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Energy & Industry Consultants Nederland B.V.

EIC

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OPPORTUNITY STUDY FOR THE ESTABLISHMENT OF A PRODUCTION CAPACITY FOR WIND DRIVEN WATERPUMPS IN ANGOLA

US/ANG/87/075

FINAL REPORT

UNITED NATIONS INDUSTRIAL
DEVELOPMENT ORGANIZATION
UNIDO - VIENNA

OPPORTUNITY STUDY FOR THE ESTABLISHMENT OF A PRODUCTION CAPACITY FOR WIND DRIVEN WATERPUMPS IN ANGOLA

US/ANG/87/075

FINAL REPORT

12

(2+2)

Prepared by the United Nations Industrial
Development Organisation for the
Government of the People's Republic of Angola

February 1989

All information, statistics, and back-up data upon this report is based, were gathered through discussions and interviews with DNFRE, Ministry of Industry, other Provincial and Governmental officials and through questionnaires.

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Backstopping : V. Klykov, backstopping officer feasibility study branch UNIDO

Abbreviations

1.	COMFAR	Computer model for feasibility analysis and reporting
2.	DNFRE	Department of renewable and new energy sources of the Ministry of energy and petroleum
3.	EIC	Energy and Industry Consultants Nederland B.V.
4.	GDP	Gross domestic product
5.	GEPI	Department of study and planning of the ministry of industry
6.	GNP	Gross national product
7.	I.R.R.	Internal rate of return
8.	MEP	Ministry of energy and petroleum
9.	UNICEF	United Nations Children's Fund
10.	UNIDO	United Nations Industrial Development Organisation, Vienna

TABLE OF CONTENTS

		page
1.	SUMMARY, CONCLUSIONS AND RECOMMENDATIONS	1
	1.1 Summary on the establishment of an integrated windpumps production unit in Metafus-workshop, Lubango	1
	1.2 Conclusions	3
	1.3 Recommendations	5
2.	PROJECT BACKGROUND AND GENERAL DATA ON ANGOLA	7
	2.1 Project background	7
	2.2 General data on the People's Republic of Angola	9
	2.3 Basic facts on the provinces Namibe, Huila and Cunene	13
3.	RELEVANT ASPECTS OF THE SITUATION IN THE FIFTH REGION	14
	3.1 Geographic situation	14
	3.2 Rural population and means of subsistence	15
	3.3 Existing metal workshops	18
	3.4 Existing windpumps	20
4.	WATER AND WIND RESOURCES	23
	4.1 Wind conditions	23
	4.2 Water resources	30
5.	WATER LIFTING EQUIPMENT	35
	5.1 General	35
	5.2 Water lifting equipment	36
	5.3 Windpumps	39

		page
6.	MARKET AND PLANT CAPACITY	48
	6.1 Product specifications	48
	6.2 Applications	49
	6.3 Demand present and future	52
	6.4 Market volume	55
	6.5 Prices of windpumps	56
	6.6 Production programme	57
7.	MATERIALS AND INPUTS	58
	7.1 Materials and components	58
	7.2 Utilities	58
	7.3 Spareparts	61
	7.4 Variable cost	61
8.	LOCATION AND SITE	62
9.	PROJECT ENGINEERING	63
	9.1 Production process	63
	9.2 Equipment and machinery	64
	9.3 Civil works	66
	9.4 Human resources	67
10.	PLANT ORGANIZATION	71
11.	FINANCIAL AND ECONOMIC EVALUATION	72
	11.1 Economic and financial data	72
	11.2 Financial evaluation	74
	11.3 Sensitivity analysis	76
	11.4 National economic and social benefits	82

page

12. IMPLEMENTATION SCHEDULING OF THE WIND-PUMP PRODUCTION PROJECT 83

13. PROJECT RELATED ACTIVITIES 86

14. REFERENCES 88

15. ESTABLISHED CONTACTS 89

Appendix

A 1 Existing metal workshops

A 2 Survey of existing wells equiped with windpumps

A 3 Visited locations during the missions

A 4 Data of existing wells in the fifth region

A 5 Wind conditions

A 6 Windpump parameters

A 7 Analysis of rotordiameter in relation to the groundwaterresources

A 8 Windpump transmission parts

A 9 Comfar output data

A10 Presentation of the of the draft final report

A11 Offer of windpumps

1. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

1.1 Summary on the establishment of an integrated windpumps production unit in Metafus-workshop, Lubango

An opportunity study has been made for the establishment of a production capacity for the manufacture of windpumps within the fifth region of Angola. It was found that manufacturing of windpumps in Angola is viable.

The analysis of the study were based on:

- An inquiry regarding the state of existing windpumps in the fifth region.

  A survey made in 1988 resulted in some 90 existing windpumps in the 5th region, 28 of them have been visited during the first and second mission. Two of the visited windpumps were still in operation. About 12 of the 28 windpumps could be rehabilitated.

- A preliminary inquiry on windregimes.

  In Huila the windregime appears to be less favourable than in Namibe. The average windspeed is estimated on 4.5 m/s for Namibe and 3.5 m/s for Huila. However the basis of these estimations is too small. Windmeasurements are needed for a longer period of time as a continuation of the measurements, made with help of the 4 wind data loggers, which were installed during the mission.

- An investigation of metal workshops within the fifth region.

  Presently only Metafus has the capacity to start windpump production. For the implementation some investments are needed.

- A market survey indicating three segments:
  - a - human drinking water
  - b - livestock watering
  - c - irrigation

  The total demand on windpumps is estimated of the segments a + b. Windpumps for irrigation purposes can only be considered for the long term.

- A preliminary analysis of type and specification of a suitable windpump.

  A 14 feet geared windpump appears to be the best suitable machine.

- An analysis of financial parameters, when considering an estimated selling-price of USD 6,000.—.

  The I.R.R. (without considering taxes) is 22% for an isolated plant. For an existing workshop the I.R.R. is 32%.

- A comparison of the total expenses in foreign currencies of imported windpumps and locally produced windpumps, if manufactured by a new (isolated) plant as well as manufactured by an existing metal workshop.

  Except from social benefits (watersupply) during the accounting period of 15 years approx. USD 4,000,000.— could be saved on foreign currency.

The study shows the viability of establishment of production of 100 classic geared windpumps of 14 - 25 feet per year in Angola and recommends the integration of their production in the existing workshop Metafus at Lubango which represents the most effective solution.

1.2 Conclusions

1. Considering different ways of water supply it appears that about 50% of the existing and new tube wells can be equipped succesfully with a windpump. Windpumps are competitive with other water lifting devices, even in areas with a modest windregime.

2. In first instance a 14 feet windpump is best suited for the local condition within the fifth region. After the third production year a bigger windpump (25 feet) could be introduced for use in regions with a modest windregime and/or a high waterdemand.

3. Based on qualitative and quantitative analysis of all relevant aspects made in the opportunity study, the set-up in the fifth region of Angola of a production capacity for windpumps is viable.

4. According to a preliminary techno-economic evaluation an optimum plant should have a production capacity of 100 windpumps per year to be achieved in the fourth production year.

5. The potential short term demand for windpumps is 600 units. The real market depend on the number of tubewell available for the installation of a windpump and is estimated to be 35 in 1991, 50 in 1992, 70 in 1993 and 100 in 1994. Those numbers are based on the expectation that:

   a) the well rehabilitation and drilling capacity in the fifth region is sufficient.
   b) the goverment of Angola is willing to purchase windpumps (eventually with financial support from donor countries) as being part of the policy to satisfy rural water needs.

   The total demand for windpumps to cover present rural drinking water needs for lifestock and human beings is 1200 units.

6. The production should be based on a proven classic windpump design. During the first 2 years more complicated components have to be imported but may gradually be substituted by locally engineered and manufactured ones.

7. In this respect implementation in the Metafus factory at Lubango leads to the best solution for the short term. Implementation within the Emel factory at Lubango could be an alternative after 1 or 2 years, if this factory has been extended according to the existing plans.

   Preliminary calculations show an internal rate of return for Metafus and Emel to be comparable (32%). The IRR for a completely new, isolated plant is 22,71%.

8. The more components are produced locally the better a technological and economical basis for the long term production is created.

9. The unit costs (fifth year) are US$ 3370 for a production within Metafus or Emel when the unit costs for an isolated plant are US$ 4090.

10. The implementation of a production unit will lead to the employment of 19 persons and a saving of foreign currency of approx. USD 4,000,000 in an accounting period of 15 years. Within this period 1350 units can be produced meeting the governmental objective to provide drinking water for rural areas.

1.3 Recommendations

A) Recommendations related to the production of windpumps

Following the findings/results of the study it is recommended to start with preparatory activities in order to establish windpump production within Metafus:

1. (Technical) pre-investment activities, implying the evaluation of the workshop concerning:
   - plant organisation
   - civil structure
   - machines and equipment
   - human resources
   - procurement procedures

   The results of these activities are a set of specifications for machines, civil structures, raw materials and components.

2. Engineering of the first units to be produced. Preparation of a call for tender. Recommendations for procurement and/or cooperation with foreign manufacturers based on an evaluation of tenders.

3. Detailed analysis of sales prices.

4. Detailed financial and economic evaluation of the workshop.

5. Determination of conditions and schedule of financement of the project.

- In order to accomodate a technological basis training of local staff should start immediately after or during the pre-investment activities. Foreign experts should be recruted for technical as well as administrative support. During the pre-investment phase job descriptions should be prepared.

The activities 1 to 5 are estimated to take up 6 months.

B) General recommendations related to the project

1. Winddata

The output of a windpump highly depends on the average windspeed and the matching between pumpdiameter and rotordiameter. It is recommended that a windmeasurement programme is executed as a follow-up of the installation of 4 winddataloggers which has taken place during the present opportunity study.

2. Installation and maintenance

An institution for site selection, installation and maintenance has to be created and integrated within existing structures and plans.

3. Rehabilitation of existing windpumps

A minor part of the existing 90 windpumps could be rehabilitated. This should preferably be realised in conjunction with the effectuation of local manufacture of windpumps.

4. It is necessary that the drilling capacity for boreholes and the construction capacity for storage tanks increases. The government should consider this in order to solve the urge for water need in a proper way.

2. PROJECT BACKGROUND AND GENERAL DATA ON ANGOLA

2.1 Project background

The State Secretariat of co-operation of Angola requested the United Nations Industrial Development Organisation (UNIDO) by means of a letter dated July 22, 1986 to execute an opportunity study concerning the possibility for the establishment of a production capacity for wind-driven waterpumps (windpumps) in Angola.
The project fits into the priorities, set by the Government concerning the development of the industry and providing for the basic needs of the rural population in the southern provinces Huila, Cunene and Namibe.
The UNIDO has contracted a team of dutch consultants from E.I.C. Nederland B.V to conduct the study.

Two missions have been executed to Angola. A first mission from June 8, 1988 until July 8, 1988 by

C.J.A. Versteegh, experts windpumps/team leader
F.J. Föllings, energy expert
T. Henssen, agro economist

A second mission from October 9, 1988 until November 4, 1988 by:

C.J.A. Versteegh, expert windpumps/team leader
H.P. Stekelenburg, industrial economist
M. Kuitert, electrotechnical mechanic.

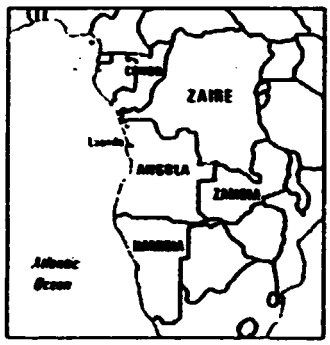
During the second missing 4 wind data loggers have been installed. The department of new and renewable sources of energy of the Ministry of Energy and Petroleum (DNFRE-MEP) has guided the missions.

To meet the objective of the study, a technical, economic and financial analysis has been made, based on:

- An inquiry regarding the state of existing windpumps in the fifth region.
- A preliminary inquiry on windregimes.
- An investigation of existing metal workshops.
- A market survey.
- A preliminary analysis of type and specification of a suitable windpump.
- An analysis of commercial prices offered by windpump manufacturers.
- A comparison between manufacturing windpumps in an existing metal workshop and an isolated plant.

The draft final report has been presented and discussed in Angola during a visit from 20-24 February by Mr. C.J.A. Versteegh (EIC) and Mr. V. Klykov (UNIDO). Minutes of the final meeting are presented in annex 10.

2.2 General data on the People's Republic of Angola



The situation of Angola in Africa is illustrated in the figure alongside.

The basic facts indicated below were derived from reference 1

Basic facts (June '87)

Area : 1,246,700 sq. km.
Climate : tropical to subtropical
Population : 9,1 Mn. (see details on page 5)

Ethnic groups	Ovimlundi	37%	Haneca and Humbe	3%
	Kimbundu	25%	Ovambo	2%
	Bakongo	15%	Mestico and European	2%
	Lunda Chokwe	8%	Other	2%
	Nganguela	6%		

Capital : Luanda

Language : Portugese

Workforce : Agriculture - 75%

Agriculture : (42% of GNP)

Products : carsave, maize, plantains, sweet potatoes, milk, milliet, citrus, beans, potatoes, sugar, beef, palm oil, sisal, coffee.

Industry : (28% of GNP)

Types : petroleum, mining, food processing, beer, tires, textiles.

Natural resources	:	petroleum, diamonds, iron, phosphate, copper, feldspar, gold, bauxite, uranium.
Form of government	:	Marxist People's Republic. Political Party: Popular Movement for the Liberation of Angola - Labor Party. President: José Eduardo dos Santos.
Administrative subdivision	:	18 provinces.

General economic data

Economic characteristics

Official conversion rate of kwanza.

	1983	1984	1985	1986
kw./1$	29,6	29,6	29,6	29,92

Table 2.1 is based on references 2 and 3.

Table 2.1

Macro economic indicators	1983	1984	1985	1986	1987
GDP at market prices Kz bn.	126,3	141,6	144,9[a]		
Rate of increase		0,12	0,02		
Population[b] mn.	8,2	8,4	8,7	8,9	9,1
GDP per capita (1000 Kz)	1,54	1,68	1,66		
Exports fob[c] $ mn.	1,587	1,960	1,976	1,278	2,300[b]
Imports fob[c] $ mn.	993	1,265	1,384	1,062	1,275[d]
Trade balance $ mn.	+ 594	+ 695	+ 592	+ 216	+1025
Overall balance $ mn.	- 34	- 57	- 236	- 447	
Gross Foreign Exchange reserves Total ($ mn.)	112	173	205		
Total external debt outstanding ($ mn.)	2358	2442	2700	3071	
Debt service ratio[e]	20,4	18,1	17,2	31,1[f]	

Table 2.1 Macro economic indicators.

footnotes on next page.

Economic System and Policy

Angola has a socialistic society, with a centrally planned economy. The key sectors of the Angolan industry as well as the large-scale agriculture are based on state-enterprices. Besides these enterprises, private ones exist as well. Wages and prices are set by the government.
The three year economic and financial reconstruction program, "SEF", which tries to create a more attractive climate to foreign investments in Angola has started in 1988. The program aims at more autonomy for the management of state-enterprises, and will stimulate the private initiative.
It is expected that this law will lead to changes in monetary-, pricing- and exchange-rate-policies.

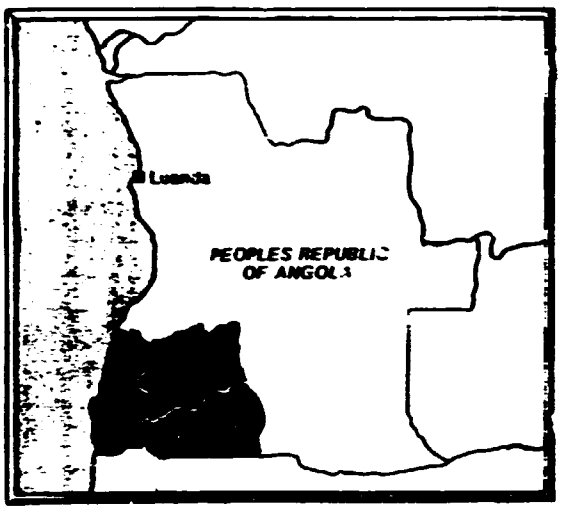
The Angolan government conveys a very careful financial policy. It aims to keep the foreign debt as low as possible. As a result of this policy Angola was able to pay its debt services until 1985.
This situation changed in 1986, when the decrease in oil-earnings, led to an increase in debts. In 1988 however it is expected that the oil-output will be twice as high as in 1986.
Also part of this policy is the attempt to spend as few foreign currencies as possible. For this reason imports are restricted to the most necessary.

Imports of consumption goods are charged with a tax of 20 per cent, but production goods are free of charges.

Footnotes for table 2.1

a) Provisional
b) Estimated
c) From balance of payments data
d) Official forecast
e) Long term debt service % total current accounts receipt
f) Including unrescheduled debt service not paid; excluding these arears the ratio was 16.4 per cent

2.3 Basic facts on the provinces Namibe, Huila and Cunene



The situation of the provinces Namibe, Huila and Cunene in Angola is illustrated in the figure alongside.

The basic facts indicated below were derived from references 3 and 4.

Basic facts

	Namibe	Huila	Cunene	Total
Area	57.090	78.992	78.956	215.038 (17% of total pop.)
Climate	tropical			
Population (1000) 1986	84	917	310	1108
Population per sq km	1,3	10,1	3,1	
Ethnic groups (rough division)	Herero	Nyaneka-Humbe	Ambo	
Capital	Namibe	Lubango	Ngiva	

3 RELEVANT ASPECTS OF THE SITUATION IN THE FIFTH REGION

3.1 Geographic situation

The fifth region, situated in the far southwest of Angola between the latitudes of 13 and 17 degrees south and the longtitudes 12 and 17 degrees east is composed of the provinces of Namibe, Huila and Cunene and covers an area of some 220.000 square kilometres.
Travelling west from the coast to the interior of the country, crossing the city of Namibe, one meets a succession of progressively higher plains where rocky hills exist.
At 150 kilometer from the coast the altitude is risen to 900 m reaching the escarpment marking the main plateau. This is the Serra da Chela which has its highest point at 2300 m. at Bimbe. In the Northern part of the region the plateau has an altitude between 1600 and 2000 metres. Towards the south the altitude declines steadily to reach 1100 metres on the frontier with Namibia.
In general three etnic groups inhabit the fifth region. The Nganeka-Humbe in Huila , the Ambo in Cunene and the Herero in Namibe.
For an extensive description see reference 4.

3.2 Rural population and means of subsistence

The extend of the rural population is difficult to estimate. According to reference 1 the rural population in the three provinces should be 695.000 in Huila, 39.000 in Namibe and 290.000 in Cunene. The department of planning estimates the rural population on 700.000 for Huila and 115.000 for Namibe. Because of the war situation the number of inhabitants in Cunene cannot be estimated.

In the north of Huila rainfed agriculture is well developed. Traditional farmers with about 10 ha of land produce 70-80% of the total production, mainly consisting of maize (55%), wheat and potatoes.
Some 5000 ha (4% of the total cultivated area) is irrigated with surface water by gravity or motorpumps.
Most of the traditional substantive farmers in this area also own some livestock. In the south of the fifth region extensive cattle raising is the main source of income.
One of the main problems is a lack of good drinking water for both human and cattle. Namibe, the southern part of Huila and the western part of Cunene traditionally has a nomadic population whose grazing territories are given in fig 3.1. Water needs are fulfilled by means of the so-called chimpacas and cacimbas. A chimpaca is a hole in the ground, used as a reservoir for rainwater while a cacimba can be compared to a shallow well.
A properly constructed and maintained chimpaca (fig. 3.2) can supply good drinking water if cattle do not enter the water. Between 1947 and 1973 some 1200 boreholes were drilled and for a great deal equipped with handpumps and windmills by the colonial government. The water was for free for traditional peasants.

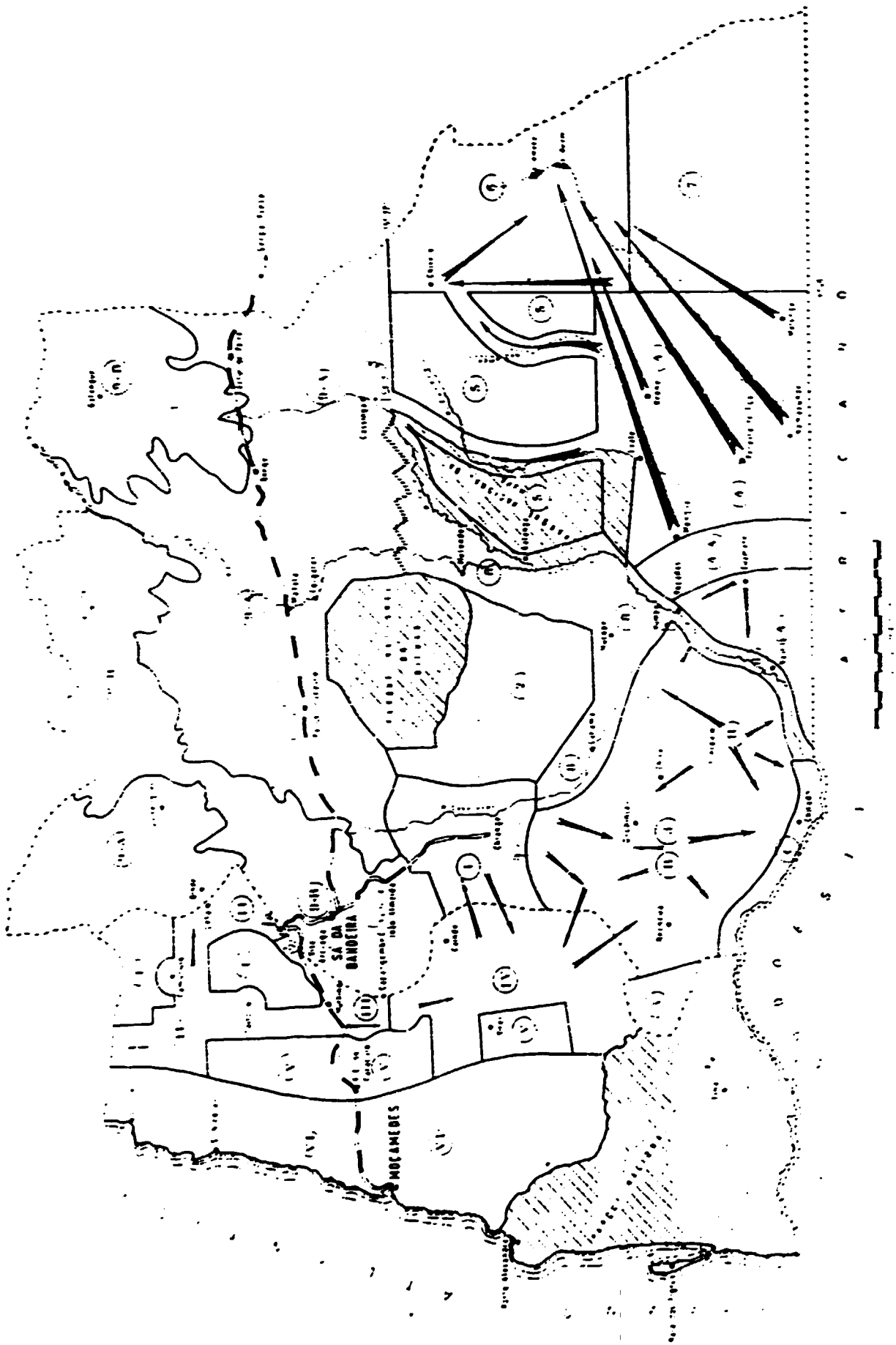


Fig. 3.1 Nomad routes in the fifth region

After independence in 1975 maintenance of water sources stopped leading to deminishment of quantity and quality of water. If handpumps and windmills stop functioning, people will drink from polluted chimpacas. It is estimated by the Ministry of Agriculture that 80% of the original water supply infrastructure is out of order. This percentage is increasing. Due to the war a lack of all kinds of goods in adequate quantities exist, regular trade channels do not function. As a result the number of cattle is increasing, thus causing local overgrazing near watersources. As an average, families have 40 - 60 cows while they can make a living out of 20 cows.
In tabel 3.1 the amount of live stock is given, based on data from reference 4 and estimations from the Ministry of Agriculture.

	cows	sheep	goats	pigs
Cunene and Huila	2.500.000	42.000	467.000	120.000
Namibe	300.000	40.000	570.000	17.000

Table 3.1 Live stock

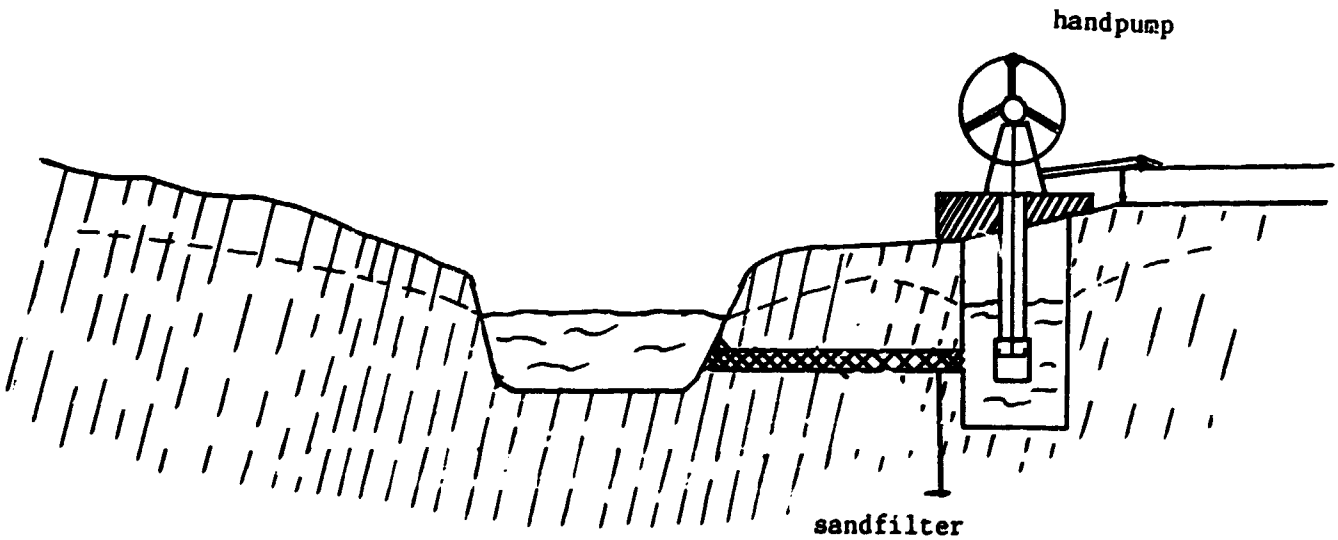


Fig. 3.2 A chimpaca or extraction dith with handpump.

3.3 Existing metal workshops

Before independence industry in the fifth region was developed close to the cities Namibe and Lubango (concentrated in their respective industrial estates). After independence most industry was nationalized and functioned directly under administration of the Ministry of Industry. Activities of private companies have been incorporated within the national programs, which have been set up by the Ministry of Industry. Changes and difficulties facing the country after independence have resulted in operational problems for industry. Little investment has occured in the last decade. Failure of equipment and shortage of supplies have resulted in a very low utilisation of installed capacity.
All relevant workshops in the region have been visited, as well as some in Luanda. Visited are Metalvi, EMIN, FATA/METANG and ALFAG in Luanda, Metafus, EMEL and CFM in Lubango and Ermanal and Metalomecanica in Namibe. In appendix A1 a brief description and analysis of these workshops is given.

From the companies in Lubango and Namibe currently only Metafus has in some degree an industrial production. Metafus is willing to produce windpumps or parts of it and possesses most of the necessary machinery and has foundry facilities. The company constructs its own buildings and the productivity is stimulated by offering good working conditions to the labourers e.g. free food. They also develop their own products or improve and build existing machinery e.g. handpumps. At the moment they are analizing a windpump in order to build one but progress is slow due a lack of engineers. One of the two directors is responsable for all technical matters, including civil constructions.
The Ministry of Industry is effectuating a development plan for the EMEL workshop resulting in an industrial production facility after 1990 for agricultural machinery.

At the moment EMEL is a sheet metal workshop with elementairy tools, not suited for windpumps. The navy work for the new buildings has started but it is doubtfull whether 1990 will be the first year of production. The project foresees in training and education of technicians and craftsman by foreign staff. According to the Ministry of Industry windpumps could be one of the products produced. EMEL will not have foundry facilities but contracts Metafus or C.F.M.

The supply of raw materials for windpump production by Angolan companies is very limited. Only FATA could supply galvanised tubes, but only of limited dimensions. FATA also produces corrugated iron of imported steel sheets. Thickness of these sheets allows limited use in windpump constructions.

From the 8 companies / metal workshops within the region only the partially private owned company Metafus has at present a minimum required level of workmanshop and equipment to develope an adequate (integrated) production facility of windpumps.
According to the development and investment plans for the state owned company Emel, this company should be in a position after 1990 to implement the production of windpumps, but as stated allready considerable efford and time will be needed to achieve this.

According to the investment plan Emel should have the disposal of all relevant machinery and equipment necessary for the production of windpumps. Metafus has 70% of the necesarry machinery, 30% of the machinery, for the production of windpumps (about $ 50.000,--) should be bought.
Both workshops will be analysed for the integration of windpump production.

3.4 Existing windpumps

In the colonial times a large amount of windmills were imported and installed especially in Namibe.
A survey done by Hidromina in March 1988 shows an actual situatin with 90 windpumps (3 in Huila, 7 in Cunene and 81 in Namibe). As to our own observation the data on the brand (fabricante) and the condition (estado) are not quit reliable (appendix A2). Most of the windmills were installed in the fifties and sixties on new drilled wells. Encountered marks are Climax, Adler, Southern Cross and Springbok, the latter being manufactured in South Africa. Two Bornays from Spain were recently installed by DNFRE. The pumped water in general is used as drinking water for both cattle as human. Storage tanks with a capacity between 40 and 160 m^3 are in use.

During the missions 28 locations were visited in Namibe and 13 in Huila. For safety reasons Cunene could not be visited. In appendix A3 a review is given of the visited sites. Of the windmills, installed before 1975 seventeen have been visited. Two of them were still in operation, but in very bad condition. It is estimated that about 50% of the visited windmills can be rehabilitated. In Namibe most of the locations are favourable for windenergy. In Huila and Cunene this will be less but it is estimated at least 50% of the total number of wells can be equipped with windpumps.

Officials estimate that in the past 250 windmills have been installed in Namibe. The rotordiameters vary from 10 feet to 14 feet (3 - 4,20 m.) and all are of the double geared type, using reciprocating pumps.

In colonial times maintenance and repair was done by the owner/user. The nearby communities' blacksmiths or metal workshops could give assistance. After the departure of the Portuguese, maintenance ceased and windmills as well as handpumps stopped functioning.

Apart from drilling wells the department of subterranean water resources Hidromina has the task to install and maintain waterlifting equipment. At the moment Hidromina has one maintenance team operational which is due to vehicle problems, not very effective. Hidromina confirmed that during the last 8 years practically no maintenance or repair has taken place, due to lack of skilled personnel, money, equipment and spareparts.

Repairs to be made in order to put existing windmills in operation again are:

- Lifting of the pump and replacement of worn or corroded parts, such as pump cups, valves and pumprods.

- Check of the tower, mounting of missing girts and braces, mounting of a new wooden tower platform.

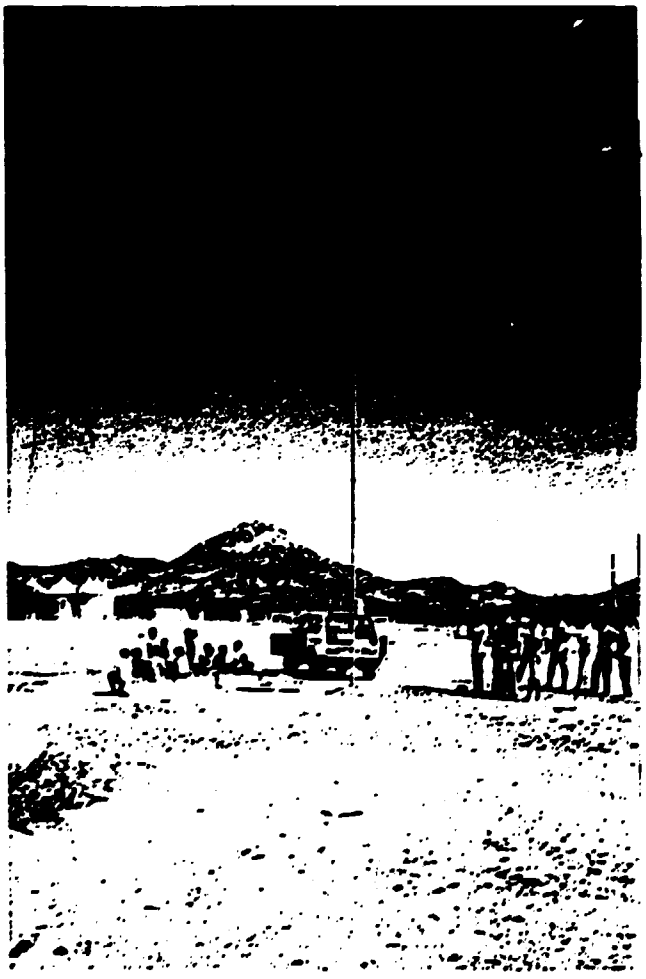
- Repair, cleaning, adjustment and lubrification of the furling and yawing mechanism.

- It depends on the state of the transmission if a complete overhaul is necessary or not. If the crankcase (head) still contains oil, bearings and gearwheels probably are in a resonable state. Cleaning of the mechanism and replacement of the seals will do in that case.

  Generally the condition of the windmills was reasonable, taking into account an operational life of 15to 30 years. All steel parts are hot dip galvanised and the cast iron parts are coated.
  Altough rust occurs, repaired windmills don't need further anti corrosion treatments to function at least another 10 to 20 years.
  If windmills are dismantled and re-installed an anti-corrosion treatment is advised.

A 14 feet Climax of unknown age. The windmill is reinstalled in 1981 in Mungolo, Humpata municipality in the province of Huila.

One of the wind data loggers, supplied and installed within the scope of the present opportunity study (community of Virei in the province of Namibe).



4. WATER AND WIND RESOURCES

4.1 Wind conditions

The quantity of water lifted by a windpump highly depends on the local wind regime.
A key-parameter to characterize the wind regime in the mean wind speed is eleborated in appendix A 5.

In the procinces Huila, Cunene and Namibe there are only two meteorological stations, one in Lubango and one in Namibe.
The stations measure the momentary (in stead of the average) wind speed and wind directions two times a day at 9.00 a.m. and 15.00 p.m.
For wind energy purposes these data are inadequate. However by lack of better, the measurements of recent years have been used to get some indication of the wind regime.

In Appendix A 5 the wind speed and wind direction of Lubango and Namibe are given from 1983 till 1988 for Namibe and from 1984 till 1988 for Lubango.
The data from Lubango in the first month's of 1984 appear to be very low and in the rest of the year very high. The latter is also the case for a large part of 1985 (see figure 4.1 and 4.2).

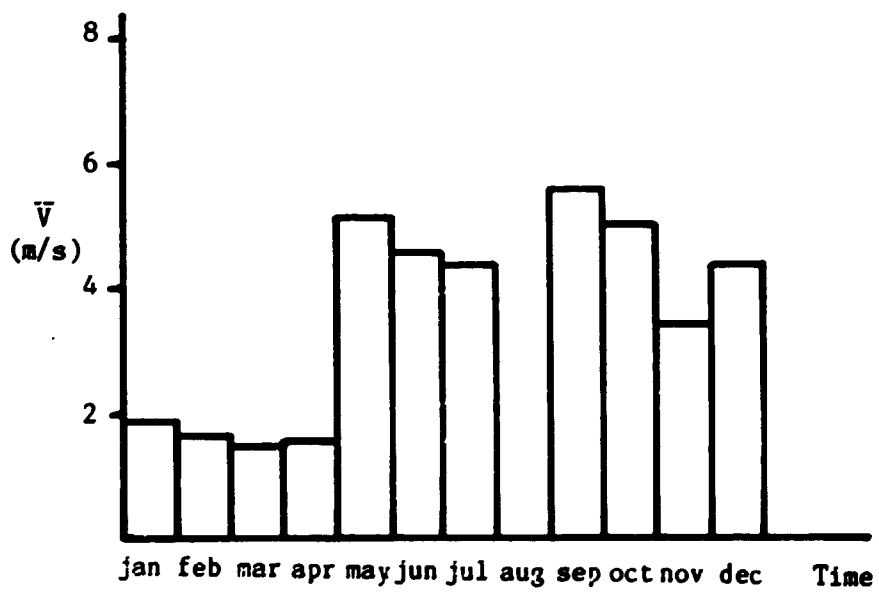


Fig. 4.1 Mean wind speed Lubango
1984 (m/s)

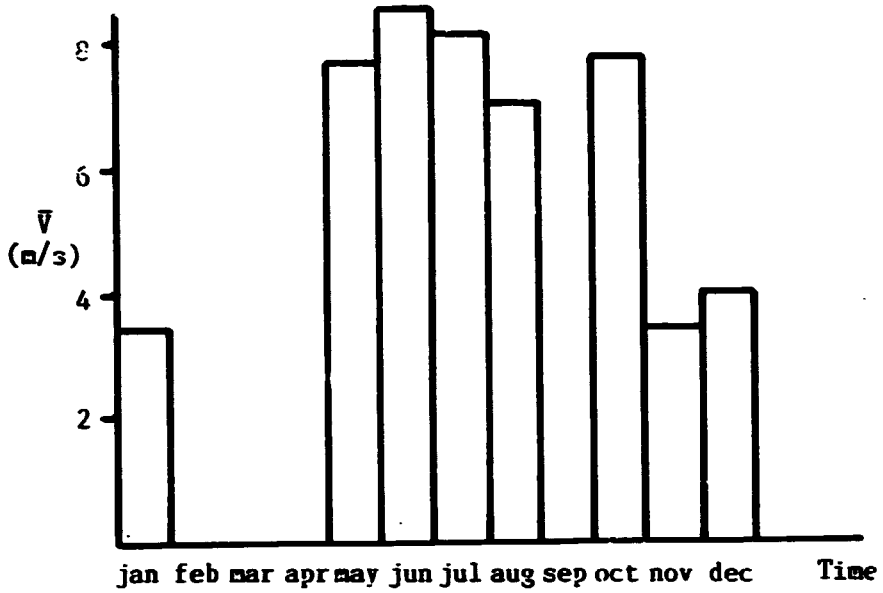


Fig. 4.2 Mean wind speed Lubango 1985 (m/s)

These relatively low and high values could not be explained by the used unity nor any other way. So finally for Lubango only the data of 1986 and 1987 have been used.

The distribution of the wind speed in seven classis (according to WMO-recommandations) is given in figure 4.3 and 4.4.

With special Weibull sheets the shape factor of the distribution can be determined as shown in Appendix A 5.

For Lubango the shape factor is about 2.0 and for Namibe 2.4.

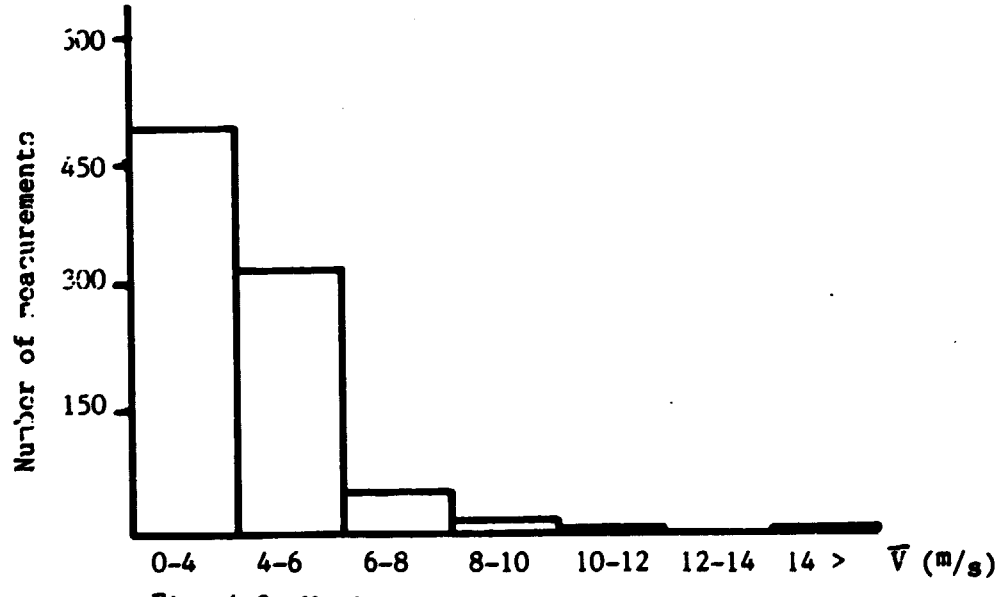


Fig. 4.3 Wind speed distribution Lubango 1986 t/m 1987

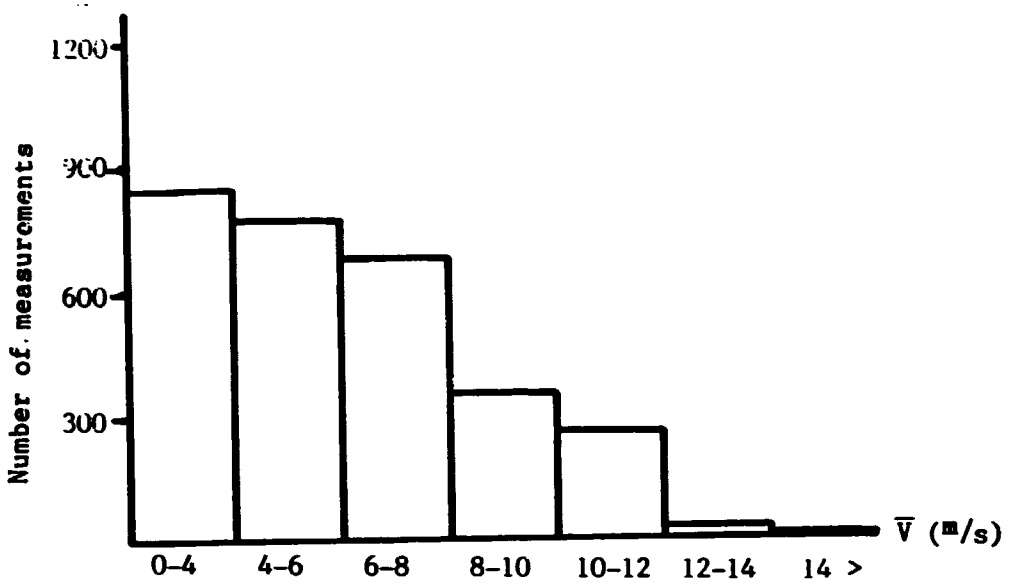


Fig. 4.4 Wind speed distribution
Namibe 1983 t/m 1987

In Namibe as well as in Lubango seasonal variation in the mean wind speed can be appointed as can be seen in figure 4.5 and 4.6.

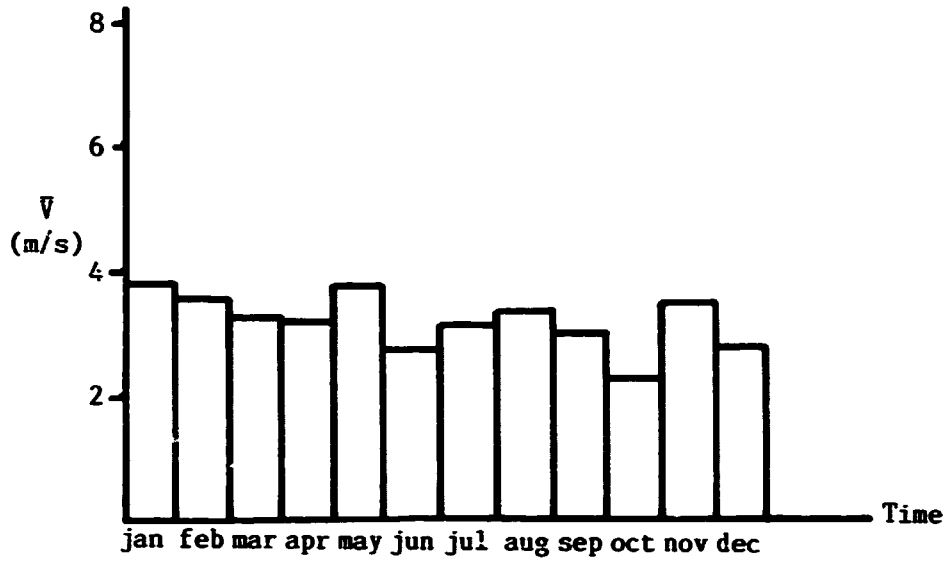


Fig. 4.5 Mean monthly wind speed during 1986 - 1987 in Lubango

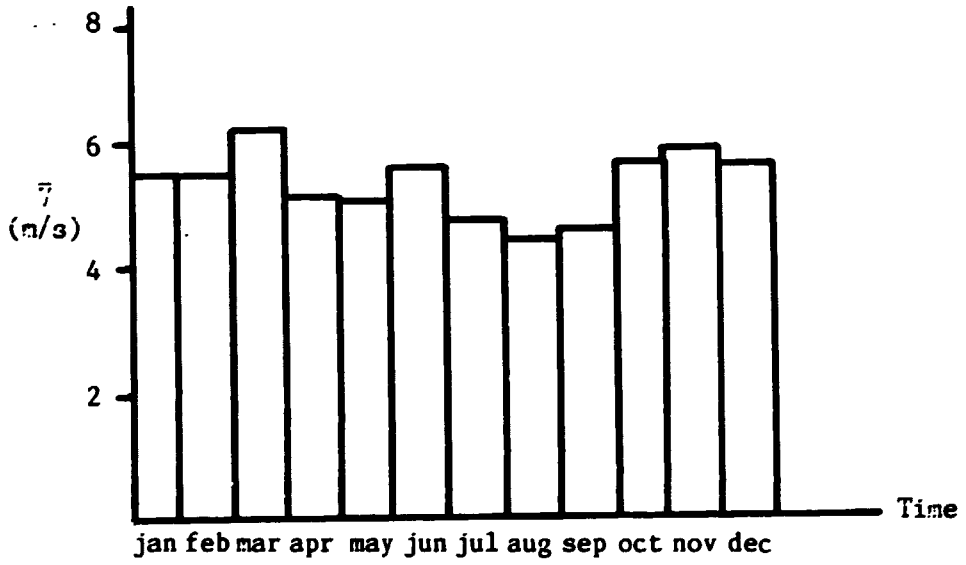


Fig. 6 Mean monthly wind speed during 1983 - 1987 in Namibe

In Namibe the annual average wind speed lies between 5.2 and 5.8 and in Lubango between 3.3 and 3.9 (see figure 4.7 and 4.8).
The cup-anemometer in Namibe is standing on the roof of the (approximate height 10 metre) on a mast of about 5 metre.
The surrounding of the airfield is very flat (desert) and the airfield is situated about 2.5 kilometre from the coast.
During the visit at the station it appeared that the anemometre had an off set of 1 m/s. Thus the measured wind speed has to be reduced with 1 m/s to obtain the real value.

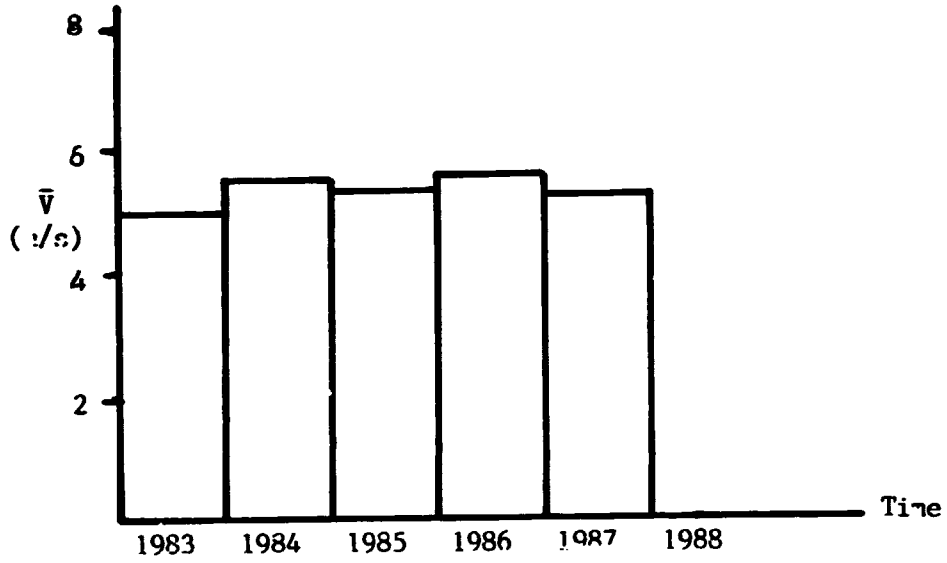


Fig. 4.7 Mean wind speed Namibe
(average 1983-1987 : 5,5 m/s)

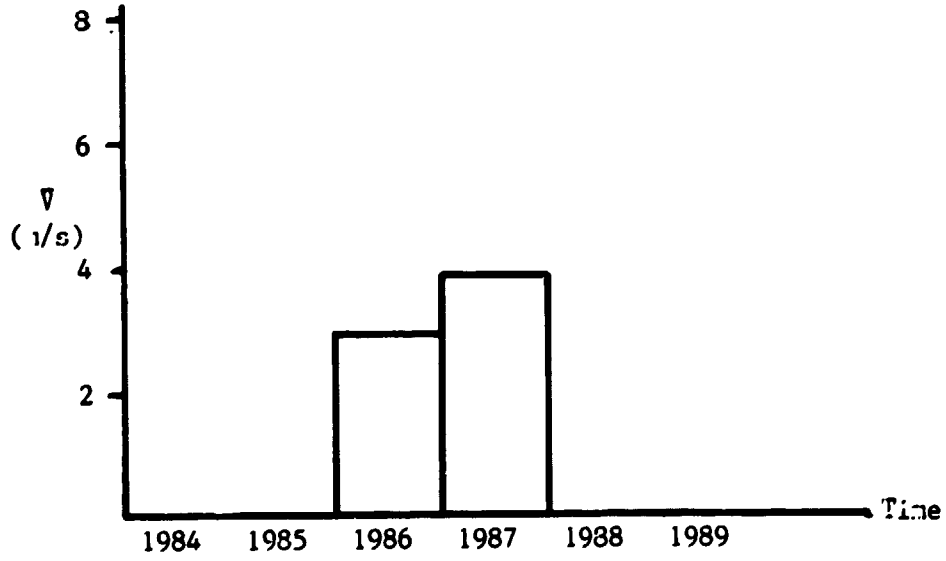


Fig. 4.8 Mean wind speed Lubango
(average 1986 : 3,3 m/s)

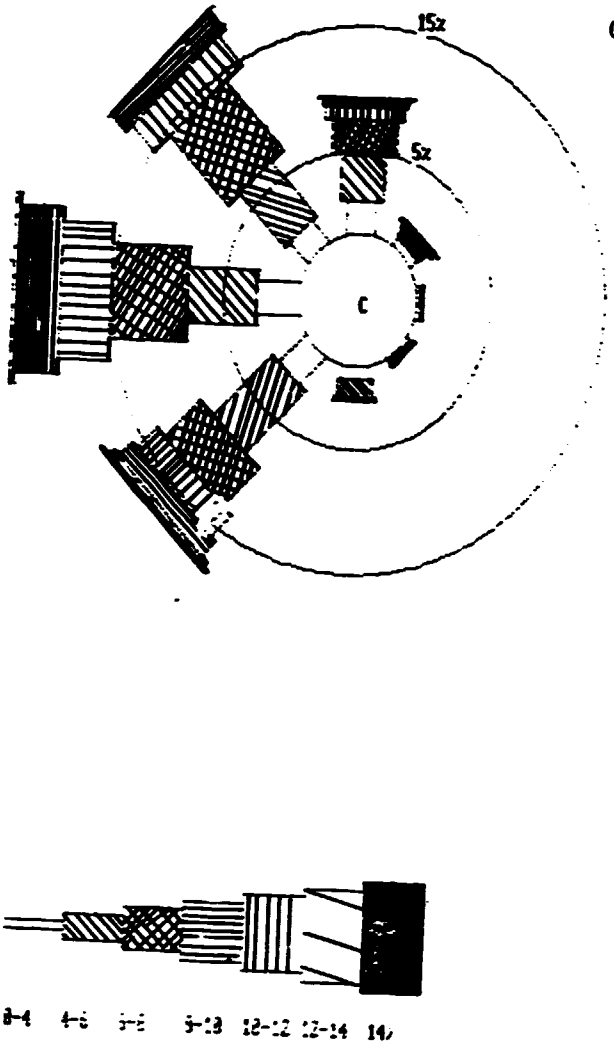


Fig. 4.9 Wind rose Namibe

The mean wind speed direction is from the West (coast) as shown by figure 4.9.

Probably heating up of the desert during the day draws air from the cool Atlantic Ocean (Benguela current)

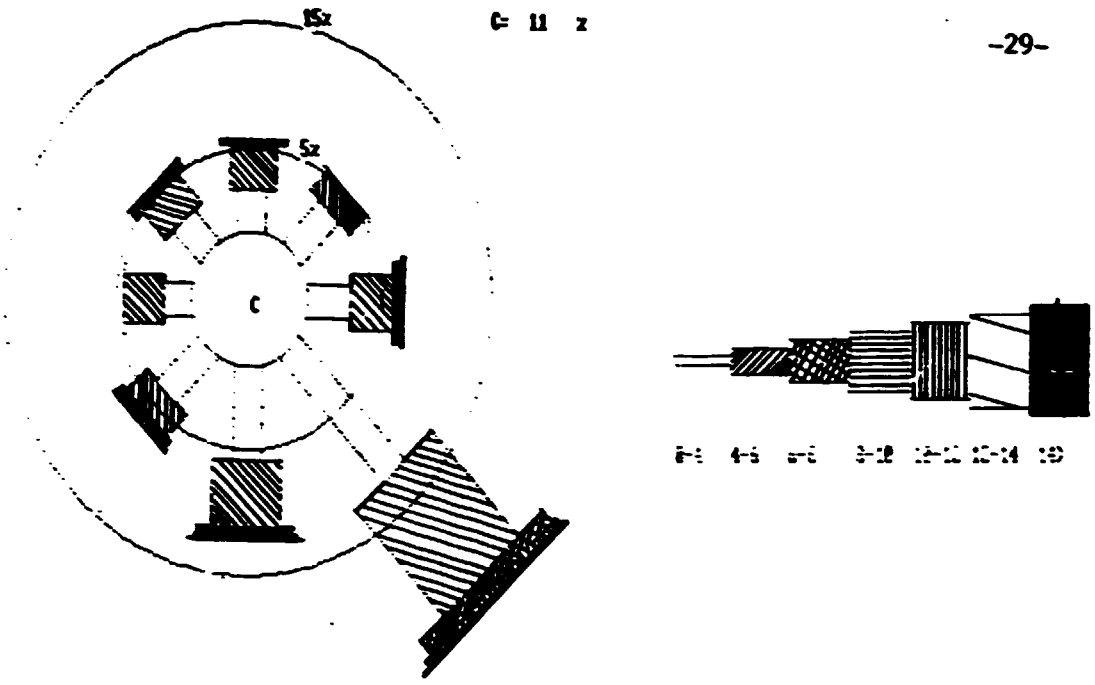


Fig. 4.10 Wind rose Lubango

In Lubango the dominant direction of the wind is South-East as shown by figure 4.10.

Probably this is a result of the "Hadly-circulation" see figure 4.11.

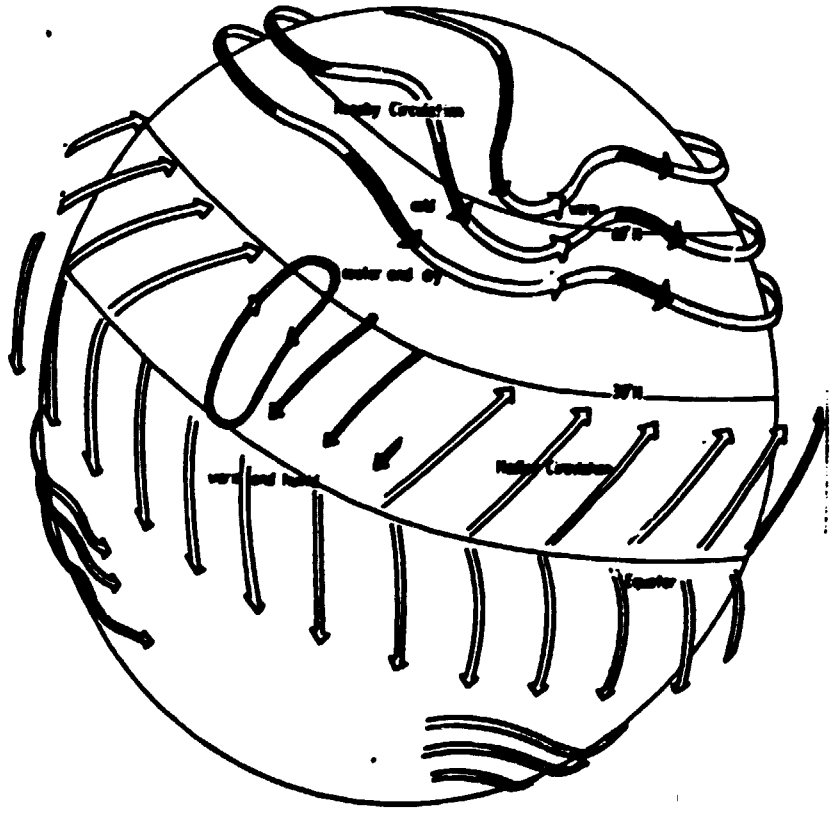


Fig. 4.11 Schematic representation of principal winds.

