REPUBLIC OF NAMIBIA

GEF

NAMIBIA

MINISTRY OF MINES AND ENERGY
DIRECTORATE OF ENERGY

BASELINE STUDY : BARRIER REMOVAL TO NAMIBIAN RENEWABLE ENERGY PROGRAMME (NAMREP)

FINAL REPORT

17 OCTOBER 2005

Prepared for:
Ministry of Mines and Energy
Directorate of Energy
Private Bag 13297
Windhoek
Namibia

Tel : + 264 61 2848111
Fax : +264 61 238643

Prepared by:
Consulting Service Africa
P O Box 3362
Windhoek
Namibia

Tel : + 264 61 237427
Fax : + 264 61 225704

Table of Contents

Table of Contents - continued

Table of Contents - continued

Table of Contents - continued

Table of Contents - continued

LIST OF TABLES IN THE EXECUTIVE SUMMARY

LIST OF TABLES IN THE REPORT

LIST OF FIGURES

1 EXECUTIVE SUMMARY

1.1 INTRODUCTION

In November 2004, the Namibian Renewable Energy Programme (NAMREP) appointed Consulting Services Africa (CSA) to conduct this Baseline Study. The Baseline Study has the following objectives:

- To determine the existing status of solar technologies in Namibia so that NAMREP can best decide the type and extent of interventions needed to facilitate the improvement of the solar technology industry in Namibia and promotion cost-effective, enviromentally friendly technologies.
- To provide accurate, quantitative data with which NAMREP can measure in the future the impact of their interventions.
- To recommend interventions to NAMREP that could be implemented during Phases 1 and 2 of the programme.

1.2 SUMMARY OF THE DESKTOP STUDY

CSA performed an extensive desktop study that included the review of approximately 60 documents. The findings of this review that have been included in the Baseline Study include demographic information, regional profiles, and identification of key programmes, policies and projects regarding the national energy sector and solar technology. The following key programmes, policies and projects were identified and described:

- *National Rural Electrification Programme*

  The objective of the Rural Electrification Programme is to connect previously off-grid rural towns, villages and settlements to the national electricity grid.

- *Rural Electricity Distribution Master Plan*

  The Rural Electricity Distribution Master Plan identifies all remaining unelectrified rural localities, and priotises future connections of these localities to the national electricity grid according to the level of importance and infrastructure costs.

- *White Paper on Energy Policy*

  The White Paper is a comprehensive document setting out the Namibian Government's overall energy policy. It considers all types of energy needs, resources and technologies.

- *Home Power Revolving Fund*

  The revolving fund was established in 1996 with the purpose of making solar home power systems (SHS) more affordable, especially to low-income unelectrified households.

- *Ovitoto Fee-for-Service Project*

  The project included a fee-for-service approach to SHS. Approximately 100 SHS were installed in the village of Ovitoto. The logistical support required for the fee-for-service approach was determined to be unfeasible.

- *Solar Villages Project*

  The project included the installation of solar home systems, solar water heaters and solar water pumps in three villages located in the Ohangwena, Erongo and Caprivi Regions. The technologies were provided free of charge by MME.

- *AccuPower Project*

  The project included a solar battery charging station in the village of Uupindi in the Oshana Region. Solar rechargeable batteries and household electrical installations (wiring, lights, etc.) were provided to 148 households. The project concept turned out to be unfeasible because it was too difficult for villagers to carry the heavy batteries long distances.

1.3 FIELDWORK PERFORMED

CSA performed extensive fieldwork in the process of collecting information for the Baseline Study. One part of the fieldwork included visits to 12 of the 13 regions of Namibia in order to conduct interviews with communal and commercial farmers. Another part of the fieldwork included numerous meetings and interviews with solar technology suppliers, NGO's, private sectors, and Government institutions. The fieldwork is reponsible for many of the findings that are summarised in Section 1.4 below.

1.4 KEY FINDINGS

The tables provided in sections 1.4.1 – 1.4.4 provide a concise summary of the key findings for the four different types of solar technologies.

1.4.1 Solar Home Systems

Table A: Capacities of Various Solar Home Systems

System load /appliance	50W (hours/day)	100W (hours/day)	150W (hours/day)	350W (hours/day)
Lights (12V/7W)	2 Lights @ 4hrs/day	2 Lights @ 4hrs/day	2 Lights @ 4hrs/day	3 Lights @ 4hrs/day
Lights (12V/11W)	1 Light @ 4hrs/day	2 Lights @ 4hrs/day	2 Lights @ 4hrs/day	2 Lights @ 4hrs/day
Radio (9V/100mA)	**	**	*	*
HiFi (12V/8W)	3	4	*	*
HiFi (230V/20W)	*	*	4	4
TV, black, white, 28cm (12V/15W)	3	**	*	*
TV, colour, 36cm (12V/50W)	*	4	*	*
TV, colour, 51cm (230V/80W)	*	*	4	3
TV, colour, 72cm (230V/140W)	*	*	*	**
Video & receiver (230V/60W)	*	*	3	3
Refrigerator (150 Litres)	*	*	*	Automatic

Note: * System is not capable of operating the particular appliance.

** Appliances can be operated but will result in a change in daily energy budget

Table B: Price History of Solar Home Systems

Description	Available Price History (Materials only; VAT incl.)*					
	1999	2000	2001	2002	2003	2004
50W DC (includes 50W PV panels and stand, one 105 amp/h battery, charge controller, power gauge, 4 lights, plugs (9 and 12V) and wiring)	N$ 5,189	N$ 6,557	N$ 6,201	N$ 6,364	N$ 7,287	N$ 6,764
100W DC (includes two 50W PV panels and stand, two 105 amp/h batteries, charge controller, power gauge, 8 lights, plugs (9 and 12V) and wiring)	N$ 9,166	N$ 8,886	N$ 9,235	N$10,400	N$11,502	N$10,821
150W AC (includes four 50W PV panels and stand, three 105 amp/h batteries, 300W sine wave inverter, charge controller, power gauge, 8 lights, plugs (9V, 12V and 220V) and wiring)	N$11,762	N$11,876	N$14,790	N$21,541	N$20,214	N$18,913
350W AC (includes three 100W and one 50W PV mono-crystalline modules and stand, three 105 amp/h batteries, 400W sine wave inverter charge controller, power gauge, 8 lights, plugs (9V, 12V and 220V) and wiring)	N$18,194	N$21,588	N$23,901	N$30,383	N$31,176	N$26,159

* Prices determined based on an average of prices obtained from suppliers and other references.

Table C: Total Number of Solar Home Systems Sold Per Year

Solar Home System Power Classification (P)	1999	2000	2001	2002	2003	2004
P : less than or equal to 50 W	82	120	96	86	43	53
P : greater than 50 W, and less than or equal to 100 W	59	103	58	44	44	57
P : greater than 100 W, and less than or equal to 200 W	10	10	21	27	20	34
P : greater than 200 W	16	52	27	31	28	23
Total	**167**	**285**	**202**	**188**	**135**	**167**

Table D: Administrators of the Home Power Programme for Solar Home Systems

Time Period	Administrator
2005 - Present	Konga Investment
2001 – 2004	Premier Electric
1996 – 2000	Namibian Development Corporation

Table E: Number of Loans Issued for Solar Home Systems through the Home Power Programme

Time Period	Apr 96 to Mar 97	Nov 97 to Oct 99	Nov 99 to Jul 00	Aug 00 to Jun 01	Jul 01 to Dec 01	Jan 02 to Jun 02	Jul 02 to Jun 03	Jul 03 to Jun 04	
Recorded Number of Loans Issued	96	165	196	57	68	81	42	33	
Time Period	1996	1997	1998	1999	2000	2001	2002	2003	2004
Estimated Annual Loans Issued*	74	33	82	109	185	99	102	38	17

- The annual figures were estimated by distributing proportionally the recorded number of loans issued over the time periods concerned.

1.4.2 Solar Water Heaters

Table F: Price History of Solar Water Heaters

Water Heater Capacity	Available Price History (Materials only; VAT incl.)*					
	1999	2000	2001	2002	2003	2004
100 litre Solar Water Heater	N$ 6,000	N$ 6,000	N$ 8,000	N$ 5,000	N$ 5,000	N$ 7,000
150 litre Solar Water Heater	N$ 7,000	N$ 7,000	N$13,000	N$11,000	N$11,000	N$10,000
180 litre Solar Water Heater	N$ 9,000	N$ 9,000	N$15,000	N$12,000	N$12,000	N$11,000
300 litre Solar Water Heater	N$10,000	N$13,000	N$19,000	N$17,000	N$17,000	N$14,000

* Prices determined based on an average of prices obtained from suppliers and other references.

Table G: Total Number of Solar Water Heaters Sold Per Year

Solar Water Heater Capacity	1999	2000	2001	2002	2003	2004
100 *l*	10	15	10	19	21	21
150 *l*	0	0	0	0	0	3
200 *l*	44	41	89	44	43	97
More than 200 *l*	37	42	61	55	71	85
Total	**91**	**98**	**160**	**118**	**135**	**206**

1.4.3 Photovoltaic Pumps

Table H: Price History of Various Photovoltaic Pumps

ETA HR 04 DC Input (including PV panels and stand, cables, installation materials, etc.)
Daily water delivery: 7,000 litres and installed at 50m
Type: DC Submersible
Available price history (N$, VAT excl.):
NOTE: The ETA pump only began to be sold in 2003

1999	2000	2001	2002	2003	2004
*	*	*	*	N$ 20,000	N$ 24,000

JUWA (including solar panels and stand, cables, installation materials, etc.)
Daily water delivery: 15,000 litres and installed at 50m
Type: DC Hammerhead
Available price history (N$, VAT excl.):

1999	2000	2001	2002	2003	2004
N$ 30,000	N$ 35,000	N$ 35,000	N$ 41,000	N$ 43,000	N$ 55,000

Grundfos SQFlex AC or DC power input (including PV panels and stand, cables, installation materials, etc.)
Daily water delivery: 15,000 litres and installed at 50m
Type: DC Submersible
Available price history (N$, VAT excl.):

1999	2000	2001	2002	2003	2004
*	*	*	N$60,000	N$54,000	N$56,000

Grundfos SA / 1500 3-phase stainless steel centrifugal pump (including DC/AC inverter, PV panels [54 @ 55Wp] and stand, cables, installation materials, etc.)
Daily water delivery: 50,000 litres and installed at 50m
Type: AC Submersible
Available price history (N$, VAT excl.):

1999	2000	2001	2002	2003	2004
N$175,000	N$175,000	N$180,000	N$200,000	N$150,000	N$ 110,000

Table I: Total Number of Photo-voltaic Pumps Sold Per Year

Photo-voltaic Pump Power Rating (P)	1999	2000	2001	2002	2003	2004
P : less than or equal to 60 W	3	2	4	5	5	6
P : greater than 60 W, and less than or equal to 150 W	6	5	5	4	2	3
P : greater than 150 W, and less than or equal to 250 W	36	58	67	78	130	150
P : greater than 250 W, and less than or equal to 500 W	1	4	0	0	3	12
P : greater than 500 W	1	1	1	2	2	3
Total	**47**	**70**	**77**	**89**	**142**	**174**

Analysis of PVP vs Diesel Powered Water Pumps

CSA performed an analysis of PVP vs diesel powered water pumps. The analysis points out that the cost effectiveness of PVP compared to a diesel water pumps depends on two important factors: the required yield and the total pumping head. The following conclusions were drawn for various total heads:

50m Total Head:

- PVP is more cost effective for yields up to 24,000 litres per day.
- Some PVP technologies have cheaper capital costs than diesel water pumps for deliveries up to 15,000 litres per day.
- PVP and Diesel water pumps are equally cost effective for yields between 30,000 and 40,000 litres per day over a 10 year period. However, PVP becomes more cost effective after the 10 year period.
- Diesel water pumps are more cost effective for yields more than 50,000 litres per day.

100m Total Head:

- PVP is more cost effective for yields up to 16,000 litres per day.
- Diesel water pumps are more cost effective more than 16.000 litres per day,. This is currently the technical limitation for PVP technologies in Namibia.

150m Total Head:

- PVP is more cost effective for yields up to 8,000 litres per day.
- Diesel water pumps are more cost effective for yields more than 10,000 litres per day.

The table below illustrates which technology is more cost effective over a 10 year period given various yields and pump heads.

Table J: The Most Cost EffectiveTechnology: PVP vs Diesel

The Most Cost Effective Technology during the First 10 Years of Operation				
		Total Pumping Head		
		50 m	**100 m**	**150 m**
Litres per day	**5.000**	**Solar**	**Solar**	**Solar**
	7.000	**Solar**	**Solar**	**Solar**
	8.000	**Solar**	**Solar**	**Solar**
	12.000	**Solar**	**Solar**	**Diesel**
	15.000	**Solar**	**Solar**	**Diesel**
	16.000	**Solar**	**Solar**	**Diesel**
	24.000	**Solar**	**Diesel**	**Diesel**
	40.000	**Solar / Diesel**	**Diesel**	**Diesel**
	50.000	**Diesel**	**Diesel**	**Diesel**
	80.000	**Diesel**	**Diesel**	**Diesel**

1.4.4 Solar Cooker

Table K: Solar Cookers

Description	Available Price History (VAT excl.)					
	1999	2000	2001	2002	2003	2004
Valombola Box Cooker: Chicken size	*	*	N$ 490	N$ 500	N$ 500	N$ 500
Valombola Box Cooker: Goat size	*	*	N$ 640	N$ 700	N$ 700	N$ 700
Parabolic Concentrator: Normal Size	*	*	N$ 800	N$ 800	N$ 800	N$ 800
Parabolic Concentrator: Small Size	*	*	N$ 550	N$ 550	N$ 550	N$ 550

Table L: Total Number of Solar Cookers Sold Per Year

Solar Cooker	1999	2000	2001	2002	2003	2004
Valombola Box Cooker Chicken size	0	0	0	24	19	11
Valombola Box Cooker Goat size	0	0	0	30	33	40
Parabolic Concentrator Normal Size	50	49	20	62	52	53
Parabolic Concentrator S Size	50	49	20	8	0	0
Total	**100**	**98**	**40**	**124**	**104**	**104**

1.5 BARRIERS TO SOLAR TECHNOLOGY IN NAMIBIA

Five types of barriers to solar technology in Namibia have been defined for the NAMREP programme and are described below. The barriers are the focus of the recommendations of the Baseline Study.

- *Capacity Barriers*

  A general lack of human capacity and resources by the private sector, NGO's and Government to identify, design, appraise, manage, advocate and implement solar technology projects.

- *Institutional Barriers*

  A lack of understanding by Government institutions regarding the potential benefits of utilising solar technologies.

- *Public Awareness and Social Acceptability Barriers*

  A lack of understanding, and in some cases a negative image, by the public regarding the types and benefits of solar technologies and the financial mechanisms available to consumers.

- *Financial Barriers*

  Excessive capital costs of solar technologies; lack of financial mechanisms available to consumers; and inadequate financial incentives to potential solar technology entrepreneurs.

- *Technical Barriers*

  Lack of solar technology training institutions and curricula for all technical levels; lack of trained technicians; non-existence of national technical standards.

The table below concerns the awareness of potential consumers of the PVP and the Home Power Programme for SHS. The table presents the findings obtained from interviews with communal and commercial farmers.

Table M: Awareness of Communal and Commercial Farmers Regarding PVP and the Home Power Programme for SHS

Regions	Awareness about PVP (%)	Awareness about Home Power Programme (%)
1. Caprivi	None	None
2. Erongo	None	None
3. Hardap	None	90%
4. Karas	None	90%
5. Kavango	None	60%
6. Khomas	10%	90%
7. Kunene	80%	None
8. Ohangwena	67%	80%
9. Omaheke	100%	80%
10. Omusati	None	83%
11. Oshikoto	None	100%
12. Otjozondjupa	10%	100%

1.6 NAMREP INDICATORS

In addition to addressing the above barriers, the recommendations of the Baseline Study need to address indicators (goals) that have already been established for NAMREP programme. The programme consists of two phases: Phase 1 and Phase 2. Phase 1 began in February 2004 and ends in August 2006 (21/2 year duration); and Phase 2 begins in September 2006 and ends in December 2008 (21/2 year duration). The following are the NAMREP indicators:

SET Usage/ Sales/Cost Indicators:

- Total number of household SET installations per year to be increased by 10% by the end of Phase 1, and 50% by the end of Phase 2.
- Total number of social sector (schools, clinics, etc.) SET installations per year to be increased by 10% by the end of Phase 1, and 50% by the end of Phase 2.
- Cost of SET's for end user to be reduced by 5% by the end of Phase 1, and 20% by the end of Phase 2.

Capacity-Related Indicators:

- 20% increase in RET suppliers located outside of Windhoek by end of Phase 1, and 100% increase by end of Phase 2.
- 50 new personnel from GRN, NGO's and private sector trained in SET activities by the end of Phase 1.
- Develop an SET master plan by the end of Phase 1.
- NAMREP PMU staff engaged, PMU offices and Resource Centre established and fully functioning by early 2005.

Institutional-Related Indicators:

- Line Ministries and the ECB have introduced at least two new policy measures in support of SET's by the end of Phase 1.
- Utilities and other institutions finance/implement at least two new projects in SET's by the end of Phase 1.

Public Awareness/Social Acceptability-Related Indicators:

- At least three thousand people reached through dissemination campaigns for educational and public awareness materials on SET's, and three hundred people through workshops and meetings – by the end of Phase 1.
- Number of customers enquiring information about SHS and SWH from local dealer shops increased by 20% by the end of Phase 1.
- One active network and/or association of stakeholders to be established by the end of 2005.

Financial-Related Indicators:

- At least one new strategy/policy to reduce the first cost of SET's established by the end of Phase 1.
- At least one effective financing scheme for SET's is available by the end of Phase 1.

Technical-Related Indicators:

- An REEE Institute is capacitated to fulfil its mandate by the end of Phase 1.
- At least one vocational training centre is capacitated and ready to provide technical training in SET's by the end of Phase 1.

1.7 RECOMMENDATIONS

The recommendations were developed based on both the findings of the research performed for the Baseline Study and on the ideas and opinions of stakeholders. Valuable ideas and opinions were obtained from the stakeholders during a workshop on 21 July 2005. As stated in the sections above, the recommendations address the barriers and the indicators that have been identified by NAMREP. The following is a summary of the recommendations:

Capacity-Related Recommendations:

- A technical training curriculum in solar energy technologies (SETs) to be developed and offered at all vocational training centres in Namibia. Phase 1 and 2
- A solar energy stakeholder association should be established. Timeframe: Phase 1
- Assess the capacities of suppliers and make plans for assisting those who are less experienced and capable. Timeframe: Phase 1
- Assess in-house training that is provided by suppliers to technicians. Encourage suppliers to improve and expand training opportunities. Encourage suppliers to provide bursaries to technicians to attend future RE training curricula. Timeframe: Phase 1 and 2
- Perform a survey of RE curricula that is available at higher education institutions in other countries. Timeframe: Phase 2
- Prepare a synopsis of donor-funded educational opportunities, inside and outside Namibia. Timeframe: Phase 2

Institutional/Policy-Related Recommendations:

- An SET Master Plan should be developed as soon as possible to provide strategic and detailed direction to the NAMREP PMU, MME, REEE, and other SET project/programme implementers. Timeframe: Phase 1
- Convince Government to adopt a policy that all schools, clinics and Government institutions must have access to electricity, even if those institutions are located off-grid. Timeframe: Phase 1

- Convince Government to adopt a policy that solar water heaters are compulsory for all public buildings (new buildings and replacement of broken electricity water heaters). Timeframe: Phase 2
- Convince Government to adopt a policy that 10% of the national power demand is supplied through RET's. Timeframe: Phase 2
- An energy desk should be established at all Government Ministries with appropriate platforms. Timeframe: Phase 2
- An incentive policy should be developed that rewards RET grid in-feeding. Timeframe: Phase 2

Public Awareness/Social Acceptability-Related Recommendations:

- Launch regular awareness campaigns using radio, television, posters, trade fairs, public demonstrations, and testimonials by popular persons. Timeframe: Phase 1 and 2
- Launch an aggressive awareness raising campaign on the existence of the solar energy revolving fund. Timeframe: Phase 1 and 2
- Cost comparisons of SET's versus grid electricity and diesel water pumps should be made widely available to potential SET users. Timeframe: Phase 1 and 2
- Perform an in-depth study on the perspectives of rural persons regarding SET's. Timeframe: Phase 1 or 2

Financial-Related Recommendations:

- Convince Government to reduce or eliminate any duties on RET's and RET components that are imported from non-SACU countries. Timeframe: Phase 1
- The feasibility and possible advantages of trading carbon credits on the international market should be investigated. Timeframe: Phase 1
- Make the solar energy revolving fund accessible to community collectives. Timeframe: Phase 2
- Convince Government to introduce an energy tax levy in order to establish a renewable energy project/programme fund. Timeframe: Phase 2
- Introduce a scheme whereby SET suppliers are motivated to provide lines of credit to regional SET technicians/installers/retailers. Timeframe: Phase 2

Technical-Related Recommendations:

- Assess the potential for value-adding in Namibia for different SET's. Timeframe: Phase 1
- Promote the funding of local SET product development and adaptation. Timeframe: Phase 1 and 2
- Encourage the above-recommended association of SE stakeholders to establish technical standards for SET's. Timeframe: Phase 1

2 ACKNOWLEDGEMENTS

Consulting Services Africa wish to thank NAMREP, Governmental departments, Solar Energy Suppliers, Parastatals, Private Sector and Non-Governmental Organizations, farmers and all the individuals who have made significant contributions to the completion of this Baseline report.

We also want to acknowledge the survey interviwers' outstanding work, which is reflected in the high quality of data and impressive response rates they achieved.

A great deal of appreciation goes to Mr Evat Kandongo (CSA: Chief Executive Officer) for the overall responsibility in ensuring the quality for the work undertaken.

3 LIST OF ACRONYMS

CSA	Consulting Services Africa
DRWS	Directorate of Rural Water Supply
EE	Energy Efficiency
GEF	Global Environmental Facility
GHG	Green House Gas
MME	Ministry of Mines and Energy
MAWRD	Ministry of Agriculture and Rural Water Development
NAMREP	Namibian Renewable Energy Programme
NDC	Namibia Development Corporation
PE	Premier Electric
PMU	Project Management Unit
PVP	Photovoltaic Pumping
RE	Renewable Energy
RET	Renewable Energy Technologies
SC	Solar Cookers
SHS	Solar Home Systems
SWH	Solar Water Heating
UNDP	United Nation Development Programme
WPC	Water Point Committee

Table 1: Average Exchange Rate of N$ TO US$ 1.00

Year	1999	2000	2001	2002	2003	2004
Amount	6.1095	6.9398	8.6092	10.5407	7.5648	6.4597

4 INTRODUCTION

Although Namibia has a National Policy on Rural Electrification in place, many rural Namibians do not have access to electricity from the national power grid. This is due to a highly dispersed settlement structure, low household incomes, relatively low energy demand and the resultant economic unfeasibility to extend the grid into Namibia's furthest corners. Stand-alone renewable energy (RE) technologies and applications, such as solar home systems (SHS), photovoltaic pumping (PVP) and solar water heating (SWH), remain the only viable energy option for many rural and peri-urban households. Unfortunately though, there are a number of barriers hindering a more expansive utilization of RE. The newly established Namibian Renewable Energy Programme (NAMREP) aims to remove these barriers.

