. capacity 2.5 MVA
- Ondangwa 66 kV/11 kV, transf. capacity 5 MVA
- Oshakati 66 kV/11 kV, transf. capacity 5 MVA

These are fed from the Otjikoto substation near Tsumeb with one 40 MVA 132 kV/66 kV transformer in operation plus one spare.

The transmission line from Tsumeb to Okatope via Oshivelo has a route length of about 175 kilometres, designed for 132 kV as a single-circuit line on steel lattice towers and stranded conductor ACSR "Wolf". It is presently operated at 66 kV. From Okatope to Ondangwa and Oshakati, a distance of about 115 kilometres, the transmission line is 66 kV single circuit line on wooden poles with "Hare" conductor.

From the substation in Oshivelo there are two outgoing 22 kV lines:

- One to Namutoni, south of the boarder to the Owambo province.

- One to King Kauloma. This is now a resettlement camp for returning refugees. Prior to independence it was a SADF base. The transformer and all power reticulation works have recently been destroyed.

From the substation in Okatope there are two outgoing 22 kV lines:

- One to a former SADF base.

- One to Onyana Secondary School which is the only supply in the Okatope/Onyana area which is connected to the national grid.

The two substations in Oshakati and Ondangwa both have one 5 MVA, 66 kV/11 kV transformers and three outgoing 11 kV lines. SWAWEK is responsible for power supply at and operation of the substation whereas the operation of the 11 kV and low-voltage distribution networks are the responsibility of the Ministry of Works in the Owambo province.

Single line diagrams for the distribution networks in the Ondangwa and Oshakati areas were not available. It was, however, informed that the total peak load for the area presently is about 3 MW, evenly distributed between Ondangwa and Oshakati. These distribution networks comprise approximately 70 kilometres of 11 kV lines of which more than 80% is overhead. There are altogether about 90 11 kV/400 V distribution transformers of which nearly 50 in the Oshakati area.

Isolated Dieselgenerators

The following locations have isolated dieselgenerators operated by the Ministry of Works in the Owambo Province:

1. Tsandi

Installed capacity:	2 x 250 kVA plus 1 x 80 kVA standby
Supply:	Small network comprising hospital, secondary school, pump station and approx. 5 shops.

2. Outapi, capital village of Ombalantu

Installed capacity:	2 x 100 kVA for supply of secondary school with living quarters
	2 x 150 kVA plus 1 x 125 kVA for supply of hospital
	1 x 40 kVA plus 1 x 80 kVA for supply of police station

3. Okahao, capital village of Ongandjera

   Installed capacity: 2 x 250 kVA

   Supply: Small network comprising hospital, secondary school and 3 pump stations

4. Onesi

   Installed capacity: 2 x 180 kVA
1 x 50 kVA

   Supply: Secondary school, water pumping, clinic

5. Nakalaye

   Installed capacity: 1 x 25 kVA

   Supply: Clinic

6. Oshikuku

   Installed capacity: 1 x 100 kVA

   Supply: Secondary school, water pumping

7. Omungwelume, headquarters of Vukwanyame district

   Installed capacity: 2 x 100 kVA

   Supply: Secondary school, water pumping

8. Ongha

   Installed capacity: 1 x 50 kVA

   Supply: Secondary school

9. Enhana

   Installed capacity: 2 x 180 kVA
1 x 50 kVA

   Supply: Secondary school, water pumping

10. Nkongo

   Installed capacity: 2 x 100 kVA

   Supply: Secondary school

11. Onajena

    Installed capacity: 1 x 100 kVA

    Supply: Secondary school, water pumping

12. Ogongo

    Installed capacity: 1 x 100 kVA

    Supply: Secondary school, water pumping

13. Ohangwena

    Installed capacity: 1 x 100 kVA

    Supply: Secondary school, water pumping

In addition to these facilities under the responsibility of the Ministry of Works there are smaller units operated by missions or others at Amalungwe, Elim, Oshikuku, Onekwaya, Engela, Odibo, Oshigambo, Mahene and most likely also at other places.

Dieselgenerators at locations with hospital are run 24 hours per day, others normally 12 hours per day or less.

4.4.4.2 Administration

<u>Facilities connected to the national grid</u>

SWAWEK is responsible for the operation of the 66 kV substations. Outgoing 11 kV lines and related distribution networks are technically and commercially administrated by the provincial Ministry of Works. This technical maintenance and operation are undertaken with 4 skilled people.

Subscribers are classified according to geographical area and consumer category as follows:

- Geographical area

    - Oshakati east
    - Oshakati west
    - Ondangwa
    - Oluno (near Ondangwa)

- Consumer category

  - Households
  - Business < 25 kVA
  - Business > 25 kVA
  - Factories, etc.
  - Clinics
  - Commercial outlets
  - Hospitals
  - Schools

Isolated dieselgenerators

Daily operation is undertaken by staff at the secondary schools or hospitals at the various locations.

Periodical maintenance is undertaken by the Ministry of Works which has a staff in Oshakati of three skilled electricians/ mechanics and 4 handymen at their disposal for this task.

4.4.5 Future Demand

4.4.5.1 General

The future demand for electricity will most likely not reflect the current and past consumption pattern.

The Owambo region and the people living there are characterised by the gross negligence of the previous Government. As already described, the institutional infrastructure such as health and education have been most inadequate.

The new Government's aspirations and plans for a rapid change of this picture will have a significant effect on the institutional demand for electricity. Not only will there be a significant addition to the number of institutions demanding electricity, but the usage pattern and amount of electricity will also be changed.

A major problem in forecasting the future demand has been the lack of information about the timing for the new infrastructural developments, and details about the various development programmes. As was explained in the first part of this chapter, Government has not had time to finalise the various programmes; so far one has mainly developed the framework and basis for the sectorial policies.

Our forecast for future electricity demand does therefore not take direct departure from the current situation, but is based on the assumption of a rapid implementation of the envisaged health and educational policies.

The objective of the forecast is <u>not</u> to be a precise description of what will happen in the individual village at a defined point in time. Rather, the forecast aims at:

a) indicating a likely order of magnitude of electricity demand; and

b) serving as a pointer to which villages that will become the major load centres.

The Government of Namibia has presented a list of villages that it will give priority to for electrification. This list does not contain neither demand information, population data, nor planning information. Our approach has therefore been to compile as much relevant information as possible for all the villages in the region, in order to test whether Government's list represents a sound technical and economically justifiable programme. Will all the villages listed have a probable consumption large enough to warrant electrification; and are there other likely load centres that could be added to the list ?

4.4.5.2 The Health Sector

The demand forecast for the health sector reflects the system for and infrastructure planned by Government for the region. Government has defined which infrastructure that shall be implemented in which village (hospitals, health centres and clinics).

The forecast assumes as a simplification, that all clinics and all health centres will have the same consumption. Due to the lack of detailed population data, it not possible to be more site specific. Forecast hospital consumption is related to the number of beds planned for each of the upgraded and new hospitals.

We have made the following consumption assumptions:

Energy	Clinic	Health Centre	Hospital
Electricity	4,600 kWh/mth	9,200 kWh/mth	580 kWh/bed/mth
LPG	4,600 kWh/mth	9,200 kWh/mth	580 kWh/bed/mth
Staff houses per facility	3	5	0.10 per bed

Staff house energy consumption

Electricity:	2 x the general average
LPG:	2 x the general average

This would reflect a higher purchasing power among professional health staff than for the average el. and gas user in society.

The facility consumption pattern is based on various assumptions, including the configuration of equipment and a high level of voluminous services. The unit assumptions are also based on experience from Botswana, where the health facilities are of a type similar to what Government intends for Namibia.

A survey carried out in Botswana for the purpose of this exercise shows that the largest (300 beds) hospital (in the capital) had a consumption of electricity ranging from 656 to 208 kWh/bed/month; depending on the season of the year. A major village hospital (254 beds) had a monthly consumption per bed ranging from 210 to 83 kWh/bed/month. Both hospitals use coal or gas for cooking and water heating.

Since an overall monthly average would underestimate the consumption and capacity demand during the peak periods of the year, there is used the higher figures. The major hospital above serves population of approx. 100,000 people; a figure not very different from what major hospitals in Owambo will have to cater for. As an order of magnitude, we have assumed a consumption figure in Namibia of 580 kWh/bed/month.

One health centre in Botswana (38 beds) had a consumption between 9,000 and 10,880 kWh per month during a third of the year; during the remainder of the year the figures were lower. We have assumed that the average clinic consumption will be 50 % of the average health centre's.

4.4.5.3 Schools

A Botswana day secondary school had a consumption of 4.7 to 1.5 kWh per student per month. A boarding school had an average consumption of 35 kWh per student per month during the peak half of the year. A combined school, with 60 % of the pupils being day students, had a high of 3.2 and a low of 1.0 kWh per student per month. (All schools used gas and or coal for cooking and water heating).

We have assumed, again for the sake of indicating an order of magnitude, that the figures for Namibia will be:

	Primary school	Secondary school
Electricity	1 kWh/student/month	10 kWh/student/month
Gas	0 kWh	7 kWh student/month

The gas figure is based on the current consumption pattern in secondary schools in the Owambo province; they are currently all boarding schools. No primary schools are envisaged to cater for the pupils.

One difficulty in forecasting the school consumption is that one does not know which secondary schools that will be boarding schools in the future, and which ones will be day schools. Currently they are all boarding schools; but Government want more day secondary schools.

4.4.5.4 Households

The household forecasting cannot be anything but a very rough guestimate; no detailed population information exist at the village level, and the growth in real incomes, changes in population pattern, housing standard and the propensity to wanting to electrify, are all very uncertain parameters.

In the absence of population data, we have assumed that the villages with a primary school are the most populated ones. Based on regional and national macro statistics, we have assumed that the ratio of population size to actual primary school enrolement is 5:1. And that the average household has got 8 members.

Some villages have health facilities, but not a primary school (it could be that they do have a school, but that the school name is different from the name of the village; thus we are not able to locate all schools on the map). We have assumed that a village with a health facility without a known primary school, will have in average 300 households which corresponds to the average primary school village.

Since the rural population do not live in clusters, but in spread patterns that makes electricity distribution at the local level difficult, and in view of the very low household incomes, we have assumed that at the starting point only 1 % of the households will connect to the electricity supply. Most household income are currently at the absolute minimum level; they cannot afford electricity unless the general income level is significantly increased.

Based on consumer statistics from the Oshakati - Ondangwa area, we have estimated a monthly household consumption figure of 250 kWh to be representative.

From the scarce LPG consumption information we were able to obtain, the average monthly household figure is set at 300 kWh equivalent.

(This energy distribution between electricity and LPG compares well with the situation in similar electrified areas in Mozambique. In poorer peri-urban Maputo the average electricity consumption is around 150 kWh per <u>connected</u> household per month).

4.4.5.5 Shops

There are very few shops in the rural areas. As an order of magnitude we have assumed that the number of commercial shops that demand/will demand electricity is half the number of households being electrified.

Some villages, as observed through our field visit, have more and some fewer shops than what emerge through this average approach.

But since each of them have rather insignificant consumption of electricity, relatively speaking, and as the idea is to present a global pattern rather than a detailed picture, we do probably not make any major mistakes by adopting this approach.

The average shop consumption is assumed to be twice that of the household subsector; i.e. 500 kWh and 600 kWh per month of electricity and LPG respectively.

Again, we have collected major village information from Botswana that implies total small to medium shop consumptions in the range 200 to 2,000 kWh per month.

4.4.5.6 Water Pumps

Our forecast on water pump side is based on the current installations of such pumps, and the observed capacities. The assumptions are that at each place 50 % of the capacity is stand-by (each place has more than one generator), and that they run 15 hours per day at half capacity.

4.4.5.7 Other Users

Our forecast does not explicitly include other usergroups; such as the local administrative offices likely to come up, police, military etc.

4.4.5.8 Growth

The methodology sets a forecast based on a more or less immediate implementation of the new health and educational services. This is obviously not realistic. On the other hand, it is too early for anybody to say when the various projects will be implemented. The main point in this context is that the implementation of the new structures will eventually be done at all the designated villages.In order to forecast the load requirements in year 2010 it is not essential whether a facility is connected in 1991 with a low load, or in 1997 with a load which in the meantime has grown; the end result will be same.

The timing of the implementation is mainly important when it comes to calculating the financial and economic viability of the schemes; the timing of the investment viz the resultant revenue stream will decide the overall viability of any proposed scheme.

In our forecast we have assumed an annual growth of 5.5 %, based on an "immediate" implementation of the new/upgraded social infrastructure.

The 5.5 % covers several elements. It assumes a significant population growth 3.5 %; i.e. all the social infrastructure will have continuously expand, and thereby increase their electricity consumption, in order to keep up a constant service level. The number of households and shops etc. will increase along the same rate (at least).

The remaining 2 % is a residual element. It includes an increased propensity to connect and consume as a real economic growth per capita takes place. The 2 % also reflects that with economic growth additional public services like libraries, street lighting, police, etc., and private sector services such as small scale village based industry, will appear, and demand electricity.

It could be argued that the 5.5 %, if anything, is too small. At some stage some larger industries will probably be established in the region. And big agricultural scheme, some very irrigation intensive and therefore demanding significant electricity for pumping purposes will probably become a reality. However, it is most uncertain where such industries and schemes will be established; at this stage it is not possible to include them in any specific village demand forecast. The 5.5 % figure will therefore serve as global average for the entire region; in order to map out the probable load centres and their relative order of magnitude.

4.4.5.9 Load Factor

For design purpose the corresponding peak load for each rural centre has also been calculated. A load factor of 0.45 has been anticipated. This is lower than for the national grid, but should reflect the consumption pattern in the rural centres.

4.4.5.10 Demand Forecast

On basis of above consideration the following demand forecast are established:

Village:	El: Cons. MWh	LPG: Cons. MWh	El + LPG: Cons. MWh Year 1990	Cons. MWh 2010 5.5% p.a.	Capc. KW 2010 0.45 Lo.Fa.	No.of HHs 2010	El.f. shops 2010	Hosp. beds	He. ce.	Clin.	SecS	PriS
OWAMBOLAND												
Tsandi	917	351	1267	3697	924	15	7	0	1	0	816	820
Elondo	85	79	164	479	120	6	3			1		332
Ogandjera	1029	466	1495	4362	1091	5	3			1	1629	300
Ombombo	84	78	162	472	118	5	3			1		300
Okahau	1539	455	1995	5820	1455	7	3	60				357
Oluteyi	98	85	183	534	133	11	5			1		591
Etilyasa	95	83	179	521	130	10	5			1		531
Onaanda	84	78	162	472	118	5	3			1		300
Uutsathima	84	78	162	472	118	5	3			1		300
Eengedjo	209	200	409	1193	298	0	0				840	
Eluwa	47	45	92	267	67	0	0				188	
Ongwadiwa	187	163	350	1022	255	12	6				619	677
Valombola	63	60	123	359	90	0	0				253	
Nangola	19	9	28	82	21	7	4					391
Oluno	396	375	770	2247	562	3	2				1554	188
Onipa	57	26	83	242	61	21	11					1152
Ongenga	271	260	531	1550	387	0	0				1091	
Oshikango	165	158	324	945	236	0	0				665	
Odiba	163	141	304	886	221	11	5				536	592
Engela	2475	2493	4968	14495	3624	5	3	300	1		475	300
Edjuna	84	78	162	472	118	5	3			1		300
Ondobe	231	222	454	1324	331	11	5		1	1		592
Okatope	92	82	174	509	127	9	4			1		473
Ohangwena	472	241	712	2078	520	7	4			1	672	400
Onekwajo	84	78	162	472	118	5	3			1		300
Ongha	192	179	371	1083	271	8	4			1	413	413

Village:	El: Cons. MWh	LPG: Cons. MWh	El + LPG: Cons. MWh Year 1990	Cons. MWh 2010 5.5% p.a.	Capc. KW 2010 0.45 Lo.Fa.	No.of HHs 2010	El.f. shops 2010	Hosp. beds	He. ce.	Clin.	SecS	PriS
Ohaingo	217	216	433	1262	316	5	3		1	1		300
Oshikuku	1778	1556	3334	9727	2432	15	7	200			200	800
Okalango	232	223	455	1328	332	11	6		1	1		614
Ogongo	660	185	846	2468	617	5	3		1		172	300
Olupandu	86	79	165	482	120	6	3			1		344
Onheleiva	99	85	184	538	135	11	6			1		612
Omungwelum	337	95	432	1261	315	19	10			1		1054
Oshitekela	217	216	433	1262	316	5	3		1	1		300
Kamhaku	811	815	1626	4743	1186	5	3	90	1			300
Nakayale	822	809	1632	4761	1190	16	8	106				851
Ruacana	84	78	162	472	118	5	3			1		300
Mahenene	84	78	162	472	118	5	3			1		300
Anamulenge	271	241	512	1494	373	26	13		1	1		1400
Epoko	84	78	162	472	118	5	3			1		300
Ogelange	84	78	162	472	118	5	3			1		300
Ombalantu	600	358	958	2796	699	15	7		1		850	800
Ukwaludi	442	447	889	2593	648	0	0	60				
Onesi	493	256	749	2186	547	11	5			1	721	583
Eunda	220	217	437	1275	319	7	3		1	1		360
Eenhana	1479	1477	2956	8625	2156	8	4	150	1		888	429
Nkongo	529	308	838	2444	611	3	1	30			340	163
Ekoka	82	77	159	464	116	5	2			1		260
Oshuli	89	81	170	497	124	8	4			1		415
Oshifuti	76	75	150	438	110	3	1			1		138
Omundaungi	84	78	162	472	118	5	3			1		300
Olukula	70	72	142	415	104	0	0			1		25
Ohamwimbi	84	78	162	472	118	5	3			1		300
Oshakati	0			0	0	0	0					
Elim	467	458	925	2699	675	9	5	60				504
Okatana	564	544	1108	3232	808	18	9	70				983
Endola	84	79	163	476	119	6	3			1		316
Onamutayi	98	85	182	532	133	11	5			1		582
Ohalushu	81	77	158	460	115	4	2			1		242
Omusimboti	102	87	188	549	137	12	6			1		665
Ompundja	79	76	155	454	113	4	2			1		211
Onayena	541	514	1055	3078	770	14	7		1	1	1206	790
Onyaanya	325	305	630	1839	460	9	5			1	930	514
Oshigambo	230	221	450	1314	329	4	2			1	607	203
Omuntele	84	78	162	472	118	5	3			1		300
Ontananga	89	81	170	496	124	8	4			1		412
Omuthiya	84	78	162	472	118	5	3			1		300
Okankolo	96	84	179	523	131	10	5			1		541
Ondangwa				0	0	0	0					
Olukonda	87	80	166	485	121	7	3			1		359
Eheke	97	84	181	528	132	10	5			1		566
Oshivelo	84	78	162	472	118	5	3			1		300
Total	22521	17933	40453	118033	29508							
Total, proposed	13612	10900	24512	71519	17880							

4.5 THE KAVANGO PROVINCE

4.5.1 Introduction

The Owambo and Kavango provinces have many features in common; particularly in the socio-economic sense. The population is in general very poor, the provinces have both been grossly neglected by the previous Government when it comes to social infrastructure and services, the population depends on agriculture for survival, they live on lands that by general definition were not of any value or major interest to the colonialists, there is no developed industrial or major commercial activities in any of the regions, etc.

The general observations made in the previous sections on Owambo are therefore valid also for Kavango. The energy use/situation is resemblant, and the same basic assumptions as used for Owambo, will be applied when it comes to forecasting the electricity needs.

The following paragraphs are therefore limited to the features that are special for Kavango.

4.5.2 Geographic and Economic Setting

4.5.2.1 General

The Kavango province lies in the north east of Namibia, bordering to Owambo in the west and Caprivi in the east. Its northern border is the Okavango river.

The Kavango region covers approximately 51,000 km^2; or 8.2 % of the surface of Namibia.

The population probably counts about 150,000 people; exact figures are not available. The average population density is therefore in order of 3 people per m^2. At first glance this implies a low density; compared for example with the Ovambo region's density of approximately 13 people per km^2.

However, recent estimates indicate that as much as 80 % of the population live in a belt within 5 km along the Kavango river.

Rundu is the region's capital, and is also the only town in Kavango.

The Ministry of Health estimates that 65,000 people stay within a radius of 50 km west, south and east of Rundu.

The area around Rundu has seen a large influx of people over the last years; the unrest and war in southern Angola since 1975 has caused a number of people to migrate to Kavango, and to the Rundu area in particular.

4.5.2.2 Agriculture

The land in Kavango is considered to be of a better quality than in Owambo. The rainfall is also better, and the Kavango river represents a reliable and accessible water source for domestic and agricultural use.

Most of the people in the province are small scale farmers; the IDC report estimates the average planting to be 4-6 hectares per farmer.

People herd cattle, grow millet and fish (IDC). Most Kavango families are self-sufficient in millet, and a number have a surplus to sell.

There is a potential for expanding this production; by using more land, and the current land more efficiently. Water can be brought further inland from the river.

The constraints for small scale agricultural development are in the form of capital, access to well functioning and structured marketing systems, and more modern agricultural skills and technique among the farmers.

Fishing is done daily by most families; for their own consumption (IDC). Only a minor portion of the catch is sold in local markets.

The First National Development Corporation (FNDC) runs three large irrigation schemes in Kavango (consuming 500,000 litres of diesel per year for the water pumps etc.). These are the only major commercial agricultural schemes in the province.