4.2 Water resources

A brief survey of the water availability in the fifth region is given in reference 1. Most important facts are:

- Of 1300 tubewells, drilled by 1976, 50% were not functioning anymore by 1982.
- Of 600 not working ones, only 290 are considered to be capable of being used after the installation of pumps. The remainder requires extensive reparation work.
- In Cuiene only 2 out of 153 wells were considered to be operational.
- According to a UNESCO/UNDRO mission of March 1982 in Huila 46C wells were functioning in areas, not affected by the war.
- Aquifers vary between 40 and 150 m. and resources should be sufficient for small scale irrigation purposes (reference 1).

Hidromina, resorting under the Ministry of Industry, meets a lack of means, materials and skilled personnel. Presently Hidromina is executing a program to drill 180 wells (UNICEF project). In 1987 19 wells have been drilled but the productivity has to increase to solve drinking water problems.

Drilling a well costs 1.500.000 kwz (USD 50.000) and cleaning a well 300.000 kwz (USD 10.000), as stated by Hidromina.
The maintenance of pumps is an acivity of Hidromina. The province has to aprove and pay for these activities, which have to be requested upon by companies, farmers or municipalties. Due to a lack of money, parts, means and skilled personnel Hidromina is unable to fulfill these tasks. The result is an increasing number of non-operating wells and pumps. Project proposals have been made for the aquisition of drilling equipment and technical assistance in order to strengthen Hidromina (UNTCD-Samilenko proposal).

Besides the UNICEF project an Italian project will start to rehabilitate 200 wells. Both projects have to be completed by the end of 1992. Furthermore the drilling of 80 wells in Cunene is proposed within the framework of the Food for Work Programme, but no timeschedule is known.

In reference 1 it is proposed that an inventory of existing wells in the fifth region should be executed, as well as an evaluation of the present pumps.
Some activities in this area have been carried out and are mentioned below.

- A survey on the condition of wells, equipped with windpumps executed by Hidromina in March 1988 (Appendix A 2).
  No conclusions can be drawn about the state of the wells.
- A survey made by the commissioner of the municipalty of Gambos where 95 wells are situated, of which 31 equipped with a handpump, urgently needing repair costing 62 million kwz. At the moment 4 wells are operational.
- In Chibia a survey has been executed on existing wells (phase II project pilote Chibia FAO TCP/ANG/4504).
  There is a total of 59 wells of which 7 working, 8 equipped with a motorpump, 32 with a handpump, 2 with a windpump and 17 without a pump.
  Probably 7 pumps are working but the study is not clear on this subject.

  Hidromina supplied data of about 1200 wells (Appendix A4). However a lot of wells are non-operational, the data are considered to be representive for future drilled wells in the same area and for pump-tests done on repaired or cleaned wells. The average of those data is given in table 4.1. For Namibe for a few wells only the static level was given. The dynamic level has been extrapolated from data of the other two provinces.

Province	Nº	Dynamic level	yield
Huila	345	34,6 m.	7236 1/h
Cunene	303	33,8 m.	6659 1/h
Namibe	414	21,8 m.	6650 1/h

Table 4.1 Average data of tube wells in the fifth region.

It can be concluded that on short term the following number of tubewells will become available up to the end of 1992 (conservative estimation)

New wells (Unicef)	180
Others	30
Rehabilitated wells	200 +
Total	410

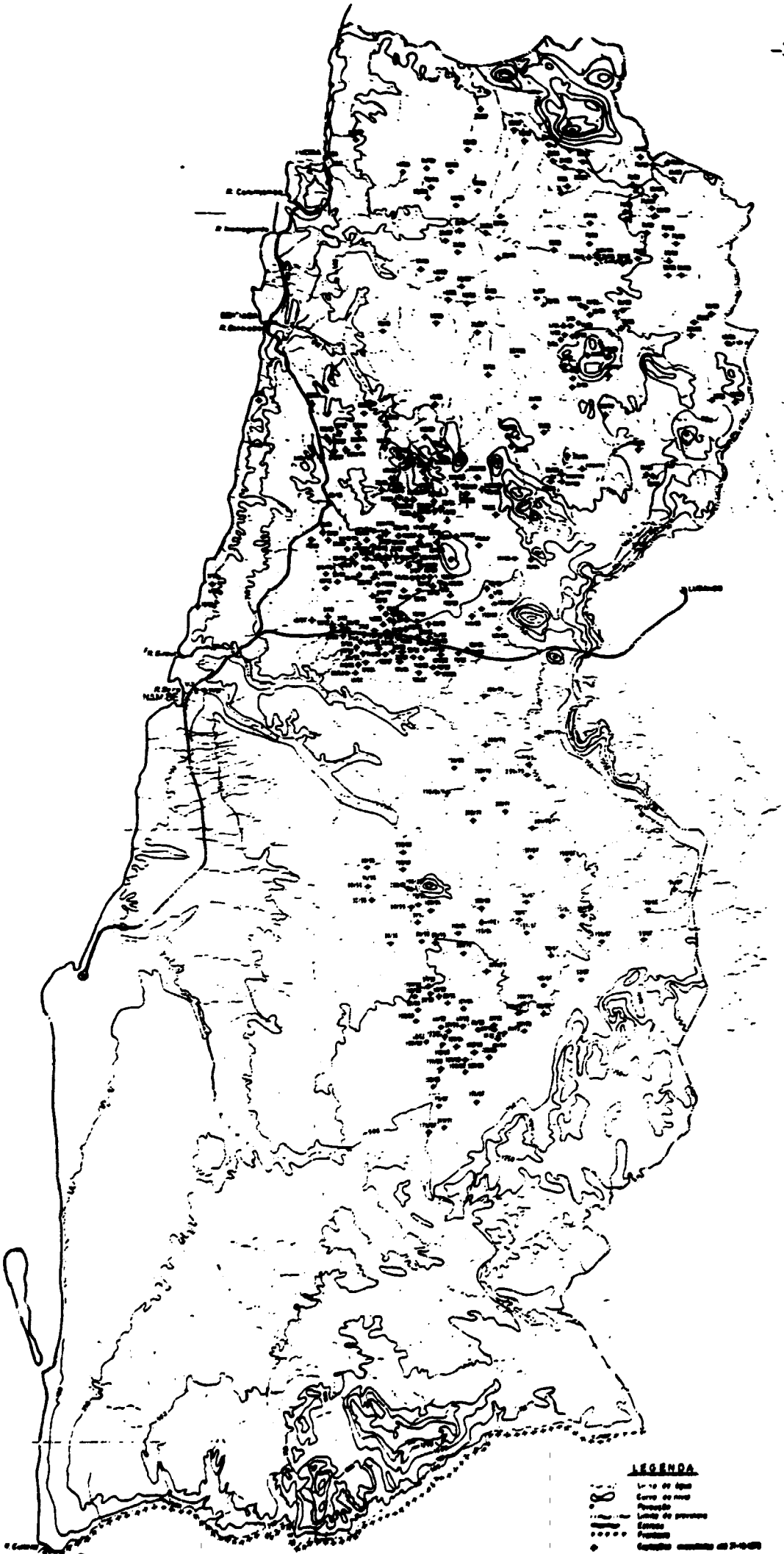


Fig. 4.12 Captacions in the province of Namibe

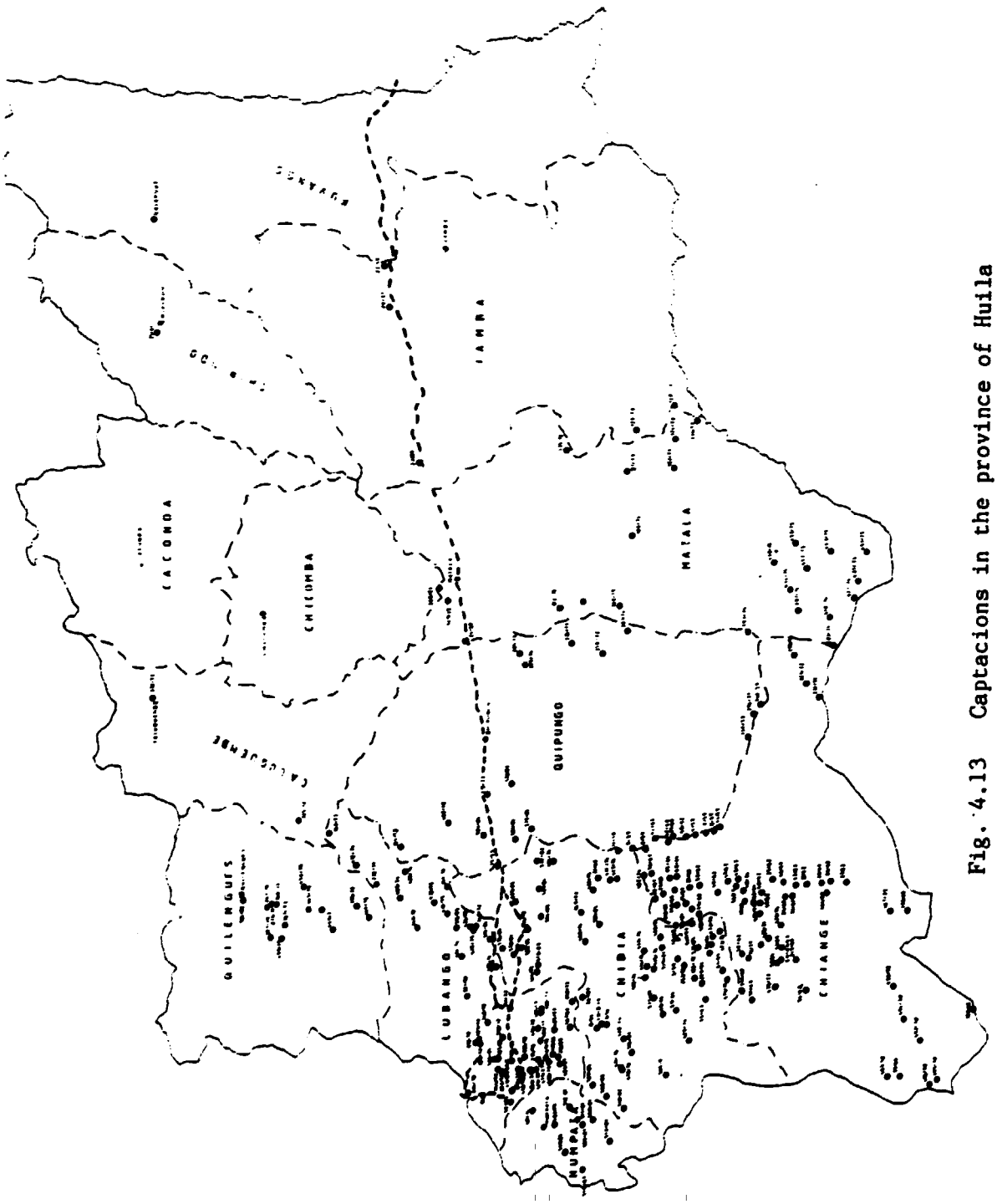


Fig. 4.13 Captacions in the province of Huila

5. WATER LIFTING EQUIPMENT

5.1 General

Water lifting devices exist in a large variety. Options which can be thought of are:

- handpumps
- windpumps
- solarpumps
- diesel- or kerosene pumps

Water lifting methods, based on animal- or human traction (except for handpumps) are not of interest for the considered region, nor exist a tradition in its use except for surface water lifting.
In this chapter the four mentioned options will be compared, focusing on the windpump.

5.2 Water lifting equipment

5.2.1 Handpumps

Generally waterpumping by means of handpumps is used for drinking water-purposes only, due to the limited pumping capacity.
Handpumps are widely spread in the fifth region, but meet a lack of maintenance which has put many of them out out of order.
Handpumps basically use the same pumptype as windpumps; a reciprocating pistonpump.
In fact, most of the windpumps are designed in such a way that in case of no wind, a pump lever can be linked, thus using the pump as a handpump. This option however is only interesting for private owners who have the knowledge and tools to do so.

On less windy spots with delivery heights of less than 20 - 30 m., a handpump is a good alternative for a windpump and can be made locally as well. However, in the case water has to be pumped for cattle as well, the capacity is not sufficient. For example, if a shepherd has to pump water for twenty cows from a depth of 20 m., he has to pump half an hour continuously.
The costs of water pumped with a handpump for more than 90% are wellcost in case of a tubewell. Waterprices will vary between USD 1,50 - 2,00 per cubic meter.

5.2.2 Diesel and kerosene pumps

The costs of motor pumps highly depends on fuel prices. At the moment however the biggest problems are the availability of spare parts and the supply of fuel. In nomad regions water pumps requiring an operator are not feasible as there is no tradition in using them by the local people. Maintenance intervals are short what is considered to be a disvantage in remote areas. Furthermore there is no fuelsupply in these regions.
For agricultural purposes motor pumps could be more feasible as more knowledge and means will be available. If the cost of storage tanks, piping and taps are included tube well cost stipulate 10% of the total costs. Waterprices will vary between USD 0,30 - 0,40 per cubic meter (1 liter of diesel = 12 kusanzas~ USD 0,40).

5.2.3 Solar pumps

In areas with a relatively high yearly average of solar radiation, solar water pumping can be competitive with conventional pumping systems.
Two systems can be distinguised:
- Thermal solar pumps.
- Photovoltair pump systems.

In case of a thermal solar pump solar energy is converted into mechanical energy by means of a closed thermal cycle. In reference 5 it is stated the techno-economics of mass-produced thermal solar pumps are comparable with conventional systems. The reliability however is judged not to be sufficient.
Photovoltaic pumps in Angola are operational and judged to be more reliable. In reference 5 a cost estimate is given of $ 0,40/m^3 for villages ranging in size from 1000 to 2000 persons. Most of the system has to be imported as sophisticated manufacture technics are needed. Besides civil works as storage tanks and supports only the frames for the solairpanels could be made local.

5.2.4 Windpumps

The price of water pumped by means of windenergy highly depend on the average annual windspeed. With a daily production of 30 m^3 and a lifting head of 40 m in areas with an average windspeed at 3 m/s water cost will be approximately USD 0,70 per m^3. For average windspeeds of 4 m/s with the same required production a smaller mill can be used and watercost lower to USD 0,45 per m^3.

5.2.5 Conclusions

Tube wells are expensive and if the well capacity can be met by a waterlifting device the lowest proces per cubic meter can be achieved. In regions with reasonable windspeeds and/or sufficient solar radiation, solar- and windpumps can compete with dieselpumps at waterprices of ca USD 0,40 per cubic meter. In most of the fifth region dieselpumps are no alternative as spares and fuel not available.

The government tries to encourage the use of solar and windenergy in remote areas as setting up a distribution grid is very expensive. In order to save foreign currency local production is preferable. Furthermore the availability of spareparts will be better and the out of operation periods shorter.

5.3 Windpumps

5.3.1 General description

Waterpumping by means of windenergy can be done in many different ways. Mentioned are electrical centrifugal deepwell pumps driven by a modern wind turbine; ejector type pumps using a compressor, directly coupled to the windrotor and a reciprocating piston pump directly driven by the windmill.
The latter, also called windpump, exists in a wide varity of designs and constructions. There are low cost designs, locally built with cheap materials as wood and cloth for the sails. Maintenance and repair is done by the owner or user, a farmer who generally uses the mill for irrigation.
In Angola windpumps are and will be installed in remote areas and will be used for drinking water purposes. For this application a reliable more expensive design is needed, with a minimum of maintenance and repair.

The type of windpump which meets these demands is the multibladed windpump as has been designed some eighty years ago and has changed little since. The rotor has numerous blades and thus generates a high torque compared to a fast running rotor with two or three blades.
Windpumps of this design (fig. 5.1) can be divided in direct acting mills and geared mills. In case of the former, the pump is directly coupled to the crank of the rotor. The latter type uses a reduction in order to limit the number of strokes of the piston. In general this is necessary for small rotor diameters as the optimal speed of the blade tips is independent of the rotor diameter.
Double geared windmills are manufactured up to rotor diameters of 16 feet (4.9 m.). Bigger wind pumps (up to 30 feet - 9.1 m.) are direct acting. For rotor diameters above 30 feet mechanical and physical restrictions become too big and electricity generating wind turbines could be used.

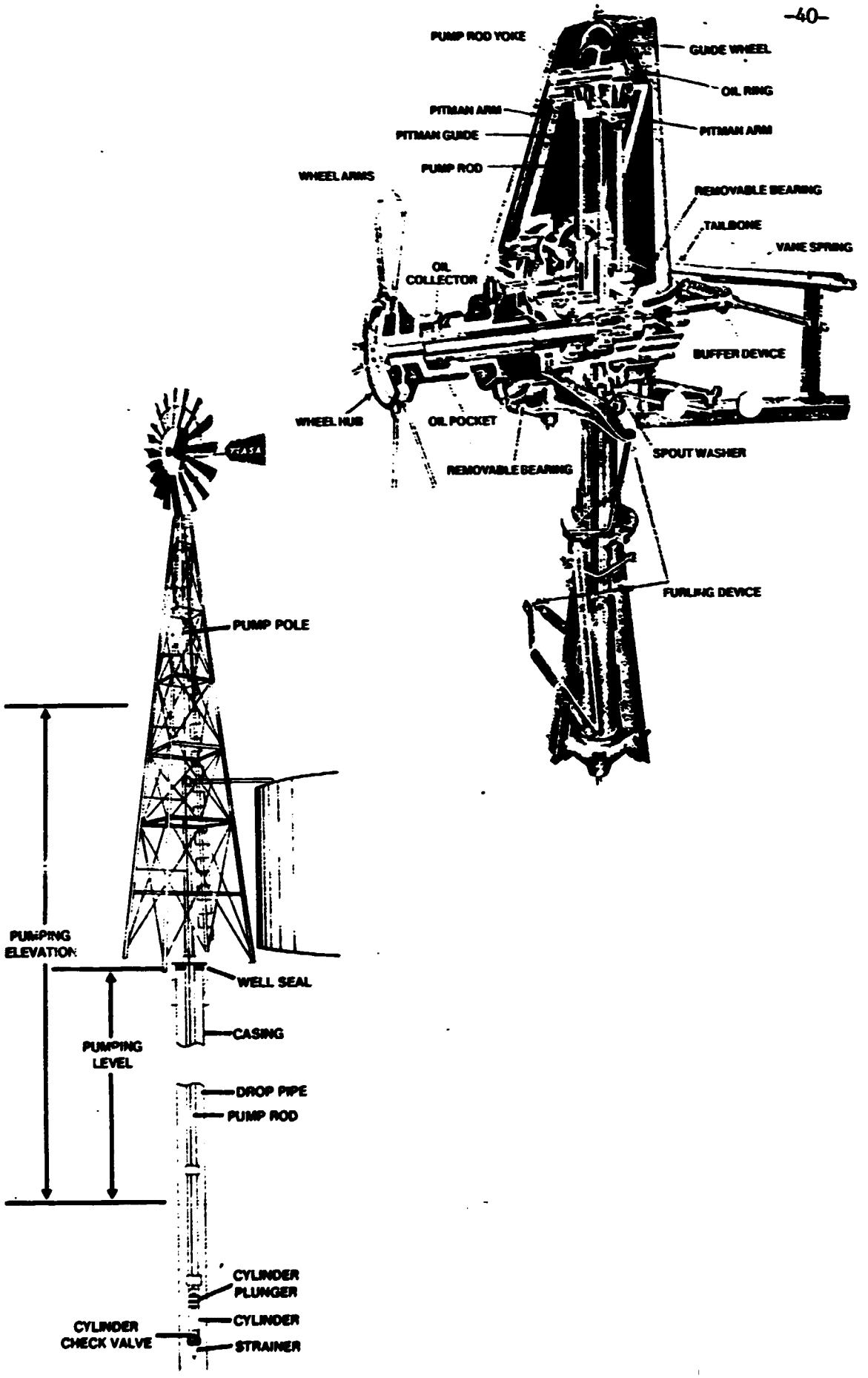


Fig. 5.1 Classic geared windpump

The meteorological station of Lubango uses a cup-anemometer on a 10 metre heigh mast.
The station is situated on a hill next to the local prison.
The surrounding is very rough. At 20 metres from the anemometer there is standing a 2 m. high wall in the dominant wind direction, behind this wall lies the prison.

The wind regimes in Lubango and Namibe are not related, as indicated by the difference in dominant wind directions. It is likely that the abrupt leap in altitude between both provinces is (one of) the causes of this uncoupling.

The altitude and distance to the coast of Cunene are comparable with those of Huila.
Therefore for the time being it is assumed that the average wind speed in Cunene has the same order of magnitude as in Lubango.

To obtain more suitable wind data it is necessary to monitor the wind speed on several locations in the mentioned provinces. The best way is recording the wind speed distribution.
Suitable locations have a flat surrounding with few obstacles and with wells in the neighbourhood. In Caraculo and Virei in Namibe and Chiange and Lufinda in Huila, windrunmeters have been installed. For safety reasons locations north and east of Lubango as well as Cunene could not be visited but also in these regions, on suitable locations anenometers should be installed.

The rotor rotational speed and axial thrust force on the rotor are limited and regulated by turning the rotor side ways to be achieved by means of a hinged vane. The regulations and safety systems are based on a balance between the yawing moment caused by the axial force on the rotor and an opposite moment provided by the inclined hing- or spring loaded vane.
The mill can be closed down by means of a furling mechanism to be activated on ground level.
Based on the same design concept last decades lighter-weight and cheaper windpumps have been developed (fig. 5.2 and 5.3). These windpumps are simpler to manufacture and assemble and claim to have a better performance than the classic designs. Cast iron parts are avoided and grease lubrificated roller bearings are used instead of oil-bath lubrificated sleeve bearings.
Some designs have the reduction eliminated by allowing a higher rotational speed. The higher pumprod forces have to be limited by using air chambers. For use in boreholes physical restrictions make it difficult to apply airchambers and thus the use of this design.

Of these "cost-effective" designs it is known that they are not as proven and reliable as the classic designs what means shorter maintenance intervals and higher maintenance and repair costs.
The pump is of a simple design, usually equipped with flat valves and leather piston cups. The materials used are bronze, cast iron, galvanised steel or stainless steel.

The I.T. Windpump

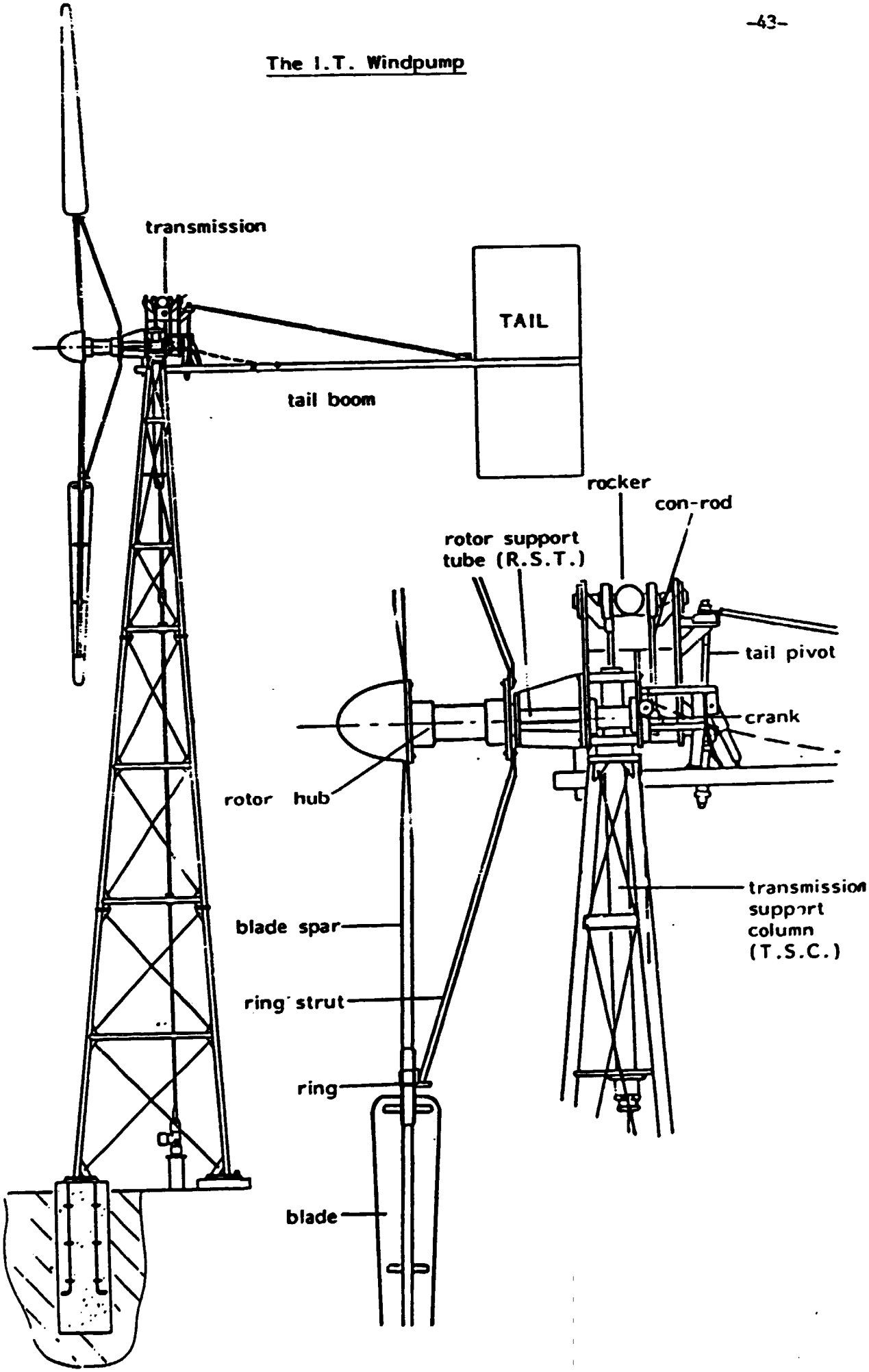
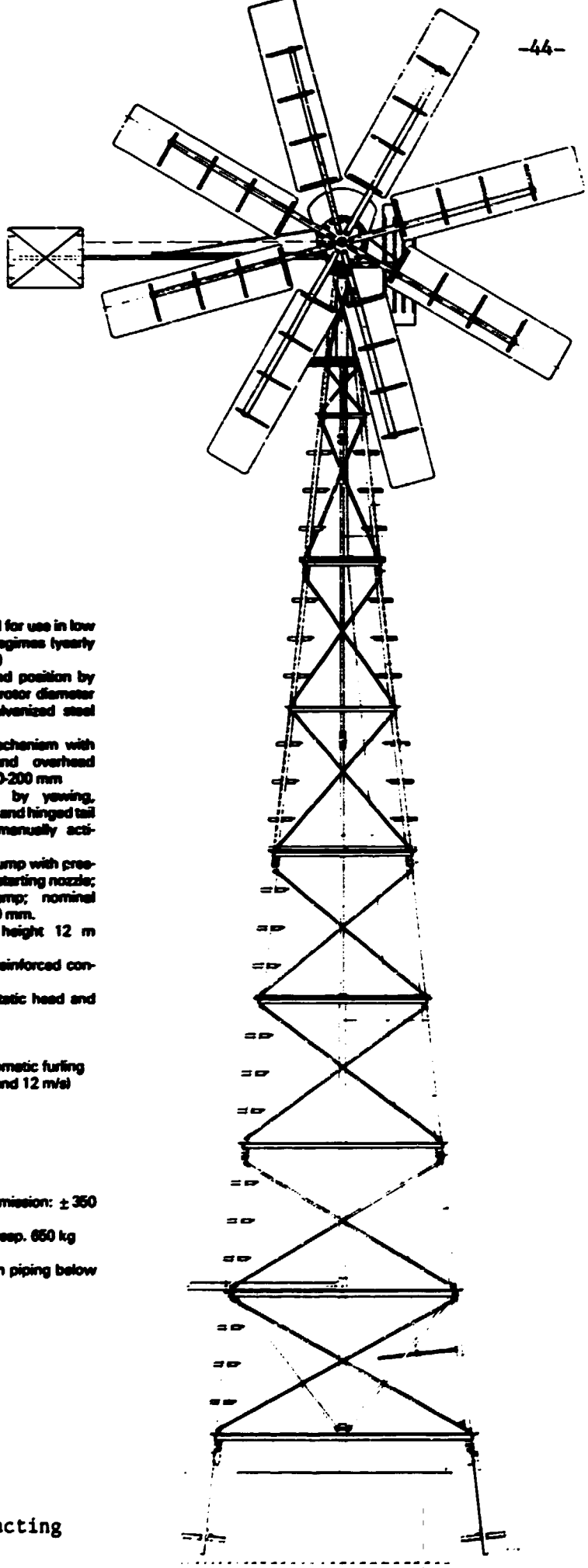


Fig. 5.2 Modern direct acting windpump (6 en 7,5 m. diameter).



CWD 5000 LW

PURPOSE	: water lifting; designed for use in low and moderate wind regimes (yearly averages below 6 m/s)
ROTOR	: horizontal axis; upwind position by means of a tail vane; rotor diameter 5 m, 8 blades of galvanized steel sheet; fixed pitch
TRANSMISSION	: direct drive crank mechanism with adjustable stroke and overhead swing arm; strokes: 80-200 mm
CONTROL SYSTEMS	: over speed control by yawing, activated by side vane and hinged tail vane system; with manually activated furling device
PUMP SYSTEM	: single acting piston pump with pressure air chamber and starting nozzle; galvanized steel pump; nominal pump diameter of 150 mm.
TOWER	: lattice steel tower; height 12 m (alternative 9 m)
FOUNDATION	: requires about 1 m³ reinforced concrete per leg.
CAPACITY	: 50 m³/day at 20 m static head and 4.5 m/s wind speed.
OPERATING WIND SPEEDS	: -cut-in : 4 m/s -rated : 9 m/s -cut-out : 12 m/s (automatic furling between 8 and 12 m/s) -survival: 50 m/s
AERODYNAMIC PROPERTIES	: -λ (design): 2 -Cp (max): 0.35 -solidity: 0.34 -typical design wind speed: 4.5 m/s
WEIGHTS	: -rotor, head and transmission: ± 350 kg; -tower: 460 kg (9 m) resp. 650 kg (12 m) -pump including 25 m piping below ground level 280 kg

Fig. 5.3 Modern direct acting windpump

5.5.2 Main components

Below follows a brief description of the main components of a windpump.

The rotor

In fig. 5.1 and 5.2 some examples of rotors are given, which all have in common curved steel plate blades mounted on a structure of galvanised pipes or rolled angle iron rings. The hub of this structure is bolted or keyed to the rotorshaft.
The classic design uses cast hubs, while modern designs use welded hubs from steel plate or tube.
Machine operations are cutting, rolling, bending and drilling what can be done on universal machines.

The head construction and transmission

The main body of a windpump is the head frame, normally an iron casting which needs some machining to fairly narrow tolerance, especially for the rotorshaft line up. Where the classic design uses oil-bath lubrification for transmission and bearings, the modern design uses a welded support from angle iron or tubes, carring bearing blocks (for a detailed parts list see annex 8).

As a result, all modern designs all are of the direct drive type as gears are difficult to integrate in such a head construction.
The crank case of a classic design is a rather complicated part to cast. A welded one of steel plates can be an alternative.

Machining can be done in universal lathes and simple milling machines. Manufacture operations such as drilling and threads production could be carried out with a simple pillar drilling machine and hand tools.
As foundry facilities are available simple parts could be cast such as connecting rods, gearwheels and other small parts.
As no special steel qualities are required, normal carbon steel will meet the specifications.

Yawing and furling mechanism

The yawing and furling mechanism consists of the vane assembly, a lever mechanism to swing the vane over 90 degrees and an operating mechanism consisting of a hand whinch or wooden lever and a steel wire chain or cable with guides. Main materials are sheet, angle and strip iron. Principle machine operations are cutting, welding, drilling and bending. The yaw bearing assembly varies from bronze sleeve-bearings to balls or rollers in cast iron housings.
The bearing parts can be machined on a universal lathe and a high accurracy is not required.

The tower

The tower usually is a 3 or 4 legged lattice tower of angle iron bolted together. The girts are also of angle iron when the braces are of angle iron for the bigger mills and strip or wire for the smaller ones. A tower can be produced by relatively low skilled mechanics.

The pump

Commercial available pumps are cast, some all bronze, others with cast iron cylinders and bronze linings. Pumps of this type, have a proven reliability and the lifetime of the leather cups is good. The pumprods are of round galvanised mildsteel. Parts can be machined on a universal lathe.
Modern designs try to avoid foudry technics and use appropriate technologies or imported parts such as stainless steel or bronze cylinders. As foundry facilities are available the classic design could be used.

5.5.3 Manufacture

Although a windmill seems to be a relatively simple piece of machinery, especially the production of the head, the transmission and the pump needs a good level of skill to guarantee reliability and a sufficient long lifetime, as well as the interchargeability of parts.

Regarding the type of the end-use of the windpumps, the production should be based on a fully developed, reliable, windpump design rather than a newly developed one.
Main components such as rotor, yawing and furling mechanism, tower and parts such as pump rods can be made locally. During the first two years of the production it will be necessary to purchase parts from a foreign windpump manufacturer according to table 7.1 in order to build up the local production of these parts gradually. On this basis skill and capability of the metal workshop can expand gradually while a fast start-up of the windpump production is achieved.
The development and implementation of adequate manufacturing technologies regarding the gradual substitution of imported components and parts requires foreign technical expertise. Within the scope of this development one has to decide if components like cranck case and wheel hub should be welded or casted.

Initially the production will be based on a 14 feet (4.2 m) geared windpump. On the longer term there is a need for different rotor sizes. The bigger types with rotor diameters above 5 m. are not more complicated but due to the dimensions more difficult to handle. A comparison between the classic design and modern direct acting mills show a 50% weight reduction for the latter. For the manufacture of a bigger type it is advised also to consider the use of a modern design.

6 MARKET AND PLANT CAPACITY

6.1 Product specifications

Windpumps are and will be used in remote areas, where service and maintenance intervals have to be large in order to limit exploitation costs and out operation periods. A high reliability of the windpump is the main selection criterium.

For this reason the windpumps under consideration are of the classic type, with a minimum of frequently changing parts and a minimum of operational failures. The only parts to be replaced with some frequency are the pumpcups.
The maintenance interval is determinated by the yearly oiling interval. The lifetime of the pumpcups is variable but one year is considered to be the minimum. As an illustration: some windpumps in Angola have been pumping for ten years with the same pumpcups without any maintenance.

In appendix A 7 an analysis has been made of the required rotorsizes in relation to the ground water resources. In order to match the windpump diameter to the well capacity, a range of windpumps with different rotorsizes should be available.
To reduce the number of different rotorsizes to manufacture, taken into account the water needs and the different windregimes the 14 and 25 feet windpumps are most indicated.

6.2 Applications

The average capacity of a 14 feet and 25 feet windpump is given in fig. 6.1 and table 6.1. Main parameters herein are the average windspeed and the rotordiameter. The output prediction is based on the average pumping height as given in chapter 4.

For drinking water applications it is assumed that human beings consume 25 liters per day if the water has to be carried home (reference 6).
For live stock the water needs are given in tabel 6.2.
For agriculture purposes an average water need of 60 m^3/day is assumed to irrigate 1 ha (ref. 7).
In Huila and Cunene this demand can be fulfilled with big windmills (up to 25 feet). In Namibe the same windmill seize can irrigate 2,4 ha. due to better windconditions.

Other applications such as traction of small agricultural machines are possible but only known as private initiatives. In this area no commercial activities are known. The bottleneck is the available shaft power (range 120 - 340 Watt as an equivalent of the average water output) which is relatively low and not constant. Except for waterlifting no other applications will be considered.

Resuming, three main categories of windmill applications can be indentified:

1. Windpumps for human drinking water in the rural, sprawling settlements and nomads areas.

2. Windpumps for sedentary farmers in behalf of irrigated agriculture and live stock watering.

3. Windpumps for nomads in behalf of live stock watering.

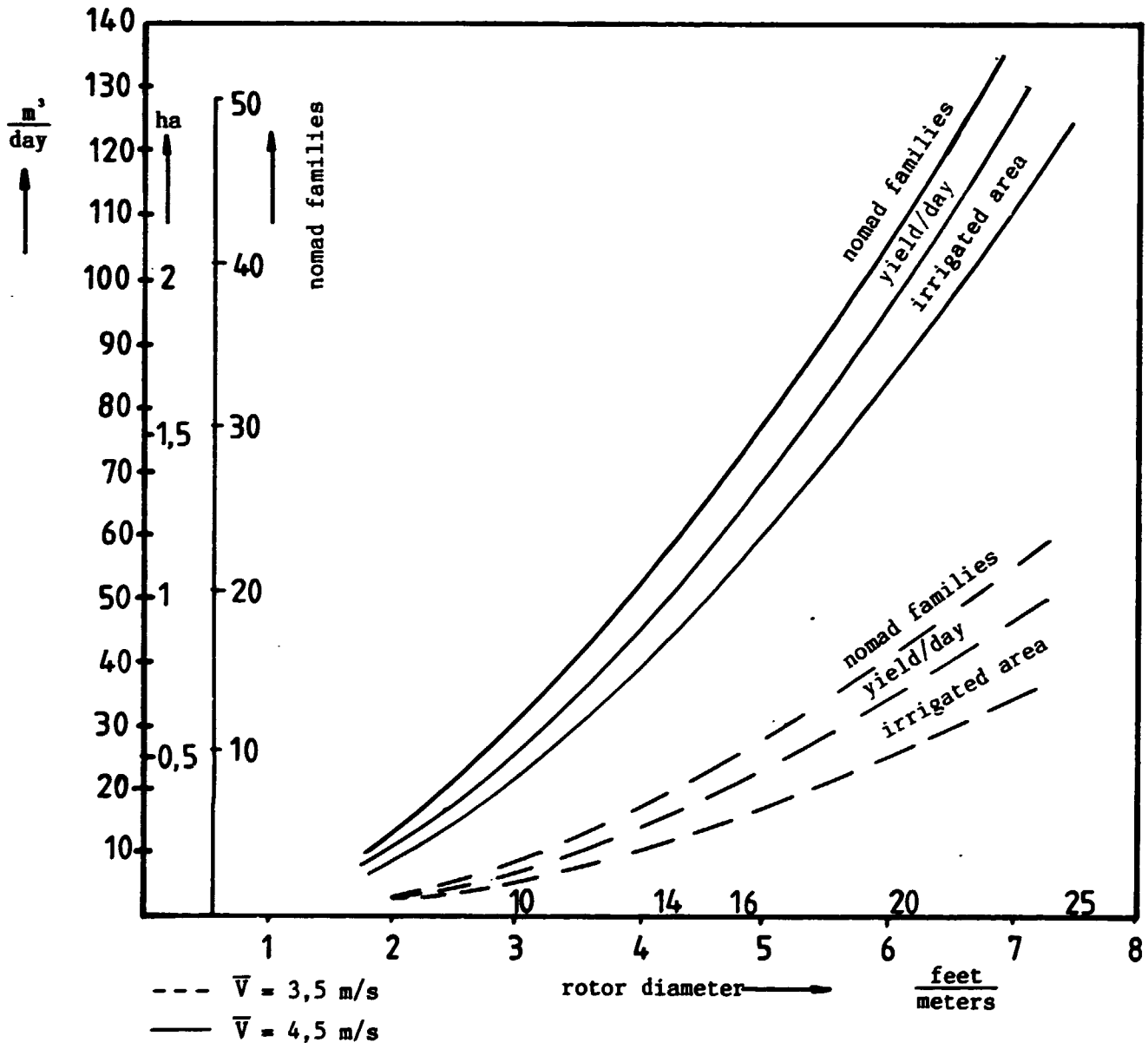


Fig. 6.1 Production as a function of the rotordiameter for the windregime of Huila (- - -) and Namibe (——)

	Pump A (14 feet)		Pump B (25 feet)	
	Namibe	Huila/Cunene	Namibe	Huila/Cunene
Daily yield	50 m^3/day	16 m^3/day	132m^3/day	50 m^3/day
Irrigateble area	0,76 ha	0,23 ha	2,20 ha	0,76 ha
Livestock cows 40 l/day	1150	350	3300	1150
Families 5 persons 125 l	368	112	1060	368
Nomadic families livestock and human beings	22	7	63	22

Table 6.1 Applications of windpumps

Species	Liter of water/day
Horses	30 - 40
Cows	20 - 40
Milk-cow in production	70 - 100
Sheep and goats	1 - 5
Swine	3 - 6
Lactating sow	25
Poultry	0,2 - 0,3

Table 6.2 Water need for livestock

6.3 Demand present and future

Obviously a potential demand for waterlifting equipment exists which cannot be fulfilled at the moment, due to a lack of imports and production.

The demand on short term is concentrated on the main categories 1 and 3 (human drinking water and live stock watering). At the moment no small scale waterpumps are used for irrigation. There also is no tradition with it. There is an urgent need for the reconstruction of the infrastructure in relation with the rehabilitation of about 1200 boreholes made before independence and equiping these with pumps in order to meet the present water need. This has been recognised by the central and local authorities to be a top priority.

Fieldtrips and study of the windclimate show that about 50% of the present boreholes can be equipped with windpumps (chapter 3.4). This leads to the following number of windpumps to be installed: Namibe 320, Huila 170 and Cunene 110, totally 600 windpumps.

It is stated by the Ministry of Agriculture that in nomad areas urgent lifestock water needs could be supplied by installing windpumps at distances of 15 km.
Not taking into account the national parcs, it is estimated that one third of the fifth region is used by nomads. This also leads to a total demand of approximately 600 windpumps, what should be needed on short term to meet priorities set by the government.

The short term demand for windpumps can be fulfilled according to the progress of the restoration of the infrastructure (reparation of water tanks, cleaning of tubewells etc.).
When production of windmills starts, first locations could be available to start installation.

According to the water consumption data of par. 6.2 and the population and livestock data of par. 3.2 the total demand for windpumps is estimated to be 1200 windpumps. In this case drinking water needs for livestock and human beings in remote areas is fulfilled by means of windenergy. In Huila and Cunene the introduction of bigger windmills (25 feet) will be necessary due to less favourable windconditions.

The development of irrigated agriculture can cause a demand for windpumps on the long term.
A priority set by the Government is the reduction of the present level of food imports. For this purpose a reconstruction programme has been proposed, aiming at:

1. the production of maize, being the staple diet of the local population.

2. the achievement of production volumes that generate surplus of subsistence needs in order to feed the expanding urban populations.

3. the providing of the necessary support and infrastructure for resettlement of farmers.

In this respect the development of rainfed agriculture has short-term priority because of its substantial potentials. New irrigation developments with national resources is considered a long-term priority. It takes a long time to create a tradition of irrigated farming, which could contribute to the mitigation of the crises concerning local rural food supply and the commercial exploitation of high value crops. Some preparatory projects for the development of irrigated agriculture have been planned.

North of the 15° parallel rainfall is sufficiently reliable for the cultivation of crops like maize and potatoes. Irrigation should in the first instance be focused on the area south of the 15° parallel where rainfed cultivation, besides some fast maturing crops like millet, pulses or sorghum, is not possible.

Within the total investments, needed for irrigation of 1 ha., pumped from a borehole the windpump is not a dominating part, as is showed in fig. 6.2.

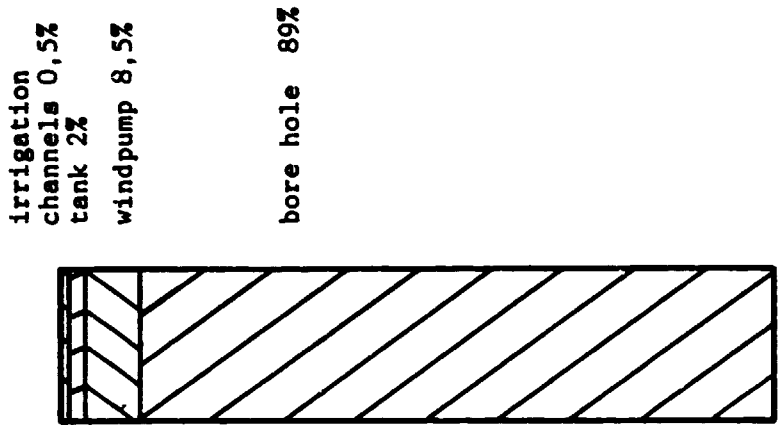


Fig. 6.2 Investments, needed for the irrigation of 1 ha.

Boreholes with good capacities should be equipped with pumps of sufficient capacity to atteign an economic exploitation. From the present wells in Namibe 51%, in Huila 36% and in Cunene 27% have a capacity meeting the maximum pumping capacity of a windmill.

Some remarks are:

- In an economic evaluation motorpumps have to be considered as an alternative as more infrastructure will be needed in case of irrigation than for cattle raising.

- Near rivers irrigated agriculture always will be more feasible compared to drier areas where boreholes are needed.
  In a situation of high pumping rates and low delivery heads windpumps are not recommanded, taking into account the average windspeeds.

- Irrigation projects on a small scale (1 ha) don't have a high priority as food supply is the first priority.

Based on these findings it is concluded that there is no obvious windpump market for irrigation purposes on the short term. On the longer term small scale irrigation could be developed and could form a market. This market, which could develop end 1990's is difficult to quantify at this stage.

6.4 Market volume

Based on the analysis made in par. 6.3 one arrives at a potential market volume within the fifth region of:
- 600 windpumps on the short term
- 1200 windpumps as the total demand based on present needs.

As sales should start in 1990 a certain arrear market should have a positive influence on the sales. The estimated lifetime of a windpump is 15-20 years. Taking into account the total demand and the replacement demand the average sales can be 100 windpumps a year.

The real market volume depends on the actual number of boreholes, which is available for installing windpumps.

According to the expected number of operational tubewells of par. 4.2 one arrives at estimations of attainable sales volumes of Table 6.3. The demand for windpumps is based on the assumption that 50% of the wells are situated at windy locations (par. 3.2). Sales can equal the demand in order to meet the governmental goal to fulfill water needs.

	1987	1988	1989	1990	1991	1992	Total
New wells	9	31	60	70	100	140	410
Total demand for windpumps	4	15	30	35	53	70	207
Sales	-	-	-	35	53	70	158

Table 6.3 Sales forecast

6.5 Prices of windpumps

Prices vary according to capacity rating and to the brand. Also the quantity of purchases is of influence. Some of the most common brands are Comet and Southern Cross (Australia), Fiasa (Argentinia), Climax (Zimbabwe) and Fortuna (Brasil).
In ref. 8 an analysis is given of manufacturers and products (data 1982). One arrives at the conclusions that the cost per square meter of rotor is relatively independent of machine size (or diameter). A price range of 150 - 600 USD/m^2 is given. American and European windmills are more expensive, compared to the Australian and Asian ones. Two leading American factories (Dempster and Aermotor) have been closed a few years ago as they were not able to compete with other manufacturers.
Windpumps at low prices often have a short lifetime and a short maintenance interval (e.g. lubrification intervals). Often the private owner does the maintenance and (small) reprais himself. It is judged these windpumps do not meet the specifications required. Based on ref. 8 and an analysis made of f.o.b. prices, i.a. offered by Southern Cross and Fiasa showed a price range of 250 - 350 USD/m^2, for rotorsizes from 8 up to 25 feet.

This results in a price range as follows:

Rotorsize	Prices f.o.b. Max	Min	Prices c.i.f. Max	Min
14 feet	5.000	3.575	6.000	4.200
25 feet	16.000	11.400	19.000	13.100

Table 6.4 Sales prices (USD) per unit

In annex 11 Sothern Cross offers a 14 feet windpump with a 9 m tower for USD 6,000.--. This price will be used for the financial evaluation.

6.6 Production programme

As a result of the analysis of wind conditions, water recources, water demand and windpump parameters (paragraph's 4 and 6,2) it is concluded that at least two sizes of windpumps should be produced: a 14 feet rotordiameter and a 25 feet rotordiameter windpump.

As a 14 feet windpump appears to be applicable in most situations for the short term demand, it is recommended to start with the development of the manufacture of this type. After 3 to 4 years the introduction of a 25 feet windpump can be realised based on thorough design evaluation and detail engineering.

Three options will be considered: the production of the windpumps by EMEL, by Metafus and as a base case in an isolated plant. For production of the windpumps the choice of Emel and Metafus from all existing metalworking workshops in the fifth region of Angola has been justified in par. 3.3.

Actual production by the Metafus factory can start in 1990 after a certain preparatory period. If an isolated production facility has to be set up the total preparatory period will be one year longer due to the construction of the workshop. Production by the new factory of Emel could start in 1990 according to the planning of the EMEL project but, as the start up of such a plant is time consuming the total preparatory period will be the same as for the isolated production facility.

The production of windpumps is based on a gradual increasement of local produced components. During the first year(s) more complicated parts will be imported. End assembly (tower, rotor and mainvane) is realised at the site. In the fourth production year full capacity can be achieved (100 units as stated in par. 6.4).

Year of project implementation		1	2	3	4	5 - 15
1. Isolated plant	prep.	-	35	53	70	100
2. Production by Emel	period	-	35	53	70	100
3. Production by Metafus		35	53	70	100	100

Table 6.5 Estimated production

7. MATERIALS AND INPUTS

7.1 Materials and components

It is assumed as a start most of the head assembly will be imported at an estimated cost of USD 800,— per unit. If more complicated parts (head-frame and hub) are casted locally, labour will increase as well as the quantity of imported semiprocessed materials.

In table 7.1 and 7.2 a list of the main parts and materials to be purchased is given in the first and fourth year of production. By making more components locally, material cost will be USD 400 lower. Most of the raw materials are imported, however not necessarily by the production unit itself. As most of the raw materials are common construction items, the existing import channels could be used. It is assumed that prices are equal the world market prices c.i.f. Angola.

On the local market only corrugated sheets and tubes are available but production is not regular and products are of limited dimensions.

For locally made castings scrap iron and bronze is used at transport costs. If other materials or parts of good quality such as paint or bolts and nuts from local manufacturers will become regularly obtainable imports could decrease more. Due to communication difficulties and long transportlines it is advisable to have a minimum stock of a half of the year production.

7.2 Utilities

The production of windmills requires utilities such as electricity, water, fuel and compressed air, but not beyond normal workshop requirements. The cost of utilities is expected to amount USD 2000 in the first production year and USD 3000 at full capacity.

	Imports	Unit price (USD)	Locally produced
Components	Wheel hub	100	Blades
	Main shaft assy	150	Wheel arms
	Pitman assy	200	Main vane
	Crank case		Vane structure
	Buffer device }	250	Tower
	Bolts and nuts		Pumprod
	Springs }	60	Drop pipe
	Pump cups		Pump barrel
	Paint	40	Piston and valves
	Bearings	+	
		800	
Semi processed materials	Sheet (> 0,5 mm thickness)	250kg à 1,50	Scrap iron
	Shaft (various)	50kg à 2	Wood
	Strip (various)	100kg à 1	Bronze
	Angle iron (various)	500kg à 1	Tubes (< 1 inch diam.)
	Tubes (inch thickness)	150kg à 2	Sheet (< 0,5 mm thickn.
	Welding electrodes	3kg à 30 +	
		1.400	
Total costs imported materials		USD 2,200	

Table 7.1 Parts/components for windpump manufacture at the start of the project and material cost/unit

Imports		Locally produced
Components	Springs	Blades
	Bolts and nuts	Wheel arms
	Paint	Wheel hub
	Bearings	Mainshaft assy
Total value	USD 200	Crante case
		Buffer device
		Pitman assy
		Main vane
		Vane structure
		Tower
		Pumprod
		Drop pipe
		Pump barrel
		Piston and values
		Pumps cups
Semi processed materials	Sheet (> 0,5 mm)	Scrap iron
	Shaft	Wood
	Strip	Bronze
	Angle iron	Tubes (< 1 inch)
	Tubes (> inch)	Sheet (< 0,5 mm)
	Welding electrodes	
Total value	USD 1,600	
Total costs imported materials	USD 1,800	

Table 7.2 Parts/components for windpumps manufacture after 4 years of operation and material cost/unit

7.3 Spareparts

The value of spareparts at full production capacity is estimated to be USD 3000 a year (ca. 2% of the investment in machines and vehicles). This is an average value as vehicles relatively will need more spares than production machines. It is advised to procure spareparts once a year.

7.4 Variable cost

Variable costs are given for the first 3 years of production in table 7.3. However the value of imported materials decreases, labour cost increase. Direct labour varies from 150 hours in the first year to 250 hours per windmill in the third year at an average hourly wage of USD 2,--. Wages vary from USD 1.50 for an apprentice to USD 2,50 for a skilled labourer.

Item	Year of production		
	1	2	3 - 15
Components (imported)	800	400	200
Foreign raw mat. (imported)	1400	1500	1600
Local raw mat.	50	75	100
Direct labour	300	400	500
Total	2550	2375	2400

Table 7.3 Variable cost in USD/unit

8. LOCATION AND SITE

The fifth region consists of three provinces each with their own autonomy. In Lubango, the capital of Huila, projects concerning the fifth region are coordinated. Furthermore in Lubango the best metal workshops of the region are settled.

It is concluded the production unit should be situated in Lubango. The cost of land and infrastructure such as roads has not been taken into account as building sites can be provided by the government.

9. PROJECT ENGINEERING

9.1 Production process

The manufacture of windpumps has the following sequence:

1. Inspection and storage of incoming materials, parts and components according to table 7.1.

2. Production of parts and components

3. Coating

4. Subassembly of e.g. head, furling mechanism

5. Storage of finished subassemblies and parts

The flow of materials and components is given in fig. 9.1.

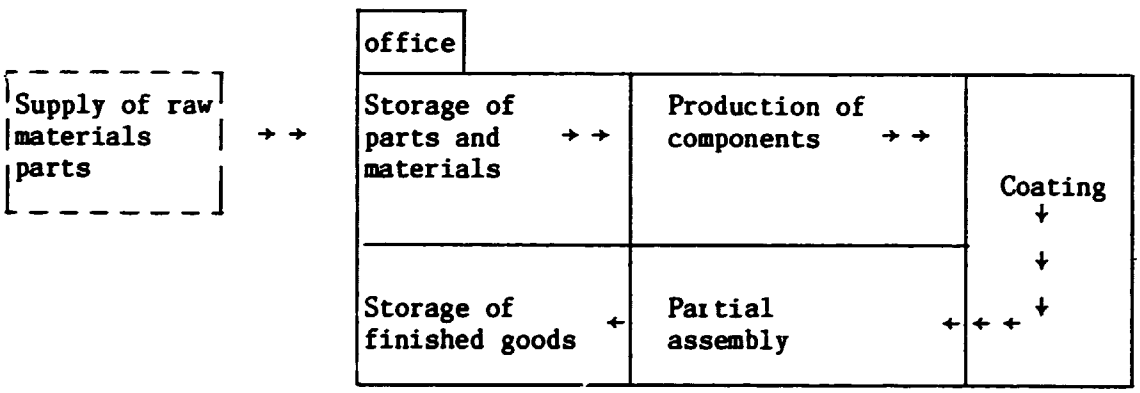


Fig. 9.1 Plant lay-out

9.2 Equipment and machinery

For the production process machinery and equipment is needed according to table 9.1. All items have to be imported and are average world market prices.

Vehicles	USD	55.000
Hacksaw	USD	3.500
Drilling machine	USD	5.000
Universal lathe	USD	25.000
Milling machine	USD	25.000
Welding and cutting equipment	USD	15.000
Compressor with accesoires	USD	10.000
Sheet metal bender and -roller	USD	21.500
Hand tools of various types	USD	5.000 +
Total costs machinery and equipment	USD	175.000

Table 9.1 Costs of equipment and machinery for an isolated plant

If production is integrated within the existing workshop Metafus investments in hacksaw, universal lathe, milling machine, welding equipment and cutting equipment can be omitted. The allocated costs for equipment and machinery for the production by Metafus is given in table 9.2.

Truck	USD	40.000
Drilling machine	USD	5.000
Compressor with accessoires	USD	10.000
Sheet metal bender and -roller	USD	21.500
Handtools	USD	5.000
Existing machinery	USD	58.500
Total	USD	140.000

Table 9.2 Cost of equipment and machinery production by Metafus/EMEL

If production takes place within EMEL part of the investments have to be allocated to windpumpproduction. It is expected investment in machines and equipment is comparable with the data from table 9.2.

The average annual depreciation rate of machines and equipment is 12,5% and for vehicles 25%.

9.3 Civil works

The civil works for an isolated plant consists of site preparation and the construction of a production building of ca. 2000 m^2.

The costs of the civil works for a building including provisions for electricity, water and compressed air have been stipulated to USD 250.000 with a depreciation percentage of 4%.

If production is integrated within the Metafus workshop, adaptations of the building are necessary. The costs of these adaptations including the allocated costs of the present building are estimated on USD 150.000.

In case of the production integrated within EMEL building cost are comparable with those of the isolated plant (USD 200.000).

9.4 Human resources

Though Metafus is relatively well equiped, one has no actual experience working with construction drawings. In behalf of the development of the production of more complicated parts and the development of a certain level of quality control and skills it is necessary having a drawing cabinete. Training of local draftsman and engineers by a foreign expert is of vital importance to create a technological basis for the continuation of the production on the long term.

The allocated manpower for the production of windpumps by Metafus is given in table 9.3. For production of windpumps by EMEL the same manpower will be required as for Metafus. For an isolated plant the estimated manpower also is given in table 9.3.

The contribution of the foreign experts is given in table 9.5. The existing workshops will need less support than an isolated plant, specially administrative assistance. Besides activities related to the production of windpumps the experts shall have to assist in related activities e.g. site selection (chapter 11 and 12).

Production unit	isolated	EMEL/Metafus
a - Director	1	0,5
b - Mechanical engineer	1	0,5
c - Draftsman	1	0,5
d - Chief workshop	1	0,5
e - Machinist (skilled)	1	1
f - Welder/Caster (skilled)	2	2
g - Sheet metal worker (skilled)	2	2
h - Mechanic (skilled)	1	1
i - Apprentices	7	7
j - Painter	1	1
k - Bookkeeper	0,5	0,5
l - Secretary	0,5	0,5
m - Driver	1	0,5
n - Guard/cleaner	2	1
Total	22	19

Table 9.3 Estimation of allocated manpower
(production capacity 100 windpumps/year)

The salaries of manpower under a, k, l, m and n are administration labour cost and under b, c and d factory overheads. In table 9.4 the indirect labour cost is given based on monthly salaries at an exchange rate of 1 USD = 30 kwanzas. E up to j are direct cost and mentioned under chapter 7.3.