The UNDP/GEF/MME Barrier Removal to Namibian Renewable Energy Programme was officially approved in April 2003 with an agreement between the Namibian government and UNDP. The objective of the Programme is to implement the Namibian Ministry of Mines and Energy (MME), Energy White Paper strategy for Renewable Energy: *"Government will promote the use of renewable energy through the establishment of an adequate institutional and planning framework, the development of human resources and public awareness and suitable financing, systems. It also seeks to meet development challenges through improved access to renewable energy sources, particularly in rural electrification, rural water supply and solar housing and water heating."*

This will be achieved through increasing the affordable access to RE services and accelerating market development for RE technologies by reducing institutional, information, human capacity, financial, technical, awareness and other market barriers.

NAMREP comprises the following six components:

- Component 1: Capacity Building
- Component 2: Removal of Institutional Barriers
- Component 3: Public Awareness and Social Acceptability
- Component 4: Removal of Financial Barriers
- Component 5: Removal of Technical Barriers
- Component 6: Demonstrations and Pilots

NAMREP's key stakeholders are:

- Namibian Ministry of Mines and Energy, as National Executing Agency
- UNDP Namibia, as GEF Implementing Agency
- GEF, as main financier
- Renewable energy technologies (RET) suppliers
- RET users
- GRN institutions dealing with RET issues
- Financing and Capacity building institutions
- Utilities
- ECB as a regulatory body

NAMREP's activities are implemented by a Project Management Unit (PMU).

Consulting Services Africa (CSA) was appointed in November 2004 by NAMREP to conduct this baseline study. The following are the objectives of this study:

- Determine the currently existing status and extent of RE applications and utilizations in Namibia in respect to the six components identified for barrier removal

- Study the relevant indicators by collecting data, analyzing the current status, and assessing the necessary baseline values of all parameters that can be influenced due to the introduction of the different barrier removal activities
- Based on the indicators and identified parameters, recommend the appropriate methodologies to monitor the changes in these parameters due to the barrier removal interventions
- Carry out all other detailed tasks as outlined in the TOR and supporting addendums.

The outcomes and findings of the study are herewith presented.

5 BACKGROUND INFORMATION

5.1 NATIONAL DEMOGRAPHICS[1]

The country covers an area of 824 269km^2 and has a population of 1.9 million people, with an estimated average population density of about 2.3 persons per km² in 2000. Of Namibia's total population only 28% is considered urban. The national population growth rate from the 2001 census was 2.6% per annum and the average household size was 5.1 people.

Namibia has a labour force of about 500,000 people. Agriculture accounts for 49% of employment, industry and commerce for 25%, services for 5%, government for 18% and mining for 3%. (1994 est.)

The rural population is dispersed over large parts of the country, which often makes grid extensions unviable. The cost of grid electricity distribution is high, and this has prompted the government to seek alternative decentralized technologies, such as solar energy systems.

Namibia is the driest country of sub-Saharan Africa and the most compelling features of Namibia's climate are the scarcity and unpredictability of rainfall. This situation is further aggravated by Namibia's extremely high rate of evaporation. It is estimated that 83% of rainfall evaporates and a further 14% is lost through transpiration by plants. Only 2% of Namibia's annual rainfall enters the drainage system, where dams retain some of the water, and only 1% recharges the underground water table.

Due to its aridity, agriculture in Namibia places heavy emphasis on range farming and livestock production. These include goats, sheep, cattle, ostriches, game or a combination thereof. Only 6.5% of the country's land area has suitable soil types and rainfall figures to allow mixed arable farming. Less than 5% of Namibia is under irrigation.

There are roughly 6,100 commercial farms in Namibia, focusing primarily on meat production (cattle, sheep, ostrich and game). Crop production, like maize, is limited to a few above-average rainfall areas, or areas with strong and shallow underground water resources. Karakul pelt production in the south of Namibia is only recovering slowly from international sensitivity to pelt and fur trade.

The vast majority of Namibians practice subsistence farming on relatively small farming land parcels (5 – 6ha), and this necessitates the production of a wide variety of produce, often not aimed at the national or international retail markets.

Namibia's strong semi-commercial water, electricity and telecommunication sectors ensure that commerce and the major urban areas are adequately and reliably supplied with these commodities. However, the majority of Namibia's population, which lives in rural areas in relative poverty, has yet to fully experience the convenience and utility of modern energy services.

Most of the rural households rely on fuel-wood for cooking and heating - the ecological pressures of the environment are evident. Paraffin is used by nearly half of the rural households as lighting fuel, the other main light source being candles. However, paraffin, candles and batteries deliver light of inferior quality at comparatively high cost per unit of light. This has the consequence of limiting evening activities to a minimum and reducing opportunities for income generation or improvements in the quality of education, health, and police service delivery. Low rural cash income is seen as a main obstacle for the rapid electrification of households, which

[1] Source: MME, *Rural Electricity Distribution Master Plan: National Overview Report*, 2000
Source: NPC, *2001 Population and Housing Census National Report*, 2003

implies that fuel-wood, paraffin and candles will remain the mainstay of rural energy provisions unless large scale measures are introduced to alter the current user patterns.

NATIONAL MAP WITH 13 REGIONS

5.2 NATIONAL ENERGY SECTOR

5.2.1 National Rural Electrification Programme

The country launched a rural electrification programme in 1990, and an appropriate and sustainable electrification strategy has been developed over the years. At independence in 1990, an estimated 9 700 rural households were connected to the electricity grid. Since then some 400 rural towns, villages and settlements have been grid electrified and an estimated 8 330 households have benefited from the electrification programme so far. The majority of the remaining 2 486 unelectrified rural settlements are much smaller than those targeted during the first nine years of the rural electrification programme. There are, however, still a few large settlements to be electrified, which due to their remoteness from existing electricity distribution infrastructure could not be included in the initial phases of the electrification programme.

The private sector, most notably through Northern Electricity, has significantly contributed towards the growth and sustainability of rural electricity supply, while the country energy policy and an appropriate legal and regulatory framework for the electricity sector were being developed. A new electricity pricing methodology has been developed in 2001 to enable the implementation of cost-reflective tariffs. The Electricity Supply Industry is currently being restructured to pave the way for improved sector efficiency and accelerated electrification through the establishment of Regional Electricity Distributors.

5.2.2 National Energy Policy White Paper

Namibia's White Paper on Energy Policy, promulgated in1998, pursues the following main policy goals:

- Security of Supply
- Social Upliftment
- Effective Governance
- Investment and Growth
- Economic Competitiveness and Efficiency
- Sustainability

> *'Government will develop a capacity building and energy information strategy on the affordable, safe, healthy, efficient and environmentally sustainable use of energy.'* – ***White Paper on Energy Policy, MME, 1998***

The policy provides a clear focus on social upliftment and rural development through electrification, with special attention given to those demand sectors that have been historically neglected, poor urban and rural households. Renewable energy sources and technologies are regarded as an integral part of rural electrification strategy that aims to improve access to safe, reliable and affordable energy.

> *'Government will promote the use of economically viable renewable technologies, as a complement to grid electrification, to improve energy provision to rural areas.'* – ***White Paper on Energy Policy, MME, 1998***

The White Paper estimated that rural household access to electricity has increased from 5% in 1991 to 8-9% in 1997, and that about 75% of urban households have access in 1997. This translates in a national household electricity access figure of approximately 30% in 1997. The Rural Electricity Distribution Master Plan for Namibia (2000) has identified more than 2,500 rural localities (with more than 55,000 potential consumers) that do not have access to electricity at all.

5.2.3 The Rural Electricity Distribution Master Plan

The Rural Electricity Distribution Master Plan, finalized in 2000, has identified all remaining unelectrified rural localities in the country and prioritised the unelectrified localities on the basis of level of importance and electrification costs. The Plan considers appropriate electrification options and has scheduled the electrification programme for the next 20 years within a fixed annual budget. A new Rural Electrification Master Plan is currently in the process of being finalized.

A unique feature of the Master Plan is an integrated approach that considers both grid and off-grid options for rural electrification. The computerised prioritisation tool has been developed to enable an objective ranking of electrification projects, based on electricity demand and electrification costs. Settlements that have a high demand for electricity by virtue of the existing infrastructure, but that are too costly to grid-electrify because of their remoteness, are automatically classified as off-grid priorities. For these settlements off-grid electrification solutions such as minigrids, solar home systems and hybrid systems (a combination of various energy sources, such as solar, wind, diesel, gas, etc.) are considered.

5.2.4 Renewable Energy

Namibia, with a strong supportive energy policy, solar regime and compact institutional environment has the possibility to provide a small yet efficient market for solar energy technologies. The implementation of NAMREP will help to reduce the barriers for the development of the demand for solar technologies and thus mitigate greenhouse gas emissions by addressing institutions, information, human capacity, financial, technical, awareness and

other market barriers to increase use of solar energy services by government institutions, NGO facilities, private sector facilities, communal and commercial farms.

5.2.4.1 Home Power Programme Revolving Fund[2]

In 1996 Government set up the Home Power Programme for ownership-based solar home systems (SHS). The programme included a revolving fund allowed for the purchase of SHS at an interest rate of 5% and a pay-back period of 5 years. In 2003, the operations of the fund were restructured. The restructuring aimed at separating financial and technical procedures in order to ensure after-sales services by the solar suppliers and to free the administrator from issues such as quality control and system maintenance. The following table provides the names of the administrative agencies, and the time periods during which they operated.

Table 2: Administrators of the Home Power Programme

Time Period	Administrator
2005 - Present	Konga Investment
2001 – 2004	Premier Electric
1996 – 2000	Namibian Development Corporation

The Home Power Programme consisted of five phases during the period 1996 - 2001. In Phase 1, the programme offered one system, a 50Wp SHS. In Phase 2 the programme offered additional systems: 20W solar lantern, 50Wp SHS, 100Wp SHS and 150Wp SHS. The solar lantern performed poorly and was removed during Phase 3. During Phase 4 additional systems were added to increased the top of the range of SHS to 250Wp. No additional systems were added during Phase 5. In addition to the above systems, customers have also been permitted to use the fund to acquire solar components instead of a complete system (e.g. solar PV modules).

The following table presents the number of loans issued through the Home Power Programme.

Table 3: Number of Loans Issued for SHS Through the Home Power Programme

Time Period	Apr 96 to Mar 97	Nov 97 to Oct 99	Nov 99 to Jul 00	Aug 00 to Jun 01	Jul 01 to Dec 01	Jan 02 to Jun 02	Jul 02 to Jun 03	Jul 03 to Jun 04	
Recorded Number of Loans Issued	96	165	196	57	68	81	42	33	
Time Period	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Estimated Annual Loans Issued*	**74**	**33**	**82**	**109**	**185**	**99**	**102**	**38**	**17**

* The annual figures were estimated by distributing proportionally the recorded number of loans issued over the time periods concerned.

5.2.4.2 Ovitoto Fee-for-Service[3]

A fee-for-service approach using SHS was launched in 2002 and approximately 100 SHS were installed at the village of Ovitoto. The logistical support that a fee-for-service approach requires, such as maintenance and revenue collection, coupled with a low population density made this

[2] Source: MME, *Assessment of two Namibian Solar Home System Programmes - Socio-economic and technical evaluation, and comparison with grid electrification for the period of 1996 to 2001*, 2003

[3] Source: MME, *Assessment of two Namibian Solar Home System Programmes - Socio-economic and technical evaluation, and comparison with grid electrification for the period of 1996 to 2001*, 2003

approach unfeasible. It is currently perceived that Namibia does not have the critical mass to support such an approach. In 2004 the fee-for-service systems were converted to ordinary SHS with beneficiary households paying monthly installments for a specified period, after which they will own the system.

5.2.4.3 Solar Villages

Three solar villages were installed by MME. The first at Onamunhama village, Ohangwena Region, in 1997 and a further two in 2000 at the villages of Spitzkoppe (Erongo Region) and Lianshulu (Caprivi Region). The solar villages were provided with SHS for individual households, solar systems for clinics, schools and/or community halls, solar street lights and solar water pumps. The systems were provided free of charge by MME, but the villages are required to ensure the maintenance of the systems. In order to cater for the communal systems community-based revenue collection was established and households are required to make minimal monthly contributions towards a general maintenance fund. Although the majority of systems are still operational no further large scale investments into the installations have been made.

5.2.4.4 AccuPower Project

The University of Namibia, commissioned by MME in 1999, installed a solar battery charging station at Uupindi, Oshana Region. The battery charging station sported a large solar PV array at which households could charge their batteries. Households were provided with complete SHS, but without the PV panels and 148 systems were installed. In order to charge their batteries, a household would swap its "empty" battery with a "full" battery at the charging station against a fee. Objective of the project was to reduce the overall cost of rural electrification, by avoiding the high expenses for the PV modules. Transporting of the 12kg batteries did prove cumbersome however, and it was later opted to provide the households with the PV panels. The project expired in 2002.

5.2.4.5 Institutional Systems

Solar systems for schools, clinics, street lighting and other community infrastructure were installed by MME and the Ministry of Works, Transport and Communication since the mid 1990s. About 50 schools and clinics were solar electrified. In addition the Ministry of Agriculture, Water and Rural Development and the Ministry of Environment and Tourism have made use of solar technologies for water pumping.

5.2.5 Green House Gas Emissions[4]

Green House Gas (GHG) emissions in 1994 were 5,614 Gg CO_2 equivalent, with the transport sector being the single largest contributor at 50%. Enteric fermentation through digestion in cattle and sheep contributes 98% of methane (CH_4) emissions. However, Namibia is nonetheless classified as a carbon sink, absorbing an estimated 3 times as many GHG than it produces. The GHG Inventory currently being finalized by the Directorate of Environmental Affairs only considers GHG actually emitted here in Namibia. As such, GHG emissions resulting from electricity imports from South Africa, which produces 98% of its electricity from coal-fired power stations, are not regarded as "Namibian emissions", despite Namibia being an end-user of this electricity. Thus, accurate figures on GHG savings for grid electricity replacing RE technologies, such as SHS and SWH, are not available.

However, a study (REEE 6/99 – Phase 1 Promotion and Macro-Economic Analysis of Solar Water Heating in Namibia) commissioned by the MME and completed in January 2001 estimates that the current 73,000 electrical geysers consume an estimated 255 GWh/annum,

[4] Source: MET, *Review of Greenhouse Gas Emission Factors for Namibia Draft Report*, 2005

which amounts to 28% of the total municipal purchases from NamPower, or 14.3% of the total units sent out by NamPower. Using different market penetration scenarios, the study calculated that an income from GHG Credits (Carbon Trading) could amount to between N$20m to N$125m over 15 years at a value of N$100 per ton of CO2 mitigated.

In 2003 Namibia's Agricultural Sector consumed 30,114 tonnes of diesel. In terms of diesel consumption for water pumping, figures were not available. In the absence of calculating the average diesel consumption per water installation and the amount of diesel-operated water installations, the potential GHG emission savings are hard to estimate. PVP, a viable alternative to diesel pumps, operate most cost-effectively within the parameters of boreholes with up to 5 m³/hour capacity and with a total head not exceeding 150 meters.

5.2.6 Renewable Energy Technologies and Applications

5.2.6.1 Introduction

This Baseline Study focuses on solar energy technologies as applicable to Namibia. The solar technologies with the most scope in Namibia are Photovoltaic Pumps (PVP), Solar Water Heaters (SWH), Solar Home Systems (SHS) and Solar Cookers (SC). This study did not further investigate other RE technologies, such as solar street lighting and solar-hybrid mini-grid installations.

5.2.6.2 PV Pumping

There are three main types of photovoltaic (solar) water pumps commercially available in Namibia: AC Submersibles, DC submersibles and DC hammerheads. Submersible pumps are attached to a water pipe, power cable and rope and lowered directly into a well or borehole (it is recommended however that AC submersibles be attached to steel pipes, since they are high volume water pumps). Hammerheads are installed above ground and utilise conventional piston-type cylinders, steel pipes and pump rods, as they are used by wind water pumps and some types of Diesel pumps. Submersibles are more electronic in nature, while hammerheads are more mechanical. AC submersibles require a DC/AC inverter and are designed for bulk water supply (40,000 - 80,000 litres per day), DC submersibles are coupled directly to the solar panels and supply 4,000 - 10,000 liters per day and hammerheads are designed mostly for deep-well pumping applications and deliver 7,000 - 25,000 litres per day. The water deliveries are only a rough indication and vary significantly depending on the pumping depth, required up-hill pumping, number of solar panels, geographic location, season, etc. AC submersibles are imported from Europe and the USA, DC submersibles are mostly imported from South Africa and Europe, and hammerheads are manufactured in Namibia.

The table below provides more information about the different solar water pumps, according to a fixed pumping depth (50 meters) and their respective maximum daily water deliveries.

Rural PVP with Tower
(Robert Schultz: 2005)

Game PVP with Solid Tower
(Robert Schultz: 2005)

Table 4: Photovoltaic Pumps

ETA HR 04 DC Input (including PV panels and stand, cables, installation materials, etc.)

Daily water delivery: 7,000 litres and installed at 50m

Type: DC Submersible

Available price history (N$, VAT excl.):

NOTE: The ETA pump only began to be sold in 2003

1999	2000	2001	2002	2003	2004
*	*	*	*	N$ 20,000	N$ 24,000

JUWA (including solar panels and stand, cables, installation materials, etc.)

Daily water delivery: 15,000 litres and installed at 50m

Type: DC Hammerhead

Available price history (N$, VAT excl.):

1999	2000	2001	2002	2003	2004
N$ 30,000	N$ 35,000	N$ 35,000	N$ 41,000	N$ 43,000	N$ 55,000

Grundfos SQFlex AC or DC power input (including PV panels and stand, cables, installation materials, etc.)

Daily water delivery: 15,000 litres and installed at 50m

Type: DC Submersible

Available price history (N$, VAT excl.):

1999	2000	2001	2002	2003	2004
*	*	*	N$60,000	N$54,000	N$56,000

Grundfos SA / 1500 3-phase stainless steel centrifugal pump (including DC/AC inverter, PV panels [54 @ 55Wp] and stand, cables, installation materials, etc.)

Daily water delivery: 50,000 litres and installed at 50m

Type: AC Submersible

Available price history (N$, VAT excl.):

1999	2000	2001	2002	2003	2004
N$175,000	N$175,000	N$180,000	N$200,000	N$150,000	N$ 110,000

Additional Information:

- Installation costs are included in the above costs, since it is recommended that the installation is done by a suitably experienced contractor. Only the Watermax could be sold "off-the-shelve" if a comprehensive installation manual is provided. However, transport costs to a site are not included and are typically N$ 4.50 per km.
- Maintenance requirements differ significantly. All pumps include electric motors whose carbon brushes need periodic (2 – 3 years) replacement, unless a brushless motor is supplied. Maintenance for submersible pumps needs to be done by qualified personnel, while maintenance for hammerheads can be done by semi-qualified personnel on site. Maintenance for the latter mostly involves the replacement of bearings, fan belts and cylinder piston rings.
- There are 4 companies in Namibia specialising in PV pumping and a number of other companies who periodically supply PV pumps.
- Submersible pumps are installed below ground and are thus not accessible. Care should be taken with hammerheads, which are above ground and which, during operation, could injure careless persons.
- PV pumps consist predominantly of steel and other metals, which are easily recyclable. They further have very few components that require regular replacing or that would cause an environmental hazard.

* The ETA Pump only start to be sold in 2001 while the Grundfos SQFlex only in 2002.

5.2.6.3 Solar Water Heating[5]

Solar water heating has a significant potential in Namibia on both macro- and micro-economic levels and is extensively used in off-grid areas by rural clinics, hostels and an increasing number of commercial farms. Although there are different types of solar water heating technologies, the most appropriate for Namibian conditions is the indirect or dual-cycle system. In this system the water heated by the Sun is not in contact with the tap water and rather transfers its heat through a heat exchange mechanism and then returns to be heated anew. This prevents fresh water from passing continuously through the system and depositing lime into pipes and tubes, thus clogging the solar water heater. Indirect solar water heaters have extremely low maintenance requirements, no operating requirements, up to five-year warranties and have a lifetime of 10 to 15 years, after which leakages and glass discolouration might occur. There are at least four different indirect solar water heater brands in Namibia (unfortunately none manufactured locally), all with a similar quality, distributed and installed by their respective Namibian companies. The information below was provided by one of these companies.

Solar Water Heaters

(Robert Schultz 2005)

[5] Source: MME, *REEE 6/99 – Phase 1 Promotion and Macro-Economic Analysis of Solar Water Heating in Namibia*, 2001
Source: MME, *REEE 6/99 – Phase 2 Promotion and Macro-Economic Analysis of Solar Water Heating in Namibia*, 2002
Source: MME, *REEE 2/98 – Technical and Micro-economic comparison between Solar Water Heaters and Electrical Storage Water Heaters*, 1999

Table 5: Solar Water Heaters

Water Heater Capacity	Available Price History (VAT incl.)					
	1999	2000	2001	2002	2003	2004
100 litre Solar Water Heater	N$ 6,000	N$ 6,000	N$ 8,000	N$ 5,000	N$ 5,000	N$ 7,000
150 litre Solar Water Heater	N$ 7,000	N$ 7,000	N$13,000	N$11,000	N$11,000	N$10,000
180 litre Solar Water Heater	N$ 9,000	N$ 9,000	N$15,000	N$12,000	N$12,000	N$11,000
300 litre Solar Water Heater	N$10,000	N$13,000	N$19,000	N$17,000	N$17,000	N$14,000
Installation, including installation materials (could also be done by an experienced plumber)	N$ 1,000	N$ 1,000	N$ 1,000	N$ 1,500	N$ 1,500	N$ 2,000
Transport (N$ per driven km)						
2x4 Bakkie	N$ 3.00	N$ 3.00	N$ 3.00	N$ 3.00	N$ 3.00	N$ 3.00
4x4 Bakkie	N$ 4.00	N$ 4.00	N$ 4.00	N$ 4.00	N$ 4.00	N$ 4.00
Flatbed (Dyna truck)	N$ 5.00	N$ 5.00	N$ 5.00	N$ 5.00	N$ 5.00	N$ 5.00
Additional Information:						
▪ Bi-annual to annual visual inspection (for leakages) and cleaning of absorber glass. No regular spare parts required and eventual repair costs difficult to determine (depends on whether whole components need to be replaced)						
▪ There are 4 different solar water heater brands commercially available in Namibia. Most with excellent track records and extensive local expertise and experience.						
▪ Solar water heaters are very safe to use						
▪ Most components (metal, glass, copper tubes, etc.) can be recycled, except possible insulation linings.						