4.5.2.3 Education

The general facilities are just as inadequate as in Owambo.

Due to the higher population concentration and therefore shorter walking distances, not all the secondary schools are boarding institutions. However, in our forecasting we have as a matter of simplification assumed the same pattern as in Owambo.

The majority of the schools are situated as "pearls on a string" along the river. The remainder are mainly located in the north western part of the region; with only very few in the deeper inland of Kavango.

4.5.2.4 Health

The health plan includes the two existing hospitals in the region, Rundu (250 beds) and Bunya (52 beds), 4 health centres and 15 clinics.

According to the same plan, many of the people in the Rundu district live in peri-urban squatter settlements where housing, clean water supply, refuse removal and sanitation facilities are inadequate. People are very vulnerable to various gastrointestinal diseases and malaria.

One third of the patients attending health services in the Rundu district come from southern Angola.

4.5.3 The Electricity Subsector

4.5.3.1 Existing Facilities

Existing facilities in the Kavango province can broadly be grouped as follows:

- Facilities connected to the national grid
- Small isolated networks/installations fed by diesel-generators.

Facilities connected to the national grid

With reference to the single line diagram in Appendix 3.2 it appears that the SWAWEK operated 66 kV/11 kV substation in Rundu is supplied by a transmission line departing from a substation near Tsumeb. This transmission line is on steel lattice towers and designed for 132 kV, but is presently operated at 66 kV.

There are two outgoing 11 kV lines from the substation in Rundu and the network from here and onwards is the responsibility of the Ministry of Works in the Kavango province. One of these 11 kV lines goes to the main switchyard for the Rundu network located near a thermal power station. This power station is presently kept as back-up and is under the responsibility of SWAWEK.

A single line diagram of the Rundu network was not available. The network comprise, however, approximately 30 kilometres of 11 kV overhead lines and about 10 kilometres of 11 kV underground cables. One line reaching 18 kilometres east of Rundu centre gives the extreme point. There are about twenty 11 kV/400 V transformers and the present peak load is about 2 MW.

The number of consumers is about 1,500 of which the major part are domestic.

Isolated Dieselgenerators

The following dieselgenerators are administered and operated by the Ministry of Works in the Kavango province.

1. Max Makuse, 180 kms east of Rundu

   Installed capacity: 2 x 375 kVA

   Year of fabrication: 1984

   Supply: Secondary school including hostel and living quarters. Police station

2. Linus Shanipapo, 113 kms east of Rundu

   Installed capacity: 2 x 180 kVA

   Year of fabrication: 1982

   Supply: Secondary school including hostel and living quarters.

3. Mashari, 45 kms east of Rundu

   Installed capacity: 2 x 160 kVA

   Supply: Agricultural college including hostel, living quarters and water pumping for irrigation.

4. Kapaku, 22 kms west of Rundu

   Installed capacity: 2 x 125 kVA

   Year of fabrication: 1982

   Supply: Secondary school including hostel and living quarters

5. Kandjumi, 117 kms west of Rundu

   Installed capacity: 2 x 125 kVA

   Year of fabrication: 1984

   Supply: Secondary school including hostel and living quarters. Water pumping.

6. Murandi, 118 kms west of Rundu

   Installed capacity: 2 x 125 kVA

   Year of fabrication: 1989

   Supply: Hospital

All above supplies are on 24 hour basis. One unit is normally run at the time.

Other isolated dieselgenerators, not operated by the Ministry of Works, are:

Arnst Nest, police camp:	2 x 160 kVA
Nkurukuru, police camp:	50 kVA, hospital: 40 kVA
Mpungu, hospital:	10 kVA

Musese, Agricultural Project, several small diesel engines for water pumping.

Kaisosi, lodge near Rundu, approx. 50 kVA

Mayana, lodge near Rundu, approx. 50 kVA

There is also a small hydropower plant, about 20 kVA at Andara mission school.

4.5.3.2 Administration

Network connected to the national grid

The operation and maintenance of the Rundu network is under the responsibility of the Ministry of Works for the Kavango province. They have two qualified electricians and a supporting staff of about 30 for this task.

Isolated generators

Daily operation is undertaken by the staff at the schools. An electrician from the provincial Ministry of Works tries to make monthly visits for periodical maintenance.

4.5.4 Future Demand

4.5.4.1 General

The demand forecast for the Kavango province is based on the same assumptions, approach and methodology as previously described for the Owambo province.

4.5.4.2 Demand Forecast

Village:	El: Cons. MWh	LPG: Cons. MWh	El + LPG: Cons. MWh Year 1990	Cons. MWh 2010 5.5% p.a.	Capc. KW 2010 0.45 Lo.Fa.	No.of HHs 2010	El.f. shops 2010	Hosp. beds	He. ce.	Clin.	SecS	PriS
KAVANGO												
Nankudu	884	890	1774	5175	1294	5	3	100	1	0	0	300
Nkurunkuru	544	482	1027	2995	749	16	8	62				900
Tondoro	434	432	866	2527	632	5	3	57				300
Mpungu	173	156	328	958	240	15	7		1			800

Village:	El: Cons. MWh	LPG: Cons. MWh	El + LPG: Cons. MWh Year 1990	Cons. MWh 2010 5.5% p.a.	Capc. KW 2010 0.45 Lo.Fa.	No.of HHs 2010	El.f. shops 2010	Hosp. beds	He. ce.	Clin.	SecS	PriS
Nepara	84	78	162	472	118	5	3			1		300
Mbambi	84	78	162	472	118	5	3			1		300
Gcarnha	84	78	162	472	118	5	3			1		300
Insu	84	78	162	472	118	5	3			1		300
Kahenge	94	83	176	514	129	9	5			1		500
Nyangana	1351	1348	2699	7874	1968	15	7	160	1			800
Ndonga	89	81	169	493	123	7	4			1		400
Shinguru	84	78	162	472	118	5	3			1		300
Barnasoni	84	78	162	472	118	5	3			1		300
Mbambi	89	81	169	493	123	7	4			1		400
Shadikongoro	148	144	292	853	213	5	3		1			300
ShadikongoroFNDC					1564							
Shinyungwe	84	78	162	472	118	5	3			1		300
Andara	1101	1041	2142	6250	1562	7	4	120	1			400
Omega	84	78	162	472	118	5	3			1		300
Bagani	79	76	155	454	113	4	2			1		210
Mbira	79	76	155	454	113	4	2			1		210
Shamatura	84	78	162	472	118	5	3			1		300
Kangongo	85	79	163	477	119	6	3			1		320
Rundu	0	0	0	0	0	0	0					
Sambyu	145	143	288	840	210	4	2		1			240
Mupini	148	144	292	853	213	5	3		1			300
Bunya	148	144	292	853	213	5	3		1			300
Rupara	252	242	494	1442	361	7	4		1		400	400
Kaisosi	83	78	161	469	117	5	3			1		285
Nkarapwe	84	78	162	472	118	5	3			1		300
Sauyema	84	78	162	472	118	5	3			1		300
Kapako	84			0	0	5	3			1		300
Kayangana	208	196	404	1179	295	7	3			1	488	362
Mashari	1000	100	1100	3209	802	4	2			1	100	200
Takwasau	84	78	162	472	118	5	3			1		300
Sharukwe	84	78	162	472	118	5	3			1		300
Ncuncini	84	78	162	472	118	5	3			1		300
Ncaute	84	78	162	472	118	5	3			1		300
Dewasingu	84	78	162	472	118	5	3			1		300
Myl 10	84	78	162	472	118	5	3			1		300
Myl 30	84	78	162	472	118	5	3			1		300
Linus Sc.	129	116	246	717	179	5	3				460	300
Max Makusa	143	129	272	793	198	5	3				514	300
Levi Hakus	143	129	272	795	199	5	3				515	300
MaseseFNDC					827							
ShatemboFNDC					1660							
TOTAL	9137	7799	16852	49170	16344							

Note:
The three FNDC schemes have the current diesel consumption and power needs (according to FNDC):

Location:	Litres of diesel per year: (000s)	Power needs:
Masese (90 km west of Rundu)	96	458 KW
Shitembo (90 km east of Rundu)	229	919 KW
Shadikongoro (190 km east of Rundu)	161	866 KW

4.6 THE CAPRIVI PROVINCE

4.6.1 Introduction

The Owambo and Caprivi provinces have many features in common; particularly in the socio-economic sense. The population is in general very poor, the regions have all been grossly neglected by the previous Government when it comes to social infrastructure and services, the population depends on agriculture for survival,, they live on lands that by general definition were not of any value or major interest to the colonialists, there is no developed industrial or major commercial activities in any of the provinces.

The general observations made in the previous sections on Owambo are therefore valid also for the Caprivi province. The energy use/situation is resemblant, and the same basic assumptions as used for Owambo, will be applied when it comes to forecasting the electricity needs of Caprivi.

4.6.2 Geographic and Economic Setting

4.6.2.1 General

The Caprivi province is located in the extreme north-east of Namibia, boarding Angola and Zambia in the north, Zimbabwe at one point in the east and Botswana in the south. The province capital Katima Mulilo is approximately 1,200 kilometres from Windhoek. There is regular and frequent air connection with Windhoek.

The Caprivi province is about 25,000 km^2 with a population of about 60,000 out of which approximately 20,000 live in the Katima Mulilo area. The Caprivi strip, between the Kavango Province and Eastern Caprivi, is basically a game park with very small population. A part of Eastern Caprivi, east of Katima Mulilo is flooded during rainy seasons and communications are therefore difficult.

Katima Mulilo is the administrative and commercial centre of the province and do also have some small industries. It is the only town in the Caprivi province. The basic occupation outside the Katima Mulilo area is subsistence farming and fishing. Some of these products are though sold.

4.6.2.2 Education

There are about 35 primary and secondary schools in the province. Seven of these are considered as major secondary with hostels. These also have power supply by isolated diesel generators. These are: Simataa, Sengwati, Mayuni, Senjo, Memphela, Kebbe and Impalila.

4.6.2.3 Health

There is one modern, well equipped hospital in the town of Katima Mulilo with 200 beds and 6 doctors.

Apart from the hospital in Katima Mulilo the other health facilities in the Caprivi province include 7 major clinics, class A and 17 clinics, class B. The class A clinics normally have two qualified nurses whereas the class B clinics have one. The clinics only provide treatment whereas beds are not available. The class A clinics have radio communication with the hospital in Katima Mulilo.

Five of the class A clinics are fully wired for electricity and were supplied by dieselgenerators until 3-4 years ago. The generators are, however, not working at present. These clinics are Mbalila, Ngoma, Bukalo, Chinchimani, and Sangwali.

4.6.2.4 Agriculture

As already indicated, the basic occupation outside Katima Mulilo is subsistence farming and fishing. Some irrigation projects are also being undertaken, and the Ministry of Agriculture for Caprivi informed the 38 6 HP diesel pumps were at their disposal and were employed for irrigation purposes at various locations throughout the province. These included Singalane, Kasheshe, Tshindjimani, Tshoe, Linyandi, Sanguali, Shukmansberg and Sindua.

A new project for sugar production on basis of irrigation at Kwena was also planned for implementation in two years time. This might need power with a peak load in the order of 0.5 - 1.0 MW.

Above mentioned ministry had also planned for major canals for irrigation with a capacity of about 4 m^3/s and heights of approximately 10 m. These were Katima - Sanguali, Katima - Bukalo -Ngoma, Linyandi - Singalagwe and Schukmansberg - Kasika.

4.6.2.5 Church

The Catholic, Reform, Seventh Day Adventist and Apostolic churches are all active in the Caprivi province. The rural centres where at least one of these churches have houses of permanent structure are Mafuta, Bukalo, Linyanti, Chinchimani, Sebinda, Mahajana, Kongola, Lusese, Ngoma and Kasheshe.

4.6.3 The Electricity Subsector

4.6.3.1 Existing Facilities

Existing facilities in the Caprivi province can broadly be grouped as follow:

- The Katima Mulilo network.
- Small isolated networks/installations fed by diesel-generators.

<u>The Katima Mulilo Network</u>

The network in the Katima Mulilo area was until August 1990 fed by a thermal power station comprising 6 dieselgenerators of 500 kVA each. Two and two of these generators were connected to step-up transformers 400 V/11 kV and the resulting three step-up transformers fed an 11 kV busbar. This power station and 11 kV switchyard were operated by SWAWEK. The 11 kV busbar has two outgoing feeders. These feeders and the related 11 kV/400 V distribution network are both technically and economically the responsibility of the Ministry of Works in Caprivi. Since August 1990 the 11 kV busbar is fed by and 11 kV line from Katima substation in Zambia. This line is about 10 kilometres and is sufficient for the present peak load of approximately 1 MW. ZESCO in Zambia is, however, planning a 66 kV supply instead of the newly commissioned 11 kV line.

The distribution network in the Katima Mulilo area comprises about 25 kilometres of 11 kV lines and approximately fifteen 11 kV/400 V distribution transformers. All facilities are at present located within an area of 7 kms from the town centre.

The number of consumers is about 1,400 of which the major part are domestic.

Isolated Dieselgenerators

The Ministry of Works in the Caprivi Province is responsible for the operation of isolated dieselgenerators at 7 secondary schools and 5 clinics.

The schools are Simataa, Sengwati, Mayuni, Senjo, Mephela, Kebbe and Impalite. All diesel engines are 1 x 11 HP corresponding to approximately 10 kVA. This power is only used for lighting and the generators are normally in operation only 3 hours at night for about 25 days each month. Each school has about 400 litres of diesel per month.

The clinics with dieselgenerators are Mbalila, Ngoma, Bukalo, Chinchimani and Sangwali. They have the same type of generators as the schools, but they have not been in operation since three to four years ago.

4.6.3.2 Administration

The Katima Mulilo Network

The Ministry of Works is responsible for the operation and have 8 electricians available for maintenance and one linesman with a team for the construction of new distribution lines. All new constructions are also undertaken with this staff.

It was indicated that financial management would be transferred to another local ministry/department.

Isolated Generators

The daily operation of the dieselgenerators at the secondary schools is normally undertaken by the staff of the school. Periodical maintenance and trouble-shooting is the responsibility of the Ministry of Works. They have 2 electricians and 1 mechanics at disposal for this work. This is not sufficient and maintenance is not satisfactory. Lack of transport facilities is also a constraint.

4.6.3.3 Development Plans

According to the Ministry of Works there are plans to extend an existing 11 kV line from its terminal point at the police camp located 7 kms from the town centrer to the airport at about 15 kms from the town centre and thereby eliminate dieselgenerators with a peak load of approximately 200 kW.

Another project which is underway includes approximately 300 domestic connections in a township in Katima Mulilo.

4.6.4 Future Demand

4.6.4.1 General

The demand forecast for the Caprivi province is based on the same assumptions, approach and methodology as previously described for the Owambo province.

4.6.4.2 Demand Forecast

Village:	El: Cons. MWh	LPG: Cons. MWh	El + LPG: Cons. MWh Year 1990	Cons. MWh 2010 5.5% p.a.	Capc. KW 2010 0.45 Lo.Fa.	He. ce.	Clin.	No. of stud. Secs	PriS
CAPRIVI									
Katima M.									
Sanjo + Bukalo	313	295	608	1773	443	1		600	624
Sibbinda	100	86	185	541	135		1		624
Choi + Mayuni	134	125	258	754	189		1	192	343
Sangwali	164	117	281	819	205		1	174	174
Ngwezi	306	272	577	1685	421	1	0	443	1264
Cincimane	80	77	157	457	114		1		226
Ngoma	88	80	168	491	123		1		388
Impalila	185	175	360	1051	263		1	407	300
Sesheke	53	44	97	284	71		0.5		375
Sachona	136	125	261	761	190		0.5	347	300
Batubja	157	147	304	886	221		0.5	439	274
Linyati	49	43	92	268	67		0.5		300
Kanono + Simataa	233	219	452	1318	329		0.5	739	300
Masokotwan	162	150	312	910	227		0.5	452	300
Muyako	46	41	87	254	63		0.5		233
Ibbu	124	114	238	694	173		0.5	300	300
Lusese	141	130	271	792	198		0.5	369	300
Mbalasinte	154	143	296	864	216		0.5	420	300
Tshindjimu	43	0	43	126	32				
Tshoe	43	0	43	126	32				
Itomba	0	0	0	0	0				
Kabbe	172	160	332	968	242		0.5	493	300
Schulmansburg	194	140	334	975	244		0.5	409	300
Isize	57	46	103	301	75		0.5		460
Lisikiili	166	155	321	935	234		0.5	470	300
Mafuta	239	225	464	1354	339		0.5	765	300
Kasheshe	100	46	145	424	106		0.5	0	443
Kizito College	139	126	265	772	193			499	300
Maonluma	32	15	47	138	34			0	655
Singalamwe	53	4	57	167	42				194
Kwena					1200				219
TOTAL	3861	3297	7158	20886	6422				

CHAPTER 5 RURAL ELECTRIFICATION PROJECT OWAMBO

5.1 INTRODUCTION

With reference to Section 4.3, rural electrification project presented by MME, the documentation given was rather limited and does not allow a proper project appraisal. The visits to rural areas of the Owambo province together with subsequent meetings with relevant authorities in Windhoek were consequently most important.

With this background and on basis of the demand forecasts given in Chapter 4, a rural electrification project is outlined. During this process several assumptions have been made both with regard to demand forecasting, selection of rural centres, design and project implementation. The project does, however, not differ significantly from the concept presented by MME. We feel that further extensive studies should not be required. It would rather be more convenient with a meeting between the parties involved to discuss the assumptions and conclude the project.

5.2 RANKING CRITERIA

The basis for selection of rural centres to be electrified is the 28 centres proposed by MME, and all these are included in various stages of the proposed project. In addition to these centres additional centres as listed in Section 4.4 have also been considered. A criteria for this consideration could be that the net present value of future power sales should equalize the net present value of the project cost of the centre in question. Project cost of the centre should in this context be additional network investment related to connection for the specific centre in question assuming that an "existing network for the 28 centres" has already been established.

This assumption would give the distance from the "existing network" as function of the energy consumption as indicated in table 5.1.

Table 5.1
Economic Distances from "Existing Network"

Annual consumption 1990 (MWh)	Distance from Existing grid
200	7
300	11
400	14
500	18
600	22

A strict application of this criteria would result in connection of a large number of centres and thereby change the concept as proposed by MME significantly. Therefore, only centres well above this criteria and fairly close to the "existing network" have been included. These are Endola, Okatana, Anamulenge, Ongwadiva, Ongha, Onyaanya. Reference should also be made to the map in Appendix 5.1 showing the location of all rural centres in question.

5.3 POWER SYSTEM CONSIDERATIONS

5.3.1 Power Generation

With reference to the demand forecasts in Section 4.4, the rural electrification in the Owambo province will require an additional power production in the order of 25 GWh in the initial year and 70 GWh after 20 years. Initially this will have to be covered from the existing generating facilities, i.e. Ruacana hydropower plant, Van Eck thermal power plant and imports from the RSA. Compared to the present power production the initial increase caused by the rural electrification project is only in the order of 2 % and will be covered by the existing generating facilities. Future increases caused by the rural electrification project will also be comparatively small as compared to increases in the whole national system and will not influence significantly to the phasing of future generation projects.

5.3.2 Power Transmission

5.3.2.1 Namibia

With reference to the considerations given regarding power generation it can be stated the influence of the rural electrification to the backbones of the national grid, i.e. the 330 kV line from Ruacana to Umburu and the 220 kV line from Umburu to Windhoek and RSA as well as the 220 kV line from Umburu to Tsumeb is insignificant.

An important transmission system consideration is the timing of the future line between Ruacana and Okatope. It should, however, be possible to feed the distribution networks included in the proposed project during the first years without concluding this 132 kV line. This can be achieved by feeding the southeastern part by the existing line from Tsumeb to Ondangwa/Oshakati and the northwestern part from the existing Ruacana - Calueque transmission line.

The first years of the project will result in load increase in the order of 3-4 MW on the existing Tsumeb - Ondangwa/Oshakati line which can be accepted without any upgrading.

The area comprising Ombalantu, Tsandi, Ogandjera and Onesi will during the first years require about 3 MW and can be fed from Ruacana. This could be achieved by constructing about 45 kilometres of 132 kV line from Ombalantu to existing Ruacana - Calueque 66 kV line and operate this at 66 kV during the first years. This investment is included in the project cost whereas other investments in the main transmission network, which are not required during the first years of operation, are not included.

Future load increases will, however, require upgrading of the main transmission network feeding the Owambo province as indicated here below. However, this should be considered more long-term development indications.

The existing 132 kV line Otjikoto (Tsumeb) Okatope must be operated at 132 kV.

This will require a 40 MVA, 220/132 kV transformer in Otjikoto.

Existing 66 kV line Okatope - Oshakati should be replaced by a new single-circuit 132 kV lattice steel line with "Wolf" conductors. Existing 66 kV line may be used as 33 kV distribution line.

132 kV substations must be established in Oshivelo, Okatope, Ondangwa and Oshakati.

There would be preferable to extend the 132 kV line from Oshakati to Ombalantu and to Ruacana as to increased reliability of supply. However, parallel operation of the two suppliers is not feasible.

A 132/33 kV substation is to be built in Ombalantu.

132 kV feeder extension in Ruacana shall be established. Transformer size in the substations in Oshivelo, Okatope, Ondangwa, Oshakati and Ombalantu could be from 5 to 20 MVA.