Factory overheads (USD)	Isolated	EMEL/Metafus
Mechanical Engineer	10.000	5.000
Draftsman	6.000	6.000
Chief workshop	8.000	4.000
Total	24.000	15.000
Administration cost		
Director	11.000	6.000
Bookkeeper	2.500	2.500
Secretary	2.500	2.500
Driver	4.000	2.000
Guard/cleaner	2.000	1.000
Total	22.000	14.000

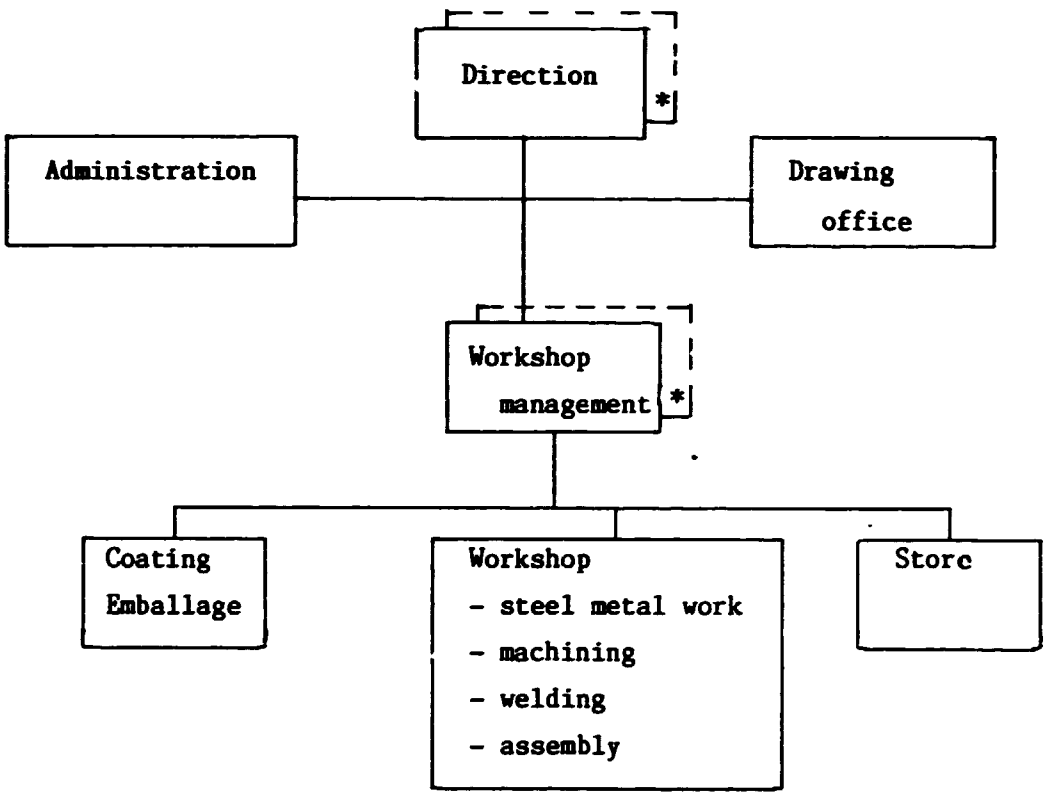
Tabel 9.4 Indirect labour cost

Isolated plant	year of production					
	1	2	3	4	5	6 - 15
Technical (factory overheads)						
% of time	100	100	100	50	25	0
cost	100.000	100.000	100.000	50.000	25.000	0
Administrative						
% of time	100	75	50	25	0	0
cost	100.000	75.000	50.000	25.000	0	0
EMEL/Metafus						
Technical						
% of time	100	75	50	25	0	0
cost	100.000	75.000	50.000	25.000	0	0
Administrative						
% of time	50	25	10	10	0	0
cost	50.000	25.000	10.000	10.000	0	0

Table 9.5 Contribution of foreign experts
cost are according to UNDP proforma-costs
(cost in USD)

10. PLANT ORGANIZATION

An organigram of an isolated plant is given in fig. 10.1. On the level of field supervision and workshop management foreign (or local) experts should be employed during the first years. Transfer of knowhow by means of on the job training and courses is an important aspect of the experts tasks.



*Foreign expert

Fig. 10.1 Organigram of the plant

The organigram of both EMEL and Metafus is given in appendix 1. The organisation of windproduction fits within the planned organisation of the EMEL plant. For the existing Metafus plant a drawing office should be added.

11. FINANCIAL AND ECONOMIC EVALUATION

11.1 Economic and financial data

The three analysed options are:
- isolated plant
- production within Metafus
- production within Emel

For Metafus analyses have been made. One without taxes to take into consideration (as for Emel and the isolated plant), and one taking into account a tax rate of 50% considering tax payments to start when an accumulated net cashflow has been achieved (carry foreward losses).

Main financial parameters:

Regarding the sources of funds it is assumed that 33% of the total investment is local equity. The other 67% is a foreign loan at an interest rate of 10% (being a conservative assumption as in 1988 the National Bank of Angola accounted 8,5%).
The considered grace period is ten years while disbursements start in the third year of production.
Inflation in Angola is officially 0%, but imported materials and goods do suffer inflation. Inflation in the present financial and economic analysis however is 0%.
The working capital is a result of the minimum stock of spareparts and materials as described in chapter 7.

The working capital is given in table "Net Working Capital" of appendix 9 for each case.

The initial fixed investment is given in chapter 9.2 and 9.3 ((costs of equipment & machinery) & (civil works)) and in table "Total Initial Investments" of the three cases in appendix 9. The preproduction capital expenditures in this table is the interest to be paid over the first year of investment.

The total current investments are rare except for the reinvestments made in vehicles and machines when the depreciation period has been finished. If vehicles and machines still are used afterwards those investments could be lower. This has a positive influence on the results.

Sales forecast and salesprices have been given in chapter 6. In chapter 7 the variable cost are given and in chapter 9.4 the indirect labour cost, split into factory overheads and administrative overheads. In the tables "total production costs" of the three cases in appendix 9 these data is given.

11.2 Financial evaluation

The financial evaluation was done for the following 3 alternatives: Isolated plant, Emel, Metafus.

In appendix 8 the results of the calculations made with help of the computer program COMFAR are presented in detail. The main results are presented in the summary sheets. The main financial data are summarized in table 11.1.

Case	Isolated plant	EMEL	Metafus
Initial investment cost total	440.400	385.500	300.000
of which foreign	315.000	260.200	200.000
Production cost in fifth year. Total	409.050	343.025	337.000
of which foreign	290.400	236.700	234.900
Total production, fifth year	100	100	100
Total sales fifth year	600.000	600.000	600.000
Net profit fifth year	190.950	256.975	365.100
Pay-back period			
I.R.R.	22,7%	32,5%	36,8%
Sales price/unit	6.000	6.000	6.000
Cost/unit fifth year	4.090	3.430	3.370

Table 11.1 Main results in USD

*Isolated plant taken as a base case

Initial investment cost are lower if the production unit is integrated within an existing workshop. For the project financing 66% was considered to be a foreign loan as a preliminary assumption.

Cash-flow analyses show a cummulated net result in the sixth production year for the base case and one year earlier for Emei and Metafus. Net cash flow is positive allready in the third, resp. second production year.

The most important parameter for financial evaluation is the internal rate of return. For Emel and Metafus the IRR is comparable but give an optimistic figure as the complete range of products was not considered within the limited scope of the present opportunity study. An analysis of the companies as a whole should be made as part of the pre-investment activities. If taxes payed according Angolean rates the IRR of the base case is 16,8%. A sensitivity analysis is given in par. 11.4. Based on analysis it can be concluded that the production of windpumps in Angola is feasible. The integration within an existing workshop gives better results than the isolated plant. Metafus should be prefered as there allready exists production practice. The manufacture of windpumps can approximately start one year earlier as in the case of EMEL, after the EMEL factory has been extended according to the existing planning.

11.3 Sensitivity analysis

In the figures 11.1 to 11.5 a sensitivity analysis is presented. It can be concluded that (without taxes) at relative low sales prices (-20% = USD 4.800 with an I.R.R. of 11%) the IRR is higher than the interest rate of 10%.

As the sales price is of importance on the results, it should be studied at what price the windpump could be sold in Angola. A sales price under USD 6,000.-- could be considered.

The IRR is not very sensitive for variations of the fixed investments. If fixed investments are 20% higher, the I.R.R. is ca. 2% less.

The influence on the break even point of the sales price is bigger than variations of variable cost and fixed cost. The break even point is achieved on 35 % of the production (ca. 500 windpumps).

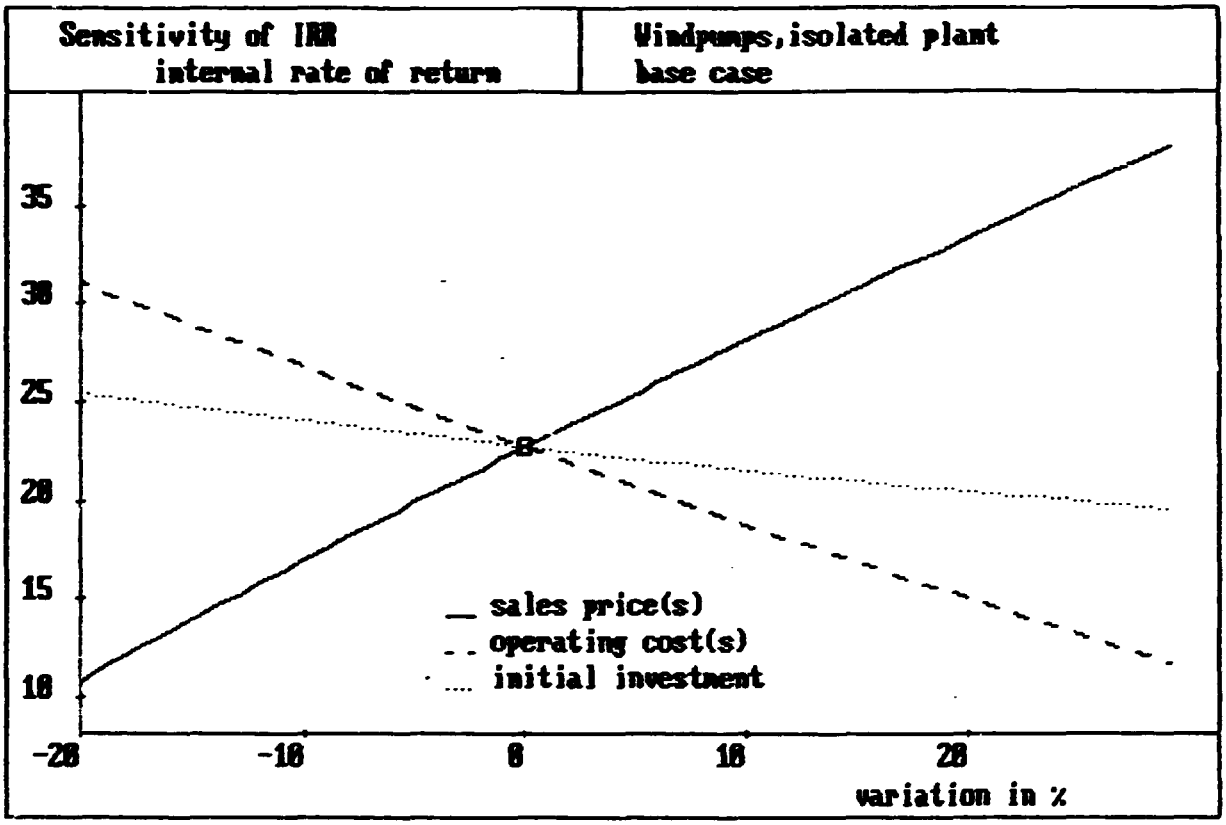


Fig. 11.1 Influence of sales price, operating cost and initial investment on the I.R.R.

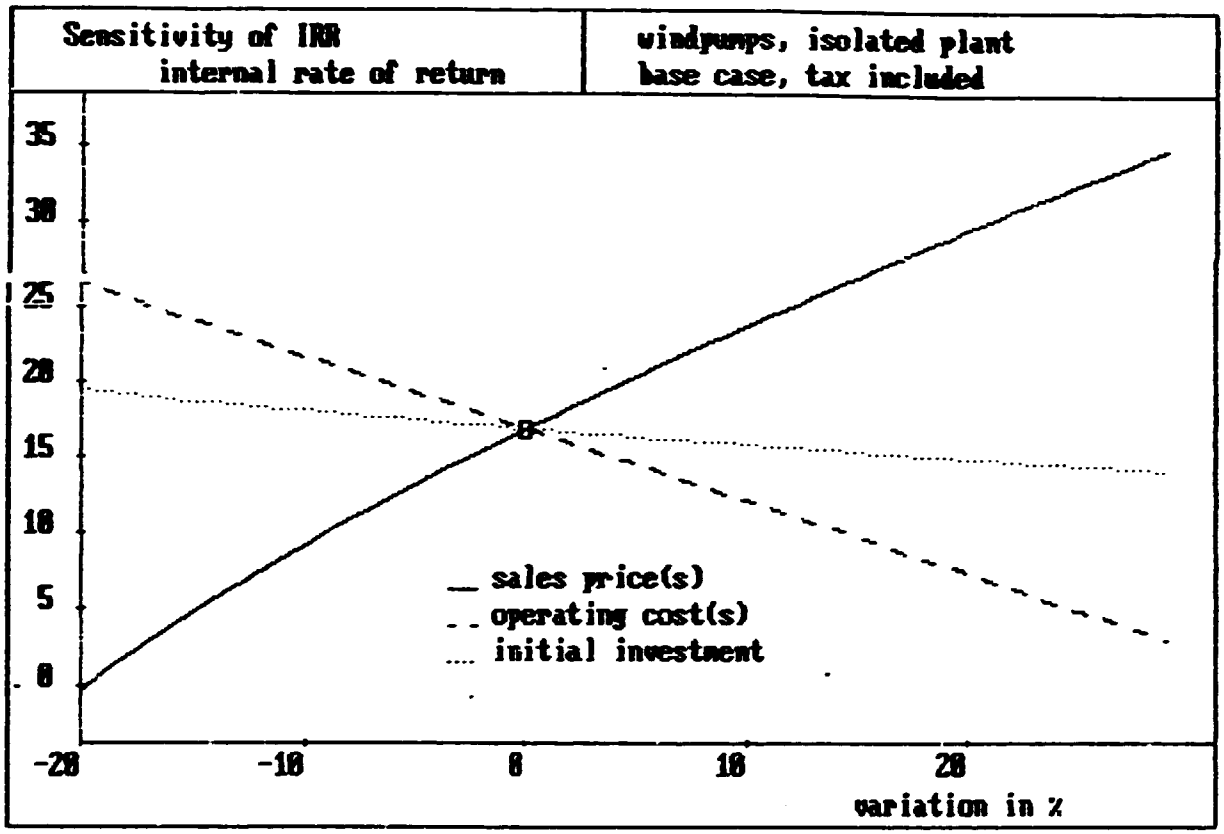


Fig. 11.2 Influence of the sales price, operating cost and initial investment on the I.R.R.

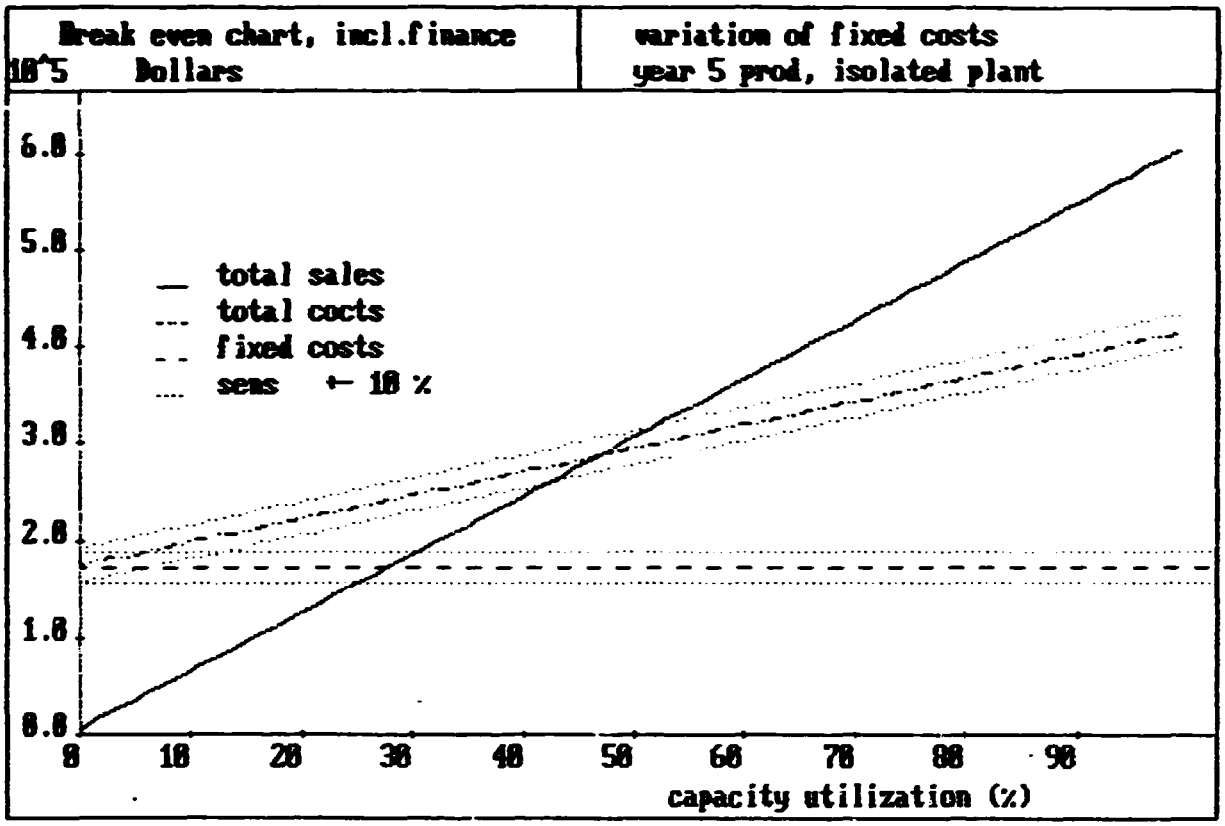


Fig. 11.3 Sensitivity of the break even point to the fixed costs variational

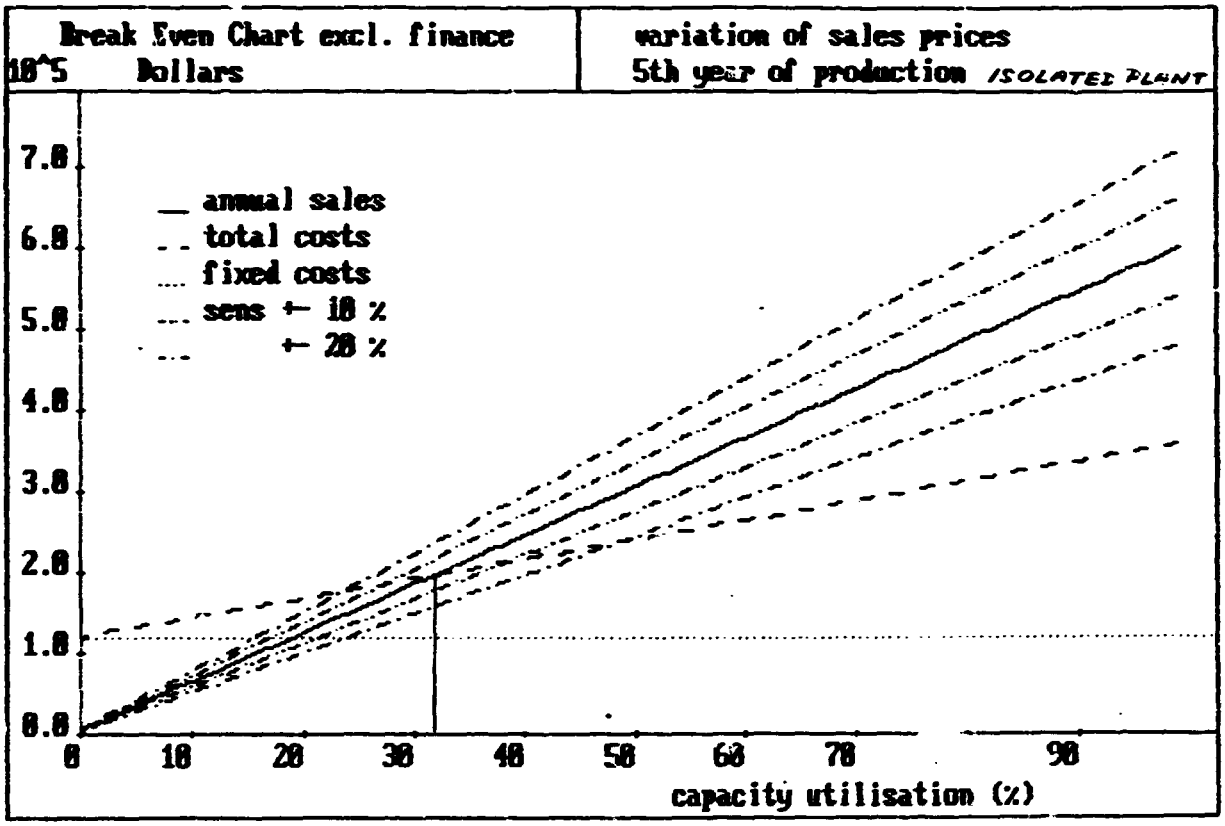


Fig. 11.4 Sensitivity of the sales price on the break even point

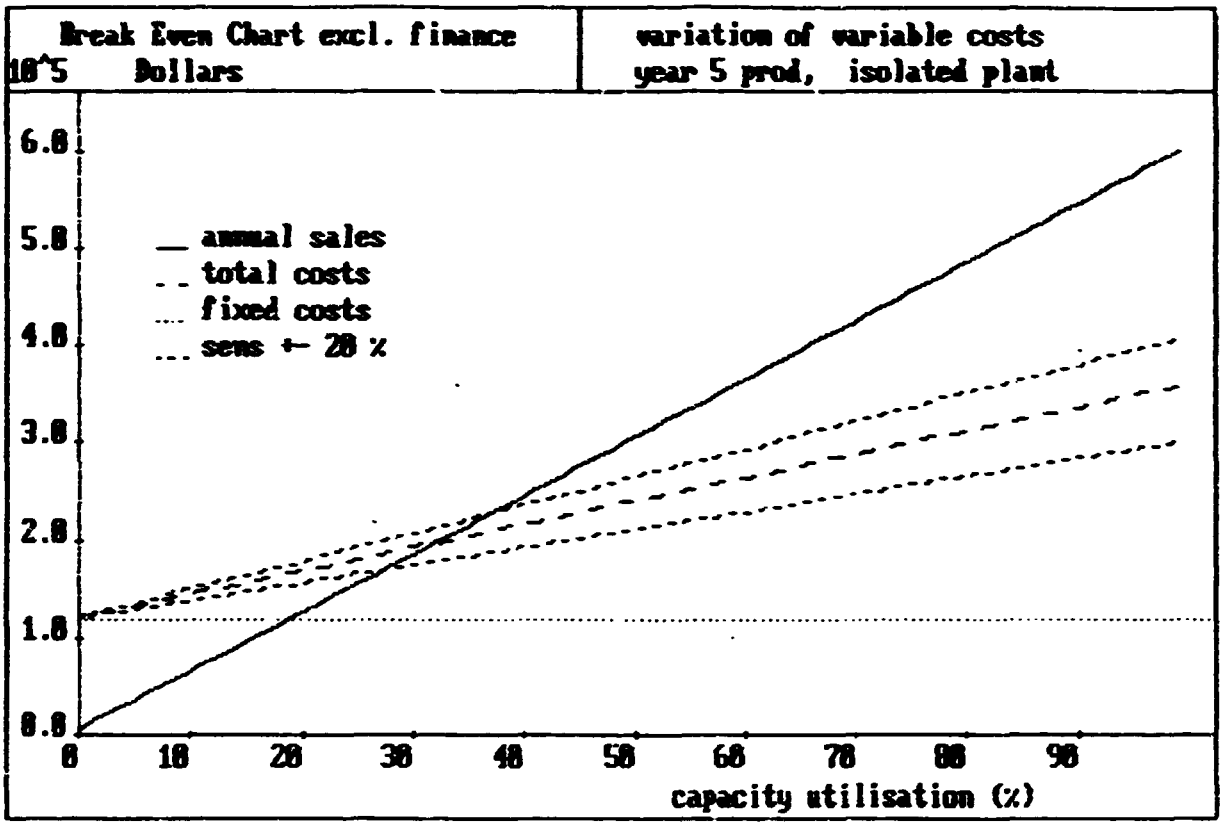


Fig. 11.5 Sensitivity on the break even point of the variable costs

11.4 National economic and social benefits

National benefits are determinated by considering the following aspects:

1. Savings on foreign currency
2. Employment
3. Water supply in rural areas

ad 1 The total production will be 1358 units in the accounting period (15 year). With a salesprice of USD 6.000 the total cash inflow is USD 8.148.000

The cash outflow in foreign cost is USD 4.111.000 resulting in savings on foreign currency of USD 4.037.000.

ad 2 The difference in employment for the three cases is relative small. Isolated unit: employees 22, total wages paid USD 1.080.000. Integrated unit: employees 19, total wages paid USD 1.035.000. Related activities will have a positive influence on the employment.

ad 3 The total demand to solve present drinking-water needs has been stipulated to be 1200 pumps. In the accounted period this quantity is produced and herewith can meet the priorities set by the government.

The savings in foreign currency by making as many parts locally as possible reach USD 400/unit. For the accounting period this leads to USD 540,000.--. Besides this economic benefit, there is the technological aspect of being less dependent on foreign suppliers and knowledge.

The results of this chapter may be finalized as follows:
The financial and economic evaluation show the viability of the project (of all 3 alternatives) from the financial and national (social and economic) point of view. The best version is Metafus.

12. IMPLEMENTATION SCHEDULING OF THE WIND-PUMP PRODUCTION PROJECT

As pointed out in chapter 6.5 a preparation period will be needed in order to be able to start the production of windpumps. For the establishment of the production unit within the existing workshop Metafus a time preliminary schedule has been made (fig. 12.1). The (only) difference between an establishment within the new EMEL plant or the Metafus plant is a longer construction period for EMEL. Compared with an isolated plant the construction period is shorter as well as the acquired presence of the foreign experts (par. 9.4). The activities during the preparatory period are:

I Pre-investment activities (6 months)

- Evaluation of existing machines and equipment.
- Evaluation of the present human resources.
- Evaluation of present plant organisation.
- Engineering of civil structures.
- Engineering of a first series of windpumps, including specifications of parts, raw materials and machines, to be imported and locally manufactured.
- Drafting a call for tenders.
- Evaluation of tenders.
- Recommendation for procurement and/or cooperation with foreign manufacturers.
- Detailed analysis of the sales prices for windpumps.
- Financial and economic evaluation of the workshop.
- Determination of the conditions of financing the project.
- (First phase of) local personel training.

II Investment activities

1. Procurements; the purchase of the machines and first materials. Every half year a shipment of materials will arrive.
2. Recrutement and installation of foreign experts. It is foreseen 2 persons will be needed, for both technical and administrative tasks.
3. Start up of the workshop, installation of the machines etc.
4. Continuation of training of local staff including the set up of an engineering/drawing office. This should start direct after the preinvestment activities and can be done by training on the job, fellowships, and courses or studies.

III Operational phase of the workshop

5. Production of first series of windpumps as a try out with emphasis on training of the craftsman.
6. Design/engineering in behalf of the local production of more complicated parts. Adaptions of the windpump construction, evaluating the production technologies to be used (welding instead of casting etc.).
7. Installation and monitoring of the first series. This activity has to produce insight in the efficiency and quality of the windpumps as well as the procedures for site selection and installation.

IV Related activities

8. Wind data collection as a continuation of the measurements started during the opportunity study.
9. Organisation, set up and implementation of site selection, installation and maintenance activities.

Item 1 to 6 concern the project and only can start if sources of finance have been found. However it should not delay the training of local staff. The items 7, 8 and 9 concerns related activities which will benefit from the presence of the foreign experts. The factory should be able to give advice on these activities.

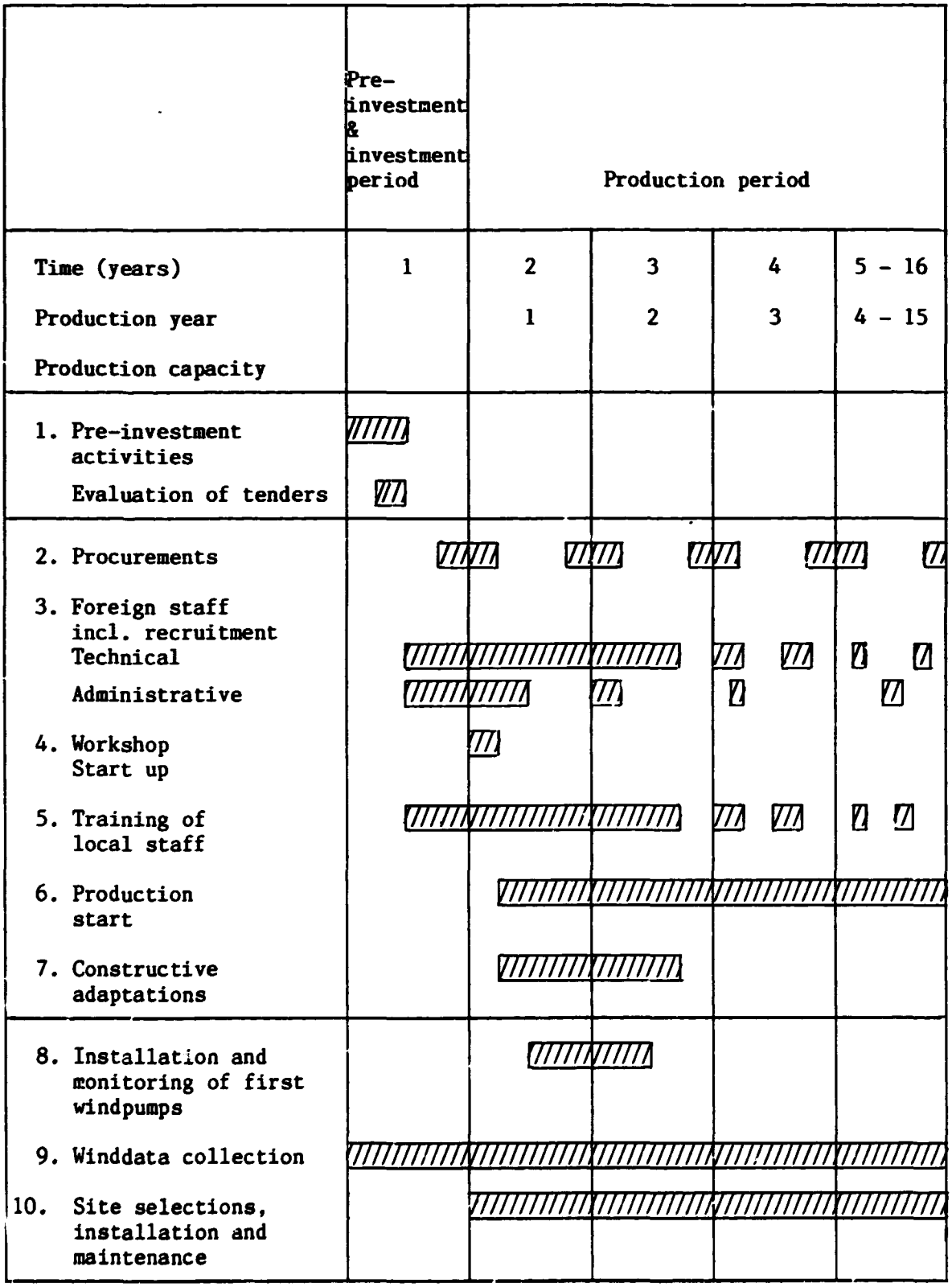


Figure 12.1 Time schedule of the project implementation of an establishment of a production unit within Metafus and production of the wind-pumps.

13. PROJECT RELATED ACTIVITIES

The main project related activities are:

- winddata analysis
- site selection
- installation and maintenance

These activities should be done in order to have windpumps properly used and to adrive a cost per cubic meter water as low as possible in the given circumstances. Beside the economic aspect it is important to have a reliable water supply. The best way to achieve a general acceptance of windenergy is to prove it in practice.

The above specified related activities could be executed by the provincial departments DNFRE, which are being created. Within the UNDP-reconstruction programme for the fifth region (ref. 4) one of the high priority projects is setting up municipality polyvalent workshops.

Fitting in existing structures the organigramme could be as shown in figure 13.1. It is not advisable to have installation and maintenance done by Hidromina (par. 3.4) as in the framework of reconstruction programme a reorganisation of Hidromina and the water management is foreseen.

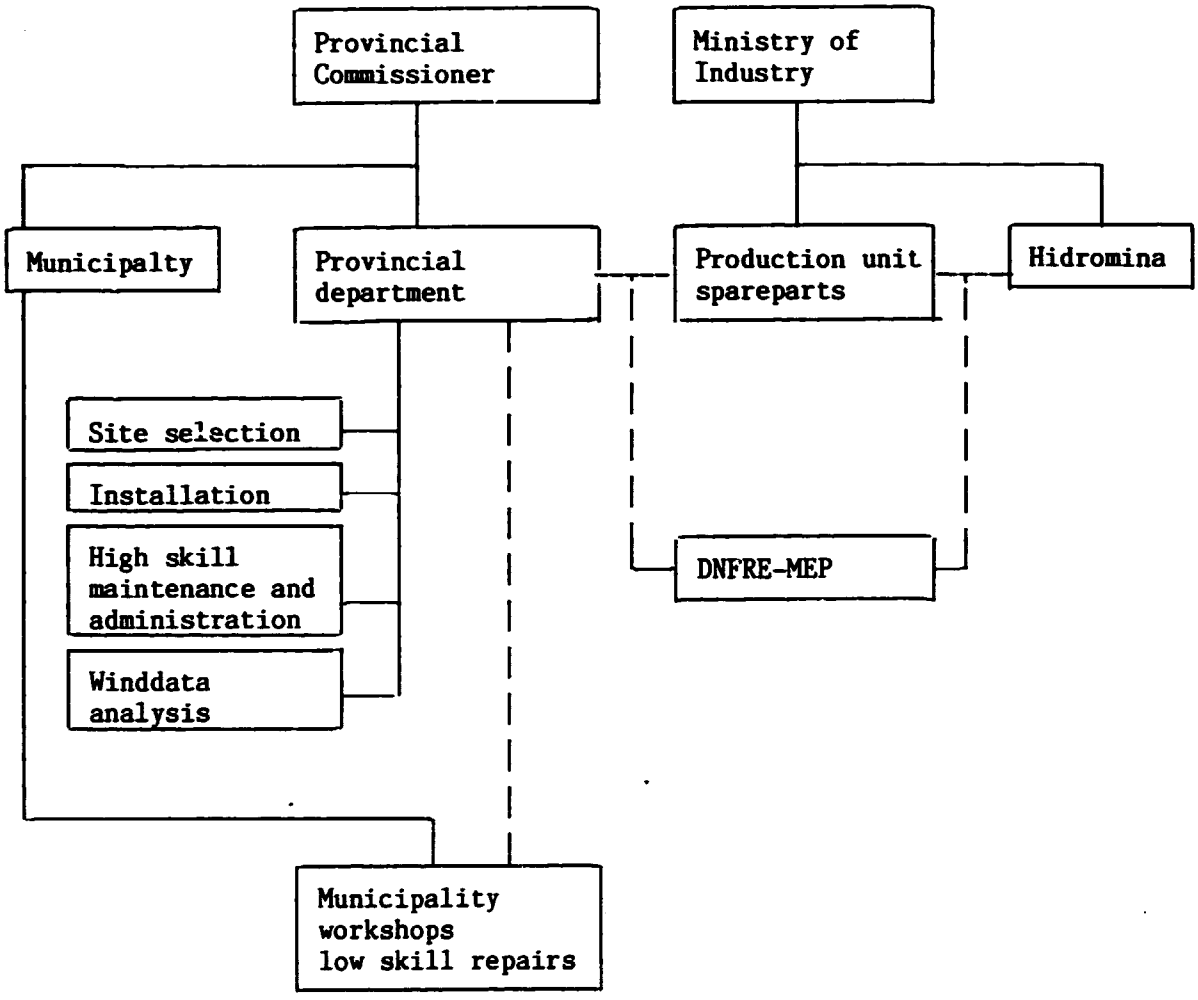


Fig. 13.1 Organisation of project related activities within existing structures

---- support (administrative, technical and financial)

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8 UNDP Project GLO/80/003 REF ITP/82041
Wind Technology Assessment Study

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Sr. Inacio	Sometal
João Silva	Fata / Metang
Emilio Antunes	C.F.M.
Morel Costa	C.F.M.

Appendices

Appendix A1

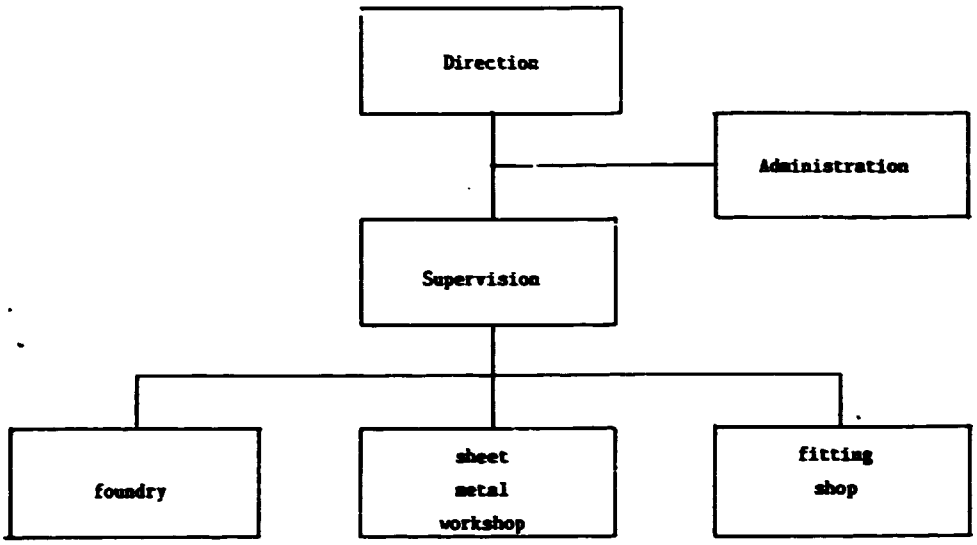
Existing metal workshops

During the mission all relevant metal workshops within the fifth region were visited. In the following a brief description is given of these workshops being:

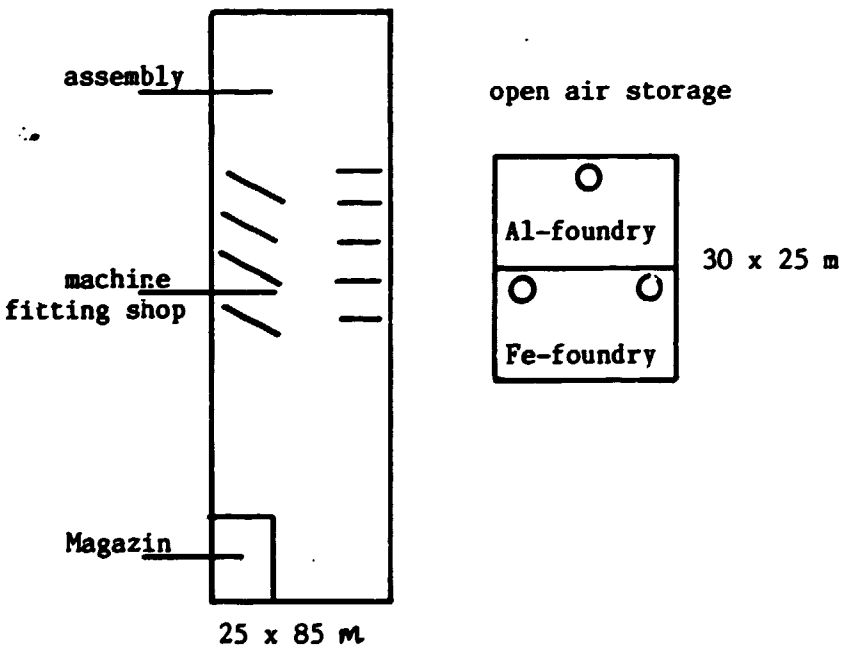
- Metafus
- Emel
- Caminha de ferro Mocamedes
- Ermanal
- Metalomecanica
- Alfag
- Metalvi
- Emin
- Sometal

Name	: Metafus
Place	: Lubango
Organisation	: Private Company (see organigramme)
Personnel	: About 120 No graduated labourers but experienced people available. Alfabetisation courses are given.
Origine	: Foundry, metal workshop
Typical products	: Al cast pressure cookers Iron cast parts for agricultural machines Domestic articles Metal sheet cabines On request all kinds of products a.o. handpumps for Unicef
Machines	: Foundry ovens (1500 kg) charcoal and diesel heated Universal lathe (5) Milling machine Planing machine (small) Hack saw Welding equipment Guilotine Bending machines
Supply of materials	: Import of special products; bearings Raw materials a.o. cast al Scrap iron is used for casting
Comments	: A good managed company Have experience with fabrication of series Not working from drawings but are very inventive Problems with supply of materials due to transport and importrestrictions Modern machines
Development	: EEG project to buy two electro-ovens and an sandblasting equipment is ongoing. Company builds its own workshop and offices

Organigram



Global plant lay-out



Metafus

M E T A L U C

METALURGIA E FUNDIÇÃO DO CUI,LDA

SEDE E FÁBRICA
ZONA INDUSTRIAL PESADA C.P. 1070
TELEFS: 22170/21119

DELEGAÇÃO [illegible] LANDA
R/EMILIO [illegible] I Nº90
TELEFS: [illegible]/322877
TELEX 32[illegible]

CAPITAL SOCIAL: 10.000.000.00

MINISTÉRIO DE TUTELA: INDÚSTRIA

EM COLABORAÇÃO COM O MINISTÉRIO DA INDÚSTRIA E DO COMISSÁRIADO PROVINCIAL DA HUÍLA E COMO RESPOSTA ADEQUADA AS EXIGÊNCIAS DE DESENVOLVIMENTO ACTUAIS E FUTURAS, ENCONTRA-SE ESTA EMPRESA EM REESTRUTURAÇÃO, REMODELAÇÃO E AMPLIAÇÃO DE INSTALAÇÕES E A CONSEQUENTE MODERNIZAÇÃO DOS MEIOS DE PRODUÇÃO E TÉCNICOS MEDIANTE UM INVESTIMENTO EM CURSO DE USD. 1.500.000,00 ANÚNCIA, EM VÉSPERA DO SEU 14º ANIVERSÁRIO, O FABRICO E COMERCIALIZAÇÃO DE BOMBAS MANUAIS PARA EXTRAÇÃO DE ÁGUA EM POÇOS ARTESIANOS E OUTROS, PARA SERVIR AS NECESSIDADES DAS POPULAÇÕES RURAIS.

INSTALAÇÕES FABRIS:

ÁREA TOTAL	13.382 m2
ÁREA COBERTA	4.066 m2
ÁREA LIVRE	9.416 m2

PRIMEIRO E UNICO FABRICANTE NACIONAL DE PANELAS DE PRESSÃO

A ADMINISTRAÇÃO

JOAQUIM MARIA MESQUITA
EDUARDO DE CASTRO MENDES

PROVINCIA DA HUILA

PROVINCIA DA HUILA

Name	: EMEL
Place	: Lubango
Organisation	: State company
Personnel	: About 90 No graduated labourers
Origine	: Sheet metal workshop Repair and maintenance workshop
Typical products	: Closets, beds, chairs
Machines	: Welding equipment Hand tools Machine equipment generally old and in an deplorable state
Supply of materials	: Imported
Comments	: Productivity is low also because of the construction of a new workshop. Problems with the supply of materials
Development	: Construction of a new workshop has started for the production of agricultural machines. The project is executing by the Ministry of Industry with financial help of the EEC and Caisse Francaise In 1990 the production is planned to start, but end 1988 only some navvy work has been completed.

Some project data *

: personnel

labourers	104
medium level employers	23
economists	2
engineers	2
foreign staff	8
(Portugese nationality)	

: investments

buildings	114	. 10^6 kwz
machines	43	. 10^6 kwz
vehicles	4,5	. 10^6 kwz
others	53	. 10^6 kwz
total	215	. 10^6 kwz

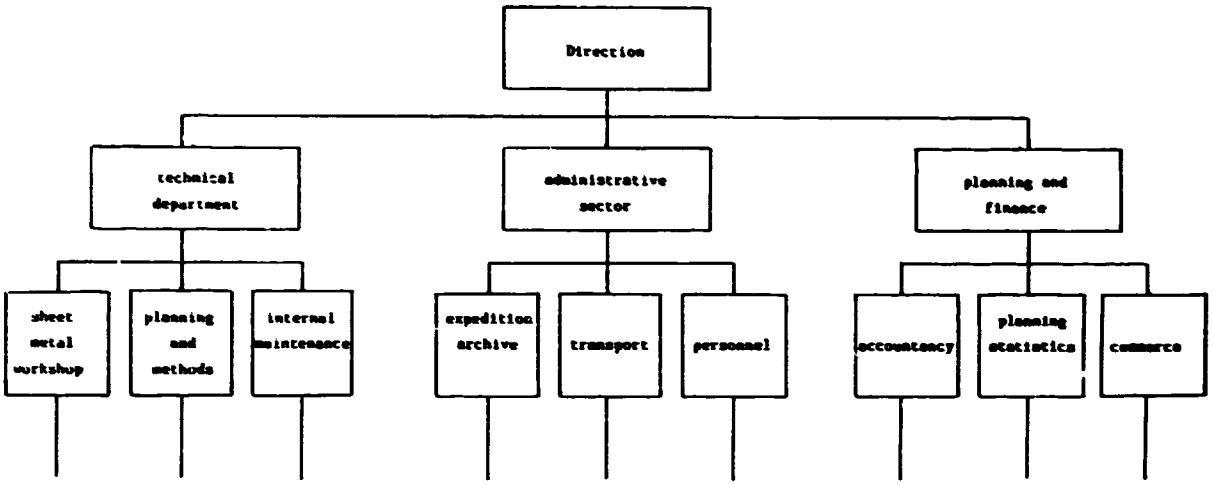
1 usd = 30,2 kwz

: estimated turn over : about 130 - 10^6 kwz

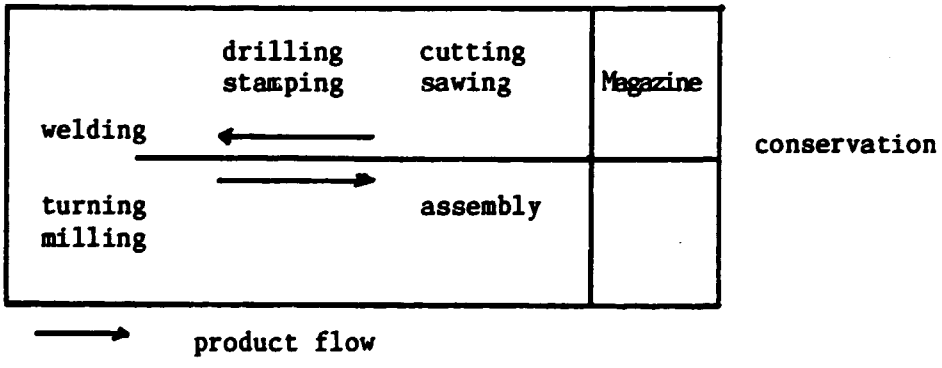
: products: small agriculture machines such as ploughs

*Report "Implantação duma fabrica metalo-mecanica" Prof. Dr. Matos

Organigram



Global plant lay-out



Name	: CFM (Caminha de ferro Moçamedes)
Place	: Lubango
Organisation	: State company
Personnel	: About 260 of which 50 experienced
Origine	: Maintenance workshop for the railroad, foundry
Typical products	: Repair and maintenance of wagons and locomotives. Work upon request.
Machines	: Lathes of various sizes; vertical lathe Milling machine Welding and cutting equipment Compressor 780 kVa back-up generator 1800 kg electro-oven
Supply of materials	: Poor, scrap iron
Comments	: A very good equipped workshop but machines are dated and lack maintenance. There is a complete foundry laboratory which is closed due to lack of qualified personnel. More than half of the personnel is 40 years or older. Young trained people are requested upon by the army. There is no practice of working from drawings. There are 35 Cuban cooperants Lack materials and spareparts.
Development	: No present projects but the need of rehabilitating the workshop is acknowledged. Proposals have been made within the frame work of the reconstruction program for the fifth region by the UNDP.

Name	: Ermanal
Place	: Namibe
Organisation	: State company
Personnel	: about 15
Origine	: Repairworkshop for the fishery
Typical products	: Repair of boats
Machines	: Lathes Bending machines Hack saw
Supply of material	: Poor. Who wants something repaired has to deliver the materials.
Comments	: Poor management Worn out machines No skilled personnel
Developement	: Non

Name	: Metalomecanica
Place	: Namibe
Organisation	: State company
Personnel	: About 10
Origine	: Sheet metal workshop
Typical products	: Doors, fences
Machines	: 4 Lathes Welding equipment
Supply of materials	: Poor
Comments	: Worn out machines (only one lathe could work) Poor management No skilled personnel
Development	: Non

Name	: ALFAG
Place	: Luanda
Organisation	: State company
Personnel	:
Origine	: Sheet metal workshop
Typical products	: Agricultural machines
Machines	: Lathe Welding and cutting equipment Hack saw etc.
Supply of materials	: Imported
Comments	: Works in close cooperation with EMEL and is producing small agriculteral machines using some imported parts.
Development	: ALFAG in Luanda and Emel in Lubango are cooperating companies making both simular products. The development of these companies is an activity of the Ministry of Industry.

Name	: Metalvi
Place	: Luanda
Organisation	: Private company
Personnel	: About 100
Origine	: Foundry of fittings
Typical products	: Wheel barrows
Machines	: Thread cutting machines for fittings Lathes Milling machine Welding and cutting equipment Bending machine 2 electro ovens
Supply of materials	: Imported
Comments	: Metalvi is a very complete foundry and workshop but without graduated personnel. The company is operational on low level The ovens do not work only a small one for Aluminium casting
Development	: Preparation for a project is started, to rehabilitate the foundry. Due to financial restrictions progress is slow.

Name	: EMIN
Place	: Luanda
Organisation	: State company
Personnel	: About 100
Origine	: Repair workshop for industrial machines
Typical products	: On request machine parts
Machines	: Lathes, milling machines, bench workmachines
Supply of materials	: Imported. Supplied by the customer
Comments	: Good managed workshop Make complicated parts from drawings and archieve these Lack of graduated personnel
Development	: An UNIDO project for the supply and installation of machines including training of personnal has ended. The project will be continued a.o. to set up a better administration.

Name	: Sometal
Place	: Luanda
Organisation	: Private company
Personnel	: about 10, no graduated personnel
Origine	: Sheet metal workshop and foundry
Typical products	: Watertanks
Machines	: Welding equipment, old machinery
Supply of materials	: Imported
Comments	: Sometal once has been a good equipped and complete company At the moment practically no machine is operational except for welding equipment
Developments	: Non

Appendix A2

Survey of existing wells equiped with windpumps

In the following a survey is given of existing wells equiped with windpumps. The survey was made by Hidromina in march 1988.

EMPRESA NACIONAL DE AGUAS SUBTERRANEAS HIDROMINA

RELAÇÃO DAS CAPTAÇÕES EQUIPADAS COM BOMBAS AEROMOTORAS

PROVINCIA DA HUÍLA

TIPO	FABRICANTE	PROVINCIA	MUNICIPIO	CAPTAÇÃO	ESTADO
AEROMOTOR	PORTUGAL	HUÍLA	CHIBIA	60/64	
AEROMOTOR	"	"	GAMBOS	139/66	OPERANTE
AEROMOTOR	"	"	HUMPATA	514/81	"
		PROVÍNCIA-CUNENE			
AEROMOTOR	PORTUGAL	CUNENE	CUROCA	80/65	OPERANTE
"	"	"	"	90/65	"
"	"	"	"	99/65	INOPERANTE
"	"	"		105/65	OPERANTE
"	"	"	CUAMATO	206/68	"
"	"	"	CUROCA	146/66	"
"	"	"	"	165/68	"
		PROVINCIA-NAMIBE			
AEROMOTOR	PORTUGAL	NAMIBE	CARACULO	6/49	OPERANTE
"	"	NAMIBE	"	8/49	"
"	"	"	MUNHINO	9/50	"
"	"	"	"	10/50	"
"	"	"	"	12/50	"
"	"	"	CARACULO	14/50	"
"	"	"	"	18/50	"
"	"	"	MUNHINO	19/50	"
"	"	"	BIBALA	23/52	"

TIPO	FABRICANTE	PROVINCIA	MUNICIPIO	CAPTAÇÃO	ESTADO
AEROMOTOR	PORTUGAL	NAMIBE	CARACULO	25/51	OPERANTE
"	"	"	MUNHINO	27/51	"
"	"	"	"	29/51	"
"	"	"	"	30/51	"
"	"	"	CARACULO	37/52	"
"	"	"	MUNHINO	40/57	"
"	"	"	"	43/52	"
"	"	"	CARACULO	44/52	SITUAÇÃO DESCONHECIDA
"	"	"	"	47/57	" "
"	"	"	"	51/53	OPERANTE
"	"	"	VIREI	52/53	OPERANTE
"	"	"	CARACULO	56/53	SITUAÇÃO DESCONHECIDA
"	"	"	VIREI	57/53	" "
"	"	"	CARACULO	61/53	OPERANTE
"	"	"	CARACULO	69/53	SITUAÇÃO DESCONHECIDA
"	"	"	CARACUULO	82/55	" "
"	"	"	BIBALA	91/55	" "
"	"	"	MUNHINO	95/55	" "
"	"	"	BIBALA	96/56	" "
"	"	"	MUNHINO	96-A/72	" "
"	"	"	CARACULO	98/56	" "
"	"	"	MUNHINO	100/56	" "

TIPO	FABRICANTE	PROVÍNCIA	MUNICÍPIO	CAPTAÇÃO	ESTADO
AEROMOTOR	PORTUGAL	NAMIBE	KUNHINO	101/56	OPERANTE
" "	"	"	"	102/57	"
"	"	"	CAMUCUO	105/58	"
"	"	"	KUNHINO	107/58	"
"	"	"	CUROCA-NORTE	165/67	"
"	"	"	BIBALA	169/67	"
"	"	"	"	171/67	"
"	"	"	"	172/67	"
"	"	"	"	173/67	"
"	"	"	"	177/68	SITUAÇÃO DESCONHEC.
"	"	"	"	180/68	" "
"	"	"	"	185/68	OPERANTE
"	"	"	"	199/68	"
"	"	"	"	202/70	"
"	"	"	"	149/66	"
"	"	"	CUROCA-NORTE	157/67	SITUAÇÃO DESCONHEC.
"	"	"	" "	158/67	" "
"	"	"	CARACULO	124/64	OPERANTE
"	"	"	BIBALA	219/72	"
"	"	"	NAMIBE	223/73	"
"	"	"	"	228/73	"
"	"	"	CARACULO	1/53	SITUAÇÃO DESCONHEC.
"	"	"	"	2/53	" "
"	"	"	"	3/54	" OPERANTE
"	"	"	"	4/54	INOPERANTE
"	"	"	"	5/54	"
"	"	"	"	6/54	"
"	"	"	SEDE	38/66	"
"	"	"	BIBALA	51/66	SITUAÇÃO DESCONHEC.
"	"	"	"	53/66	" "
"	"	"	"	55/67	OPERANTE
"	"	"	"	87/67	"
"	"	"	"	58/67	SITUAÇÃO DESCONHEC.
"	"	"	"	64/68	operante
"	"	"	"	86/69	"

TIPO	FABRICANTE	PROVÍNCIA	MUNICÍPIO	CAPTAÇÃO	ESTADO
AEROMOTOR	PORTUGAL	NAMIBE	BIBALA	87/69	OPERANTE
"	"	"	"	50/70	"
"	"	"	"	52/70	"
"	"	"	"	53/70	"
"	"	"	"	54/70	"

SECÇÃO DE ESTATISTICA , no Conjenje, aos 18 de Março de 1988.

Appendix 3

Visited locations during the missions

Prov.	Municipality	Captation no.	equipment	favourable wind conditions	remarks
Huila	Gambos	58/64	motorpump	y	watersupply
Huila	Chibia		windpump	r	in operation
Huila	Gambos	555/83	handpump	n	needs repair
Huila	Gambos	52/63	handpump	y	needs repair
Huila	Gambos	33/62	non	n	wel obstructed
Huila	Gambos	51/63	handpump	r	needs repair
Huila	Gambos	Mpata	non	y	-
Huila	Humpata	514/81	windpump	r	needs repair
Huila	Gambos	41/63	non	r	-
Huila	Chibia	638/88	non	r	new well
Huila	Lubango	open well	windpump	r	needs repair
Namibe	Caraculo	172/67 C	windpump	y	in operation
Namibe	Caraculo	8/49 C	windpump	y	needs repair
Namibe	Bibala	2 a/73 C	windpump	y	in operation/ needs repair
Namibe	Bibala	8/49 C	non	y	well to be cleaned
Namibe	Bibala	7/49	non	y	well to be cleaned
Namibe	Bibala	69/72	windpump	y	needs repair
Namibe	Bibala	217/72	handpump	r	needs repair
Namibe	Bibala	98/56	windpump	y	to be dismantled
Namibe	Bibala	-	windpump	y	to be dismantled
Namibe	Bibala	2[illegible]/62	windpump	y	needs repair
Namibe	Bibala	-	motorpump	r	under repair
Namibe	Bibala	213/71 C	non	r	well obstructed
Namibe	Bentiaba	2 open wells	motorpump	r	irrigation Bentiaba
Namibe	Bentiaba	open well	windpump	y	needs repair
Namibe	Virei	202/70 C	windpump	y	needs repair
Namibe	Virei	160/57 C	handpump	y	needs repair
Namibe	Virei	264/67 A	windpump	y	in operation/ needs repair
Namibe	Bibala	103/57 C	windpump	y	destroyed/well obstructed
Namibe	Bibala	24/51	windpump	y	to be dismantled/ well obstructed
Namibe	Namibe	open well	windpump	r	needs repair
Namibe	Namibe	open well	windpump	r	monument
Namibe	Namibe	open well	windpump	r	to be dismantled

Appendix 4

Data of existing wells in the fifth region

In the following data on existing wells in the fifth region are given. These data have been collected from different sources, mainly being maps of parts of the region indicating locations of wells. The data have been processed and implemented into an EIC computer data base.