5.2.6.4 Solar Home Systems

A solar home system is designed to provide a household with a basic electricity service using the Sun as a source of power. Depending on the size and its components, a solar home system can supply electricity for lights, radio, television, hi-fi, refrigerators, small electric tools and even computers. Solar home systems cannot be used for any equipment that produces heat, like stoves, kettles and irons.

A typical solar home system consists of solar panels (mounted outside the house on the roof or a pole), batteries (standing inside the house or in a special little room), a controller (to protect the batteries), cables, sockets and lights. A solar home system only provides electricity to one household and is never connected to another household's solar home system. Costs, maintenance requirements and other relevant information are summarised below and are based on the Home Power specifications.

Large Solar Home System

(Robert Schultz: 2005)

Medium Solar Home System with Street Light

(Robert Schultz: 2005)

Table 6: Solar Home Systems

Description	Available Price History (VAT incl.)					
	1999	2000	2001	2002	2003	2004
50W DC (includes 50W PV panels and stand, one 105 amp/h battery, charge controller, power gauge, 4 lights, plugs (9 and 12V) and wiring)	N$ 5,189	N$ 6,557	N$ 6,201	N$ 6,364	N$ 7,287	N$ 6,764
100W DC (includes two 50W PV panels and stand, two 105 amp/h batteries, charge controller, power gauge, 8 lights, plugs (9 and 12V) and wiring)	N$ 9,166	N$ 8,886	N$ 9,235	N$10,400	N$11,502	N$10,821
150W AC (includes three 50W PV panels and stand, three 105 amp/h batteries, 200W sine wave inverter, charge controller, power gauge, 8 lights, plugs (9V, 12V and 220V) and wiring)	N$11,762	N$11,876	N$14,790	N$21,541	N$20,214	N$18,913
350W AC (includes five 50W PV mono-crystalline modules and stand, three 105 amp/h batteries, 400W sine wave inverter charge controller, power gauge, 8 lights, plugs (9V, 12V and 220V) and wiring)	N$18,194	N$21,588	N$23,901	N$30,383	N$31,176	N$26,159
Additional Costs:						
Installation (depending on exchange rate per system)						
System B (50W)	N$ 510	N$ 510	N$ 510	N$ 510	N$ 510	N$ 510
System C (100W)	N$ 750	N$ 750	N$ 750	N$ 750	N$ 750	N$ 750
System D (200W)	N$1,150	N$1,150	N$1,150	N$1,150	N$1,150	N$1,150
System E (350W)	N$1,650	N$1,650	N$1,650	N$1,650	N$1,650	N$1,650
Transport (N$ per driven km)						
2x4 Bakkie	N$ 3.00	N$ 3.00	N$ 3.00	N$ 3.00	N$ 3.00	N$ 3.00
4x4 Bakkie	N$ 4.00	N$ 4.00	N$ 4.00	N$ 4.00	N$ 4.00	N$ 4.00
Flatbed (Dyna truck)	N$ 5.00	N$ 5.00	N$ 5.00	N$ 5.00	N$ 5.00	N$ 5.00
Solar 105 Battery (lifetime 3 – 4 years)	N$580	N$ 600	N$ 600	N$ 700	N$ 700	N$ 750
9W Fluorescent lights (lifetime: 6,000 hours @ 3hrs/day)	N$ 240	N$ 240	N$ 240	N$ 240	N$ 240	N$ 240
Additional Information:						
▪ Mono-crystalline PV modules are provided with a 25-year warranty						
▪ General maintenance tasks include: cleaning of PV modules, recommissioning and checking cable connections annually						
▪ Namibia has extensive experience and expertise in the configuration, supply and installation of solar home systems.						
▪ The only component posing a safety risk is the battery, if it short circuits. The battery should thus be covered, protected and stored in a cool and ventilated place.						
▪ Except for the battery, a solar home system contains no toxic components. The batteries can be 100% recycled, electric cables can be reused. Recycling of PV modules, regulator and other electronic components is currently not available in Namibia.						

* Prices determined based on an average of prices obtained from suppliers and other references.
* It was found that there is variation in prices from the references.

5.2.6.5 Solar Cooking

A solar cooker captures the Sun's heat and uses this heat for cooking, boiling and baking. There are three main types of solar cookers: box type solar cookers, parabolic concentrators and flat plate collector systems.

A box type solar cooker consists of an insulated box with a transparent cover made from glass or plexi-glass. Sometimes the box includes one or more adjustable external flat collectors in order to enhance solar radiation into the cooker. In the case of the Valombola wooden box cooker, this flat collector also functions as a lid for the glass cover. The maximum temperature reached by a box cooker is about 150°C. Solar box cookers operate on the greenhouse principle and do not need to track the Sun.

Parabolic concentrator solar cookers have a satellite dish shaped collector, which concentrates the solar radiation onto a focal point. The cooking pot is placed at the focal point. A parabolic concentrator solar cooker can reach temperatures as high as 200°C, but needs constant solar tracking.

A flat plate collector system is a solar cooker where the collector and the cooking part are physically separated. They thus allow solar irradiation to be harvested outside and the heat to be transferred to a kitchen in the shade or in a building. There is also no upper limit in size and very large flat plate collector solar cookers for institutional and possibly industrial use can be designed. Although this cooker does not need tracking, the heat transfer mechanism must be well designed and organized, which makes this cooker more expensive. Depending on the collector size and heat transfer efficiency, this solar cooker can provide temperatures of 130°C - 170°C. Costs, maintenance requirements and other relevant information are summarized below.

Solar Box Cooker

(Robert Schultz: 2004)

Solar Parabolic Cooker

(Robert Schultz: 2005)

Table 7: Solar Cookers

Description	Available Price History (VAT excl.)					
	1999	2000	2001	2002	2003	2004
Valombola Box Cooker Chicken size	*	*	N$ 490	N$ 500	N$ 500	N$ 500
Valombola Box Cooker Goat size	*	*	N$ 640	N$ 700	N$ 700	N$ 700
Parabolic Concentrator Normal Size	*	*	N$ 800	N$ 800	N$ 800	N$ 800
Parabolic Concentrator S Size	*	*	N$ 550	N$ 550	N$ 550	N$ 550
Note: The Valombola project started in 1999 were the project staff were under training and in 2000 with production of the different cookers before putting them for sale to their clients.						
Additional Costs:						
▪ 2 × Black Pots = N$ 100 (for solar box cookers)						
▪ Glass plate for solar box cooker (in case of accidental breakage) = N$ 30.00						
Additional Information:						
▪ Solar cookers require no regular maintenance. The black-painted base of the solar box cooker does scratch after frequent use and a new coat of paint should be applied after about 2 years. The reflector foil of the solar box cooker could also be scratched, but can be patched with ordinary tin foil.						
▪ There is 1 manufacturer of solar box cookers, while other solar cookers are periodically supplied by other dealers, most notably in the camping equipment industry.						
▪ Solar cookers require no safety precautions.						
▪ The solar box cooker is made from wood, glass, reflector foil and paint.						
▪ When purchasing more than 10 solar box cookers, discount is given by the supplier or seller. The goat size is the most common cooker purchased by clients. Sales of solar box cookers were increasing in the past, but have decreased recently due to a lack of marketing and financial support.						

* Box cooker was not available during 1999 and 2000; and the price of the parabolic cooker could not be determined for 1999 and 2000.

6 SURVEY SUMMARIES

6.1 RESEARCH METHODOLOGY

Information for this Baseline Study was obtained through surveys, interviews with relevant stakeholders and desk top studies of data contained in previous RE and related studies. The reviewed studies are listed in the Bibliography.

The survey activity included the compilation of questionnaires – refer to the Appendices section. These questionnaires were designed in partnership and consultation with the NAMREP Project Management Unit (PMU) and aimed to address both technical and socio-economic issues. Two different questionnaires were designed in view of varying interviewee expertise and involvement in the RE sector. Interviewers were recruited from higher education institutions, such as the Polytechnic of Namibia and Windhoek College of Education, and were given an intensive 1-day session in terms of conducting the interviews. After trial-testing the questionnaires and their interviewing skills, presenting their findings, the questionnaires were modified where necessary and the interview teams commenced with their tasks.

The table below indicates the sample size for the survey of *communal and commercial farms*:

Table 8: Sample Sizes in the 13 Regions

Region	Number of Questionnaires
Caprivi	10
Erongo	10
Hardap	10
Karas	10
Kavango	10
Khomas	5
Kunene	5
Ohangwena	6
Omaheke	10
Omusati	6
Oshana	0
Oshikoto	8
Otjozondjupa	10

Less than 10 questionnaires were performed in Kunene, Ohangwena, Omusati and Oshikoto, due to long distances (more than 100 km) between boreholes. The questionnaires in the Khomas Region was done telephonically because most commercial farmers work in Windhoek. There are no boreholes installed in the Oshana region – communal farmers rely on water points in the Omusati region.

For the survey of *Organisations*, individual interviews were conducted with relevant directorates and divisions. The organizations contacted included:

- Government Ministries
- Donour Agencies

- Non-Governmental Organizations
- Parastatals and
- Others (such as consulting engineer firms and private companies)

For the survey of *RE Suppliers*, individual interviews were conducted with several companies based in Windhoek and Northern Namibia that specialize in the sale and/or installation of various RE technologies.

6.2 RENEWABLE ENERGY SUPPLIERS

6.2.1 Introduction

A number of suppliers of solar energy technologies were interviewed in order to obtain information about products, sales figures and general perspectives. The interview questionnaire and the list of interviewed suppliers are included in the Appendices section.

6.2.2 Survey Results

6.2.2.1 Suppliers

Suppliers sell their products mainly to local clients at a market-related price. Most Namibian suppliers are based in Windhoek, while only a small number of suppliers service Eastern, Southern and Northern Namibia. The HOME POWER Programme introduced a supplier registration mechanism in 2004 and had received seven applications for registration from suppliers wishing to participate in the programme. Of those who applied, only two were not based in Windhoek - one was based in Tsumeb and one in Oshakati. Six companies fulfilled the registration requirements and all, except the Tsumeb supplier, are based in Windhoek.

The survey for the Baseline Study includes a total of 14 suppliers.

6.2.2.2 Supplier Interactions

Interaction and networking between the different suppliers is infrequent and the circumstances for communication between the suppliers are mostly focused on product related inquiries. Suppliers dedicate their communication to purchasing products, troubleshooting technical faults and assessing product warranties in order to sustain their own individual businesses. The limited interaction, possibly due to a competitive spirit between the suppliers, results in a lack of coordination and cooperation, which in turn makes the RE suppliers a poor lobbying entity with restricted influence on national policies and development initiatives.

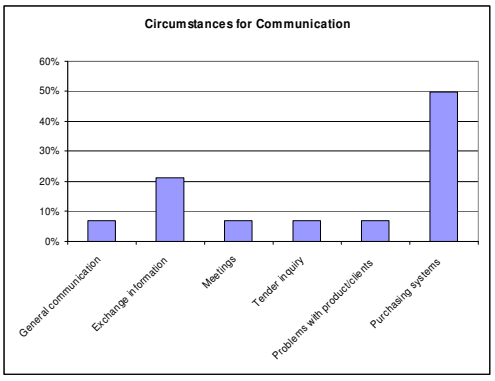


Figure 1: Circumstances for Communication

6.2.2.3 Supplier Association

The suppliers are however aware that a more coordinated approach to promoting RE in Namibia is beneficial and 85% would support an Association of RE Suppliers. Of prime concern to the suppliers is ensuring that adequate technical standards and quality control of RE technologies and equipment are maintained and possibly even enforced. There have been several attempts in the past to establish such an association, but as yet these attempts have been unfruitful. Without identifying an independent and objective driver to spearhead the association, competitiveness between the suppliers will always discourage any one of them to assume such responsibilities. In addition, the lack of funds within the RE industry, characteristically small and medium enterprises, to operate an association places an additional financial burden on the suppliers, which most can ill afford.

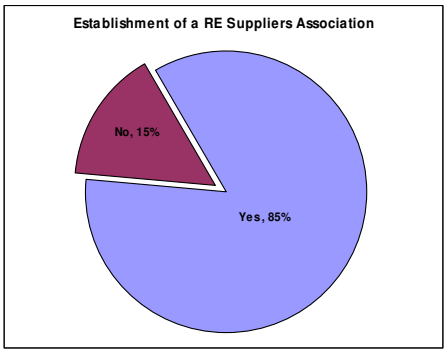


Figure 2: Establishment of RE Supplier Association

6.2.2.4 Product Marketing

Product marketing is extremely fragmented and no clear marketing strategy is in place. Most suppliers responded by indicating only one method of marketing, while a few others indicated two to three or none. Although some marketing approaches seem more popular than others, suppliers have not yet identified which marketing mechanisms are most effective in terms of selling RE technologies. Certainly financial constraints are a reason for the lack of a comprehensive and successful marketing campaign, but the suppliers' lack of marketing skills is in all likelihood a greater constraint.

Table 9: Methods of Marketing Employed by Suppliers

Method for marketing	**Suppliers**													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Demonstrations														*
Community meetings									*					
Brochure									*					
Car stickers													*	
Internet							*							
Web page									*					
Post box distribution											*			
Workshop				*										
Leaflets						*		*						
Newsletter						*			*					
Television						*		*						
Newspaper	*				*		*							
Trade fair							*						*	*
Radio								*		*			*	
Schools						*			*			*		
Other		*	*											

6.2.2.5 Product Enquiries

Suppliers are generally very proficient in the technical issues regarding their products and undoubtedly strive to deliver quality products and good service, but they lack the finesse to actively capture new clients. Marketing by "word-of-mouth" is still regarded as sufficient and it is often interpreted that it reflects positively on a supplier that he does not "need" to conduct active marketing. The poor performance of the RE sector contradicts this sentiment though. The estimated number of enquiries received by suppliers is a mere average of 22 enquiries per annum and while Suppliers 5 to 7 did not respond. The variation in number of enquiries suggests that some suppliers have more market presence (and possibly market share) while others are virtually unknown to a prospective RE client. The variation further signifies that RE technologies as such do not have a bad reputation in Namibia and is indeed a product with a potentially significant client base.

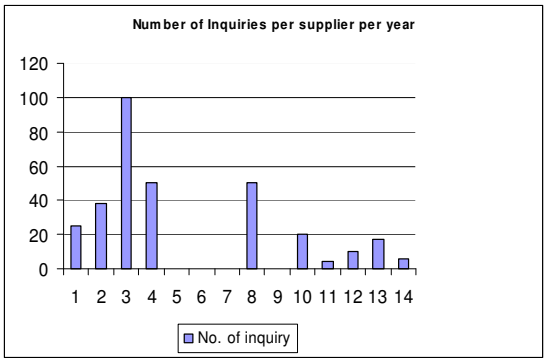


Figure 4: Product Inquiries Per Supplier Per Year

6.2.2.6 Supplier Sales

The variation in supplier performance is further confirmed in the sales tables of small SHS per supplier for the period 1999 to 2004. Some suppliers succeed in capturing significantly more clients than others. This is likely due to the fact that some suppliers have access to more marketing means and mechanisms than others. It is notable that few suppliers were registered under the Home Power programme, and only one of those interviewed has a strong market presence in Northern Namibia, where the market for RE technologies is extensive and concentrated.

Total supplier sales figures for the different RE technologies have been estimated as accurately as possible based on sales figures provided by the major suppliers. The figures include purchases made by both persons using the revolving fund and by persons/organisations not using the fund. Note that the sales of small (50 W) and large (200 W) SHS systems decreased markedly in 2003. This was due to the restructuring of the Home Power Programme, during which time the loan facility was temporarily unavailable. Since small SHS systems are typically purchased by low-income households and small businesses - the lack of a loan facility made these systems unaffordable for many. The situation improved slightly after the restructuring was completed and a Home Power Awareness Campaign was launched. The Home Power restructuring did result in increased sales of large 200 W SHS.

Table 10: Total Number of Solar Home Systems Sold Per Year

Solar Home System Power Classification (P)	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
P : less than or equal to 50 W	82	120	96	86	43	53
P : greater than 50 W, and less than or equal to 100 W	59	103	58	44	44	57
P : greater than 100 W, and less than or equal to 200 W	10	10	21	27	20	34
P : greater than 200 W	16	52	27	31	28	23
Total	**167**	**285**	**202**	**188**	**135**	**167**

Sales of solar water heaters (SWH) were somewhat erratic during the six year period;. however, the general trend is increasing.

Table 11: Total Number of Solar Water Heaters Sold Per Year

Solar Water Heater Capacity	1999	2000	2001	2002	2003	2004
100 *l*	10	15	10	19	21	21
150 *l*	0	0	0	0	0	3
200 *l*	44	41	89	44	43	97
More than 200 *l*	37	42	61	55	71	85
Total	**91**	**98**	**160**	**118**	**135**	**206**

Sales of PV Pumps (PVP) show a steady increase over the six year period, with a significant increase during 2003. Buyers paid for their pumps in a single payment. Most of the pumps were purchased by commercial and communal farmers; a few were purchased by the Ministry of Agriculture, Water and Rural Development (MAWRD) through the Directorate of Rural Water Supply.

Table 12: Total Number of Photo-voltaic Pumps Sold Per Year

Photo-voltaic Pump Power Rating (P)	1999	2000	2001	2002	2003	2004
P : less than or equal to 60 W	3	2	4	5	5	6
P : greater than 60 W, and less than or equal to 150 W	6	5	5	4	2	3
P : greater than 150 W, and less than or equal to 250 W	36	58	67	78	130	150
P : greater than 250 W, and less than or equal to 500 W	1	4	0	0	3	12
P : greater than 500 W	1	1	1	2	2	3
Total	**47**	**70**	**77**	**89**	**142**	**174**

The total sales of solar cookers have been relatively flat with no apparent trend of an signifcant increase over the six year period. Most of the cookers were purchased by environmental-related school and community projects. Only a few were purchased by individuals.

Table 13: Total Number of Solar Cookers Sold Per Year

Solar Cooker	1999	2000	2001	2002	2003	2004
Valombola Box Cooker Chicken size	0	0	0	24	19	11
Valombola Box Cooker Goat size	0	0	0	30	33	40
Parabolic Concentrator Normal Size	50	49	20	62	52	53
Parabolic Concentrator S Size	50	49	20	8	0	0
Total	**100**	**98**	**40**	**124**	**104**	**104**

6.2.2.7 GRN Support

The impact of the Home Power Programme on sales figures is apparent. Government support schemes are vital to leveling the playing field between grid and off-grid electrification. All suppliers would encourage such schemes and many are not satisfied with current GRN support and cite a general lack of policies that would create an enabling policy framework for RE. Although the White Paper on Energy Policy strongly supports RE, a White Paper on RE Policy should be formulated that supports these technologies specifically and gives a clear direction to the implementation of Namibia's RE programmes and initiatives. Government support should also include considerateion of reducing or eliminating the Value Added Tax (VAT) and any import duties on RE technologies, and negotiations with the other members of the Southern Africa Customs Union (SACU) to reduce or eliminate import duties on all RE technologies. Under current conditions, when a supplier imports solar technologies into Namibia he must pay 15% VAT, 1.5% Upliftment (10% x VAT), and sometimes an import duty. Import duties are not charged on items imported from countries belonging to the the Southern Africa Customs Union (SACU): Namibia, South Africa, Botswana, Lesotho, Swaziland). An import duty is charged on the following items when imported from a non-SACU country: inverter (10%); battery depending on size (10% or 20%), refrigerator (25% for 150 litres), lights (20%). Import duties are not charged on PV panels.

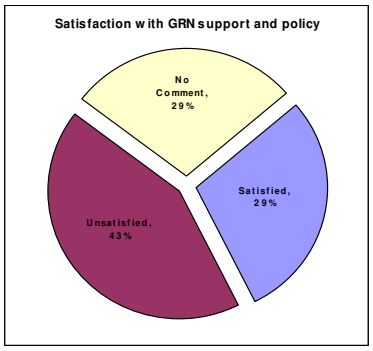


Figure 5: Satisfaction with GRN Support

6.2.2.8 RE Policy Issues

The proposed White Paper on RE Policy should address taxation issues and make allowances for RE technologies based on its value in rural development efforts. Particular emphasis should be given to the various RE technologies, rather than just treating RE in general, since each of the technologies requires different approaches, different support mechanism and addresses different target groups. The Policy should be synchronized with other development policies and programmes, e.g. the National Rural Electrification Programme, in order to avoid duplications and conflicts between different energy technologies. This in turn would ensure a stable and secure investment climate. A quality assurance and accreditation mechanism should also be pursued and the Policy should encourage the establishment of a RE Suppliers Association and the inclusion of RE into school curricula. Both would be vital in supporting additional training and capacity building programmes, which the majority of suppliers felt were necessary. Coupled to this, intensive awareness raising and marketing should also be emphasized and resources should be allocated towards these activities.

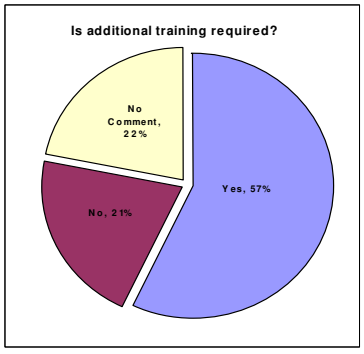


Figure 6: Additional Training

6.2.2.9 Technicians

Training in RE technologies is currently conducted mostly in-house by the suppliers and they indicated that a shortage of trained staff is a barrier to their businesses. Although suppliers generally find that the technical standard of their technicians is adequate, there are a number of areas in which their technicians would require further training. Apart from more in-depth technical skills, such as electrical and mechanical engineering, training should also be offered to increase their technicians' marketing and business management skills, general business professionalism and an ability to install and maintain a greater variety of RE technologies. More than 100 technicians were trained through the Ministry of Mines and Energy and Ministry of Agriculture, Water and Rural Development capacity building programmes. Other technicians received training in India and Germany for 6 to 12 months and obtained Certificates and Diplomas.

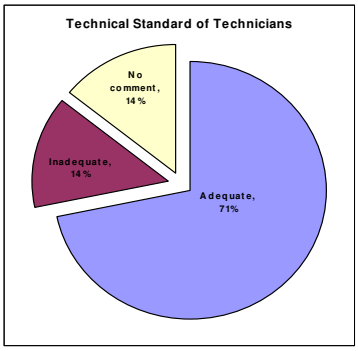


Figure 7: Technical Standard of Technicians

6.2.2.10 Product Problems

In terms of the reliability of RE technologies in the field and customer satisfaction, suppliers indicated that they do not experience too many problems. The most persistent product problems could be addressed through greater end-user awareness and information (to minimize system abuse), improved availability of trained technicians (to minimize faulty installations and poor workmanship) and more secure sources for various RE technology components (to minimize installation delays due to an unavailability of basic components). General system failures are addressed directly with the manufacturers and are often also related to the harsh operating conditions that RE technologies are sometimes exposed to.