5.3.2.2 Angola

SADCC has put forward a project whereby the two southern Angolan villages of Xangongo and Ondjiva should be supplied from northern Namibia.

The idea was to construct a 110 kV line from Ruacana to Xangongo with a sideline to Ondjiva, and later from Xangongo onwards to Cahama, Matala, Lubango etc. I.e. gradually a full interconnection between the Namibian system and the southern system in Angola.

These ideas would probably still be valid for the long term. However, the Angolan Ministry of Energy and Petroleum states, in a meeting with the consultant September 1990, that for the short to medium term such an arrangement is not a priority. Instead, the Ministry is currently examining a Portuguese financed proposal concerning the construction of a 66 kV line from Calueque to Xangongo; which has a population of possibly 80,000 people and an eventual demand of 1.5 MW.

SWAWEK has reportedly offered to construct this line at a cost of USD 1 million; but Angolan authorities feel that the Portuguese proposal is more interesting; possibly also from a financing point of view.

The Ministry feels that Ondjiva is too destroyed by the war to have any real power needs for the medium term future. The population is estimated to be about 10,000 people, but the infrastructure in the town needs to be rebuilt before any concrete actions concerning power supply will be considered.

For these reasons supply of centres in southern Angola from Namibia has not been included in the planning process of rural electrification in the Owambo province.

5.4 DESIGN CRITERIA

5.4.1 System Voltage

Distribution voltages in Namibia are at present 33 kV, 22 kV and 11 kV. Three different system voltages should be avoided, and preferably the new distribution network should be planned for one system voltage.

Comparing the three voltages, one must have in mind that for a given conductor crossection and distance, the maximum load of a 33 kV line is a little more than twice of a 22 kV line and 9 times of a 11 kV line. The increase in costs is considerably less.

Consequently 11 kV can only be of interest where it can be connected to existing 11 kV network and the distance is very short or possibly the load is minor. Usually the distance of the distribution lines in question for this project are comparatively long. This indicates that 33 kV is the recommended distribution voltage and forms the basis for the project as outlined in this report.

5.4.2 Voltage Drop and Losses

The voltage drop in the transmission network can be controlled by different means (on-load tap changers on transformers, capacitors). However, the transmission network should be dimensioned in such a way that voltage fluctuations greater than ± 5 % in the towns and ± 10 % in the most remote areas, will be avoided.

Total losses from generation to main distribution transformer, are today about 10 %. Losses in the distribution network should not exceed 7-8 % at maximum load.

5.4.3 Conductors

The following ACSR conductors are assumed to be used: Gopher, Rabbit and Hare for 33 kV lines and Wolf for 132 kV lines.

5.5 PROJECT DEFINITION

Rural electrification in the Owambo province is rather a programme than a project due to its scope and nature. It is therefore in this report presented in stages. The different stages reflect geographical areas with regard to power distribution.

The number of stages as presented in this report is 8. Depending of available financial support and mode of implementation two or more phases could be implemented simultaneously.

When dividing into different stages one must have in mind that 33 kV feeding voltage must be available. It is assumed that 66/33 kV transformers temporarily have to be installed in Ondangwa, Ombalantu and Oshakati. These transformer costs are not included. At least three 33 kV bays will also have to be built at these places. These costs are included.

With regard to low-voltage distribution it is assumed an average of one 33 kV/0.4 kV distribution transformer is required per 100 kW peak load as according to the initial peak loads forecasted.

It is also assumed that each of these distribution transformers has a low-voltage of 1,000 metres of air cable network, 10 wooden poles and 10 distribution panels.

5.6 COST BASIS

5.6.1 General

All costs are in NOK, based on 1990 prices. Calculation of costs are divided into two main parts, material and labour. Transport inside Namibia is included in labour costs. The main reason for doing this is that labour and local transport both are local currency costs. Material, however, will have to be imported. Labour and transport prices from SWAWEK are based upon costs for own workers and truck drivers. Material used in the distribution network have up to now mainly been imported from South Africa. We have, however, assumed import from other countries (Europe price level).

It must be observed that prices are based on standard construction design and line configurations. This might lead to somewhat higher material costs, especially on the distribution lines where SWAWEK has implemented a low-cost design.

5.6.2 Transmission line costs

As indicated in 5.2 the feeder lines into the district are assumed to be 132 kV single-circuit lines of the same type as existing lines which are lattice steel tower lines with stranded ACSR "Wolf" conductors.

Estimated price per km for this type of line is:

Material	NOK 230,000.-
Labour	NOK 70,000.-
Engineering and project management	NOK 50,000.-
Total cost	NOK 350,000.-

5.6.3 Transformer Costs

Budget prices for 132/33 kV transformers with on-load tap changers, based on international price level are:

MVA	NOK
10	1,700,000.-
15	2,200,000.-
25	3,000,000.-
50	4,200,000.-

5.6.4 Substation Costs

Rough estimates for the costs per bay for transformers and feeders extensions are indicated as follows:

	NOK
330 kV	8 mill.
220 kV	6 mill.
132 kV	3 mill.
33 kV	1 mill.

About 20 % is local currency costs.

5.6.5 Distribution Network Costs

33/0.4 kV transformer points

KVA	NOK	Note
25	35,000.-	Pole mounted
50	44,000.-	" "
100	50,000.-	" "
200	77,000.-	" "
500	250,000.-	Mounted on foundation at ground

About 20 % is local currency costs.

33 kV distribution lines. Prices in NOK per km

Conductor	Material	Labour	Total
Gopher	60,000.-	25,000.-	85,000.-
Rabbit	75,000.-	25,000.-	100,000.-
Hare	90,000.-	30,000.-	120,000.-

Prices collected from SWAWEK based upon their standard design and material from South Africa are considerably lower, especially for distribution lines. Total costs according to SWAWEK prices will be 60-70 % of the above figures for distribution lines.

Dependable data for the 0.4 kV network are unsure. In our calculations we have made an estimate for all material and labour expenses from the transformer point down to the consumer. Average costs per transformer point are estimated to NOK 60,000.- (poles, cable, clamps, distribution panels).

The local currency part of this is estimated at 20 %.

5.7 PROJECT DESCRIPTION AND COSTS

Reference should also be made to the map in Appendix 5.1 where the various stages are indicated.

<u>Stage 1</u>	Mill. NOK
3 pcs. 33 kV bays in Ondangwa	3.00
33 kV line Ondangwa - Oshikango, length 66 km, "Hare" conductor	7.92
33 kV branchoff connection lines, length 27 km, "Rabbit" conductor	2.70
22 pcs. 33/0.4 kV transformers	1.10
22 pcs. 0.4 kV distr. network	1.32
Subtotal Stage 1	16.04

Connected villages: Ongha, Onekwayo, Okatope, Ohangwena, Engela, Oshikango, Odiba and Edunja.

<u>Stage 2</u>	Mill. NOK
3 pcs. 33 kV bays in Oshakati	3.00
33 kV line Oshakati - Elim - Oshikuku - Ogongo, length 51 km, "Hare" conductor	6.12
16 pcs. 33/0.4 kV transformers	0.80
16 pcs. 0.4 kV distr. network	0.96
Subtotal Stage 2	10.88

Connected villages: Elim, Oshikuku and Ogongo.

Stage 3	Mill. NOK
33 kV line Ondangwa - Oshigambo - Ondobe - Eenhana, length 79 km, "Hare" conductor	9.48
12 pcs. 33/0.4 kV transformers	0.6
12 pcs. 0.4 kV distr. network	0.72
Subtotal Stage 3	10.80

Connected villages: Oshigambo, Ondobe and Eenhana.

Stage 4

Main transmission network

Approximately 45 km 132 kV steel tower line, "Wolf" conductor Ombalantu - connection to Ruacana - Calueque 66 kV line near Etunda.

The line should be operated at 66 kV until permanent 132 line is built from Ruacana and 132 kV operational voltage is available.

Cost 15.80 mill. NOK

132/33 kV substation in Ombalantu, temporary operated at 66 kV feeding voltage. 1 pc. 66/33 kV transformers must temporarily be available for installation in Ombalantu.

Cost 7.00 mill. NOK

Price for a 5 MVA 66/33 kV transformer is approximately NOK 0.7 mill and is not included.

Cost stage 4 main transmission network NOK 22.80 mill.

Distribution network	Mill. NOK
33 kV line Ombalantu - Tsandi - Ongandjera, length 54 km, "Hare" conductor	6.48
33 kV line Ombalantu - Nakayale, length 8 km, "Hare conductor	0.96
33 kV line Tsandi - Onesi, length 28 km "Rabbit" conductor	2.80

	Mill. NOK
24 pcs. 33/0.4 kV transformers	1.20
24 pcs. 0.4 kV distr. network	1.44
Stage 4 Distribution network	12.88
Subtotal Stage 4	35.68

Connected villages: Ombalantu, Nakayale, Tsandi, Ongandjera, Okahao and Onesi.

Stage 5

	Mill. NOK
33 kV line Oshikati - Ongenga, length 40 km, "Hare" conductor	4.80
6 pcs. 33/0.4 kV transformer	0,30
6 pcs. 0.4 kV distr. network	0.36
Subtotal Stage 5	5.46

Connected villages: Okatana, Endola and Ongenga.

Stage 6

	Mill. NOK
33 kV branchoff lines from existing 66 kV line Okatope - Ondangwa - Oshikati, length 18 km, "Rabbit" conductor	1.80
4 pcs. 33/0.4 kV transformers	0.20
4 pcs. 0.4 kV distr. network	0.24
Subtotal Stage 6	2.24

Connected villages: Onipa (Onandjokwe), Olukonda, Ontatanga and Ongwadiva.

Stage 7

	Mill. NOK
33 kV line Okatope - Onyaanya - Onayena and branchoff to Okankola, length 37 km, "Rabbit" conductor	3.70
6 pcs. 33/0.4 kV transformer	0,30
6 pcs. 0.4 kV distr. network	0.36
Subtotal Stage 7	4.36

Connected villages: Okatope, Onyaanya, Onayena and Okankolo.

Stage 8	Mill. NOK
33 kV line Ombalantu - Ogonga, length 42 km, "Hare" conductor	5.04
33 kV line Ombulantu - Okalongo, length 40 km, "Rabbit" conductor	4.00
4 pcs. 33/0.4 kV transformer	0,20
4 pcs. 0.4 kV distr. network	0.24
Subtotal Stage 8	9.48

Connected villages: Okalongo and Anamulenge.

5.8 SUMMARY PROJECT COST ESTIMATE

Stage	Foreign exchange	Costs Local currency	Total NOK mill.
1	12,83	3.21	16.04
2	8.70	2.18	10.88
3	8.64	2.16	10.80
4	28.54	7.14	35.68
5	4.37	1.09	5.46
6	1.79	0.45	2.24
7	3.49	0.87	4.36
8	7.58	1.90	9.48
Subtotal	75.94	19.00	94.94
Contingencies	12.06	3.00	15.06
Total	88.00	22.00	110.00

5.9 MAIN TRANSMISSION SYSTEM

As previously indicated future load increases will later require investments in the main transmission system. Desription and tentative costs are given here below. It should again be emphasized that these investments are some years ahead and have consequently not been included in the project.

Reinforcement of the main transmission system should be realized in phases. The following phases are proposed:

Phase 1

Approximately 75 km new 132 kV steel tower line, "Wolf conductor Okatope - Ondangwa - Oshikati. Price: NOK 0.35 mill./km.

Building of the new 132 kV Okatope - Oshikati line at an early stage will release the existing 66 kV line which can be used as a 33 kV line and places along this line can be connected.

Subtotal phase 1: 26 mill. NOK

Phase 2

1 pc. 220 kV bay in Otjikoto	6 mill. NOK
1 pc. 132 kV bay in Otjikoto	3 mill. NOK
1 pc. 40 MVA, 220/132 kV transf. in Otjikoto	4 mill. NOK
4 pcs. 15 MVA, 132/33 kW transf.(Oshivelo, (Okatope, Ondangwa, Oshakati)	9 mill. NOK
2 pcs. 132 kV bays (Ondangwa, Oshakati)	6 mill. NOK
6 pcs. 33 kV bays (Okatope, Oshivelo)	6 mill. NOK
Subtotal phase 2	34 mill. NOK

Existing 66 kV bays in Oshivelo and Okatope are designed for 132 kV and relatively small changes have to be done.

Phase 3

1 pc. 330 kV bay in Ruacana	8 mill. NOK
1 pc. 132 kV bay in Ruacana	3 mill. NOK
1 pc. 40 MVA, 330/132 kV transf. Ruacana	5 mill. NOK
1 pc. 15 MVA, 132/33 kV transf. Ombalantu	2 mill. NOK
130 km, 132 kV steel tower line "Wolf" conductors Ruacana - Etunda and Ombalantu - Oshikati	46 mill. NOK
Subtotal phase 3	64 mill. NOK

Total cost	124 mill. NOK
Engineering, administration and contingencies are estimated to 20 %	26 mill. NOK
Total	150 mill. NOK

Approximately 20 % is estimated to be in local currency.

5.10 ALTERNATIVE ENERGY SOURCES

5.10.1 Costs

The following calculations are based on economic information collected as part of the field visit to Namibia, standard conversion factors as used by the SADCC Energy Secretariat, and efficiency calculations used by the World Bank in the ESMAP assessment of neighbouring Angola.

The table summarises the data and assumptions used:

Energy source:	Unit price:	Energy contents:	Efficiency in use:	Gross cost R/GJ	Net cost R/GJ
LPG	110R/48 kg	45.5 GJ/T	55 %	50.33	91.5
ELECTRICITY					
a) SWAWEK	6.28 c/kWh	3600 GJ/GWh		17.44	
b) At consumer level (1)	16 c/kWh			62.22	
FIREWOOD					
a) Commercial	20 c/kg	11.4 GJ/T	10 %	17.5	175
b) Collected (2)	7.5 c/kg			4.38	43.8
CHARCOAL (3)	4R/10 kg	33.1 GJ/T	15 %	12.1	80.6
KEROSENE	1.05 R/l	35.9 GJ M^3	40 %	20.2	50.4
SOLAR (4)					
AUTOGENERATORS (5)					

The density figures (T/M^3) implied above are LPG 0.54, kerosene 0.83 and firewood 0.71.

The figures in the "gross" column show the cost of the energy contents in the various energy carriers. The "net" column shows the effective cost of using the various energy sources; taking into consideration their different levels of efficiency.

1) In Rundu the tariff is 16 c/kWh. However, the demand charge is ZAR 12.50 per month (for small consumers). The calculation above assumes an average household consumption of 200 kWh per month.

2) It appears from our and others observations that the average rural family spends 1.5 hour per day in collecting firewood. With a consumption of 1.25 kg per person per day (figures from similar areas in Botswana), and an average household size of 8 people, the average rural household consumption amounts to 10 kg per day.

Assuming (and this is a major assumption) that with improved possibilities and conditions for agriculture and alternative job opportunities, that the person (often the female household member) could instead of spending her time on firewood collection, work more productively in agriculture or in the modern sector at a pay of ZAR 100 per month, the <u>opportunity</u> cost of collecting the family firewood becomes 7.5 c/kg.

3) We are not confident about the unit price quoted for charcoal. We observed the price being ZAR 4 per bag; but were never able to weigh it. But the average weight is probably in the range of 10^{+} kg.

4) At the time of writing we have not received the installation cost for solar systems. The cost of solar energy mainly lies in the investment phase; with minor maintenance and repair costs. The energy cost is calculated as the ratio between NPV (Net Present Value) of the investment and recurrent costs, divided by the NPV of the energy produced over the equipment's lifetime.

Solar photovoltaic systems are usually specified in terms of their peak output in watts (Wp). The international production costs for photovoltaic modules are said to be below 3 USD per Wp. (This solar photovoltaic information is largely based on "Gerald Foley, PANOS, 1989"). Some predict these prices to fall below 1 USD per Wp in the 1990's. These costs are only the manufacturing costs; in addition comes profit, mark-up by intermediaries, etc.

These costs also exclude installation, control systems, batteries, etc. Often these costs account for approximately 50 % of the total.

Assuming that a 100 Wp system would have a lifetime of 15 years, a <u>total</u> cost (all inclusive), and a production of 0.9 kWh on the average day; then the solar photovoltaic cost would be in the region of ZAR 0.3 - 0.4 per kWh (this is possibly a conservative estimate.

5) The energy efficiency of a diesel generator depends on the size of the generator; and so does the unit cost of installation. In average one could say that the effective energy contents of diesel is roughly 3 kWh per litre; i.e. approximately ZAR 0.35 per kWh (before the recent increases in the oil price).

Assuming that the fuel is in average approximately 50 % of the total cost (investment depreciation, operation, maintenance, spares and fuel), the effective kWh cost would probably amount to ZAR 0.6 - 0.7 per kWh (which is 4 times as much as grid electricity is sold for in the Rundu and Oshakati/Ondangwa areas).

5.10.2 Comments

In the table above there are no efficiency figure for electricity. LPG and electricity probably have the same efficiency in water heating (geyser); but electricity would be more efficient than LPG in cooking.

From all practical purposes we can conclude that LPG and electricity cost the same for consumers. The wide spread use of LPG must be explained by traditional arguments, and the fact that an electricity user is committed to a standard demand charge regardless of his/her actual consumption per month. There might also be an element of explanation in different reticulation costs, and some differences in equipment purchase.

The net figures in the table above do not tell the full story of the various costs. I.e. the shown woodfuel costs only include collection/distribution; the environmental and replantation costs are not measured. The electricity and LPG figures omit the cost of expensive reticulation and equipment required for the use of electricity.

Electricity is far cheaper than commercial woodfuel. There are, however, various major barriers to fuelswitching. One being the equipment and reticulation costs associated with electricity. Another being that a majority of woodfuel users live outside or at the fringes of the monetary economy; one cannot simply translate time saved on fuelwood usage and collection into alternative money income rendering employment.

The reliability of the various alternatives are not reflected in the costs. Solar water heating might in principle be cheap; but a number of the systems we observed were not functioning properly or at all. Regular deliveries of gas and diesel to rural health facilities are of crucial importance if these are used for refrigeration of medicines. But in most cases observed by us, one reported that the systems were often out of operation due to the lack of scheduled diesel or gas supplies.

5.10.3 Conclusions

Based on our observations and the data shown above, we feel confident that in respect of northern Namibia that

i) based on the current electricity tariffs and international LPG prices (which are going up), that grid based electricity in general is a cost effective and practical alternative to LPG energy for institutional, commercial and higher income households (dependant of course on the associated grid extension costs for the individual area/village);

ii) electricity can provide a viable alternative to households that currently depend on commercial firewood and charcoal for their energy use; particularly as the living standards will increase and equipment purchases will become more affordable;

iii) isolated photovoltaic systems can only be an alternative to electricity in very remote areas, where the distance to the grid is far too long for connections to be cost effective (it is doubtful whether solar systems would be competitive with LPG in most such cases);

iv) small diesel driven autogenerators do not provide an economic alternative to grid electricity (again; except in very remote areas far away from any possible grid connection);

v) from society's point of view, considering environmental and agricultural aspects, that electricity would in principle provide a sound alternative to the current firewood usage pattern. However, there are major financial constraints associated with such fuelswitch. (The solution lies probably in the establishment of communal, commercial or private woodlots with organised tree felling and replanting).

5.11 ECONOMIC ANALYSIS

5.11.1 Assumptions

The following assumptions are made in the economic analysis:

i) All institutional LPG users in the project area will convert to the use of electricity as and when the proposed scheme is implemented (the effective cost is more or less the same; and the supply is more dependable)

ii) The foreseen institutional development program (new health and educational facilities, etc.) will proceed regardless of whether the electrification scheme is implemented. In the absence of an implementation of an electrification programme their electricity consumption will be catered for through isolated small dieselgenerators where the effective total cost will be in the region of 70 cents/kWh.

iii) 61 % of the institutional energy demand will, with the current demand pattern, be in the form of electricity. 39 % is through the use of LPG.

iv) The effective rural tariff is currently above 18 cents/kWh (including the monthly demand charge). SWAWEK's current generation and transmission cost is approx. 6 cents/kWh. It is assumed that a realcost increase for generation entirely be passed on to the consumer through the tariff.

v) The exchange rate NOK/ZAR is 2.53.

vi) The annual operation and maintenance cost of the extended distribution (and transmission network where applicable) is estimated as 1 % of the investment cost.

5.11.2 Methodology

The economic analysis is based on the consumption forecast outlined previously in this report; at an annual growth rate of 5.5 % in demand.

No attempt has been made to produce a shadowprice for the local currency in Namibia. The country is still tightly integrated monetarily with the Republic of South Africa; although this will soon change. It is beyond the scope of this study to start calculating the effect such a monetary and economic de-linking will have on the relative cost scenario relevant for electricity development.

The quantifiable benefit side in this analysis is mainly the difference between the alternative cost of electricity (local diesel generators) and the generation and transmission cost through the (extended) SWAWEK grid. This applies to approximately 60 % of absence of electricity development probably be LPG based; for this portion the benefit is equal to the LPG price minus the same SWAWEK generation and transmission costs as above.

Currently it is difficult to calculate the opportunity cost of capital in the Namibian economy; for the same reasons as given regarding the value of currency. Currently there is only a small inflation; this could at first glance indicate a low real value of capital. However, Namibia faces major development tasks, and the potentials for economic development is there. One constraint in this process will probably be the availability of capital; one added unit of capital could probably produce a significant return in the national economy. In our base case we have assumed the opportunity cost of capital could probably produce a significant return in the national economy. In our base case we have assumed the opportunity cost of capital to be 6 %, but we have also used 8 % and 10 % respectively to test out the resultant effect in the economic analysis.