Number	Localization	Depth (m)	Diameter (inch)	Static waterlevel (m)	Dynamic waterlevel (m)	Pumping rate (l/h)	Municipality	Observations and sap number
3/59-AC	KARIMBONDE	17,00	6"0	4,50	15,72	1.700	GAMBOS	357
4/59-AC	DUMANGUE	25,00	6"0	3,20	12,30	23.200	GAMBOS	357
5/59-AC	KAPANDA	25,00	6"0	9,50	17,70	10.250	GAMBOS	378
6/59-AC	TCHIPEIO	20,50	6"0	5,35	12,65	14.400	GAMBOS	357
7/59-AC	NEPO	30,00	6"0	17,45	34,75	4.800	GAMBOS	421
8/59-AC	NEVA	21,50	6"0	7,79	12,65	4.000	GAMBOS	357
9/59-AC	CAMPANDA	24,00	6"0	6,00	16,10	5.300	GAMBOS	357
10/59-AC	CHIMPEXIE	45,65	6"0	10,00	31,71	2.140	GAMBOS	421
11/59-AC	SOLDADO	32,00	6"0	8,50	25,50	1.800	GAMBOS	357
136/59-AC	EPHE TCHAMBOLELO	124,00	8"0	89,00	111,50	1.800	GAMBOS	379
12/59-AC	VICUSSE-CUSSO	90,00	6"0	32,00	39,25	1.100	GAMBOS	399
13/59-AC	VICUSS-CUSSO	65,00	6"0	4,30	54,00	770	GAMBOS	399
14/59-AC	PANGUE	14,00	6"0	8,70	10,00	1.300	GAMBOS	378
140/59-AC	PANGUE	151,50	6"0	97,50	113,00	750	GAMBOS	379
15/60-AC	PORRACAO-DUMANGUE	60,00	6"0	16,02	24,00	800	GAMBOS	357
17/60-AC	PORRACAO B.D'AREIA	31,00	6"0	10,00	30,00	13.200	GAMBOS	378
19/60-AC	IBAMBOS	34,00	5"0	5,00	7,60	6.000	GAMBOS	357
20/60-AC	TCHACUSSE-TAMPO	130,00	6"0	34,40	48,00	670	GAMBOS	399
21/60-AC	SECULADO CAPANDI	33,60	6"0	23,00	31,00	5.200	GAMBOS	357
216/60-AC	BIKE	64,00	8"0	31,05	63,00	550	GAMBOS	399
22/60-AC	BOMBA TCHICHATILE	24,60	6"0	3,65	6,50	15.840	GAMBOS	357
23/61-AC	NOMPOMPO	18,70	6"0	4,70	8,25	15.840	GAMBOS	357
25/61-AC	BOMBA	34,00	5"0	13,70	25,50	5.600	GAMBOS	357
33/62-AC	CHIBEYDA	60,00	8"0	27,45	34,00	1.200	GAMBOS	378
336/62-AC	LUBATA	55,00	6"0	12,00	16,40	200	GAMBOS	377
34/62-AC	CHIBEYDA	25,00	6"0	8,65	15,00	12.200	GAMBOS	378
35/62-AC	LUENE	47,30	6"0	17,70	45,00	3.200	GAMBOS	378
36/62-AC	CAALA	42,00	6"0	24,00	40,00	6.600	GAMBOS	378
37/62-AC	SATEMA	70,50	6"0	53,50	67,55	800	GAMBOS	378
38/63-AC	CHIBEO	55,00	6"0	19,50	27,00	1.[illegible]00	GAMBOS	378
39/63-AC	TCHIPUMBAMBILA	34,00	6"0	20,30	23,30	5.200	GAMBOS	378
38/69-AC	CHIBEO	20,00	3"0	18,20	-	1.000	GAMBOS	378
40/63-AC	VALE DO TCHIB.	30,00	6"0	15,30	17,00	14.400	GAMBOS	357
41/63-AC	RIO D'AREIA	40,00	8"0	26,70	32,50	12.770	GAMBOS	378
42/63-AC	VALE DO CHIB.	30,00	7"0	5,40	11,50	13.200	GAMBOS	357
43/63-AC	POTECHATUMBO	52,00	6S/8"0	36,50	47,00	6.600	GAMBOS	378
44/63-AC	VALE DO CHIB.	32,00	7"0	5,50	23,50	10.500	GAMBOS	357
45/63-AC	KAPANDA	40,00	6"0	23,70	33,70	3.500	GAMBOS	378
46/63-AC	TCHILANDO	55,00	6"0	3,00	44,00	2.560	GAMBOS	378
47/63-AC	TCHIMUCUA	35,00	8"0	7,30	15,00	1.500	GAMBOS	378
47A/69-AC	TCHIMUCUA	22,00	3"0	8,75	-	2.000	GAMBOS	378
48/63-AC	NOUCANDA	20,00	8"0	13,40	14,50	6.600	GAMBOS	378
49/63-AC	TCHIVI	35,70	6 1/4"	22,00	31,70	4.600	GAMBOS	378
48A/69-AC	NOUCANDA	20,00	3"0	12,50	-	1.600	GAMBOS	378
50/63-AC	BUNGUNGO	16,30	6"L/4"	8,00	11,90	6.600	GAMBOS	377
51/63-AC	TANDUA TOMBA	29,00	8"0	17,70	26,20	5.940	GAMBOS	377
51A/69-AC	TANDUA TOMBA	30,00	3"0	16,55	-	4.800	GAMBOS	377
52/63-AC	NUAMBUNGO	31,00	6"0	10,80	27,40	12.500	GAMBOS	377
53/63-AC	PANGUE	41,80	6"0	29,00	39,80	3.100	GAMBOS	357
53A/69-AC	PANGUE	40,00	3"0	26,80	-	1.250	GAMBOS	357
54/63-AC	POGOLO	36,00	6"0	12,60	18,15	16.500	GAMBOS	377
55/63-AC	LUPALE	46,00	6"0	19,90	44,00	5.000	GAMBOS	356
56/64-AC	NINUE	55,60	6"0	16,40	53,00	8.500	GAMBOS	357
57/64-AC	CHIANGE-NOVO	11,80	6"0	3,75	8,40	7.000	GAMBOS	377
58/64-AC	CHIANGE-NOVO	20,20	9"0	7,30	8,10	9.900	GAMBOS	377
61/64-AC	PAPO	25,80	7"0	10,80	24,20	12.000	GAMBOS	377
62/64-AC	RIO D'AREIA	45,00	-	30,80	39,00	8.000	GAMBOS	378
63/64-AC	NOGUELENGUE	20,00	7"0	12,15	17,05	5.500	GAMBOS	357
64/64-AC	CAPI	15,00	7"0	2,20	5,00	6.000	GAMBOS	377
65/64-AC	NUMPAUE	42,00	7"0	20,30	33,00	8.000	GAMBOS	357
26/61-AC	SECULADO TCHITI	40,00	6"0	20,600	26,00	3.130	CHIBIA	357
59/64-AC	NONDO	15,00	5"0	5,75	8,50	500	CHIBIA	356
60/64-AC	BARRAGEM	35,00	6"0	18,50	32,00	700	CHIBIA	356
253/70-AC	CAPANDE	20,00	6"0	14,35	18,20	3.200	CHIBIA	356
254/70-AC	OLIVENCA-A-NOVA	32,00	6"0	4,70	29,00	8.300	CHIBIA	356
299/71-AC	NIANDA	32,00	6"0	12,80	30,00	5.300	CHIBIA	356
300/72-AC	CHIMBUNDA	21,00	6"0	9,50	13,40	24.000	CHIBIA	356
369/73-AC	TCHCHI	25,00	6"0	14,00	22,50	4.800	CHIBIA	357
400/74-AC	QUINITA	20,00	6"0	6,00	12,60	9.500	CHIBIA	356
406/74-AC	NAFICO	16,00	6"0	4,50	13,00	1.800	CHIBIA	357
408/74-AC	LUEINDA	26,00	6"0	7,00	23,00	2.500	CHIBIA	356
411/74-AC	TCHICUATITE	28,00	5"0	4,00	20,00	2.550	CHIBIA	357
413/74-AC	TCHICUATITE	24,00	5"0	12,60	20,00	800	CHIBIA	357
414/74-AC	BARRETE	33,00	5"0	14,00	27,60	1.100	CHIBIA	356
415/74-AC	CHAPEU	40,00	5"0	23,50	28,00	12.100	CHIBIA	356
417/74-AC	PERU	20,00	5"0	8,90	17,00	6.600	CHIBIA	356
418/74-AC	APOLO	30,00	5"0	16,90	27,00	7.900	CHIBIA	356
428/75-AC	AQUARIO	15,50	5"0	3,80	12,50	2.840	CHIBIA	356
429/75-AC	NANUTENHA	31,00	5"0	5,80	28,00	1.900	CHIBIA	356
438/75-AC	TOLIMA	75,50	5"0	30,90	72,00	4.950	CHIBIA	357

Number	Localization	Depth (m)	Diameter (inch)	Static waterlevel (m)	Dynamic waterlevel (m)	Pumping rate (l/h)	Municipality	Observations and map number
444/75-AC	CANGALO	34,00	5"0	33,35	31,00	840	CHIBIA	356
470/76-AC	NUCUBA FAZ.DIAS	26,00	6"0	4,85	21,90	9.200	CHIBIA	356
471/76-AC	NUCUBA -ESCOLA	34,00	6"0	3,55	32,00	2.900	CHIBIA	356
472/76-AC	FAFA	16,00	6"0	7,75	14,00	4.800	CHIBIA	377
474/77-AC	CANDEAL	31,00	7,5"0	15,00	15,90	14.940	CHIBIA	377
482/77-AC	BISSAO DA QUINITA	27,00	5"0	15,00	18,50	7.540	CHIBIA	356
515/81-AC	NAVAL	29,00	6"0	3,15	9,75	12.184	CHIBIA	356
516/81-AC	MATAMPA	21,00	6"0	8,20	20.20	2.514	CHIBIA	356
518/81-AC	NOVIALOLA	29,00	6"0	17,45	25,00	1.427	CHIBIA	357
519/81-AC	NEMBIUNGO	27,90	8"0	12,20	18,24	7.764	CHIBIA	356
521/81-AC	CACHICIA	26,50	8"0	10,00	12,80	10.560	CHIBIA	356
535/82-AC	CHINGONGO	70,00	7 1/2"0	21,70	29,70	18.418	CHIBIA	356
540/82-AC	CANGALUNGUE	24,00	6 1/2"0	2,00	22,00	3.000	CHIBIA	355
548/82-AC	FAZENDA CALOTA	71,00	6 1/2"0	12,00	24,22	13.200	CHIBIA	356
556/83-AC	NEMBALE	34,00	6 1/2"0	0,00	20,00	4.800	CHIBIA	356
557/83-AC	LUNDI	44,00	6 1/2"0	1,00	8,00	16.500	CHIBIA	356
561/83-AC	CANCACA	34,00	6 1/2"0	5,45	16,51	9.900	CHIBIA	356
565/83-AC	VANDE	40,00	6 1/2"0	8,25	37,00	6.600	CHIBIA	356
567/83-AC	VCHIMBONGOMA	36,70	6 1/2"0	3,20	32,20	1.930	CHIBIA	356
570/83-AC	CAMBA	29,00	7,1/2"0	3,10	26,82	2.329	CHIBIA	337
573/83-AC	SECTOR-CANGALO	34,00	8 1/2"0	7,95	20.25	10.150	CHIBIA	336
574/84-AC	CALCOVA	28,00	6 1/2"0	1,70	24,35	4.000	CHIBIA	335
594/85-AC	TYIMANGAI	32,00	8"0	1,70	27,00	1.000	CHIBIA	357
578/84-AC	VIFELELE	43,50	8"1/20	9,85	39,20	9.000	CHIBIA	336
588/84-AC	VIFELELE	49,00	8"1/20	3,15	20,70	13.200	CHIBIA	336
583/84-AC	VIUDUNDI	20,00		4,00	18,09	4.400		
594/85-AC	TYIMANGAI	32,00		1,70	27,00	1.000		
598/85-AC	CAMBA	39,00		11,00	36,90	8.800		
599/85-AC	NOVE-UMA	48,00		15,00	47,00	15.840		
605/85-AC	VCHIMBOLOLUMA	39,00		13,00	24,00	2.770		
607/86-AC	FAZ.GIRAO	37,50		4,25	13,00	12.370		
32/62-AC	RETUMBA YY-16	55,00	6"0	19,75	45,00	7.200	LUBANGO	356
122/66-AC	CANOCO	41,70	6"0	4,50	41,20	3.700	LUBANGO	336
165/68-AC	ARVORE REDONDA	34,50	6"0	26,00	34,00	2.200	LUBANGO	336
209/68-AC	CASA DOS RAPAZES	49,00	6"0	5,65	43,00	2.300	LUBANGO	335
216/69-AC	CONJENJE	23,00	6"0	19,75	22,00	3.000	LUBANGO	356
229/70-AC	NDENGUE	72,00	6"0	53,50	66,00	9.900	LUBANGO	339
235/70-AC	RIO GRANDE	30,00	6"0	7,20	20,50	5.300	LUBANGO	356
241/70-AC	CHIER-CHIEN	44,50	6"0	4,85	43,50	3.450	LUBANGO	337
250/70-AC	STRAL	27,00	6"0	5,90	21,00	2.800	LUBANGO	335

Number	Localization	Depth (m)	Diameter (inch)	Static waterlevel (m)	Dynamic waterlevel (m)	Pumping rate (l/h)	Municipality	Observations and map number
301/72-AC	SIMOES DE ABREU	52,00	6"0	10,60	49,00	8.300	LUBANGO	335
302/72-AC	SOFRID	27,50	6"0	2,50	24,50	7.500	LUBANGO	335
318/72-AC	VENANCIO G.SOBRINHO	50,80	6"0	10,00	46,00	4.300	LUBANGO	336
322/72-AC	SENHORA DO MONTE	105,30	6"0	44,50	49,00	33.600	LUBANGO	335
323/72-AC	VILA PAULA	46,50	6"0	13,80	45,00	7.500	LUBANGO	336
327/72-AC	TOCO	46,00	6"0	7,00	43,00	2.300	LUBANGO	336
328/72-AC	ARVORE REDONDA I	47,00	6"0	27,70	45,00	3.100	LUBANGO	336
329/72-AC	CHAMACA	34,00	6"0	12,20	32,40	6.900	LUBANGO	336
330/72-AC	ARVORE REDONDA I	20,00	6"0	2,75	18,00	4.800	LUBANGO	336
332/72-AC	CAPITAO	38,50	6"0	18,75	35,00	3.600	LUBANGO	336
333/72-AC	CERAMICA	78,00	6"0	5,05	26,47	2.364	LUBANGO	336
334/72-AC	QUILENDA	31,75	6"0	12,35	29,50	3.800	LUBANGO	335/6
335/72-AC	ARIMBA	31,50	6"0	10,20	29,00	3.850	LUBANGO	336
337/72-AC	CHIOCO-NOVO	25,50	6"0	1,20	22,50	3.950	LUBANGO	336
338/72-AC	EVENTAL	21,00	6"0	9,00	18,00	1.000	LUBANGO	336
340/72-AC	GAVIAO	40,00	6"0	28,62	38,60	1.400	LUBANGO	336
342/72-AC	QUARTEIS	21,00	6"0	7,50	14,10	2.700	LUBANGO	336
344/72-AC	MUTUNDO	17,00	6"0	2,50	14,00	2.000	LUBANGO	336
345/72-AC	CHIOCO-NOVO	37,00	6"0	8,50	26,00	1.200	LUBANGO	336
346/72-AC	QUARTEIS	25,00	6"0	2,50	23,50	5.000	LUBANGO	336
347/72-AC	SENHORA DO MONTE	123,00	6"0	54,20	55,79	27.000	LUBANGO	335
348/72-AC	NATETA	25,00	6"0	1,00	23,00	9.900	LUBANGO	336
349/72-AC	VIAMBA	36,00	6"0	15,80	33,00	900	LUBANGO	336
351/72-AC	CACULUVAR	26,00	6"0	12,80	23,50	8.800	LUBANGO	336
352/72-AC	QUARTEIS	33,50	6"0	4,50	31,50	3.100	LUBANGO	336
355/73-AC	QUARTEIS	37,00	6"0	6,70	35,00	16.100	LUBANGO	336
356/73-AC	FIGUEIRA DA MUCANCA	28,00	6"0	13,12	25,00	4.400	LUBANGO	336
357/73-AC	QUARTEIS	35,50	6"0	3,20	31,50	9.600	LUBANGO	336
358/73-AC	BANDA	25,50	6"0	10,65	23,50	2.600	LUBANGO	356
359/73-AC	VINI	27,00	6"0	10,15	27.76	2.028	LUBANGO	339
361/73-AC	LAPLACE	11,00	6"0	1,00	6,30	9.100	LUBANGO	356
364/73-AC	CAVIOMBO	44,60	6"0	28,60	42,00	3.750	LUBANGO	337
375/73-AC	AEROPORTO	54,00	6"0	1,60	52,00	4.400	LUBANGO	336
378/73-AC	BARRACOES	17,00	6"0	4,30	13,50	1.300	LUBANGO	336
383/73-AC	CAPITAO	44,00	6"0	12,00	41,00	8.800	LUBANGO	336
385/74-ac	CERVEJA	34,00	7"0	5,70	17,50	10.000	LUBANGO	335
388/74-AC	CERVEJA	47,00	6"0	4,70	23,20	4.450	LUBANGO	335
389/74-AC	SENHORA DO MONTE	119,50	9"/2,6"0	71,30	72,68	26.200	LUBANGO	335
391/74-AC	SENHORA DO MONTE	119,00	12,8 e 6"0	52,10	58,50	30.460	LUBANGO	335
392/74-AC	BARRACOES	36,00	6"0	3,50	33,00	6.900	LUBANGO	336

Number	Localization	Depth (m)	Diameter (inch)	Static waterlevel (m)	Dynamic waterlevel (m)	Pumping rate (l/h)	Municipality	Observations and map number
394/74-AC	CAPITao	51,50	6"0	10,00	49,00	5.600	LUBANGO	336
395/74-AC	CHICCO-NOVO	14,50	6"0	0,00	14,00	3.000	LUBANGO	336
396/74-AC	BARRACHES	24,50	6"0	3,30	22,00	1.800	LUBANGO	336
398/74-AC	TCHICALA	28,50	6"0	2,00	12,40	11.300	LUBANGO	336
401/74-AC	ZAMA	36,50	7"0	6,50	34,00	15.000	LUBANGO	336
403/74-AC	ZAMA	29,00	6"0	41,10	26,00	12.200	LUBANGO	336
404/74-AC	CHEVAVE	19,00	6"0	3,90	16,00	1.800	LUBANGO	336
407/74-AC	BAMBANDE	34,00	6"0	1,95	31,00	9.300	LUBANGO	336
409/74-AC	CEBRA	39,00	5"0	22,30	34,00	3.300	LUBANGO	337
412/74-AC	BA	40,00	5"0	3,70	35,00	3.400	LUBANGO	337
416/74-AC	SENHORA DO MONTE	96,00	14,122e8"0	51,30	53,42	30.500	LUBANGO	335
420/74-AC	SENHORA DO MONTE	104,00	12,8e6"0	74,50	75,50	28.300	LUBANGO	335
422/74-AC	BARRAS	36,00	5"0	0,00	33,00	4.200	LUBANGO	337
424/74-AC	SENHORA DO MONTE	104,00	12,10 e 6"0	62,00	26,36	26.400	LUBANGO	335
426/74-AC	GAVIAO	38,00	5"0	12,10	35,00	2.250	LUBANGO	336
430/75-AC	GAVIAO	45,00	5"0	13,10	42,00	6.600	LUBANGO	336
432/75-AC	JACUBA	23,00	5"0	5,00	12,50	7.900	LUBANGO	337
433/75-AC	BAMBANDE	36,50	5"0	1,90	14,00	2.200	LUBANGO	336
435/75-AC	POMBO	31,50	6"0	8,30	20,70	8.334	LUBANGO	336
436/75-AC	NIVA	32,00	5"0	10,00	29,00	1.000	LUBANGO	337
437/75-AC	POMBO	37,00	5"0	2,00	13,95	4.600	LUBANGO	336
442/75-AC	ZOMBO	26,50	5"0	2,50	25,00	4.400	LUBANGO	336
446/75-AC	POMBO	33,00	5"0	8,50	25,60	6.600	LUBANGO	336
447/75-AC	ZOMBO	27,00	5"0	9,50	25,60	4.800	LUBANGO	336
452/75-AC	UMBANGA	30,00	5"0	5,70	27,00	3.700	LUBANGO	335
454/75-AC	ZAMA	32,00	5"0	3,00	31,00	10.300	LUBANGO	336
455/75-AC	ZAMA	24,00	5"0	3,50	23,00	6.500	LUBANGO	336
456/75-AC	SENHORA DO MONTE	135,00	?	75,00	76,95	26.400	LUBANGO	335
459/75-AC	POMBO	35,00	10 e 8"0	0,65	32,00	1.450	LUBANGO	336
462/75-AC	GAMA	46,00	?	5,00	44,00	6.090	LUBANGO	336
463/75-AC	FAISAO	25,00	?	3,45	22,00	1.200	LUBANGO	336
468/75-AC	CASA BRANCA	37,50	5"0	5,00	35,50	3.950	LUBANGO	336
469/76-AC	CHAJENJE-2	24,00	6"0	17,35	23,00	3.000	LUBANGO	336
477/77-AC	CHAJENJE-III	25,00	7"0	7,50	22,00	2.200	LUBANGO	336
478/77-AC	JOAO LAMBA	83,00	6"0	2,85	78,30	7.200	LUBANGO	336
479/77-AC	BAIE	27,00	6"0	3,00	26,00	1.500	LUBANGO	336
480/77-AC	KIBANGOLO	17,06	5"0	1,90	16,90	2.640	LUBANGO	336
481/77-AC	KIBANGOLO	32,00	5"0	31,49	31,49	7.600	LUBANGO	336
483/77-AC	BAMBANE	20,00	5"0	7,00	17,30	200	LUBANGO	336
485/77-AC	KIBANA	23,00	5"0	9,60	18,00	550	LUBANGO	336

Number	Localization	Depth (m)	Diameter (inch)	Static waterlevel (m)	Dynamic waterlevel (m)	Pumping rate (l/h)	Municipality	Observations and map number
486/77-AC	MAMBANJA	27,00	5"0	2,75	19,90	8.330	LUBANGO	336
489/78-AC	NANDEIRO	25,00	5"0	3,40	19,00	9.900	LUBANGO	336
490/78-AC	ALIANCA	33,70	6"0	10,00	31,24	2.436	LUBANGO	335
491/78-AC	VULCAO	38,00	5"0	13,00	29,80	5.280	LUBANGO	336
498/79-AC	CARITA	37,00	6"0	16,00	32,00	2.650	LUBANGO	335
500/79-AC	CONJENJE-IV	28,00	5"0	19,10	25,00	750	LUBANGO	336
502/79-AC	LAPIS	35,00	7"0	2,70	9,80	11.300	LUBANGO	335
503/79-AC	CARNEIRO	50,00	8 e 5"0	3,57	38,10	8.336	LUBANGO	336
505/80-AC	LENTE	54,50	6"0	0,00	53,37	7.542	LUBANGO	336
506/81-AC	SAMPO-1	28,00	6"0	7,45	26,78	2.200	LUBANGO	336
507/81-AC	VILA PAULA	34,00	6"0	2,50	31,30	5.100	LUBANGO	336
510/81-AC	BOMANGOL	39,30	6"0	10,00	38,60	13.200	LUBANGO	336
526/82-AC	ABRACATI	20,80	7"0	4,50	19,00	1.440	LUBANGO	336
527/82-AC	PEAO	26,00	6"0	10,00	24,30	240	LUBANGO	336
529/82-AC	TORRE	31,00	6"0	0,35	27,30	1.350	LUBANGO	336
530/82-AC	REI	33,00	6"0	11,80	25,00	6.600	LUBANGO	336
532/82-AC	TCHIPONGOLO	27,50	7 1/2"0	2,40	24,50	8.000	LUBANGO	336
532/82-AC	TCHIPONGOLO	45,00	8"0	14,65	36,50	2.160	LUBANGO	336
534/82-AC	MISSAO C.N. DA HUILA	29,00	6"0	4,70	24,50	7.200	LUBANGO	336
536/82-AC	N'GOLA	38,00	6"0	5,75	26,47	3.300	LUBANGO	336
537/82-AC	N'GOLA	60,50	7"0	3,20	51,80	5.657	LUBANGO	336
539/82-AC	MUMPACA	37,00	6"0	1,30	33,40	3.600	LUBANGO	336
541/82-AC	CANBA	77,50	8 1/2"0	3,60	69,40	3.771	LUBANGO	335
542/82-AC	VIHANGO	34,65	7 1/2"0	6,25	34,25	3.863	LUBANGO	336
544/82-AC	HORIZONTE	114,00	6 1/2"0	17,98	83,51	660	LUBANGO	336
545/82-AC	CONCENTRACAO-VIAMBA	42,00	6 1/2"0	8,20	28,00	5.657	LUBANGO	337
546/82-AC	ALUNO-DIA	74,00	6 1/2"0	6,50	68,15	3.046	LUBANGO	336
549/83-AC	N'GOLA	37,00	7 1/2"0	0,50	34,02	1.537	LUBANGO	336
551/83-AC	NONGIUE	61,00	6 1/2"0	20,00	24,00	13.200	LUBANGO	336
552/83-AC	NOMBAU-ESCOLA	23,00	6 1/2"0	2,25	19,65	3.300	LUBANGO	336
553/83-AC	CANGOLO-NAQUIPA	48,00	6 1/2"0	3,85	12,88	9.317	LUBANGO	336
556/83-AC	RAINHA	61,00	6"0	1,33	58,39	2.640	LUBANGO	336
571/83-AC	CHITUNO	47,00	6 1/2"0	2,45	45,00	2.930	LUBANGO	336
572/83-AC	BOMBO	35,00	6 1/2"0	6,20	29,00	8.000	LUBANGO	337
575/84-AC	EUCALIPTO	58,00	10 1/2"0	3,90	25,70	19.200	LUBANGO	335
372/73-AC	MAI - MAI	46,00	6"0	17,00	43,00	1.900	QUIPUNGO	337
387/74-AC	SAPO	76,50	6"0	43,80	56,35	12.350	QUIPUNGO	350
336/72-AC	GAMBO	63,50	6"0	49,65	59,10	10.400	QUIPUNGO	350
350/72-AC	BANDARRA	70,00	6"0	47,00	49,60	4.100	QUIPUNGO	350
381/73-AC	PLANETA	31,00	6"0	18,70	28,00	2.200	QUIPUNGO	337

Number	Localization	Depth (m)	Diameter (inch)	Static waterlevel (m)	Dynamic waterlevel (m)	Pumping rate (l/h)	Municipality	Observations and map number
399/74-AC	PLANETA	84,00	6"0	46,00	68,30	7.920	QUIPUNGO	336
400/74-AC	CAIMBE	64,00	5"0	24,65	46,20	4.860	QUIPUNGO	337
575/83-AC	BONDO	35,00	6"1/20	6,20	29,00	8.000	QUIPUNGO	337
388/82-AC	TIN-TIN	42,00	6"0	27,00	28,70	8.000	HUMPATA	355
389/84-AC	TIP-TOP	74,50	6"0	35,20	41,69	8.334	HUMPATA	355
511/84-AC	WHITE	19,00	8"0	3,15	11,50	22.620	HUMPATA	355
512/84-AC	KING-KONG	24,00	8"0	0,40	5,30	19.800	HUMPATA	355
513/84-AC	JAMAICA	82,50	6"0	13,20	77,67	2.640	HUMPATA	355
514/84-AC	MANGELO	103,00	6"0	74,00	97,50	3.443	HUMPATA	355
517/84-AC	COLUMBIA	22,00	7"0	4,50	19,30	3.300	HUMPATA	355
421/74-AC	FLORESTA	90,00	6"0	5,90	34,40	12.750	HUMPATA	355
361/73-AC	LAPLACE	11,00	8"0	1,00	6,30	9.180	HUMPATA	355
339/72-AC	BOCA - HUMPATA	80,00	6"0	16,00	72,00	10.000	HUMPATA	355
502/79-AC	LAPIS	35,00	7"0	2,70	9,80	11.300	HUMPATA	355
541/82-AC	CAUBA	77,50	8"1/20	3,60	69,40	3.771	HUMPATA	355
560/83-AC	CAIAMA	31,00	6 1/2"0	2,20	27,40	1.800	NATALA	338
560/83-AC	CAIAMA	31,00	6 1/2"0	9,40	49,00	1.102	NATALA	338
331/72-AC	VISSUNGE	54,00	6"0	41,70	51,00	17.200	CAPELONGO	350
360/73-AC	ALBACIN	64,00	6"0	53,30	60,00	2.400	CAPELONGO	350
373/73-AC	BOSSI	97,00	6"0	65,00	76,30	24.750	CAPELONGO	350
386/74-AC	EVA	42,50	6"0	18,40	20,55	12.000	CAPELONGO	359
393/74-AC	TURIA	110,00	6"0	78,70	91,50	5.200	CAPELONGO	379
397/74-AC	TUPANASO	110,00	6"0	69,30	92,00	3.200	CAPELONGO	379
431/75-AC	PREMOA	107,00	5"0	62,50	96,00	7.500	CAPELONGO	380
434/75-AC	MACUNA	99,50	5"0	58,70	96,00	2.500	NATALA	380
440/75-AC	TECHIRA	105,00	5"0	58,50	83,00	7.500	CAPELONGO	380
443/75-AC	CAIMONE	106,00	5"0	57,50	68,50	8.000	CAPELONGO	380
451/75-AC	ERE	109,00	5"0	60,00	92,00	8.300	CAPELONGO	380
453/75-AC	CANHANGONGA	109,00	5"0	55,00	64,55	9.300	CAPELONGO	380
457/75-AC	CANHANACUMA	114,00	5"0	60,00	82,20	7.800	CAPELONGO	380
68/64-AC	NIVENGUE	39,00	6"0	22,00	26,00	450	GAMBOS	
110/65-AC	BONGUE 2	15,00	6"0	3,70	5,40	12.000	GAMBOS	
133/66-AC	VALELA	25,00	6"0	15,00	22,00	8.000	GAMBOS	
215/69-AC	TCHINDONGA	30,00	6"0	10,30	14,00	2.200	GAMBOS	
260/71-AC	MAFI	140,00	6"0	144,00	130,00	11.650	GAMBOS	
276/71-AC	MANDANDE	113,50	6"0	90,00	110,00	3.900	GAMBOS	
283/71-AC	PEREIRA	129,00	6"0	75,00	86,00	10.000	GAMBOS	
296/71-AC	MAPOTUNA	110,00	6"0	94,00	107,00	2.100	GAMBOS	
321/72-AC	CHICONDE	156,00	6"0	100,00	109,00	11.000	GAMBOS	
390/74-AC	PELO	118,00	6"0	80,00	95,00	10.100	GAMBOS	

Number	Localization	Depth (m)	Diameter (inch)	Static waterlevel (m)	Dynamic waterlevel (m)	Pumping rate (l/h)	Municipality	Observations and map number
402/74-AC	CAVIMI	38,00	6"0	16,00	26,00	11.300	GAMBOS	
419/74-AC	COLOLA	18,00	5"0	8,90	15,00	3.500	GAMBOS	
423/74-AC	NIMLIO	32,00	5"0	8,90	18,00	12.200	GAMBOS	
475/76-AC	MONDEGO	20,00	5"0	15,00	17,00	600	GAMBOS	
472/76-AC	PAPA	16,00	6"0	7,75	14,00	4.800	GAMBOS	
473/76-AC	LIMA	18,00	6"0	13,00	17,00	4.900	GAMBOS	
475/77-AC	SABO	19,00	6"0	11,90	14,00	5.400	GAMBOS	
476/77-AC	BORORO	15,00	5"0	11,00	13,00	1.277	GAMBOS	
477-AC	VIVIAMBUNGO	17,00	7"0	4,85	12,00	7.920	GAMBOS	
484/77-AC	VIVIAMBUNDO	20,00	7"0	5,85	14,00	11.800	GAMBOS	
492/78-AC	ECOMBO	21,00	5"0	10,85	16,00	3.216	GAMBOS	
493/78-AC	COLOMBA	37,00	6"0	6,50	24,00	18.370	GAMBOS	
494/78-AC	NIVIGUILO	15,00	5"0	5,50	10,00	4.400	GAMBOS	
495/78-AC	MANDU	26,00	5"0	12,40	22,00	1.466	GAMBOS	
496/78-AC	BAFUA	60,00	6"0	9,20	57,00	11.340	GAMBOS	
497/78-AC	METRALHA	20,00	5"0	6,20	19,00	10.020	GAMBOS	
555/83-AC	TUNDA	22,00	8"0	10,50	13,00	7.942	GAMBOS	
556/83-AC	CHINCONDONGALO	45,00	8"0	9,00	17,00	10.500	GAMBOS	
559/83-AC	MONGELO	33,00	6"0	16,00	30,00	5.530	GAMBOS	
562/83-AC	TCHIMUCUA	66,00	6"0	42,00	65,00	2.730	GAMBOS	
564/83-AC	IBALIMA	18,00	6"0	6,00	7,00	13.200	GAMBOS	
566/83-AC	TYPUNDULO	47,00	7"0	7,00	37,00	4.950	GAMBOS	
331/72-AC	VICUBUCUE	54,00	10"0	41,00	51,00	17.200	CAPELONGO	
360/73-AC	ALBACIN	64,00	8"0	53,00	60,00	2.400	CAPELONGO	
386/74-AC	EVA	42,00	8"0	18,00	20,00	12.000	CAPELONGO	
373/73-AC	BOSSI	97,00	8"0	65,00	76,00	24.750	CAPELONGO	
393/74-AC	TURIA	110,00	10"0	78,00	91,00	5.200	CAPELONGO	
397/74-AC	TUPANASO	110,00	8"0	69,00	92,00	3.200	CAPELONGO	
431/75-AC	PREMOA	107,00	8"0	62,00	96,00	7.500	CAPELONGO	
440/75-AC	TECHIRA	105,00	8"0	58,00	83,00	7.500	CAPELONGO	
443/75-AC	CAIMONE	106,00	8"0	57,00	68,00	8.000	CAPELONGO	
451/75-AC	ERE	109,00	8"0	60,00	92,00	8.300	CAPELONGO	
453/75-AC	CANHANGONGA	109,00	6"0	55,00	64,00	9.300	CAPELONGO	
457/75-AC	LUANAMACUMNA	114,00	6"0	60,00	82,00	7.900	CAPELONGO	
89/71-AC	ONGUENHA	39,00	6"0	25,70	28,00	16.500	CAPELONGO	
90/71-AC	ALFO ONGUENHA	39,00	6"0	28,05	32,00	15.800	CAPELONGO	
122/73-AC	ELINGUETE	62,00	6"0	22,00	60,00	4.400	CAPELONGO	
123/73-AC	MUIJAPULO	46,00	6"0	13,00	44,00	1.350	CAPELONGO	
124/73-AC	TECHICOTE	38,00	6"0	5,00	14,00	13.200	CAPELONGO	
127/73-AC	UALENDE	37,00	6"0	20,00	27,00	14.400	CAPELONGO	

No. Captacao	Nome do local	Profund (m)	Diametr (Ø) (inch)	Nivel Est. (m)	Nivel Din. (m)	Caudal (l/h)	Municipio	Carta
1/58	Calovango Chilau	27,20	6"0	8,50	9,50	4.000	Cahama	421
2/59	Calovango Bogue	63,40	6"0	83,15	35,40	230	Curoca	421
7/59	Bupo Calovango	50,00	6"0	15,20	36,75	7.500	Sede Cahama	421
10/59	Chuapombe	45,45	6"0	00,00	31,71	1.000	Curoca	421
12/59	Vicuasso-Cuasso	94,00	6"0	32,00	39,25	1.100	Cahama	399
13/59	Vicuasso-Cuasso	65,00	6"0	34,30	56,00	770	Cahama	399
16/60	Pov. da Cahama	105,00	8"0	35,50	65,50	2.000	Cahama	399
20/60	Ichicuasso-Iaudo	66,00	8"0	32,40	48,00	670	Cahama	399
208/60	Bano	65,00	8"0	31,85	63,00	550	Cahama	399
24/61	Ichicuasso-Iaudo (Bano)	93,00	6"0	64,00	66,30	12.000	Cahama	399
27/61	Ichicuasso-Iaudo (Bano)	100,00	6"0	75,00	85,00	6.000	Cahama	399
28/61	Cavalovo	50,30	6"0	31,00	45,00	5.000	Cahama	399
29/61	Ichua	99,00	6"0	76,00	90,00	4.500	Cahama	400
30/61	Ichicuasso-Iaudo (Ichua)	99,00	6"0	83,70	93,00	3.300	Cahama	400
31/62	Ichicuasso	114,20	8"0	70,00	100,00	2.000	Cahama	399
66/64	Nangimba III	31,50	7"0	13,50	27,00	8.300	Curoca	421
67/64	Jombouvuo	28,00	7"0	8,65	25,00	3.200	Curoca	421
69/64	Edivo	33,00	6"0	21,00	31,00	5.300	Cahama	399
70/64	Ichicuasso	50,00	6"0	29,00	46,00	7.000	Curoca	421
71/65	Gata e Borges	66,00	6"0	22,20	27,50	13.200	Cahama	399
72/65	Gata e Borges	48,00	6"0	22,20	34,00	1.200	Cahama	399
73/65	Arango do Bulo	10,00	6"0	2,85	6,20	12.000	Curoca	443
74/65	Chala do	20,00	6"0	4,50	17,00	7.000	Curoca	443
75/65	F. 3 - 1	12,50	6"0	4,70	6,20	15.600	Curoca	443
76/65	Gata e Borges (Edivo)	25,00	6"0	16,00	18,50	12.200	Cahama	399
77/65	F. 3 - 1	22,50	6"0	14,60	19,50	1.000	Curoca	443
78/65	Arango (M-1)	19,50	6"0	5,70	16,50	3.000	Curoca	444
79/65	Fagenda 4 - P.2	19,50	6"0	9,00	10,60	22.600	Curoca	443
80/65	Fagenda 4 - P.1	17,00	6"0	5,50	7,30	34.400	Curoca	443
81/65	Fagenda 5 - P.2	29,00	6"0	21,70	25,50	1.400	Curoca	444
82/65	Londovire	32,00	6"0	24,70	28,00	3.450	Curoca	399
83/65	Fagenda 2 - P.2	22,00	6"0	10,50	20,00	14.400	Curoca	443
84/65	Fagenda 1 - P.2	13,00	6"0	6,70	10,00	8.000	Curoca	443
85/65	Reserva 4 - P.1	30,00	6"0	17,50	25,00	5.000	Curoca	443
86/65	Reserva 4 - P.2	24,50	6"0	13,70	14,60	20.000	Curoca	443
87/65	Lomdo	21,00	6"0	5,10	14,70	13.000	Curoca	421
88/65	Banha (M - 3)	26,00	6"0	10,75	13,30	22.600	Curoca	443
89/65	Fagenda 16 - P.1	30,00	6"0	11,10	21,00	1.000	Curoca	419/442
90/65	Fagenda 2 - P.1	23,00	6"0	12,90	14,00	16.500	Curoca	443
91/65	Fagenda 14 - P.2	35,00	6"0	14,20	23,00	7.200	Curoca	443
92/65	Fagenda 1 - P.1	16,00	6"0	7,30	6,65	54.600	Curoca	443
93/65	Fagenda 14 - P.1	23,50	6"0	5,70	21,00	6.600	Curoca	420
94/65	Fagenda 12 - P.2	25,00	6"0	6,70	12,00	2.650	Curoca	443
95/65	Fagenda 10 - P.2	28,00	6"0	4,90	9,60	33.000	Curoca	443
96/65	Fagenda 11 - P.1	27,50	6"0	19,10	20,50	16.500	Curoca	444
97/65	Fagenda 10 - P.1	16,50	6"0	6,30	14,00	3.300	Curoca	443
98/65	Fagenda 11 - P.2	31,00	6"0	20,20	30,00	1.650	Curoca	444
99/65	Reserva 5	23,00	6"0	3,70	22,60	2.000	Curoca	443
100/65	Fagenda 15 - P.1	32,00	6"0	12,70	31,00	2.600	Curoca	444
101/65	Caranbona	11,00	6"0	3,50	10,20	2.000	Curoca	443
102/65	Reserva a-Lavango	40,00	6"0	13,70	34,00	2.000	Curoca	444
103/65	Fagenda 15 - P.2	46,50	6"0	29,00	46,00	6.000	Curoca	444
104/65	Fagenda 12 - P.2	30,00	6"0	13,00	16,45	19.000	Curoca	443
105/65	Fagenda 1 - P.3	17,00	6"0	9,00	16,50	6.300	Curoca	443
106/65	Reserva 5 -P.1	24,00	6"0	16,50	19,65	15.500	Curoca	444
107/65	Reserva 7 - P.2	31,00	6"0	12,30	30,50	7.200	Curoca	444
108/65	Pouucuauuaro	45,00	6"0	33,00	44,00	1.500	Curoca	399
109/65	Fagenda 17 - P.1	57,00	6"0	35,00	50,00	2.750	Curoca	444
110/65	Fagenda 13 - P.2	30,00	6"0	20,40	25,00	200	Curoca	444
111/65	Fagenda 9 - P.2	30,00	6"0	20,00	28,50	440	Curoca	444
112/65	Reserva 7 -	24,50	6"0	14,50	19,60	15.000	Curoca	444
113/65	Fagenda 9 - P.1	26,00	6"0	17,50	24,00	3.160	Curoca	444
114/65	Calovango	41,00	6"0	21,70	35,00	1.900	Curoca	399
115/65	Pouucuauuaro	41,00	6"0	33,00	40,50	1.015	Curoca	399
116/65	Nangimba II	29,00	6"0	15,70	27,50	16.000	Curoca	421
117/65	Pov. Tocluyoa	16,50	6"0	8,60	15,00	10.500	Curoca	421
120/66	Luala	27,00	6"0	11,70	22,00	6.000	Cahama	398
121/66	Otunge	16,00	6"0	9,20	12,50	3.300	Cahama	360
123/66	Luala	24h,00	6"0	11,70	22,00	4.400	Cahama	398
124/66	Onge	20,50	6"0	16,20	17,60	500	Cahama	398
125/66	Otchimjau	10,00	6"0	4,00	8,50	3.000	Curoca	420
126/66	Huana	25,00	6"0	14,70	23,00	1.900	Cahama	398
127/66	Chifito II	34,00	6"0	15,65	26,00	4.000	Cahama	399
128/66	Lucado	27,00	6"0	10,50	24,50	3.000	Cahama	398
129/66	Nanja	25,00	6"0	18,70	24,50	7.200	Cahama	398
130/66	Iongava	29,00	6"0	16,50	23,00	5.500	Cahama	399
131/66	Condova	29,00	6"0	14,60	20,50	2.000	Cahama	399
132/66	Efua	20,00	6"0	11,30	18,00	5.500	Cahama	398
134/66	Cangoabe	20,00	6"0	9,50	10,20	13.200	Cahama	398
135/66	Iongava	29,00	6"0	20,65	24,00	5.300	Cahama	399

No. Captacao	Nome do local	Profund (m)	Diametr (Ø) (inch)	Nivel Est. (m)	Nivel Din. (m)	Caudal (l/h)	Municipio	Carta
136/66	Candova	25,00	6"Ø	15,75	16,50	13.200	Cahama	399
137/66	Chifito	30,00	6"Ø	11,50	48,00	2.900	Cahama	399
138/66	Bunga	23,00	6"Ø	14,60	19,50	5.000	Cahama	398
139/66	Cambando	42,00	6"Ø	12,30	36,50	2.400	Cahama	398
140/66	Tchaute	27,50	6"Ø	12,50	25,50	2.000	Curoca	420
141/66	Bacocos	21,00	6"Ø	550	18,50	1.600	Curoca	419/442
142/66	Kaulueva	18,50	6"Ø	8,40	12,30	13.200	Curoca	420
143/66	Cambora	29,00	6"Ø	16,20	22,00	2.400	Curoca	420
144/66	Bluebuca	21,50	6"Ø	11,50	18,00	5.000	Curoca	419/442
145/66	Bichanjan	16,00	8"Ø	4,40	13,50	70.000	Curoca	420
146/66	Bacocos	21,50	6"Ø	7,50	12,50	8.000	Curoca	419.442
147/66	Canangauvi	21,50	6"Ø	9,65	15,00	2.000	Curoca	420
147A/66	Canangauvi	15,50	6"Ø	6,15	13,50	7.900	Curoca	420
148/66	Tchicuhima	33,50	6"Ø	20,00	31,00	2.600	Curoca	421
149/71	Chandando	53,00	6"Ø	22,50	29,00	12.200	Curoca	421
150/67	Fazenda 13 - P.1	37,00	6"Ø	14,50	32,00	7.200	Curoca	444
151/67	Cacimbas do Navaro	16,50	6"Ø	3,00	14,50	9.000	Curoca	444
152/67	Lupaca	30,00	6"Ø	16,30	20,00	2.000	Curoca	444
153/67	Bacaca - P.2	29,00	5 7/8"Ø	18,20	27,00	2.700	Curoca	445
154/67	Lalavanga	22,00	6"Ø	11,00	19,00	8.000	Cahama	399
155/67	Bacaca - P.3	37,00	5 7/8"Ø	20,20	29,50	4.500	Curoca	445
156/67	Bajanbo	112,00	8"Ø	60,00	102,00	4.000	Cuanato	400
157/67	Bacaca - P.4	44,00	6"Ø	20,30	38,00	4.500	Curoca	445
158/67	Caulaca	10,00	8"Ø	2,30	4,10	5.000	Curoca	444
159/67	Cutanga	14,00	8"Ø	3,50	5,50	12.000	Curoca	444
160/67	Fazenda 16 - P.3	35,00	6"Ø	12,00	27,00	1.100	Curoca	419/442
161/67	Bundungambue	55,00	5"Ø	29,50	82,50	1.200	Curoca	421
162/67	Fazenda 3 - P.1/67	20,00	6"Ø	5,50	15,00	2.600	Curoca	443
163/67	Fazenda 6A - P.1	17,50	8"Ø	6,50	9,00	13.200	Curoca	443
164/67	Fazenda 6 - P.1	32,00	6"Ø	5,50	22,00	2.000	Curoca	443
165/67	Bunlo	12,50	8"Ø	4,00	7,00	8.000	Curoca	444
166/67	Bupa I	17,00	8"Ø	4,50	10,00	9.900	Curoca	444
167/67	Bupa	23,00	8"Ø	6,50	14,00	8.000	Curoca	444
168/67	Bunguabe	77,00	8"Ø	57,00	68,40	7.000	Cuanato	401
169/67	Gando	93,00	6"Ø	74,00	83,60	6.000	Cuanato	400
170/67	Bunangunga	20,00	6"Ø	14,70	17,70	3.000	Curoca	421
171/67	Luifo	34,00	6"Ø	28,70	39,00	2.000	Curoca	421
172/67	Vinne	109,00	6"Ø	70,00	80,50	8.000	Cuanato	400
173/67	Pov. da Lalenga	79,00	6"Ø	7,00	16,00	2.000	Cahama	399
174/67	Bumbo	70,00	6"Ø	55,00	66,00	800	Cahama	399

No. Captacao	Nome do local	Profund (m)	Diametr (Ø) (inch)	Nivel Est. (m)	Nivel Din. (m)	Caudal (l/h)	Municipio	Carta
175/67	Capujoa	23,00	6"Ø	8,65	11,25	13.200	Cahama	398
176/67	Liasse	39,00	6"Ø	18,80	20,00	13.200	Cahama	398
177/67	Luala II	19,00	6"Ø	11,40	16,50	7.550	Cahama	398
178/67	Tachiole	25,00	6"Ø	11,90	17,30	13.200	Cahama	398
179/67	Tachinduca	40,00	6"Ø	16,15	19,65	13.200	Curoca	420
180/67	Tchipeoba	25,00	6"Ø	11,40	26,00	41.500	Curoca	420
181/67	Vilundo	72,00	6"Ø	61,50	68,50	3.750	Cuanato	400
182/67	Chicusse	50,00	6"Ø	11,20	42,00	1.270	Cahama	399
183/68	Categuero	60,00	6"Ø	50,30	55,20	5.650	Onbadja	422
184/68	Seluairia	79,00	6"Ø	67,30	75,20	6.300	Onbadja	400
186/68	Caluvango II	24,00	6"Ø	15,25	24,00	4.650	Cahama	399
187/68	Chipanda	81,00	6"Ø	66,50	75,40	5.650	Onbadja	400
188/68	Pavacao-Mucope	82,00	6"Ø	59,00	80,00	4.650	Onbadja	400
189/68	Tachilau	80,00	6"Ø	62,80	77,30	6.100	Onbadja	400
190/68	Viganqala	86,00	6"Ø	64,75	67,50	6.600	Onbadja	400
191/68	Lovresavia Chiulo	64,00	6"Ø	53,20	62,00	5.300	Onbadja	422
192/68	Calandeja	93,00	6"Ø	71,00	90,00	2.000	Onbadja	400
193/68	Conje	21,00	6"Ø	11,50	20,50	3.000	Cahama	399
194/68	Napunde	94,00	6"Ø	67,30	70,05	6.600	Onbadja	400
195/68	Canbandeqe	50,00	6"Ø	14,30	36,75	13.200	Cahama	399
196/68	Nongala	23,00	6"Ø	11,75	21,00	9.300	Cahama	399
197/68	Lovresavia Chiulo	68,00	6"Ø	54,00	58,50	5.000	Onbadja	422
198/68	Blutue	17,00	6"Ø	4,40	15,00	5.460	Cahama	399
199/68	Baimanqala	84,00	6"Ø	66,60	74,10	6.600	Onbadja	400
200/68	Cahama-Velha	46,00	6"Ø	27,70	43,00	10.560	Cahama	399
201/68	Liambinga	9,20	6"Ø	0,70	7,00	1.600	Cahama	399
202/68	Loana	80,00	6"Ø	67,30	86,00	11.300	Onbadja	400
202A/68	Loana	80,00	5"Ø	67,40			Onbadja	400
203/68	Bieba I	83,50	6"Ø	62,00	81,50	5.400	Onbadja	422
204/70	Tachinqoalala	26,50	6"Ø	6,00	24,50	2.500	Cahama	399
205/68	Pavacao da Mata	110,00	6"Ø	84,90	105,00	4.000	Cahama	400
206/68	Tachacoabe	24,00	6"Ø	8,30	22,00	2.400	Cahama	399
207/68	Matoeda I	56,00	6"Ø	55,00	84,00	5.660	Onbadja	422
208/68	Canquetua	120,00	6"Ø	84,50	115,00	10.300	Onbadja	400
210/68	Etute	73,00	6 1/4"Ø	59,50	70,00	6.000	Cahama	400
211/69	Cone II	67,00	6"Ø	5,30	9,50	500	Cahama	421
212/69	Matocarne	38,00	6"Ø	9,60	30,50	700	Cahama	421
213/69	Nanduabe	32,00	6"Ø	9,00	30,00	1.500	Cahama	421
214/69	Tchuapeabe	29,00	6"Ø	14,00	16,50	500	Cahama	421
217/69	Canunganga	38,00	6"Ø	10,00	27,00	4.000	Onbadja	445

No. Captacao	Nome do local	Profund (m)	Diametr (Ø) (inch)	Nivel Est. (m)	Nivel Din. (m)	Caudal (l/h)	Municipio	Carta
215/69	Cafito	110,00	6 1/6"Ø	70,00	87,00	13.200	Cahama	400
218A/69	Cafito	110,00					Cahama	400
219/69	Categuero	9,00	12"Ø	3,00	7,45	420	Oshadja	422
220/69	Categuero	9,00	6"Ø	3,75	7,42	440	Oshadja	422
221/69	Lubolanto	44,00	6"Ø	21,30	41,00	15.000	Oshadja	445
222/69	Lungo Ponto II	17,30	6 1/4"Ø	10,50	15,50	5.000	Cureca	420
223/69	Cavalala	48,00	6"Ø	30,20	46,00	4.050	Oshadja	445
224/69	Tiavana	101,00		71,00	98,00	5 050	Oshadja	422
225/69	E.T. Sousa-Ponto 1/69	24,00	6"Ø	8,40	11,00	700	Cahama	420
226/69	Tochatolombo	42,50	6"Ø	16,70	40,50	2.000	Oshadja	421
227/69	Calualama	52,00	6"Ø	30,00	48,50	1.400	Oshadja	421
228/7	Tochatotombo	57,00	6"Ø	31,20	40,00	700	Cahama	421
229/70	Mongue	72,00	6"Ø	33,50	66,00	9.900	Oshadja	399
230/70	Mucuso do Chiulo	70,00	6"Ø	55,20	60,15	10.600	Oshadja	422
231/70	Huila Comercial P. 1/69	24,00	6"Ø	9,00	17,00	2.000		
233/70	Iando	89,00	5"Ø	68,60	80,30	5.650	Oshadja	400
234/70	Cavalo	61,00	6"Ø	51,00	58,00	3.400	Cahama	421
236/70	Ouapciva II	25,00	6"Ø	13,30	17,00	4.000	Cahama	399
237/70	Mupando	95,00	6"Ø	67,10	77,60	6.900	Oshadja	400
238/70	Tulombongue	16,50	6"Ø	2,00	8,50	11.200	Cureca	419/442
239/70	Cachanbo	17,00	6"Ø	2,50	14,00	3.300	Cureca	419/442
240/70	Cavuanguelo	23,50	6"Ø	3,60	15,40	6.600	Cureca	419/442
242/70	Canano	22,00	6"Ø	16,00	16,60	4.400	Cureca	419/442
243/70	Bolongo	17,50	6"Ø	5,00	11,30	5.900	Cureca	419/442
244/70	Chilau	21,50	6"Ø	7,30	19,50	2.900	Cahama	421
245/70	Mandumbo I	20,00	6"Ø	9,30	18,00	8.000	Cahama	421
246/70	Mungo							399
247/70	Ponto 2/69	18,00	8"Ø	8,20	13,00	1.500	Cahama	420
248/70	Tchiamlentale	90,00	6"Ø	75,00	85,60	5.100	Cahama	422
249/70	P.2/69 - Huila Comercial	70,00	6"Ø	43,00	73,60	6.100	Cahama	421
251/70	Cano	14,00	6"Ø	6,00	8,00	19.000	Cahama	420
252/70	Tochiamlemale	91,00	6"Ø	78,50	86,30	8.000	Cahama	422
255/70	Pov. do Ocuba	63,00	6"Ø	48,10	60,00	6.300	Oshadja	422
256/70	Ochalo	16,00	6"Ø	4,00	13,25	20.000	Cahama	420
257/71	Ouacho	20,00	6"Ø	4,90	9,90	34.000	Cahama	420
258/71	Cuba	17,00	6"Ø	2,90	3,00	20.000	Cahama	420
259/71	Cacuio	25,00	6"Ø	4,30	8,20	20.000	Cahama	420
261/71	Mualueve I	38,00	6"Ø	8,30	28,00	1.100	Cahama	420
262/71	Ombaca	17,00	6"Ø	6,00	15,00	8.000	Cahama	420
263/71	Ombaca I	25,00	6"Ø	16,00	23,00	2.900	Cahama	420