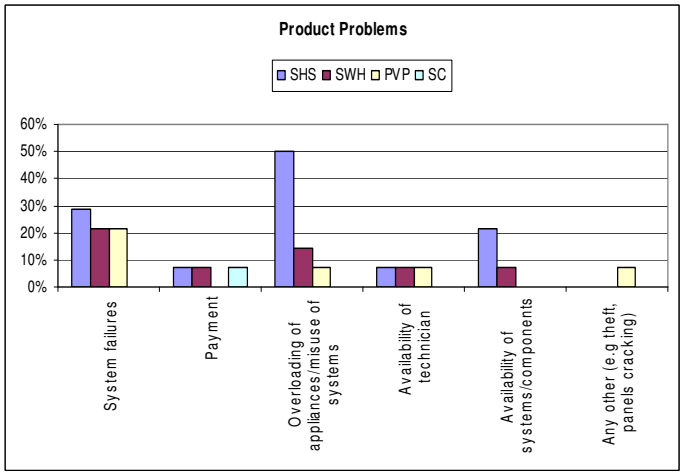


Figure 8: Product Problems

6.3 ORGANISATIONS

6.3.1 Introduction

A number of organizations were interviewed and classified into various categories. These organizations and the respective category are listed in the table below. Full contact details are included in the Appendix section.

Table 14: Organizations Interviewed

Government Ministries	Non-Governmental Organizations	Donor Agencies	Parastatal	Others
Ministry of Mines and Energy (MME), Directorate of Energy	Gobabeb Training and Research Centre (GTRC)	Gesellschaft für Technische Zusammenarbeit (GTZ)	Namibia Wildlife Resorts (NWR)	Mobile Telecommunications Company (MTC)
Ministry of Prisons and Correctional Services (MPCS)	Desert Research Foundation of Namibia (DRFN)	European Union (EU)	Telecom Namibia	City of Windhoek (CoW), Electricity Department
Ministry of Women Affairs and Child Welfare (MWACW)	SchoolNet Namibia	United Nations Education, Science and Culture Organization (UNESCO)	NamWater	Emcon Consulting Group
Ministry of Higher Education, Training and Employment Creation (MHETEC)	Renewable Energy and Energy Efficiency Bureau of Namibia (R3E)	United Nations Development Programme (UNDP), Small Grants Programme (SGP)	Habitat Research and Development Centre (HRDC)	Electricity of Control Board (ECB)
Ministry of Basic Education, Sports and Culture (MBESC)			AgriBank	Namibia Agricultural Union (NAU)
Ministry of Agriculture, Water and Rural Development (MAWRD), Directorate of Rural Water Supply			Namibia Broadcasting Corporation (NBC)	
Ministry of Trade and Industry Department of Investment Directorate of Registry of Companies				
Ministry of Works, Transport and Communication				
Konga Investment				
Ministry of Finance Directorate of Inland Revenue Directorate of Customs and Excise				

6.3.2 Survey Results

6.3.2.1 RE Technology Utilization

The utilization of RE technologies and selection criteria vary between the different organizations. Of the GRN ministries interviewed, half operate RE technologies, mostly where this technology is cheaper (e.g. PVP in very remote areas) or where donor agencies have contributed financially to the purchase and installation of the technologies. Of the parastatals that use RE technologies the criteria for selection was almost exclusively financial (e.g. telecommunication installations on inaccessible mountain tops). NGOs making use of RE technologies consider the high initial cost, but also use sustainable development, energy self-sufficiency and environmental protection as criteria. Most NGOs are also proficient in compiling project proposals that include RE technologies and have experience in accessing international funding.

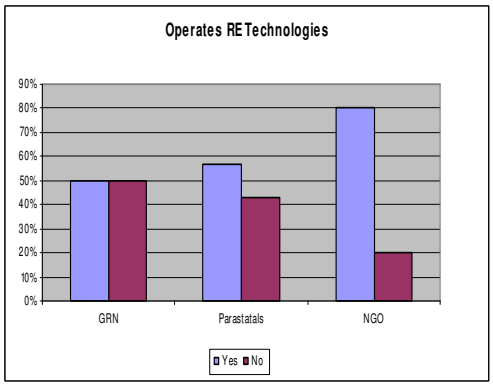


Figure 9: RE Technology Utilization

6.3.2.2 Awareness

There is a general awareness about the potential of RE technologies, but little in-depth knowledge and little real consideration for RE technologies to be included in long-term development initiatives. The survey also indicates that there is limited interaction and information exchange between organizations as is reflected in the low awareness of the Home Power Programme. NGOs surveyed were all aware of the programme and have in the past promoted the programme through their own initiatives and projects.

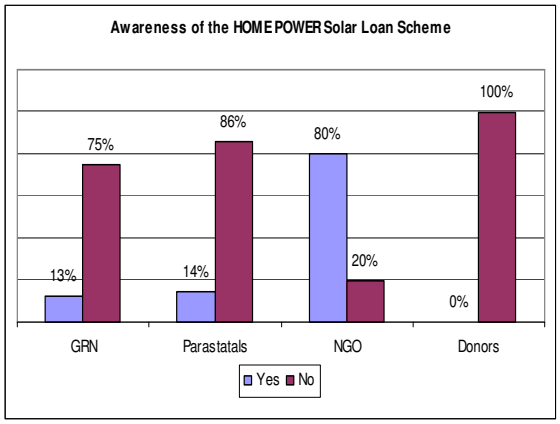


Figure 10: Awareness of the Home Power Programme

6.3.2.3 RE Barriers

The organizations surveyed identified issues they regard as barriers to the greater implementation of RE technologies. As would be expected, the high initial cost of RE technologies was considered the dominant barrier and all organizations shared this view. The fact that many of the technologies or important components thereof were imported, rather than manufactured locally, contributed to the high cost. Spare parts are generally not available when needed, which has a negative impact on the image of RE for potential owners. Theft of RE systems and components is also a significant barrier and strongly affects isolated installation where there is little supervision and no sense of ownership by the surrounding communities. Protective measures such as increased pole height for PV panel arrays and barbed wire are a proven deterrent, but increase the cost and are still no guarantee against theft. Although males are typically the buyers, females are often the actual end-users. The lack of early involvement by the actual RE users contributes to an image that maintenance of RE technologies is complicated.

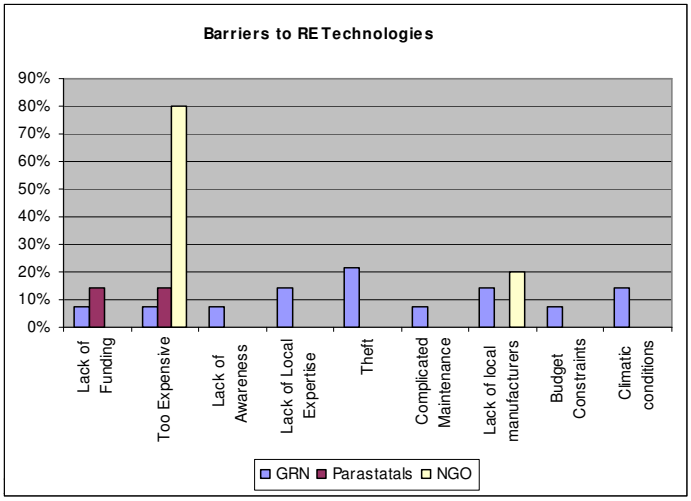


Figure 11: Barriers to RE Technologies

6.3.2.4 RE Policy

In terms of national policies that support RE, donor agencies refer mostly to: National Development Plans 1, 2 and 3, Vision 2030, the White Paper on Energy Policy and various UN Policies on climate change (UNFCCC, UNCBD, UNCCD). Many donor agencies can support RE projects only if they contribute to greater national objectives, as they have been specified by Namibia's highest governing bodies. Unless RE is given a clear mandate, support for the sector can only be very limited. Several donor agencies indicated that GRN should consider a policy on RE and one agency recommended that an Urban Energy Policy is also drafted. The RE policy should address taxation issues and encourage mechanisms to ensure that commercial banks provide loans for RE technologies.

6.3.2.5 Installed PVP

The most reliable figures for installed PVP were obtained from the Directorate of Rural Water Supply. The figures depict the water points by technology installed by DRWS. Only a mere 1% of total installations are PVP. There is a high value for installed windmills (either as stand alone or in combination with Diesel), since this was the off-grid technology of choice in the past. There are an estimated 30,000 windmills in Namibia, but the technology is gradually being replaced by more efficient and cheaper PVP technology. Communal taps along pipelines dominate the water point infrastructure. This is in many cases, especially in sandy northern Namibia, the most cost effective means of supplying water. Bulk water installations at strategic location supply the pipelines and can be maintained centrally. It is unlikely that PVP technology can replace this means of water supply in the short-term. However, PVP can in most instances replace windmills, hand-pumps and Diesel installations.

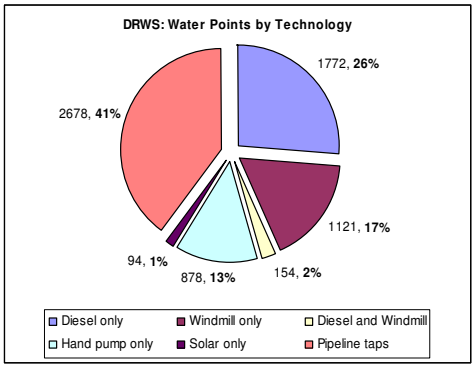


Figure 12: Water Points by Technology

6.4 COMMUNAL AND COMMERCIAL FARMS

6.4.1 Introduction

A survey of communal and commercial farms was conducted in several villages of 12 of the 13 Namibian Regions. The results of the survey are presented on a regional basis in Section 7 of this report. The table below indicates the regions and villages where the surveys were conducted:

Table 15: Regions and Villages where Communal and Commercial Farms Were Surveyed

Region	Villages
Caprivi	Mayoni, Ncheza-Namalubi, Kongola, Kanono, Simanga, Mutombwe-Sikumbi, 35 Miles, Ikumwe, Milunga, Sinte liyali
Erongo	Usakos, Erekere, Omuzema, Otjohorongo, Okanuanambuku, Ovihitua, Ondgombo, Ozondate
Hardap	Gibeon, Swartrand, Bondels traditional
Karas	Feldschuhorn, Keetmanshoop, Narubis, Beseba,Karasburg
Kavango	Yinsu, Mile 10, Kaguni, Mile 20, Cuma, Mavanze, Shamambungu, Shimpanda, Ncancana, Ngarama
Khomas	Prospect, Windhoek district, Nauzerus, Kleinboesman, Langbeen,
Kunene	Otutati, Ondjete, Okahozu, Okondaurue
Ohangwena	Oshiti, Onele yiwa, Oshiti shiwa, Omadiva, Okongo/Jin
Omaheke	Aminius, Epukiro, Otjinene, Otjombinde
Omusati	Onamukuku, Okatha kongala, Okambombona, Omakange no.1, Omutumba
Oshikoto	King Kauluma, Manghetti, Onamishu, Omakunde, Onghumbula
Otjozondjupa	Otjiunutjokotjone, Omupanda, Okakarara, Okavare, Okatuakovenua, Marullaboom, Okamatapati, Okondjatu

The objective of the survey was to assess the current status and potential of specific RE technologies, most notably SHS, SWH and PVP. Sample sites were selected following advice from the Ministry of Agriculture and Water Rural Development (MAWRD), Regional Directorate of Rural Water Supply (DRWS) on borehole distribution, general borehole

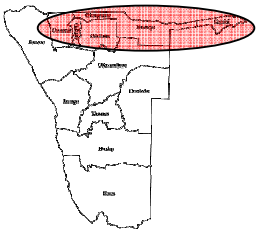
characteristics and the presence of Water Point Committees. In addition the Rural Electricity Distribution Master Plan was analysed to provide information on unelectrified rural settlements with a strong SHS and SWH potential. Villages were chosen with maximum distances from each other in order to ensure a wider spread of information and to avoid basing assumptions on unique local conditions.

6.4.2 Background Information

6.4.2.1 Demographic Areas

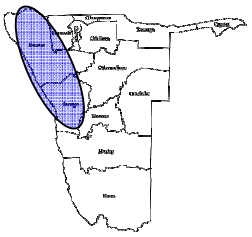
In terms of the demographics of communal and commercial farms in Namibia with regard to RE technologies, one can roughly distinguish 4 different areas:

- **North Central and Far Eastern Namibia:**



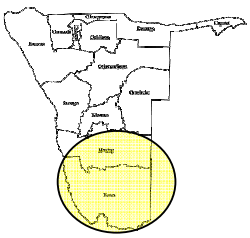
This area is characterized by high population numbers and population densities. Levels of education are low to very low and society is strongly patriarchal. Agricultural activities are mostly subsistence in nature and focus primarily on cattle and goats coupled with crop production in the rainy season. The vast majority of the population lives in rural areas and there is heavy reliance on government sponsored infrastructure. The area comprises almost exclusively communal land. There is a low to medium level of RE awareness. Communities are generally not well informed about RE and in most cases; the care takers responsible for maintaining the village boreholes are the only persons that are informed.

- **North Western Namibia:**



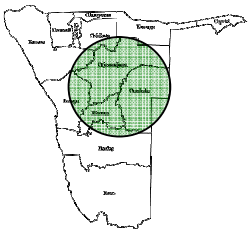
This area characterized by extremely low population numbers and density. Education levels are very low and strong patriarchal structures persist. The climate is arid and agricultural activities are mostly subsistence in nature and focus primarily on cattle and goats. There is virtually no crop production on a household level. About a quarter of the population lives in urban centres and more than half the area is communal land. There is a low level of RE awareness.

- **Southern Namibia:**



This area is characterized by extremely low population numbers and density. Levels of education are moderate to low and society shows more female emancipation. The climate is arid and agricultural activities focus on small livestock such as sheep and goats and drought hardy livestock such as ostriches. There is virtually no crop production on a household level. About half the population lives in urban centres and about 70% is commercial farm land with national parks covering another 20%. There is a medium level of RE awareness.

- **Central and East Namibia:**



This area is characterized by low population numbers and population densities. Levels of education are moderate to low and society shows limited female emancipation. The climate is semi-arid and agricultural activities focus on large livestock such as cattle and the area is severely bush encroached due to overgrazing. There is very limited crop production on a household level. About a quarter to half the population lives in urban centres and about 60% is commercial farm land and 35% is communal land. There is a medium level of

RE awareness.

The differences in the above areas need to be considered when addressing barriers to RE technologies. Product choices and awareness approaches need to be adjusted and different service delivery approaches identified.

6.4.2.2 PVP Potential in Rural Areas

PVP technologies are relatively common in southern Namibia compared to the rest of the country, but total penetration is still low. PVPs operate most cost effectively on boreholes with a total head not exceeding 150m and where low (up to 5 m³ per day) to medium (up to 15 m³ per day) water pumping is sufficient. In these instances the amortisation of a PVP's cost compared to diesel is between 18 to 24 months. Diesel pumps can deliver far more water and can pump from greater depths, but regarding boreholes within the above parameters, diesel technology often results in over pumping. This in turn increases cavitations of borehole wall (specifically those that are not protected by steel or plastic casings), increased erosion and a subsequent collapse of the borehole. To avoid over pumping, diesel pumps need to be switched off as the water level sinks below the borehole cylinder, this requires constant daily supervision and can be cumbersome and costly especially if boreholes are remote (due to traveling). Another option is to throttle the diesel pump's power output, thus reducing the hourly water delivery, but diesel engines not operating on peak performance and load are far more prone to damage and require greater maintenance.

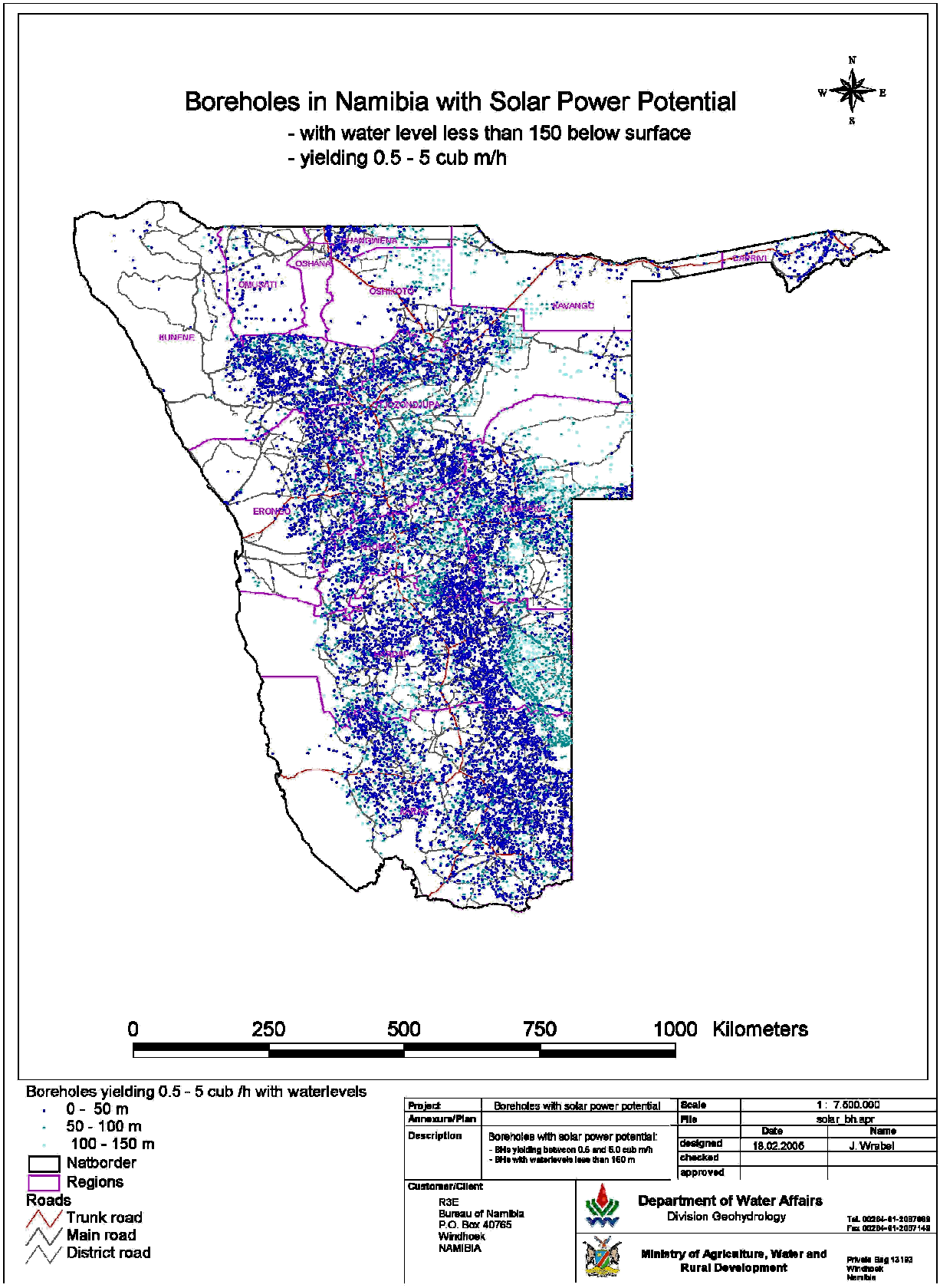


Figure 13: Boreholes with Solar Powered Potential

Namibia has 15,747 boreholes that fulfill the crieria of water deliveries between 0.5 and 5 m³ per day and with water levels less than 150 m below surface. This is a significant PVP potential.

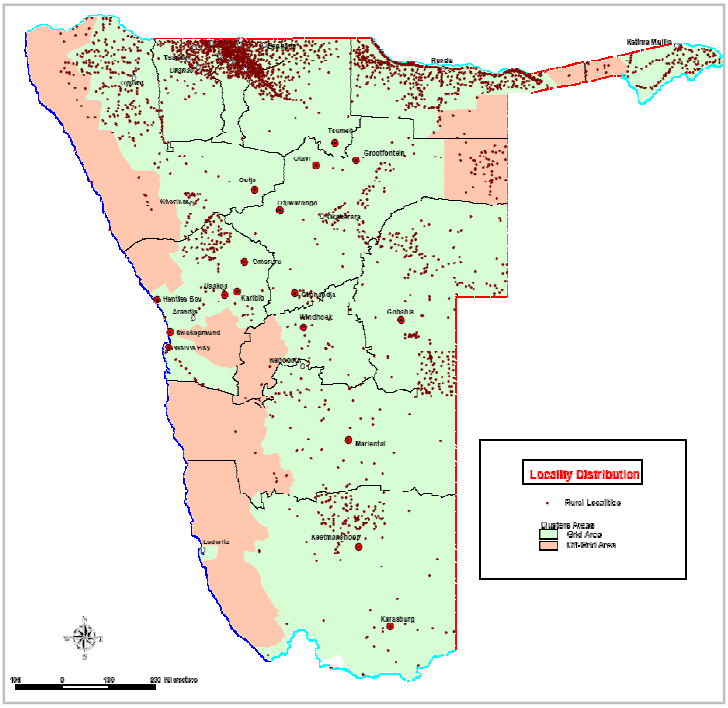
The table below provides detailed figures and percentage distribution of these boreholes.

Table 16: Catergorisation and Percentage of Boreholes by Depth and Yield

Number of boreholes	Depth range (m)	% of total	Number of boreholes	Yield range (m³)	% of total
11,406	0-50	72.4	7,030	0.5-2.0	44.6
3,522	50-100	22.4	4,499	2.0-3.5	28.6
819	100-150	5.2	4,218	3.5-5.0	26.8

6.4.2.3 SHS Potential in Rural Areas

Of Namibia's 2,855 rural settlements about 2,400 are unelectrified, of which 131 are situated in designated off-grid areas. The remaining unelectrified settlements are scheduled for grid electrification over a 20 year period. There is a clear demand for SHS ranging from 50Wp for basic household energy services to 350Wp for small and medium enterprises such as cuca shops.

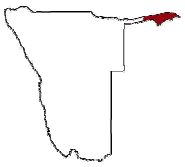


Source: Rural Electrification in Namibia, MME, 2001
Figure 14: Rural Electrification

SHS are technically more sensitive than PVPs primarily because they are more prone to tampering and abuse by end users. The 250 Wp SHS offered under the HOME POWER Programme (referred to a System E) was very popular, but was also the most troublesome of all the systems. Although undersizing was the main reason for System E's failures, undersizing by nature automatically implies overutilisation. Possibly more efficient usage of the system by end users and more awareness about the limitations of SHS systems might have prevented some of the failures.