The opportunity cost has been used as the discounting factor to calculate the Net Present Value (NPV) of the 8 electrification stages proposed. (I.e. the rate that equalises present and future values/costs). A positive NPV indicates that the benefits exceed the value of the associated investment and recurrent costs; i.e. that the project is a worthwhile investment from society's point of view. A negative NPV indicates that the value of the resources consumed by the project exceeds the benefits the project creates; i.e. that society would be better off by investing the same capital in a different project.

5.11.3 Analysis

Base case

In our base case we found the following results: (5.5 % annual growth in electricity demand).

Net Present Value ('000 ZAR)

Discounting factor	Stages 1	2	3	4	5	6	7	8
6 %	2317	460	895	-1150	140	1099	3752	-958
8 %	805	-348	7	-3282	-248	736	2730	-1396
10 %	-321	-947	-652	-4850	-535	464	1960	-1716

In the Base case 6 of the 8 stages show a positive NPV. I.e. the present value of the benefits would exceed the costs associated with 6 of the proposed schemes; they would represent an efficient use of resources seen from the point of view of the national economy.

However, with higher (8 % and 10 %) discounting factors (i.e. if our assumption regarding the opportunity cost of capital is too low), only 4 and 2, respectively, of the 8 proposed schemes represent sound economic investments.

The 6.5 % growth case

In this case we have increased the assumed growth in electricity demand to 6.5 % per year over the 20 year planperiod.

The matrix changes to the following figures:

Net Present Value ('000 ZAR)

Discounting factor	Stages 1	2	3	4	5	6	7	8
6 %	3230	957	1436	187	379	1311	4344	-674
8 %	1501	30	420	-2261	-66	899	3181	-1180
10 %	218	-654	-333	-4060	-393	589	2309	-1549

In this 7 of the 8 stages represent economically viable investments; assuming a 6 % opportunity cost of capital.

Compared to the base case, with an 8 % factor 5 (6) stages (instead of 4) are viable. At a 10 % discount factor 3 (instead of 1) are economically viable investments.

The 7.5 % growth case

By increasing the annual growth in demand for electricity from 5.5 % to 7.5 %, we get the following net present values:

Net Present Value ('000 ZAR)

Discounting factor	Stages 1	2	3	4	5	6	7	8
6 %	4254	1516	2046	1694	649	1551	5010	-354
8 %	2283	456	884	-1115	139	1080	3688	-937
10 %	820	-326	24	-3177	-235	730	2700	-1361

Compared to the base case, 7 out of 8 stages (at 6 % discounting rate) are economically viable. At 8 % and 10 % respectively 6 and 4 stages would be economically viable.

The picture emerging, with improved net present values, by increasing the assumptions regarding annual growth, points to be very important features.

Timing

The longer one waits before implementing the electrification schemes, the more the demand for electricity will have grown, and the more viable the individual stage/scheme will become (if the electricity sector is considered isolated from other sectors and development consequencies).

This is demonstrated by the following tables:

By positioning the stages 8 and 4 by 5 years (i.e. to 5 years after the starting point for our forecast), the Net Present Values will be:

Net Present Value ('000 ZAR)

Discounting factor	Stage 4			Stage 8		
	Growth rates p.a.					
	5.5 %	6.5 %	7.5 %	5.5 %	6.5 %	7.5 %
6 %	-166	385	1032	2584	5185	8234
8 %	-759	-332	167	-277	1738	4092
10 %	-1197	-860	-470	-2400	-815	1027

I.e.; the question is not whether each of the proposed schemes are viable or not. The key question becomes when should they be implemented; the longer one waits the more electricity will each of the stages distribute during their 20 year lifetime, and thus the benefit of the associated investment will increase.

5.11.4 Conclusion

No firm conclusions can be drawn. There are too many assumptions and uncertainties involved to enable us to draw a very certain picture of how the economic development and demand for electricity will grow over the coming 20 years.

Our base case could be characterised as cautious since it does not take into account the emergence of major industrial, commercial or industrial schemes. Indeed, it also excludes major irrigation schemes. Some are already planned at a general level; but the location and details are not adequately known for us to locate them and quantify the effects viz the 8 stages proposed.

Experience from other parts of the world indicate that the rate of growth in demand when areas are electrified can be very high. But a precondition is always a conducive economic setting, and appropriate pricing policies.

But it could also be that we have been too optimistic regarding the implementation capacity and relative consumption of the various social infrastructural facilities envisaged as consumers of electricity in the region.

Our economic analysis exclude a very important potential benefit which for all practical purposes is impossible to quantify. The positive environmental effects could become significant if a major proportion of households during the plan period do switch from woodfuel to electricity. An added benefit would probably be that rural electrification in Namibia should be one of several factors required in order to stem urban migration; a development which is costly not only in economic but also social and political terms.

To sum it all up; in our point of view the rural electrification project, comprising the proposed 8 stages, represent socio economic sound investment to Namibia. With regard to stage 4 it should be mentioned that some costs of the main transmission have been allotted which will be beneficial to the whole northern Namibia in the future.

5.12 PROJECT IMPLEMENTATION

As previously mentioned SWAWEK is capable of undertaking projects of power distribution and transmission up to 132 kV. Transmission lines for higher voltages on steel lattice towers are contracted. It was also emphasized by MME that Namibian resources should be utilized to the best possible extent to save foreign exchange for required import of materials. This approach should also coincide with the one of most donors in question.

For these reasons turn-key contracts with foreign contractors, involving stationing of several expatriates, should be avoided.

Nevertheless, with comprehensive financial support from foreign donors and procurement in accordance with their guidelines, it is recommended to include some foreign involvement in the preparation of tender documents, tender evaluation and project follow-up.

The fact that SWAWEK for this project may deal with unknown suppliers indicates that arranging all equipment in one bid package should be advantageous to avoid coordination problems. Elements of training may also be included in this contract.

The responsibilities of the various stages in the project implementation could then be outlined as follows:

- Preparation of tender documents: SWAWEK in cooperation with consultant. This point will depend on the extent of the supply and type of equipment.

  This is to ensure that the specifications satisfy the requirement to allow foreign suppliers to be competitive as well as SWAWEK's requirements regarding compatibility with existing facilities.

- Tender evaluation: SWAWEK in cooperation with donor's representative/consultant.

- Construction works: SWAWEK.

- Program evaluation: Jointly by SWAWEK and donor's representative/consultant.

5.13 PROJECT OPERATION

5.13.1 General

As previously indicated a new legislation is now being prepared for the power subsector in Namibia. For this reason it is not yet known in detail how the future organizational structure will be. Based on the present organization and available resources the following comments could be given:

5.13.2 Technical operation

The number of skilled staff available at the Ministry of Works in the Owambo province is not sufficient for the operation of existing facilities in the Ondangwa - Oshakati area. The needs will, of course, increase when the network is being extended into rural areas in the future.

This problem was also discussed with SWAWEK and it was informed that SWAWEK is continuously training personnel for maintaining and operating its expanding network. These resources should be fully utilized. Details should be discussed between MME, SWAWEK and the donor at an early stage in the project.

Elements of training could also be included in contract(s) with supplier(s). Training could also be undertaken at utilities abroad.

5.13.3 Financial management

The situation with regard to financial management, i.e. meter reading, billing, revenue collection, etc. is similar to the one for technical operation.

CHAPTER 6. RURAL ELECTRIFICATION KAVANGO

6.1 INTRODUCTION

The MME did not present a project proposal for the Kavango province as was the case for Owambo. However, on basis of the demand forecast given in Chapter 4 a selection of rural centres have been made and a project tentatively defined. The selection of centres will, of course, need to be discussed between MME, SWAWEK and various relevant ministries prior to concluding a project or programme. However, even if the basis is more vague than for the Owambo province it is our opinion that the project concept presented gives a good illustration of structure, scope and costs for electrification of rural centres in the Kavango province.

6.2 POWER SYSTEM CONSIDERATIONS

The existing power supply to the province capital of Rundu comprises a 132 kV transmission line on steel lattice towers, presently operated at 66 kV from the Otjikoto substation near Tsumeb. Apart for additional substation facilities required for operating this transmission line at 132 kV no major investments in the national grid will be needed for supply of the Kavango province in connection with rural electrification in the range as defined in this report.

6.3 PROJECT DEFINITION

On the basis of demand forecasts as given in Chapter 4 the rural centres tentatively selected to demonstrate the scope for electrification are given in table 6.1 here below.

Table 6.1
Rural Centres Tentatively Selected for Electrification

Name	Initial energy cons. (MWh)	Initial load (kW)	Line distance from Rundu (km)
Mashari	1100	280	50
Mabushe	260	65	62
Shinguru	240	60	72
Ndonga	260	65	80
Shitembo	3600	900	100
Nyangana	2700	675	105
Ndyondo	200	50	107
Ruacara	240	60	110
Katere	200	50	115
Shinyungwe	240	60	125
Mbambi (east)	240	60	141
Mayara	240	60	145
Max Makuse	270	80	170
Shadikongoro	2100	540	180
Andara	2140	550	190
Bagami	160	40	210
Musinik	240	60	15
Ebeneser	240	60	15
Mbunza	400	100	45
Rupara	500	125	73
Musese	1800	450	85
Katare	600	150	100
Tondoro	900	225	110
Nankudu	1800	450	115
Kahenge	180	45	125
Nkurunkuru	1000	250	135
Simunga	160	40	150
Mbambi (west)	160	40	160
Total	22370	5590	

6.4 PROJECT DESCRIPTION AND COSTS

It appears that all centres in Kavango are located along the Cubango/Okavango river in direction east or west from Rundu. Reference should also be given to the map in Appendix 6.1.

With the given geographic setting electrification can be achieved by constructing one 33 kV line from Rundu to the west and another to the eastern part of the province. However, the distances from Rundu to the most remote villages along the river are very long.

Going west the distance to Nkurunkuru is about 135 km and to Mbambi about 160 km.

Going east the distance to Nyangana is about 105 km, to Andara about 190 km and to Bagami about 210 km.

Electricity supply from Rundu to remote villages at 33 kV voltage is not technically feasible due to unpermissible voltage drop and high losses. Loads during the first years are comparatively low and 33 kV supply up to about 100 km from Rundu are considered acceptable.

To the east Nyangana can be supplied. Before going as far as Andara and Bagami a 132 kV or 66 kV line should be built to some place near to Nyangana.

In the western direction there is a load concentration in the Tondoro - Nankudu areas which are about 110 - 115 km from Rundu. These distances will be too long for 33 kV. It is, however, recommended to start building a 33 kV line from Rundu. When the load is too high a 132 kV or 66 kV line should be built from Rundu to somewhere near Tondoro. This will, however, not be necessary for many years.

As a conclusion the first stage of the electrification in Kavango should be to build on 33 kV line from Rundu to Nyangana and connect the villages between, and one 33 kV to the west from Rundu to Nankudu and connect the villages between.

The more remote villages should be electrified in stage 2.

Stage 1

33 kV line Rundu-Nyangana, length approx. 105 km, "Hare" conductor	NOK 12.60 mill.
33 kV line Rundu-Nankudu, length approx. 115 km, "Hare" conductor	NOK 13.80 mill.
45 pcs. 33/0.4 kV transformers	NOK 2.25 mill.
45 pcs. 0.4 kV distr. network	NOK 2.70 mill.
Total costs Stage 1	NOK 19.35 mill.

Stage 2

33 kV line Nyangana-Bagami, length approx. 110 km, "Hare" conductor	NOK 13.20 mill.
33 kV line Nankudu - Mbumba, length approx. 45 km, "Hare" conductor	NOK 5.40 mill.
25 pcs. 33/0.4 kV transformers	NOK 1.25 mill.
25 pcs. 0.4 kV network	NOK 1.50 mill.
Total costs Stage 2	NOK 21.35 mill.

6.5 MAIN TRANSMISSION SSYSTEM

By means of voltage regulation devices it may be possible to reach even Nkurunkuru with 33 kV of the load on the line is moderate (up to 2 MW). Feeding at 132 kV into this area should therefore not be expected for many years.

To establish satisfactory delivery of electric power in the eastern part a 132/33 kV feeding point should be available somewhere near the Nyangana region. A 66 kV or 132 kV line should be built from Rundu. If the load growth is moderate a 66 kV line will be sufficient. A wooden pole 66 kV line with "Wolf" or "Hare" will be considerably cheaper than a 132 kV line on steel lattice towers. Transformer and substation costs will also be lower.

An estimate on basis of today's price level indicates the following costs:

Alternative 1

105 km 132 kV steel tower line, "Wolf" conductor	NOK 36.8 mill.
132/33 kV substation (1 pc. 132 kV bay, 4 pcs. 33 kV bays)	NOK 7.0 mill.
10 MVA 132/33 kV transformer	NOK 1.7 mill.
Total costs Alternative 1	NOK 45.5 mill.

Alternative 2

105 km 66 kV wooden pole line, "Wolf" conductor	NOK 21.0 mill.
66/33 kV substation (1 pc. 66 kV bay, 4 pcs. 33 kV bays)	NOK 6.0 mill.
10 MVA 66/33 kV transformer	NOK 1.0 mill.
Total costs Alternative 2	NOK 28.0 mill.

It should be mentioned that if the substation in Rundu at the time is operated at 132 kV, a 132/66 kV transformer is needed in Rundu. Such a transformer with accessories is not included.

As mentioned before it is not necessary to take any decisions with regard to voltage level at the stage as the need for this investment is still some years ahead.

CHAPTER 7. RURAL ELECTRIFICATION CAPRIVI

7.1 INTRODUCTION

It should be mentioned that visits to rural centres in Caprivi were not undertaken, and that the basis for the demand forecasts may be somewhat weaker than for the Owambo and Kavango provinces. The loads identified for the rural centres are also comparatively small. More detailed load forecasts should consequently be carried out prior to concluding a project.

Another important consideration is the possible supply of rural centres directly by connecting to the Zambian grid. The geographical setting should indicate that this should be considered.

We have also understood that Botswana is going to implement a rural electrification project in the near future which may involve rural centres that possibly could be supplied from Caprivi.

These two factors should also most certainly be integrated in the planning process.

Even if the basis for project definition is weak a concept for rural electrification, based on supply from Katima Mulilo, is presented to demonstrate the scope and costs for such a project with above reservations in mind.

7.2 POWER SYSTEM CONSIDERATIONS

As previously mentioned the only present power supply to the Caprivi province is the newly commissioned 10 kilometres 11 kV line from Katima substation in Zambia to the province capital of Katima Mulilo.

ZESCO in Zambia is presently planning a new 66 kV line as a replacement for the existing 11 kV line. This line will be fed from the existing 66 kV line between Livingstone and Mongo with a branch-off at Katima substation in Zambia.

According to information from SWAWEK the Zambian system will not be able to supply much more than the present peak load to Katima Mulilo of about 1 MW.

7.3 PROJECT DEFINITION

On the basis of demand forecasts as given in Chapter 4 the rural centres selected for electrification are given in table 7.1 here below.

Table 7.1
Rural Centres Tentatively Selected for Electrification

Name	Initial energy cons. (MWh)	Initial load (kW)	Distance from Katima (km)
Muyaba	160	40	43
Cincimane	160	40	63
Linyandi	100	25	80
Sangwali	280	70	130
Kasheshe	150	40	30
Sibbinda	200	50	63
Kongola	300	75	105
Bukalo	200	50	37
Ngoma	180	45	65
Lusese	280	70	65
Lisikiili	320	80	13
Kalambera	200	50	26

Reference should be given to the map in Appendix 7.1. It should also be mentioned that south-eastern part of the Caprivi province is flooded for several months each year with resulting difficult communications. Further investigations will be needed prior to concluding electrification costs in this area.

7.4 PROJECT DESCRIPTION AND COSTS

When it is decided to start electrification outside the Katima Mulilo region a line along the district road 3511 down to Linyandi may be a first stage. It is possible later on to extend this line to Sangwali.

The villages of Lisikiili and Kalambera east of Katima Mulilo are near to the existing Katima network and it may probably be more feasible to connect these to the existing network.

In the eastern part a line from Katima to Bukalo and Ngoma should be considered. Lusese can also be connected to this line.

A 33 kV line to Kongola in the western part of the region can also be built along the main road. Sibbinda and Kasheshe can also be connected.

An estimate cost for these 33 kV lines built with "Hare" conductor, 33/0.4 kV transformers and 0.4 kV distribution network is presented.

Price per km line: NOK 0.12 mill.

Price per transformer point included 33/0.4 kV transformer and 0.4 kV network: NOK 0.11 mill.

80 km 33 kV line Katima - Linyandi	NOK 9.6 mill.
10 pcs. transf. points	NOK 1.1 mill.
Total	NOK 10.7 mill.

65 km 33 kV line Katima - Ngoma	NOK 7.8 mill.
15 km 33 kV line to Lusese	NOK 1.8 mill.
8 pcs. transf. points	NOK 0.9 mill.
Total	NOK 10.5 mill.

115 km 33 kV line Katima - Sibbinda - Kongola	NOK 13.8 mill.
12 pcs. transf. points	NOK 1.3 mill.
Total	NOK 15.1 mill.

20 km 33 kV line Katima - Lisikiili - Kalambera	NOK 2.4 mill.
5 transf. points	NOK 0.6 mill.
Total	NOK 3.0 mill.

CHAPTER 8. DEVELOPMENT OF THE CUNENE WATER RESOURCES

8.1 GENERAL DESCRIPTION

The Cunene river originates in the central highlands of Angola; close to the town of Huambo. From there it flows 1100 km before it ends up in the Atlantic ocean, just south of Baia dos Tigres.

During the first 750 km the river flows in a north south direction towards Xangongo. There it turns south westerly towards Ruacana. From there on the river forms the border between Angola and Namibia.

The hydrographic basin covers an area of 106,500 km^2; of which 92,400 km^2 are on the Angola side of the border.

During the first third of its run, the river falls from an altitude of 1,600 m, to about 1,200 m in the Matala area. From there it has a slow fall for 400 km, until it reaches Calueque. Thereafter the river falls sharply, the fall is about 350 m between Calueque and just after Ruacana (a distance of about 50 km). During the remaining one third of its flow, the river falls 800 metres in an even decline. Half of the total fall (800 m out of 1,600 m) takes place after Ruacana, i.e. during the last one third of the flow; 350 km out of 1,100 km.

Cunene is joined by various other rivers. Calai and Cuando join half way between Gove and Matala, Colui and Cuculuvar between Matala and Calueque. See also map in Appendix 8.1.

8.2 STUDIES

A number of studies have been carried out in the past concerning the utilization of the Cunene water resources.

The Mixed Technical Commission established between South Africa and Portugal worked on the Cunene issue in the period 1926-28. Nothing concrete came out of this study except that one implied the need for an establishment of a new agreement between the two countries.

In 1946 a plan was presented concerning the utilisation of the Cunene Water resources (south of Matala) for power generation, agricultural and fishery purposes. This plan was based on information contained in existing studies carried out by Portuguese and South African interests. The plan suggested six hydro electric schemes, including Matala, Calueque and Ruacana in the Cunene.

In 1962 the Matala hydroelectrical development plan was made. The plan also suggested the continuation of the collection of hydro data. The plan pointed out the need/benefit of regulating the water flowing to Matala. The plan pointed out altogether 8 proposed hydropower schemes; Matala, Gove and 3 more between Gove and Matala; and 3 in the tributary rivers of Calai and Cuando. As a result of this plan, work started on the elaboration of the Gove project.

Of these hydroelectric schemes, only one has been implemented; Matala with an installed capacity of 27.2 MW. The Gove dam was mainly constructed for the regulation of water for Calueque and Ruacana. Irrigation purposes were also of importance.

Another study made available to the mission in Namibia by SWAWEK was called "Cunene Hydropower Potential" of August 1989. This report lists potentials downstream of Ruacana with special emphasis on the Epupa project. The hydrology of the Cunene river and the influence of the Gove dam on existing Ruacana power plant is also discussed.

8.3 EXISTING FACILITIES

The following existing facilities are relevant with regard to power production:

i) Ruacana Hydropower Station
Head: 158 m
Installed capacity: 240 MW

ii) Calueque Dam, on Angolan territory about 40 kms upstream of Ruacana.

iii) Matala Hydropower Plant
Installed capacity: 27 MW

iv) Gove Dam, on Angolan territory, nearly 600 kms upstream of Ruacana.

8.4 POWER PRODUCTION CONSIDERATIONS

According to the report from SWAWEK called Cunene Hydropower Potential, of August 1989, the mean annual runoff at Ruacana of the last 50 years period is estimated at 5,500 mm^3 whereas 1:20 year drought runoff is estimated at 2,100 mm^3. Maximum flows, which normally occurs in March through May, are more than 1,500 m^3/sec whereas the runoff during June through February rarely exceed 200 m^3/s, with minimum of about 50 m^3/s.

During last five years the average capacity on annual basis for Ruacana hydropower station has been about 130 MW, i.e. 55% of rated capacity. The corresponding present demand in Namibia is 180 MW and the difference is currently being covered by Van Eck thermal power station in Windhoeck and import from RSA, both of which are escalating in cost at no less than 12% per annum.

The status and operation of the Calueque and Gove dams during recent years, resulting in above production results, are not known in detail. However, the previously mentioned report on Cunene Hydropower Potential concludes that the minimum regulated flow is about 90 m^3/s with the Gove dam as the prevailing factor for maintaining flow at the level. The influence of the Calueque dam is said to be minor.