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264/71	Cuio	22,00	6"Ø	11,40	14,40	17.600	Cahama	420
265/71	Ombaca II	78,00	6"Ø	11,70	16,70	26.000	Cahama	420
266/71	Povoacao de Ichica	88,50	6"Ø	49,00	85,50	3.100	Oshadja	401
268/71	Lufeno	32,00		14,00	23,30	6.900	Cahama	420
269/71	Lyonongaca	118,00	6"Ø	107,20	117,40	1.300	Oshadja	400
270/71	Lisona	130,00	6"Ø	87,70	101,00	4.100	Cahama	399
271/71	Uanguebela	22,00	6"Ø	90,10	17,90	13.200	Cahama	420
272/71	Palue	19,50	6"Ø	12,00	17,50	3.200	Cahama	421
274/71	Uanguebela I	17,00	6"Ø	9,60	11,70	15.840	Cahama	420
275/71	Vipundo I	22,00	6"Ø	4,60	20,00	10.600	Cahama	421
276/71	Nashando	113,50	6"Ø	90,00	110,00	3.900	Cahama	379
277/71	Pundo	24,00	6"Ø	6,30	19,30	900	Cahama	421
278/71	Pundo	19,40	6"Ø	7,20	10,00	1.250	Cahama	421
279/71	Nunhando	13,00	8"Ø	6,40	8,00	14.900	Cahama	421
280/71	Ouacado	29,00	6"Ø	12,30	15,65	4.000	Cureca	444
281/71	Ouacado	15,00	5"Ø	8,00	13,00	2.200	Cureca	444
282/71	Pombo	83,00	6"Ø	51,30	80,00	4.300	Oshadja	422
283/71	Pombona	129,00	6"Ø	75,25	86,15	18.000	Cahama	379
284/71	Nuelo	30,00	5"Ø	21,00	28,00	1.650	Cureca	444
285/71	Luinge	20,00	6"Ø	10,00	17,50	4.500	Cahama	420
286/71	Cabacate	18,00	8"Ø	10,30	12,00	13.200	Cureca	444
287/71	Bombacono	19,00	6"Ø	9,50	17,00	4.950	Cureca	443
288/71	Bomba	19,00	8"Ø	5,50	8,60	15.800	Cureca	443
289/71	Codongaba I	20,00	6"Ø	5,70	6,00	15.800	Cureca	444
290/71	Cocuti	31,00	6"Ø	4,50	28,00	5.300	Cureca	420
291/71	Codongaba	34,00	6"Ø	7,20	27,75	5.650	Cureca	443
292/71	Anguabi	17,00	6"Ø	7,45	14,50	14.400	Cureca	420
293/71	Enjamba	17,50	6"Ø	6,20	15,00	6.600	Cahama	420
294/71	Padova	25,50	6"Ø	16,90	23,00	1.350	Cureca	443
295/71	Nuiseve	17,00	6"Ø	7,20	12,00	1.500	Cahama	420
296/71	Nutotava	110,00	6"Ø	93,00	107,00	2.100	Cahama	379
297/71	Chigue	13,00	6"Ø	7,00	10,00	3.300	Cureca	421
298/71	Canhandi	15,00	6"Ø	8,30	13,00	4.050	Cahama	420
303/71	Cutanga I	17,50	6"Ø	5,70	7,40	15.800	Cureca	444
304/71	Catemi II	34,00	6"Ø	20,30	31,50	2.500	Cureca	444
305/71	Lue	20,50	6"Ø	11,40	17,00	7.200	Cureca	443
306/72	Chivia	17,50	6"Ø	6,00	7,40	13.200	Cureca	444
307/72	Canbulanga	20,00	6"Ø	6,35	14,40	900	Cureca	421
308/72	Iavo I	13,00	6"Ø	7,00	8,70	7.900	Cureca	444
309/72	Mulolo	26,00	6"Ø	4,60	6,70	15.800	Cureca	444

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310/72	Bunda	44,00	6"Ø	32,00	43,50	1.300	Curoca	444
311/72	Canhalunga	24,50	6"Ø	7,50	24,00	4.300	Curoca	421
312/72	Cisse	34,00	6"Ø	26,50	32,50	5.450	Curoca	421
313/72	Capira	42,00	6"Ø	10,00	39,00	7.900	Curoca	444
314/72	Ionha	28,00	6"Ø	8,50	16,00	450	Curoca	444
315/72	Tschipa III	34,50	6"Ø	12,00	27,20	17.600	Curoca	421
316/72	Nunhande I	20,00	6"Ø	6,00	18,00	3.450	Curoca	421
317/72	Tschipa IV	46,00	6"Ø	16,50	44,00	5.000	Curoca	421
319/72	Ionhole I	51,50	6"Ø	21,00	48,50	5.650	Curoca	444
320/72	Aluvovo	43,00	6"Ø	30,65	41,00	2.900	Bebadja	421
324/72	Quvangulo	20,00	6"Ø	12,10	18,00	950	Curoca	421
326/72	Tschipa I	35,00	6"Ø	8,50	21,00	1.350	Curoca	421
341/72	Cudungaba II	17,00	6"Ø	6,30	14,00	11.300	Curoca	444
343/72	Nunlueva II	37,00	6"Ø	15,00	23,00	850	Cahasa	421
353/72	Tschipeso Ponto B.Norte	116,00	6"Ø	81,50	112,50	4.000	Cahasa	399
354/72	Tschipeso Ponto A.Sul	118,00	6"Ø	93,70	115,20	3.750	Cahasa	399
363/72	Ponto II	23,00	8"Ø	13,60	20,50	2.900	Cahasa	420
365/72	Cuno	17,00	6"Ø	10,00	14,50	5.250	Cahasa	420
366/72	Cuno	18,00	6"Ø	92,00	13,50	3.300	Cahasa	420
370/73	Pinga	120,00	6"Ø	65,00	116,00	5.250	Cahasa	400
376/73	Cuco	104,00	6"Ø	82,00	102,00	12.150	Bebadja	400/401
377/73	Sami	113,50	6"Ø	76,00	92,00	13.200	Cahasa	400
379/73	Raquel	109,50	6"Ø	28,50	89,00	12.500	Cahasa	400
383/73	Fag. 13 Ponto A Norte	45,00	6"Ø	20,20	42,50	4.050	Curoca	444
384/73	Ponto A Norte Fag. 111	52,00	6"Ø	28,50	29,00	1.850	Curoca	444
405/73	Gaze	110,00	6"Ø	72,00	94,00	3.000	Cahasa	379
410/73	Bunda	99,00	6"Ø	60,00	92,00	4.900	Cahasa	379
427/73	Valova	105,00	5"Ø	80,00	98,00	3.800	Cahasa	379
439/74	Buara	91.00	5"Ø	22,50	88,00	1.450	Cahasa	400
438/74	Ichiandanda	34,00	5"Ø	16,90	23,00	13.200	Curoca	444
440/74	Nacabanha	47,00	5"Ø	34,00	32,00	3.150	Cahasa	399
461/75	Kaimba	48,00	5"Ø		44,00	3.850	Curoca	444
464/75	Cangando	32,00				1.150	Cahasa	399
465/75	Nunue					11.300	Curoca	444
466/75	Cavicolua					4.400	Curoca	444
1/53	Nungua	43,00	8"Ø	22,20	32,80	4.500	Cuanhama	423
2/53	Nungua (Pov.)	19,00	8"Ø	5,10	15,30	1.600	Cuanhama	423
3/53	Nuhanca	28,00	8"Ø	16,00	24,60	2.400	Cuanhama	424
4/53	Postofiscal 7	11,20	8"Ø	8,65	10,64	2.000	Naacundo	448
5/53	Nohono	30,00	8"Ø	9,00	21,00	1.600	Cuan Aama	425
6/53	Nohono	30,00	5"Ø	11,70	24,40	0,800	Cuan Aama	425
7/53	Posto fiscal no. 6	15,20	6"Ø	5,60	17,10	5.000	Naacundo	447
8/53	Posto fiscal no. 5	20,00	8"Ø	8,25	14,80	0.600	Naacundo	447
9/53	V. Pereira D'eca	16,50		1,90	9,30	4.600	Cuanhama	447
10/53	V. Pereira D'eca	19,00	10"Ø	6,50	17,50	3.600	Cuanhama	447
11/53	Oaupanda	12,00	10"Ø	6,00	11,00	1.500	Cuanhama	447
12/53	Oaupanda	17,00	5"Ø	6,00	14,00	3.000	Cuanhama	447
13/53	Nupiacundo	20,00	8"Ø	9,50	16,50	2.000	Naacundo	447
14/53	Chiedo	28,00	4 1/2"Ø	11,80	15,00	2.400	Cuanhama	447
14A/53	Chiedo	25,50	6"Ø	18,20	23,00	2.200	Cuanhama	447
15/53	Chiedo	25,50	8"Ø	5,20		2.800	Cuanhama	447
16/54	Naacundo	19,00	8"Ø	9,70	19,50	1.200	Naacundo	447
17/70	Cuanato	23,00	8"Ø	7,50	20,20	0.170	Bebadja	446
18/54	Cuanato	24,00	6"Ø	6,35	20,70	1.700	Bebadja	446
19/54	Cuanato	26,25	6"Ø	15,70	23,80	0.730	Bebadja	446
20/54	Cuanato	26,00	6"Ø	10,30	24,50	0.300	Bebadja	446
21/54	Cuanato	28,60	6"Ø	13,40	26,70	0.750	Bebadja	446
22/54	Evale	32,25		6,50	20,77	0.200	Cuanhama	424
23/54	Posto Fiscal no. 4	15,40		8,03		0.100	Bebadja	446
24/54	Evale	33,20	6"Ø	10,30	24,56	1.500	Cuanhama	424
25/54	Posto Fiscal no. 3	31,00	4"Ø	4,70	13,20	0.205	Bebadja	446
26/54	Cafu	43,20	chapa 4e/e	17,10	31,80	2.050	Bebadja	401
27/55	Cafu	37,00	chapa 4e/e	12,50	25,00	2.400	Bebadja	401
28/55	Cafu	35,65	3e/e e 6"Ø	7,50	25,50	1.000	Bebadja	401
29/55	Cafu	42,80	3e/e e 6"Ø	16,50	34,00	2.660	Bebadja	401
30/55	Cafu	30,10	3e/e e 6"Ø	16,50	26,50	0.800	Bebadja	401
31/55	Cafu	39,75	6"Ø	5,70	28,50	9.000	Bebadja	401
32/55	Cafu	30,00	6"Ø	13,60	28,50	0.700	Bebadja	401
33/55	Reserva do Acando	68,60		17,00		1.500	Bebadja	423
34/55	Reserva do Acando	35,50		15,50		0,800	Bebadja	423
35/56	Reserva do Acando	43,00		12,00	19,50	4.500	Bebadja	446
36/56	Reserva do Acando	26,00		11,70	24,00	2.800	Bebadja	446
37/56	Reserva do Acando	32,00		14,00		1.200	Bebadja	423
38/56	Reserva do Acando	29,00		9,10	15,50	1.000	Bebadja	446

No. Captacao	Nome do local	Profund (m)	Diametr (0) (inch)	Nivel Est. (m)	Nivel Din. (m)	Caudal (l/h)
1/48-C	P.E.C.	10,00				1.300
2/48-C	Eduardo Torres	20,00				2.600
20/73-C	Eduardo Torres	16,00				650
3/48-C	S.O.S.	33,10				1.000
4/48-C	Caracule	41,50				2.000
5/48-C	P.E.C.	25,00				2.200
6/49-C	S.O.S.	29,60				350
7/49-C	Pastoril do Sul Lda	66,00				200
8/49-C	Pastoril do Sul Lda	27,60				2.000
9/50-C	Luis Nabrega	40,00				1.100
10/50-C	Conservera do Sul	21,10				2.300
11/50-C	V. Gonsavais	32,90				2.200
12/50-C	Carvalho E Oliveira	35,10				9.500
13/50-C	Chapia	45,50				1.000
14/50-C	Antunes da Cunha	42,90				2.600
15/50-C	Carlos Eugenio	23,50				1.650
16/50-C	Ichivicuro	24,00				10.560
17/50-C	P.E.C.	23,50				8.800
18/50-C	P.E.C. Mangata	22,75				4.040
19/50-C	P.E.C.	24,00				9.450
20/50-C	Caracule	54,00				1.000
21/50-C	Caracule	50,00				140
22/51-C	Caracule	30,00				1.650
23/51-C	Luis Nabrega	33,90				3.300
24/51-C	Eduardo Torres	30,00				2.860
25/51-C	Caracule	26,60				8.800
26/51-C	Caracule	50,00				3.700
27/51-C	Caracule	19,00				660
28/51-C	Conserves do Sul	43,20				330
29/51-C	Caracule	65,20				450
30/51-C	Cunha	23,10				250
31/51-C	Caracule	37,00				220
32/52-C	Concessao A.	34,90				6.800
33/52-C	Caracule	16,00				8.600
34/52-C	Caracule	36,40				1.200
35/52-C	Caracule	15,50				10.860
36/52-C	Horizonte	16,00				14.600
37/52-C	Caracule	50,30				1.060
38/52-C	Caracule	22,60				3.300
39/52-C	Caracule	33,30				200
40/52-C	Caracule	20,50				520
41/52-C	Caracule	20,60				260
42/52-C	Pastoril do Sul Lda	16,00				11.500
43/52-C	Caracule	49,10				1.830
44/52-C	Rancho Taliscas	30,60				100
45/52-C	Caracule	33,50				250
46/52-C	Caracule	51,40				5.020
47/52-C	Rancho Taliscas	20,30				10.500
48/52-C	Capelapapo	22,70				7.340
49/52-C	Capelapapo	15,70				10.560
50/52-C	Caracule S.O.S.	25,00				350
51/53-C	Caracule	44,50				1.130
52/53-C	Von Marshal	17,85				12.300
53/53-C	Pastoril do Sul Lda	51,90				150
54/53-C	Caracule	23,00				2.360
55/53-C	Totocaba II	33,00				6.420
56/53-C	Caracule	20,50				5.750
57/53-C	Von Larisch	31,00				10.430
58/53-C	Von Larisch	50,00				900
59/53-C	Capelapapo	21,50				7.400
60/53-C	Capelapapo	21,00				3.760
61/53-C	Caracule	40,00				1.200
62/53-C	Capelapapo	24,70				3.580
63/53-C	Caracule	20,70				1.400
64/53-C	Vipetenge	32,15				1.280
64A/53-C	Vipetenge	32,50				400
65/53-C	Caracule	23,00				1.780
66/53-C	Nucoio	14,10				8.500
66A/72-C	Nucoio	14,00				1.100
67/53-C	Chicabe	16,90				8.390
67A/72-C	Chicabe	16,50				7.900
68/53-C	Chicabator	14,00				8.500
69/53-C	P.E.C.	22,60				8.450
70/53-C	Caracule	19,00				960
71/53-C	Caracule	36,00				400
72/53-C	P.E.C.	14,00				1.730
73/54-C	Caracule	24,60				1.700
73A/72-C	Caracule	14,50				5.050
74/54-C	Caracule	25,00				1.470
75/54-C	Caracule	25,00				2.600

No. Captacao	Nome do local	Profund (m)	Diametr (Ø) (inch)	Nivel Est. (m)	Din. (m)	Caudal (l/h)
76/54-C	Chipia	34,30				9.900
77/54-C	Caracule	37,10				650
78/54-C	Capolopopo S.B.S.	22,30				1.700
79/55-C	Capolopopo	39,15				8.000
80/55-C	Capolopopo S.B.S.	28,20				6.600
81/55-C	Manuel A. Carvalho	30,30				440
82/55-C	Caracule	30,00				1.200
83/55-C	Capolopopo	31,80				13.200
84/55-C	Caracule	23,20				4.000
85/55-C	Manuel A. Carvalho	21,65				8.400
86/55-C	Caracule	44,60				10.000
87/55-C	Ranche Talriscas	37,00				200
88/55-C	Capolopopo	39,70				200
89/55-C	Capolopopo	34,65				2.500
90/55-C	Caracule	30,00				1.700
91/55-C	Caracule	44,20				8.000
92/55-C	Caracule	35,50				6.100
93/55-C	Caracule	21,00				1.600
94/55-C	Capolopopo	34,30				1.650
95/55-C	Luis Mabreqa	23,00				570
96/56-C	Nangonga	25,00				12.000
966/72-C	Nangonga	32,00				6.100
97/56-C	Capolopopo	34,30				10.000
98/56-C	Caracule	23,50				9.000
99/56-C	Caracule	25,00				4.800
100/56-C	Caracule	30,00				3.300
101/56-C	Carvalho Oliveira	44,30				2.300
102/57-C	Nantazno	42,90				4.200
103/57-C	Caracule	59,30				700
104/58-C	Caracule	42,50				3.100
105/58-C	Baba	37,00				2.300
106/59-C	Ao 105 Caracule	30,20				2.550
107/59-C	A.B.	35,00				1.000
108/59-C	Posto do Virei	12,10				15.840
109/60-C	Caracule	13,20				15.000
110/60-C	Capolopopo Virei	73,50				100
111/60-C	Canhala	71,00				3.300
112/63-C	Mapina	25,00				4.000
113/64-C	Viembe 2	33,00				3.000
114/64-C	Cavelocano	20,00				14.300
115/64-C	Buchelequete	17,00				8.000
116/64-C	Saiona	15,00				6.500
117/64-C	Djambaitai-Caiado	20,00				2.500
118/64-C	Virei	20,00				15.800
119/64-C	Cuililua	15,00				4.000
120/64-C	Cahelenque	18,00				4.400
121/64-C	Chitundulo	15,00				8.000
122/64-C	Gieba-Catenqo	17,00				11.000
123/64-C	Brutuei	26,00				15.800
124/64-C	Retenhenque	41,00				3.000
125/64-C	Chipia	24,00				2.300
126/64-C	Catengoli	33,00				800
127/65-C	Catengoli	55,00				540
128/65-C	Canquate	19,40				400
129/65-C	Munhino	11,50				7.650
130/65-C	Rio da Onca	14,00				3.300
131/65-C	Caapato	10,00				7.200
132/65-C	Chiutapo	14,70				7.200
133/65-C	Jindicobe	27,00				1.100
134/65-C	Erindo	22,00				440
135/66-C	Catuitui	37,00				30.300
136/66-C	Caapato	10,00				1.200
137/66-C	Serra da Lua	32,00				12.100
138/66-C	Tapechero	14,00				800
139/66-C	Baobabi	40,00				2.554
140/66-C	Catuitui	21,45				14.400
141/66-C	Luso	14,50				12.000
142/66-C	Chicale	22,00				3.100
143/66-C	Munhino	14,00				11.000
144/66-C	Muangungululo	30,00				12.160
145/66-C	Caicua	30,00				2.700
146/66-C	Bungochiao	27,00				890
147/66-C	Furo do Meio	45,00				6.099
148/66-C	Furo no. 3	39,00				4.950
149/66-C	Furo no.4 Vinching	50,00				1.100
150/66-C	Catuitui	28,00				130.000
151/67-C	Catuitui	36,00				3.000
152/67-C	Mutuiela	19,00				15.900
152A/67-C	P.E.C.	60,00				430
153/67-C	Diangolulo II	19,00				150

No. Captacao	Nome do local	Profund (m)	Diametr (Ø) (inch)	Nivel Est. (m)	Din. (m)	Caudal (l/h)
134/67-C	Nsolo	22,00				2.900
135/67-C	Cubal	22,00				5.300
136/67-C	Cubal II	11,00				5.000
137/67-C	Chapaquela	26,00				6.600
138/67-C	Bramgolelo	30,00				7.900
139/67-C	Penhalt	22,00				2.400
140/67-C	Nuve II	20,00				4.000
141/67-C	Nuve I	14,00				4.000
142/67-C	Chitaxi	17,00				15.000
143/67-C	Kravantcha	21,00				4.000
144/67-C	Lunga	29,00				9.900
145/67-C	Londe	26,50				7.200
146/67-C	Gunga	25,00				4.500
147/67-C	Vazangala	21,00				5.000
148/67-C	Pandangala	22,00				15.000
149/67-C	Cuto	11,50				2.200
170/67-C	Nocoio	16,00				9.000
171/67-C	Iotevalo	19,00				1.400
172/67-C	Buso	25,00				8.300
173/67-C	Iaiona	17,00				2.200
174/67-C	Buringo	21,50				3.600
175/67-C	Lusipungo	14,00				6.900
176/67-C	Buanhuta	27,00				8.000
177/68-C	Nuteiancaba	23,50				600
178/68-C	Nuteiancaba	30,00				600
179/68-C	Chitulo	25,00				14.400
180/68-C	Nacharocoto	25,50				14.400
181/68-C	Nupupo	22,50				3.300
182/68-C	Pupa	15,00				30.500
183/68-C	Chicalo	17,50				2.100
184/68-C	Covalo	14,00				23.276
185/68-C	Cuto	14,00				2.640
186/68-C	Bamba	12,50				4.600
187/68-C	Nunupo	40,00				2.100
188/68-C	Bessi I	17,50				3.200
189/68-C	Congolo	18,50				4.000
190/68-C	Chichaiur	10,00				900
191/68-C	Capalapapo	14,00				5.300
192/68-C	Capalapapo	30,00				15.840
193/68-C	Gunga III	24,00				1.000
194/68-C	Bessi II	25,00				11.300
195/68-C	Gunga II	23,00				3.200
196/68-C	Nupolo	36,00				9.000
197/68-C	Nupolo	15,00				8.300
198/68-C	Nunga	21,50				3.300
199/68-C	Chiva	30,00				29.600
200/70-C	Noivas I	40,00				4.500
201/70-C	Laranjo	77,00				20.864
202/70-C	Cali	45,00				6.600
203/70-C	Chibiba II	36,00				1.300
204/70-C	Chibiba II	62,00				1.000
205/70-C	P.I. 10	20,50				6.100
206/70-C	Saiona	17,00				7.900
207/70-C	Nanda	13,50				16.000
208/70-C	Ionconca	16,00				3.000
209/70-C	Finque	15,50				8.300
210/71-C	Poacuipue	30,50				1.900
211/71-C	Buanhuta II	37,50				1.500
212/71-C	Chitanga	23,00				15.000
213/71-C	Ponte C	17,00				4.000
214/71-C	Nucanga P.A.	17,50				2.000
215/72-C	Tiuoanha	46,00				1.400
216/72-C	Choe	33,00				500
217/72-C	Nacangala	37,00				800
218/72-C	Baiaua	24,00				1.900
219/72-C	Lupapa	15,50				8.500
220/72-C	Chiaiva	42,00				1.650
221/72-C	Vale do Curoca	35,00				170.000
222/73-C	Navatala	26,00				15.000
223/73-C	Ionbe II	16,00				1.200
224/73-C	Iacuni	15,00				10.500
225/73-C	Iaunda	16,00				17.600
226/73-C	Laue	14,00				10.500
227/73-C	Ionbe	25,00				13.200
228/73-C	Chitunqua	40,00				1.500
229/73-C	Bunjo	27,50				5.600
230/73-C	Nuenque	19,00				9.650
231/74-C	Nacala	30,00				46.550
232/81-C	Bonbi	24,00				8.000
233/82-C	Nortav II	58,50				7.761

No. Captacao	Nome do local	Profund (m)	Diametr (Ø) (inch)	Nivel Est. (m)	Din. (m)	Caudal (l/h)
1/53-VA	L.P. experimental	29,10				3.470
2/53-VA	L.P. experimental	30,00				2.000
3/54-VA	P.EXP. do Lungo	37,30				900
4/54-VA	P.EXP. do Lungo	38,50				3.560
5/54-VA	P.EXP. do Lungo	49,00				160
6/57-VA	Lungo	54,00				3.100
7/57-VA	Lungo	45,00				4.200
8/58-VA	Lungo	40,00				1.000
9/58-VA	Carlos	50,00				3.150
10/58-VA	Lungo	40,00				1.200
11/58-VA	Lungo	30,00				1.000
12/58-VA	Lungo	30,00				900
13/59-VA	Lungo	45,00				970
14/59-VA	Bamucuio	40,00				320
15/63-VA	Rio do Barro	20,00				3.100
16/64-VA	Sordos Sanzarongos	24,00				2.650
17/65-VA	Matuiroia	13,00				8.000
18/65-VA	Rua D'Arcia	9,00				1.650
19/65-VA	Tchamba	24,00				4.200
20/65-VA	Dintoca	15,00				1.750
21/65-VA	Macuquia	40,00				11.360
22/65-VA	Mambaude A	18,00				3.700
23/65-VA	Bacacha	14,00				1.760
24/65-VA	Gamamaria	24,50				2.000
25/65-VA	Maurua	14,00				1.500
26/65-VA	Matrafaricua	7,10				1.400
27/65-VA	Bramfraque	22,50				2.200
28/65-VA	Bulumbala	22,00				2.170
29/65-VA	Mangonga	14,50				4.400
30/65-VA	Samba	18,00				14.000
31/65-VA	Bhirumbangal I	27,00				5.200
32/65-VA	Bhirumbangal II	19,00				6.100
33/65-VA	Tchibico	10,00				2.600
34/65-VA	Bairro-Ponsaca	14,50				8.000
35/65-VA	Lambaca	30,00				600
36/65-VA	Bole Jalala	45,00				750
37/65-VA	Bleiacaudua	10,50				9.300
38/65-VA	Barua	22,00				2.300
39/65-VA	Bleiacaundua	22,00				750
40/65-VA	Bleiaga	10,00				2.500
41/65-VA	Blupuabuira	26,00				7.200
42/65-VA	Nacueuluauta	14,50				3.600
43/65-VA	Baelafra	19,50				3.200
44/65-VA	Lola	12,00				33.000
45/65-VA	Belule	34,00				4.100
46/65-VA	Lerau	15,00				5.100
47/65-VA	Buelau	14,00				11.300
48/65-VA	Laue	29,00				1.000
49/65-VA	Caudiaugala	11,00				6.900
50/65-VA	Buiua	16,50				4.800
51/65-VA	Virulova I	15,00				8.300
52/65-VA	Virulova I	40,00				1.200
53/66-VA	Bauba	20,50				1.100
54/67-VA	Matoma	15,00				1.400
55/67-VA	Mantete-Baca	26,00				1.200
56/67-VA	Gaufa	18,00				4.200
57/67-VA	Euqueufue	23,00				1.050
58/67-VA	Corva II	21,00				8.000
59/67-VA	Rau diu guir	23,00				13.200
60/67-VA	Vacaiuv	34,00				1.400
61/67-VA	Muuhaude	27,00				900
62/68-VA	Macufruta	15,00				7.500
63/68-VA	Iuubua	19,00				1.800
64/68-VA	Mucualuquio	27,00				2.500
65/68-VA	Vinguadua	38,00				3.300
66/68-VA	Mualiauguv	25,00				9.300
67/68-VA	Mafranva 3	32,00				1.300
68/68-VA	Gaubuei	48,00				1.600
69/68-VA	Vilata	54,00				900
70/68-VA	Ilaufe	41,00				4.800
71/68-VA	Vilue II	39,00				2.200
72/68-VA	Macaqira	22,00				3.200
73/68-VA	Bauta-Chica	32,00				2.600
74/69-VA	Baunue	42,00				850
75/69-VA	Batete	15,00				1.000
76/69-VA	Negaia	35,00				700
77/69-VA	baxira	40,00				2.800
78/69-VA	Nambonque	51,00				700
79/69-VA	bonqua	10,00				3.500
80/69-VA	Naujongala	25,00				2.600

No. Captacao	Nome do local	Profund (m)	Diametr (Ø) (inch)	Nivel Est. (m)	Nivel Din. (m)	Caudal (l/h)	Municipio	Carta
81/69-MA	Tenga	80,00				1.300		
82/69-MA	Bauducos	38,00				500		
83/69-MA	Virgleva II	15,00				6.600		
84/69-MA	Bauducos	40,00				900		
85/69-MA	Bia I	17,00				13.200		
86/69-MA	Caramanjo	19,00				19.800		
87/69-MA	Corea IV	13,00				6.600		
88/69-MA	Biacunlola II	15,00				8.000		
89/69-MA	Gale-Gale II	17,00				1.100		
90/70-MA	Vichiquichique	30,00				26.400		
91/70-MA	Gubaruba	121,00				500		
92/70-MA	Tula-Tula	18,00				17.100		
93/70-MA	Bandua	21,00				350		
94/70-MA	Biacunbi	10,00				7.900		
95/71-MA	Bagalo	10,50				2.260		
96/72-MA	Bhireca	22,00				1.700		
97/72-MA	Filue	31,00				1.000		
98/72-MA	Bauba	24,00				4.400		
99/72-MA	Chitemba	31,00				1.300		
100/72-MA	Toco-Litoral	22,00				14.400		
101/72-MA	Lundrola	15,50				3.000		
102/72-MA	Biaslola	14,50				15.000		
103/72-MA	Gale	15,00				13.200		
104/72-MA	Landaudaal	19,50				12.200		
105/73-MA	Tumbo	40,00				1.850		
106/73-MA	Batombos	37,00				3.300		
107/73-MA	Biafralaue	16,70				2.700		
108/74-MA	Chapalaue	21,00				1.900		
109/82-MA	Bafung. Parsacan	32,65				1.320		
110/83-MA	Tumbalunda II	25,00				22.620		
111/84-MA	Tumbalunda I	24,30				7.200		
1/51	Ba. 81	19,50				13.000		
2/51	Ba. 101					6.500		
3/53	Chiange	43,00				410		
4/53	Chiange	27,70				1.375		
5/54	Bacaquete	33,45				1.330		
6/54	Chiange	11,65				3.520		
7/54	Chibia	30,60				1.300		
8/54	Chibia-Estacao	22,50				1.050		
9/55	Guipungo	29,00				2.300		
10/55	Guipungo	28,70				760		
11/55	Capunda	25,00				4.000		
12/55	Capunda	22,50				1.950		
13/55	Guipungo	34,00				900		
14/55	Munhino-Apeados	56,50				9.560		
15/56	Chirungo	20,00				8.800		
16/57	Bongo	82,00				1.550		
17/57	Bongo	60,40				650		
18/57	Bongo	53,50				1.450		
19/57	Guipungo	74,00				2.600		
20/57	Guipungo	52,00				6.700		
21/57	Guipungo	50,50				2.370		
22/59	Apend. Micosso	40,00				8.500		
23/59	Apend.do Colue	50,00				4.900		
24/59	Apend.do Bombor	100,00				8.000		
25/61	Chipindo	26,00				900		
26/61	Oci	50,00				.00		
1/50	Vale do Bero	98,75				7.250		
3/56	Mucuio	52,70				4.600		
4/56	Mucuio	53,30				2.300		
5/56	Chapeu Armado	39,50				1.650		
6/56	Tumbalunda	20,00				6.000		
7/56	Luciva	96,00				550		
11/57	Bero	31,00				65.400		
13/57	Bata dos Pipas	41,00				1.200		
38/66	Corea	22,00	6"Ø	4,75	8,50	7.300	NAMIBE	314
41/66	Chipuebuiva	26,00	6"Ø	5,50	16,00	7.200	NAMIBE	314
42/66	Manucutuculo	14,50	6"Ø	5,40	12,00	3.600	NAMIBE	314
49/66	Candiangolo	11,00	6"Ø	3,80	9,00	6.900	NAMIBE	314
58/67	Corea II	21,00	6"Ø	6,60	19,90	8.800	NAMIBE	314
59/67	Mandingueir	23,00	6"Ø	8,30	17,70	13.200	NAMIBE	314
85/69	Bia I	17,00	6 1/8"Ø	6,40	12,10	12.200	NAMIBE	314
87/69	Corea IV	13,00	6 1/8"Ø	6,60	11,00	6.600	NAMIBE	314
92/70	Tula-Tula	18,00	6"Ø	7,00	16,00	17.100	NAMIBE	314
93/70	Bandua	21,00	6"Ø	12,50	19,00	350	NAMIBE	314
102/72	Chilela	14,50	6"Ø	5,80	7,70	15.800	NAMIBE	314
103/72	Cule	15,00	6"Ø	3,00	5,30	13.200	NAMIBE	294

Number	Localization	Depth (m)	Diameter (inch)	Static waterlevel (m)	Dynamic waterlevel (m)	Pumping rate (l/h)	Municipality	Observations and cap number
/73-GC	MAIUNGA	26,00	6"0	15,00	26,00	9.300	CAPELONGO	
135/73-GC	BOSE-PONACAO	24,00	6"0	3,00	22,00	1.650	CAPELONGO	
368/83-GC	CALANGA	31,00	6"0	2,00	27,00	1.000	CAPELONGO	
369/83-GC	CALANGA	51,00	6"0	9,00	49,00	1.102	CAPELONGO	
434/75-GC	MACOVA	99,00	5"0	50,00	96,00	2.500	CAPELONGO	
232/70-GC	CACULA	51,00	6"0	32,00	41,50	15.000	QUILENDUES	
267/71-GC	CASSENDO	28,00	6"0	0,00	22,50	2.400	QUILENDUES	
233/71-GC	MESENDO	54,00	6"0	1,70	52,00	2.400	QUILENDUES	
362/73-GC	MANENENE	31,00	6"0	9,25	25,00	7.900	QUILENDUES	
367/73-GC	BENGA	16,00	6"0	7,00	13,00	2.850	QUILENDUES	
368/73-GC	CASSENDO	55,00	6"0	2,85	53,00	6.100	QUILENDUES	
371/73-GC	VILA-VILANE	30,00	6"0	3,30	24,00	3.750	QUILENDUES	
441/75-GC	CACHALO	17,00	6"0	4,50	14,00	7.900	QUILENDUES	
445/75-GC	CAVI I	55,00	5"0	17,40	41,50	7.900	QUILENDUES	
448/75-GC	PASA	21,01	5"0	10,00	18,00	2.600	QUILENDUES	
449/75-GC	LUCENDO	30,00	5"0	7,50	19,00	1.200	QUILENDUES	
450/75-GC	CHANCIA	11,00	5"0	2,10	8,00	1.800	QUILENDUES	
499/79-GC	VINENDO	16,00	5"0	2,20	11,00	7.760	QUILENDUES	
504/79-GC	BENGO	30,00	6"0	7,50	1,00	800	QUILENDUES	
504/80-GC	MALANIA	21,00	8"0	2,00	3,90	24.000	QUILENDUES	
520/81-GC	CALUNGA	26,00	6.5"0	14,00	22,17	3.960	QUILENDUES	
523/81-GC	MENGOMA	28,00	6"0	8,00	13,00	11.314	QUILENDUES	
522/81-GC	BANDE	36,00	8"0	16,00	22,00	13.200	QUILENDUES	
524/81-GC	MAPEPIMA	47,00	6"0	4,00	10,00	10.560	QUILENDUES	
525/81-GC	SENDAL	43,00	6"0	6,70	37,00	1.584	QUILENDUES	
526/82-GC	MAIAO	20,00	8.5"0	0,00	1,00	14.000	QUILENDUES	
531/82-GC	SANFUNDO	67,00	7"0	3,45	52,60	11.314	QUILENDUES	
533/82-GC	LILO	33,00	6"0	6,00	25,60	6.336	QUILENDUES	
538/82-GC	MUSSANGE	44,00	5"0	23,00	44,60	150	QUILENDUES	
547/82-GC	UVEN	48,00	7"0	41,00	43,60	6.600	QUILENDUES	

Nr. Captacao	Nome do local	Profund. (m)	Nivel Estatico (m)	Caudal (l/h)	Nivel Din. (m)	Provincia	Carta
1/HU/87	Macala II	31,00	5,23	7.457	?	MANIBE	353
2/HU/87	Capunda I	46,50	12,10	2.570	?	MANIBE	353
	Capunda II					MANIBE	353
3/HU/87	Capunda II	16,00	8,73	3.300	?	MANIBE	
4/HU/87	Macalo	34,00	4,80	3.900	?	MANIBE	353
5/HU/87	Macala III	18,70	9,00	7.000	?	MANIBE	353
6/HU/87	Mucuno	77,00	56,60	1.120	?	MANIBE	353
7/HU/87	Mahonbo	27,00	7,00	22.628	7,40	MANIBE	353
8/HU/87	Saco-Nar II	10,45	2,44	9.317	4,90	MANIBE	353
9/HU/87	Saco-Nar. III	18,00	2,88	21.405	4,40	MANIBE	353
10/HU/88	Saco-Nar I	21,96	3,20	17.600	5,30	MANIBE	353
11/HU/88	Saco-Nar I	12,00	3,50	1.000	8,20	MANIBE	353
12/HU/88	Lucira I	10,00	6,00	4.400	6,50	MANIBE	
13/HU/88	Lucira	7,60	2,69	4.658	4,85	MANIBE	
14/HU/88	Tumbalunda I	24,00	5,20	4.400	16,00	MANIBE	294
15/HU/88	Tumbalunda II	15,00	2,85	1.200	?	MANIBE	293
16/HU/88	Corunjamba I	22,80	4,55	13.655	11,30	MANIBE	293
17/HU/88	Inaconcando I	33,96	8,45	4.950	21,54	MANIBE	213
18/HU/88	Inaconcando II	20,00	7,44	10.285	10,90	MANIBE	213
19/HU/88	Corunjamba II	26,00	4,20	12.175	14,90	MANIBE	293
20/HU/88	Eucaliptos II	25,25	0,85	7.200	13,35	MANIBE	253
21/HU/88	Eucaliptos III	20,00	4,00	15.840	5,54	MANIBE	253
22/HU/88	Ichinducuto I	12,00	3,00	10.560	6,40	MANIBE	253
23/HU/88	Ichinducuto II	12,00	1,10	12.184	3,48	MANIBE	253
	Iaranja				?	MANIBE	
24/HU/88	Iaranja	85,70	41,47	9.000	?	MANIBE	
	Chiue						375
	Caracule I						334
	Caracule I						
	P.E.C.						
25/HU/88	P.E.C.	37,15	11,74	1.200	?		
	Pedreira						334
26/HU/88	Pedreira	43,00	28,30	4.200	?		
	Caracule II						375
	Caracule II						
27/HU/88	Furo no. 3	73,80	29,50	7.500	?		354
	S.O.S.						354
	S.O.S.						334
28/HU/88	S.O.S.	42,90	16,63	1.200	40,00		354
29/HU/88	Nanduve	30,00	10,20	10,000	28,00		354
	Caracule						354
	Caracule						
	Caracule						
	Retenhanque						354

Appendix A5

Wind conditions

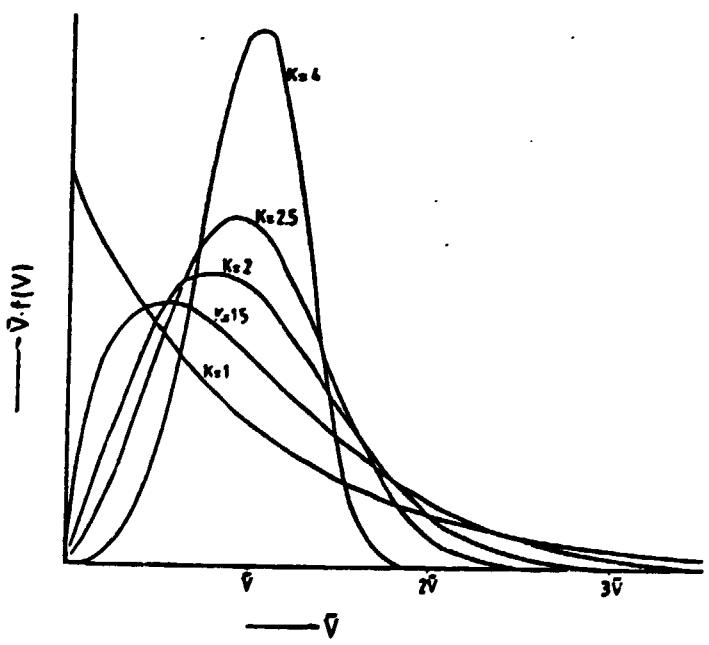
The energy output of wind mill is defined by the probability density function of the wind speed f(V) and the power wind speed curve P(V) of the wind mill. The latter gives the power output as a function of the wind speed V; the probability density function f(V) * ΔV the fraction of the time the considered wind speed occurs. The output E in a period T is given by the integral:

$$E = T \int P(V) * f(V) \; d\,V$$

The probability density function is characterized by two parameters, the shape parameter k (dimensionless) and the scale parameter c (m/s), in case a Weibull function is used:

$$f(V) = \frac{k}{c} \left(\frac{v}{c}\right)^{k-1} \exp. \left(-\frac{v}{c}\right)^{k}$$

Graphs of f(V) are shown in the figure below:



Probability density function

The scale parameter can be written as:

$$c = \frac{\overline{V}}{\Gamma(1 + \frac{1}{k})}$$

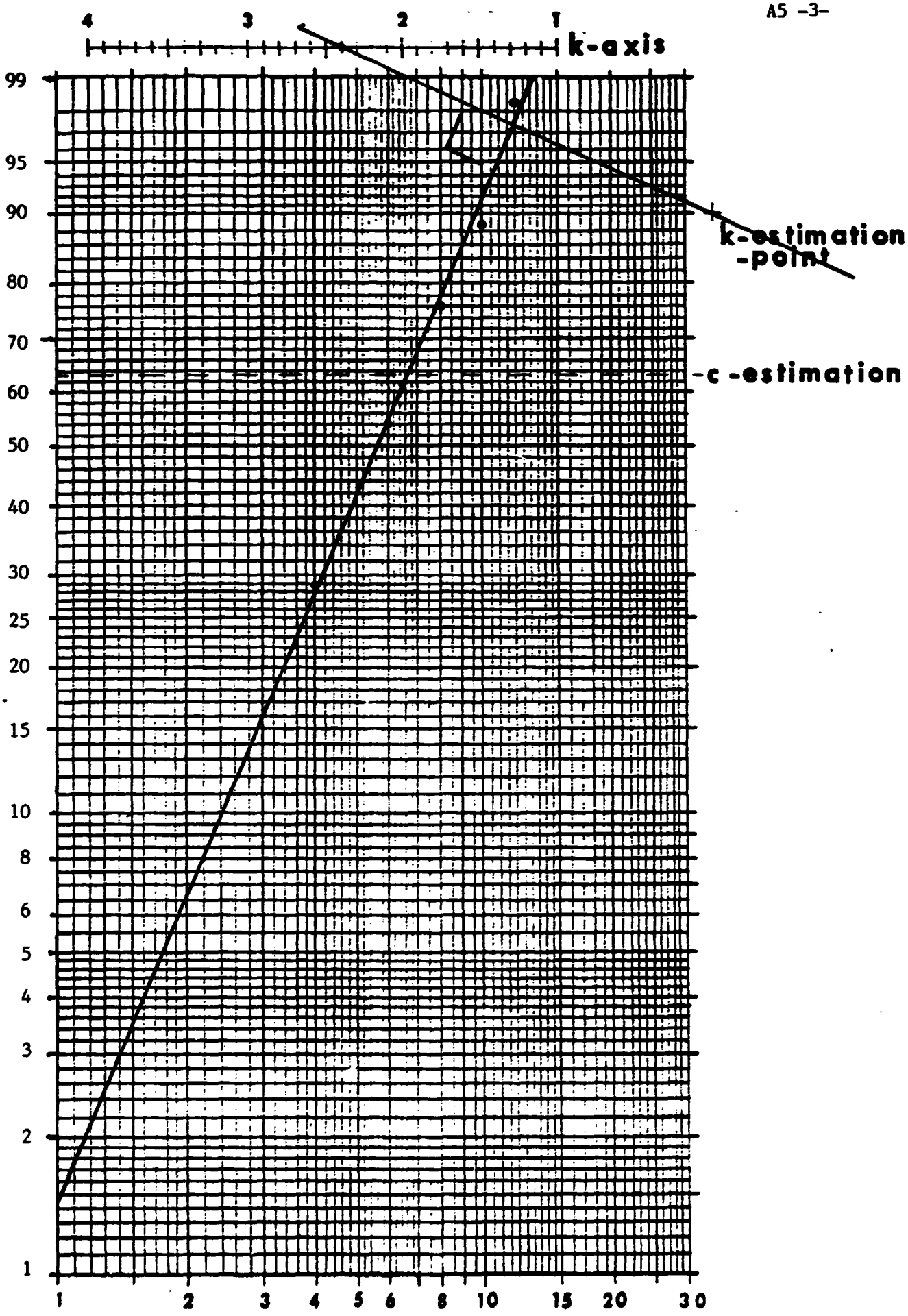
with: V = mean annual wind speed

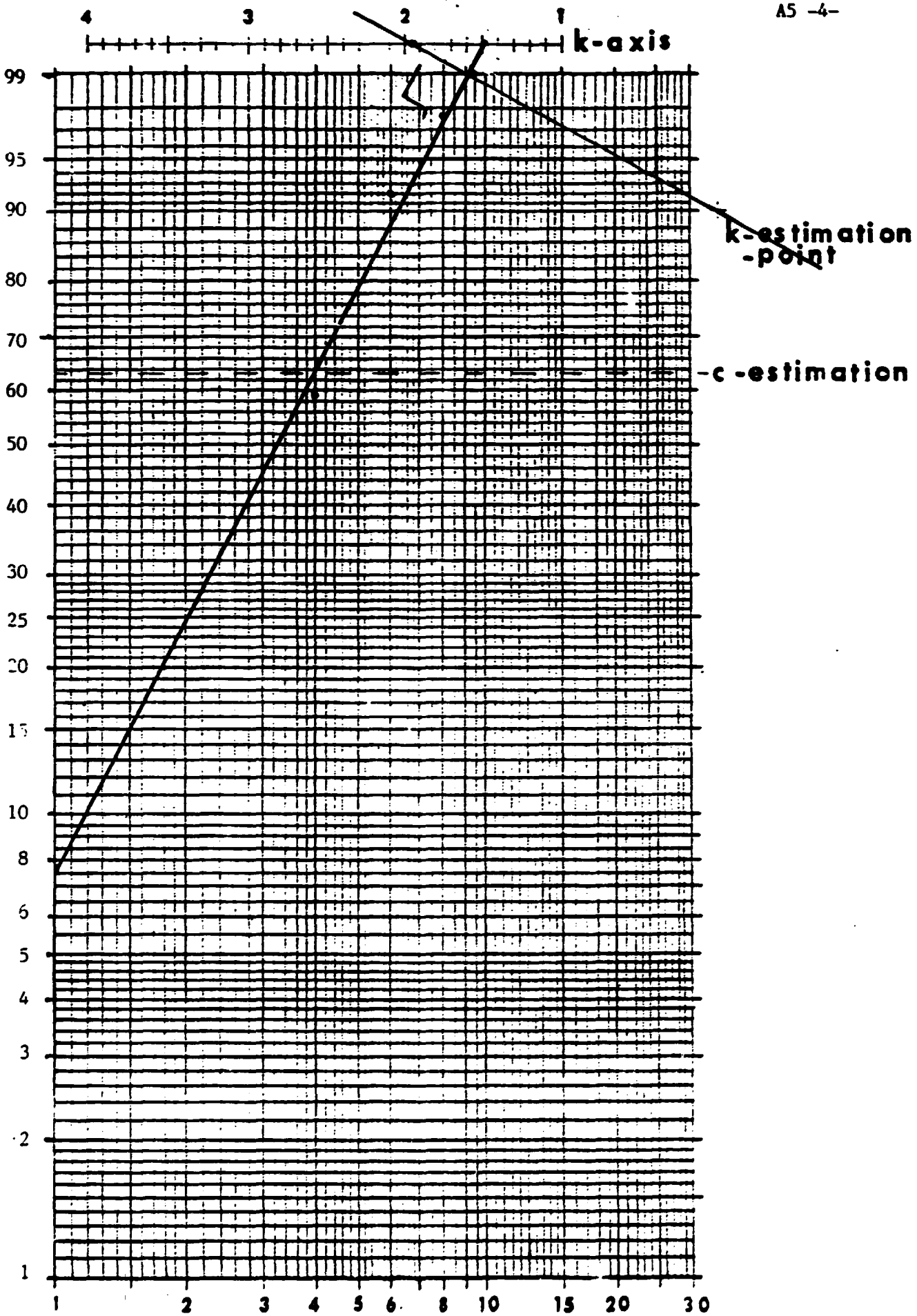
and : $$\Gamma(1 + \frac{1}{k}) = \int_0^\infty x^{\frac{1}{k}} e^{-x} dx$$

As can be seen the scale parameter is determined by the shape factor k and the annual mean wind speed V. The former mainly depends on the climate and not so much on the site. So the key parameter that determines the potential energy in the wind is the mean annual wind speed.

The shape factor k is about 2.0 and 2.4 for Lubango respectively Namibe as can be seen from figure .

The tables in this appendix give the momentary wind speeds and directions from Lubango and Namibe as measured two times a day.


4
3
2
1
k-axis
99
95
90
80
70
60
50
40
30
25
20
15
10
8
6
5
4
3
2
1
k-estimation
-point
-c -estimation
1
2
3
4
5
6
8
10
15
20
30


4
3
2
1
k-axis
99
95
90
80
70
60
50
40
30
25
20
15
10
8
6
5
4
3
2
1
k-estimation
-point
-c-estimation
1
2
3
4
5
6
8
10
15
20
30

Lubango

	1983 January	1983 February	1983 March	1983 April	1983 Mai	1983 June
1	NW 10, NW 25	W 10, W 22	W 10, NW 33	S 14, NW 10	S 7, W 36	N 22, SW 22
2	W 12, W 25	N 10, NW 29	NW 22, C	SW 12, NW 36	SW 22, W 25	N 29, NE 10
3	NW 22, C	N 11, NW 22	W 11, W 22	W 24, C	SW 20, W 11	N 22, C
4	NW 11, NW 23	N 10, W 32	W 15, W 25	S 12, W 20	NW 25, C	N 30, E 14
5	W 11, NW 16	N 10, NW 22	W 11, W 22	W 16, W 25	N 22, NW 11	SE 15, W 20
6	NW 12, NW 11	W 20, C	N 11, W 30	N 14, W 24	N 12, NW 22	NE 7, NW 20
7	W 10, NW 32	N 16, W 15	W 10, W 32	W 12, NW 25	N 10, NW 10	N 10, W 14
8	NW 10, NW 10	SW 11, NW 12	W 11, NW 22	W 12, W 32	N 14, N 20	S 15, SW 27
9	SE 22, W 34	NW 14, C	N 14, N 15	N 10, W 25	S 25, W 32	S 11, SW 22
10	NE 11, NW 22	W 10, W 25	E 0, W 25	SW 10, W 32	S 14, W 22	SW 14, W 30
11	W 27, NW 10	SW 10, W 25	NW 22, C	SW 10, W 20	N 20, NE 12	SW 10, W 36
12	W 12, W 30	SW 7, NW 23	N 25, NE 14	W 36, C	SW 12, SW 25	S 20, NW 25
13	W 14, W 29	W 14, W 20	NW 29, C	SW 10, W 36	S 32, W 22	S 10, NW 10
14	W 12, W 25	W 10, W 29	SW 10, NW 25	W 14, W 32	SW 32, W 36	S 10, W 15
15	NW 25, C	NW 25	W 11, N 10	N 22, C	W 36, C	S 22, W 20
16	N 12, W 29	S 11, NW 20	W 36, C	SW 25, W 32	SW 10, W 25	S 16, W 32
17	NW 25, C	W 12, W 30	SW 25, NW 25	SW 12, W 32	SW 10, NW 10	N 10, E 10
18	W 12, W 25	S 10, W 10	W 20, NW 23	W 10, W 27	N 8, W 20	N 22, C
19	W 25, C	W 10, W 34	W 10, W 32	W 11, W 27	SW 14, W 27	N 10, NW 11
20	E 12, W 29	N 12, NW 22	SW 20, W 36	N 25, W 32	W 10, W 20	N 12, NW 22
21	N 10, C	N 21	W 14, W 30	N 10, N 22	SE 11, W 36	SW 10, W 24
22	NE 11, NW 27	SW 14, NW 30	W 15, W 22	SW 11, NW 10	N 32, E 22	SW 22, W 32
23	NW 25, C	SW 30, W 36	SW 22, W 39	N 20, W 14	N 16, N 25	N 25, W 10
24	W 11, W 25	W 11, NW 10	W 10, W 36	N 22, W 10	N 14, NE 10	NW 10, C
25	W 11, W 31	S 11, W 32	SW 22, W 25	N 22, W 7	S 10, W 20	E 14, NW 10
26	W 16, W 25	W 10, W 12	W 14, NW 25	W 16, NW 20	SW 16, NW 10	N 24, C
27	W 29, NE 22	W 14, W 32	SW 20, W 29	W 25, C	N 22, N 10	N 22, NE 19
28	N 29, NE 16	N 11, N 10	SW 29, C	S 14, NW 22	NE 14, W 25	N 12, N 22
29	W 10, N 23		N 11, N 25	N 17, N 10	N 20, W 14	N 12, N 20
30	E 14, NW 29		N 10, NW 32	W 10, W 10	N 32, NE 8	E 14, NW 22

1 km/h = 3,6 m/s

Lubango

	1983 July	1983 August	1983 September	1983 October	1983 November	1983 December
1	N 12, W 15	SW 10, W 14	N 24, W 14	SW 25, W 25	N 30, NW 22	W 14, W 20
2	NE 10, W 24	SW 14, W 20	SW 20, NW 10	N 10, N 20	NW 25, C	W 15, W 32
3	N 23, C	W 14, C	W 22, W 14	N 16, NW 10	N 23, NW 29	W 10, W 29
4	W 14, W 20	N 7, N 12	W 14, NW 25	N 10, NW 14	SW 13, W 34	W 7, W 10
5	S 10, NW 10	W 11, N 20	NW 20, C	SW 15, NW 22	SW 10, W 29	SW 22, W 25
6	NE 12, NW 22	N 15, W 22	W 20, W 25	N 11, W 25	NW 14, F	W 24, W 25
7	W 20, NW 10	SW 10, W 25	W 14, W 22	SW 14, W 10	W 20, W 22	W 32, C
8	NW 23, C	N 10, SW 12	SW 12, W 22	W 12, NW 32	SW 15, SW 10	N 25, W 12
9	N 10, SW 12	SW 10, NW 24	N 29, W 11	W 10, NW 25	N 14, NW 25	W 14, NW 32
10	NW 25, C	S 10, NW 25	S 7, NW 10	SW 12, NW 32	W 22, C	NW 22, NW 36
11	N 20, SW 11	N 10, SW 12	W 20, W 22	W 30, NW 16	N 25, NW 22	NW 10, C
12	N 14, S 10	NW 7, NW 22	N 14, W 26	W 10, NW 25	W 22, NW 11	N 32, W 12
13	N 10, NW 10	N 12, N 22	W 22, NW 11	N 22, C	N 7, W 25	NW 16, NW 25
14	N 12, SW 15	N 16, NW 20	SW 20, W 10	NW 12, NW 10	SW 10, W 29	N 10, NW 25
15	N 16, N 10	N 14, NW 10	N 14, W 10	S 11, W 29	SW 10, W 22	NW 11, NW 22
16	SE 10, NW 16	SW 14, NW 25	W 17, NW 10	SW 10, W 17	N 10, SW 16	JN 16, W 22
17	N 22, W 11	SW 14, SW 20	N 20, W 24	W 25, NW 31	W 10, C	W 10, W 29
18	N 12, NW 20	W 7, NW 22	N 22, NE 24	SW 14, NW 25	W 32, NW 10	
19	N 20, SW 14	SW 16, NW 24	N 20, SW 16	N 12, NW 25	SW 22, W 36	
20	S 10, NW 10	SW 14, W 20	NW 34, C	W 14, N 30	W 20, W 22	
21	N 12, NW 11	N 12, W 25	N 14, N 22	N 12, NW 24	W 22, NW 26	
22	N 24, E 7	SW 10, SW 10	N 25, N 10	N 10, SW 14	W 11, W 32	
23	N 10, N 14	N 16, NW 22	N 10, N 22	NW 22, C	N 10, W 25	
24	N 22, SE 12	N 14, W 14	N 10, N 24	N 36, NW 14	W 11, NW 32	
25	N 10, E 12	N 12, NW 12	SW 25, W 30	SW 15, NW 24	N 22, NW 11	
26	SW 20, NW 25	S 16, NW 10	W 22, C	N 10, NW 34	N 11, NW 26	
27	SW 16, W 20	N 14, NW 25	W 26, NW 22	W 20, NW 25	SW 14, NW 20	SW 10, W 37
28	N 15, N 10	W 11, NW 25	W 14, W 10	SW 10, W 36	SW 32, W 32	SW 27, W 39
29	N 22, W 12	N 12, W 22	N 10, NW 16	W 10, W 23	SW 15, W 22	W 10, W 25
30	N 10, W 15	N 11, N 22	SW 14, W 10	N 20, SW 10	W 11, W 32	W 10, C
31	N 10, SW 12	W 16, NW 24		W 20, W 10		W 16, W 34

1 km/h = 3,6 m/s

Lubango

	1984 January	1984 February	1984 March	1984 April	1984 May	1984 June
1	SW 22, W 20	SW 12, SW 25	S 15, W 19		W 27, SW 32	SE 45, NW 34
2	W 12, W 23	SW 23, W 18	S 12, W 40		SW 27, W 27	SW 18, W 41
3	SW 15, W 32	SW 14, W 28	SW 18, W 37		SW 17, W 46	W 24
4	SW 15, NW 27	S 15, W 27	SW 20, W 38		SW 29, C	W 12, W 30
5	NW 34, C	W 20, C	W 36, C		SW 16, W 41	W 46, C
6	NW 38, C	SW 22, W 20	NE 10, W 40		SW 36, W 14	W 41, NW 15
7	W 32, E 10	SW 15, W 37	W 32, SW 18		SW 16, NW 26	SE 35, NW 31
8	W 22, NW 18	SW 14, W 37	SW 30, C		SW 18, C	W 22, C
9	W 47, W 29	SW 35, C	SW 22, W 22		W 16, C	W 11
10	SW 10, W 41	NW 27, C	S20, NW 37		W 31, NW 18	NW 18, C
11	SW 18, W 46	W 40, C	S 34, W 40		SW 12, SW 35	W 17, W 18
12	NW 20	W 15, W 30	SW 10, W 40		SW 20, W 36	W 40, C
13	W 34, W 10	W 18, W 37	W [illegible], W 18		W 09, NW 18	S 15, W 37
14	C, C	S 15, W 34	SE 15, W 37		W 25, NW 24	SW 18, W 28
15	W 20, C	W14, W27, C	W 20, E 15		W 20, SW 13	S 14, W 27
16	W 15, NW 27	W 14, W 42	W 24, C		W 12, SW 14	C, C
17	NW 32, C	W 27, C	SW 18, SW 42		W 12, SW 22	W 27, C
18	NW 15, NW 24	NW 38, C	SW18, SW42, W 34, C		SW 27, W 33	SW 18, W 23
19	SW 14, W 29	SE 18, NW 42	E 13, W 38		C, F	SW 22, C
20	W 20, NW 17	SW [illegible], W 46	NW 34, C		W 21, C	C, C
21	W 17, C	S 27, W 40	W 38, C		SW 18, W 24	W 13, W 27
22	SW 13, W 22	W 27, C	W 34, C		S 17, S 46	W 30, C
23	NW 22, C	W 41, C	SW 24, W 38		W 12, F	W 10
24	W 34, C	[illegible], C	W 37, F		SW 20, W 22	W 32, C
25	W 32, C	W [illegible], NW 37	SW 27, W 45		W 27, C	W 27
26	NW 27, C	SW 34, W 46	W 54, C		W 37, F	SW 18, W 26
27	SW 18, W 40	W 34	SW 31, NW 10		W 36, F	NW 27, C
28	NW 37, C	SW 15, W 23	W 38, C		W 26, NW 12	W 18, W 22
29	SW 18, W 34	NW 17, C	W 18, W 32		W 30, C	W 18, C
30	SW 13, W 20		SW 38, C		C, F	W 24, C
31	NW 37, C		S 18, W 17		SE 64, NW 29	