Beyond SHS, Namibia's off-grid areas also present some ideal locations for larger solar systems such as solar mini-grids (possibly combined with other energy technologies like Diesel). The Gobabeb Desert Research Station (situated in the Namib Naukluft Park in the Hardap Region) recently launched a 26kWp solar-Diesel hybrid system, while Tsumkwe (in Eastern Bushmanland in the Otjozondjupa Region) also offers excellent prospects due to its relatively high population and remoteness from the national electricity grid.

7 REGIONAL REPORTS



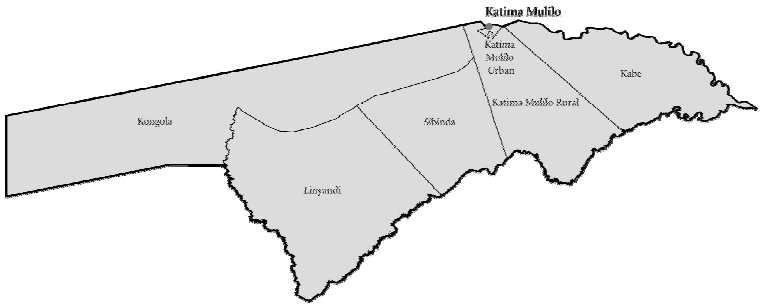
7.1 CAPRIVI[6]

7.1.1 Introduction

The Caprivi Region, covering an area of 14,564 km^2, is the most north-eastern region of Namibia and is surrounded by the countries of Angola, Zambia and Botswana. It borders the Kavango Region in the west.

The Caprivi stretches 295km from east to west and ranges between 32 and 100km in width from north

to south and is divided into two distinct areas: Eastern Caprivi, east of the Kwando River, and Western Caprivi, west of the Kwando River. The main centres of the Region are Katima Mulilo, Bukalo, Linyanti, Kongola and Ngoma. The Region comprises 6 constituencies: Kabe, Katima Mulilo Rural, Katima Mulilo Urban, Kongola, Linyanti and Sibinda.



The climate in the Caprivi Region is distinctly more tropical than any of the other regions. This part of Namibia receives relatively high rainfall, with Katima Mulilo averaging about 700 mm per annum and the trend declining southwards to an average of about 500 mm per annum. Nevertheless, rains are still highly variable in time and space, and recorded totals vary between 300 and 1,000 mm. Temperatures are mild to hot, with the highest maximums in early summer, and minimum temperatures a few degrees above zero in winter.

Agriculture is one of the most important economic activities in the Caprivi Region and the Region is suitable for livestock and crop production. Cattle dominate livestock farming while three crops (mahango, sorghum and maize) are cultivated in the Caprivi. The agricultural sector is strongly subsistence in nature, but with growing a growing commercial farming sector. Land in the Caprivi Region is either under state or communal administration. Communal land is enclosing about 56%, agricultural projects about 1,8%, state forest 7,5% and national parks enclose about 34,6% of the Region. Tourism is proving a viable supplement and alternative to subsistence farming.

The Caprivi Region has an estimated total population of 91,800 people (6.4% of the Namibian population), a high average population density 8.17 people per km^{2}and an average household size of 4.8 people. Most people derive their livelihood from agriculture and an estimated 85% of the Caprivi Region's population live in rural areas.

The Caprivi Region is served by 1 hospital, 4 health centres, 22 clinics and104 schools. There are 126 rural settlements in the Caprivi Region of which 118 are unelectrified. The unelectrified settlements include 71 unelectrified schools, 14 unelectrified agricultural development centres, 25 unelectrified and several unelectrified administration and public offices.

[6] Source: MME, *Rural Electricity Distribution Master Plan: Caprivi Regional Report*, 2000
Source: NPC, *2001 Population and Housing Census National Report*, 2003

7.1.2 Survey Results

7.1.2.1 Respondents

Of the 10 respondents interviewed, one was female and most were farmers. A few of the respondents were teachers and businessmen. The level of formal education of the respondents is diverse and relatively low except very few respondents with teaching diploma. All villages surveyed were located on communal lands. The strong patriarchal culture demands that males make most decisions regarding the development of the households. These needs to be strongly considered when RE technologies are promoted in the Region. RE technologies that decrease the male's burden on the household and increase livestock productivity would have greater success than technologies that decrease the female's burden. Awareness campaigns through radio and other print media might be successful, although demonstration approaches would be preferred.

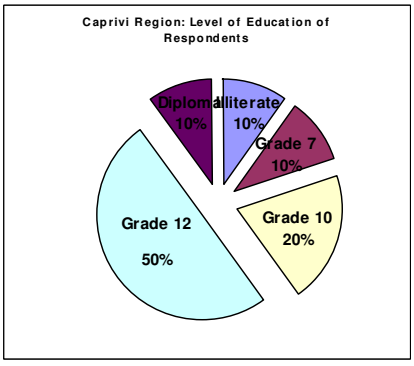


Figure 15: Level of Education of Respondents in the Caprivi Region

7. 1.2.2 Livestock

Regarding livestock distribution in the Region, farming is dedicated mostly to cattle, with goat farming a suitable supplement in the region. Exact livestock figures per household range between 60 and 192 heads of cattle and 25 to 65 goats. Cattle provide traction power necessary to plough fields, milk, hides, or cash and meat. Goats are kept for meat production and sale. Water sometimes is a problem and livestock diseases. Household normally buy drugs from nearby town or make use of veterinary services.

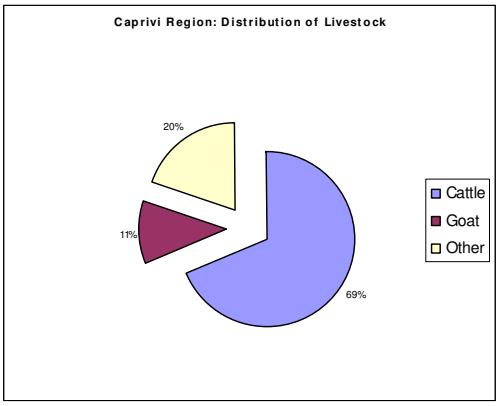


Figure 16: Distribution of Livestock in the Caprivi Region

7.1.2.3 Water

Water in the Caprivi Region is supplied by boreholes, except in the Katima Mulilo constituency, where a pipeline from the Zambezi River supplies water to Katima Mulilo, Mpacha and Mafuta. All respondents rely on diesel boreholes, which were established by DRWS. The greatest borehole depth noted was 45m. Borehole installations are managed by Water Point Committees and their designated Water Point Caretakers. The caretaker position is voluntary - the person fulfilling the duty receives no remuneration. Apart from being responsible for the installation's maintenance, a Water Point Committee also has a treasurer responsible for collecting fees from users.

7.1.2.4 Income and Expenditure

In terms of monthly expenditures diesel fuel expenses and maintenance of borehole installation equipment rank highest. Few of the respondents have electricity while wood fuel is collected free of charge. Household income ranges between N$ 800 (selling of livestock) to N$ 5000 (teacher and business) per month with an average income of N$1 906 per month.

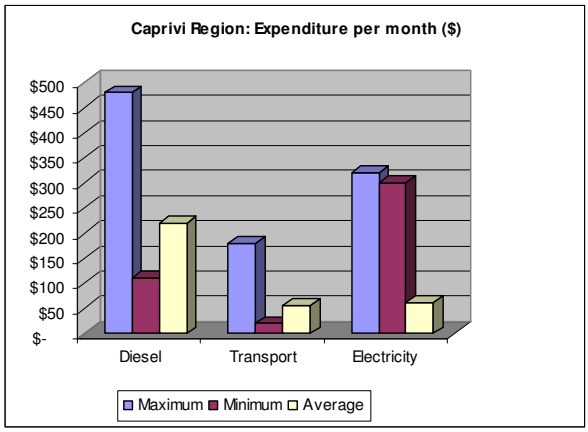


Figure 17: Income and Expenditure in the Caprivi Region

7.1.2.5 Awareness

More than 70% of the respondents were unaware of the HOME POWER Programme. Substantial awareness raising needs to be conducted to increase the usage of RE technologies in the Region. Although none of the respondents own or operate a PVP, 30% of them were familiar with PVPs, mostly due to communication and interactions with neighbouring people. 30% of the respondents are willing to buy PVP technologies.

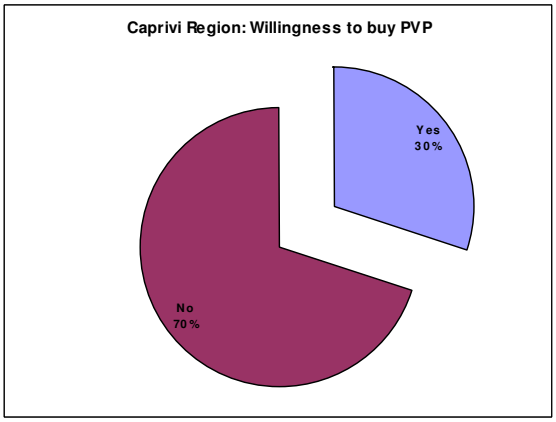
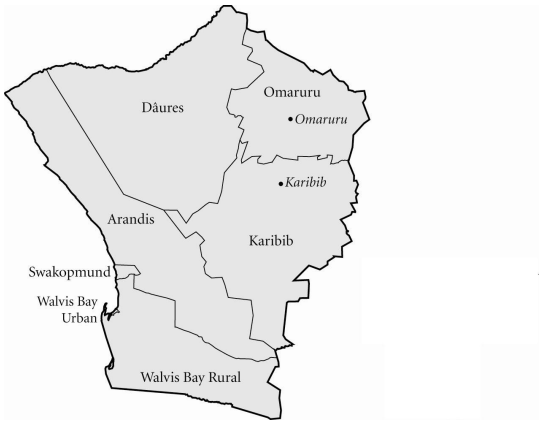


Figure 18: Willingness to Buy PVP

7.2 ERONGO

7.2.1 Introduction

The Erongo Region has a surface area of 63,720 km^2 and is located in the central western section. Erongo is bordered in the north by the Kunene Region; in the east by the Otjozondjupa and Khomas Regions; in the south by the Hardap Region; and in the west by the Atlantic Ocean. The Region includes 7 constituencies: Swakopmund, Walvis Bay Urban, Walvis Bay Rural,region, Omaruru, Karibib, Arandis and Daures.



The climate of Erongo Region is very dry. The average annual rainfall follows the escarpment, and rainfall decreases sharply towards the coast. At Omaruru in the interior, annual rainfall can get as high as 60mm. Frequent fog in the coastal belt brings moisture that is vital to the desert ecosystem. Seasonal changes in climate are moderate at the coast, and more pronounced in the interior. Here, summers are hot and there is a fairly distinctive wet season from about October to March.

The agricultural sector in most of the region is comprised of mixed stock farming. Commercial farmland is primarily situated in the Omaruru and Karibib magisterial districts, while communal farmland is found in the Omatjette, Otjihorongo an Otjimbingwe reserves.

The Region is served by 4 hospitals, 1 health centre, 16 clinics and 52 schools. 16 of the schools are not supplied with electricity.

7.2.2 Survey Results

7.2.2.1 Respondents

Of the 10 respondents interviewed, 6 were female. Most respondents were self – employed farmers. The level of education of the respondents was considerably low. The relatively low level of education would necessitate greater efforts to promote RE technologies. Awareness raising initiatives could include television, but should also include print media such as newspaper advertisements & articles, posters and brochures.

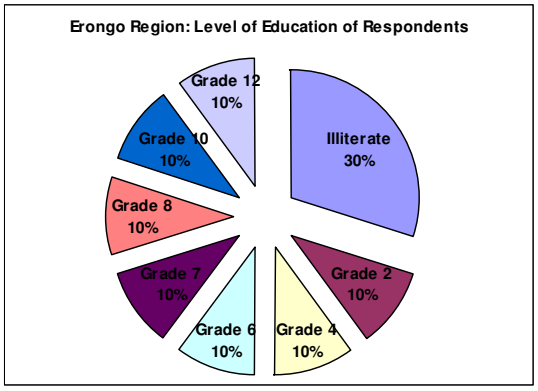


Figure 19: Level of Education in the Erongo Region

7.2.2.2 Livestock

Livestock farming in the Region represents an important source of income. Cattle and goats are the main source of income and provide traction, milk and meat for households. Exact livestock figures per households range between 8 to 270 goats and 2 to 120 heads of cattle, 5 to 90 sheep and 6 to 20 donkeys. Water scarcity is the main problem for livestock farmers who must move their livestock to seek water and grazing areas.

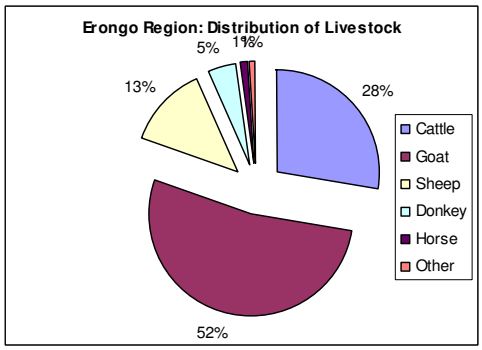


Figure 20: Distribution of Livestock in the Erongo Region

7.2.2.3 Water

Two of the respondents rely on wind-powered boreholes – all of the other respondents rely on diesel-powered boreholes that are maintained and funded by the DRWS. The maintenance expenses are recovered by Water Point Committees (households contribute towards expense such as diesel, transport and replacement of belts and other small items). Borehole installations are managed by Water Point Committees and their designated Water Point Caretakers. The caretaker position is voluntary - the person fulfilling the duty receives no remuneration. Apart from being responsible for the installation's maintenance, a Water Point Committee also has a treasurer who is responsible for collecting fees from users. In view of a lack of remuneration, this position is susceptible to profiteering and abuse.

7.2.2.4 Income and Expenditure

In terms of monthly expenditures diesel fuel expenses and maintenance of borehole installation equipment rank highest. Very few respondents have access to electricity, while wood is collected free of charge.

Household income ranges between N$ 700 (selling bread) to N$ 1 000 (teacher) per month.

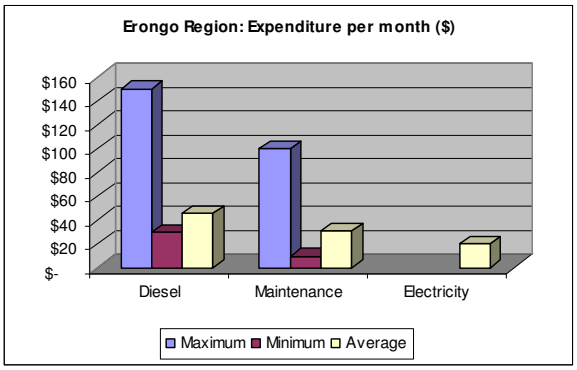
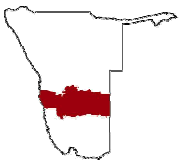


Figure 21: Expenditure Per Month in the Erongo Region

7.2.2.5 Awareness

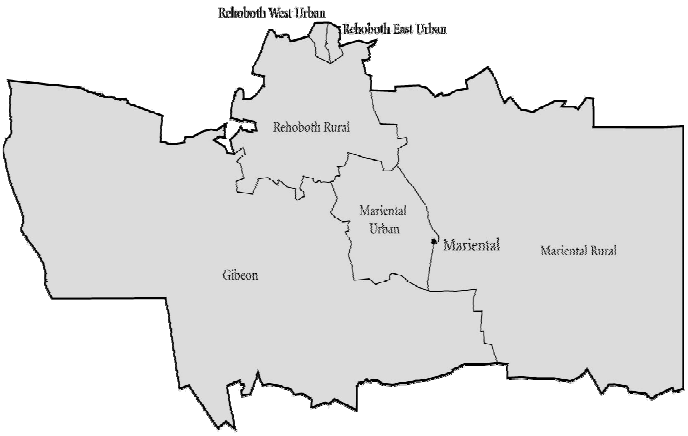
None of the respondents were aware of the Home Power Programme. It is clear that significant awareness raising is needed to increase the usage of RE technologies in the Region. There is no willingness to buy PVP technologies due to the high price and risk of theft of PV panels.

7.3 HARDAP[7]



7.3.1 Introduction

The Hardap Region comprises an area of 109,888 km^2. It stretches from the Atlantic Ocean in the west to the Botswana border in the east. To the south it is bordered by the Karas Region and to the north by the Erongo, Khomas and Omaheke Regions. The Region is divided into six constituencies: Rehoboth-West Urban, Rehoboth-East Urban, Rehoboth Rural, Mariental Urban, Mariental Rural and Gibeon. The main centres are Mariental, Rehoboth, Aranos, Gibeon, Maltahöhe, Kalkrand, Stampriet and Gochas.



The greater part of the Region can be described as either desert or arid scrubland. The mean annual rainfall at Mariental, in the centre of the Region, is 196.1mm with very little rainfall (21.5mm at Gobabeb) towards the west. In addition the rainfall is extremely variable from year to year. The southern part of the Region has a mean rainfall of 67-352mm per annum, and the northern part 99-402mm per annum.

The 50km-wide zone bordering the coastline could be described as a cool desert with a very small difference between minimum and maximum temperatures, almost no rainfall, but with a high occurrence of fog. The annual mean temperature at Mariental is 21.4°C. The mean maximum temperature for the summer months and the mean minimum temperature for the winter months are 34.5°C and 5.2°C respectively.

The extreme aridity of the Hardap Region makes suitable to only to livestock production, mostly sheep, goats and ostrich, with crop production being limited to drought resistant crops such as prickly pear. Approximately 15% of the Hardap Region is taken up by part of the Namib-Naukluft Park, 75% by commercial farmland and 10% by communal farmland. Tourism has proven a viable alternative to farming in the Region.

The Region is populated by about 61,000 people (4.7% of Namibia's total population) with an average population density of 0.8 people per km^2 and an average household size of 4.6 people. Approximately 35% of the economically active people are employed in agriculture, the largest employer and 51% of the population lives in rural areas while 49% live in urban areas.

The Region is served by 2 hospitals, 3 health centres, 12 clinics and 59 schools. Of the 61 rural settlements in the Region, 44 are unelectrified, including 11 unelectrified schools.

[7] Source: MME, *Rural Electricity Distribution Master Plan: Hardap Regional Report*, 2000
Source: NPC, *2001 Population and Housing Census National Report*, 2003

7.3.2 Survey Results

7.3.2.1 Respondents

Of the 10 respondents interviewed, 2 were women and all respondents were farmers. Namibia's southern regions (Karas and Hardap) experience greater levels of female emancipation and women have adopted stronger decision-making positions within the household, community and higher authorities. This adds another dimension to awareness raising, since women's needs can be clearly highlighted and women can be addressed directly in terms of making investment decisions. The level of formal education of the respondents is diverse and relatively low. Awareness campaigns through newspapers and other print media might be successful although demonstrations and more visual and audio approaches would be preferred.

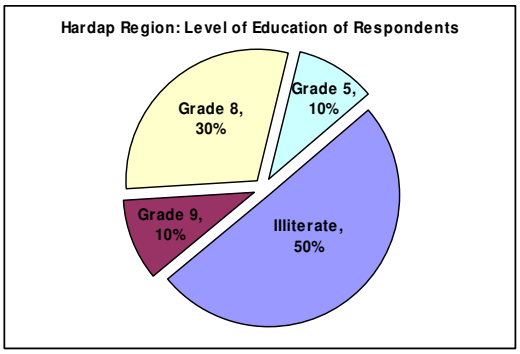


Figure 22: Level of Education in the Hardap Region

7.3.2.2 Livestock

Livestock distribution in the Hardap Region places a strong emphasis on hardy, drought-resistant animals and is dominated by goats and sheep. Livestock figures per household vary between 3 to 500 sheep and 6 to 600 goats. In comparison, heads of cattle figures vary between 5 and 150 and only one respondent farms primarily with cattle. Livestock is kept for meat and selling, while donkeys and horses are used for transport. Livestock problems are mostly related to drought conditions, availability of water, several natural predators and pests, theft and livestock diseases such as urgenea.

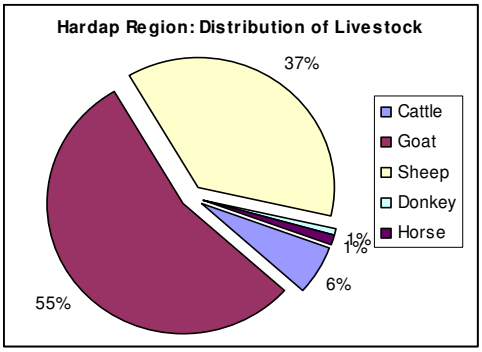


Figure 23: Distribution of Livestock in the Hardap Region

7.3.2.3 Water

Water sources in the Hardap Region are mostly boreholes due to the significant depth of ground water (between 30m and 250m). Most boreholes are located in the immediate vicinity of the household and traveling time rarely exceeds 35 minutes. Except for one respondent, who owns, operates and maintains his own borehole system, all other boreholes were maintained by the DRWS. Due to the great depth of boreholes, Diesel pumping systems are preferred. More shallow boreholes are equipped with PVP; the prevalence of PVP usage is significantly higher than in other regions and 30% of respondents use PVP technology.

7.3.2.4 Income and Expenditure

Household expenditure per month on water and energy services varies significantly due to the fact that some respondents use PVP. In all instances maximum expenditures on Diesel fuel and maintenance of Diesel equipment apply only to respondents who do not have PVP, while minimum expenditures apply to those respondents who use PVP (as expected, these respondents have reported a zero fuel cost to operate their borehole systems and monthly maintenance expenses of about N$ 100 to N$150). Respondents using PVP also reported no expenses for the transport of Diesel fuel from fuel depots to their boreholes. The survey also indicates wood shortages in the Hardap Region and all households have to purchase fuel wood rather than collecting it from the veld. None of respondents had access to electricity. Household income ranges between N$ 300 to N$ 5,000 per month with an average income of N$ 1,480 per month.

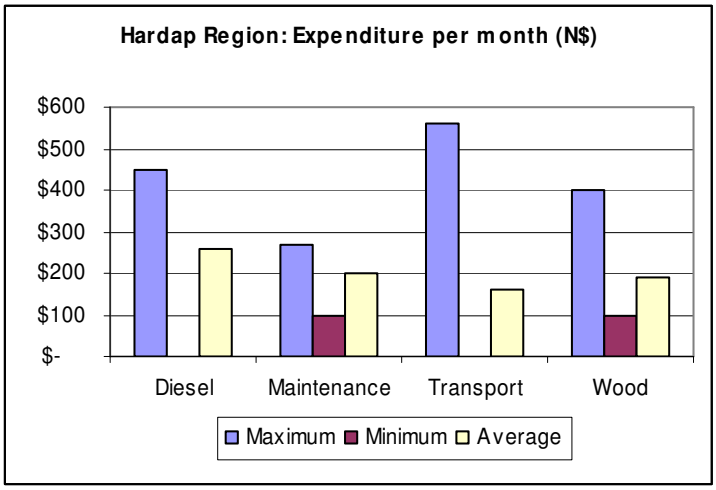


Figure 24: Expenditure Per Month in the Hardap Region

7.3.2.5 Awareness

There is a high willingness to buy PVP technology and the only uncertainties reported were related to financial concerns and some technical concerns. Respondents indicated that they would prefer training on PVP in order to make an educated decision. Although there is a high level of awareness about PVP and other RE technologies, none of the respondents was aware of the Home Power Programme.