The option of maximum power production at Ruacana and related influence of Gove and Calueque dams was also investigated in above mentioned report. It was found that 1,060 GWh per year could be generated by operating Ruacana as a "run of river" power station. Regulating Gove dam for maximum power output could add 200 GWh per year, which appears to be a disappointing result, but can be explained in terms of the size of the catchment upstream of the Gove Dam.

Monthly production figures for the various power plants in the Namibian system was not available in Windhoek. The production and export/import figures given in Chapter 3, however, show that the sum of power import from RSA and thermal production at van Eck were 527 GWh and 677 GWh in 1989 and 1988, respectively, which is about 40 % of the production required for the Namibian power market. Export of occasional power to RSA during flow periods was 267 GWh and 233 GWh during the same years. As indicated in the SWAWEK study rehabilitation and optimal operation of the Gove dam for maximal power output would add about 200 GWh of firm power at Ruacana. This shows that on basis of the present Namibian power market and also assuming that the Gove dam has been rehabilitated there is a deficit of firm power in the order of 400 GWh. This is presently covered by power import from the RSA system and by thermal power based on coal imported from RSA. On basis of the unit production cost figures given in Chapter 3 of about 0.07 ZAR/kWh the corresponding foreign exchange requirements are in the order of ZAR 30 million. This figure will, of course, increase rapidly with a growing Namibian power market.

Taking the implementation time for development of hydropower schemes into consideration it is obvious that project planning should commence as soon as possible.

8.5 CONTRACTUAL POSITION

The colonial powers of South Africa and Portugal entered 1964 into an agreement concerning the utilisation of the hydroresource in the Cunene. This agreement was augmented in 1969.

The agreement covers the Gove dam, Ruacana and Matala power stations, and the Calueque dam with irrigation in Namibia. The agreements sets out rights and obligations, and the terms payable by the two parties including for the construction and benefits of the Gove dam.

Development of projects at the common border downstream of Ruacana will require a bilateral agreement. SWAWEK indicated that this might be arranged by an addendum to the existing agreement whereas Angolan official claimed that its terms and conditions were no longer appropriate, and consequently that the whole agreement had to be reworked.

Angolan officials also informed that a new Mixed Commission with representatives from the Governments of Angola and Namibia is under formation to discuss the Cunene water resources. The commission will look into all aspects; including water both for power generation and agricultural and domestic purposes.

8.6 REGIONAL CONSIDERATIONS

The Government of Angola is in the midst of the implementation of the Capanda hydropower scheme; east of Luanda. The ultimate capacity of the plant will be 520 MW (4 x 130 MW). Our most recent information indicate that in the first phase 260 MW will be installed; possibly by 1992.

Several studies have been carried out (by the Belgian BEP, the Brazilian THEMAG and the ESMAP mission) concerning the power and energy requirements of the northern electrical system in Angola, to which the Capanda scheme would belong. The most optimistic of the three forecasts mentioned (THEMAG) indicate a requirement of an additional power need of around 200 MW compared to power available power today. The least optimistic (ESMAP) indicates an additional requirement of 70 MW compared to power currently available.

The Capanda power could therefore become partly unnecessary for a number of years, unless new major power intensive industries are established in the area; none is currently envisaged.

It will therefore be in the interest of the Angolan Government to find demand for the Capanda capacity in other locations. The central and southern systems will probably be adequately served by their currently installed capacities for a number of years.

Angola will therefore be interested in turning to Namibia to offload some of its surplus Capanda capacity. It has been suggested to construct a line straight south from Capanda to Namibia, at a cost in the order of USD 150 million.

In theory the power thus available to Namibia from Capanda could be in the region of 200 MW to 500 MW.

There are, however, certain outstanding issues related to supplying Namibia from Capanda.

The distance from Capanda to the Namibian border is more than 800 kilometres. An A.C. connection of this distance, connecting the Namibian grid with the northern system in Angola might cause problems including system stability. Another option could be a D.C. connection. This would, however, require costly AC-DC converters in each end and also at the connecting points to the other systems in Angola, if these should be interconnected.

The economics of the solution might not be all that favourable either. The World Bank estimates the LRMC of the Capanda scheme to be in the order of 0.33 USD/kWh; based on the envisaged firm power capacity. In addition would come the cost of transmission to Namibia. The Capanda energy would thus be very expensive in absolute terms. If the Angolan Government was to charge economic prices for Capanda energy supplied to Namibia, there is a high probability that the unit price would grossly exceed whatever options that are open to Namibia. However, if Angola would consider Capanda as a sunk cost, they might be willing to negotiate a lower than economic price in order to get as much revenue as possible from their major hydro investment.

8.7 OPTIONS DOWNSTREAM OF RUACANA

The previously mentioned SWAWEK report lists 8 potentials downstream of Ruacana. It is on the basis of preliminary engineering concluded that Epupa is the most feasible project.

The project described in the SWAWEK report envisages a concrete dam of about 120 m height and a volume of approximately 1 million m^3. This will give a storage capacity of 5,000 m^3 and an annual power production of about 1,600 GWh with an installed capacity of about 400-500 MW.

According to SWAWEK Epupa is definitively the best site and further studies with the objective of ranking sites should not be necessary. SWAWEK also means that the hydrology is fairly well studied and that they are capable of undertaking power market analysis and economic evaluation by their own resources.

They will, however, need assistance in all other facets of hydropower planning and design. The next step should consequently be a feasibility study, for which Terms of Reference should be worked out in collaboration with SWAWEK.

As such a study will require access also to Angolan territory a bilateral agreement between Angola and Namibia will be required.

8.8 CONCLUSIONS

From the Namibian power market point of view it is obvious that additional generating capacity, based on comparatively cheap hydropower, is required. Even with the Gove dam rehabilitated nearly one third of the possible energy produced from the Epupa project would be needed to replace thermal power or coal imported from RSA based on present Namibian needs.

Epupa has been identified as a promising site and a concept based on preliminary engineering has been worked out. A full feasibility study, for which Terms of Reference should be worked out in collaboration with SWAWEK, is recommended. Norwegian expertise is most appropriate for this assignment.

Development of Epupa will require a bilateral agreement between Angola and Namibia. Angola has so far been reluctant to enter into such an agreement. One reason may be that the country itself in the future will have excess of power from the Capanda project, the first stage of which is envisaged to be implemented in 1992. Export of power to Namibia will, however, require transmission facilities for which both technical feasibility and economic viability would need further perusal.

It might therefore be appropriate to undertake a brief assessment of technical and economic characteristics of interconnecting the two systems. The scope for such an assessment could be:

- Collect necessary data from the power systems in Angola and Namibia required for system analysis.

- Evaluate various technical alternatives of power transmission from Capanda to the Namibian grid with regard to technical feasibility, including system stability, and costs. Assessment of cost should be at prefeasibility level.

- Assess power production and costs of development of the Epupa hydropower project at prefeasibility level.

- Evaluate technical feasibility and economic viability of power transmission from Capanda in view of supplying the Namibian power market from Epupa.

CHAPTER 9. OPTIONS FOR NORWEGIAN TECHNICAL ASSISTANCE

9.1 INTRODUCTION

As indicated in the Terms of Reference the mission should, in addition to rural electrification and development of the Cunene water resources, also look at other issues and possibilities of Norwegian assistance to the electricity subsector. These are elaborated in this chapter.

9.2 LEGISLATION

As explained in Chapter 3, Namibian authorities are now in the process of establishing a new legislation for the electricity subsector.

In the final meeting 17th August, 1990, between the Ministry of Mines and Energy and the Delegation, the Ministry requested professional assistance from Norway during the process of drafting the new legislation for the electricity subsector.

An assignment on the above matter may include the following scope of work:

1. Identify the various aspects of political, social, organizational, economic and technical nature a new electricity act should contain.

2. Verify and substantiate the above through collection of essential data, and through discussions with the MME and other Namibian authorities that might contribute.

3. Evaluate and compile relevant material from existing legislation that have or might have bearing in connection with a new electricity act.

4. Eventually scrutinize existing policy documents and drafts on the subject, in order to advise on changes and supplements.

5. Elaborate a proposal for a legislative document concluding in a draft of an "Electricity Act" with any appurtenant "Regulations" deemed necessary.

9.3 TARIFFS

The current tariff structure in Namibia is probably not adequate in view of the LRM generating costs facing the electricity subsector, and in view of the Government drive for rural electrification.

It is therefore suggested that the tariff structure is assessed with the objective of drafting a new pricing structure (consumption tariff and associated costs) which takes LRMC into consideration, and is as conducive as possible for rural electrification and consumption.

Elements to be considered in this context would include:

1) The identification of probable future costs for generation, transmission and distribution.

2) The costs (and organisation of) consumer connections, and individual housing reticulation.

3) Consumer affordability and willingness to pay.

4) Suggestions as to financing schemes for potential rural electricity consumers: schemes such as revolving funds, including reticulation in the Government housing subsidy, loans for connection/reticulation from banks, SWAWEK, etc.

I.e. the objective is to design a pricing structure, covering all the facets facing the potential rural consumer, which will be conducive to promote and facilitate rural electrification.

9.4 URBAN ELECTRIFICATION

Currently only part of the high density peri-urban areas benefit from electrification. There are obvious negative results of this in the form of high woodfuel consumption with negative environmental effects, lower standard of living, high energy costs, etc.

It is suggested that one assesses the demand for peri urban electricity based on:

1) A departure in the current energy consumption pattern, and

2) the associated financial, economic and environmental costs

3) Estimating the affordability and willingness to pay for electricity in the same area

4) Demand projections for the peri-urban areas for the coming 10 year period

5) A suggested peri-urban electrification program; including also factors as investment costs, revenues, and resultant effect on the overall system and viz SWAWEK's capacity and organisation.

9.5 SOCIO ECONOMIC DATA BASE

One of the problems encountered in connection with this planning study, has been the lack of socio economic information for the rural areas, and the lack of empirical experience in Namibia concerning rural electrification.

It is therefore suggested that one urgently establishes a socio economic base line survey in the key areas to be covered by the rural electrification project. Mapping out the situation before electrification will make it possible to measure the effects after the introduction of electricity to the project area.

The objectives would be to enable better planning and design of electrification programmes for other areas (and indeed the later stages) under this project. An up front base line survey would facilitate a regular evaluation of rural electrification in Namibia, and help set the future course in this respect. The survey would also have important use for infrastructural programmes in other sectors in the same (type of) areas (i.e. water, roads, health development, etc.).

9.6 COORDINATION AND PREPARATION OF PROJECTS

Since independence both bilateral donors and international lending institutions have paid considerable interest to Namibia. This also prevails for the electricity subsector and will, of course, contribute to its development.

To achieve the best possible benefit of this interest it is, however, important that MME is active with regard to project coordination and preparation. It might, for example, be possible that also projects within the electricity subsector in former black homelands or even low-income peri-urban areas could be considered for soft term financing from the World Bank or the African Development Bank. There could be scope for technical assistance to MME with the objective of promoting projects in this field.

9.7 GENERAL TECHNICAL ASSISTANCE TO MME

The present number and practical experience of the professional staff in MME working specifically with the electricity subsector are limited. A strengthening is required both with regard to dealing with international institutions and companies as well as with authorities within Namibia.

Technical assistance either on short-term or on a more permanent basis may help and improve the situation. Visits by MME staff to Norway may also be considered.

LIST OF APPENDICES

Appendix 1.1

Terms of Reference for the mission

Terms of Reference

for

NORAD Mission to Namibia

in connection with

Norwegian Technical Assistance

to

the Electricity Sub-Sector

I BACKGROUND

With reference to NORAD's letter of 30 May 90 and letter of 4 June 1990 from the Republic of Namibia, represented by the Ministry of Mines and Energy (MME), NORAD is sending a mission to Namibia during weeks 32 and 33, 1990 for technical assistance in the electricity sub-sector.

II OBJECTIVES

As agreed by MME and NORAD the objectives should be as follows:

1. Define priorities with regard to rural electrification in collaboration with relevant Namibian authorities. Specific emphasis should be given to northern Namibia, but other areas should also be considered.

2. Evaluate existing plans and define future needs for technical assistance with regard to the joint Angolan/Namibian development of the Cunene water resources.

3. Be prepared to discuss, evaluate and give advice to the general development of the electricity sub-sector in Namibia.

III ORGANIZATION

The visit will be organized through MME with SWAWEK actively participating.

The Norwegian team will be composed as follows:

Mr. S. Grongstad:	Power system engineer/team leader
Mr. T. Westeren:	Power engineer/consultant team leader
Mr. E. Nordrik:	Transmission engineer
Ms. I. Endresen:	Socio-economist
Mr. B. Sebetela:	Energy engineer

IV SCOPE OF WORK

<u>1. Rural electrification</u>

With regard to rural electrification in the northern part of Namibia the following should be undertaken:

- On the basis of readily available information, give a summary description of present use of energy.

- Give a description of existing facilities for power generation, transmission and distribution.

- Give a description of past and present use of electricity and evaluate future needs.

- Discuss and evaluate specific electrification projects proposed by Namibian authorities. Priority projects should be recommended and outlined as follows:

    - Brief socio-economic description of the project area.

    - Indication of the number of consumers to be served.

    - Estimate of future electricity consumption.

    - Brief project description, including all relevant major components required to reach the end consumer. Possible alternative sources of generation should be discussed.

    - Indication of project costs, both foreign exchange and local currency costs.

    - Recommendations regarding project implementation and organization.

    - Project justification, including estimate of future electricity sales, discussion of alternatives and indication cf benefits, both quantitative and additional.

The team shall also be prepared to discuss rural electrification issues in other Namibian areas with MME and SWAWEK.

2. Development of the Cunene water resources

With regard to future development of joint Angolan/Namibian projects on the Cunene river the following should be undertaken:

- Review and evaluate existing development plans, project documents, etc.

- Assess needs for Norwegian expertise in relation to possible future planning and design activities in collaboration with Namibian authorities.

3. General development of the electricity sub-sector

With regard to the general development of the electricity sub-sector in Namibia the team should be prepared to:

- Discuss and evaluate existing development plans not included in items 1 and 2, and possibly give advice to MME/SWAWEK.

- Inform about Norwegian goods and services that could be relevant to the electricity sub-sector in Namibia.

4. Recommendations to MME/SWAWEK and NORAD

The team shall give recommendations to MME/SWAWEK and NORAD concerning future Norwegian technical assistance to the electricity sub-sector.

V REPORTING

A report shall be submitted within six weeks after return to Norway.

Oslo, July 1990

Kjell Storløkken
Director, Africa Division

Appendix 2.1

Tentative itinerary for the mission

PROPOSED ITINERARY BY THE MINISTER OF MINES AND ENERGY FOR THE FACT FINDING MISSION TO NORTHERN, NORTHWESTERN AND NORTHEASTERN RURAL AREAS TO BE ELECTRIFIED

Monday, 6th August 1990

7.00 hrs	Departure by road from Windhoek
14.00 hrs	Assembling time at Oshivelo (Namutoni)
14.15 hrs	Departure in convoy to Okatope, Onyaanya, Okankolo, Onayena, Ontananga and Olukonda
19.30 hrs	Arrival at Ondangwa

Tuesday, 7th August 1990

7.00 hrs	Departure from Ondangwa
7.40 hrs	Arrival at Oshakati
8.00 hrs	Meeting with community leaders
9.30 hrs	Departure to Oshikuku
10.15 hrs	Departure from Oshikuku - Ogongo
11.20 hrs	Departure from Ogongo to Ongandjera
12.00 hrs	Arrival at Ongandjera
12.30 hrs	Meeting community leaders
14.00 hrs	Departure to Tsandi
14.20 hrs	Arrival at Tsandi
15.15 hrs	Departure to Onesi
15.40 hrs	Arrival to Onesi
16.00 hrs	Departure to Eunda, Oliva, Ruacana
18.00 hrs	Arrival at Ruacana hydro-power station
	Overnight at Ruacana rest camp

Wednesday, 8th August 1990

7.00 hrs	Departure to Ombalantu
8.00 hrs	Meeting with community leaders
10.00 hrs	Departure Nakayale, Anamulenge and Okalongo
12.15 hrs	Arrival at Omungwelume
12.45 hrs	Departure to Ongenga
13.00 hrs	Arrival
13.30 hrs	Departure to Engela (± 30 km)
14.30 hrs	Departure from Engela to Oshikango, Odiibo, Edundja
15.30 hrs	Departure to Ohangwena
16.00 hrs	Meeting with the community leaders
17.15 hrs	Departure to Okatope, Ondombe, Ondangwa
19.00 hrs	Arrival at Ondangwa for overnight

Thursday, 9th August 1990

7.00 hrs	Departure to Oniipa
7.45 hrs	Meeting with community leaders
9.15 hrs	Departure to Oshigambo
10.30 hrs	Departure to Eenhana (± 55 km)
11.30 hrs	Arrival
12.30 hrs	Departure to Rundu
20.00 hrs	Meeting the community leaders
	Further programme will then be drawn up for the places to be visited on the 10th August 1990

Friday, 10th August 1990

Places in Kavango to be visited. Afternoon - departure to Katima Mulilo.

<u>Saturday, 11th August 1990</u>

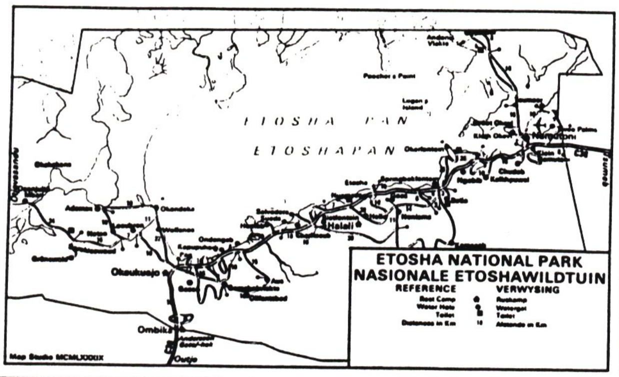
8.00 hrs	Meeting community leaders
10.30 hrs	Departure to places identified for electrification

<u>Sunday 12th August 1990</u>

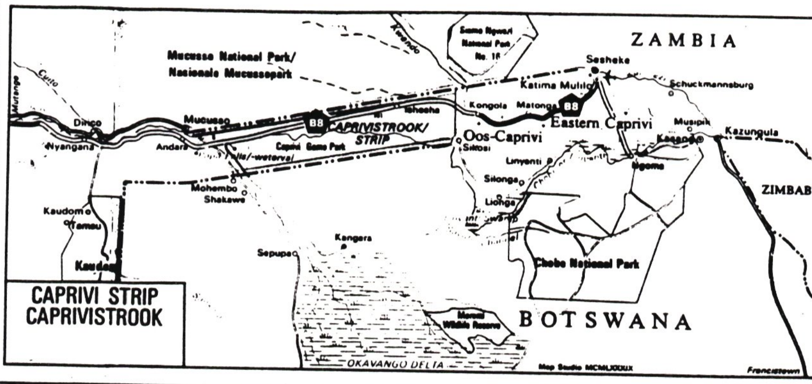
7.00 hrs	Departure to Windhoek

Appendix 2.2

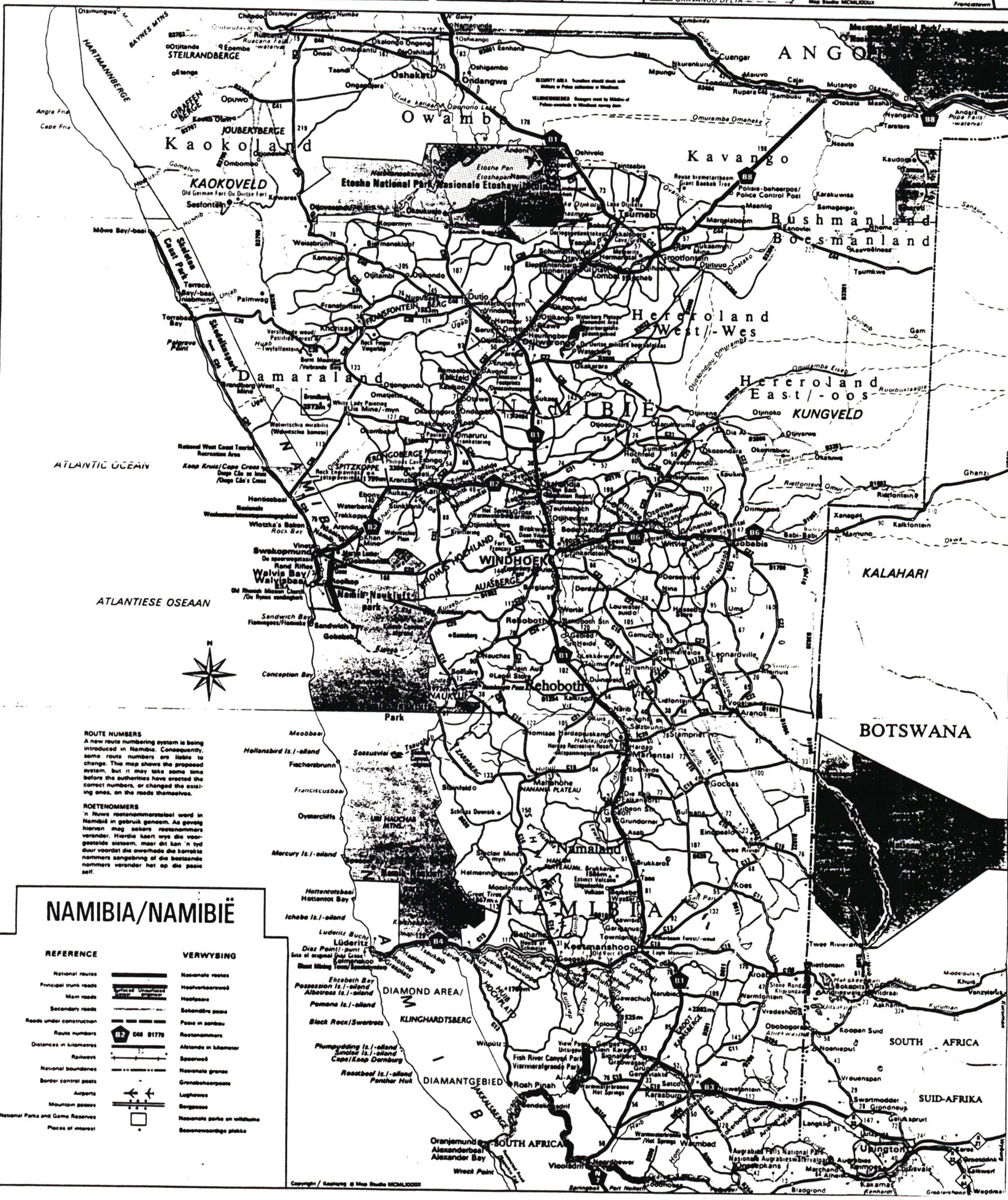
Map of Namibia



ETOSHA PAN
ETOSHAPAN
Okaukuejo
Halali
Namutoni
Outjo
ETOSHA NATIONAL PARK
NASIONALE ETOSHAWILDTUIN
REFERENCE
VERWYSING
Map Studio MCMLXXXIX