1 km/h = 3,6 m/s

Lubango

	1984 July	1984 August	1984 September	1984 October	1984 November	1984 December
1	E 42	NE 16	W 20, C	W 32	SW 32, W 41	SW 27, SW 40
2	E 34, W 36	W 22, NW 56	W 27, C	SW 18, NW 19	W 35	W 20
3	W 22, C	NE 36	W 25	SW 18, NW 19	W 40	SW 29, W 34
4	SW 18, W 44	W 30	W 23	W 18	W 28, NW 36	NW 20
5	SW 34	W 18, W 20	W 11, C	W 24, C	SW 16, W 47	SW 24, SW 54
6	SW 32, W 41	W 19	SE 18, SW 19	SW 18, NW 22	W 21, W 27	SW 24, SW 36
7	SW 25	W 15, C 0	W 18, C	W 40	SW 18, SW 41	W 28
8	SW 18	W 32, C 0	C, C	W 35, C	SW 16, W 41	SW 30, NW 18
9	NW 27	SW 17, NW 16	C, F	SW 19, W 41	W 18, W 39	W 13, W 26
10	NW 18	SW 16, NW 22	SW 10, W 32	SW 40	W 14, NW 35	NW 18, NW 36
11	SW 20, SW 10	W 15	SW 16, W 20	SW 18, W 20	W 32	W 18, NW 28
12	SW 24	W 20	SW 27, SW 17	W 18, NW 30	SW 18, W 27	NW 12, NW 29
13	SW 54, C	NW 19, C 0	W 22, C	SW 15	W 12, W 18	W 22, NW 27
14	NW 18, C	W 24, W 31	SW 18, NW 23	NW 13	SW 16, W 32	NW 28
15	E 46, W 27	W 17, SE 15	SE 24	W 38, C	SW 38, W 40	NW 28
16	W 26, NW 35	NE 16, NW 24	W 32	W 15, C	W 33, NW 37	W 12, W 33
17	NW 27, C	W 21, W 19		S 31, NW 20	NW 27	W 30
18	W 37, W 15	W 20	SE 14, NW 17	W 25, NW 17	W 20	SW 30, SW 28
19	NW 18, C		C, C	S 20		SW 22, NW 27
20	NW 37, C	SW 25, NW 27	SW 22, W 16	W 8, NW 12	W 32	SW 26, W 34
21	E 12	NW 33, C 0	NW 15	SW 23, W 37	NW 34	NW 26, NW 41
22	NW 25, C	W 12, C 0		W 19, W 34	W 18, W 35	W 27
23	SW 11, NW 18	W 34, C 0	NW 20	NW 35, C	W 29	SW 28, NW 18
24	W 30, C	NW 13, C 0	NW 15, C	W 19, C	S 10, SW 27	NW 17, NW 27
25	W 33, C	C 0	W 40, C	SW 19, W 25		C, C
26	NW 15, C	W 34	SW 28	W 16, NW 13		SW 34, C
27	W 41, C	W 15, NW 27	NW 15	C, C	SW 28, W 18	SW 23, SW 25
28	SW 12, SW 10	SW 22, C 0	W 32	W 32	W 09, NW 29	W 18, NW 18
29		E 15, W 32	SW 15	W 27	W 18, NE 32	NW 18, C
30	W 23, C	S 24, SW 23	SW 33	SW 23, W 30	W 19, NE 33	NW 43, NW 37
31	S 21, SW 35	SW 28, C 0		W 32, NW 34		W 24, NW 18

1 km/h = 3,6 m/s

Lubango

	1985 January	1985 February	1985 March	1985 April	1985 May	1985 June
1	W 19, W 26	S 19, W 29	SW 10,NW 30	SW 18, W 34		W 16
2		W 12	NW 10	SW 22	SW 37	
3	W 20	W 37	NW 38	NW 24, C	SW 15, SW 40	W 10, W 10
4	W 19, C	C, C	C, C	W 12, C	SW 24, W 34	W 17, C
5	W 8, W 24	W 15, W 40	NW 20, C	W 34	SW 30, W 37	NW 13, C
6	W 23, NW 34	NW 20, C	W 40	SW 18	W 12, W 26	NE 16, NW 24
7	W 15, NW 10	W 24, W 29	C, C	W 24	SE 13, SW 24	W 18, C
8	NW 18, NW 37	W 15, W 40	NW 30, C	S 15, NW 23	W 18	W 15, NW 24
9	SW 10, W 37	SW 18	E 23, W 45	W 24, C	SW 18, W 20	SW 13
10	SW 18, W 24	NW 27	W 18, W 37	W 10, W 34	SW 18, NW 15	W 27
11	W 34, C	SW 18	SW 18, W 27	W 32, C	W 27	SW 34
12	W 37, C	SW 18, W 34	SW 34, W 12	W 15, NW 30		S 24, W 18
13	SW 12, NW 16	S 38, SW 41	SW 20, C	NW 26, C	NE 20, NW 18	W 37, C
14	SW 16, W 32	SW 22, SW 42	SW 18, W 30	S 17, W 27	SW 18	W 17, C
15	NW 35, C	SW 18, W 42	S 13, W 34	SW 14, C	NW 13	SW 19
16		W 11	W 18	W 20, C	S 13, W 20	W 15
17	SW 25	NW 35	W 20	W 13, W 38	SW 22, W 34	SW 18, NW 24
18	NW 26, C	W 26, C	W 15, W 27	SW 27, SW 39	SW 27	SW 16, C
19	C, C	NW 34, C	SW 15, W 16	SW 17, NW 39	SW 23, SW 21	SW 22, NE 16
20	W 18, W 35	SW 35, C	W 30, C	W 47, NW 17	SW 35, SW 40	S 18, NW 34
21	W 35, W 29	SW 16, W 36	W 17, W 34	SW 30	SW 37, SW 36	SW 32, NW 46
22	W 18	SW 16, W 26, NW 34, C	SW 15, SW 24	C, C	SW 20	S 18, NW 18
23	SW 18, W 11	W 12	C, C	W 27, C	SW 22, W 22	W 24
24		W 30	W 32	NW 16, C	SW 10	
25		W 17, W 27	C, C	NW 30, C	S 17	NW 18
26		S 18, NW 37	NW 19, C	SW 22, W 12	SW 47	SW 27
27	SW 18, W 19	W 34, C	W 13	W 17, C	SW 12, SW 36	SW 18, SW 42
28	W 37, C	W 34	SW 15, W 17	NW 17, C	NE 23, SW 41	W 34, NE 15
29	C, C		W 24, C	NE 10, NW 18	W 37, NE 18	SW 27
30	W 20		W 19, W 19	W 12, W 18	SW 18, W 26	
31					SW 17, SW 21	

1 km/h = 3,6 m/s

Lubango

	1985 July	1985 August	1985 September	1985 October	1985 November	1985 December
1	W 37, SW 18	W 8, W 6	W 24	NW 29, C	SW 35, W 28	
2	NW 2, C	NW 23, C	NW 27	W 18, C	W 28, NW 18	NW 18
3	SW 23, NW 19	NE 27	SW 27, SW 36	NE 18, NW 21	NW 18	W 10
4	NW 15, NW 18	SW 37	W 28, W 34	SW 13, W 16	NE 16, W 34	W 10
5	W 18, C	SW 20, SW 37	SW 29, W 10	C, C	S 18, SW 41	
6	SW 18	S 18, SW 27	W 12, NW 28	W 18	NW 24, NW 18	
7	W 18	W 18, NW 25		C, C	NW 16	
8	NW 18, C	W 27, C	NW 22	W 23	NW 23	W 14
9	NE 20, NW 21	NW 28, C	SW 22, W 37	S 21, W 32	SW 12, SW 20	C, C
10	SW 17, SW 34	NW 12, NW 23	W 20, C	W 23, NW 25	W 16	W 26
11	NW 16, C	W 27	SW 27	SW 24, W 37	NW 18, NW 38	W 22
12	NW 32, C	W 10, W 22	W 18, C	C, C	NW 30, C	NW 15
13	SE 11, NW 37	S 15, W 35	S 18, SW 30	W 32	SW 18, W 28	W 38
14	NW 18	NW 20, C	C, C	NW 27, C	SW 18, W 24	W 18, C
15	W 40, C	NE 22, NW 22	SW 32	W 18, W 34	SW 35	SW 18, NW 31
16	NW 34, C	W 18, C	W 18	NW 15, NW 20	SW 18, W 45	SW 18, W 34
17	SW 15, NW 24	SW 24, C	SW 19, NW 24	W 41, C		W 19, W 41
18	NW 28, C	W 22	W 18, W 30	SW 24, C	W 29	NW 25, C
19	SW 13, NW 27	W 22, W 13	S 37, SW 50	SW 28, C	NW 35	NW 16
20	NE 18	W 25	W 34, NE 34	SW 19	NW 18, NW 34	W 40
21	SW 18	SW 26, W 28	C, C	W 19	SW 27, C	W 27, W 44
22	NW 18, C	W 15, W 27	W 32	SW 25, C	NW 33, C	SW 18, W 30
23	SW 16	NW 24, C	W 18	W 25, NW 16	SW 18, NW 28	W 15, W 41
24	NE 17, NW 18	C, C	W 27, W 37	W 18, W 25	SW 26, NW 35	W 18, NW 23
25	W 24, NW 28	W 22	NW 16, C	W 13, NW 30	W 34, NW 18	W 34, NW 19
26	S 15, NW 18	NE 14, W 18	W 34	NW 18	W 18, W 24	C, C
27	NE 35, NW 23	NW 25, C	W 22, NW 38	SW 34	SW 24, W 29	W 27
28	C, C	NW 23, C		S 12	SW 20, W 34	NW 34, C
29	C, C	NW 30, C	W 22	SW 18, W 43	SW 29, W 18	W37, NW31, C
30	W 23, W 37	SW 14, W 32	W 18, NW 24	W 18, W 32	SW 19, W 22	W 18, NW 35
31	C, C	SW 18		W 28, NW 28		SW 18, NW 39

1 km/h = 3,6 m/s

Lubango

	1986 July	1986 August	1986 September	1986 October	1986 November	1986 December
1	N 39, N 38	N 15, C	SW 36, N 12	NW 37, C	N 24, NW 30	NW 33, C
2	NE 19, NW 28	SE 23, NW 43	N 15, N 32	N 32, C	N 41, NW 28	N 27, NW 18
3	N 8, N 25	SW 18, C	N 12, NW 12	N 34, C	SW 22, NW 24	N 12, N 38
4	N 19, NW 36	N 15, C	NW 14, NW 26	N 19, NW 26	NW 30	NW 17, NW 17
5	N 13, C	N 16, C	SW 22, C	N 36, NW 9	N 32, NE 33	N 16, N 34
6	S 7, N 26	N 28, C	N 15, N 34	N 39, N 38	N 17, NW 17	NW 34
7	NE 18, N 27	NE 15, N 32		NE 19, NW 34	NW 26, NW 26	NW 34, NW 38
8	N 13, N 15	N 14, C	N 15, C	SW 24, N 30	NW 13, NW 15	NW 27, NW 29
9	N 25	SW 17, N 32	NW 24, C	N 25, C	N 23, NW 24	N 28, NW 17
10	SW 19, NW 18	N 18, NW 16	NW 18, C	N 14, NW 28	N 21, N 15	NW 23, C
11	N 19, N 22	N 24, NW 17	SW 15, SW 47	NW 13, NW 26	N 18, C	NW 27, C
12	SW 16, N 38	N 14, N 18	N 22, C	SW 21, SW 52	N 27, N 30	N 12, N 27
13	SW 19, NW 25	SW 15, NW 16	SW 36, NW 18	N 35, C	SW 33, C	N 42, NW 18
14	SW 12, N 33	NE 18, NW 12	N 24, SW 18	N 24, N 20	SW 32, C	SW 10, N 30
15	N 14, N 25	N 18, N 9	N 15, NW 18	NW 13, NW 33	SW 38, C	NW 12, NW 37
16	SW 22, N 38	SW 15, N 23	N 14, NW 18	NW 33, C	NW 18, C	NW 41, C
17	N 6, C	SW 23, N 22	NW 4, C	SW 18, N 30	SW 52, C	N 15, NW 34
18	NE 14, NW 29	SW 15, SW 27	SW 24, N 34	SW 36, SW 32	S 20, SW 34	N 15, N 37
19	N 18, NW 23	SW 18, N 23	NW 23	N 33, NW 44	NE 15, NW 24	SW 37, C
20	NW 22, C	NW 12, C	NW 24, C	N 18, N 26	SW 19, C	SW 33
21	N 5, NE 36	N 20, C	N 22, C	SW 16, N 44	NW 20, C	SW 41, N 18
22	S 20, NW 14	N 15, C	N 14, NW 38	SW 18, NW 18	C, C	SW 40
23	N 18, N 14	NW 20, C	SW 17, N 34	N 14, NW 26	NW 20, C	N 12, N 18
24	SW 34, C	SW 37, C	N 14, N 18	NW 32, C	NW 26, C	N 12, NW 37
25	NW 30	SW 12, NW 19	NW 24, C	NW 34, C	NW 30, C	
26	N 27, N 24	S 14, NW 22	N 14, SW 15	NW 39, C	N 21, C	NW 32
27	NW 13, C	N 15, C	N 22, C	SW 18, N 37	NE 12, NW 38	N 15, NW 22
28	NW 22, NW 14	SW 23, N 46	S 14, N 40	SW 34, C	NW 15, NW 34	NW 24
29	NW 15	N 32, C	N 24, N 34	S 15, N 43	N 18, NW 15	NW 17, NW 26
30	N 29	NE 15, NW 18	N 21, C	N 44, C	NW 15	N 17, NW 37
31	NW 33	NE 24, NW 18		N 22, NW 36		SW 16, NW 33

1 km/h = 3,6 m/s

Lubango

	1986 January	1986 February	1986 March	1986 April	1986 May	1986 June
1		SW 24, N 37	SW 15, NW 18	SW 41, C 0	E 39, SW 36	SE 25, N 34
2	N 27, NW 28	E 15, NW 24	SW 18, N 45	NW 27, C 0	SE 41, NW 27	SW 22, SW 17
3	SW 15, NW 34	SW 36, C	SW 16, SW 37	S 18, SW 43	N 12, N 36	SW 26, SW 43
4	SW 16, NW 36	NW 32, C	SW 13, SW 23	NW 19, C 0	SW 16, SW 28	N 13
5	N 34	N 18, NW 34	SW 30, SW 28	SW 15, NW 22	NW 27, C 0	N 15, SW 25
6	NW 34	NW 32, C	S 12, SW 34	SE 13, N 20	SW 18, N 24	SW 23, SW 29
7	N 38, NW 18	N 27, C	SW 27, SW 36	N 16, NW 28	SW 24, SW 34	SW 24, SW 39
8	N 28, N 27	SW 18, SW 35		N 13, NW 27	SW 30, SW 37	SW 18, N 27
9	SW 12, NW 35	N 17, C	SW 11, N 22	N 36, C 0	N 27, C 0	SW 18, SW 30
10	N 18, NW 41	NW 18, C	NW 27	NE 18, SW 24	N 26, C 0	N 12, N 27
11	N 38, NW 37	SW 18, SW 35	N 33	SW 19, SW 41	N 9, N 18	SW 19, N 37
12	NE 20, NE 27	SW 18, N 38	SW 21, N 40	N 13, C 0	SW 12, SW 25	N 38
13	N 34	S 30, N 20	SW 32	N 21, C 0	N 11, C 0	N 25, NW 18
14	N 12, N 46	SW 15, N 37	NW 28	NE 19, SW 18	N 18, C 0	N 18
15	N 22, N 34	SW 35, N 47	SW 19, SW 20	N 18, C 0	NW 18, C 0	NW 21
16	SW 18, NW 38	NW 15, NW 27	SW 48	SW 18, N 38	SW 24	SW 38, N 25
17	N 09, NW 27	SW 18, SW 35	SW 07, N 24	SW 17, N 36	N 27, NW 24	NW 17
18	NW 28	NW 20, C		SW 18, N 36	N 34, C 0	N 14, NW 17
19	N 18	NE 13, NW 37	SW 18, SW 19	SW 39, NW 18	N 15, NW 18	NW 21
20	N 37	NW 18, C	SW 18, N 18	N 18, C 0	N 23	SW 13, NW 18
21	NW 35	N 32, C	SE 30, N 34	N 18, C 0	N 15, NW 18	NW 26
22	SW 19	NW 18, C	S 18, N 18	SW 18, SW 24	SE 43, SW 34	N 27
23	NE 13, NE 34	NW 20, C	SE 13, NW 26	SW 23, N 32	SE 38, SW 37	SW 15, N 19
24	S 18, SW 18	NW 34, C	NW 34	S 18, N 28	NW 14, C 0	N 20, NE 13
25	NW 30	SW 17, N 34, NW 12, NW 27	S 18, N 22	SW 12, N 32	NE 32, NW 28	S 14, NW 22
26	S 27, NW 15	NW 12, NW 27	NW 26	S 11, SW 27	N 34, C 0	
27	SW 22, N 20	SW 14, SW 36	SW 34	SW 12, SW 27	SW 41, N 22	NW 17
28	NW 24	SW 15, N 22	NW 36	S 15, SW 55	SW 52, C 0	SW 26, NW 15
29	NW 18		NW 18	N 27, C 0	SW 37, C 0	SW 18
30	NW 23		N 16	NW 27, C 0	SW 18, SW 58	NE 30, NW 13
31	SW 32, SW 40		NW 23		N 11, C 0	

1 km/h = 3,6 m/s

Lubango

	1987 January	1987 February	1987 March	1987 April	1987 May	1987 June
1		NW 14, NW 26	W 32, F	W 34, C	NW 27	NW 10, C
2	SW 20, SW 20	NW 19, NW 33	W 27, W 36	W 26, NW 15	SW 19, C	NW 20, C
3		W 10, W 37	W 42, C	W 26, NW 31	NW 09, C	SW 27, C
4	W 30	NW 26	SE 9, SW 32	W 30, W 30	W 26, NW 19	SW 36, C
5	W 14, NW 24	C, C	C, F	W 12, W .7	NW 27, C	W 20, NW 13
6	NW 13, NW 37	NE 33, NW 34	SE 52, SW 43	NW 15, F	SW 15, NW 15	SW 13, NW 15
7	W 15, W 36	NW 22	SW 10, NW 37	SW 24, SW 44	SW 22, C	SW 20, NW 22
8	NW 23, C	NW 20, NW 41	W 10, F	SW 15, SW 30	S 10, W 20	SW 19
9	NW 20, C	NW 10, NW 34	SW 47, W 10	W 35, C	SW 17, NE 49	W 20, C
10	C, C	W 10, W 10	SW 32, C	SW 20, W 41	W 22	W 22, C
11	NE 12, NW 22	NW 41, C	SW 19, SW 38	SW 22, F	SW 10, SW 26	SW 20
12	W 10, W 39	SW 34, C	SW 10, W 29	W 36, C	NW 25, C	SW 20, SW 20
13	SW 20, C	S 12, NW 34	SW 20, SW 19	SW 10, SW 40	SW 32, W 24	W 10, NE 15
14	SW 34, C	W 10	SW 22, SW 26	W 10	NW 13, C	NE 29, NW 13
15	W 17, NW 37	W 41	SW 27, W 10	NW 12	NW 09, NW 10	NW 16, C
16	NW 34, C	SW 30, W 10	SW 35, W 10	SW 27, NW 10	NW 13, W 10	SW 32, C
17	NW 19, NW 36	NW 20, C	SW 10, W 20	NW 10, NW 20	NW 11, C	W 10, C
18	NW 39, C	SW 14, W 34	SW 34, W 0	NW 20, C	NW 34, C	W 23, W 20
19	NW 23, NW 10	SW 32, NW 24	SW 10, W 23	NW 13, NW 10	W 11, W 03	W 27, C
20	NW 10, NW 27	NW 42, I	SW 20, NW 27	W 22	W 14, NW 13	C, F
21	NW 19, NW 35	W 27, C	SW 10, W 41	SW 55	NW 20, C	W 10, W 27
22	W 20, C	W 41, C	SW 36, W 20	S 24, W 30	SW 10, W 27	W 20, C
23	NW 19, NW 20	SW 10, SW 33	SW 10, NW 27	W14, NW10	SW 22, NW 20	W 22, F
24	W 17	NW 10, NW 10	NW 33, C	W 10	SW 19, SW 30	W 34, C
25	NW 27	NW 24, C	SW 12, SW 55	SW 30, C	SW 25, W 27	SW 39, C
26	W 22, NW 26	SW 19, W 37	SW 10, W 36	W 22, C	SW 27, W 13	NE 15, NW 24
27	W 17, W 35	SW 10, W 22	SW 24, NW 30	SW 17, SW 33	NW 20, C	W 43, C
28	SW 27, NW 20	W 20, C	W 11, NW 36	W 20, C	NE 17, NW 30	SW 10, NW 26
29	C, C		SW 20, F	NW 10, NW 20	W 27, NW 20	NW 10, C
30	SW 34, NW 20		S 14, SW 34	C, F	NW 20, C	SW 10, SW 30
31	S 15, NW 34		SW 09, NW 26		SW 10, NW 27	

1 km/h = 3,6 m/s

Lubango

	1987 July	1987 August	1987 September	1987 October	1987 November	1987 December
1	SE 24, NW 24	NW 36, C	W 10, NW 10	C, C	NW 13, NW 23	W 22, W 22
2	NW 20, C	F, F	W 15, NW 16	NW 26, NW 30	NW 34, NW 30	NW 20
3	NW 10, C	SW 22, NW 24	S 19, NW 22	W 36, C	NW 13, NW 37	W 30, C
4	W 10, NW 13	W 33, C	W 14, NW 15		NW 26, NW 26	SW 14, W 40
5	NW 20, F	W14, NW15, C	NW 17, C	SW 22, SW 34	W 47, NW 43	NW 30, C
6	W 10, SW 14	C, C	S 13, NW 32	SW 26, NW 31	W 26, W 34	NW 42, F
7	SW 15, NW 24	SW 25, C	SW 10, NW 41	SW 20, NW 10	NW 12, NW 22	W 10, NW 10
8	S 24, NW 22	NW 27, F	SW 15	SW 10	W 24	SW 36, C, F
9	NE 10, NE 10	W 13, NW 22	SW 19	W 11, W 26	SW 27	SW 30, C
10	SW 35, NW 37	S 14, C	W 19, NW 20	W 10, W 27	SW 12, NW 40	NW 26, C
11	C, F	SW 20, SW 34	NW 10, C	W 37, C	SW 16	W 30, C
12	SW 16, NW 15	NE 27, NW 24	NE 9, W 30	W 30, NW 13	W 16	NE 21, W 27
13	W 17, C	W 34, C	W 30, NW 26	W 10, C	SW 44	C, F
14	SW 11, SW 20	SW 14, SW 41	SW 24, SW 23	C, C	W 36	SW 24, SW 39
15	S 14, W 10	SW 10, SW 44	SW 26, SW 30	SW 24	SW 13, SW 44	W 15, C
16	S 10, SW 9	F, F	W 10, NW 24	SW 10, W 27	NW 10, NW 26	SW 14, SW 40
17	W 10, C	W 22, C	C, C	NW 00	SW 34	SW 7, F
18	SW 10, W 27	SW 15, SW 14	SW 17, W 24		NE 20, NW 29	SW 10, SW 27
19	F, F	NW 22, C	SW 24, SW 21	NE 10, NW 30	SW 20, SW 39	SW 10, W 16
20	W 11, F	S 12	NW 30, C	NW 00, NW 26	SW 40	C, F
21	E 17, W 27	S 12, SW 30	SW 22, W 22	NW 36, C	SW 20, SW 20	NW 10, NW 22
22	W 20, C, F	SW 12, F	SW 34, C	SW 37, C	SW 27, SW 46	NW 24, C
23	SW 15, NW 10	W 15, F	W 50, NW 26	SW 10, SW 34	NE 24, NW 39	
24	NW 15, C	SW 26, C	W 10, W 10	W 13, W 20	SW 26, W 34	W 27, F
25	C, F	C, F	NW 14, NW 24	NW 22	SW 43, SW 34	NW 12, F
26	W 22	W 27, C	SW 10, C	SW 14, NW 24	W 27	SW 36, F
27	NW 29, C	W 10, W 20	SW 17, W 30	W 27, NW 24	W 15	C, F
28	NW 23, C	NW 34, C	SW 30, C	NW 14, NW 42	NW 37	NW 15, F
29	SW 13, SW 10	NW 10, F	W 26, C	NW 36, C		C, F
30	NW 19, C	W 20, C	SW 10, SW 45	W 34, W 36	W 10	W 22, C
31		C, C		SW 20		C, F

1 km/h = 3,6 m/s

Namibe

	1984 january	1984 february	1984 march	1984 april	1984 may	1984 june
1	S 6, SW 10	N 4, C		C, C	SE 14, C	SE 36, SE 34
2	N 8, SW 5	N 4, C	N 4, C	NW 4, NW 6, C	SE 14, C	SE 32, SE 36
3	N 4, NE 4, C	N 10, C	SE 6, SE 10	NW 4, C	SE .. N 22	SE 22, SE 36
4	N 10, C, C	NE 5, C	NE 6, S 4	S 5, C	NW 14, .	SE 36, C
5	C	N 3, N 6	NE 5, S 3	SW 6, W 4	SE 22, C	SE 29, C
6	NE 4, C	N 6, C	N 4, SE 6	C, C	N 29, S 14	SE 14, SE 14
7	S 10, C	N 4, C	W 4, NW 4	SE 4, C	SE 29, SE 29	C, C
8	N 3, C	N 5, NW 4	N 3, C	N 4, C	SE 22, S 32	C, C
9	S 10, C, C	N 3, E 4	NW 6, C	S 3, NW 3	SE 29, SE 22	C, C
10		C, C		S 4, S 5	SE 22, SE 22	C, C
11	N 4, S 4	E 5, C	E 4, C	C, C	C, C	N 22, C
12	SE 4, C	SE 8, C	SE 4, C	C, C	SE 29, C	SE 29, SE 36
13	C, C	SE 3, C	SE 4, C	S 2, C	SE 14, SE 22	SE 36, C
14	SE 10, W 4	SE 3, SE 6		SE 4, C	SE 22, SE 29	SE 36, SE 36
15	SE 8, S 12	SE 8, S 8	NE 4, SE 4	N 3, W 6	C, C	SE 29, SE 43
16	N 5, N 10	SE 10, C	NW 4, C	S 3, S 3	SE 22, SE 22	SE 29, S 36
17	NE 4, S 7	SE 6, C	SE 4, C	SE 6, S 4	SE 14, S 22	SE 29, C
18	E 4, NW 4	SW 5, C		SE 5, SE 9	SE 29, SE 29	SE 36, SW 21
19	C, C		SE 4, NW 4	SE 12, SE 6	SE 29, SE 29	SE 36, C
20	SE 5, S 6	NE 4, SW 2	NW 4, C	SE 5, SE 5	SE 7, SE 22	SE 22, C
21	E 10, C	NW 12, C	NE 2, SW 5	SE 6, C	SE 14, SE 65	SE 29, C
22	E 6, C	SE 2, C		SE 5, SE 4	SE 29, SE 29	SE 14, C
23	E 5, SE 4	N 5, NE 6	SE 3, C	SE 5, S 5	SE 29, E 7	SE 29, SE 22
24	NW 10, C	NE 10, NW 6		S 4, C	SE 22, C	SE 36, SE 14
25	4 4, C	NE 6, C	SW 6, SW 6	C, C	SE 29, SE 14	SE 14, SE 14
26		SW 3, C	S 2, C	SE 6, SE 5	SE 22, SE 29	SE 22, SE 22
27	N 4, C	SW 6, C	S 4, C	SE 5, SE 4	SE 14, SE 40	C, C
28	N 6, E 3	SE 4, SE 5		SE 5, SE 6	SE 7, NW 14	NW 14, C
29	N 6, N 5	C, C		SE 3, SE 3	E 29, SE 14	N 36, C
30	NE 4, S 4		NE 2	C, C	SE 32, SE 40	SW 36, C
31	N 4, NE 4		C		SE 32, SE 22	E 14, C

Namibe

	1984 july	1984 august	1984 september	1984 october	1984 november	1984 december
1	SE 22, NW 29		SE 14, S 14	SE 22, SW 14	SW 29, C	
2	N 29, NW ..		SE 14, SE 36	SE 22, W 29	C, C	SW 22
3	N 36, NW 2		SE 22, C	E 22, C	S 14, C	
4	NE 22, NE 29		SE 14, S 29	SE 22, C	SW 14, SW 36	SW 11, SW 14
5	SE 22, SE 29		SE 22, C	N 36, C	SW 36, C	SW 10
6	SW 29, SW 14		SE 29, SE 14	SE 14, SW 43	C, C	SW 10
7	SW 29, SW 29		SE 29, S 29	SE 36, S 36	C, C	SW 14, SW 11
8	SE 7, C		SE 36, SE 36	SE 36, SE 29	SW 29, C	SW 10
9	SE 14, C		SE 36, S 29	E 14, SE 29	SW 29, C	SW 11
10	SE 14, C		SE 29, SE 36	SE 29, C	SW 20, C	
11	NE 22, C		SE 36, SE 36	SE 43, SE 14	SW 14, SW 22	
12	SW 52, C		C, C	SE 36, SE 14	E 14, SW 29	SW 11
13	NW 29, NW 14		SE 50, S 14	E 29, C	SW 29, SW 43	
14	SE 14, NW 22		SW 14, C	SE 14, C	SW 22, SW 50	
15	SE 36, SE 14		E 43, SE 14	S 22, C	SW 22, SW 25	SE 10
16	SE 29, SE 14		SE 29, SE 36	SE 14, S 65	SW 22, C	SE 14
17	SE 14, C		SE 49, C	S 29, C	SW 14, SW 36	
18	C, C		SE 22, S 36	SW 43, SW 14	SW 22, C	SE 14
19	SE 14, C		SE 29, C	SW 22, C	SW 14, C	SE 10
20	E 14, SE 14		SE 36, SE 36	C, C	C, C	S 22
21	SE 14		SE 36, SE 14	SW 94, C	C, C	SE 22, SE 22
22	SE 29, SE 29		SE 50, C	C, C	SW 14, C	SW 11
23	SE 22, S 14		SE 22, C	SW 29, C	SW 14, SW 22	SE 14
24	C, C		C, C	C, C	C, C	SE 10, SE 14
25	C, C		E 50, SE 22	SW 14, SW 29	C, C	SE 11
26	SE 14, C		E 29, C	SW 22, SW 14	SW 36, C	SE 10, SE 11
27	C, C		E 22, C	SW 29, C	SW 14, C	SE 11, SE 25
28	SE 29, C		S 36, C	SW 43, C	SW 14, SW 29	SE 10, SE 25
29	SE 29, SE 14		N 36, C	SW 22, SW 29	SW 29, C	SE 11, SE 29
30	SE 43, SE 43		NE 14, C	SW 22, SW 22	SW 29, C	
31				S 14, SW 22		SE 22, SE 22

1 knot = 0,51 m/s

1 km/h = 3,6 m/s

1 km/h = 3,6 m/s

Namibe

	1985 january	1985 february	1985 march	1985 april	1985 may	1985 june
1	SE 22, C					
2	C, C				E 22, SE 36	N 14
3	SE 14, C				SE 36	
4	C, C					
5	SE 18, C				SE 14	SE 22, N 20
6	SE 14, C				SE 86	SE 22, N 36
7	C, C				SE 43, S 29	NW 22
8	NW 14, C				E 36, SE 22	N 43, NW 29
9	N 11, C				SE 22	NW 65
10	C, C				S 22	NW 29, NW 29
11	C, C					S 50
12	C, C				SW 14, N 22	SE 29
13	C, C				SE 14, NW 22	SE 29
14	NW 18, C				NW 29, NW 36	N 29
15	N 50, N 22				NW 29	E 43, SE 22
16	N 47, NW 22				N 43, E 29	E 29, SE 14
17	NW 22, C				N 29	N 29
18	E 22, NW 22				SW 22, NW 22	
19	SE 40, C				N 36, NE 14	N 22, E 22
20	N 11, C					E 36, E 29
21	S 36, C				SW 36	E 50, E 43
22	SW 25, C				N 29	E 36
23	S 47, SW 25				N 14	
24	NW 14, C				N 29, NE 29	E 14, NW 50
25	N 36, SW 22				NE 29	N 50, N 36
26	S 22, NW 25				S 29	N 29
27	SW 18, SW 18				SE 29	N 22, SE 29
28	N 36, SW 25				N 36, SE 29	N 36, N 29
29	N 43, SW 25				NE 50	E 50, SE 50
30	SW 14, C				E 29	SE 22
31	NW 18, C				E 22	

1 km/h = 3,6 m/s

1 km/h = 3,6 m/s

Namibe

	1985 july	1985 august	1985 september	1985 october	1985 november	1985 december
1		E 22, SE 29		N 14, S 22	NE 5, N 11	N 11, N 11
2	SE 14	E 14, E 14		N 22	N 9, C	N 13, N 22
3		E 14		N 36, SE 29	S 7, SW 7	N 19, NW 33
4	E 29, NW 14	NE 14		S 22, S 22	S 11, N 7	N 11, N 15
5	S 14	E 14		S 14	SE 7, S 33	N 9, C
6	N 29, NW 43	N 14		E 36, NW 50	SE 9, S 5	SE 9, S 9
7	NW 22	SE 27		N 22, E 22	N 11, N 13	E 9, C
8	SE 14	N 22		N 79	SE 7, NW 9	SE 9, S
9	NE 14, E 22	E 29, S 36		N 22, SE 22	E 5, SW 5	S 11, N 11
10	NE 22, S 22	SE 29, SW 14		N 97, SE 22	SW 9, N 7	SE 11, C
11	SE 22, S 43	E 36		E 29, E 29	N 9, NE 7	C, C
12	SE 50, S 36	E 14, SE 43		N 36, N 43	SE 5, SW 9	S 9, S 9
13	E 43, SE 36	E 22, SE 43		SE 36, S 29	N 5, N 4	S 11, S 11
14		E 79		N 22	SW 9, C	N 6, C
15	SE 90			N 14, N 36	E 9, F	N 11, C
16	N 36	NE 29		N 22, NE 14	N 7, SW 9	C, C
17	E 14, N 22	N 29		NE 43, E 36	C, C	N 9, C
18	N 29, N 22	E 29		N 22	SE 7, SE 15	N 11, C
19	N 29, SE 14	SE 14, SE 36		E 29, S 36	E 7, SW 11	E 11, N 15
20		N 29, SE 29		SE 14, S 22	SW 7, F	E 6, C
21	SE 29	E 22		NE 14, NW 22	N 11, C	S 9, C
22	E 14, SE 29	E 22, E 22		SE 22, S 22	N 9, C	N 26, NW 11
23	E 36, SE 29	SE 29		SW 36	N 7, C	N 9, NE 13
24	NE 65, SE 65	E 29, SE 36		NW 14	SE 11, C	NW 9, NW 11
25	E 29, E 29	E 29		SW 14	C, C	N 19, C
26	E 36, SE 29	E 22, SE 36		SE 14	NE 7, E 9	C, C
27	E 29	SE 29		SE 36	S 15, S 15	SE 9, SE 9
28	NE 22, E 14			E 22, SW 29	E 7, NW 7	S 9, S 9
29	E 22, S 43	E 43, SW 14		SE 14, SW 43	C, C	NE 9, C
30	E 86, E 14	SW 29, NW 22		SW 65, SW 43	SE 9, N 9	E 9, N 11
31	E 29, E 36	SE 22, SE 22		N 22, SE 22		N 11, S 11

1 km/h = 3,6 m/s

1 knot = 0,51 m/s

Namibe

	1986 january	1986 february	1986 march	1986 april	1986 may	1986 june
1	S 10, SW 22	SE 11, C	NE 8, E 6	E 9, SE 8	SE 9, SE 13	NW 9
2	S 5, S 17	N 9, C	SE 8, C	E 8, S 6	E 13, E 9	SW 6, NW 9
3	SE 8, C	N 11, N 11	C, C	SW 8, SW 8	E 8, SE 9	SW11, W11, NW6
4	NW 13, C	N 8, N 9	C, C	SE 8, S 11	E 6, C	NW 11, NW 11
5	E 5, S 13	N 9, NE 6	SW 8, C	SE 6, SE 8	SE 6, C	N 8, NE 8
6	S 15, SW 11	E 8, SE 6	N 9, C	S 9, S 8	SE 8, SE 8	N 6, SE 9
7	S 8, SW 19	NW 4, C	SE 6, S 9	SE 9, S 8	NE 6, C	NE 8
8	S 8, SW 19	S 8, C	SE 8, C	SE 8, C	SE 6, S 6	
9	SE 11, C	E 6, C	N 8, SE 6	S 8, S 6	NE 6, SE 6	NE 8, SE 6
10	N 9, SE 9	N 11, N 13	NE 6, C	C, C	SE 6, C	SE 6
11	SE 8, N 9	N 13, NE 8	S 8, C	SE 8, S 8	SE 6, SE 6	NW 6
12	N 11, C	N 8, C	SE 4, C	SE 11, S 6	NE 6, SE 8	SE 6, SE 8
13	NE 6, SW 15	NE 8, C	NW 8, C	E 9, SE 9	N 8, SE 8	SE 8, S 6
14	N 6, C	E 11, C	NW 8, NW 11	C, C	E 8, C	SE 6, S 6
15	SE 9, SE 8	SE 6, SE 13	N 6, N 4	SE 8, S 4	NE 6, SE 8	
16	SE 14, S 13	SE 11, N 8	SE 8, S 8	SE 8, SW 9	N 6, NW 8	E 8
17	N 9, NE 8	E 15, C	C, C	NE 6, NW 6	NE 8, SE 6	
18	S 20, C	N 11, C	SE 6, C	SE 9, SE 6	NE 8, SE 6	
19	NE 8, SE 11	N 6, C	SE 8, C	SE 8, SE 9	SE 11, SE 6	
20	SE 8, S 6	SE 13, N 11	NE 11, C	NE 9, E 6	SE 17, C	
21	SE 9, C	NW 13, NW 11	SE 6, NW 8	SE 8, SE 8	NE 6, SE 13	SE 6, SE 6
22	SE 8, C	NW 11, C	N 8, SE 6	SE 6, NW 8	SE 11, SE 6	SE 11, SE 8
23	C, C	SW 8, N 8	C, C	SE 6, SE 6	N 6, SE 6	SE 13, SE 8
24	N 8, C	N 8, C	S 6, C	NE 9, S 8	SE 6, C	SE 11, SE 6
25	SE 17, C	N 6, N 9	NE 9, SE 9	N 11, SW 8	SE 9, NW 15	NE 6, E 9
26	N 9, NE 8	SW 9, NW 6	SE 17, SE 8	N 8, NE 8	SE 6, NW 9	E 9, SE 9
27	N 8, C	SE 8, C	SE 6, C	E 8, N 6	N 9, C	SE 6
28	C, C	SE 9, SW 6	SE 9, SE 11	SE 8, SE 8	E 6, C	SE 6
29	N 6, N 9		SE 11, SE 8	SE 9, C	SE 9, SE 6	SE 8, NW 8
30	E 8, S 6		SE 6, SW 6	SE 13, SE 11	SE 6, C	
31	S 6, C		SE 8, C		NW 14, C	

1 knot = 0,51 m/s

Namibe

	1986 july	1986 august	1986 september	1986 october	1986 november	1986 december
1		E 4	SE 6, SE 4	SE 7, S 6	NW 6, C	C, C
2	NW 3	NE 3, S 3	SE 4, NW 3	SE 6, S 7	SE 9, SE 13	SE 13, C
3	N 4	NW 4	SE 3	SW 3	NE 6, S 8	SE 11, S 15
4	N 5	N 4	NE 3, SE 6	S 3, SW 4	SE 15, S 13	SE 11, SE 9
5	NW 3	N 4	SE 4	N 3, SE 6	NE 6, W 8	S 11, S 11
6	NE 3	NW 6	SE 6, SE 3	N 6, N 4	SE 8, NW 9	SE 6, C
7	N 3	N 8, NW 3	SE 3	N 4, SE 7	E 8, NW 15	NE 6, E 8
8	N 3	NW 4	S 4		NW 15, NE 6	C, C
9	N 5	E 3	NW 5	W 4	SE 8, NW 6	SE 6, C
10	N 6	N 4, S 6	N 5	SE 5, SW 2	NE 8, E 13	SE 6, SE 6
11	NE 3	SE 3	SE 4, S 6	SE 5, S 3	SE 11, S 11	C, C
12	SE 3, SE 4	NW 4	SE 3	S 4	SE 9, NW 9	S 8
13	SE 3	SE 3, W 3		S 4, S 5	NE 11, SW 15	S 11, C
14		SE 4, S 4	NE 4, S 3	S 6, S 3	N 9, C	SE 8, C
15	N 5	E 4, SE 3	NE 5, SE 3	SW 5	S 11, W 6	E 6, SE 9
16	S 4	S 4, S 5	N 5, SE 4	SE 5, S 4	N 11, E 6	E 8, C
17	SE 4	SE 4	NE 3, SE 3	SE 5, S 5	C, C	S 6, SW 8
18	SE 3, SE 6		SE 3, S 3		NW 6, C	SE 9, S 8
19	SW 5, SW 6	E 5, S 4	N 3, SE 8		SE 6, S 15	SW 6, SE 6
20	SE 3, SE 4	E 6, S 4	NE 4, SE 3	N 3	E 11, SE 9	S 8, C
21	NE 6, SE 3	NE 3, SE 5	NW 4	SE 6, S 8	N 13, C	SE 6, S 8
22	NE 4, E 4	E 3, S 3	S 3, NW 4	S 6, SW 5	C, C	E 8, S 6
23	NE 3, NE 3	E 5	SW 4		SE 17, C	SE 8, C
24	NE 4, NE 4		NE 4, E 3	W 8	N 8, C	SE 9, C
25	NE 3, NW 3	NW 6	SE 4, S 3	NE 4	E 6, C	S 6, S 8
26	E 5, W 4	NW 6	S 3, SW 3	NE 3, SE 3	C, C	E 8, C
27	E 3, S 4	SE 4, SW 4		S 4	N 6, S 9	SE 8, S 6
28	SE 4	W 8	E 5		S 6, S 8	W 11, C
29	NE 6, W 3	N 5	N 5, SE 3	SE 3	S 11, C	C, C
30		N 3, SE 4	W 4	N 3	SE 6, S 8	W 11, C
31	NE 3	NE 3, SE 3		W 6		W 11, NW 11

1 knot = 0,51 m/s

Namibe

	1987 january	1987 february	1987 march	1987 april	1987 may	1987 june
1	N 6, NE 6		S 9, S 6	S 8, SW 6	E 13, SE 17	SE 6, N 10
2	SW 6, SW 9			SW 6	SE 6, SE 6	
3	SE 8, NW 3	SW 6	NW 5	E 6	E 8	SE 7, S 6
4	SE 8	N 9, NW 6			N 8, E 8	N 8, SE 8
5	S 15	SE 9	S 3	SW 4	E 8	SE 10
6	SE 8, S 5	NW 6	N 8		N 8, E 6	E 10
7	SE 5, SE 10		SW 6		N 9	
8	SE 5	S 8		S 4		
9	NW 8	N 6, NW 9	SW 5	SW 6, SW 8	S 6	
10	NW 13	NW 6		S 6, SW 6		W 6
11	SW 8	NW 8			S 8	
12	N 5	N 6	SE 22	E 6	SW 7, SW 5	[illegible], E 6
13	N 5, SW 17	NE 6	S 6, N 6			[illegible]
14	NW 7	SE 6, SW 5	SE 6	SW 8	SW 6	SE [illegible]
15	N 9, NE 8	SE 4	SW 4	N 8	SW 6, SW 8	NW 14
16	N 9	N 11, N 10		SE 6	E 11	E 9, E 6
17	NW 9	SE 34	S 4, SW 8	SW 7, SW 8		E 6, SE 8
18	NW 10	S 8	S 6, SW 3	E 15	E 8, SE 8, SE 6	
19	N 9	SW 5	S 4, SW 3		SE 8, SE 6	SW 6
20	NE 6, N 6	S 6	N 9	NE 6	S 6	E 7, E 4
21	N 9, NW 10	SE 15	SW 8, SW 4	SE 8, SW 6	S 8, N 8	N 6, SE 5
22	N 13			SW 6, NW 8	NW 13	SE 6
23				S 8, S 10	N 8	
24	NE 6	S 5, SW 4	SW 6, N 13	E 5	N 8	
25	N 6, NW 13	S 6				E 6, SE 8
26	NW 8	S 3, S 29	S 8	NW 6		SE 6
27	N 9		S 3, SW 7	S 6, S 7	N 10	S 8
28		S 3, S 11	SE 8, S 6	E 8		SE 5, SE 4
29	SW 3, SW 5		SW 6, SW 5	SE 8, S 8	SE 6	
30	SE 8, SW 12		S 11, SW 6	E 8	N 6	SE 10, SE 6
31			SW 6		N 6	

1 knot = 0,51 m/s

Namibe

	1987 july	1987 august	1987 september	1987 october	1987 november	1987 december
1		SE 8	NE8	SE 7, S 6	NW 6, C	C, C
2	NE 10	E 9, E 5	NW6	SE 6, S 7	SE 9, SE 13	SE 13, C
3	SE 6, S 10		SE 8, SW 6	SW 3	NE 6, S 8	SE 11, S 15
4			NE6	S 3, SW 4	SE 15, S 13	SE 11, SE 9
5	N 6		NE 5, SW 8	N 3, SE 6	NE 6, N 8	S 11, S 11
6	E 6, E 8		SE 6, SW 8	N 6, N 4	SE 8, NW 9	SE 6, C
7	SE 10, SE 6	E 3	SW 10	N 4, SE 7	E 8, NW 15	NE 6, E 8
8			SW 6		NW 15, NE 6	C, C
9		N 5		N 4	SE 8, NW 6	SE 6, C
10		SW 6, SW 16		SE 5, SW 2	NE 8, E 13	SE 6, SE 6
11	NW 8			SE 5, S 3	SE 11, S 11	C, C
12	NE 12	SE 6, SE 10	SE 8	S 4	SE 9, NW 9	S 8
13		E 8, S 10	SE 10	S 4, S 5	NE 11, SW 15	S 11, C
14	N 8	NE 12, SE 8	S 6	S 6, S 3	N 9, C	SE 8, C
15	N 8	SE 8, SW 8	S 10, S 10	SW 5	S 11, N 6	E 6, SE 9
16	N 5	SE 6, SE 6	SE 6, SE 10	SE 5, S 4	N 11, E 6	E 8, C
17		SE 4, SE 5	E 11	SE 5, S 5	C, C	S 6, SW 8
18	S 14	SE 12	SE 12, SW 8		NW 6, C	SE 9, S 8
19	SW 12	E 10, SE 20	NW 8		SE 6, S 15	EN 6, SE 6
20		E 15, S 10	N 10, NW 6	N 3	E 11, SE 9	S 8, C
21	SE 6	SE 11, SE 8	NW 6, NW 16	SE 6, S 8	N 13, C	SE 6, S 8
22		SE 10, SE 6	NE 6	S 6, SW 5	C, C	E 8, S 6
23		SE 8			SE 17, C	SE 8, C
24			E 6, E 10	N 8	N 8, C	SE 9, C
25	S 8, S 8	SE 12	S10	NE 4	E 6, C	S 6, S 8
26		SE 6	SW 12	NE 3, SE 3	C, C	E 8, C
27	N 10		N10	S 4	N 6, S 9	SE 8, S 6
28	NW 10	SE 6	SW 10		S 6, S 8	N 11, C
29		SE 10, SE 12	SW 12	SE 3	S 11, C	C, C
30	N 6	SE 14	E 10, N 8	N 3	SE 6, S 8	N 11, C
31	E 5	S 6		N 6		N 11, NW 11

1 knot = 0,51 m/s

Appendix A6

Windpump parameters

A windstream that passes a given area A with a velocity V represents a kinetic power of

$$P_k = \tfrac{1}{2} \rho_A V^3 \frac{\pi}{4} D^2 \ (W)$$

Where ρ_A = air density (kg/m)

D = rotor diameter (m)

V = undisturbed wind velocity (m/s)

The rotor converts windpower into mechanical power with a certain efficiency (Cp) which has a theoretical maximum of 59,3%, the so called Betz-maximum (ref 5.1).

$$P = P_k \cdot C_p \ (W)$$

Where P = mechanical power (W)

The power extracted from the wind is a function from the rotational speed of the rotor (fig.1).

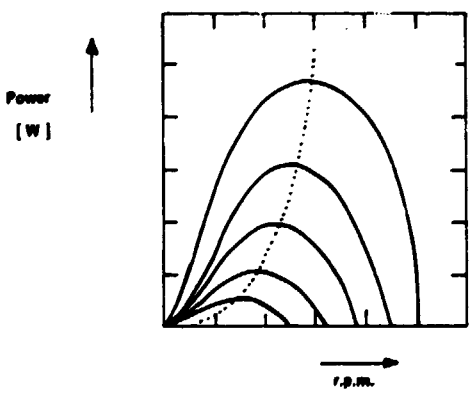


Fig. 1 Power versus rotational speed of a windrotor.

The torque of the rotor, of special interest when coupled to a piston-pump can be written as

$$\Phi = \frac{\rho}{\Omega} \quad (Nm)$$

were Φ = the rotortorque (Nm)

Ω = the angular rotorspeed (rad/s)

In fig. 1 the torque as a function of the rotorspeed is given for different windspeeds.

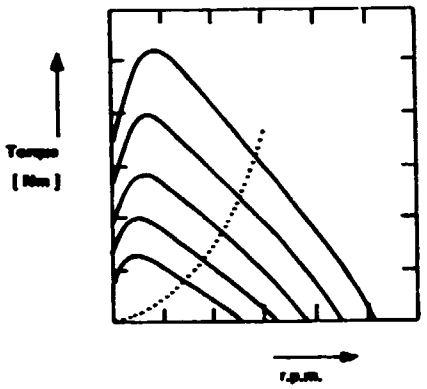


Fig. 2 Torque versus rotational speed of wind rotor.

The average power required by a piston pump (fig. 5.2) can be writen as

$$P = \frac{q.\rho w.g.H}{\eta m}$$

were q = yield of water (m /s)

ρw = water density (kg/m)

g = acceleration of gravity (m/s^2)

H = delivery head (m)

ηm = mechanical pump efficiency

The yield q can be written as

$$q = \frac{1}{8} \eta v \, D_p^{\,2} . S_p . \Omega . i$$

were η_v = volumetric pump efficiency (-)

D_p = pump diameter (m)

S_{p_o} = pump stroke (m)

i = transmission reduction factor (-)

For a pump coupled to a windrotor one can compile
to determine the rotordiameter, geven a windspeed, delivery head and possible or necessary yield.

$$D = \sqrt{\frac{q.\rho w.g.H.8}{C_p.\rho_A.V^3.\pi.\eta m}} \qquad (m)$$

The windspeed at which the overal efficiency reaches its maximum is called the design windspeed. As the pump effeciencies mary little in practice the design windspeed is the windspeed where the rotor effeciency C_p has its maximum.
For this study the average windspeed is considered to be the design wind speed.
The design wind speed can be changed by choosing a different stroke or pump diameter.
For each site an analysis has to be made in order to match pump and windmill in such a way to meet the demand for water, taken into account the local windregime and the ground water resources.

As a general rule can be used: $P_{hydr} = 0{,}1\ V^3\ A$

P_{hydr} = average hydraulic output (W)
V = average wind speed (m/s)
A = rotor swept area (m^2)

In fig. 3 a graph is given based on the here presented formules. For a given average windspeed and rotordiameter the water output can be estimated for a given lifting head.

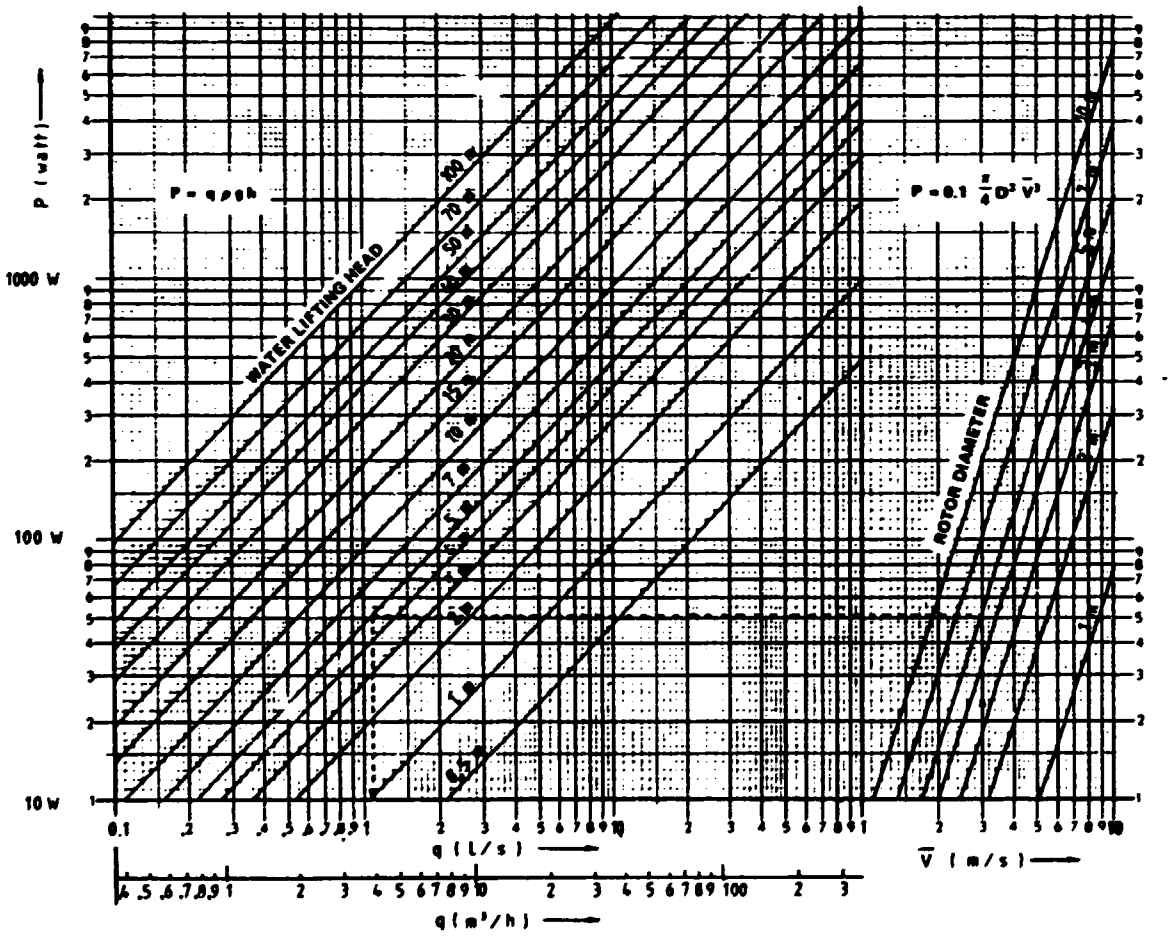
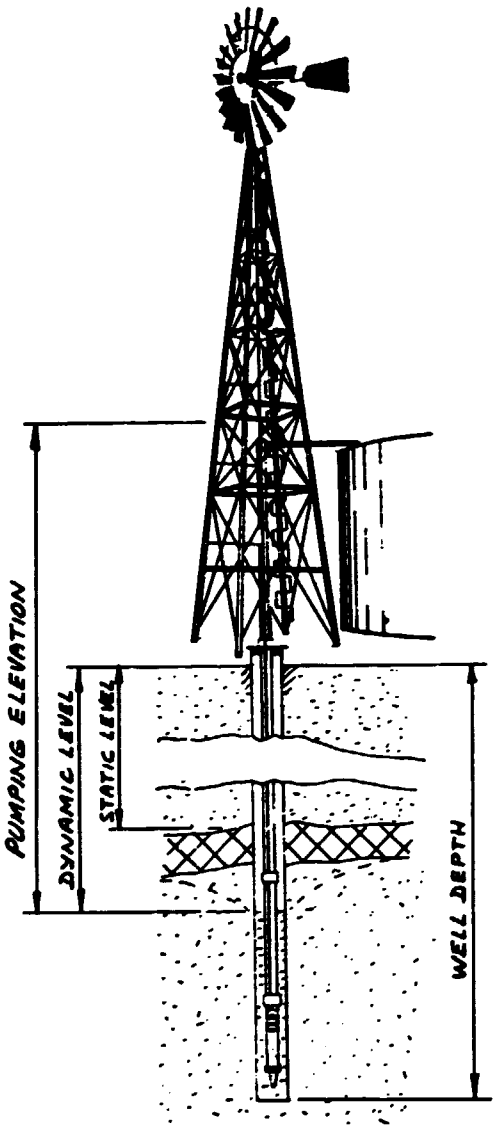


Fig. 5.4 Water output as a function of windspeed, rotordiameter and delivery head.
(Source: Introduction to Wind Energy by E.M. Lysen)
CWD 82 - 1 May 1983

Appendix A7

Analysis of rotordiameters in relation to the groundwaterresources

Well-characteristies of importance for the installation of a pump are the depth, the pumping rate and the dynamic level (fig. 1). Latter data is achieved by executing a pump test in such a way that in a certain time interval with a constant pumping rate the dynamic water level stays constant. Time intervals can be one hour up to 24 hours. The given pumping rate is considered to be the maximum capacity of the well.



The pump of a windmill at least has to be mounted under the dynamic water level. The delivery height is given by teh dynamic water level and together with the pumping rate the maximum power to instal is known.