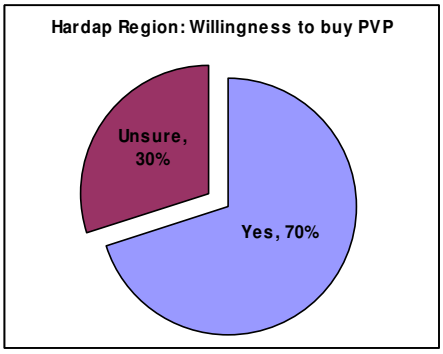
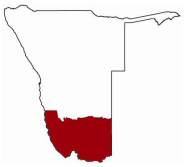


Figure 25: Willingness to Buy PVP

7.4 KARAS[8]



7.4.1 Introduction

The Karas Region is the largest region in Namibia, with a surface of over 162,000 km^2, and is bordered in the south and east by the international boundary with South Africa, the Atlantic Ocean to the west and the Hardap Region to the north. It comprises the magisterial districts of Lüderitz, Bethanie, Keetmanshoop and Karasburg. It furthermore includes the constituencies of Keetmanshoop Urban, Berseba, Lüderitz, Oranjemund, Karasburg and Keetmanshoop Rural. The main urban centres are: Keetmanshoop, Lüderitz, Oranjemund, Karasburg, Noordoewer, Aroab, Bethanie, Koës, Aus, Grünau, Ariamsvlei, Warmbad and Rosh Pinah. The Region also accommodates 144 rural settlements.

The greater part of the Region is considered arid or scrub land. The rainfall in the region is highly varied with average rainfall for Keetmanshoop, located in the central parts of the Region, at 168mm per annum, whereas the average annual rainfall for Lüderitz, located at the west coast, is 17mm. The south-western corner of the region is the only part of Namibia that receives winter rainfall.

The annual mean temperature at Keetmanshoop is 20.7ºC with a mean maximum temperature of 34.4ºC for the summer months and a mean minimum temperature of 6.9ºC for the winter months. Coastal temperatures are more stable and the range between minimum and maximum temperatures hardly exceeds 8ºC, with maximum monthly temperature ranges between 17ºC and 22ºC. The mean annual temperature at the coast is approximately 16ºC.

The extreme aridity of the Region makes suitable to only to livestock production, mostly sheep, goats and ostrich, with crop production being limited to drought resistant crops such as prickly pear. Approximately 20% of the Karas Region is taken up by the Namib Desert, 70% by commercial farmland and 10% by communal farmland. Tourism has proven a viable alternative to farming in the Region.

The population of the Karas Region is about 69,400 people (4.3% of Namibia's population) with a population density of 0.5 people per km^{2}and an average household size of 4.7 people. Just under half the Region's population live in urban areas. Mining (27%) is the largest employer in the Region, followed by agriculture and fisheries (23%).

The Karas Region is served by 3 hospitals, 2 health centres, 11 clinics serve and 46 schools. Of the 144 rural settlements in the Karas Region, 126 are unelectrified. These unelectrified settlements include 7 schools.

[8] Source: MME, *Rural Electricity Distribution Master Plan: Karas Regional Report*, 2000
Source: NPC, *2001 Population and Housing Census National Report*, 2003

7.4.2 Survey Results

7.4.2.1 Respondents

All 10 respondents interviewed were males and self-employed farmers. However, Namibia's southern regions (Karas and Hardap) experience greater levels of female emancipation and women have adopted stronger decision-making positions within the household, community and higher authorities. This adds another dimension to awareness raising, since women's needs can be clearly highlighted and women can be addressed directly in terms of making investment decisions. The level of formal education of the respondents was considerably higher than of most respondents in the northern regions of Namibia. This allows for greater scope when promoting RE technologies. Awareness raising initiatives could include television, but also print media like newspaper articles, posters and brochures.

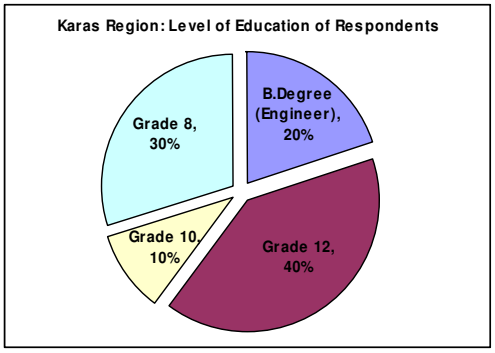


Figure 26: Level of Education in the Karas Region

7.4.2.2 Livestock

Livestock distribution in the Karas Region places a strong emphasis on hardy, drought-resistant animals and is dominated by sheep. Ostrich farming is also receiving significant attention and 4 of the respondents dedicate their farming exclusively to ostriches. Livestock figures per household vary between 500 to 1,700 sheep and 100 to 130 ostriches. In comparison, heads of cattle figures vary between 10 and 40. Livestock is kept for meat and selling. Livestock problems are mostly related to drought conditions, availability of water, several natural predators and pests and livestock diseases such as urgenea.

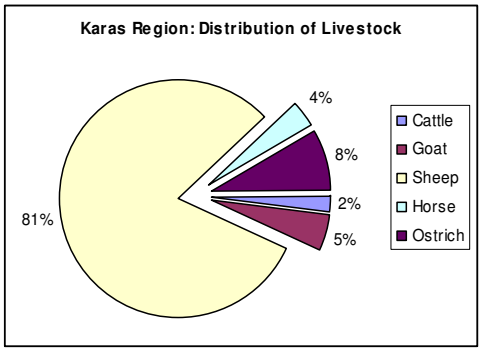


Figure 27: Distribution of Livestock in the Karas Region

7.4.2.3 Water

Water sources in the Karas Region are mostly boreholes and, in a few places fountains and hand dug wells. Ground water levels vary significantly between 40m and 130m, but the boreholes are located in the immediate vicinity of the household and traveling time rarely exceeds 20 minutes. All respondents owned, operated and maintained their own borehole equipment and have secured commercial loans or purchased the systems cash. Prevalence of PVP usage is significantly higher than in other regions and there is a strong awareness of the technology. The only limitation cited by respondents was that PVP in some instances does not deliver enough water to satisfy daily requirements. This can be attributed to undersized systems, insufficient ground water supply and seasonal factors such as overcast days.

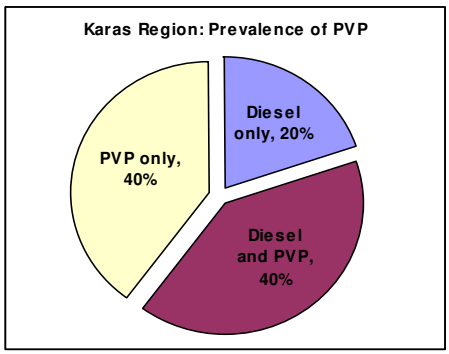


Figure 28: Prevalence of PVP in the Karas Region

7.4.2.4 Income and Expenditure

Household expenditure per month on water and energy services varies significantly due to the fact that some respondents use PVP. In all instances maximum expenditures on Diesel fuel and maintenance of Diesel equipment apply only to respondents who do not have PVP, while minimum expenditures apply to those respondents who use PVP (as expected, these respondents have reported a zero fuel cost to operate their borehole systems and monthly maintenance expenses of about N$ 100 to N$130). Transport expenses are more evenly spread, since all respondents regularly inspected their different boreholes and travel to nearby settlements and towns. The survey also indicates wood shortages in the Region and 90% of households have to purchase fuel wood rather than collecting it from the veld. Only 30% of respondents had access to electricity.

Household income ranges between N$ 1,000 to N$ 22,000 per month with an average income of N$ 6,600 per month. Interestingly, the 40% of respondents who only operated PVP on their farm reported the lowest levels of income.

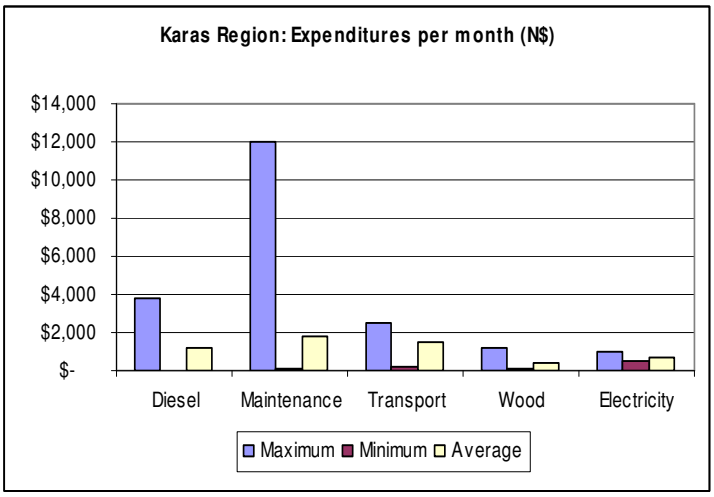
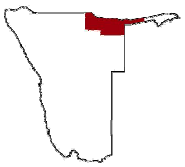


Figure 29: Expenditure Per Month in the Karas Region

7.4.2.5 Awareness

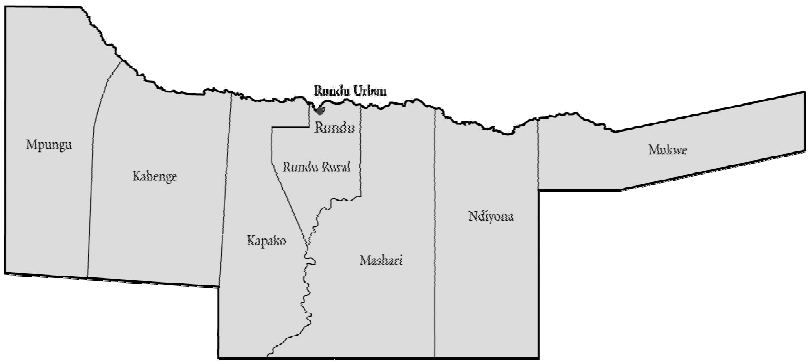
Despite the strong presence of PVP and knowledge of RE technology, none of the respondents were aware of the Home Power Programme. Respondents were informed of PVP technologies mostly through interactions with neighbours and relatives.

7.5 KAVANGO[9]



7.5.1 Introduction

The Kavango Region covers a surface area of 43,417km². Angola borders it to the north, via the Kavango River, and Botswana and the Caprivi Region to the east. To the west the Region is bordered by the Oshikoto and Ohangwena Regions and to the south by the Otjozondjupa Region. The main centre is Rundu with approximately 616 villages and small settlements also located within the Region. The Region consists of seven constituencies: Mpungu, Kahenge, Kapako, Rundu, Mashari, Ndiyona and Mukwe.



The climate of the Kavango Region is mild sub-arid to sub-arid, with hot summers and cool to warm winters. The annual mean temperature at Rundu is 22.1ºC with a mean maximum temperature of 31.1ºC for the summer months and a mean minimum temperature of 6.9ºC for the winter months. The average annual rainfall of the Region lies between 450 and 600mm generally increasing from south to north, however from May to August the Region is very dry. This explains why more than 80% of the people live along the Kavango River while the remote areas of the Region are almost unpopulated.

A mixed subsistence agricultural system is practiced with cultivation of mahango (pearl millet) as staple crop combined with extensive beef production. The cultivated area is estimated to be about 3-4 ha per household fragmented into two or more fields. Apart from the mahango, very small-scale maize, cowpea, sorghum, melons, pumpkins, groundnut and vegetables are also produced. Although people in the Kavango Region rely more on crops for their livelihood, they also keep a variety of livestock. There are about 45 commercial farms in the Kavango Region, which constitute about 6.5% or 2,841km² of the total area. Communal areas in the Kavango Region cover about 71.5% or 31,076km² while 3 game parks cover approximately 22% or 9,500km². Approximately 73.4% of the economically active population is employed in agriculture.

The Kavango Region has an estimated population of 132,500 people (8.2 % of the total Namibian population) of whom 83% live in rural areas. The average population density is about 3.54 people per km², with an average household size of 6.2 people. The Kavango Region is served by 3 hospitals, 7 health centres, 50 clinics and a total of about 300 schools.

Of the 616 rural settlements in the Kavango Region, 522 are unelectrified. The unelectrified settlements include 213 unelectrified schools, 4 unelectrified agricultural development centres, 39 unelectrified health facilities and a number of unelectrified administration and public offices.

[9] Source: MME, *Rural Electricity Distribution Master Plan: Kavango Regional Report*, 2000
Source: NPC, *2001 Population and Housing Census National Report*, 2003

7.5.2 Survey Results

7.5.2.1 Respondents

Of the 10 respondents interviewed, 1 was female. Most of the respondents were farmers. The level of formal education of the respondents is diverse, but relatively low. All villages surveyed were located on communal lands. In locations where larger subsistence farming and commercial farming is performed, male dominance is prevalent. The strong patriarchal culture demands that males make most decisions regarding the development of the households. These needs should be strongly considered when RE technologies are promoted in the Region. RE technologies that decrease the male's burden on the household and increase livestock productivity would have greater success than technologies that decrease the female burden. Awareness campaigns through newspapers and other print media may be successful, although demonstrations and visual and audio approaches would be preferred.

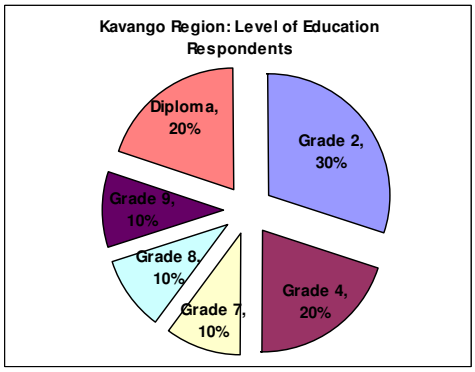


Figure 30: Level of Education in the Kavango Region

7.5.2.2 Livestock

Farming in the region is dedicated mostly to cattle, is the main source of wealth, and is an indication of social status. Commercial selling of cattle is very limited and the major source of income from livestock comes from goats and chickens. However, cattle remain the most important livestock species in the Kavango Region. Cattle provide traction power necessary to plough fields, milk, and when old, sick or dead, cattle provide meat, hides or cash. Cattle are herded during the wet season to protect the growing crops. For most of the rest of the year they roam unattended on the Okavango floodplains surrounding homesteads, grazing on the stubble and stalks of mahango and maize after the harvest. Livestock production in the Kavango Region is hampered by a lack of water since theland around water sources is often overgrazed, while good grazing land does not have sufficient open water sources.

Goats are kept for meat production and sale, but they are less numerous than cattle and make up only about one third of total livestock numbers. Goat fertility is high, but so is mortality. Goats are most susceptible to disease during the wet rainy season.

Other animals kept in roughly decreasing order of abundance are donkeys, horses, pigs and sheep.

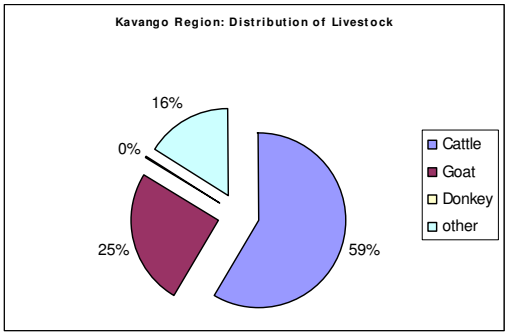


Figure 31: Distribution of Livestock in the Kavango Region

7.5.2.3 Water

Diesel technology is the most common means of water pumping in the Region, partly due to the great depth of ground water levels in some areas. This type of installation requires frequent maintenance and is costly to operate. Diesel fuel is costly, is

invariably not available in the immediate vicinity, and communities do not always have access to transport to collect the diesel fuel. Breakdowns of facilities occur frequently since the communities generally have not been trained adequately to maintain and take care of their installations. Vandalism is a common occurrence indicating that there is very little, if any, sense of ownership. Diesel installations generally supply water for more than one settlement and people often have to walk 8 km or more to collect water.

There are a number of PVP installations in the Region, which supply water to schools and clinics. Although the installation is intended for the sole use of the school or clinic, surrounding communities also collect water from these installations. Unfortunately PVP components, particularly PV panels, are prone to theft (especially when the borehole is situated in an uninhabited area or far from regular supervision) and some PVP technologies are not suitable for the harsh operating conditions (fluctuating ground water levels, high soil contents in borehole water and tampering by people, particularly for charging batteries).

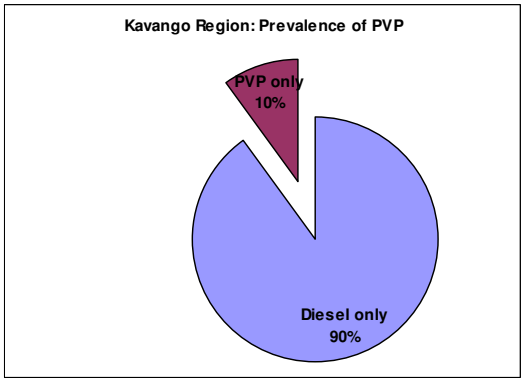


Figure 32: Prevalence of PVP in the Kavango Region

7.5.2.4 Income and Expenditure

Most rural households do not have any wage earners. Only about 25% of rural households have one wage earner and another 15% have two to three members earning salaries. Most of the farmers have to travel long distances to purchase diesel equipment at nearby settlements.

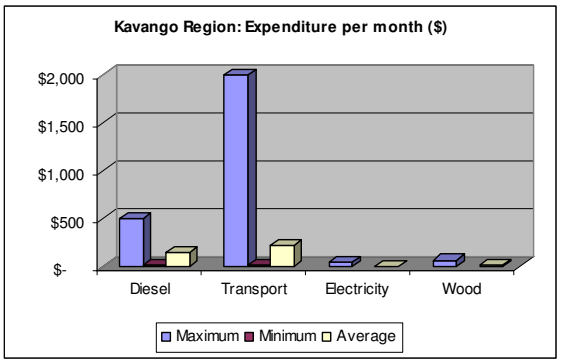


Figure 33: Expenditure Per Month in the Kavango Region

7.5.2.5 Awareness

Among the respondents, 10% of the farmers are willing to buy PVP technology and the only uncertainties reported were related to financial concerns and some technical concerns. Respodents indicated that they would prefer training on PVP in order to make a educated decision. None of the respondents is aware of the Home Power Programme.

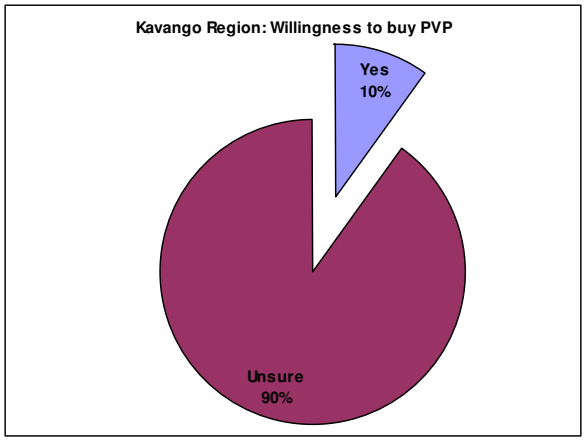
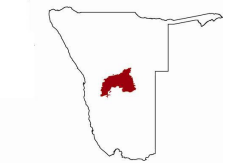


Figure 34: Willingness to buy PVP

7.6 KHOMAS



7.6.1 Introduction

The Khomas Region covers a surface area of 36,805 km^2. It is the central region of the country. The region is bordered by the Otjozondjupa Region in the north, by the Omaheke Region in the east, by the Hardap Region in the south, and by Erongo Region in the west. The Region includes 9 constituencies: Hakahana, Wanaheda, Katutura Central, Katutura East, Khomasdal North, Windhoek West, Windhoek East, Windhoek Rural and Soweto.

The Region can be described as mostly mountainous and characterized by three prominent mountain ranges, namely the Eros Mountains to the north-east of Windhoek, the Auas Mountains to the south-east of Windhoek and the Khomas Hochland Mountain range to the west of Windhoek. To the west of the Khomas Hochland, below the escarpment the landscape comprises plains with scattered inselbergs becoming more isolated closer to the Namib Desert.

The climate is defined as sub-arid, with summer rainfall averaging just over 300mm per year, but varying from 50 to 950mm. The rain falls mostly in localized thunderstorms, but occasionally covers larger areas in systems that move down from the north bringing more widespread, softer and longer lasting rain. Rains usually fall between October and March, with more in the second half of the season.

Cold weather sets in about May and lasts till about August. Minimum temperatures occasionally drop below zero in Windhoek. The hottest time of the year is usually in November and December, when skies are often clear, and midday temperatures get into the 30s and sometimes the low 40s.

The population of the Region is approximately 250,305, with an average population density of 6.8 people per km^2. Approximately 71% of the regional population is considered to be within the labour force.

There are 922 Commercial farms in the Khomas Region. They occupy about 89% of the total regional area. The remaining 11% comprises urban areas, communal areas and other uses.

The Region is served by 5 hospitals, 2 health centres, 7 clinics and 64 schools.

7.6.2 Survey Results

7.6.2.1 Respondents

All 5 of the respondents interviewed were male. The level of education of the respondents is mostly tertiary with majority of the respondents occupied with full time farming. There is a strong interaction between farming community in the hinterland of Windhoek and the city. Not only are most of the farming products marketed in or through Windhoek, but it is also the most important farming supply centre. Khomas Region residents are generally aware of RE technologies. Credit facilities need to be persuaded to administer RE technologies to those who would benefit.

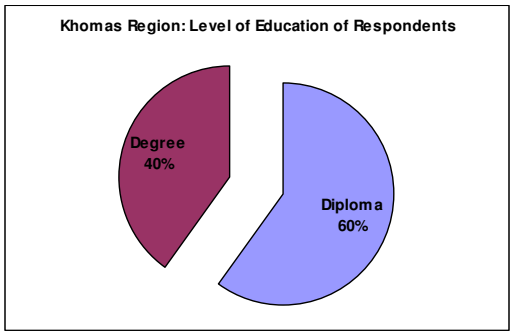


Figure 35: Level of Education in the Khomas Region

7.6.2.2 Livestock

Livestock distribution in the Khomas Region plays an important role as a source of income, while Ostrich, Springbock and Zebra are more of a social status for farmers. Commercial selling of livestock is also very significant to commercial farmers. Livestock figures per household vary from 100 to 1200 heads of cattle and 50 to 800 goats. In comparison, sheep figures vary between 10 to 1000 and game from 10 to 100. All farmers buy drugs for their livestock and make use of veterinary services from the Ministry of Agriculture, Water and Rural Development.