ZAMBIA
Mucusso National Park/
Nasionale Mucussopark
Sesheke
Katima Mulilo
Eastern Caprivi
Oos-Caprivi
Kazungula
ZIMBABWE
Chobe National Park
CAPRIVI STRIP
CAPRIVISTROOK
BOTSWANA
OKAVANGO DELTA
Map Studio MCMLXXXIX



ANGOLA
Owambo
Kaokoland
KAOKOVELD
Kavango
Bushmanland
Boesmanland
Etosha National Park/Nasionale Etoshawildtuin
Hereroland
West/-Wes
Hereroland
East/-oos
KUNGVELD
Damaraland
NAMIBIË
ATLANTIC OCEAN
ATLANTIESE OSEAAN
Skeleton Coast Park
Swakopmund
Walvis Bay/
Walvisbaai
WINDHOEK
Rehoboth
KALAHARI
BOTSWANA
Namaland
NAMIBIA
Keetmanshoop
Lüderitz
DIAMOND AREA/
DIAMANTGEBIED
SOUTH AFRICA
SUID-AFRIKA
Upington
ROUTE NUMBERS
A new route numbering system is being introduced in Namibia. Consequently, some route numbers are liable to change. This map shows the proposed system, but it may take some time before the authorities have erected the correct numbers, or changed the existing ones, on the roads themselves.
ROETENOMMERS
'n Nuwe roetenommerstelsel word in Namibië in gebruik geneem. As gevolg hiervan mag sekere roetenommers verander. Hierdie kaart wys die voorgestelde stelsel, maar dit kan 'n tyd duur voordat die owerhede die korrekte nommers aangebring of die bestaande nommers verander het op die paaie self.
NAMIBIA/NAMIBIË
REFERENCE
VERWYSING
National routes
Nasionale roetes
Main roads
Hoofpaaie
Secondary roads
Sekondêre paaie
Roads under construction
Paaie in aanbou
Route numbers
Roetenommers
Distances in kilometres
Afstande in kilometer
Railways
Spoorweë
National boundaries
Nasionale grense
Border control posts
Grensbeheerposte
Airports
Lughawens
Mountain passes
Bergpasse
National Parks and Game Reserves
Nasionale parke en wildtuine
Places of interest
Besienswaardige plekke
Copyright / Kopiereg © Map Studio MCMLXXXIX

Appendix 2.3

Summary description of each location visited

SUMMARY DESCRIPTION OF LOCATIONS VISITED IN OWAMBO AND KAVANGO PROVINCES

OWAMBO 6-11 AUGUST, 1990

1. OSHIVELO

The Norad Mission met the Deputy Minister of Mines & Energy, Mr. Helmut Angula. The group then inspected the 66KV/22KV substation.

2. KING KAULOMA RESETTLEMENT CAMP

About 18 km from Oshivelo towards Ondangwa. The Camp is a former SADF base and was prior independence supplied with power through a 22KV line from Oshivelo. The transformer and all power reticulation works were destroyed by the SADF before their departure.

The Camp is being used to accommodate returnees and will be developed to provide primary education, health, and other services.

3. OKATOPE

A former SADF Army Camp. The Camp is supplied with an 11 KV line from a 66KV/11KV substation.

There are 2 primary schools in the village and 2 others about 5-10 km. There are also some 2 clinics in the same area. No electricity. The clinics use gas for refrigeration.

Population (Radius 0-15km) = 15,000.

Other:

a) Commerce - Several Cuca shops, at least 10-15. They use LPG and paraffin for refrigeration and lighting.

b) Domestic Sector: Plots are scattered, houses are traditional and made of timber and grass.

Subdivision of households by visual inspection:

Traditional households - 90%
Modern households - 10%

High cost

The domestic sector rely on wood, straws, cowdung, palm kernels for cooking. Very few people indeed use paraffin and gas. Candles and paraffin are used for lighting.

c) The environment - Simply barren. There are very few trees, and straws from millet are the main energy source. Water supply very poor.

d) Potential for electricity use: Commercial sector, supermarkets, etc. and clinics.

4. ONYAANYA

Served with electricity from Okatope (HKV).

Population: 10-15,000 (15 km radius)

Facilities:

Schools: 3 primary schools (1200 students)
1 secondary school (830 students)
(Secondary school electrified)

Health : Clinic - no electricity. Gas for refrigeration.

Employment: Subsistence farming main economic activity.

Commerce : Large wholesale, and 3 large shops, as well as several Cuca shops. Gas, paraffin, and diesel generators are used for refrigeration.

Domestic Sector: As for Okatope. Water supply very poor.

Environment: As for Okatope.

5. OKANKOLO (35 km from main road to the East)

Population: 15-20,000 (15 km radius)

Facilities:

Schools: Primary school (550), there is another some 30 km away. (No electricity)

Health: Mission clinic (gas)

Commerce: Mainly Cuca shops scattered some 3-5 km apart. No large shops.

Employment: Subsistence farming.

Domestic Sector: Households 100% traditional and separated by several km's. Cooking mainly by woodfuel.

Water: Poor Supply

Environment: Good grass and tree cover.

Roads & Telephones: Bad roads, no phones.

Potential for electricity use - Very low indeed.

6. ONAYENA (15 km from main road East)

Population: 15-20,000

Facilities:

Schools: Primary school (700). No power.
Secondary school (1200) on 80 KW (100 KVA) generator.

Health: Large clinic with 4 beds and maternity. Treats 7000 patients per month. Uses gas for refrigeration.

Commerce: Several large shops and a concentration of Cuca shops.

Water: Poor supply.

Domestic: As for Okatope.

Fuelwood costs about R0.20 per kg.

Roads & Phones: Good services.

7. ONDANGWA - Rested.

<u>7-11 AUGUST</u>

8. OKAHAO (Ondandjera District). 17 km from Oshakati West. This is the centre of the district.

Population: 15-20,000.

Facilities:

Schools: 2 primary schools (900). No power
2 secondary schools (1500) supplied with power from central diesel generators. Both schools are on power supply for 20 hrs. per day. Cooking mainly gas. No hot water - Solar system not working.

There are other primary schools in the district.

Health: 60 bed hospital, treats 8000-10000 per month. Power from central diesel generators for 24 hrs. Cooking - mainly gas. Solar system not working.

Police & Tribal Admin. - no power.

There are 3 other clinics some 15-30 km away.

Parish: 11,000 members, Lutheran. They run a resettlement camp with 200 children at school. Power from central diesel generators. Cooking is mainly gas. No hot water.

Water: Poor supply. Small water treatment plant 1.5KVA which operates for about 10 hrs on diesel.

Domestic Sector: Okahao is a modern village with several modern houses. The hospital, schools and the Parish have several high cost houses. Sub-division of households.

Traditional - 75%
Modern - 25%

Wood is very scarce. Straw and cowdung are the main energy sources for most people. Paraffin and candles used for lighting. It was reported that villagers travel 5-7 km to collect wood.

Environment: Devastated. There are very few trees indeed. In fact there are no trees, just shrubs about a metre high. Grass is also very sparse.

Commercial Sector:
Very well developed. There are several wholesales and supermarkets on stand alone generators. Many Cuca shops too using gas and paraffin for refrigeration.

Roads, Phone and Postal Services: Good.

Potential for electricity use: Vast given the fact that Okahao is the district centre for Ondandjera. District administration, education.

Police, commercial sector are all potential users. There are also several private houses which will benefit from power supply.

Central generator capacity - 500 KVA (2x250 KVA)

Operating at a load of 150 KW at a load factor of 40-50%. Diesel use: 20,000 l per month.

9. TSANDI: 73 km from Oshakati West. Capital village of the Uukwaludhi District. District has population = 70,000.

Schools: Primary - 2 (900). No power.
Secondary - 2 (850). Supplied with power from central diesel generator (24 hrs).

There are 25 primary schools 15 km from Tsandi.

Cooking: Both gas and electricity used. One school uses 100% electricity and the other 100% gas (480 kg per month). Hot water - Solar system working but not sufficient.

Health: One 60 bed hospital, supplied from central diesel generator.

Cooking: Gas and electricity, hot water - Solar system not working.

Water: Not good. Small water treatment plant 1.5 KVA. Runs on diesel 10 hrs per day.

Domestic Sector:
As for Okahao. Wood situation is better. Villager walk about 2-3 km to collect wood. The village itself is barren. Private households have applied for power connection.

Commercial Sector:
As for Okahao. Some shops have even connected to the central power supply.

Roads, Phones, Postal Services - Good.

Potential for electricity - as for Okahao.

Installed diesel capacity 2 x 250 KVA
1 x 80 KVA

Consumes 20,000 l per month. Load of 150 KW at 40-50% load factor. Both Okahao and Tsandi have tribal admin. offices.

10. ONESI - Uukwaludhi (28 km from Tsandi North-West).

Population: 40,000 (15 km radius)

Schools: Primary school - 1 in Onesi and 25 others in the area. No power. Primary school population about 7000.

Secondary schools; 1 (700) supplied with power from own diesel plant. Also provides power to clinic (20 hrs).

Cooking: Mainly electricity and wood.

Hot water: Nothing

Water: Not good, small plant 1.5 KVA running on diesel 10 hrs per day.

Commerce: 3 main shops and several Cuca shops on both diesel and gas/paraffin for refrigeration and lighting.

Domestic Sector: Sub-division:

Traditional - 85%
Modern - 15%

Woodfuel relatively better than in most parts of Owambo. Candles and paraffin used for lighting. Main economic activity is subsistence farming.

Health: Clinic with 2 staff houses, treats 700-800 patients per month. There is another 10 km away.

General: Tribal admin. office and education inspectors' office and house, garages and filling stations.

Environment: Good grass and tree cover.

Roads: Good

Postoffice: No

Phones: Yes

Installed generation at Secondary school

2 x 180 KVA
1 x 73 KVA load of 100 KW at 30-40% load factor - diesel = 15000 l per month

Potential for electricity. The village serves a large population. The potential for new public services such as secondary schools, hospitals, police, etc. and the commercial sector development is high.

11. OUTAPI (Capital village of Umbalantu, 1.5 km South of Ruacana - Oshakati road)

Population (District): 80,000

Schools: Primary: 4 in Outapi and 24 outside. With about 9000 students, no power.

Secondary: 1 (820) own diesel, cooking - gas = 480 kg per month, diesel = 10,000 l per month.

Hot water: Nothing. Teacher's quarters supplied with electricity.

Health: 1 hospital 90 beds (maximum admitted to date 210 patients). 400 patients per day, cooking is gas (720 kg per month), solar system not working.

Own diesel, 24 hrs per day, 2 x 150 KVA
1 x 125 KVA at load of 100 KW at load factor of 50-60%.

Diesel use about 20,000 l per month.

There are 2 other clinics in the district.

General: Vocational Training Centre 6 km away, Tribal office, garage, filling station.

Commerce: Very well developed. Several wholesalers and supermarkets using stand alone generators of about 15 KVA operating 0800-2000 hrs. Numerous Cuca shops on gas, diesel and paraffin.

Domestic Sector:
Households, sub-division as for Tsandi and Okahao. Subsistence farming main activity. Woodfuel main energy source for traditional houses.

Water: Not good. Small water plant 1.5 KVA using diesel engine 10 hrs per day.

Roads, Phones, Postal Services: Good.

Environment: Relatively good. Woodfuel is still scarce though.

Potential for electricity use - as for Okahao and Tsandi. Furthermore, there are several villages close to Outapi with several public facilities.

12. NAKAYALE (3 km from Outapi South)

Parish Mission which houses a clinic and centre for the disabled (69). Own diesel plant of 1 machine.

Cooking: Gas

Hot water: Nothing. The Complex has over 15 modern houses which can be electrified.

Nakayale can be connected to mains power from Outapi via 22 KV line: Several good houses and shops.

13. ANAMULENGE - A (3 km from Outapi North).

Parish Mission - Large centre with over 25 modern houses. Offers clinic, 3 primary schools (1200). Power requirement 70 KW. They have own diesel which runs 6 hrs per day. Diesel use 1000 l per day.

Also houses 200 returnees and 40 handicapped people.

Several modern houses and large shops.

Water: Main problem.

Woodfuel: Villagers walk 3-5 km to collect firewood.

Could be electrified from Outapi.

14. ELIM - UKWAMBE

Population: 3.000.

Schools: Secondary (700 - 150 day students). No power. Use mainly firewood for cooking, and gas for lighting. Use 12 ?? per month of wood. The wood is collected on contract at a price of R350/3t. The wood is collected some 60-90 km away. There is no wood at all in Elim. Villagers use cowdung and straws while those who have money buy wood.

Parish: Runs clinic, primary school. Has own diesel for clinic and Mission houses.

Domestic Sector:
Very few modern houses indeed. Most houses traditional. Subsistence farming main activity.

Commerce: Several Cuca shops and a few main shops.

Electricity Potential: Parish Mission and secondary school.

Water: Poor supply. Local reservoir on 1.5 KVA diesel pump running about 10 hrs per day.

15. OSHIKUKU - UKWAMBE (Very close to main road but 145 km from Ruacana).

Parish Mission: Hospital - 313 beds, 60,000 patients per year.

Church

Primary schools: 2

Secondary school: 1

Nursing school

Cooking: Gas and electricity

Solar system not working.

Water: From Ruacana. Local water reservoir with diesel pump (1.5 KVA)

Own diesel generators:
About 400 KVA with load of 200 KW at load factor of 40-60% 24 hrs operation. Diesel use 26-30,000 l per month.

Commerce: Developed. Several large shops and many Cuca shops, garage and filling stations.

Domestic Sector:
Several large modern houses about 20-25%.

16. OKALONGA - VUKWANYAMA

A very small settlement with clinic treating 6-70 patients per day, using gas (96 kg per month) for refrigeration.

Primary School

Church

Very poorly developed, no phones, bad roads. Almost 100% traditional houses. Very few shops.

Water: Main problem.

Electricity Potential: Very poor.

17. OMUNGWELUME - Headquarters of Vukwanyama District.

Population: 45,000

Schools: Primary - 2 (800)

Secondary - 1 (1000) and several staff houses. Own power, 2 x 108 KVA with load of 50 KW at 30% load factor for 8 hrs per day, diesel 7000 l per month, cooking - gas 480 kg per month. Solar system not working.

Tribal Office: No police

Commerce: 3 medium shops and several Cuca shops.

Domestic Sector:
About 100 modern houses in the village. The rest are traditional. Tree and grass cover good but firewood still a big problem. Subsistence farming main pastime.

Health: Clinic - gas for refrigeration (96 kg per month).

Energy prices:
Candle 50c each
Gas R2.00 per kg.
Paraffin 90c per litre
Wood 12-25c per kg.

Electricity potential: Good.

18. ONGENGA

Small settlement.

Church: 8000 members

2 primary schools (1000)

Clinic (96 kg per month) gas

About 25 modern houses

Water: Serious shortage.

Good tree and grass cover. The community live on subsistence farming.

Electricity potential: No (Solar)

19. ENDOLA

Clinic (96 kg per month, gas) 400 patients per day, 4 beds.

Primary school.

No trees and grass cover. The settlement is very primitive indeed. Several houses (10) are modern but like in the other villages they are scattered.

Electricity potential: Very low (Solar).

20. OKATANA

Parish Mission: Connected to Swawek power with diesel standby.

Hospital: 63 beds

Primary school: No power

Secondary school

Cooking and Water Heating: Electricity

Other services: Water Department - connected power.

A modern settlement with several large shops and houses. One shop owner has connected his shop to power.

21. ONGHA - 20 km from Ondangwa along road to Oshinga.

Secondary school - 400, cooking and hot water - all electrical. Own diesel, 50 KVA, 9-1/2 hrs per day, 5000 l per month diesel.

Primary schools - 42 in the district (1 in Ongha)

Phones: Good

Roads : Good

Clinic: No power, 96 kg per month - gas.

Domestic/Commerce:
A modern settlement with some large shops and several modern houses albeit scattered.

22. OHALUSHU (UUKWANYAMA)

Clinic: 48 kg per month - gas

Church: 9000 members

Very small settlement indeed. Almost 100% traditional settlement.

23. ONEKWAYA - UUKWANYAMA

Small settlement.

Secondary school - 175, use gas and wood for cooking, school wired but diesel not connected yet (8 KVA). Also runs a small Craft centre.

Primary school - (700), no power.

Electricity potential: Poor (Solar)

24. ENGELA (3 km from Road to Oshikanga)

Parish complex: Own diesel (178 KVA, 20 hrs per day, 6000 l per month)

Hospital: 202 beds

Primary school

50 modern houses

Energy costs: Paraffin - R0.69
Diesel - R1.20

A modern settlement with several modern houses, garages, filling stations and large shops.

Domestic sector: Good tree and grass cover.

Wood supply is relatively good. Straws still used though.

Electricity potential: Good.

25. ODIBO

Parish complex: Similar to Oshikuku. It was destroyed during the war. It is being renovated and is due to start operations in January 1991 and will include mechanical workshop for welding, carpentry, etc. in addition to hospital and secondary school.

Church has over 20,000 members.

Church operates a small generator 2-1/2 hrs per day. The old diesel plant was destroyed during the war.

Apart from the Mission the settlement is traditional and very poor.

Water: Main problem.

Environment: Devastated. Straws and cowdung used for wood.

Electricity potential: Poor (Solar)

26. EDUNJA

Primary school (500)

Clinic (48 kg per month gas for cooking)

Church

Traditional community. No wood at all. They rely on straws and cowdung. Almost 100% traditional.

27. OKATOPE - UUKWANYAMA

Traditional community.

Clinic: No fridge

Primary school

Church: 6,500 members

Water: Poor supply

Good roads, no phones

Electricity potential: Poor (Solar)

28. OKAKU - Small location.

Church: 8-10,000 members

Clinic: (48 kg per month gas for cooking)

Primary school

Water: Big problem

Traditional houses with few modern houses scattered

Electricity potential: Low (Solar application)

29. EHEKE (Traditional Community)

Church: 8-10,000 members

Clinic: (96 kg per month gas for cooking)

Primary schools: 2

Water: Main problem

15-20 modern houses scattered

Woodfuel scarce.

Electricity potential: Poor (Solar)

Several Cuca shops using gas and paraffin for refrigeration)

30. ONDOPE (Traditional Community)

Clinic: (48 kg per month for cooking)

Primary school: 1 but 15 in the area

Std. 8 & 10 - part time classes (160)

Very few modern houses. Barren village, no trees. Straws and cowdung used for cooking.

31. ONDANGWA - Oluno Secondary School

Electrified - 11.000 students

Water heating - Solar, not working

Cooking - electrical

School does not receive bills for power.

32. OSHIGAMBO

Modern settlement with modern houses and developed commercial sector.

Secondary school (204) own diesel, 30 KW diesels, diesel 1200 l per month, 9 hrs per day, cooking 48 kg per month gas.

Water: Poor supply

No police station

No post office

Church: 8000 members

Clinic: (96 kg per month gas for cooking)

Wood scarce - Villagers use anything dry - straws, cowdung, etc.

Lighting: Paraffin, candles.

33. ONANDJOKWE - Hospital in Onipa Village

Parish Mission Hospital - 450 beds. Connected to Swawek power. Power supply not adequate and charges in excess of R15,000 monthly.

Hospital has standby diesel, cooking - gas and electricity.

Hot water: Some houses only.

34. LUTHERAN Regional Office - Owambo

Membership of Church: 400,000 (including Kavango)

Onipa population: 5,000

Printing press

Primary school: 3

Church: 4,000 members

Power supply to hospital, press and houses not adequate.

Onipa is a modern village with over 250 modern houses and several large supermarkets. Several of these buildings use diesel generators.

Domestic: Large proportion of Onipa in formal employment - hospital, teaching, government, etc.