In tabel 1 characteristies of commercial available windpumps are given. The data is given by Fiasa and Southern Cross however for other brands slight differences can be found. Due to the regulation system of the windpump at a certain windspeed (V-rated), the maximum output is achieved which stays constant at increasing windspeeds.

A medium value for the rated windspeed is 9 m/s (this is independent of the wind regime).
In fig. 2 the required rotor diameters for the wells in the three provinces are plotted. It occurs a 5 m. diameter windpump will reach the capacity of about 70% of the wells. The same analysis done for the average windspeed lead to rotorsizes which are given in fig. 3. In this case 25% of the wells could be equipped with a 5 m. diameter windpump of which most in Namibe due to a higher average windspeed.

It is judged for a good matching of well and windpump at least two different sizes should be provided. Chosen are a 14 feet and a 25 feet rotordiameter. The 14 feet geared windmill can be used on many wells as has been showed, and for drinking water purposes the output can meet the demand. The 25 feet mill is more expensive and will be of use on wells with a high capacity or delivery height. For sites with low average wind speeds if still could meet the demand where a 14 feet mill cannot. This analysis only gives an indication of the most suitable rotorsize. Other important aspects in this matter are the water demand and the storage capacity.

Table 1 Windpump characteristics

Diameter (feet)	Diameter (m)	Maximum nº. of strokes (strokes/min)	Stroke length (mm)
6	1,83	32	95
8	2,44	32	140
10	3,05	26	184
12	3,66	21	210
14	4,27	18	248
* 17	5,18	33	178
* 21	6,40	27	210
* 25	7,62	23	219
* 30	9,14	18,8	245

Maximum nº of strokes achieved at 9 m/s.

* Direct acting windpumps.

Rated Power

HUILA

INTERVAL (-)	NUMBER (-)	PUMPING RATE (L/H)	DYN.HEIGHT (M)	ROTOR DIAMETER (M)	SELECTION VARIABLE ROTORDIAMETER
0	0	415.0	18.41	.6974	0
1	42	1821.	22.22	1.598	1
2	73	3458.	25.41	2.468	2
3	74	6766.	26.14	3.581	3
4	51	8144.	35.33	4.499	4
5	41	9332.	41.62	5.426	5
6	14	10932	49.79	6.495	6
7	17	10628	62.21	7.591	7
8	7	9975.	78.76	8.380	8
9	3	14833	65.66	9.388	9
10	15	27827	71.1	12.72	10

NAMIBE

INTERVAL (-)	NUMBER (-)	PUMPING RATE (L/H)	DYN.HEIGHT (M)	ROTOR DIAMETER (M)	SELECTION VARIABLE ROTORDIAMETER
0	27	423.7	23.34	.8144	0
1	122	1470.	21.35	1.561	1
2	112	4091.	20.76	2.485	2
3	73	8327.	19.75	3.524	3
4	44	11528	21.24	4.491	4
5	22	14115	24.81	5.346	5
6	3	14040	34.37	6.310	6
7	3	21333	40	7.705	7
8	1	30300	27.75	8.976	8
9	0	0	0	0	9
10	7	77428	40.07	15.17	10

CUNENE

INTERVAL (-)	NUMBER (-)	PUMPING RATE (L/H)	DYN.HEIGHT (M)	ROTOR DIAMETER (M)	SELECTION VARIABLE ROTORDIAMETER
0	15	367.3	16.35	.7011	0
1	52	1633.	21.25	1.588	1
2	70	3628.	23.21	2.446	2
3	55	7576.	25.08	3.486	3
4	33	10735	29.76	4.455	4
5	32	13581	40.99	5.492	5
6	26	6550.	77.43	6.570	6
7	8	8237.	82.13	7.567	7
8	3	9866.	77.7	8.500	8
9	2	40649	99.75	9.583	9
10	7	17264	85.73	10.80	10

Average Power

HUILA

INTERVAL (-)	NUMBER (-)	PUMPING RATE (L/H)	DYN.HEIGHT (M)	ROTOR DIAMETER (M)	SELECTION VARIABLE ROTORDIAMETER
0	4	444.9	10.05	1.507	0
1	12	949.7	19.78	3.229	2
2	30	2029.	23.75	5.046	4
3	40	3130.	24.77	6.894	6
4	53	6178.	23.75	8.990	8
5	45	6612.	29.23	11.03	10
6	36	7452.	39.61	12.97	12
7	31	9255.	38.05	14.88	14
8	21	10487	38.33	16.53	16
9	11	9969.	34.50	18.78	18
10	44	16850	66.88	27.86	20

NAMIBE

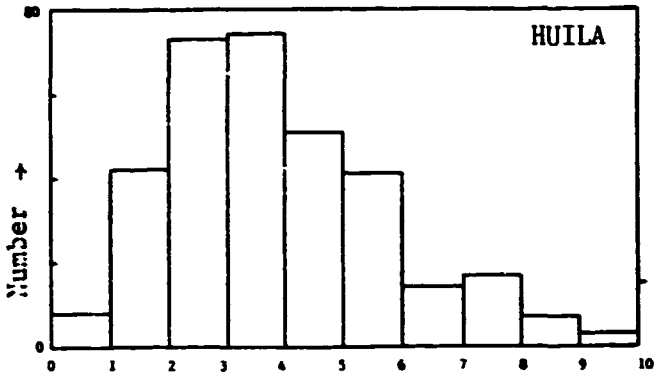
INTERVAL (-)	NUMBER (-)	PUMPING RATE (L/H)	DYN.HEIGHT (M)	ROTOR DIAMETER (M)	SELECTION VARIABLE ROTORDIAMETER
0	0	0	0	0	0
1	27	423.7	23.34	1.628	1
2	51	1063.	19.25	2.528	2
3	71	1763.	22.86	3.550	3
4	64	3365.	20.79	4.529	4
5	48	5059.	20.71	5.558	5
6	28	6860.	20.38	6.389	6
7	45	9230.	19.36	7.458	7
8	19	9638.	23.00	8.338	8
9	25	12964	19.90	9.471	9
10	36	27471	29.92	15.26	10

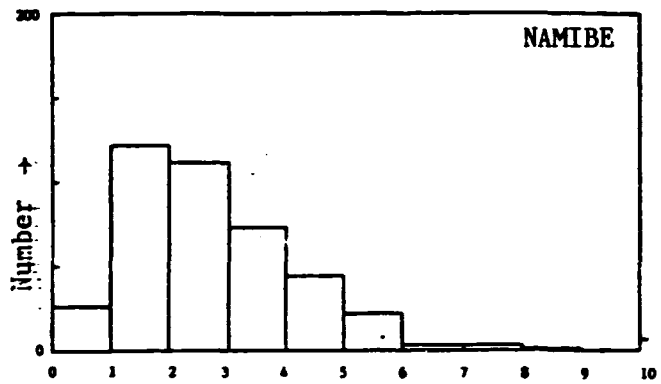
CUNENE

INTERVAL (-)	NUMBER (-)	PUMPING RATE (L/H)	DYN.HEIGHT (M)	ROTOR DIAMETER (M)	SELECTION VARIABLE ROTORDIAMETER
0	7	290.1	12.07	1.533	0
1	21	845.2	18.25	3.218	2
2	44	1863.	22.51	5.059	4
3	50	3421.	23.76	6.915	6
4	38	6716.	21.11	8.882	8
5	42	7913.	27.26	11.04	10
6	17	10249	30.31	13.17	12
7	23	11361	42.15	15.10	14
8	16	16270	39.42	16.81	16
9	24	6583.	77.89	19.18	18
10	21	14459	79.68	26.07	20

Table 2 Selection of rotor diameters with the rated power and average power as parameters

Rated Power





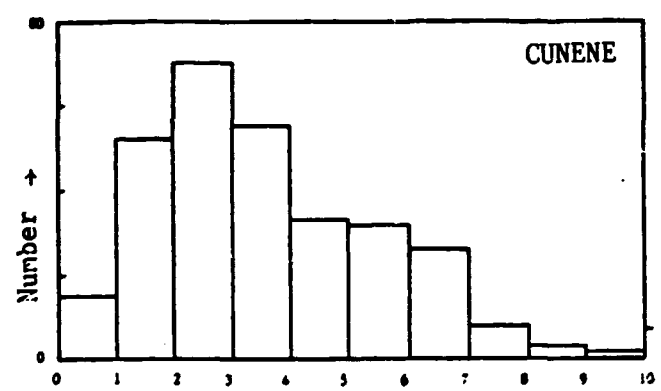
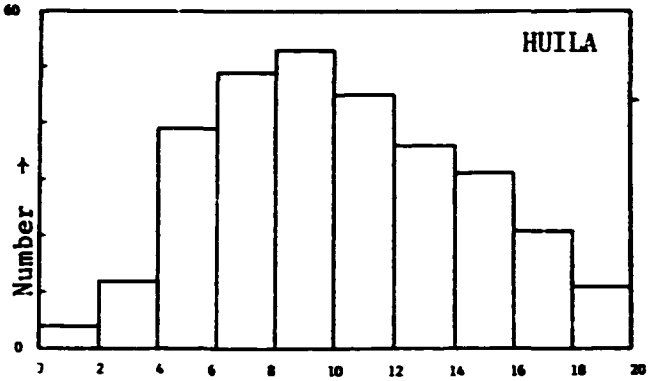
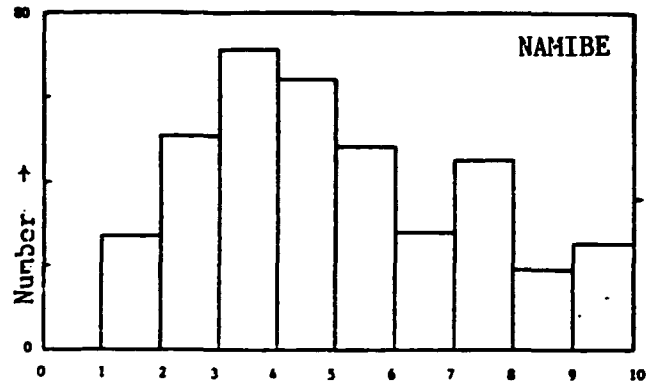


Figure 2 Distribution of the rotorsizes if rated power has to meet the well capacity

Average Power





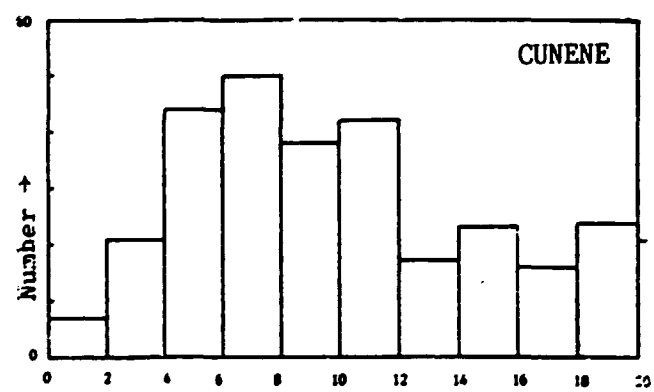


Figure 3 Distribution of the rotorsizes if average power has to meet the well capacity

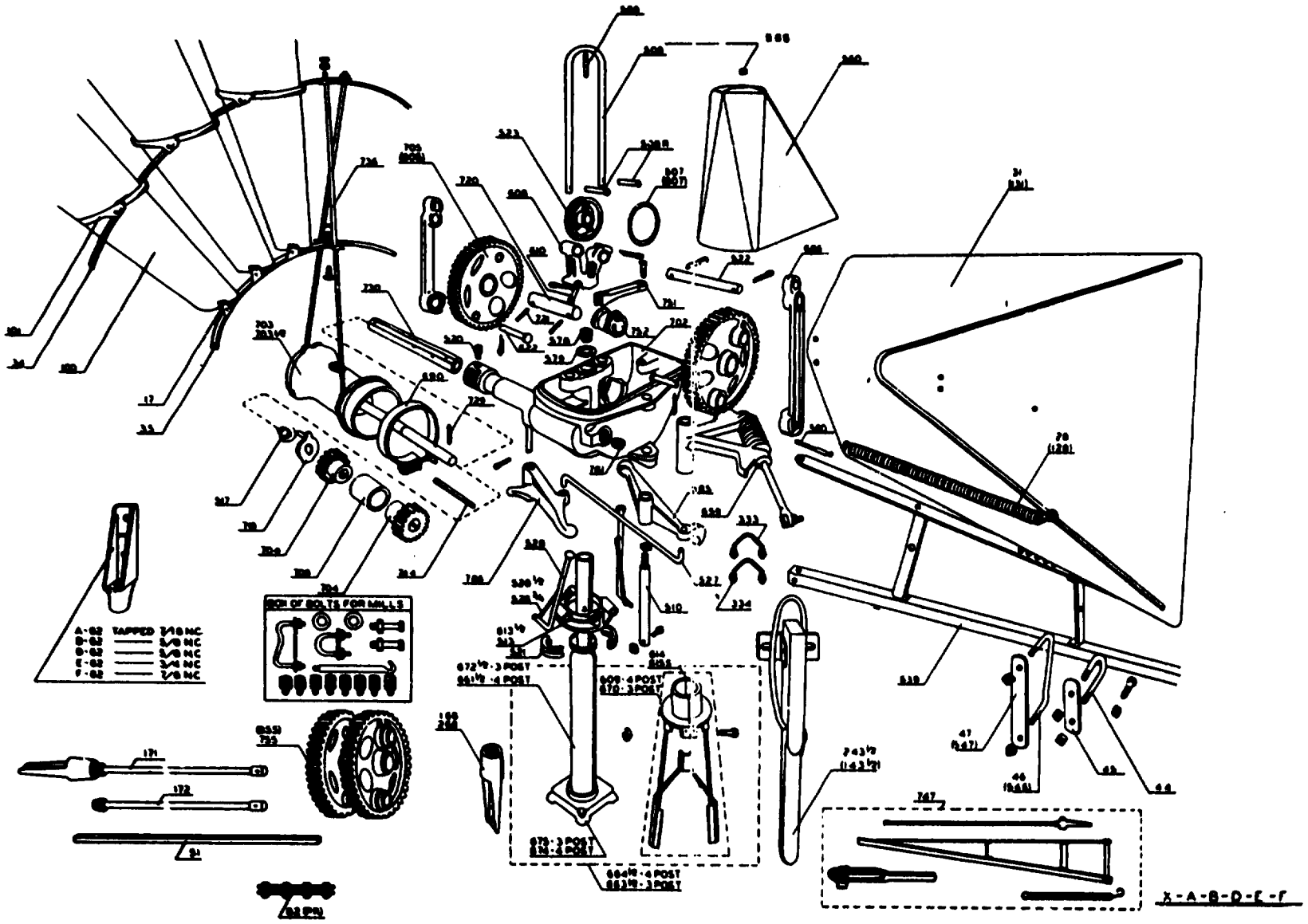
Appendix A8

Windpump transmission parts

PART NO.	DESCRIPTION
17	Sail Tie
28	Vane Spring
31	Vane (Also 131)
34	Outer Band Of Wheel
35	Inner Band Of Wheel
44	Narrow U-Bolt and Washer
46	Wide U-Bolt and Washer
47	Washer For 46
51	Wood Pump Pole — 14' Long
62	Connection, Pump Pole To Well Rod
82	Pair Splice Straps With Bolts
100	Sail With No. 17 Riveted On
100½KD	Section of 3 Sails 3 No. 100, 3 No. 101, 1 No. 34 1 No. 35, 10 Bolts, 10 Locknuts
101	Sail Rib
101N	Locknut for 101
128	Vane Spring
131	Vane
143½	Furl Handle
168	Swivel Casting For Pump Rod
171	Pump Rod w/Swivel Casting (complete)
172	Pump Rod w/Swivel Nut Only
243½	Furl Handle
268	Swivel Casting For Pump Rod
333	V-Bolt For Connecting Furl Handle Tower Corner Post
334	V-Bolt For Connecting Furl Handle Tower
507	Oil Ring
508	Pitman Guide With 588 Stud
510	Pivot Bolt For Tailbone
513PP	Split Upper Furl Ring
517	Spring For Spout Washer
520	Oil Collector in Hub
521	Split Washer
522	Shaft For Guide Wheel And Yoke
523	Guide Wheel (for Pitman and Yoke)
527	Furl Link
528	Furl Arm
528½	Furl Arm, Long For Repair (Takes Up Wear On Brake)
528¾	Furl Arm, Extra Long For Repairs (Takes Up Wear On Brake)
546	Wide U-Bolt and Washer
547	Washer for 546
580	Helmet
585	Nut For 588

PART NO.	DESCRIPTION
570	Steel Washer For Turntable
578	Locknut For Top Of Pipe
579	Lockwasher For Top Of Pipe
580	Vane Spring Holder
582	Furl Wire — 25' Long
585	Tailbone Casting
588	Stud For Pitman Guide
608	Pump Rod Yoke
609	Furl Lever Complete — 4 Post
610	Pin For 608 Yoke
613½-O	Upper Furl Ring Without Furl Arms, Solid
614	Split Furl Ring — 4 Post
615-S	Split Furl Ring — 3 Post
622	Bolt With Cotter
639	Tailbone With 510 Pivot
659	Buffer Device — Complete
661½	Pipe With Base — 4 Post
663½	Pipe With Base, Furl Lever — 3 Post
664½	Pipe With Base, Furl Lever — 4 Post
670	Furl Lever Complete — 3 Post
672½	Pipe With Base— 3 Post
674	Pipe Base Only — 4 Post
675	Pipe Base Only — 3 Post
686	Pitman Arm — Adjustable Stroke
690	Brake — Complete
702-O	Main Frame
703-O	Hub and Shaft
703½-O	Hub and Shaft
704	Small Gear
705	Large Gear
708	Replaceable Babbitt Bearing
718	Spout Washer
720	Shaft For 705 or 805
721	Pin For Large Gear
729	Pin For Shaft On Hub
730	Replaceable Sleeve Bearing
736	Wheel Arm
744	Key
747	Tailbone Bundle
751	Bearing Bar
752	Bearing For Large Gears
755	Large Gear and Bearing Assembly 2 — 705 Gears, 1 — 720 Shaft 1 — 752 Bearing, 2 — 721 Pin
781	Countersunk Plug
786	Brake Lever
799	Sails, Ribs, Wheel Arms, Bands and Bolts for Complete Wheel, and Furl Wire

WINDMILL REPAIRS AND REPLACEMENTS



Appendix A9

Comfar output data

In the following the output data are given regarding financial analysis made with help of the computer program "Comfar" concerning 4 different situations:

1. Isolated plant — page A9- 2 to page A9-21
2. Isolated plant, tax included — page A9-22 to page A9-30
3. Integration with EMEL — page A9-31 to page A9-50
4. Integration with Metafus — page A9-51 to page A9-70

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Production Unit for Windpumps
10-02-1989
Isolated plant

1 year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: Dollars

Total initial investment during construction phase

fixed assets:	440400.00	71.617 % foreign
current assets:	0.00	0.000 % foreign
total assets:	440400.00	71.617 % foreign

Source of funds during construction phase

equity & grants:	154000.00	0.000 % foreign
foreign loans :	308000.00	
local loans :	0.00	
total funds :	462000.00	66.667 % foreign

Cashflow from operations

Year:	1	3	4
operating costs:	336250.00	370000.00	367000.00
depreciation :	41250.00	41250.00	41250.00
interest :	37800.00	50800.00	50800.00
production costs	415300.00	462050.00	459050.00
thereof foreign	86.15 %	78.95 %	74.89 %
total sales :	210000.00	420000.00	600000.00
gross income :	-205300.00	-42050.00	140950.00
net income :	-205300.00	-42050.00	140950.00
cash balance :	-14740.97	-9402.69	111747.20
net cashflow :	-176941.00	41397.31	162547.20

Net Present Value at: 10.00 % = 817557.10
Internal Rate of Return: 22.71 %
Return on equity1: 21.27 %
Return on equity2: 32.34 %

Index of Schedules produced by COMFAR

Total initial investment
Total investment during production
Total production costs
Working Capital requirements
Cashflow Tables
Projected Balance
Net income statement
Source of finance

COMFAR 2.1 UNIDO

Total Initial Investment in Dollars

Year	1990
Fixed investment costs	
Land, site preparation, development	0.000
Buildings and civil works	250000.000
Auxiliary and service facilities	55000.000
Incorporated fixed assets	0.000
Plant machinery and equipment	120000.000
Total fixed investment costs	425000.000
Pre-production capital expenditures	15400.000
Net working capital	0.000
Total initial investment costs	440400.000
Of it foreign, in %	71.617

COMFAR 21 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Total Current Investment in Dollars

Year	1991	1992	1993	1994	1995
Fixed investment costs					
Land, site preparation, development	0.000	0.000	0.000	0.000	0.000
Buildings and civil works	0.000	0.000	0.000	0.000	0.000
Auxiliary and service facilities	0.000	0.000	0.000	55000.000	0.000
Incorporated fixed assets	0.000	0.000	0.000	0.000	0.000
Plant, machinery and equipment	0.000	0.000	0.000	0.000	0.000
Total fixed investment costs	0.000	0.000	0.000	55000.000	0.000
Preproduction capitals expenditures.	0.000	0.000	0.000	0.000	0.000
Working capital	50690.970	5020.209	8602.702	15452.770	-3680.539
Total current investment costs	50690.970	5020.209	8602.702	70452.770	-3680.539
Of it foreign, %	88.609	73.060	72.574	97.634	0.000

Production Unit for Windpumps --- 10-02-1989

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Total Current Investment in Dollars

Year	1996	1997	1998	1999-2002	2003
Fixed investment costs					
Land, site preparation, development	0.000	0.000	0.000	0.000	0.000
Buildings and civil works	0.000	0.000	0.000	0.000	0.000
Auxiliary and service facilities	0.000	0.000	55000.000	0.000	55000.000
Incorporated fixed assets	0.000	0.000	0.000	0.000	0.000
Plant, machinery and equipment	0.000	0.000	120000.000	0.000	0.000
Total fixed investment costs	0.000	0.000	175000.000	0.000	55000.000
Preproduction capitals expenditures.	0.000	0.000	0.000	0.000	0.000
Working capital	-833.336	0.000	0.000	0.000	0.000
Total current investment costs	-833.336	0.000	175000.000	0.000	55000.000
Of it foreign, %	0.000	0.000	100.000	0.000	100.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Total Production Costs in Dollars

ear	1991	1992	1993	1994	1995
of nom. capacity (single product).	35.000	53.000	70.000	100.000	100.000
aw material 1	56750.000	83474.990	119000.000	170000.000	170000.000
ther raw materials	28000.000	21200.000	14000.000	20000.000	20000.000
tilities	2000.000	2500.000	3000.000	3000.000	3000.000
nergy	0.000	0.000	0.000	0.000	0.000
abour, direct	10500.000	21200.000	35000.000	50000.000	50000.000
epair, maintenance	0.000	0.000	0.000	0.000	0.000
pares	2000.000	2500.000	3000.000	3000.000	3000.000
actory overheads	115000.000	115000.000	124000.000	74000.000	49000.000
actory costs	214250.000	245875.000	298000.000	320000.000	295000.000
dministrative overheads	122000.000	97000.000	72000.000	47000.000	22000.000
ndir. costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
irect costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
epreciation	41250.000	41250.000	41250.000	41250.000	41250.000
inancial costs	37800.000	47800.000	50800.000	50800.000	50800.000
otal production costs	415300.000	431925.000	462050.000	459050.000	409050.000
osts per unit (single product)	11865.710	8149.528	6600.714	4590.500	4090.500
f it foreign, %	86.155	83.579	78.952	74.894	71.825
f it variable,%	20.226	29.450	36.360	52.282	58.673
otal labour	132500.000	118200.000	107000.000	97000.000	72000.000

COMFAR 2.1 UNIDO

Total Production Costs in Dollars

Year	1996	1997	1998	1999	2000
% of nom. capacity (single product).	100.000	100.000	100.000	100.000	100.000
Raw material 1	170000.000	170000.000	170000.000	170000.000	170000.000
Other raw materials	20000.000	20000.000	20000.000	20000.000	20000.000
Utilities	3000.000	3000.000	3000.000	3000.000	3000.000
Energy	0.000	0.000	0.000	0.000	0.000
Labour, direct	50000.000	50000.000	50000.000	50000.000	50000.000
Repair, maintenance	0.000	0.000	0.000	0.000	0.000
Spares	3000.000	3000.000	3000.000	3000.000	3000.000
Factory overheads	24000.000	24000.000	24000.000	24000.000	24000.000
Factory costs	270000.000	270000.000	270000.000	270000.000	270000.000
Administrative overheads	22000.000	22000.000	22000.000	22000.000	22000.000
Indir. costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	41250.000	41250.000	41250.000	41250.000	41250.000
Financial costs	45720.000	40640.000	35560.000	30480.000	25400.000
Total production costs	378970.000	373890.000	368810.000	363730.000	358650.000
Costs per unit (single product)	3789.700	3738.900	3688.100	3637.300	3586.500
Of it foreign, %	69.589	69.175	68.751	68.314	67.866
Of it variable,%	63.330	64.190	65.074	65.983	66.918
Total labour	72000.000	72000.000	72000.000	72000.000	72000.000

Total Production Costs in Dollars

Year	2001	2002	2003	2004	2005
% of nom. capacity (single product).	100.000	100.000	100.000	100.000	100.000
Raw material 1	170000.000	170000.000	170000.000	170000.000	170000.000
Other raw materials	20000.000	20000.000	20000.000	20000.000	20000.000
Utilities	3000.000	3000.000	3000.000	3000.000	3000.000
Energy	0.000	0.000	0.000	0.000	0.000
Labour, direct	50000.000	50000.000	50000.000	50000.000	50000.000
Repair, maintenance	0.000	0.000	0.000	0.000	0.000
Spares	3000.000	3000.000	3000.000	3000.000	3000.000
Factory overheads	24000.000	24000.000	24000.000	24000.000	24000.000
Factory costs	270000.000	270000.000	270000.000	270000.000	270000.000
Administrative overheads	22000.000	22000.000	22000.000	22000.000	22000.000
Indir. costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	41250.000	41250.000	27500.000	41250.000	41250.000
Financial costs	20320.000	15240.000	10160.000	5080.000	0.000
Total production costs	353570.000	348490.000	329660.000	338330.000	333250.000
Costs per unit (single product)	3535.700	3484.900	3296.600	3383.300	3332.500
Of it foreign, %	67.404	66.929	65.040	65.936	65.416
Of it variable,%	67.879	68.869	72.802	70.937	72.018
Total labour	72000.000	72000.000	72000.000	72000.000	72000.000

COMFAR 2.1 UNIDO

---------- COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL -----

Net Working Capital in Dollars

Year			1991	1992	1993	1994	1995
Coverage	adc	coto					
Current assets &							
Accounts receivable	30	12.0	28020.830	28572.920	30833.330	30583.330	26416.670
Inventory and materials	116	3.1	28458.330	34854.160	43916.670	62416.670	62416.670
Energy	0	---	0.000	0.000	0.000	0.000	0.000
Spares	360	1.0	2000.000	2500.000	3000.000	3000.000	3000.000
Work in progress	2	166.4	920.139	1157.153	1594.444	1855.556	1786.111
Finished products	4	91.6	2215.278	2569.306	3302.778	3744.445	3605.556
Cash in hand	10	36.0	6930.556	6547.222	6500.000	4833.333	3444.445
Total current assets			68545.140	76200.760	89147.230	106433.300	100669.400
Current liabilities and							
Accounts payable	30	12.0	17854.170	20489.580	24833.330	26666.670	24583.330
Net working capital			50690.970	55711.170	64313.890	79766.670	76086.110
Increase in working capital			50690.970	5020.199	8602.719	15452.780	-3680.563
Net working capital, local			5774.306	7126.737	9486.111	11152.780	11152.780
Net working capital, foreign			44916.670	48584.450	54827.770	68613.880	64933.340

Note: adc = minimum days of coverage ; coto = coefficient of turnover .

---------- COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL -----

Net Working Capital in Dollars

Year			1996	1997-2005
Coverage	adc	coto		
Current assets &				
Accounts receivable	30	12.0	24333.330	24333.330
Inventory and materials	116	3.1	62416.670	62416.670
Energy	0	---	0.000	0.000
Spares	360	1.0	3000.000	3000.000
Work in progress	2	166.4	1716.667	1716.667
Finished products	4	91.6	3536.111	3536.111
Cash in hand	10	36.0	2750.000	2750.000
Total current assets			97752.770	97752.770
Current liabilities and				
Accounts payable	30	12.0	22500.000	22500.000
Net working capital			75252.770	75252.770
Increase in working capital			-833.336	0.000
Net working capital, local			11152.780	11152.780
Net working capital, foreign			64100.000	64100.000

Note: adc = minimum days of coverage ; coto = coefficient of turnover .

COMFAR 2.1 UNIDO

Source of Finance, construction in Dollars

Year	1990
Equity, ordinary ..	154000.000
Equity, preference.	0.000
Subsidies, grants .	0.000
Loan A, foreign .	308000.000
Loan B, foreign..	0.000
Loan C, foreign .	0.000
Loan A, local....	0.000
Loan B, local....	0.000
Loan C, local....	0.000
Total loan	308000.000
Current liabilities	0.000
Bank overdraft	0.000
Total funds	462000.000

Source of Finance, production in Dollars

Year	1991	1992	1993	1994	1995-96	1997-2004
Equity, ordinary ..	60000.000	40000.000	0.000	0.000	0.000	0.000
Equity, preference.	0.000	0.000	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, foreign .	140000.000	60000.000	0.000	0.000	-50800.000	-50800.000
Loan B, foreign..	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, local....	0.000	0.000	0.000	0.000	0.000	0.000
Loan B, local....	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, local....	0.000	0.000	0.000	0.000	0.000	0.000
Total loan	140000.000	60000.000	0.000	0.000	-50800.000	-50800.000
Current liabilities	17854.170	2635.417	4343.750	1833.332	-2083.332	0.000
Bank overdraft	0.000	0.000	0.000	0.000	0.000	0.000
Total funds	217854.200	102635.400	4343.750	1833.332	-52883.330	-50800.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Cashflow Tables, construction in Dollars

Year	1990
Total cash inflow . .	462000.000
Financial resources .	462000.000
Sales, net of tax . .	0.000
Total cash outflow . .	440400.000
Total assets	425000.000
Operating costs . . .	0.000
Cost of finance . . .	15400.000
Repayment	0.000
Corporate tax . . .	0.000
Dividends paid . . .	0.000
Surplus (deficit) .	21600.000
Cumulated cash balance	21600.000
Inflow, local	154000.000
Outflow, local	125000.000
Surplus (deficit) .	29000.000
Inflow, foreign . . .	308000.000
Outflow, foreign . . .	315400.000
Surplus (deficit) .	-7400.000
Net cashflow	-425000.000
Cumulated net cashflow	-425000.000

COMFAR 2.1 UNIDO

Cashflow tables, production in Dollars

Year	1991	1992	1993	1994	1995	1996
Total cash inflow . .	427854.200	420635.400	424343.800	601833.300	600000.000	600000.000
Financial resources .	217854.200	102635.400	4343.750	1833.332	0.000	0.000
Sales, net of tax . .	210000.000	318000.000	420000.000	600000.000	600000.000	600000.000
Total cash outflow . .	442595.100	398330.600	433746.500	490086.100	414919.500	387686.700
Total assets	68545.140	7655.623	12946.460	72286.110	-5763.889	-2916.667
Operating costs . . .	336250.000	342875.000	370000.000	367000.000	317000.000	292000.000
Cost of finance . . .	37800.000	47800.000	50800.000	50800.000	50800.000	45720.000
Repayment	0.000	0.000	0.000	0.000	52883.330	52883.340
Corporate tax . . .	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	-14740.940	22304.810	-9402.719	111747.200	185080.500	212313.300
Cumulated cash balance	6859.063	29163.880	19761.160	131508.300	316588.900	528902.200
Inflow, local	272437.500	359118.800	422193.800	601500.000	600000.000	600000.000
Outflow, local	59461.890	67146.180	95553.130	112166.700	109000.000	109000.000
Surplus (deficit) .	212975.700	291972.600	326640.600	489333.300	491000.000	491000.000
Inflow, foreign . . .	155416.700	61516.670	2150.000	333.332	0.000	0.000
Outflow, foreign . . .	383133.300	331184.400	338193.300	377919.400	305919.400	278686.700
Surplus (deficit) .	-227716.700	-269667.800	-336043.300	-377586.100	-305919.400	-278686.700
Net cashflow	-176941.000	-29895.210	41397.280	162547.200	286680.500	308833.300
Cumulated net cashflow	-601941.000	-631836.200	-590438.900	-427891.700	-141211.200	167622.200

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Cashflow tables, production in Dollars

Year	1997	1998	1999	2000	2001	2002
Total cash inflow . .	600000.000	600000.000	600000.000	600000.000	600000.000	600000.000
Financial resources .	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax . .	600000.000	600000.000	600000.000	600000.000	600000.000	600000.000
Total cash outflow . .	383440.000	553360.000	373280.000	368200.000	363120.000	358040.000
Total assets	0.000	175000.000	0.000	0.000	0.000	0.000
Operating costs . . .	292000.000	292000.000	292000.000	292000.000	292000.000	292000.000
Cost of finance . . .	40640.000	35560.000	30480.000	25400.000	20320.000	15240.000
Repayment	50800.000	50800.000	50800.000	50800.000	50800.000	50800.000
Corporate tax . . .	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	216560.000	46640.000	226720.000	231800.000	236880.000	241960.000
Cumulated cash balance	745462.200	792102.200	1018822.000	1250622.000	1487502.000	1729462.000
Inflow, local	600000.000	600000.000	600000.000	600000.000	600000.000	600000.000
Outflow, local	109000.000	109000.000	109000.000	109000.000	109000.000	109000.000
Surplus (deficit) .	491000.000	491000.000	491000.000	491000.000	491000.000	491000.000
Inflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, foreign . . .	274440.000	444360.000	264280.000	259200.000	254120.000	249040.000
Surplus (deficit) .	-274440.000	-444360.000	-264280.000	-259200.000	-254120.000	-249040.000
Net cashflow	308000.000	133000.000	308000.000	308000.000	308000.000	308000.000
Cumulated net cashflow	475622.200	608622.200	916622.200	1224622.000	1532622.000	1840622.000

Cashflow tables, production in Dollars

Year	2003	2004	2005
Total cash inflow . .	600000.000	600000.000	600000.000
Financial resources .	0.000	0.000	0.000
Sales, net of tax . .	600000.000	600000.000	600000.000
Total cash outflow . .	407960.000	347880.000	292000.000
Total assets	55000.000	0.000	0.000
Operating costs . . .	292000.000	292000.000	292000.000
Cost of finance . . .	10160.000	5080.000	0.000
Repayment	50800.000	50800.000	0.000
Corporate tax . . .	0.000	0.000	0.000
Dividends paid . . .	0.000	0.000	0.000
Surplus (deficit) .	192040.000	252120.000	308000.000
Cumulated cash balance	1921502.000	2173622.000	2481622.000
Inflow, local	600000.000	600000.000	600000.000
Outflow, local	109000.000	109000.000	109000.000
Surplus (deficit) .	491000.000	491000.000	491000.000
Inflow, foreign . . .	0.000	0.000	0.000
Outflow, foreign . . .	298960.000	238880.000	183000.000
Surplus (deficit) .	-298960.000	-238880.000	-183000.000
Net cashflow	253000.000	308000.000	308000.000
Cumulated net cashflow	2093622.000	2401622.000	2709622.000

COMFAR 2.1 UNIDO

Cashflow Discounting:

a) Equity paid versus Net income f'

Net present value	580332.80	at	10.00 %
Internal Rate of Return (IRRE1) ..	21.27 %		

b) Net Worth versus Net cash return:

Net present value	771714.10	at	10.00 %
Internal Rate of Return (IRRE2) ..	32.34 %		

c) Internal Rate of Return on total investment:

Net present value	817557.10	at	10.00 %
Internal Rate of Return (IRR) ..	22.71 %		

Net Worth = Equity paid plus reserves

COMFAR 2.1 UNIDO

Net Income Statement in Dollars

Year	1991	1992	1993	1994	1995
Total sales, incl. sales tax	210000.000	318000.000	420000.000	600000.000	600000.000
Less: variable costs, incl. sales tax.	84000.000	127200.000	168000.000	240000.000	240000.000
Variable margin	126000.000	190800.000	252000.000	360000.000	360000.000
As % of total sales	60.000	60.000	60.000	60.000	60.000
Non-variable costs, incl. depreciation	293500.000	256925.000	243250.000	168250.000	118250.000
Operational margin	-167500.000	-66125.000	8750.000	191750.000	241750.000
As % of total sales	-79.762	-20.794	2.083	31.958	40.292
Cost of finance	37800.000	47800.000	50600.000	50800.000	50800.000
Gross profit	-205300.000	-113925.000	-42050.000	140950.000	190950.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	-205300.000	-113925.000	-42050.000	140950.000	190950.000
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	-205300.000	-113925.000	-42050.000	140950.000	190950.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	-205300.000	-113925.000	-42050.000	140950.000	190950.000
Accumulated undistributed profit	-205300.000	-319225.000	-361275.000	-220325.000	-29375.000
Gross profit, % of total sales	-97.762	-35.825	-10.012	23.492	31.825
Net profit, % of total sales	-97.762	-35.825	-10.012	23.492	31.825
ROE, Net profit, % of equity	-95.935	-44.852	-16.555	55.492	75.177
ROI, Net profit+interest, % of invest.	-35.212	-13.756	1.788	34.255	43.473

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Net. Income Statement in Dollars

Year	1996	1997	1998	1999	2000
Total sales, incl. sales tax	600000.000	600000.000	600000.000	600000.000	600000.000
Less: variable costs, incl. sales tax.	240000.000	240000.000	240000.000	240000.000	240000.000
Variable margin	360000.000	360000.000	360000.000	360000.000	360000.000
as % of total sales	60.000	60.000	60.000	60.000	60.000
Non-variable costs, incl. depreciation	93250.000	93250.000	93250.000	93250.000	93250.000
Operational margin	266750.000	266750.000	266750.000	266750.000	266750.000
as % of total sales	44.458	44.458	44.458	44.458	44.458
Cost of finance	45720.000	40640.000	35560.000	30480.000	25400.000
Gross profit	221030.000	226110.000	231190.000	236270.000	241350.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	221030.000	226110.000	231190.000	236270.000	241350.000
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	221030.000	226110.000	231190.000	236270.000	241350.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	221030.000	226110.000	231190.000	236270.000	241350.000
Accumulated undistributed profit	191655.000	417765.000	648955.000	885225.000	1126575.000
Gross profit, % of total sales	36.838	37.685	38.532	39.378	40.225
Net profit, % of total sales	36.838	37.685	38.532	39.378	40.225
ROE, Net profit, % of equity	87.020	89.020	91.020	93.020	95.020
ROI, Net profit+interest, % of invest.	48.041	48.041	36.528	36.528	36.528

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Net Income Statement in Dollars

Year	2001	2002	2003	2004	2005
Total sales, incl. sales tax	600000.000	600000.000	600000.000	600000.000	600000.000
Less: variable costs, incl. sales tax.	240000.000	240000.000	240000.000	240000.000	240000.000
Variable margin	360000.000	360000.000	360000.000	360000.000	360000.000
As % of total sales	60.000	60.000	60.000	60.000	60.000
Non-variable costs, incl. depreciation	93250.000	93250.000	79500.000	93250.000	93250.000
Operational margin	266750.000	266750.000	280500.000	266750.000	266750.000
As % of total sales	44.458	44.458	46.750	44.458	44.458
Cost of finance	20320.000	15240.000	10160.000	5080.000	0.000
Gross profit	246430.000	251510.000	270340.000	261670.000	266750.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	246430.000	251510.000	270340.000	261670.000	266750.000
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	246430.000	251510.000	270340.000	261670.000	266750.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	246430.000	251510.000	270340.000	261670.000	266750.000
Accumulated undistributed profit	1373005.000	1624515.000	1894855.000	2156525.000	2423275.000
Gross profit, % of total sales	41.072	41.918	45.057	43.612	44.458
Net profit, % of total sales	41.072	41.918	45.057	43.612	44.458
ROE, Net profit, % of equity	97.020	99.020	106.433	103.020	105.020
ROI, Net profit+interest, % of invest.	36.528	36.528	35.721	33.970	33.770

COMFAR 2.1 UNIDO

Projected Balance Sheets, construction in Dollars

Year	1990
Total assets	462000.000
Fixed assets, net of depreciation	0.000
Construction in progress	440400.000
Current assets	0.000
Cash, bank	0.000
Cash surplus, finance available	21600.000
Loss carried forward	0.000
Loss	0.000
Total liabilities	462000.000
Equity capital	154000.000
Reserves, retained profit	0.000
Profit	0.000
Long and medium term debt	308000.000
Current liabilities	0.000
Bank overdraft, finance required	0.000
Total debt	308000.000
Equity, % of liabilities	33.333

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Projected Balance Sheets, Production in Dollars

Year	1991	1992	1993	1994	1995
Total assets	679854.200	782489.600	786833.300	929616.700	926733.300
Fixed assets, net of depreciation	399150.000	357900.000	316650.000	275400.000	289150.000
Construction in progress	0.000	0.000	0.000	55000.000	0.000
Current assets	61614.590	69653.540	82647.220	101600.000	97225.000
Cash, bank	6930.556	6547.222	6500.000	4833.333	3444.445
Cash surplus, finance available	6859.063	29163.810	19761.060	131508.300	316588.900
Loss carried forward	0.000	205300.000	319225.000	361275.000	220325.000
Loss	205300.000	113925.000	42050.000	0.000	0.000
Total liabilities	679854.200	782489.600	786833.300	929616.700	926733.300
Equity capital	214000.000	254000.000	254000.000	254000.000	254000.000
Reserves, retained profit	0.000	0.000	0.000	0.000	0.000
Profit	0.000	0.000	0.000	140950.000	190950.000
Long and medium term debt	448000.000	508000.000	508000.000	508000.000	457200.000
Current liabilities	17854.170	20499.590	24833.340	26666.670	24583.340
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	465854.200	528489.600	532833.300	534666.700	481783.300
Equity, % of liabilities	31.477	32.460	32.281	27.323	27.408

Production Unit for Windpumps --- 10-02-1989

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Projected Balance Sheets, Production in Dollars

Year	1996	1997	1998	1999	2000
Total assets	903930.000	1049865.000	1230255.000	1415725.000	1606275.000
Fixed assets, net of depreciation	247900.000	206650.000	165400.000	299150.000	257900.000
Construction in progress	0.000	0.000	175000.000	0.000	0.000
Current assets	95002.770	95002.770	95002.770	95002.770	95002.770
Cash, bank	2750.000	2750.000	2750.000	2750.000	2750.000
Cash surplus, finance available	528902.300	745462.300	792102.300	1018822.000	1250622.000
Loss carried forward	29375.600	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	903930.000	1049865.000	1230255.000	1415725.000	1606275.000
Equity capital	254000.000	254000.000	254000.000	254000.000	254000.000
Reserves, retained profit	0.000	191655.000	417765.000	648955.000	885225.000
Profit	221030.000	226110.000	231190.000	236270.000	241350.000
Long and medium term debt	406400.000	355600.000	304800.000	254000.000	203200.000
Current liabilities	22500.000	22500.000	22500.000	22500.000	22500.000
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	428900.000	378100.000	327300.000	276500.000	225700.000
Equity, % of liabilities	28.100	24.194	20.646	17.941	15.813

Production Unit for Windpumps --- 10-02-1989

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Projected Balance Sheets, Production in Dollars

Year	2001	2002	2003	2004	2005
Total assets	1801905.000	2002615.000	2222155.000	2433025.000	2699775.000
Fixed assets, net of depreciation	216650.000	175400.000	147900.000	161650.000	120400.000
Construction in progress	0.000	0.000	55000.000	0.000	0.000
Current assets	95002.770	95002.770	95002.770	95002.770	95002.770
Cash, bank	2750.000	2750.000	2750.000	2750.000	2750.000
Cash surplus, finance available	1487502.000	1729462.000	1921502.000	2173622.000	2481622.000
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	1801905.000	2002615.000	2222155.000	2433025.000	2699775.000
Equity capital	254000.000	254000.000	254000.000	254000.000	254000.000
Reserves, retained profit	1126575.000	1373005.000	1624515.000	1894855.000	2156525.000
Profit	246430.000	251510.000	270340.000	261670.000	266750.000
Long and medium term debt	152400.000	101600.000	50800.000	0.000	0.000
Current liabilities	22500.000	22500.000	22500.000	22500.000	22500.000
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	174900.000	124100.000	73300.000	22500.000	22500.000
Equity, % of liabilities	14.096	12.683	11.430	10.440	9.408

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Production Unit for Windpumps
10-02-1989
Isolated plant, tax included

1 year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: Dollars

Total initial investment during construction phase

fixed assets:	440400.00	71.617 % foreign
current assets:	0.00	0.000 % foreign
total assets:	440400.00	71.617 % foreign

Source of funds during construction phase

equity & grants:	154000.00	0.000 % foreign
foreign loans :	308000.00	
local loans :	0.00	
total funds :	462000.00	66.667 % foreign

Cashflow from operations

Year:	1	2	4
operating costs:	336250.00	342875.00	367000.00
depreciation :	41250.00	41250.00	41250.00
interest :	37800.00	47800.00	50800.00
production costs	415300.00	431925.00	459050.00
thereof foreign	86.15 %	83.58 %	74.89 %
total sales :	210000.00	318000.00	600000.00
gross income :	-205300.00	-113925.00	140950.00
net income :	-205300.00	-113925.00	140950.00
cash balance :	-14740.97	22304.78	111747.20
net cashflow :	-176941.00	-29895.22	162547.20

Net Present Value at: 10.00 % = 346957.40
Internal Rate of Return: 16.81 %
Return on equity1: 12.86 %
Return on equity2: 22.44 %

Index of Schedules produced by COMFAR

Total initial investment
Total investment during production
Total production costs
Working Capital requirements
Cashflow Tables
Projected Balance
Net income statement
Source of finance

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Cashflow Tables, construction in Dollars

Year	1990
Total cash inflow . .	462000.000
Financial resources .	462000.000
Sales, net of tax . .	0.000
Total cash outflow . .	440400.000
Total assets	425000.000
Operating costs . . .	0.000
Cost of finance . . .	15400.000
Repayment	0.000
Corporate tax . . .	0.000
Dividends paid . . .	0.000
Surplus (deficit) .	21600.000
Cumulated cash balance	21600.000
Inflow, local	154000.000
Outflow, local	125000.000
Surplus (deficit) .	29000.000
Inflow, foreign . . .	308000.000
Outflow, foreign . . .	315400.000
Surplus (deficit) .	-7400.000
Net cashflow	-425000.000
Cumulated net cashflow	-425000.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Cashflow tables, production in Dollars

Year	1991	1992	1993	1994	1995	1996
Total cash inflow . .	427854.200	420635.400	424343.800	601833.300	600000.000	600000.000
Financial resources .	217854.200	102635.400	4343.750	1833.332	0.000	0.000
Sales, net of tax . .	210000.000	318000.000	420000.000	600000.000	600000.000	600000.000
Total cash outflow . .	442595.100	398330.600	433746.500	490086.100	432407.000	498201.700
Total assets	68545.140	7655.623	12946.460	72286.110	-5763.889	-2916.667
Operating costs . . .	336250.000	342875.000	370000.000	367000.000	317000.000	292000.000
Cost of finance . . .	37800.000	47800.000	50800.000	50800.000	50800.000	45720.000
Repayment	0.000	0.000	0.000	0.000	52883.330	52883.340
Corporate tax . . .	0.000	0.000	0.000	0.000	17487.500	110515.000
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	-14740.940	22304.810	-9402.719	111747.200	167593.000	101798.300
Cumulated cash balance	6859.063	29163.880	19761.160	131508.300	299101.400	400899.700
Inflow, local	272437.500	359118.800	422193.800	601500.000	600000.000	600000.000
Outflow, local	59461.800	67146.180	95553.130	112166.700	126487.500	219515.000
Surplus (deficit) .	212975.700	291972.600	326640.600	489333.300	473512.500	380485.000
Inflow, foreign . . .	155416.700	61516.670	2150.000	333.332	0.000	0.000
Outflow, foreign . . .	383133.300	331184.400	338193.300	377919.400	305919.400	278686.700
Surplus (deficit) .	-227716.700	-269667.800	-336043.300	-377586.100	-305919.400	-278686.700
Net cashflow	-176941.000	-29895.210	41397.280	162547.200	269193.000	198318.400
Cumulated net cashflow	-601941.000	-631836.200	-590438.900	-427891.700	-158698.700	39619.700

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Cashflow tables, production in Dollars

Year	1997	1998	1999	2000	2001	2002
Total cash inflow . .	600000.000	600000.000	600000.000	600000.000	600000.000	600000.000
Financial resources .	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax . .	600000.000	600000.000	600000.000	600000.000	600000.000	600000.000
Total cash outflow . .	496495.000	668955.000	491415.000	488875.000	486335.000	483795.000
Total assets	0.000	175000.000	0.000	0.000	0.000	0.000
Operating costs . . .	292000.000	292000.000	292000.000	292000.000	292000.000	292000.000
Cost of finance . . .	40640.000	35560.000	30480.000	25400.000	20320.000	15240.000
Repayment	50800.000	50800.000	50800.000	50800.000	50800.000	50800.000
Corporate tax . . .	113055.000	115595.000	118135.000	120675.000	123215.000	125755.000
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	103505.000	-68955.000	108585.000	111125.000	113665.000	116205.000
Cumulated cash balance	504404.700	435449.700	544034.700	655159.700	768824.700	885029.700
Inflow, local	600000.000	600000.000	600000.000	600000.000	600000.000	600000.000
Outflow, local	222055.000	224595.000	227135.000	229675.000	232215.000	234755.000
Surplus (deficit) .	377945.000	375405.000	372865.000	370325.000	367785.000	365245.000
Inflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, foreign . . .	274440.000	444360.000	264280.000	259200.000	254120.000	249040.000
Surplus (deficit) .	-274440.000	-444360.000	-264280.000	-259200.000	-254120.000	-249040.000
Net cashflow	194945.000	17405.000	189865.000	187325.000	184785.000	182245.000
Cumulated net cashflow	234564.700	251969.700	441934.700	629159.700	813944.700	996189.700

Production Unit for Windpumps --- 10-02-1989

COMFAR 2.1 UNIDO

---------- COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL -----

Cashflow tables, production in Dollars

Year	2003	2004	2005
Total cash inflow . .	600000.000	600000.000	600000.000
Financial resources .	0.000	0.000	0.000
Sales, net of tax . .	600000.000	600000.000	600000.000
Total cash outflow . .	543130.000	478715.000	425375.000
Total assets	55000.000	0.000	0.000
Operating costs . . .	292000.000	292000.000	292000.000
Cost of finance . . .	10160.000	5080.000	0.000
Repayment	50800.000	50800.000	0.000
Corporate tax . . .	135170.000	130835.000	133375.000
Dividends paid . . .	0.000	0.000	0.000
Surplus (deficit) .	56870.000	121285.000	174625.000
Cumulated cash balance	941899.700	1063185.000	1237810.000
Inflow, local	600000.000	600000.000	600000.000
Outflow, local	244170.000	239835.000	242375.000
Surplus (deficit) .	355830.000	360165.000	357625.000
Inflow, foreign . . .	0.000	0.000	0.000
Outflow, foreign . . .	298960.000	238880.000	183000.000
Surplus (deficit) .	-298960.000	-238880.000	-183000.000
Net cashflow	117830.000	177165.000	174625.000
Cumulated net cashflow	1114020.000	1291185.000	1465810.000

COMFAR 2.1 UNIDO

---------- COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL -----

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value	109733.10	at	10.00 %
Internal Rate of Return (IRRE1) ..	12.86 %		

b) Net Worth versus Net cash return:

Net present value	301114.50	at	10.00 %
Internal Rate of Return (IRRE2) ..	22.44 %		

c) Internal Rate of Return on total investment:

Net present value	346957.40	at	10.00 %
Internal Rate of Return (IRR) ..	16.81 %		

Net Worth = Equity paid plus reserves

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Net Income Statement in Dollars

Year	1991	1992	1993	1994	1995
Total sales, incl. sales tax	210000.000	318000.000	420000.000	600000.000	600000.000
Less: variable costs, incl. sales tax.	84000.000	127200.000	168000.000	240000.000	240000.000
Variable margin	126000.000	190800.000	252000.000	360000.000	360000.000
As Z of total sales	60.000	60.000	60.000	60.000	60.000
Non-variable costs, incl. depreciation	293500.000	256925.000	243250.000	168250.000	118250.000
Operational margin	-167500.000	-66125.000	8750.000	191750.000	241750.000
As Z of total sales	-79.762	-20.794	2.083	31.958	40.292
Cost of finance	37800.000	47800.000	50800.000	50800.000	50800.000
Gross profit	-205300.000	-113925.000	-42050.000	140950.000	190950.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	-64350.000	0.000	0.000	0.000	34975.000
Tax	0.000	0.000	0.000	0.000	17487.500
Net profit	-205300.000	-113925.000	-42050.000	140950.000	173462.500
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	-205300.000	-113925.000	-42050.000	140950.000	173462.500
Accumulated undistributed profit	-205300.000	-319225.000	-361275.000	-220325.000	-46862.500
Gross profit, Z of total sales	-97.762	-35.825	-10.012	23.492	31.825
Net profit, Z of total sales	-97.762	-35.825	-10.012	23.492	28.910
ROE, Net profit, Z of equity	-95.935	-44.852	-16.555	55.492	68.292
ROI, Net profit+interest, Z of invest.	-35.212	-13.756	1.788	34.255	40.329

Production Unit for Windpumps --- 10-02-1989

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Net Income Statement in Dollars

Year	1996	1997	1998	1999	2000
Total sales, incl. sales tax	600000.000	600000.000	600000.000	600000.000	600000.000
Less: variable costs, incl. sales tax.	240000.000	240000.000	240000.000	240000.000	240000.000
Variable margin	360000.000	360000.000	360000.000	360000.000	360000.000
As % of total sales	60.000	60.000	60.000	60.000	60.000
Non-variable costs, incl. depreciation	93250.000	93250.000	93250.000	93250.000	93250.000
Operational margin	266750.000	266750.000	266750.000	266750.000	266750.000
As % of total sales	44.458	44.458	44.458	44.458	44.458
Cost of finance	45720.000	40640.000	35560.000	30480.000	25400.000
Gross profit	221030.000	226110.000	231190.000	236270.000	241350.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	221030.000	226110.000	231190.000	236270.000	241350.000
Tax	110515.000	113055.000	115595.000	118135.000	120675.000
Net profit	110515.000	113055.000	115595.000	118135.000	120675.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	110515.000	113055.000	115595.000	118135.000	120675.000
Accumulated undistributed profit	63652.500	176707.500	292302.500	410437.500	531112.500
Gross profit, % of total sales	36.838	37.685	38.532	39.378	40.225
Net profit, % of total sales	18.419	18.843	19.266	19.689	20.112
ROE, Net profit, % of equity	43.510	44.510	45.510	46.510	47.510
ROI, Net profit+interest, % of invest.	28.138	27.680	20.699	20.351	20.003

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Net Income Statement in Dollars

Year	2001	2002	2003	2004	2005
Total sales, incl. sales tax	600000.000	600000.000	600000.000	600000.000	600000.000
Less: variable costs, incl. sales tax.	240000.000	240000.000	240000.000	240000.000	240000.000
Variable margin	360000.000	360000.000	360000.000	360000.000	360000.000
As % of total sales	60.000	60.000	60.000	60.000	60.000
Non-variable costs, incl. depreciation	93250.000	93250.000	79500.000	93250.000	93250.000
Operational margin	266750.000	266750.000	280500.000	266750.000	266750.000
As % of total sales	44.458	44.458	46.750	44.458	44.458
Cost of finance	20320.000	15240.000	10160.000	5080.000	0.000
Gross profit	246430.000	251510.000	270340.000	261670.000	266750.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	246430.000	251510.000	270340.000	261670.000	266750.000
Tax	123215.000	125755.000	135170.000	130835.000	133375.000
Net profit	123215.000	125755.000	135170.000	130835.000	133375.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	123215.000	125755.000	135170.000	130835.000	133375.000
Accumulated undistributed profit	654327.500	780082.500	915252.500	1046088.000	1179463.000
Gross profit, % of total sales	41.072	41.918	45.057	43.612	44.458
Net profit, % of total sales	20.536	20.959	22.528	21.806	22.229
ROE, Net profit, % of equity	48.510	49.510	53.217	51.510	52.510
ROI, Net profit+interest, % of invest.	19.656	19.308	18.507	17.308	16.985

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Windpumps, EMEL
02-03-1989
EMEL2

1 year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: Dollars

Total initial investment during construction phase

fixed assets:	353000.00	71.671 % foreign
current assets:	0.00	0.000 % foreign
total assets:	353000.00	71.671 % foreign

Source of funds during construction phase

equity & grants:	130000.00	0.000 % foreign
foreign loans :	260000.00	
local loans :	0.00	
total funds :	390000.00	66.667 % foreign

Cashflow from operations

Year:	1	2	4
operating costs:	283250.00	264875.00	315000.00
depreciation :	40000.00	40000.00	40000.00
interest :	31000.00	36000.00	36000.00
production costs	354250.00	340875.00	391000.00
thereof foreign	84.97 %	80.44 %	73.91 %
total sales :	210000.00	318000.00	600000.00
gruss income :	-144250.00	-22875.00	209000.00
net income :	-144250.00	-22875.00	209000.00
cash balance :	1170.13	12938.13	93866.66
net cashflow :	-117829.90	48938.13	165866.70

Net Present Value at: 10.00 % = 1168160.00
Internal Rate of Return: 32.71 %
Return on equity1: 36.62 %
Return on equity2: 48.09 %

Index of Schedules produced by COMFAR

Total initial investment	Cashflow Tables
Total investment during production	Projected Balance
Total production costs	Net income statement
Working Capital requirements	Source of finance

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Total Initial Investment in Dollars

Year	1990
Fixed investment costs	
Land, site preparation, development	0.000
Buildings and civil works	200000.000
Auxiliary and service facilities	100000.000
Incorporated fixed assets	0.000
Plant machinery and equipment	40000.000
Total fixed investment costs	340000.000
Pre-production capital expenditures	13000.000
Net working capital	0.000
Total initial investment costs	353000.000
Of it foreign, in %	71.671

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Total Current Investment in Dollars

Year	1991	1992	1993	1994	1995
Fixed investment costs					
Land, site preparation, development	0.000	0.000	0.000	0.000	0.000
Buildings and civil works	0.000	0.000	0.000	0.000	0.000
Auxiliary and service facilities	0.000	0.000	0.000	100000.000	0.000
Incorporated fixed assets	0.000	0.000	0.000	0.000	0.000
Plant, machinery and equipment	0.000	0.000	0.000	0.000	0.000
Total fixed investment costs	0.000	0.000	0.000	100000.000	0.000
Preproduction capitals expenditures.	0.000	0.000	0.000	0.000	0.000
Working capital	44579.860	4186.876	8283.262	19133.330	-1972.219
Total current investment costs	44579.860	4186.876	8283.262	119133.300	-1972.219
Of it foreign, %	87.982	67.698	79.062	98.601	0.000

Windpumps, ENEL --- 02-03-1989

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Total Current Investment in Dollars

Year	1996-97	1998	1999-2002	2003
Fixed investment costs				
Land, site preparation, development	0.000	0.000	0.000	0.000
Buildings and civil works	0.000	0.000	0.000	0.000
Auxiliary and service facilities	0.000	100000.000	0.000	100000.000
Incorporated fixed assets	0.000	0.000	0.000	0.000
Plant, machinery and equipment	0.000	40000.000	0.000	0.000
Total fixed investment costs	0.000	140000.000	0.000	100000.000
Preproduction capitals expenditures.	0.000	0.000	0.000	0.000
Working capital	0.000	0.000	0.000	0.000
Total current investment costs	0.000	140000.000	0.000	100000.000
Of it foreign, %	0.000	100.000	0.000	100.000

Windpumps, ENEL --- 02-03-1989

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Total Production Costs in Dollars

Year	1991	1992	1993	1994	1995
% of nom. capacity (single product).	35.000	53.000	70.000	100.000	100.000
Raw material 1	56750.000	83474.990	119000.000	170000.000	170000.000
Other raw materials	28000.000	21200.000	14000.000	20000.000	20000.000
Utilities	2000.000	2500.000	3000.000	3000.000	3000.000
Energy	0.000	0.000	0.000	0.000	0.000
Labour, direct	10500.000	21200.000	35000.000	50000.000	50000.000
Repair, maintenance	0.000	0.000	0.000	0.000	0.000
Spares	2000.000	2500.000	3000.000	3000.000	3000.000
Factory overheads	115000.000	90000.000	65000.000	40000.000	15000.000
Factory costs	214250.000	220875.000	239000.000	286000.000	261000.000
Administrative overheads	69000.000	44000.000	29000.000	29000.000	19000.000
Indir. costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	40000.000	40000.000	40000.000	40000.000	40000.000
Financial costs	31000.000	36000.000	36000.000	36000.000	32400.000
Total production costs	354250.000	340875.000	344000.000	391000.000	352400.000
Costs per unit (single product)	10121.430	6431.604	4914.286	3910.000	3524.000
Of it foreign, %	84.968	90.440	75.581	73.913	71.056
Of it variable,%	23.712	37.316	48.937	61.381	68.104
Total labour	79500.000	65200.000	64000.000	79000.000	69000.000

COMFAR 2.1 UNIDO

Total Production Costs in Dollars

Year	1996	1997	1998	1999	2000
% of nom. capacity (single product).	100.000	100.000	100.000	100.000	100.000
Raw material 1	170000.000	170000.000	170000.000	170000.000	170000.000
Other raw materials	20000.000	20000.000	20000.000	20000.000	20000.000
Utilities	3000.000	3000.000	3000.000	3000.000	3000.000
Energy	0.000	0.000	0.000	0.000	0.000
Labour, direct	50000.000	50000.000	50000.000	50000.000	50000.000
Repair, maintenance	0.000	0.000	0.000	0.000	0.000
Spares	3000.000	3000.000	3000.000	3000.000	3000.000
Factory overheads	15000.000	15000.000	15000.000	15000.000	15000.000
Factory costs	261000.000	261000.000	261000.000	261000.000	261000.000
Administrative overheads	19000.000	19000.000	19000.000	19000.000	19000.000
Indir. costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	40000.000	40000.000	40000.000	40000.000	40000.000
Financial costs	28800.000	25200.000	21600.000	18000.000	14400.000
Total production costs	348800.000	345200.000	341600.000	338000.000	334400.000
Costs per unit (single product)	3488.000	3452.000	3416.000	3380.000	3344.000
Of it foreign, %	70.757	70.452	70.141	69.822	69.498
Of it variable,%	68.807	69.525	70.258	71.006	71.770
Total labour	69000.000	69000.000	69000.000	69000.000	69000.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Total Production Costs in Dollars

Year	2001	2002	2003	2004- 5
% of nom. capacity (single product).	100.000	100.000	100.000	100.000
Raw material 1	170000.000	170000.000	170000.000	170000.000
Other raw materials	20000.000	20000.000	20000.000	20000.000
Utilities	3000.000	3000.000	3000.000	3000.000
Energy	0.000	0.000	0.000	0.000
Labour, direct	50000.000	50000.000	50000.000	50000.000
Repair, maintenance	0.000	0.000	0.000	0.000
Spares	3000.000	3000.000	3000.000	3000.000
Factory overheads	15000.000	15000.000	15000.000	15000.000
Factory costs	261000.000	261000.000	261000.000	261000.000
Administrative overheads	19000.000	19000.000	19000.000	19000.000
Indir. costs, sales and distribution	0.000	0.000	0.000	0.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000
Depreciation	40000.000	40000.000	15000.000	40000.000
Financial costs	10800.000	7200.000	3600.000	0.000
Total production costs	330800.000	327200.000	298600.000	320000.000
Costs per unit (single product)	3308.000	3272.000	2986.000	3200.000
Of it foreign, %	69.166	68.826	65.841	68.125
Of it variable,%	72.551	73.350	80.375	75.000
Total labour	69000.000	69000.000	69000.000	69000.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Net Working Capital in Dollars

Year			1991	1992	1993	1994	1995
Coverage	adc	coto					
Current assets &							
Accounts receivable	30	12.0	23604.170	22072.920	22333.330	26250.000	23333.330
Inventory and materials	116	3.1	28458.330	34854.160	43916.670	62416.670	62416.670
Energy	0	---	0.000	0.000	0.000	0.000	0.000
Spares	360	1.0	2000.000	2500.000	3000.000	3000.000	3000.000
Work in progress	2	170.2	920.139	1087.708	1330.556	1661.111	1591.667
Finished products	4	92.5	1993.056	2277.639	2719.444	3300.000	3202.778
Cash in hand	10	36.0	5458.333	4380.556	3666.667	3388.889	2416.667
Total current assets			62434.030	67172.980	76966.660	100016.700	95961.110
Current liabilities and							
Accounts payable	30	12.0	17854.170	18406.250	19916.670	23833.330	21750.000
Net working capital			44579.860	48766.730	57050.000	76183.340	74211.110
Increase in working capital			44579.860	4186.875	8283.262	19133.340	-1972.227
Net working capital, local			5357.639	6710.069	8444.444	10111.110	10111.110
Net working capital, foreign			39222.220	42056.670	48605.550	66072.220	64100.000

Note: adc = minimum days of coverage ; coto = coefficient of turnover .