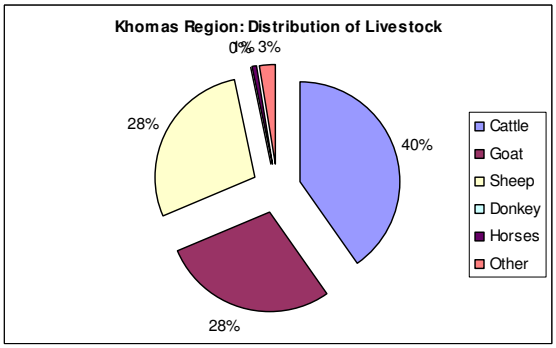


Figure 36: Distribution of Livestock in the Khomas Region

7.6.2.3 Water

There is a significant number of boreholes on commercial farms in the Khomas Region, varying between 2 to 3 boreholes per farm. Some farmers even make use of PVP to supplement diesel boreholes. The PVP used is generally the Eta and Juwa pumps. Most respondents owned, operated and maintained their own borehole equipment and have purchased the systems with cash. The Farms in the Khomas Region generally do not experience water problems.

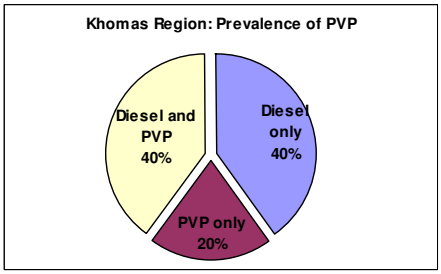


Figure 37: Prevalence of PVP in the Khomas Region

7.6.2.4 Income and Expenditure

Farmers in the Khomas Region spend significant amounts on water, energy and transport services. Electricity is the highest expenditure, while diesel and transport are also big expenses for farmers who drive to Windhoek to purchase diesel. Most commercial farmers are employed full time in the Windhoek district and have employed between 2 to 4 workers to conduct the daily routines on their farms. Household income ranges between N$ 10 000 to N$ 25 000 per month with an average income of N$ 15 000 per month.

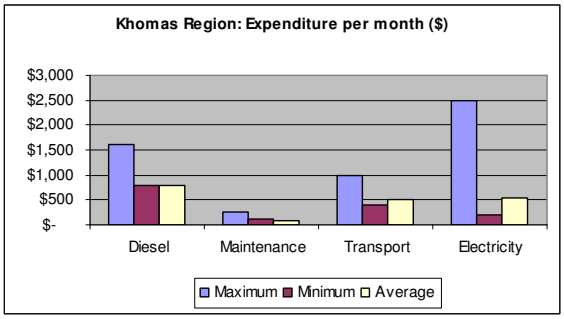
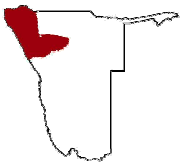


Figure 38: Expenditure Per Month in the Khomas Region

7.6.2.5 Awareness

None of the respondents were aware of the Home Power Programme. Respondents were informed of the PVP technologies mostly through interactions with other people.

7.7 KUNENE[10]



7.7.1 Introduction

This region is situated in the north-western corner of Namibia and covers an area of 114,254 km^2. To the east the region is bordered by the Omusati Region and to the south-east and south by the Otjozondjupa and the Erongo Regions respectively. The Atlantic Ocean borders the western side of Kunene Region. The main towns in this region are Outjo, Khorixas and Opuwo. The region consists of six constituencies: Epupa, Opuwo, Sesfontein, Khorixas, Kamanjab and Outjo.

The climate in the Kunene Region is considered arid and the annual mean rainfall is 2-38mm in the extreme western part, 59-339mm in the western central parts and 179-587mm in the interior. The annual mean temperature at Opuwo is 21.5°C, the mean maximum temperature is 32.7°C and the mean minimum temperature is 6.3°C.

Besides the region's contribution to the national economy from the hydro-electric Ruacana power plant and the agricultural sector (commercial livestock farming in the Kamanjab and Outjo districts and communal farming over the rest of the region), tourism is a well-developed industry in the region and a major source of revenue.

There are 738 commercial farms in the Kunene Region and about 290 rural settlements in Kunene Region. The settlement patterns in the Kunene Region vary from very basic nomad settlements that are not permanently occupied, to small and large informal villages, to formal towns.

The Kunene Region has a population of 68,224 people (4.5% of Namibia's total) and 12,555 household with an average household size is 5.3. The population density is a low 0.73 people per km^2 and being the second largest region in Namibia, the Kunene Region is the second most sparsely populated region in the country. Except for the urban constituencies of Opuwo, Khorixas and Outjo, the population density for the rest of the Region varied between 0.25 and 9.9 people per km^2. Only about 25% of people in Kunene live in urban areas, and 46% of the Region's population lives in settlements of 200 people or fewer.

The Region is served by 3 hospitals, 18 clinics and 48 schools, 30 of which provide hostel facilities. Of the 290 rural settlements, 285 are unelectrified and these unelectrified settlements include 25 schools, 2 agricultural development centres, 10 health facilities and number of administration and public offices.

[10] Source: MME, *Rural Electricity Distribution Master Plan: Kunene Regional Report*, 2000
Source: NPC, *2001 Population and Housing Census National Report*, 2003

7.7.2 Survey Results

7.7.2.1 Respondents

A total of 5 different rural villages were surveyed offering information on household demographics, infrastructure and the general area surrounding the villages. All villages surveyed were located on communal lands. A low employment rate (over 11% in the Region) might contribute be the reason for most of the respondents' gender being male, which implies that male-dominated households still prevail and men have not been successful in securing employment elsewhere. In the case of larger subsistence farming and commercial farming male dominance is the order of the day though. The strong patriarchal culture demands that males make most decisions regarding the development of the households. This needs to be strongly considered when RE technologies are promoted in the Region. RE technologies that decrease the male's burden on the household and increase livestock productivity would have greater success than technologies that decrease the female burden. The level of formal education of the respondents is low. Awareness campaigns through newspapers and other print media might be successful although demonstrations and more visual and audio approaches would be preferred.

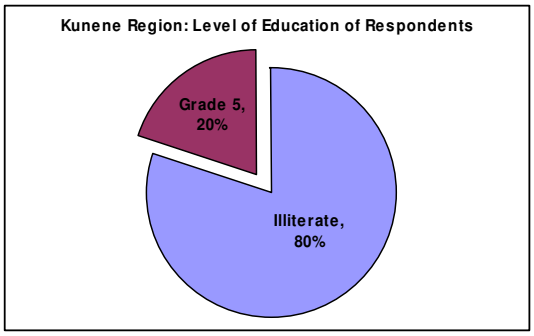


Figure 39: Level of Education in the Kunene Region

7.7.2.2 Livestock

Regarding livestock distribution in the Region, farming is dedicated mostly to cattle, with goats forming a suitable supplement in this arid region. Exact livestock figures per household range between 60 and 400 heads of cattle and 30 to 300 goats. At 45 liters (cattle) and 12 litres (goats) per day, water is used primarily for livestock production, while crop production receives little attention in the Region. As such, agriculture is highly dependent on rainfall, the pumping of water from boreholes and access to communal water points along pipelines installed by the DRWS. Major problems with livestock production were cited as a lack of access to water (mostly due to seasonal variations in water availability, but also to broken water pumping installations), lack of suitable grazing and the prevalence of livestock diseases such as anthrax. Livestock is kept primarily for meat and milk production and for selling.

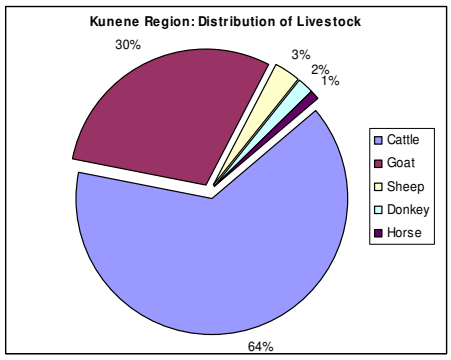


Figure 40: Distribution of Livestock in the Kunene Region

7.7.2.3 Water

The survey indicated that all respondent boreholes are currently equipped with Diesel water pumps, but 80% of respondents were familiar with PVP. In all cases the

borehole installation would be maintained by a Water Point Committee under the responsibility of the Water Point Caretaker. This position is voluntary and the person fulfilling this duty receives no remuneration. Apart from being responsible for the installation's maintenance, the Water Point Committee also has a treasurer responsible for collecting fees (calculated at a fixed daily price per head of cattle drinking at the water point, a lump sum or a fixed monthly contribution). This is situation lends itself to friction within the community. In view of a lack of remuneration, this position is susceptible to victimization or profiteering.

7.7.2.4 Income and Expenditure

The primary monthly expenses for the respondents were transport and Diesel fuel for water pumping. For two of the respondents, maintenance expenses were covered by the Directorate of Rural Water Supply. No expenses were recorded for electricity and wood, indicating that none of the respondents have access to electricity and fuel wood is still collected at no financial cost. Household income ranges between N$ 70 (unemployed / Water Point Caretaker) to N$ 600 (pensioner) per month with an average income of just above N$ 300 per month.

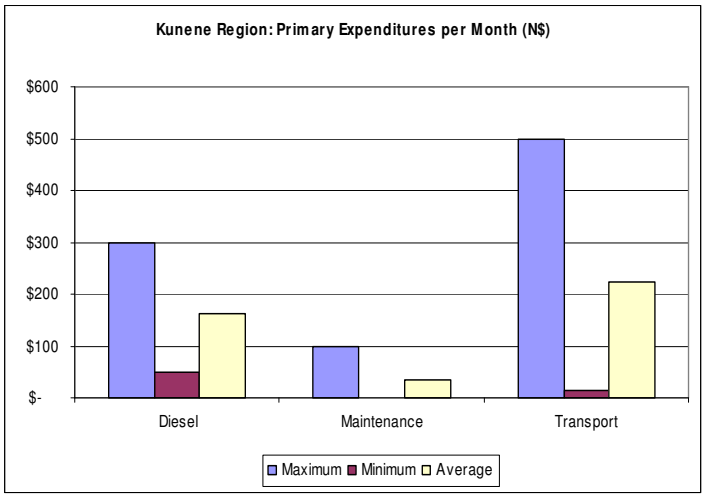


Figure 41: Expenditure Per Month in the Kunene Region

7.7.2.5 Awareness

In terms of the Home Power Programme, none of the respondents were aware of the scheme and consequently have not benefited from it. It can further be assumed that they do not know of anyone within their respective areas who has benefited from the programme either. The survey discovered that access to information is based primarily on conversations and information exchanges between community members and rare opportunities to view and inspect installed RE technologies. Respondents indicated that they would only make decisions in favour of RE technologies if they were adequately informed about the technologies. Half the respondent indicated though that they would choose PVP above Diesel, but as many were unwilling to buy a new technology. There is thus a great degree of uncertainty about the benefit of PVP and RE technologies in general.

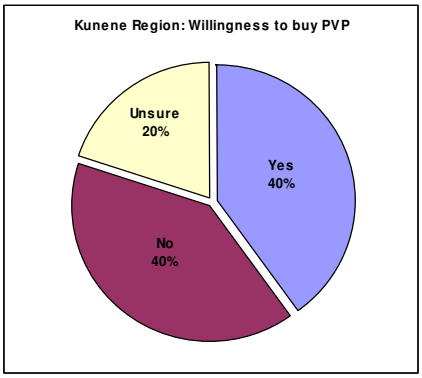
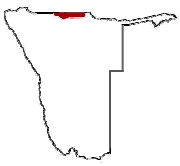


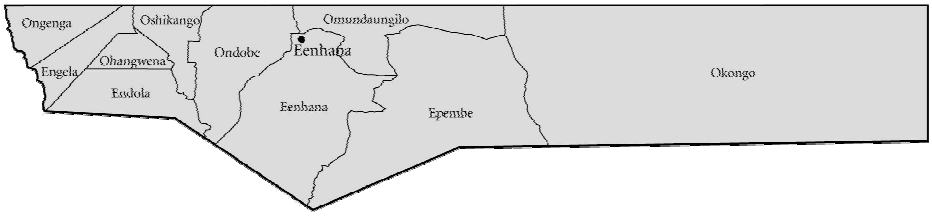
Figure 42: Willingness to Buy PVP

7.8 OHANGWENA[11]



7.8.1 Introduction

Ohangwena has a surface area of approximately 10,780km^2. To the north the Region is bordered by the international boundary with Angola, to the east by the Kavango Region, to the south by the Oshikoto as well as a small portion of the Oshana Region and to the west by the Omusati Region. The main centres of the Ohangwena Region are Eehana, Ohangwena, Omafu/Engela, Oshikango, Okongo, Omungwelume and Omundaungilo. The Region comprises 10 constituencies: Ongenga, Engela, Ohangwena, Endola, Oshikango, Ondobe, Eenhana, Omundaungilo, Epembe and Okongo. It is the most densely populated region in Namibia with over 11%of the total population of which most live along the tarred road between Oshikango on the Angolan border and Ondangwa while the remote areas of the region are almost unpopulated.The entire Region is comprised of communal land.



Agricultural activities are mainly dominated by a mixed subsistence farming system with cultivation of mahango (pearl millet) as staple crop combined with extensive beef production. The majority of the Region's population lives in rural settlements and about 72% of the Region's population are depended on agriculture for their livelihood. The cultivated area is estimated at about 2ha per household with an arable farm size at 6.5ha.

The climate of Ohangwena Region is classified as semi-arid. Mean annual rainfall increases from west to east ranging from approximately 450 mm to 550 mm per annum (321-828 mm in the west and 348 – 871 mm in the east). Rainfall supports dryland cropping of mahangu and grazing of livestock. Mean monthly temperatures range from 26.1°C in summer to 17.5°C in winter, while mean monthly humidity ranges between 50% and 17% respectively.

At over 227,700, the Ohangwena Region has the highest population in Namibia (12.9%) with an average population density of 21.9 people per km^2, which varies between 0.2 per km^2 and 50 per km^2 (the Ongenga, Engela, Ohangwena, Endola and Oshikango constituencies). The average household size is 6.3 people.

The Ohangwena Region is served by 3 hospitals, 1 health care centre, 24 clinics, 101 outreach clinics and 203 schools.

Of the 321 rural settlements in the Region, a total of 261 are unelectrified. The unelectrified settlements include 140 unelectrified schools, 95 unelectrified health facilities and approximately 95 informal businesses.

[11] Source: MME, *Rural Electricity Distribution Master Plan: Ohangwena Regional Report*, 2000
Source: NPC, *2001 Population and Housing Census National Report*, 2003

7.8.2 Survey Results

7.8.2.1 Respondents

All 6 respondents to the survey in the Ohangwena Region were males. Although a significant income for the Region comes from migrant labour, leaving most households to be headed by women, investment decisions are nonetheless made by men. The strong patriarchal culture demands that males make most decisions regarding the development of the households. This needs to be strongly considered when RE technologies are promoted in the Region. The level of formal education of the respondents is diverse, but there was a low level of illiteracy, suggesting that awareness campaigns through newspapers and other print media might be successful although demonstrations and more visual and audio approaches would be preferred.

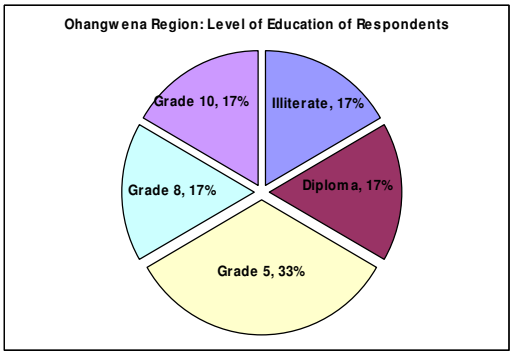


Figure 43: Level of Education in the Ohangwena Region

7.8.2.2 Livestock

Regarding livestock distribution in the Region, farming is dedicated mostly to cattle and goats while donkeys and horses serve as draught animals. Exact livestock figures per household range between 20 and 250 heads of cattle and 8 to 130 goats. At 45 liters (cattle) and 12 litres (goats) per day, water is used primarily for livestock production. Crop production, which is significant in the Region, is dependent solely on rainfall and irrigation schemes are uncommon. Water is obtained mostly from boreholes and to a lesser extent from communal water points along pipelines installed by the Directorate of Rural Water Supply. Major problems with livestock production were cited as a lack of access to water (some distances to boreholes require traveling times of up to 3 hrs), lack of suitable grazing and the prevalence of livestock diseases such as contagious bovine pleuropneumonia. Livestock is kept primarily for meat and milk production and for selling.

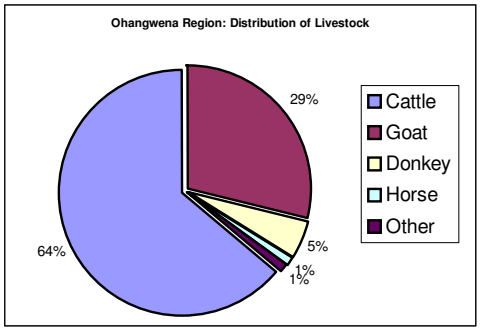


Figure 44: Distribution of Livestock in the Ohangwena Region

7.8.2.3 Water

Except for two of the respondents, who maintain their own boreholes, borehole installations were funded and maintained by the DRWS, although maintenance expenses are recovered through Water Point Committees (households contribute towards expenses such as transport, diesel and the replacement of belts and other mall items). Boreholes in the Ohangwena Region are of significant depth and ground water levels are often beyond 100m. Borehole installations are managed by Water Point Committees, which are under the responsibility of the Water Point Caretakers. This position is voluntary and the person fulfilling this duty receives no remuneration. Apart from being responsible for the installation's maintenance, the Water Point

Committee also has a treasurer responsible for collecting fees (calculated at a fixed daily price per head of cattle drinking at the water point, a lump sum or a fixed monthly contribution). This is situation lends itself to friction within the community. In view of a lack of remuneration, this position is susceptible to victimization or profiteering.7.8.3.4 Income and Expenditure

In terms of monthly expenditures Diesel fuel expenses and maintenance of borehole installation equipment rank highest. Half of the respondents do not have access to electricity, while wood fuel is collected and regarded free of charge.

Household income ranges between N$ 600 (pensioner) to N$ 5,000 (businessman) per month with an average income of under N$ 2,000 per month.

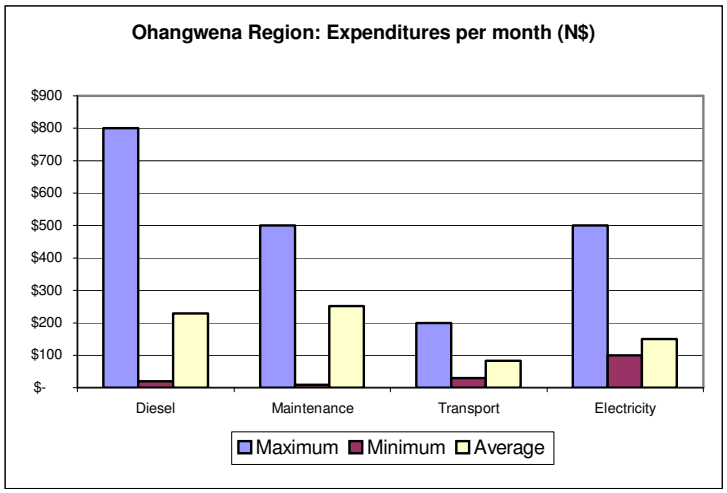


Figure 45: Expenditure Per Month in the Ohangwena Region

7.8.2.5 Awareness

More that 60% of respondents were unaware of the HOME POWER Programme and substantial awareness raising needs to be conducted to improve the uptake of RE technologies in the Region. Although none of the respondents own or operate a PVP, 90% of them were familiar with PVPs, mostly due to communication and interactions with neighbouring people. However, there is little willingness to buy PVP technologies due to the high price and risk of theft of PV panels.

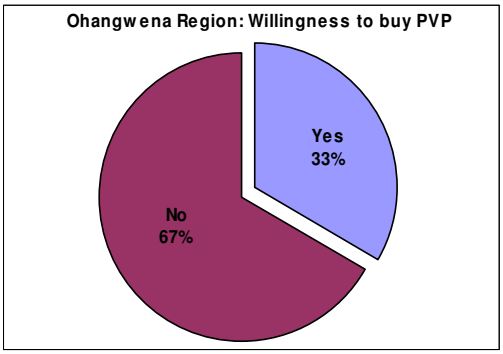
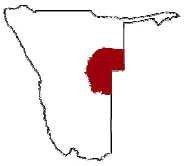


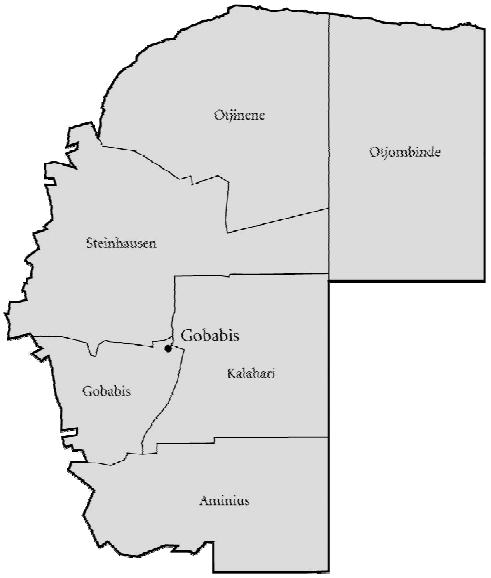
Figure 46 Willingness to Buy PVP

7.9 OMAHEKE[12]



7.9.1 Introduction

The Omaheke Region covers a surface area of 84,732km^2 and is located in central eastern Namibia and is bordered to the north and north-west by the Otjozondjupa Region. To the east it is bordered by the international boundary with Botswana, to the south by the Hardap Region and to the west by the Khomas Region. The region is divided into six constituencies: Otjinene, Otjombinde, Steinhausen, Gobabis, Kalahari and Aminuis. The main centre is Gobabis, which forms the administrative and business centre for the Region, while 219 rural localities and small settlements are also located within the Region.



The climate of the Omaheke Region can be described as mild sub-arid to sub-arid with hot summers and cool to warm winters, making most of the Region suitable only to livestock production. There are 1,161 commercial farms in the Omaheke Region, of which 264 are electrified. Commercial farms cover 49% of the area, while communal lands cover the remaining 51%. Communal lands are divided into three rural constituencies: Otjinene, Otjombinde and Aminius.

The annual mean temperature at Gobabis is 19.5°C. Summer maximum temperature is 30.5°C at Gobabis, while minimum winter temperatures can drop below 16°C. Frost may occur during the cold periods. The rainfall varies from 200mm per annum in the south, to 400 – 500mm per annum in the northern part of the region.