Electricity potential: Very good.

35. OLUKONDA - Traditional location

Church: 6,900 members

Clinic: No fridges, 9 patients per day

Primary school: 1 (700)

About 10-15 modern houses on diesel/gas but scattered.

Small returnee centre ($350m^2$)

Several Cuca shops on diesel

Domestic sector: No wood, straws and cowdung used.

Electricity potential: Poor (Solar)

36. ONTANANGA (Traditional location)

Church: 7,400 members

Primary schools: 2 (1000)

Clinic: Gas for cooking (48 kg per month using Unicef fridge (85W)

Domestic: No wood at all, very few modern houses.

Electricity potential: Poor (Solar)

37. ENHANA

Population: 10,000

Police office

Primary schools: 1 at Enhana, 9 in the area.

Parish Complex - 93 beds own diesels - 37.5 KVA, cooking - 48 kg per month, 8 houses.

Secondary school (650) Own diesel: 2 x 180 KVA, 69 KVA, 24 hrs per day, diesel 11,000 l per month. Cooking - all electrical (40 KW of cooking & water - heating & space cooling)

Load = 80 KW at load factor 40 - 50%

Other electricity uses - water - pumping.

Commercial sector: Several large shops running on diesel and gas.

Domestic sector: Several modern houses, but most still traditional. Wood scarce but better tree and grass cover.

38. OGONGO Regional water plant

Treats water from Ruacana and pumps to Oshakati, Agricultural College 6 km away.

Clinics and several schools in the area.

Water plant uses 13,000 l per month.

B. <u>KAVANGO - 11-12 AUGUST 1990</u>

39. OKONGO

Hospital (38 beds) and over 15 houses in the complex. Own diesel 1 x 10 KVA, 600 l per month.

Cooking: Mainly wood, gas sometimes.

Primary school

Secondary school: Own diesel 2 x 100 KVA, runs 8 hrs per day. Also used for water - pumping using diesel 2500 l per month.

Police camp: 2 x 55 KVA, former UNTAG Camp (8 houses)

Domestic sector: Mainly traditional, with a few modern houses. Wood supply not critical.

Environment: Good tree and grass cover.

40. MPUNGU

Population: 3,000

Parish mission: Complex

Hospital: (11 beds)

Primary school, hostel for 140 children

Church: 1300 members

Own diesel, 10 KVA 9.6 KVA, diesel 400 l per month 3 hrs per day.

Gas used for refrigeration, wood for cooking.

Village mainly traditional, very few modern houses.

Water: Main problem

Commerce: Very few shops

Domestic sector: Traditional. Good tree and grass cover.

Electricity potential: Fair - medium. Irrigated farming potential high.

41. NKURENKURU

Population: 5,000

Parish complex

Hospital

Boarding hostel

Solar heating for some houses

Church

Own diesel 40 KVA, diesel 2500 l per month

Agricultural college 1-1/2 km away.

Police station

Several shops and modern houses

Garage (Mission)

Electricity potential: Good (Irrigated farming)

Domestic sector: Mainly traditional. Good tree and grass cover.

42. KANDJIMI

Secondary school (500) and 10 houses

Own diesel 2 x 125 KVA, diesel 9000 l per month. Runs 24 hrs.

Few houses on solar but not working.

Power connection to River for water pumping, but no water pump.

Several modern shops and house along the road to Rundu.

Great potential for irrigated farming. Good tree and grass cover which may suggest good soils for crops.

43. TONDORO - Large Parish Mission similar to Oshikuku - hospital
- boarding school
- + 15 houses

44. MUSESE Agricultural Project - First National Corporation Project to try several crops.

On the 12th several agricultural projects were visited. All run on diesels. A parish centre using water wheel for power generation was also visited. Their peak load is 70 KW and without the wheel they would spend 20,000 l per month. They use the water-wheel continuously and only use diesel when the demand is higher than the 30 KW generated from the river.

The Kavango region has tremendous potential for agricultural produce.

Appendix 2.4

Press release from the mission issued by MME

PRESS STATEMENT BY THE MINISTRY OF MINES AND ENERGY ON THE JOINT INTER-MINISTERIAL FACT FINDING MISSION TO NORTHERN, NORTHWESTERN, NORTHEASTERN RURAL AREAS TO BE ELECTRIFIED

On the invitation of the MME extended to various Ministries with closely related interest with the rural electrification programme, (i.e. Education, Works and Transport, Health and Social Services, Local governments, Agriculture and National Planning Commission) an inter-ministerial consultative meeting was held on July 11, 1990 to put ideas together and to compose a team as an initial step to visit areas identified for rural electrification.

The team lead by the Deputy Minister, Hon. Helmut Angula and composed by representatives from the National Planning Commission, Health, Local Governments, SWAWEC and Consultants from Norway and Botswana, departed on August 6, 1990. The first site visited was the substation at Oshivelo for assessing possible extension for the powerline to schools, hospitals, clinics and other important economic infrastructure located in the area, from where the team proceeded further up north to Ondonga, Uukwambi, Ukaludhi, Uukologadhi, Ruacana, Uukwayama and Kavango (From Mupungu in the west till Bagani). More than 34 towns and villages in Owambo were visited and most of the towns in Kavango.

During this arduous weeklong tour (5 days in densely populated Owambo area and 2 days in Kavango) all the major centres which are potential energy consumers were visited and on spot statistical data collected through inspection of installations and through talking to the local population and in particular with the community leaders, that includes; church leaders, school principals, medical and technical personnel in charge, administrators and businessmen. The trip to Caprivi which was cancelled due to unforeseen pressure of work here at the Ministry will be continued at a later stage.

Very important facts were established during this trip, which inter-alia include:

1.1 Enormous amount of money is being spent by the Government on the inadequate diesel generated energy supply particularly in schools, hospitals, water treating plants and at water pumping stations.

1.2 Maintenance cost is equally high and inefficient, since the technicians and inspectors are operating either from Ondangwa and Oshikati were they live and with lack of communication system repair works often takes too long.

1.3 The community at large does not benefit from this diesel generated energy, which supplies solely a given centre or an individual.

1.4 Expenditure on diesel and maintenance cost could be substanticially cut by replacing diesel generators with cheaper and more efficient electricity supply from Ruacana power station, benefitting community as a whole.

2.1 One of the attributing factors in the low performance of the students is non-existence of night studies, classes, laboratories and visual education through films etc. due to lack of electricity in schools.

2.2 No illiteracy campaign can be effectively executed without electricity, because nurses, teachers etc. as potential participants are only free at night and are at work during the day.

3.1 Ecological effect caused by deforestation through wood collection for cooking and house construction is indeed alarming.

4.1 Provision of electricity would be an incentive for better housing and better cooking methods of which alternatives could be: bio gas, solar energy or any other modern method that might prove to be economical.

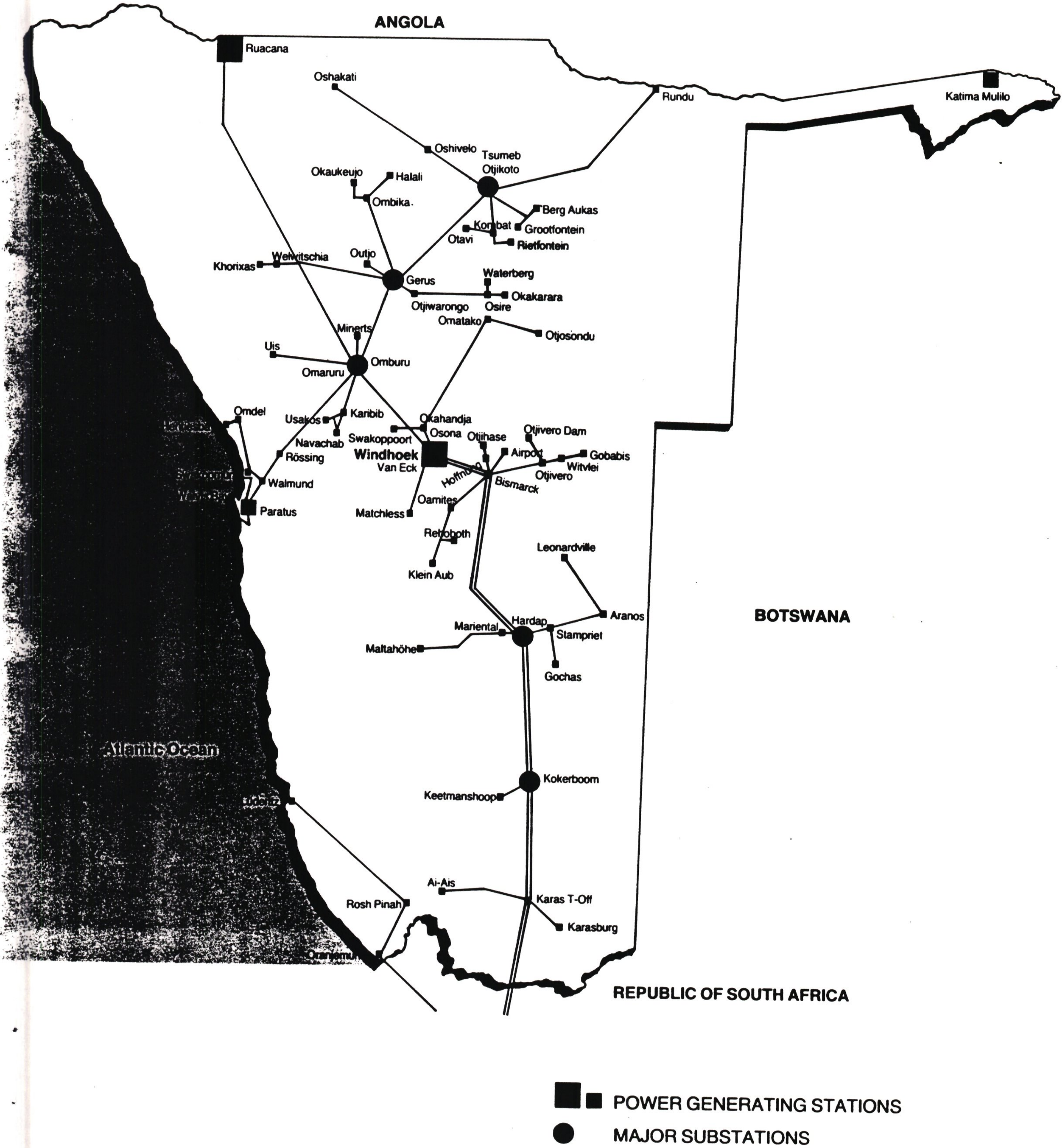
Above mentioned facts explain our Ministry's increased determination in carrying out the rural electrification. For which while preparing for submitting the project to the Cabinet for necessary approval and funding, we shall ask SWAWEC to continue with the necessary preparations for the commencement of the project.

At later stage other rural areas mainly former homelands will follow.

Appendix 3.1

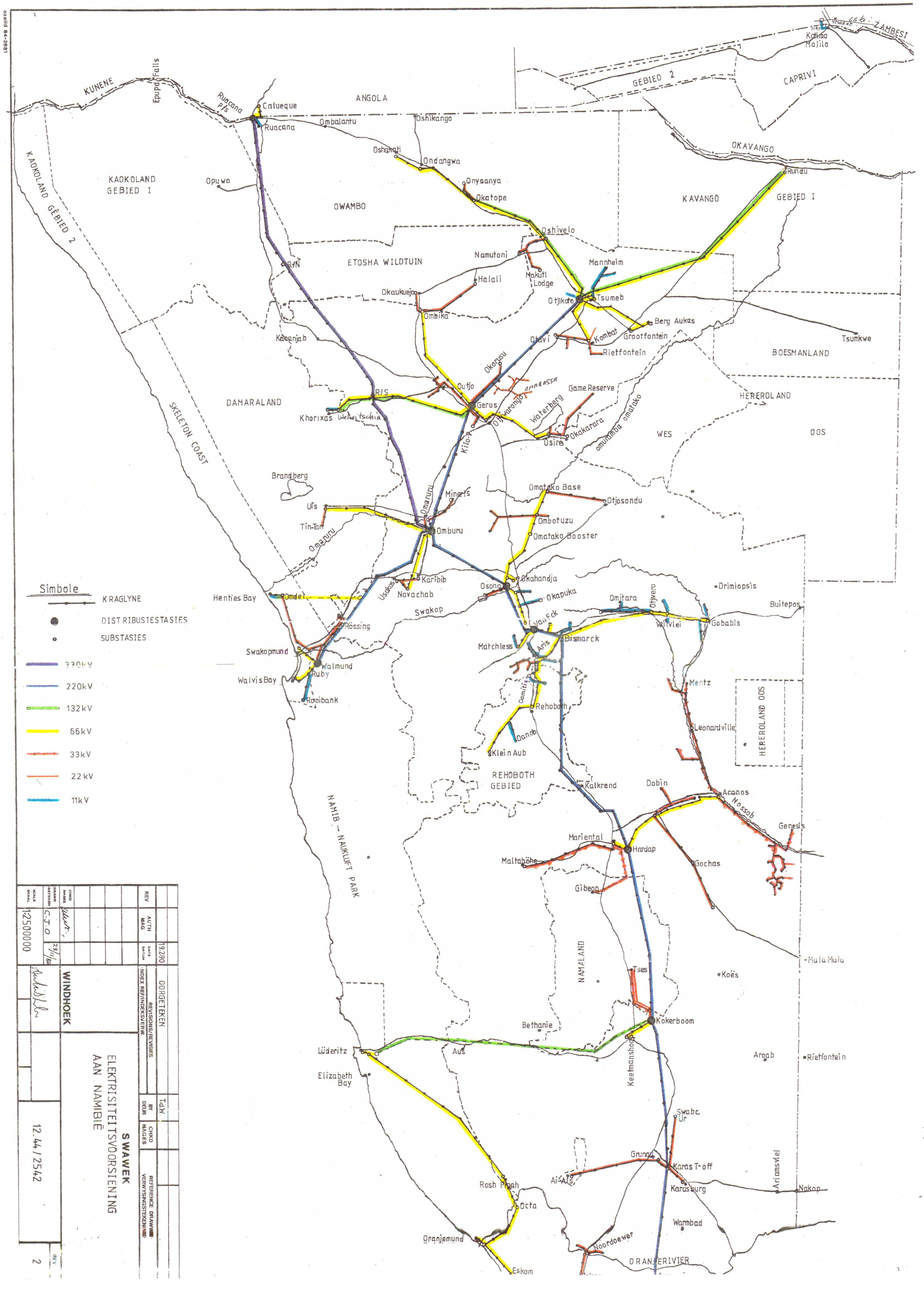
Map of Namibia with national grid

Map of Namibia with national grid



Appendix 3.2

Single line diagram of the national grid



Simbole
KRAGLYNE
DISTRIBUSIESTASIES
SUBSTASIES
330kV
220kV
132kV
66kV
33kV
22kV
11kV
ANGOLA
KUNENE
Epupa Falls
Ruacana p/s
Calueque
Ruacana
Ombalantu
Oshikango
Oshakati
Ondangwa
Onyaanya
Okatope
Oshivelo
ZAMBESI
Katima Mulilo
GEBIED 2
CAPRIVI
OKAVANGO
Rundu
KAVANGO
GEBIED I
KAOKOLAND GEBIED I
KAOKOLAND GEBIED 2
Opuwo
OWAMBO
ETOSHA WILDTUIN
Namutoni
Halali
Mokuti Lodge
Mannheim
Okaukuejo
Ombika
Otjikoto
Tsumeb
Berg Aukas
Grootfontein
Tsumkwe
BOESMANLAND
Kamanjab
Otavi
Kombat
Rietfontein
Okorusu
Outjo
Gerus
Otjiwarongo
OMARASSA
Waterberg
Game Reserve
Okakarara
Osire
Omatako
HEREROLAND
WES
OOS
DAMARALAND
Khorixas
Welwitschia
SKELETON COAST
Kilo-9
Brandberg
Uis
Tin-Tan
Omaruru
Minerals
Omburu
Omatako Base
Otjosondu
Ombotuzu
Omatako Booster
Karibib
Navachab
Usakos
Okahandja
Osona
Okapuka
Henties Bay
Omdel
Swakop
Rössing
Swakopmund
Walmund
Ruby
Walvis Bay
Rooibank
Drimiopsis
Buitepos
Omitara
Otjivero
Witvlei
Gobabis
Van Eck
Bismarck
Matchless
Aris
Mentz
Rehoboth
Oamites
Oanob
Klein Aub
Leonardville
HEREROLAND OOS
REHOBOTH GEBIED
Kalkrand
Dobin
Aranos
Nossob
Genesis
NAMIB - NAUKLUFT PARK
Mariental
Hardap
Maltahöhe
Gochas
Gibeon
NAMALAND
Mata Mata
Koës
Tses
Kokerboom
Bethanie
Lüderitz
Aus
Elizabeth Bay
Keetmanshoop
Aroab
Rietfontein
Swartkop
Grunau
Karas T-off
Ai-Ais
Karasburg
Ariamsvlei
Nakop
Rosh Pinah
Octa
Warmbad
Oranjemund
Noordoewer
ORANJERIVIER
Eskom
SWAWEK
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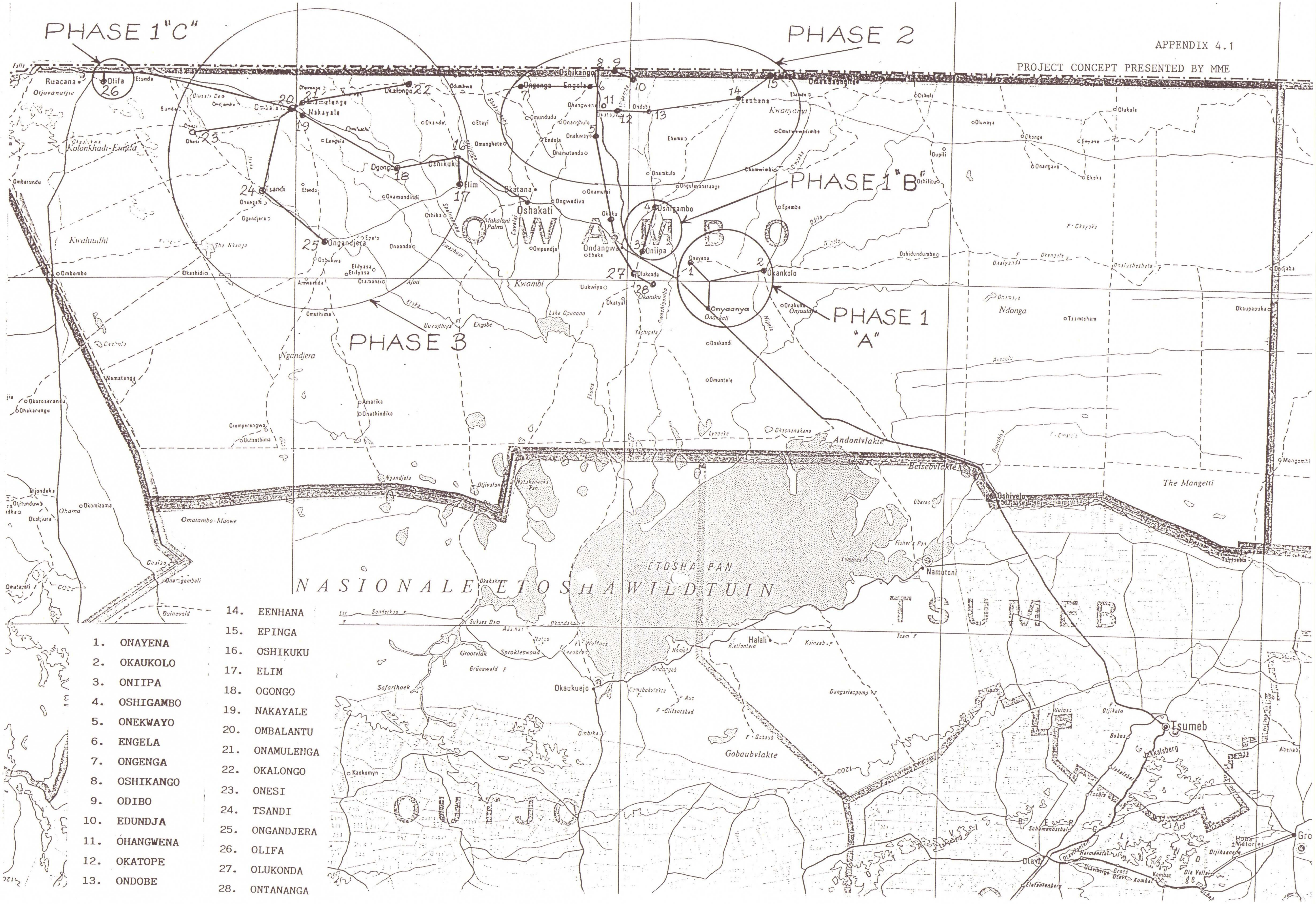
Appendix 4.1

Project concept presented by MME

APPENDIX 4.1

PROJECT CONCEPT PRESENTED BY MME



1.	ONAYENA	14.	EENHANA
2.	OKAUKOLO	15.	EPINGA
3.	ONIIPA	16.	OSHIKUKU
4.	OSHIGAMBO	17.	ELIM
5.	ONEKWAYO	18.	OGONGO
6.	ENGELA	19.	NAKAYALE
7.	ONGENGA	20.	OMBALANTU
8.	OSHIKANGO	21.	ONAMULENGA
9.	ODIBO	22.	OKALONGO
10.	EDUNDJA	23.	ONESI
11.	OHANGWENA	24.	TSANDI
12.	OKATOPE	25.	ONGANDJERA
13.	ONDOBE	26.	OLIFA
		27.	OLUKONDA
		28.	ONTANANGA

Appendix 5.1

Project concept Owambo

Appendix 5.1

NAMIBIA - RURAL ELEKTRIFIKATION

PROJECT CONCEPT - OWAMBO

Date:	Drawn:	Appr.:
4.10-90	U.KOLACZKOWSKA	E.NORDRIK

● Government proposed villages

◄ Other proposed villages

— 33kV distribution lines

- - Existing 66kV line operated at 33kV

2.