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Net Working Capital in Dollars

Year			1996-2005
Coverage	adc	coto	
Current assets &			
Accounts receivable	30	12.0	23333.330
Inventory and materials	116	3.1	62416.670
Energy	0	---	0.000
Spares	360	1.0	3000.000
Work in progress	2	170.2	1591.667
Finished products	4	92.5	3202.778
Cash in hand	10	36.0	2416.667
Total current assets			95961.110
Current liabilities and			
Accounts payable	30	12.0	21750.000
Net working capital			74211.110
Increase in working capital			0.000
Net working capital, local			10111.110
Net working capital, foreign			64100.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Source of Finance, construction in Dollars

Year	1990
Equity, ordinary ..	130000.000
Equity, preference.	0.000
Subsidies, grants .	0.000
Loan A, foreign .	260000.000
Loan B, foreign..	0.000
Loan C, foreign .	0.000
Loan A, local....	0.000
Loan B, local....	0.000
Loan C, local....	0.000
Total loan	260000.000
Current liabilities	0.000
Bank overdraft	0.000
Total funds	390000.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Source of Finance, production in Dollars

Year	1991	1992	1993	1994	1995	1996-2003
Equity, ordinary ..	50000.000	0.000	0.000	0.000	0.000	0.000
Equity, preference.	0.000	0.000	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, foreign .	100000.000	0.000	0.000	-36000.000	-36000.000	-36000.000
Loan B, foreign..	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, local....	0.000	0.000	0.000	0.000	0.000	0.000
Loan B, local....	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, local....	0.000	0.000	0.000	0.000	0.000	0.000
Total loan	100000.000	0.000	0.000	-36000.000	-36000.000	-36000.000
Current liabilities	17854.170	552.083	1510.417	3916.667	-2083.334	0.000
Bank overdraft	0.000	0.000	0.000	0.000	0.000	0.000
Total funds	167854.200	552.083	1510.417	-32083.330	-38083.340	-36000.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Cashflow Tables, construction in Dollars

Year	1990
Total cash inflow . .	390000.000
Financial resources .	390000.000
Sales, net of tax . .	0.000
Total cash outflow . .	353000.000
Total assets	340000.000
Operating costs . . .	0.000
Cost of finance . . .	13000.000
Repayment	0.000
Corporate tax . . .	0.000
Dividends paid . . .	0.000
Surplus (deficit) .	37000.000
Cumulated cash balance	37000.000
Inflow, local	130000.000
Outflow, local	100000.000
Surplus (deficit) .	30000.000
Inflow, foreign . . .	260000.000
Outflow, foreign . . .	253000.000
Surplus (deficit) .	7000.000
Net cashflow	-340000.000
Cumulated net cashflow	-340000.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Cashflow tables, production in Dollars

Year	1991	1992	1993	1994	1995	1996
Total cash inflow	377854.200	319118.800	421510.400	603916.700	600000.000	600000.000
Financial resources	167854.200	1118.750	1510.417	3916.667	0.000	0.000
Sales, net of tax	210000.000	318000.000	420000.000	600000.000	600000.000	600000.000
Total cash outflow	376684.000	306180.600	313793.700	510050.000	346427.800	344800.000
Total assets	62434.030	4738.956	9793.681	123050.000	-4055.555	0.000
Operating costs	283250.000	264875.000	268000.000	315000.000	280000.000	280000.000
Cost of finance	31000.000	36000.000	36000.000	36000.000	32400.000	28800.000
Repayment	0.000	566.667	0.000	36000.000	38083.340	36000.000
Corporate tax	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	1170.125	12938.130	107716.700	93866.690	253572.200	255200.000
Cumulated cash balance	38170.130	51108.250	158825.000	252691.700	506263.900	761463.900
Inflow, local	262437.500	319118.800	421443.800	601500.000	600000.000	600000.000
Outflow, local	56045.140	64146.180	82178.130	100166.700	97000.000	97000.000
Surplus (deficit)	206392.400	254972.600	339265.600	501333.300	503000.000	503000.000
Inflow, foreign	115416.700	0.000	66.667	2416.667	0.000	0.000
Outflow, foreign	320638.900	242034.400	231615.600	409883.300	249427.800	247800.000
Surplus (deficit)	-205222.200	-242034.400	-231548.900	-407466.700	-249427.800	-247800.000
Net cashflow	-117829.900	48938.110	143716.700	165866.700	321972.200	320000.000
Cumulated net cashflow	-457829.900	-408891.800	-265175.000	-99308.330	222663.900	542663.900

COMFAR 2.1 UNIDO

Cashflow tables, production in Dollars

Year	1997	1998	1999	2000	2001	2002
Total cash inflow	600000.000	600000.000	600000.000	600000.000	600000.000	600000.000
Financial resources	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax	600000.000	600000.000	600000.000	600000.000	600000.000	600000.000
Total cash outflow	341200.000	477600.000	334000.000	330400.000	326800.000	323200.000
Total assets	0.000	140000.000	0.000	0.000	0.000	0.000
Operating costs	280000.000	280000.000	280000.000	280000.000	280000.000	280000.000
Cost of finance	25200.000	21600.000	18000.000	14400.000	10800.000	7200.000
Repayment	36000.000	36000.000	36000.000	36000.000	36000.000	36000.000
Corporate tax	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	258800.000	122400.000	266000.000	269600.000	273200.000	276800.000
Cumulated cash balance	1020264.000	1142664.000	1408664.000	1678264.000	1951464.000	2228264.000
Inflow, local	600000.000	600000.000	600000.000	600000.000	600000.000	600000.000
Outflow, local	97000.000	97000.000	97000.000	97000.000	97000.000	97000.000
Surplus (deficit)	503000.000	503000.000	503000.000	503000.000	503000.000	503000.000
Inflow, foreign	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, foreign	244200.000	380600.000	237000.000	233400.000	229800.000	226200.000
Surplus (deficit)	-244200.000	-380600.000	-237000.000	-233400.000	-229800.000	-226200.000
Net cashflow	320000.000	180000.000	320000.000	320000.000	320000.000	320000.000
Cumulated net cashflow	862663.900	1042664.000	1362664.000	1682664.000	2002664.000	2322664.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Cashflow tables, production in Dollars

Year	2003	2004	2005
Total cash inflow	600000.000	600000.000	600000.000
Financial resources	0.000	0.000	0.000
Sales, net of tax	600000.000	600000.000	600000.000
Total cash outflow	419600.000	280000.000	280000.000
Total assets	100000.000	0.000	0.000
Operating costs	280000.000	280000.000	280000.000
Cost of finance	3600.000	0.000	0.000
Repayment	36000.000	0.000	0.000
Corporate tax	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000
Surplus (deficit)	180400.000	320000.000	320000.000
Cumulated cash balance	2408664.000	2728664.000	3048664.000
Inflow, local	600000.000	600000.000	600000.000
Outflow, local	97000.000	97000.000	97000.000
Surplus (deficit)	503000.000	503000.000	503000.000
Inflow, foreign	0.000	0.000	0.000
Outflow, foreign	322600.000	183000.000	183000.000
Surplus (deficit)	-322600.000	-183000.000	-183000.000
Net cashflow	220000.000	320000.000	320000.000
Cumulated net cashflow	2542664.000	2862664.000	3182664.000

Cashflow Discounting:

a) Equity paid versus Net income flow:
Net present value .....1044044.00 at 10.00 %
Internal Rate of Return (IRRE1) .. 36.62 %
b) Net Worth versus Net cash return:
Net present value .....1113614.00 at 10.00 %
Internal Rate of Return (IRRE2) .. 48.09 %
c) Internal Rate of Return on total investment:
Net present value .....1168160.00 at 10.00 %
Internal Rate of Return (IRR) .. 32.71 %
Net Worth = Equity paid plus reserves

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Net Income Statement in Dollars

Year	1991	1992	1993	1994	1995
Total sales, incl. sales tax	210000.000	318000.000	420000.000	600000.000	600000.000
Less: variable costs, incl. sales tax.	84000.000	127200.000	168000.000	240000.000	240000.000
Variable margin	126000.000	190800.000	252000.000	360000.000	360000.000
As % of total sales	60.000	60.000	60.000	60.000	60.000
Non-variable costs, incl. depreciation	239250.000	177675.000	140000.000	115000.000	80000.000
Operational margin	-113250.000	13125.000	112000.000	245000.000	280000.000
As % of total sales	-53.929	4.127	26.667	40.833	46.667
Cost of finance	31000.000	36000.000	36000.000	36000.000	32400.000
Gross profit	-144250.000	-22875.000	76000.000	209000.000	247600.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	-144250.000	-22875.000	76000.000	209000.000	247600.000
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	-144250.000	-22875.000	76000.000	209000.000	247600.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	-144250.000	-22875.000	76000.000	209000.000	247600.000
Accumulated undistributed profit	-144250.000	-167125.000	-91125.000	117875.000	365475.000
Gross profit, % of total sales	-68.690	-7.193	18.095	34.833	41.267
Net profit, % of total sales	-68.690	-7.193	18.095	34.833	41.267
ROE, Net profit, % of equity	-80.139	-12.708	42.222	116.111	137.556
ROI, Net profit+interest, % of invest.	-29.446	3.376	28.208	47.464	54.452

Windpumps, EMEL --- 02-03-1989

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Net Income Statement in Dollars

Year	1996	1997	1998	1999	2000
Total sales, incl. sales tax	600000.000	600000.000	600000.000	600000.000	600000.000
Less: variable costs, incl. sales tax.	240000.000	240000.000	240000.000	240000.000	240000.000
Variable margin	360000.000	360000.000	360000.000	360000.000	360000.000
As % of total sales	60.000	60.000	60.000	60.000	60.000
Non-variable costs, incl. depreciation	80000.000	80000.000	80000.000	80000.000	80000.000
Operational margin	280000.000	280000.000	280000.000	280000.000	280000.000
As % of total sales	46.667	46.667	46.667	46.667	46.667
Cost of finance	28800.000	25200.000	21600.000	18000.000	14400.000
Gross profit	251200.000	254800.000	258400.000	262000.000	265600.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	251200.000	254800.000	258400.000	262000.000	265600.000
Tax	0.000	0.000	0.000	0 000	0.000
Net profit	251200.000	254800.000	258400.000	262000.000	265600.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	251200.000	254800.000	258400.000	262000.000	265600.000
Accumulated undistributed profit	616675.000	871475.000	1129875.000	1391875.000	1657475 000
Gross profit, % of total sales	41.867	42.467	43.067	43.667	44.267
Net profit, % of total sales	41.867	42.467	43.067	43.667	44.267
ROE, Net profit, % of equity	139.556	141.556	143.556	145.556	147.556
ROI, Net profit+interest, % of invest.	54.452	54.452	42.800	42.800	42.800

Net Income Statement in Dollars

Year	2001	2002	2003	2004	2005
Total sales, incl. sales tax	600000.000	600000.000	600000.000	600000.000	600000.000
Less: variable costs, incl. sales tax.	240000.000	240000.000	240000.000	240000.000	240000.000
Variable margin	360000.000	360000.000	360000.000	360000.000	360000.000
As % of total sales	60.000	60.000	60.000	60.000	60.000
Non-variable costs, incl. depreciation	80000.000	80000.000	55000.000	80000.000	80000.000
Operational margin	280000.000	280000.000	305000.000	280000.000	280000.000
As % of total sales	46.667	46.667	50.833	46.667	46.667
Cost of finance	10800.000	7200.000	3600.000	0.000	0.000
Gross profit	269200.000	272800.000	301400.000	280000.000	280000.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	269200.000	272800.000	301400.000	280000.000	280000.000
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	269200.000	272800.000	301400.000	280000.000	280000.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	269200.000	272800.000	301400.000	280000.000	280000.000
Accumulated undistributed profit	1926675.000	2199475.000	2500875.000	2780875.000	3060875.000
Gross profit, % of total sales	44.867	45.467	50.233	46.667	46.667
Net profit, % of total sales	44.867	45.467	50.233	46.667	46.667
ROE, Net profit, % of equity	149.556	151.556	167.444	155.556	155.556
ROI, Net profit+interest, % of invest.	42.800	42.800	40.440	37.125	37.125

Windpumps, ENEL --- 02-03-1989

Projected Balance Sheets, construction in Dollars

Year	1990
Total assets	390000.000
Fixed assets, net of depreciation	0.000
Construction in progress	353000.000
Current assets	0.000
Cash, bank	0.000
Cash surplus, finance available	37000.000
Loss carried forward	0.000
Loss	0.000
Total liabilities	390000.000
Equity capital	130000.000
Reserves, retained profit	0.000
Profit	0.000
Long and medium term debt	260000.000
Current liabilities	0.000
Bank overdraft, finance required	0.000
Total debt	260000.000
Equity, % of liabilities	33.333

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Projected Balance Sheets, Production in Dollars

Year	1991	1992	1993	1994	1995
Total assets	557854.200	558406.300	635916.700	736833.300	855225.000
Fixed assets, net of depreciation	313000.000	273000.000	233000.000	193000.000	253000.000
Construction in progress	0.000	0.000	0.000	100000.000	0.000
Current assets	56975.700	62792.430	73300.000	96627.770	93544.440
Cash, bank	5458.333	4380.556	3666.667	3388.889	2416.667
Cash surplus, finance available	38170.160	51108.250	158825.000	252691.700	506263.900
Loss carried forward	0.000	144250.000	167125.000	91125.000	0.000
Loss	144250.000	22875.000	0.000	0.000	0.000
Total liabilities	557854.200	558406.300	635916.700	736833.300	855225.000
Equity capital	180000.000	180000.000	180000.000	180000.000	180000.000
Reserves, retained profit	0.000	0.000	0.000	0.000	117875.000
Profit	0.000	0.000	76000.000	209000.000	247600.000
Long and medium term debt	360000.000	360000.000	360000.000	324000.000	288000.000
Current liabilities	17854.170	18406.250	19916.670	23833.340	21750.000
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	377854.200	378406.300	379916.700	347833.300	309750.000
Equity, % of liabilities	32.266	32.235	28.306	24.429	21.047

Windpumps, EMEL --- 02-03-1989

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Projected Balance Sheets, Production in Dollars

Year	1996	1997	1998	1999	2000
Total assets	1070425.000	1289225.000	1511625.000	1737625.000	1967225.000
Fixed assets, net of depreciation	213000.000	173000.000	133000.000	233000.000	193000.000
Construction in progress	0.000	0.000	140000.000	0.000	0.000
Current assets	93544.440	93544.440	93544.440	93544.440	93544.440
Cash, bank	2416.667	2416.667	2416.667	2416.667	2416.667
Cash surplus, finance available	761463.900	1020264.000	1142664.000	1408664.000	1678264.000
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	1070425.000	1289225.000	1511625.000	1737625.000	1967225.000
Equity capital	180000.000	180000.000	180000.000	180000.000	180000.000
Reserves, retained profit	365475.000	616675.000	871475.000	1129875.000	1391875.000
Profit	251200.000	254800.000	258400.000	262000.000	265600.000
Long and medium term debt	252000.000	216000.000	180000.000	144000.000	108000.000
Current liabilities	21750.000	21750.000	21750.000	21750.000	21750.000
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	273750.000	237750.000	201750.000	165750.000	129750.000
Equity, % of liabilities	16.816	13.962	11.908	10.359	9.150

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Projected Balance Sheets, Production in Dollars

Year	2001	2002	2003	2004	2005
Total assets	2200425.000	2437225.000	2702625.000	2982625.000	3262625.000
Fixed assets, net of depreciation	153000.000	113000.000	98000.000	158000.000	118000.000
Construction in progress	0.000	0.000	100000.000	0.000	0.000
Current assets	93544.440	93544.440	93544.440	93544.440	93544.440
Cash, bank	2416.667	2416.667	2416.667	2416.667	2416.667
Cash surplus, finance available	1951464.000	2228264.000	2408664.000	2728664.000	3048664.000
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	2200425.000	2437225.000	2702625.000	2982625.000	3262625.000
Equity capital	180000.000	180000.000	180000.000	180000.000	180000.000
Reserves, retained profit	1657475.000	1926675.000	2199475.000	2500875.000	2780875.000
Profit	269200.000	272800.000	301400.000	280000.000	280000.000
Long and medium term debt	72000.000	36000.000	0.000	0.000	0.000
Current liabilities	21750.000	21750.000	21750.000	21750.000	21750.000
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	93750.000	57750.000	21750.000	21750.000	21750.000
Equity, % of liabilities	8.180	7.385	6.660	6.035	5.517

Windpumps, ENEL --- 02-03-1989

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Windpumps, METAFUS
07-03-1989
METAFUS2

1 year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit = 1.0000 units accounting currency
local currency 1 unit = 1.0000 units accounting currency
accounting currency: Dollars

Total initial investment during construction phase

fixed assets:	300000.00	75.000 % foreign
current assets:	0.00	0.000 % foreign
total assets:	300000.00	75.000 % foreign

Source of funds during construction phase

equity & grants:	100000.00	0.000 % foreign
foreign loans :	200000.00	
local loans :	0.00	
total funds :	300000.00	66.667 % foreign

Cashflow from operations

Year:	1	2	4
operating costs:	283250.00	264875.00	315000.00
depreciation :	30000.00	30000.00	30000.00
interest :	25000.00	30000.00	30000.00
production costs	338250.00	324875.00	375000.00
thereof foreign	84.63 %	79.86 %	73.13 %
total sales :	210000.00	318000.00	600000.00
gross income :	-128250.00	-6875.00	225000.00
net income :	-128250.00	-6875.00	225000.00
cash balance :	7170.13	18938.13	165866.70
net cashflow :	-117829.90	48938.13	225366.70

Net Present Value at: 10.00 % = 1273800.00
Internal Rate of Return: 36.81 %
Return on equity1: 43.49 %
Return on equity2: 59.57 %

Index of Schedules produced by COMFAR

Total initial investment
Total investment during production
Total production costs
Working Capital requirements
Cashflow Tables
Projected Balance
Net income statement
Source of finance

COMFAR 2.1 UNIDO

Total Initial Investment in Dollars

Year	1990
Fixed investment costs	
Land, site preparation, development	0.000
Buildings and civil works	150000.000
Auxiliary and service facilities	40000.000
Incorporated fixed assets	0.000
Plant machinery and equipment	100000.000
Total fixed investment costs	290000.000
Pre-production capital expenditures	10000.000
Net working capital	0.000
Total initial investment costs	300000.000
Of it foreign, in %	75.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Total Current Investment in Dollars

Year	1991	1992	1993	1994	1995
Fixed investment costs					
Land, site preparation, development	0.000	0.000	0.000	0.000	0.000
Buildings and civil works	0.000	0.000	0.000	0.000	0.000
Auxiliary and service facilities	0.000	0.000	0.000	40000.000	0.000
Incorporated fixed assets	0.000	0.000	0.000	0.000	0.000
Plant, machinery and equipment	0.000	0.000	0.000	0.000	0.000
Total fixed investment costs	0.000	0.000	0.000	40000.000	0.000
Preproduction capitals expenditures.	0.000	0.000	0.000	0.000	0.000
Working capital	44579.860	4186.876	8283.262	19133.330	-1972.219
Total current investment costs	44579.860	4186.876	8283.262	59133.330	-1972.219
Of it foreign, %	87.982	67.698	79.062	97.182	0.000

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Total Current Investment in Dollars

Year	1996-97	1998	1999-2002	2003
Fixed investment costs				
Land, site preparation, development	0.000	0.000	0.000	0.000
Buildings and civil works	0.000	0.000	0.000	0.000
Auxiliary and service facilities	0.000	40000.000	0.000	40000.000
Incorporated fixed assets	0.000	0.000	0.000	0.000
Plant, machinery and equipment	0.000	100000.000	0.000	0.000
Total fixed investment costs	0.000	140000.000	0.000	40000.000
Preproduction capitals expenditures.	0.000	0.000	0.000	0.000
Working capital	0.000	0.000	0.000	0.000
Total current investment costs	0.000	140000.000	0.000	40000.000
Of it foreign, %	0.000	100.000	0.000	100.000

Total Production Costs in Dollars

Year	1991	1992	1993	1994	1995
% of nom. capacity (single product).	35.000	53.000	70.000	100.000	100.000
Raw material 1	56750.000	83474.990	119000.000	170000.000	170000.000
Other raw materials	28000.000	21200.000	14000.000	20000.000	20000.000
Utilities	2000.000	2500.000	3000.000	3000.000	3000.000
Energy	0.000	0.000	0.000	0.000	0.000
Labour, direct	10500.000	21200.000	35000.000	50000.000	50000.000
Repair, maintenance	0.000	0.000	0.000	0.000	0.000
Spares	2000.000	2500.000	3000.000	3000.000	3000.000
Factory overheads	115000.000	90000.000	65000.000	40000.000	15000.000
Factory costs	214250.000	220875.000	239000.000	286000.000	261000.000
Administrative overheads	69000.000	44000.000	29000.000	29000.000	19000.000
Indir. costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Direct costs, sales and distribution	0.000	000	0.000	0.000	0.000
Depreciation	30000.000	30000.000	30000.000	30000.000	30000.000
Financial costs	25000.000	30000.000	30000.000	30000.000	27000.000
Total production costs	338250.000	324875.000	328000.000	375000.000	337000.000
Costs per unit (single product)	9664.286	6129.717	4685.714	3750.000	3370.000
If it foreign, %	84.627	79.861	74.771	73.133	70.104
If it variable,%	24.834	39.154	51.220	64.000	71.217
Total labour	79500.000	65200.000	64000.000	79000.000	69000.000

COMFAR 2.1 UNIDO

Total Production Costs in Dollars

Year	1996	1997	1998	1999	2000
% of nom. capacity (single product).	100.000	100.000	100.000	100.000	100.000
Raw material 1	170000.000	170000.000	170000.000	170000.000	170000.000
Other raw materials	20000.000	20000.000	20000.000	20000.000	20000.000
Utilities	3000.000	3000.000	3000.000	3000.000	3000.000
Energy	0.000	0.000	0.000	0.000	0.000
Labour, direct	50000.000	50000.000	50000.000	50000.000	50000.000
Repair, maintenance	0.000	0.000	0.000	0.000	0.000
Spares	3000.000	3000.000	3000.000	3000.000	3000.000
Factory overheads	15000.000	15000.000	15000.000	15000.000	15000.000
Factory costs	261000.000	261000.000	261000.000	261000.000	261000.000
Administrative overheads	19000.000	19000.000	19000.000	19000.000	19000.000
Indir. costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	30000.000	30000.000	30000.000	30000.000	30000.000
Financial costs	24000.000	21000.000	18000.000	15000.000	12000.000
Total production costs	334000.000	331000.000	328000.000	325000.000	322000.000
Costs per unit (single product)	3340.000	3310.000	3280.000	3250.000	3220.000
Of it foreign, %	69.835	69.562	69.284	69.000	68.711
Of it variable,%	71.856	72.508	73.171	73.846	74.534
Total labour	69000.000	69000.000	69000.000	69000.000	69000.000

COMFAR 2.1 UNIDO

Total Production Costs in Dollars

Year	2001	2002	2003	2004- 5
% of nom. capacity (single product).	100.000	100.000	100.000	100.000
Raw material 1	170000.000	170000.000	170000.000	170000.000
Other raw materials	20000.000	20000.000	20000.000	20000.000
Utilities	3000.000	3000.000	3000.000	3000.000
Energy	0.000	0.000	0.000	0.000
Labour, direct	50000.000	50000.000	50000.000	50000.000
Repair, maintenance	0.000	0.000	0.000	0.000
Spares	3000.000	3000.000	3000.000	3000.000
Factory overheads	15000.000	15000.000	15000.000	15000.000
Factory costs	261000.000	261000.000	261000.000	261000.000
Administrative overheads	19000.000	19000.000	19000.000	19000.000
Indir. costs, sales and distribution	0.000	0.000	0.000	0.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000
Depreciation	30000.000	30000.000	20000.000	30000.000
Financial costs	9000.000	6000.000	3000.000	0.000
Total production costs	319000.000	316000.000	303000.000	310000.000
Costs per unit (single product)	3190.000	3160.000	3030.000	3100.000
Of it foreign, %	68.417	68.117	66.749	67.500
Of it variable,%	75.235	75.949	79.208	77.419
Total labour	69000.000	69000.000	69000.000	69000.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Net Working Capital in Dollars

Year			1991	1992	1993	1994	1995
Coverage	adc	coto					
Current assets &							
Accounts receivable	30	12.0	23604.170	22072.920	22333.330	26250.000	23333.330
Inventory and materials	116	3.1	28458.330	34854.160	43916.670	62416.670	62416.670
Energy	0	---	0.000	0.000	0.000	0.000	0.000
Spares	360	1.0	2000.000	2500.000	3000.000	3000.000	3000.000
Work in progress	2	170.2	920.139	1087.708	1330.556	1661.111	1591.667
Finished products	4	92.5	1993.056	2277.639	2719.444	3300.000	3202.778
Cash in hand	10	36.0	5458.333	4380.556	3666.667	3388.889	2416.667
Total current assets			62434.030	67172.980	76966.660	100016.700	95961.110
Current liabilities and							
Accounts payable	30	12.0	17854.170	18406.250	19916.670	23833.330	21750.000
Net working capital			44579.860	48766.730	57050.000	76183.340	74211.110
Increase in working capital			44579.860	4186.875	8283.262	19133.340	-1972.227
Net working capital, local			5357.639	6710.069	8444.444	10111.110	10111.110
Net working capital, foreign			39222.220	42056.670	48605.550	66072.220	64100.000

Note: adc = minimum days of coverage ; coto = coefficient of turnover .

Windpumps, METAFUS --- 02-03-1989

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Net Working Capital in Dollars

Year			1996-2005
Coverage	adc	coto	
Current assets &			
Accounts receivable	30	12.0	23333.330
Inventory and materials	116	3.1	62416.670
Energy	0	---	0.000
Spares	360	1.0	3000.000
Work in progress	2	170.2	1591.667
Finished products	4	92.5	3202.778
Cash in hand	10	36.0	2416.667
Total current assets			95961.110
Current liabilities and			
Accounts payable	30	12.0	21750.000
Net working capital			74211.110
Increase in working capital			0.000
Net working capital, local			10111.110
Net working capital, foreign			64100.000

Note: adc = minimum days of coverage ; coto = coefficient of turnover .

Windpumps, METAFUS --- 02-03-1989

COMFAR
2.1 UNIDO

Source of Finance, construction in Dollars

Year	1990
Equity, ordinary ..	100000.000
Equity, preference.	0.000
Subsidies, grants .	0.000
Loan A, foreign .	200000.000
Loan B, foreign..	0.000
Loan C, foreign .	0.000
Loan A, local....	0.000
Loan B, local....	0.000
Loan C, local....	0.000
Total loan	200000.000
Current liabilities	0.000
Bank overdraft	0.000
Total funds	300000.000

COMFAR 2.1 UNIDO

Source of Finance, production in Dollars

Year	1991	1992	1993	1994	1995	1996-2003
Equity, ordinary ..	50000.000	0.000	0.000	0.000	0.000	0.000
Equity, preference.	0.000	0.000	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, foreign .	100000.000	0.000	0.000	-30000.000	-30000.000	-30000.000
Loan B, foreign..	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, local....	0.000	0.000	0.000	0.000	0.000	0.000
Loan B, local....	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, local....	0.000	0.000	0.000	0.000	0.000	0.000
Total loan	100000.000	0.000	0.000	-30000.000	-30000.000	-30000.000
Current liabilities	17854.170	552.083	1510.417	3916.667	-2083.334	0.000
Bank overdraft	0.000	0.000	0.000	0.000	0.000	0.000
Total funds	167854.200	552.083	1510.417	-26083.330	-32083.330	-30000.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Cashflow Tables, construction in Dollars

Year	1990
Total cash inflow . .	300000.000
Financial resources .	300000.000
Sales, net of tax . .	0.000
Total cash outflow . .	300000.000
Total assets	290000.000
Operating costs . . .	0.000
Cost of finance . . .	10000.000
Repayment	0.000
Corporate tax . . .	0.000
Dividends paid . . .	0.000
Surplus (deficit) .	0.000
Cumulated cash balance	0.000
Inflow, local	100000.000
Outflow, local	75000.000
Surplus (deficit) .	25000.000
Inflow, foreign . . .	200000.000
Outflow, foreign . . .	225000.000
Surplus (deficit) .	-25000.000
Net cashflow	-290000.000
Cumulated net cashflow	-290000.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Cashflow tables, production in Dollars

Year	1991	1992	1993	1994	1995	1996
Total cash inflow	377[illegible].200	319118.800	421510.400	603916.700	600000.000	600000.000
Financial resources	167854.200	1118.750	1510.417	3916.667	0.000	0.000
Sales, net of tax	210000.000	318000.000	420000.000	600000.000	600000.000	600000.000
Total cash outflow	370684.000	300180.600	307793.760	438050.000	335027.800	334000.000
Total assets	62434.030	4738.956	9793.681	63050.000	-4055.555	0.000
Operating costs	283250.000	264875.000	268000.000	315000.000	280000.000	280000.000
Cost of finance	25000.000	30000.000	30000.000	30000.000	27000.000	24000.000
Repayment	0.000	566.667	0.000	30000.000	32083.330	30000.000
Corporate tax	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	7170.125	18938.130	113716.700	165866.700	264972.200	266000.000
Cumulated cash balance	7170.125	26108.250	139825.000	305691.700	570663.900	836663.900
Inflow, local	262437.500	319118.800	421443.800	601500.000	600000.000	600000.000
Outflow, local	56045.140	64146.180	82178.130	100166.700	97000.000	97000.000
Surplus (deficit)	206392.400	254972.600	339265.600	501333.300	503000.000	503000.000
Inflow, foreign	115416.700	0.000	66.667	2416.667	0.000	0.000
Outflow, foreign	314638.900	236034.400	225615.600	337883.300	238027.800	237000.000
Surplus (deficit)	-199222.200	-236034.400	-225548.900	-335466.700	-238027.800	-237000.000
Net cashflow	-117829.900	48938.110	143716.700	225866.700	321972.200	320000.000
Cumulated net cashflow	-407829.900	-358891.800	-215175.000	10691.660	332663.900	652663.900

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Cashflow tables, production in Dollars

Year	1997	1998	1999	2000	2001	2002
Total cash inflow	600000.000	600000.000	600000.000	600000.000	600000.000	600000.000
Financial resources	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax	600000.000	600000.000	600000.000	600000.000	600000.000	600000.000
Total cash outflow	331000.000	468000.000	325000.000	322000.000	319000.000	316000.000
Total assets	0.000	140000.000	0.000	0.000	0.000	0.000
Operating costs	280000.000	280000.000	280000.000	280000.000	280000.000	280000.000
Cost of finance	21000.000	18000.000	15000.000	12000.000	9000.000	6000.000
Repayment	30000.000	30000.000	30000.000	30000.000	30000.000	30000.000
Corporate tax	0.000	0.000	0.000	0.000	0.000	0.000
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	269000.000	132000.000	275000.000	278000.000	281000.000	284000.000
Cumulated cash balance	1105664.000	1237664.000	1512664.000	1790664.000	2071664.000	2355664.000
Inflow, local	600000.000	600000.000	600000.000	600000.000	600000.000	600000.000
Outflow, local	97000.000	97000.000	97000.000	97000.000	97000.000	97000.000
Surplus (deficit)	503000.000	503000.000	503000.000	503000.000	503000.000	503000.000
Inflow, foreign	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, foreign	234000.000	371000.000	228000.000	225000.000	222000.000	219000.000
Surplus (deficit)	-234000.000	-371000.000	-228000.000	-225000.000	-222000.000	-219000.000
Net cashflow	320000.000	180000.000	320000.000	320000.000	320000.000	320000.000
Cumulated net cashflow	972663.900	1152664.000	1472664.000	1792664.000	2112664.000	2432664.000

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Cashflow tables, production in Dollars

Year	2003	2004	2005
Total cash inflow . .	600000.000	600000.000	600000.000
Financial resources .	0.000	0.000	0.000
Sales, net of tax . .	600000.000	600000.000	600000.000
Total cash outflow . .	353000.000	280000.000	280000.000
Total assets	49000.000	0.000	0.000
Operating costs . . .	280000.000	280000.000	280000.000
Cost of finance . . .	3000.000	0.000	0.000
Repayment	30000.000	0.000	0.000
Corporate tax . . .	0.000	0.000	0.000
Dividends paid . . .	0.000	0.000	0.000
Surplus (deficit) .	247000.000	320000.000	320000.000
Cumulated cash balance	2602664.000	2922664.000	3242664.000
Inflow, local	600000.000	600000.000	600000.000
Outflow, local	97000.000	97000.000	97000.000
Surplus (deficit) .	503000.000	503000.000	503000.000
Inflow, foreign . . .	0.000	0.000	0.000
Outflow, foreign . . .	256000.000	183000.000	183000.000
Surplus (deficit) .	-256000.000	-183000.000	-183000.000
Net cashflow	280000.000	320000.000	320000.000
Cumulated net cashflow	2712664.000	3032664.000	3352664.000

COMFAR 2.1 UNIDO

Cashflow Discounting:

a) Equity paid versus Net income flow:
Net present value .....1178061.00 at 10.00 %
Internal Rate of Return (IRRE1) .. 43.49 %
b) Net Worth versus Net cash return:
Net present value .....1259254.00 at 10.00 %
Internal Rate of Return (IRRE2) .. 59.57 %
c) Internal Rate of Return on total investment:
Net present value .....1273800.00 at 10.00 %
Internal Rate of Return (IRR) .. 36.81 %
Net Worth = Equity paid plus reserves

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Net Income Statement in Dollars

Year	1991	1992	1993	1994	1995
Total sales, incl. sales tax	210000.000	318000.000	420000.000	600000.000	600000.000
Less: variable costs, incl. sales tax.	84000.000	127200.000	168000.000	240000.000	240000.000
Variable cargin	126000.000	190800.000	252000.000	360000.000	360000.000
As % of total sales	60.000	60.000	60.000	60.000	60.000
Non-variable costs, incl. depreciation	229250.000	167675.000	130000.000	105000.000	70000.000
Operational margin	-103250.000	23125.000	122000.000	255000.000	290000.000
As % of total sales	-49.167	7.272	29.048	42.500	48.333
Cost of finance	25000.000	30000.000	30000.000	30000.000	27000.000
Gross profit	-128250.000	-6875.000	92000.000	225000.000	263000.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	-128250.000	-6875.000	92000.000	225000.000	263000.000
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	-128250.000	-6875.000	92000.000	225000.000	263000.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	-128250.000	-6875.000	92000.000	225000.000	263000.000
Accumulated undistributed profit	-128250.000	-135125.000	-43125.000	181875.000	444875.000
Gross profit, % of total sales	-61.071	-2.162	21.905	37.500	43.833
Net profit, % of total sales	-61.071	-2.162	21.905	37.500	43.833
ROE, Net profit, % of equity	-85.500	-4.583	61.333	150.000	175.333
ROI, Net profit+interest, % of invest.	-30.860	6.826	35.153	62.780	71.745

Windpumps, METAFUS --- 02-03-1989

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Net Income Statement in Dollars

Year	1996	1997	1998	1999	2000
Total sales, incl. sales tax	600000.000	600000.000	600000.000	600000.000	600000.000
Less: variable costs, incl. sales tax.	240000.000	240000.000	240000.000	240000.000	240000.000
Variable margin	360000.000	360000.000	360000.000	360000.000	360000.000
As % of total sales	60.000	60.000	60.000	60.000	60.000
Non-variable costs, incl. depreciation	70000.000	70000.000	70000.000	70000.000	70000.000
Operational margin	290000.000	290000.000	290000.000	290000.000	290000.000
As % of total sales	48.333	48.333	48.333	48.333	48.333
Cost of finance	24000.000	21000.000	18000.000	15000.000	12000.000
Gross profit	266000.000	269000.000	272000.000	275000.000	278000.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	266000.000	269000.000	272000.000	275000.000	278000.000
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	266000.000	269000.000	272000.000	275000.000	278000.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	266000.000	269000.000	272000.000	275000.000	278000.000
Accumulated undistributed profit	710875.000	979875.000	1251875.000	1526875.000	1804875.000
Gross profit, % of total sales	44.333	44.833	45.333	45.833	46.333
Net profit, % of total sales	44.333	44.833	45.333	45.833	46.333
ROE, Net profit, % of equity	177.333	179.333	181.333	183.333	185.333
ROI, Net profit+interest, % of invest.	71.745	71.745	53.288	53.288	53.288

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Net Income Statement in Dollars

Year	2001	2002	2003	2004	2005
Total sales, incl. sales tax	600000.000	600000.000	600000.000	600000.000	600000.000
Less: variable costs, incl. sales tax.	240000.000	240000.000	240000.000	240000.000	240000.000
Variable margin	360000.000	360000.000	360000.000	360000.000	360000.000
As % of total sales	60.000	60.000	60.000	60.000	60.000
Non-variable costs, incl. depreciation	70000.000	70000.000	60000.000	70000.000	70000.000
Operational margin	290000.000	290000.000	300000.000	290000.000	290000.000
As % of total sales	48.333	48.333	50.000	48.333	48.333
Cost of finance	9000.000	6000.000	3000.000	0.000	0.000
Gross profit	281000.000	284000.000	297000.000	290000.000	290000.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	281000.000	284000.000	297000.000	290000.000	290000.000
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	281000.000	284000.000	297000.000	290000.000	290000.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	281000.000	284000.000	297000.000	290000.000	290000.000
Accumulated undistributed profit	2085875.000	2369875.000	2666875.000	2956875.000	3246875.000
Gross profit, % of total sales	46.833	47.333	49.500	48.333	48.333
Net profit, % of total sales	46.833	47.333	49.500	48.333	48.333
ROE, Net profit, % of equity	187.333	189.333	198.000	193.333	193.333
ROI, Net profit+interest, % of invest.	53.288	53.288	51.351	49.640	49.640

COMFAR 2.1 UNIDO

Projected Balance Sheets, construction in Dollars

Year	1990
Total assets	300000.000
Fixed assets, net of depreciation	0.000
Construction in progress	300000.000
Current assets	0.000
Cash, bank	0.000
Cash surplus, finance available	0.000
Loss carried forward	0.000
Loss	0.000
Total liabilities	300000.000
Equity capital	100000.000
Reserves, retained profit	0.000
Profit	0.000
Long and medium term debt	200000.000
Current liabilities	0.000
Bank overdraft, finance required	0.000
Total debt	200000.000
Equity, % of liabilities	33.333

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Projected Balance Sheets, Production in Dollars

Year	1991	1992	1993	1994	1995
Total assets	467854.200	468406.300	561916.700	668833.300	856625.000
Fixed assets, net of depreciation	270000.000	240000.000	210000.000	180000.000	190000.000
Construction in progress	0.000	0.000	0.000	40000.000	0.000
Current assets	56975.700	62792.430	73300.000	96627.770	93544.440
Cash, bank	5458.333	4380.556	3666.667	3388.889	2416.667
Cash surplus, finance available	7170.125	26108.250	139825.000	305691.700	570663.900
Loss carried forward	0.000	128250.000	135125.000	43125.000	0.000
Loss	128250.000	6875.000	0.000	0.000	0.000
Total liabilities	467854.200	468406.300	561916.700	668833.300	856625.000
Equity capital	150000.000	150000.000	150000.000	150000.000	150000.000
Reserves, retained profit	0.000	0.000	0.000	0.000	181875.000
Profit	0.000	0.000	92000.000	225000.000	263000.000
Long and medium term debt	300000.000	300000.000	300000.000	270000.000	240000.000
Current liabilities	17854.170	18406.250	19916.670	23833.340	21750.000
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	317854.200	318406.300	319916.700	293833.300	261750.000
Equity, % of liabilities	32.061	32.023	26.694	22.427	17.511

Windpumps, METAFUS --- 02-03-1989

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Projected Balance Sheets, Production in Dollars

Year	1996	1997	1998	1999	2000
Total assets	1092625.000	1331625.000	1573625.000	1818625.000	2066625.000
Fixed assets, net of depreciation	160000.000	130000.000	100000.000	210000.000	180000.000
Construction in progress	0.000	0.000	140000.000	0.000	0.000
Current assets	93544.440	93544.440	93544.440	93544.440	93544.440
Cash, bank	2416.667	2416.667	2416.667	2416.667	2416.667
Cash surplus, finance available	836663.900	1105664.000	1237664.000	1512664.000	1790664.000
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	1092625.000	1331625.000	1573625.000	1818625.000	2066625.000
Equity capital	150000.000	150000.000	150000.000	150000.000	150000.000
Reserves, retained profit	444875.000	710875.000	979875.000	1251875.000	1526875.000
Profit	266000.000	269000.000	272000.000	275000.000	278000.000
Long and medium term debt	210000.000	180000.000	150000.000	120000.000	90000.000
Current liabilities	21750.000	21750.000	21750.000	21750.000	21750.000
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	231750.000	201750.000	171750.000	141750.000	111750.000
Equity, % of liabilities	13.728	11.264	9.532	8.248	7.258

Windpumps, METAFUS --- 02-03-1989

COMFAR 2.1 UNIDO

COMFAR 2.1 - EINDHOVEN UNI. OF TECHNOLOGY, DEPT. OF I.E., NL

Projected Balance Sheets, Production in Dollars

Year	2001	2002	2003	2004	2005
Total assets	2317625.000	2571625.000	2838625.000	3128625.000	3418625.000
Fixed assets, net of depreciation	150000.000	120000.000	100000.000	110000.000	80000.000
Construction in progress	0.000	0.000	40000.000	0.000	0.000
Current assets	93544.440	93544.440	93544.440	93544.440	93544.440
Cash, bank	2416.667	2416.667	2416.667	2416.667	2416.667
Cash surplus, finance available	2071664.000	2355664.000	2602664.000	2922664.000	3242664.000
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	2317625.000	2571625.000	2838625.000	3128625.000	3418625.000
Equity capital	150000.000	150000.000	150000.000	150000.000	150000.000
Reserves, retained profit	1804875.000	2085875.000	2369875.000	2666875.000	2956875.000
Profit	281000.000	284000.000	297000.000	290000.000	290000.000
Long and medium term debt	60000.000	30000.000	0.000	0.000	0.000
Current liabilities	21750.000	21750.000	21750.000	21750.000	21750.000
Bank overdraft, finance required	0.000	0.000	0.000	0.000	0.000
Total debt	81750.000	51750.000	21750.000	21750.000	21750.000
Equity, % of liabilities	6.472	5.833	5.284	4.794	4.388

Appendix A10

Presentation of the draft final report

February 23, 1989

Presentation draft final report

Subject: Opportunity study for the establishment of a production capacity for wind driven waterpumps in Angola. Presentation of draft final report.

Project nr. US/ANG/87/075

Present :	Felix Neto	(DNFRE - MEP)
	C. Botelho	(DNFRE - MEP)
	V. Klykov	(UNIDO - Vienna)
	K. Versteegh	(UNIDO team header, EIC)
	S. Moreira	(UNIDO CTA)
	M. v. Wallenburg	(UNIDO/UNDP - Luanda)
	Mesquita	(Metafus)
	Santos	(Metafus)
	M. Ferreira	(GEPI)
	Amadeu C. Neves	(MEP)

1. Opening of the meeting by Mr. Neto and presentation of the participants.

2. Introduction of the project by Mr. Klykov. The funds for the study have been provided by the Dutch government. The study has been executed by UNIDO which subcontracted EIC and will be presented by Versteegh. The goals of of the meeting are :

   - The presentation of the short summary, conclusions and recommendations of the study.

   - To discuss the follow-up of this study.

3. Presentation of the conclusion by Mr. Versteegh.
   Before starting the presentation it was explained that the draft report was sent before and was translated and distributed, but was not approved by UNIDO. In the now presented version, the financial analysis was done in a more detailed way (chapter XII). The report now is supported by UNIDO.

   Three option of a wind-pump production in Angola have been studied
   - an isolated production unit
   - an integrated production unit in EMEL project
   - an integrated production unit in Metafus workshop.

   The study showed that from a technical, financial and economic point of view the production of windpumps by Metafus is most viable.
   The details of the study were explained by Mr. Versteegh and Mr. Klykov.

Discussions

After the presentation of the conclusions and recommendations, which have been translated in portuguese and distributed before some questions arised.

Mr. Ferreira : will the windpump design be a patent or the product of a licence agreement? Is there a budget for this?

Answer : the brand of windmill still has to be choosen and different forms of cooperation are possible and the cost of this has to be considered as well. This will be one of the pre-investment activities. Patent rights do not have to be paid as the original design is an old one and all present brands are improved copies.

Mr. Ferreira : Is there foreseen a budget for the engineering of the windmill?

Answer : There is. In the pre-investment phase there will be choosen a brand of which a first serie will be produced as a start of the production. Simple parts will be made locally; the more complicated parts imported. There is foreseen a certain period to adapt parts for local manufacturing with the assistance of expatriates.

Mr. Ferreira : Then you need enginnering capacity. The GEPI does this because there are not enough qualified engineers to have engineering capacity for windpumps only. GEPI want to develop technical knowledge

Mr. Versteegh : What you need is a craftsman who can make designs. He can be given a course or trained on the job by a foreign expert. This may be a support to the factory as a whole. Further more foreign experts should work with an ANgolan counterpart.

Mr. Botelho : Windmill technics is not unknown in Angola as there are home-made windmill in Namibe. Together with the import of materials and parts we include the transfer of knowledge by means of drawings.

Mr. Ferreira : In Angola there is no practise in design and industrial methodes.

Mr. Versteegh : I am aware of the lack of a qualified human resources. This is not only a matter of money and it can cause delay in the implementation.

4. Presentation of the recommendations by Mr. Klykov. The recommendations have been distributed among those present. Most important recommendations are that the production unit should be integrated within Metafus workshop in Lubango and that follow-up pre-investment activities should start, resulting in specifiactions for materials and machines, call for tender and evaluatin of offers and a detailed economic and financial evaluation of the whole plant.

The study made also general recommendations related to the project development and to the following matters :

- Elaboration of winddata
- Installation and maintenance of windpumps in the Southern Region
- Rehabilitation of existing windpumps
- Drilling capacity and construction of storage tanks

Discussions

Mr. Neto stated that there was already a project prepared for the rehabilitation of windpumps. Those activities indeed can be the start of such a department as DNFRE will have in the provinces.

Concerning drilling capacity one should count on Hidrominas and for the construction of thanks on the local authorities.

Mr. Klykov explained that in April the final report will be submitted by UNIDO to the government and UNIDO would expect an official reaction and a request for further activities.

Mr. Ferreira recommended to think about interlinkage with an other project e.g. a galvanization unit which can give the best anti-corrosive treatment and thus assure a longer lifetime of the mills.

Mr. Klykov mentioned the possibility of consideration of the idea but stated that the windpump production was interlinked with a lot of other problems which may be considered in the follow-up pre-investment activities.

Mr. Ferreira indicated that Metafus could have a lack of space if integrating the windpump production.

5. A meeting was arranged with Metafus and Mr. Versteegh in order to adjust the related data used in the study.

It was agreed to discuss the preliminary comments by UNIDO mission and the Angolan authtorities on friday morning (24/2/89) in order to be integrated in the final report.

For UNIDO
Klykov UNIDO
Versteegh EIC - Consultant team leader

For DNFRE - MEP
Botelho/Neto

Appendix A11

Offer of windpumps

SHEET NO:11/9/2 CANCELLING SHEET NO: 11/9/1 FILE "11" 1 MARCH 1988
Req Ref No: 4559
EXPORT PRICE LIST

SOUTHERN CROSS "IZ" DOUBLE GEARED WINDMILL

WITH "FA" PATTERN THREE-POST OR "FB" PATTERN FOUR-POST TOWERS

Southern Cross "IZ" series Double Geared Windmills, fully enclosed automatic oiling with Galvanised windwheel and three or four post galvanised steel stub towers.

SERIES	WINDMILL DIAMETER	WINDMILL HEAD ONLY WITH 3 OR 4 POST STUB TOWER
IZ-B	2,5 metres	$2 212.00
IZ-C	3,0 metres	$2 429.00
IZ-D	3,7 metres	$3 860.00
IZ-E	4,3 metres	$4 225.00

GEARED WINDMILLS WITH "FA" PATTERN THREE-POST TOWERS AND ANCHOR POSTS WITH FOUNDATION PLATES

SERIES	6m	8m	9m	12m	15m
IZB/FAB	$3 067.00	$3 409.00	$3 663.00	$4 401.00	$5 247.00
IZC/FAC	$3 490.00	$3 819.00	$4 034.00	$4 738.00	$5 557.00
IZD/FAD			$5 580.00	$6 356.00	$7 274.00
IZE/FAE			$5 847.00	$6 518.00	$7 362.00

GEARED WINDMILLS WITH "FB" PATTERN FOUR POST TOWERS AND ANCHOR POSTS WITH FOUNDATION BOLTS

SERIES	6m	8m	9m	12m	15m
IZB/FBB	$3 338.00	$3 704.00	$3 938.00	$4 721.00	$5 593.00
IZC/FBB	$3 555.00	$4 027.00	$4 155.00	$4 938.00	$5 810.00
IZD/FBD	$5 092.00		$5 729.00	$6 549.00	$7 460.00
IZE/FBE	$5 457.00		$6 094.00	$6 914.00	$7 825.00

ROTATING INSPECTION LADDER

SERIES "BAB" for 3,0 3,7 4,3 "IZ" Mills, if required $42.00

C+F CLOSEST HARBOUR.

SHEET NO: 11/1/2 CANCELLING SHEET NO: 11/1/1 FILE "11" 1 MARCH 1988
Req Ref No: 4558
EXPORT PRICE LIST

SOUTHERN CROSS

SENESCHAL PATTERN DIRECT ACTING WINDMILLS WITH "FR" PATTERN THREE POST TOWE

MARK ..... SOUTHERN CROSS ....m SENESCHAL PATTERN Direct Acting Windmill Fully enclosed, automatic oiling, with galvanised windwheel and THREE Post Tower Casting, and with "FR" Galvanised Steel Three Post Tower....m above ground level, and with anchor posts and foundation plates for concrete foundations.

MARK	DIAMETER WINDWHEEL	MILL WITH 13.7m TOWER	MILL WITH 16.7m TOWER
RF	5,2m	$13 343.ØØ	$14 31Ø.ØØ
RG	6,3m	$19 395.ØØ	$2Ø 365.ØØ
RH	7,5m	$22 582.ØØ	$23 Ø43.ØØ

Sufficient oil for the first oiling, sufficient Hardwood Pumprods with guides and fully detailed Erecting Instruction Manual are supplied with the above windmills at no extra charge.

C+F CLOSEST HARBOUR.