Appendix 6.1

Project concept Kavango


A N G O L A
Stage 2
Nankudu-Mbambi
Nankudu
K A V A N G
Stage 1
Rundu-Nankudu
Rundu
132/33 kV
Substation
Stage 1
Rundu-Nyangana
Nyangana
A N G O L A
Stage 2
Nyangana Bagani
K A V A N G O
CAPRIVI NATURE PARK
NATUURTUIN-CAPRIVI
CAPRIVI ZIPFEL
Appendix 6.1
NAMIBIA-RURAL ELEKTRIFIKATION
PROJECT CONCEPT - KAVANGO
Date: 4.10-90
Drawn: U.KOLACZKOWSKA
Appr: E.NORDRIK
33kV distribution line
33/0,4kV transformer point

Appendix 7.1

Project concept Caprivi

Appendix 7.1

NAMIBIA-RURAL ELEKTRIFIKATION

PROJECT CONCEPT - CAPRIVI

Date:	Drawn:	Appr:
4.10-90	U.KOLACZKOWSKA	E.NORDRIK

LEGENDE

VOORGESTELDE HOOFPAD
VOORGESTELDE GROOTPAD
VOORGESTELDE DISTRIKSPAD

DEPARTEMENT VAN VERVOER S.W.A.

- A-A1-A2-A3-A4-A5-A6-A7-A8 Voorgenome proklamering van Hoofpad 8/6
- A8-A9-X-T-T7-U-V-W Voorgenome proklamering van Hoofpad 8/7
- A6-Y Voogenome proklamering van Distrikspad 3500
- A4-M-M1-M2-B4 Voorgenome proklamering van Distrikspad 3501
- A1-C Voorgenome proklamering van Distrikspad 3502
- T-T1-T2-T3-T4-T5-T6 Voorgenome proklamering van Distrikspad 3507
- X-X1-X2 Voorgenome proklamering van Distrikspad 3508
- Q-R-S-T7 Voorgenome proklamering van Distrikspad 3509
- R-R1 Voorgenome proklamering van Distrikspad 3510
- R1-U Voorgenome proklamering van Distrikspad 3512
- A1-B-B1-B2-B3-B4-B5-B6-B7-A7 Voorgenome proklamering van Distrikspad 3511.

Off. Koerant	Datum	A.G.	Distrik
5064	1-7-86	5	GROOTFONTEIN

Saamgestel	Nagetrek	
F.Snyman	G.Schönborn 82.2.26	F.K. Fyler 82/11/17 Beplannings / Instandhoudings-Ingenieur.

Lêer Nr:	Skaal	
12/3/2/8/6, 12/3/2/3511, 12/3/2/3500, 12/3/2/3508, 12/3/2/3502, 12/3/2/3501, 12/3/2/3512, 12/3/2/3509, 12/3/2/3507, 12/3/2/3510, 12/3/2/8/7	1:250 000	P 1151

Appendix 8.1

SWAWEK's comments to the draft report

NORAD MISSION TO NAMIBIA IN CONNECTION WITH NORWEGIAN TECHNICAL ASSISTANCE TO THE ELECTRICITY SUB-SECTOR

DRAFT REPORT OCTOBER 1990

SWAWEK'S COMMENTS

1. INTRODUCTION

We studied the above report and have found that although the Norpower consultants went to much trouble to collect data and that there are many aspects well explored, there are also many aspects with which we do not agree.

Some errors are also contained in the report. A list is given in Appendix 1.

DISCUSSION

2. GENERAL

2.1 Although Norpower has gone to a considerable amount of trouble to analyse the immediate and future electricity loads which could materialise from rural electrification in the Ovambo, Kavango and Caprivi areas it is our contention that the loads (guestimates as described in the report) are too high. From the experience of Swawek's seventeen years of operation in Namibia the provisional supply point transformer sizes were chosen as shown in the attached studies (Appendices 2 and 3).

2.2 We agree fully with the general idea of 33 kV being the distribution voltage in the areas and this was already decided by Swawek before the Norpower study.

2.3 METERING AND SALE OF ELECTRICITY

Norpower foresees that the normal way used in a sophisticated society of metering electricity, ie., reading meters once a month and the sending out of accounts, be used in the rural areas under consideration.

It is our contention that this method has been tried in Africa and does not work. Pre-paid meters or electricity dispensers should be used.

2.4 ECONOMIC ANALYSIS - SECTION 5.11

An economic analysis is done after making certain assumptions. Growth rates are varied between 5,5% and 7,5% and discount factors between 6% and 10% and certain results are calculated. To be able to normalise, net present values are calculated over a 20 year period for eight different proposed stages. The present day generation cost is assumed to be 6c/kWh and the rural selling price 18c/kWh. Certain allowances are made for generating cost escalations.

DISCUSSION:

1. The "opportunity cost" of capital in the case of a grant is zero. Therefore the calculations in this case would be irrelevant. Only if a "donor" country expects a return on its money, need the calculation be done.

2. The "opportunity cost" of soft loan capital with an interest rate of 0% is equivalent to the difference in the inflation rates of Namibia (as foreign aid needs to be paid back in foreign currency) and that of Norway if one assumes that the exchange rate between the NOK and ZAR also changes according to the inflation rate difference between the two countries.

ie. if NOK inflation	= 4%
and ZAR inflation in Namibia	=15%
Opportunity cost	=11%

   Using 11% in the calculations already shows a different picture.

   Usually a "soft" loan would be in the order of 4% - 6%. For 6% the "opportunity cost" of capital becomes 17%.

3. As stated in 2.1 above, we are very sure that the loads calculated are too high. The load for Ovambo calculated on page 4-30 (third column for 1990) is stated as Total 40 453 and Total proposed 24 512 MWh.

   These figures correspond to maximum demand figures (based on Norpower's assumptions) of 10,3 MW and 6,2 MW respectively.

   Our conclusion here is that the base figures from which the economic analysis is done, are far too high.

In other words, the conclusion we draw from the above economic analysis is that the above rural electrification scheme is not economical if capital costs are included.

However, if a grant is received, the returns should be able to cover the maintenance and direct operating costs as well as the generating and distribution cost of electricity. There should also be some money left over for a contribution towards depreciation and replacement.

2.5 We must make it very clear that the way Swawek sees donor aid is the following:

1. The design, specification and implementation of project must be done or supervised by Swawek.

2. Where it is at all possible, Swawek will see to it that the maximum benefit in the construction goes to local labour, local suppliers etc.

3. Swawek will normally not have any objection to equipment coming from a donor country, but it will have to comply to our specifications and be compatible with that which we have in operation.

4. It is only natural that a donor country will want to assure itself that their money is well spent and therefore Swawek will welcome one supervisor to be either full time together with the construction or to visit the construction sites from time-to-time.

   It is also only reasonable that Swawek's bookkeeping, as far as donor money is concerned, to be open for any inspection and audit.

2.6 On page 1-4 paragraph 1.2.2.4 the wish is expressed that Norwegian (or Scandinavian) suppliers should have a chance to bid for tenders. It is also recommended that the donor or this representative be involved in drawing up the tender.

To date it has been a hard and fast rule in Swawek that it is unethical and unthinkable for a tenderer also to be involved in drawing up tenders or specifications.

3. ELECTRIFICATION OF OVAMBO

3.1 LOAD FORECAST

The load forecast, although admitted by Norpower to be a guestimate, is in our opinion far too high.

It is virtually impossible to accurately forecast loads for 10 years ahead, but we are confident that the scheme as designed by Swawek will comfortably be able to cope with the requirements for the community for many years. The line capacities are well in excess of the transformer capacities. (See Appendices 2 and 3)

3.2 DESIGN

We have studied the design described in the report.

3.2.1 **132 kV**

Although it is true that a 132 kV line from Ruacana all the way through to Otjikoto Substation near Tsumeb will definitely create the capacity for large loads in Ovambo, Swawek has decided against it as

1. the link between Ruacana and Otjikoto can never be closed as any system disturbance will cause large system loads to flow along the line and it will trip out immediately. Even load fluctuations at Tsumeb mine could cause this to happen.

   The line could therefore never be used as an interconnection but only as a feeder.

2. The cost is far to high and any money available could be better utilised to serve other prospective rural consumers.

3. The Swawek design does not preclude the 132 kV development, should it be necessary in the future, to materialise.

3.2.2 **66 kV**

Norpower does not extend 66 kV to the North of Ondangwa but has two 33 kV lines running more or less parallel. Although taking 66 kV to a point South of Oshikango and than reticulating at 33 kV is slightly more expensive, it is our contention that this is technically a better scheme.

3.2.3 **11 kV AND 22 kV**

Where these voltages exist, it will be a waste of money not to utilise their potential fully.

3.2.4 LINE CONFIGURATION FOR 11 kV, 22 kV AND 33 kV

Norpower has given no drawings to show the design of their structures. We have however given them full design drawings showing our configuration. From the cost figures shown in the study, we can only assume that they have used another design. We doubt whether a more cost-effective design than ours exists with the present state of the technology and price of materials

3.3 COST

On page 5 - 8 of the report prices are given for Norwegian design and delivery. They do however, admit in their report that locally obtainable materials and locally built lines are cheaper. The prices quoted compare as follows:

1. 33 kV Rabbit conductor line per km.

Norpower	R39 500
Swawek	R22 000
Difference	R17 500

Swawek % of Norpower 56,4%

2. 50 kVA supply point.

Norpower	R17 400
Swawek	R12 000
Difference	R 5 400

Swawek % of Norpower 69%

3. 200 kVA supply point.

Norpower	R30 400
Swawek	R20 000
Difference	R 9 600

Swawek % of Norpower 66%

From the above it is of course obvious that if the Norwegian government would only donate money approximately 40% more reticulation could be done for the exact same amount. This fact should be a major consideration.

Swawek is already in process of starting the electrification of Ovambo and 7 points are to be supplied with electricity soon.

To complete the scheme as shown on our drawing, Appendix 4, will cost R18,0 million.

Norpower's scheme will cost R43,4 million.

See Appendix 5 for the breakdown of the cost.

4. ELECTRIFICATION OF KAVANGO

4.1 LOAD FORECAST

Once again, by using the same method of forecast as for Ovambo, the rural loads are considered to be too high.

However, knowing our countries future needs and growth points (pumping of water for human and animal needs as well as for limited irrigational purposes from the Okavango) we agree that the upgrading of the present 66 kV operated line from Otjikoto (near Tsumeb) to Rundu be done from 66 kV to 132 kV. This in any case was always our intention and that's why the line was built accordingly.

4.2 DESIGN

Bearing in mind 4.1 above, 66 kV lines for at least two thirds of the distances from Rundu to Mbambi (West) and Rundu to Bagani should be built.

T-offs at 11 kV or 22 kV can be established along the 66 kV line where needed, and the last section to Mbambi and Bagani should be 33 kV.

Swawek pioneered an inexpensive design for a T-off from a 66 kV power line. This design is now being used in various parts of Southern Africa. It is very unlikely that Norpower would have considered such a design.

4.3 IMPLEMENTATION OF KAVANGO SCHEME

There are two main factors which impede the implementation of a Kavango electrification scheme.

1. As justified above (4.1), it is necessary to think of the future and that one should not waste money and resources in building a small inadequate scheme for Kavango. On the other hand, Swawek has not got the monetary resources at this stage in time to implement the scheme.

2. The prime priority should be to be build another hydro power station, probably at Epupa. Only then will sufficient, inexpensive, non-escalating in price, power be available for the establishment of pumping stations and subsequential development along the Okavango river.

3. Swawek therefore proposes a scheme as shown in Appendix 6. The load transfer capacities, voltage drop etc. is shown in Appendix 7. The 500 kVA T-off substations will be designed in such a manner that the transformers can be exchanged for 2,5 MVA or 5 MVA units if the future load so dictates.

   The studies also clearly indicate that as a result of the capacitive effect of the 280 km 132 kV power line from Otjikoto (Tsumeb) to Rundu, together with the VAr's generated by the 66 kV and other lines along the Okavango river, it will be necessary to install a 15 MVAr switchable reactor on the 132 kV busbars at Otjikoto. At the far ends of the 66 kV lines a voltage rise of 6% will still occur due to Ferranti effect at no load. This is, however, considered to be acceptable.

4.4 COST

The total cost of the Kavango scheme as described is R39,0 milllion.

See Appendix 8 for the cost breakdown.

5. ELECTRIFICATION OF THE CAPRIVI AREA

5.1 A plan for the electrification of the Caprivi within approximately 70 km from Katima Mulilo has been designed by Swawek. This design allows for extending the 33 kV distribution lines to allow all hospitals, clinics, schools and shops to be supplied with power.

The system also allows for a sugar plantation, refinery and pumping station for water.

However, a serious impedement to the electrification of the area as far as industrial or irrigational purposes is concerned has arisen.

Zesco of Zambia assured Swawek that after making certain changes to their network near Victoria Falls power station, sufficient power would be available for industrial and agricultural purposes. However, at the recent SADCC meeting Swawek managed to obtain a report including drawing of the system supplying Katima Mulilo with power.

Engineers in Swawek have now studied this system, madė calculations with the newest software programs available, and have come to the conclusion that it just can not be done.

6. OTHER FORMS OF ENERGY

The section concerning making use of wood fuel, bio-mass, bio-gas, wind power and solar power is considered by Swawek to be accurate and to the point.

7. DEVELOPMENT OF CUNENE WATER RESOURCES

The assessment of Swawek's future sources of own electrical power concurs with Swawek's own views.

The conclusion drawn from Norpower's assessment of Swawek's position is clear in that Swawek should now already have embarked upon a project to build a hydro power station to supplement our own present generating capability. Swawek has known this for some time and had to wait for the independence of Namibia before it was possible to start negotiations with Angola.

It is our contention that the building of Epupa is probably the project that should have the highest priority of all projects in Namibia.

Norway is probably the world's leader in rock tunnelling for hydro power stations. They are the pioneers of using rock only as a lining for penstock tunnels in lieu of concrete or steel linings which are conventionally used. Norway is also on the forefront of technology as far as the design and fabrication of hydraulic machines and apparatus.

It is quite possible that Swawek and Norway could work together in a businesslike and technological framework in the building of Epupa.

However, unless circumstances dictate otherwise, Swawek has decided to pay for the feasibility study out of own resources so as not to be bound to any likely supplier or country.

8. ANGOLA

The idea of constructing a 110 kV line from Ruacana to Xangongo and later further Northward to eventually form a full interconnection with the Southern Angolan System will receive no support from Swawek. A 110 kV power line of that length effectively connecting the Southern Angolan system to Swawek and Eskom of South Africa will pose extremely complex problems regarding system stability and security of supply.

A 66 kV line from Calueque to Xangongo only has merit.

9. POWER SUPPLY TO OKONGO - EASTERN OVAMBO

Swawek was informed that the German government intends financing the erection of a hospital at Okongo, 100 km to the East of Eenhana. No details of power requirements are known.

We have calculated that a limited supply can be delivered at Okongo for approximately R3,0 million.

Appendix 8.2

The Norwegian team's remarks

THE NORWEGIAN TEAM'S REMARKS

1 DEMAND FORECASTING

1.1 General

SWAWEK is of the opinion that the demand forecast as presented in the report is too high. In this connection they refer to their own long experience in Namibia.

The team has chosen to give the matter of load forecasting a more analytic approach.

There is no key answer to what is wrong and what is right. However, the team feels that it is more correct to decide the network development on expected development of the provinces than on "historic" experience.

1.2 Annual Growth

The projected rate is approx. 2 % higher that the population growth. One of Governments main objectives is to increase the standard of living among the population groups and areas previously neglected. A 2 % real growth p.a. in annual consumption among the user groups does actually seem very modest in that perspective.

1.3 The Consumption Pattern

Most of the demand is in the form of institutional consumption. The figures for the health sector are based on concrete plans. The educational sector is not equally concrete, but is also less significant. We feel that a growth in the demand for these services a few percent above the general population growth is well justified.

1.4 Unit Consumption

We have for the health and educational sectors used relevant empirical information from other countries since there is so little experience with genuine rural electrification in Namibia. It should be better specified which consumption figures should be reduced.

1.5 Total Consumption

Maybe the total power figures intuitively appear too high compared to the current situation. Our forecast for the total Owambo province would, however, lead to a consumption in the year 2010 of 118 GWh. This, for a population which by then would exceed 1,500,000 people. For the sake of comparison, in 1989 the 1,200,000 people of Botswana consumed, from the grid, 119 GWh for domestic and Government purposes. I.e. the mining and commercial sectors come in addition (651 GWh to be precise). Also, domestic and Government consumption off-grid would have to be added. In our Namibia figures both domestic, Government, commerce and "others" are included; on- as well as off-grid.

It has taken Botswana 24 years of post independence development from an economic level not very different from what can be experienced in Owamboland today to reach this consumption. Our forecast gives rural Namibia 20 years to reach a level which is maybe 40 % lower than what Botswana achieved over the same years; excluding the mining sector.

2. PROJECT COSTS

The total project costs as presented in SWAWEK's comments are not comparable as the project concept is somewhat different.

With regard to differences in unit prices the following comments are given here below.

33 kV Distribution Lines

As stated in the report the basis is that all materials are imported. This gives a price of R 39,500 per kilometre of Rabbit conductor line whereas the corresponding price estimated by SWAWEK is R 22,000. Assuming that only conductors are imported, our revised estimate would be R 28,000.

Apart from the obvious difference in material import cost, the costs deviation might also be explained by minor variation in design. The SWAWEK's drawings were only available after completion of the draft report.

33/0.4 kV Distribution Points

The prices in the report include both the transformer and also components of the related low voltage distribution network such as insulated cables, poles, clamps, distributions panels, etc. We have no details with regard to what is included in SWAWEK's estimated price, but assume that the major part of the difference is caused by different scope of facilities included.

Transmission network

The report's table point 5.8 should be observed to include MNOK 22,8 which is not included in SWAWEK's figures.

3. ECONOMIC CONSIDERATIONS

3.1 Opportunity Costs

Capital expresses the value of resources. Resources can be employed productively or unproductively in a national economy. The economic rate of return is a measure of the economic productivity that an added amount of resources could yield in the national economy.

If additional resources (capital) are employed in society in a manner where they yield less than they otherwise could, then the economy is obviously faced with a loss (loss of opportunity). The loss being equal to the difference between the yield in the particular project, and the general possible yield of added capital in society.

Hence the concept of opportunity cost, which is a measure of a foregone opportunity.

In a society like the Namibian one, where capital is and will be a constraint in view of the significant development projects envisaged, obviously one would like to employ new capital in fields and manners where the yield to the national economy is at least as good as for any alternative employments of the same capital.

Therefore all new development projects should have their economic efficiency tested in the form of an economic internal rate of return (or net present value; which is the same thing). Only projects which have an IRR exceeding a defined minimum (= the opportunity cost of capital in the national economy) ought to be supported unless there are compelling social or vital national reasons for wanting to implement an inefficient project.

The donor funds that possibly will be used for a rural electrification scheme, could easily be used for other purposes in Namibia. The Norwegian contribution to Namibia will be spread over several sectors; all of which "compete" for the same overall budget. Obviously the right thing to do, both for the Namibian and the Norwegian Governments, is to put the money where they will make the largest economic impact in Namibia. In practice it is not easy, at the same time, to develop an internal rate of return (net present value) for all relevant projects in the various sectors. Some have not been identified by the time one has to make a decision on other projects, etc. The only practical way of doing this is then to at least ensure that any project to be supported represents an economic yield equal to or above the average yield for new capital added to the Namibian economy; i.e. equal to or above the opportunity cost of capital in the country.

By coincidence we had the occasion to discuss a few weeks ago the level of opportunity cost of capital in Namibia with the head of one of the two biggest banks in the country. (The discussion was not related to this project). His feeling was that the real rate is probably closer to 6 than to 10 %. But, due to the same difficulties as outlined in our report, it is currently impossible to be very exact about the precise opportunity cost of capital in Namibia.

3.2 Finance and Economics

SWAWEK mixes financial and economic issues.

SWAWEK also makes the error of confusing nominal (real + inflation) with real rates of return. An economic analysis deals with real rates of return; SWAWEK's comments in this respect are irrelevant.

A new project would normally by any Government, be appraised with its value for the national economy, but at the same time taking budgetary constraints and implications into account. If a new economically sound project is not compatible with what is financially viable, then obviously a donor, for example, is called for. By bringing in grant finance from the outside one is able to reconcile the economic and financial dimensions and requirements.

Our appraisal of the rural electrification scheme has been in terms of economics. It is our conviction that the proposed scheme will represent an economic gain for Namibia. But, due to the lack of finance (SWAWEK cannot afford the scheme), foreign support (from e.g. NORAD) should be mobilised in order to enable the economic benefits for Namibia to materialise.