Omaheke Region has a population of 67,496 persons representing just less than 4% of the national population, living in about 12,500 households with an average household size of 4.6 people. Population density averages at about 0.82 people per km^2 with the lowest population density being less than 0.25 people per km^2 (northern parts of Otjinene and Otjombinde constituencies). For the rest of the Region the population density varies between 0.25 and 9.9 people per km^2. Sixty percent of the economically active are employed in the agricultural sector and some 80% of the Region's people live in rural areas.

The Region is served by 1 hospital, situated at Gobabis, 1 health care centre, situated at Otjinene, 11 clinics and 32 schools, of which 25 provide hostel facilities. Of the 219 developing rural settlements in the Omaheke Region approximately 200 are unelectrified and most of the approximately 350 communal boreholes are not connected to the electricity grid. While there are 8 schools in unelectrified settlements, only 3 of these still do not have electric power (the other five are powered by Diesel generator or solar panels).

[12] Source: MME, *Rural Electricity Distribution Master Plan: Omaheke Regional Report*, 2000
Source: NPC, *2001 Population and Housing Census National Report*, 2003

7.9.2 Survey Results

7.9.2.1 Respondents

Of the 10 respondents in the Omaheke Region, 70% were male and 90% were earning their livelihoods from the agricultural sector. The level of formal education of the respondents is very low and a staggering 80% of the respondents are illiterate. Promoting RE technologies within the Region thus needs to take cognisance of three primary criteria: male dominance, strong association to livestock production and a very low level of formal education. Awareness campaigns through newspapers and other print media might be unsuccessful and demonstrations and more visual and audio approaches would be preferred.

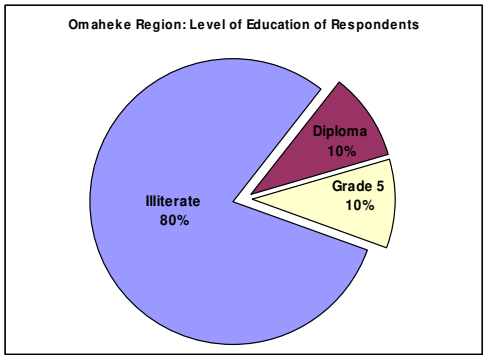


Figure 47: Level of Education in the Omaheke Region

7.9.2.2 Livestock

As demanded by the environmental conditions, livestock production dominates the agricultural sector. Regarding livestock distribution in the Region, farming is dedicated mostly to cattle, with goats forming a supplement and, in the case of poorer households, a substitute. Goats contribute significantly to a household's routine meat consumption, while cattle are reserved for economic purposes and reflect the household's social status. In addition, cattle provide most of the fresh milk used by households. Donkeys and horses are used for transport. Exact livestock figures per household range between 50 and 150 heads of cattle and 30 to 200 goats.

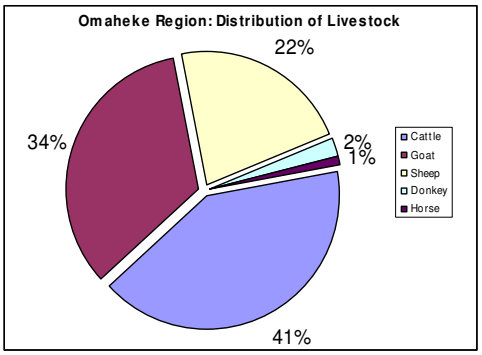


Figure 48: Distribution of Livestock in the Omaheke Region

7.9.2.3 Water

At 45 liters (cattle) and 12 liters (goats) per day, water is used primarily for livestock production, while crop production receives little attention in the Region. As such, grazing is highly dependent on rainfall. Due to the significant depth of ground water (between 50m and 120m), water is pumped exclusively from boreholes. Most of these boreholes were installed by DRWS with Diesel pumps and are managed by a Water Point Committees. Most boreholes are hardly ever located within 300m from the household with the maximum distance being 800m. As such, traveling time to water points is more than 30 minutes. The Water Point Committees appoint a Water Point Caretakers. This position is voluntary and the person fulfilling this duty receives no remuneration. Apart from being responsible for the installation's maintenance, the Water Point Committee also has a treasurer responsible for collecting fees (calculated at a fixed daily price per head of cattle drinking at the water point, a lump sum or a fixed monthly contribution). This is situation lends itself to friction within the community. In view of a lack of remuneration, this position is susceptible to victimization or profiteering.

7.9.2.4 Income and Expenditure

In terms of monthly expenditures, Diesel fuel expenses for borehole equipment ranks highest. None of the respondents have access to electricity, while wood fuel is collected and regarded free of charge. Household income ranged between N$ 800 (farmer) to N$ 2,500 (farmer) per month with an average income of under N$ 1,800 per month.

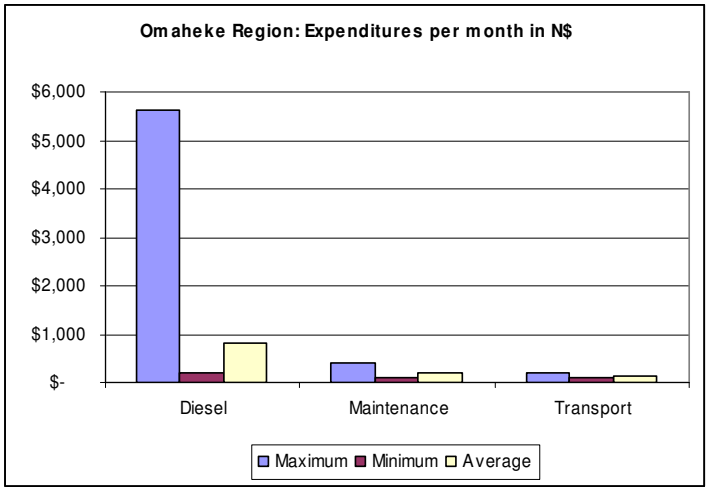


Figure 49: Expenditure Per Month in the Omaheke Region

7.9.2.5 Awareness

Although one of the respondents uses PVP technology, only one further respondent was aware of the technology (through the newspapers and through attending workshops where PVPs were mentioned). The low level of awareness about RE technologies in general is further supported by the fact that none of the respondents was aware of the HOME POWER Programme. The low level of awareness of PVP contributes to the low level of willingness to buy the technology.

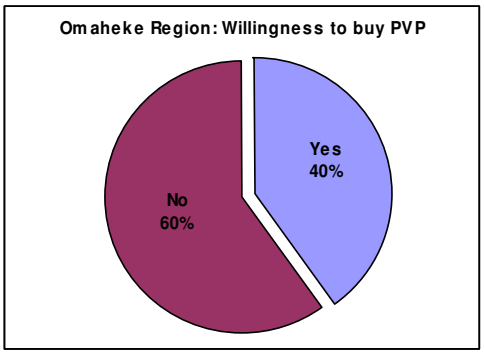
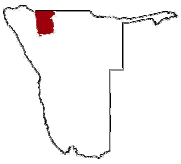


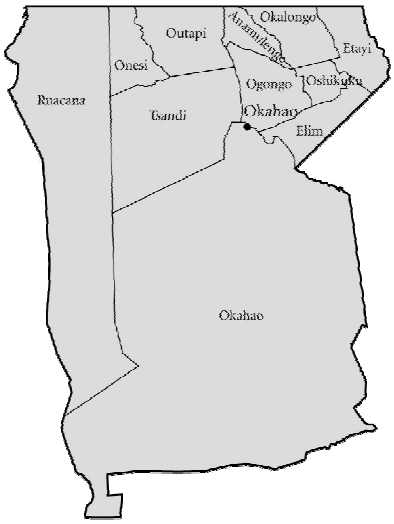
Figure 50: Willingness to Buy PVP

7.10 OMUSATI[13]



7.10.1 Introduction

The Omusati Region occupies an area of 26,720 km^2 It is bordered to the west by the Kunene Region and the east by the Oshana Region. Its northern border is the international boundary to Angola, while its southern border joins the Etosha National Park. The Region includes 11 constituencies, namely, Ruacana, Onesi, Tsandi, Uutapi, Anamulenge, Ogongo, Okalongo, Oshikuku, Elim, Etayi and Okahao.



The climate of the Omusati Region is regarded semi-arid with hot summers and cool to warm winters. Rainfall ranges between 179-587 mm per annum in the southern parts and 255 – 710 mm per annum in the northeastern parts. This represents a long-term mean of less than 300 mm to 450 mm per annum. Annual mean temperature is 23°C with a mean maximum of 32°C in summer and a mean minimum temperature of 9°C in the winter. Daily temperature fluctuations can be as high as 20°C.

The agricultural sector is mainly dominated by mixed subsistence farming with cultivation of mahango (pearl millet) as staple crop combined with extensive livestock production. Most households in the Omusati Region have access to arable land and about 50% of household's own livestock. The cultivated area is estimated at about 2ha per household with arable farm size at 6.5ha. Most farms include an area for the homestead, fields, livestock kraals, and an area with mopane trees or scrub. Over 70% of the Region's population derives their income from agricultural activities.

The Region has a population of about 228,400 people (about 13.5% of the total Namibian population), living in about 38,500 households (with an average household size of 5.9 people) and the entire region is classified as communal land. At an average population density of 9.4 people per km^2, the Omusati Region is the third most populated Region in Namibia after Oshana and Ohangwena. The population density in the Region varies between less than 0.25 persons per km^2 in the south-eastern part of the Region, to as high as more than 50 persons per km^2, especially in the Okalongo, Onamulungwe, Oshikuku and Elim constituencies. The reason for the distribution of population is directly linked to the availability of water resources, arable land and access to infrastructure. Denser populations occur in the northern parts along the Etaka and Cuvelai Oshanas as well as the Oshakati-Ruacana trunk road.

The Omusati Region is served by a total of 4 hospitals, situated at Tsandi, Uutapi, Okahao and Oshikuku, 5 health centres, 35 clinics and 76 outreach clinics. There are a total of 249 schools in the Region.

A total of 328 rural settlements occur in the Omusati Region of which 39 have been electrified. The 289 unelectrified rural settlements include 190 unelectrified schools, 88 unelectrified health facilities and approximately 98 informal businesses.

[13] Source: MME, *Rural Electricity Distribution Master Plan: Omusati Regional Report*, 2000
Source: NPC, *2001 Population and Housing Census National Report*, 2003

7.10.2 Survey Results

7.10.2.1 Respondents

Of the 6 respondents interviewed, all were male. Although a significant income for the Region comes from migrant labour, leaving most households to be headed by women, investment decisions are nonetheless made by men. The strong patriarchal culture demands that males make most decisions regarding the development of the households. This needs to be strongly considered when RE technologies are promoted in the Region. The level of formal education of the respondents is diverse and relatively low. Awareness campaigns through newspapers and other print media might be successful although demonstrations and more visual and audio approaches would be preferred.

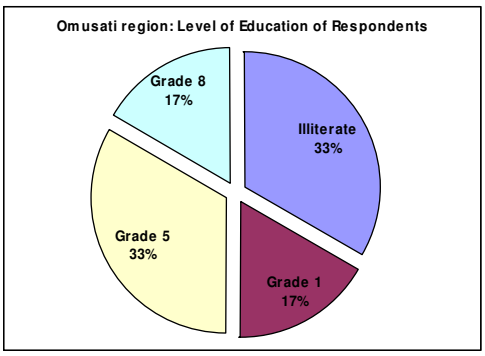


Figure 51: Level of Education in the Omusatie Region

7.10.2.2 Livestock

Livestock distribution indicates a high number of goats, who have proven highly adaptable to the conditions (aridity and denser population) of the Omusati Region. Cattle however remain very dominant in the agricultural sector for their economic value and milk production. A fair number of sheep add to livestock diversity. Donkeys and horses are used mostly for transport. Exact livestock figures range between 15 to 100 heads of cattle and 18 to 150 goats. Livestock diseases such as anthrax are common in the Region. Crop production, which is significant in the Region, is dependent solely on rainfall and irrigation schemes are uncommon.

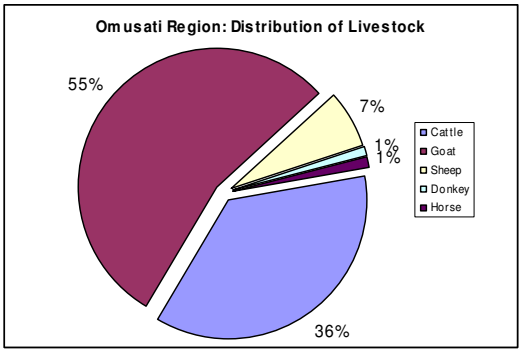


Figure 52: Distribution of Livestock in the Omusati Region

7.10.2.3 Water

Water is obtained mostly from boreholes and to a lesser extent from communal water points along pipelines installed by the DRWS. The distance from household to borehole and water point ranges from 2 to 20 km. Persons living in the Omusati Region travel up to 2 hours on foot to obtain water. Persons living in the Oshana Region (who rely on boreholes in the Omusati region) travel up to 4 hours on foot. All of the boreholes were installed by DRWS with diesel pumps and are managed by a Water Point Committees. The Water Point Committees appoint Water Point Caretakers. This position is voluntary and the person fulfilling this duty receives no remuneration. Apart from being responsible for the installation's maintenance, the Water Point Committee also has a treasurer responsible for collecting fees (calculated at a fixed daily price per head of cattle drinking at the water point, a lump sum or a fixed monthly contribution). This is situation lends itself to friction within the community. In view of a lack of remuneration, this position is susceptible to victimization or profiteering.

7.10.2.4 Income and Expenditure

In terms of monthly expenditures, Diesel fuel for water pumping accounted for the highest cost. Of all respondents, only on spent money on maintaining the borehole installation, while DRWS covered maintenance expenses for all other respondents. Interestingly, one respondent even needed to purchase fire wood. None of the respondents have access to electricity. Household income ranged between N$ 100 (an unemployed respondent) to N$ 10,000 (a business man) per month with an average income of about N$ 3,700 per month.

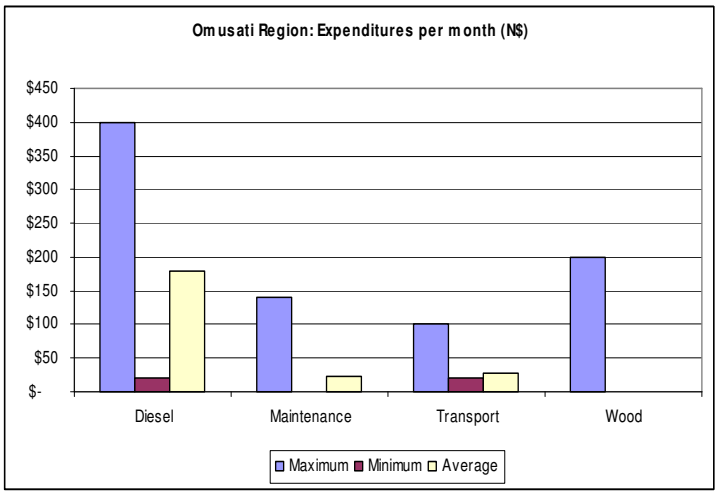


Figure 53: Expenditure Per Month in the Omusati Region

7.10.2.5 Awareness

Over 80% of the respondents were aware of PVP technology through interactions with other villages and nearby development projects, but none owned or operated a PVP. The majority indicated a willingness to buy PVP technology and was clearly aware of the benefits. A number of respondents also indicated that they would personally invest in the technology and operate it themselves, rather than securing a borehole installation from DRWS and making use of a Water Point Committee. However, none of the respondents were aware of the Home Power Programme.

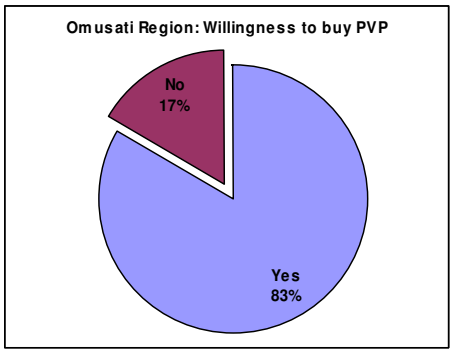
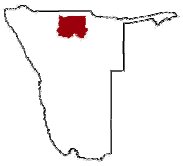


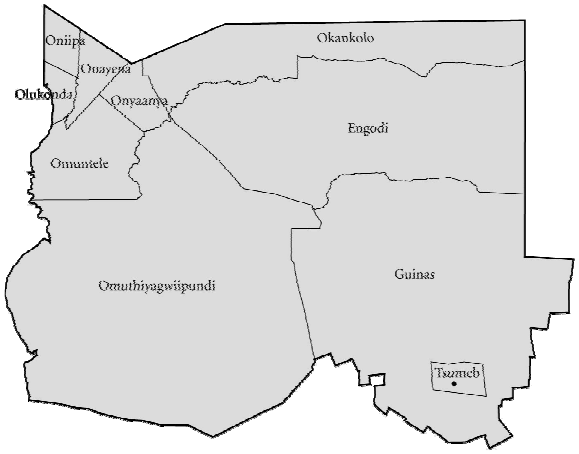
Figure 54: Willingness to Buy PVP

7.11 OSHIKOTO[14]



7.11.1 Introduction

The Oshikoto Region has a surface area of 38,800 km^2 and is bordered by the Oshana Region (west) the Omusati Region (north), the Kavango Region (east) and the Ojozondjupa Region (south). It comprises 10 constituencies: Oniipa, Olukonda, Onayena, Omuntele, Omuthiya-gwiipundi, Onyaanya, Okankolo, Engodi, Guinas and Tsumeb.



The climate of Oshikoto Region is semi-arid with mean maximum summer temperatures of 22 - 32°C and mean minimum winter temperatures of 9°C. Rainfall varies with the Karstland of the Otavi Mountains being one of the highest rainfall areas in Namibia. The western portion of the region has rainfall ranging from 255 – 710 mm per annum while the eastern part, including the Karstland, has a range between 321 – 828 mm per annum.

The agricultural sector is mainly dominated by mixed subsistence farming with cultivation of mahango (pearl millet) as staple crop combined with extensive livestock production. Most households in the Oshikoto Region have access to arable land and about 50% of household's own livestock. The cultivated area is estimated at about 2ha per household with arable farm size at 6.5ha. Most farms include an area for the homestead, fields, livestock kraals, and an area with mopane trees or scrub. Over 80% of the Region's population lives in rural areas and over 90% of the population derives their income from agricultural activities. Two-thirds of the Region's land is communal land, occupying the northern parts of the region, while about 350 commercial farms occupy the south-eastern part of the Region.

With a population size of 160,788 persons in 28, 417 households (with an average household size of 5.8 people), the Oshikoto Region accounts for about 9% of Namibia's population.

Tsumeb is the only formal town in the Region and the average population density is about 4.4 people per km^2. However, the population density for the Region varies between less than 0.20 persons per km^2 in the western part of the Engodi and Okankolo constituencies to more than 50 persons per km^2 in the Oniipa, Olukonda and Onayena constituencies. Apart from Tsumeb and Oniipa, people have settled in a corridor along the trunk road between Tsumeb and Ondangwa, sometimes forming quite dense settlement concentrations.

The Oshikoto Region is served by 2 hospitals, 4 healthcare centres, 16 clinics, 72 outreach clinics and 148 schools. A total of 285 rural settlements occur in the Ohikoto Region of which 40 are electrified. The remaining 245 unelectrified rural settlements include 103 unelectrified schools, 72 unelectrified health facilities, 1 unelectrified agricultural development centre and approximately 67 unelectrified informal businesses.

[14] Source: MME, *Rural Electricity Distribution Master Plan: Oshikoto Regional Report*, 2000
Source: NPC, *2001 Population and Housing Census National Report*, 2003

7.11.2 Survey Results

7.11.2.1 Respondents

Of the 8 respondents interviewed, all were male. Although a significant income for the Region comes from migrant labour, leaving most households to be headed by women, investment decisions are nonetheless made by men. The strong patriarchal culture demands that males make most decisions regarding the development of the households. This should be strongly considered when RE technologies are promoted in the Oshikoto Region. The level of formal education of the respondents is diverse and relatively low. Awareness campaigns through newspapers and other print media might be successful although demonstrations and more visual and audio approaches would be preferred.

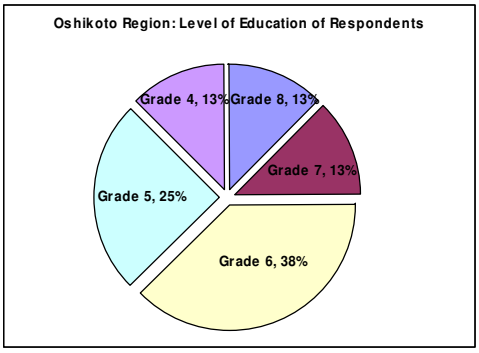


Figure 55: Level of Education in the Oshikoto Region

7.11.2.2 Livestock

Regarding livestock distribution in the Region, farming is dedicated mostly to cattle and goats. Exact livestock figures per household range between 40 and 500 heads of cattle and 4 to 150 goats. A significant number of donkeys are used for transport, especially in the flat and sandy northern areas and for ploughing fields. Major problems with livestock production were cited as a lack of sufficient water sources, lack of suitable grazing and range land and the prevalence of livestock diseases such as contagious bovine pleuropneumonia and botulism. Cattle are kept primarily for meat and milk production and for selling, while goats provide a source for routine meat consumption.

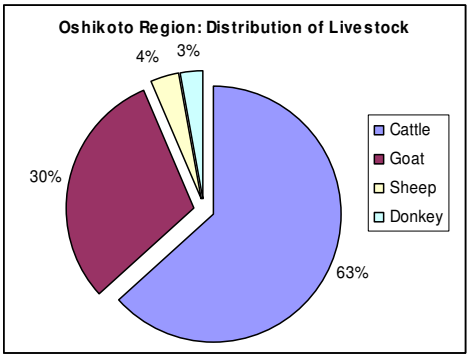


Figure 56: Distribution of Livestock in the Oshikoto Region

7.11.2.3 Water

At 45 liters (cattle) and 12 litres (goats) per day, water is used primarily for livestock production. Crop production, which is significant in the Region, is dependent solely on rainfall and irrigation schemes are mostly only found in the commercial farming areas. Due to significant ground water depths (between 100m and 150m), water is obtained largely from boreholes installed by DRWS, supplemented by communal taps installed by the Directorate along pipelines. One respondent makes use of a PVP, while all others rely on Diesel installations. Although some water points or boreholes are located within 20m from households, others are much farther away in order to be close to the grazing ares. Some households are located up 120km from the nearest water point, and the travel times to required to obtain water for the household range up to 5 hours.

7.11.2.4 Income and Expenditure

In terms of monthly expenditure, average maintenance expenses are greater than the average expenses for Diesel fuel consumption. Highest Diesel fuel and maintenance expenses were recorded for a farmer responsible for covering his own costs, while maintenance expenses for half the respondents was covered by the DRWS. None of the respondents had access to electricity, while wood fuel consumption is largely collected free of charge.

Household income ranged between N$ 300 (pensioner) to N$ 4,500 (farmer) per month with an average income of about N$ 1,300 per month.

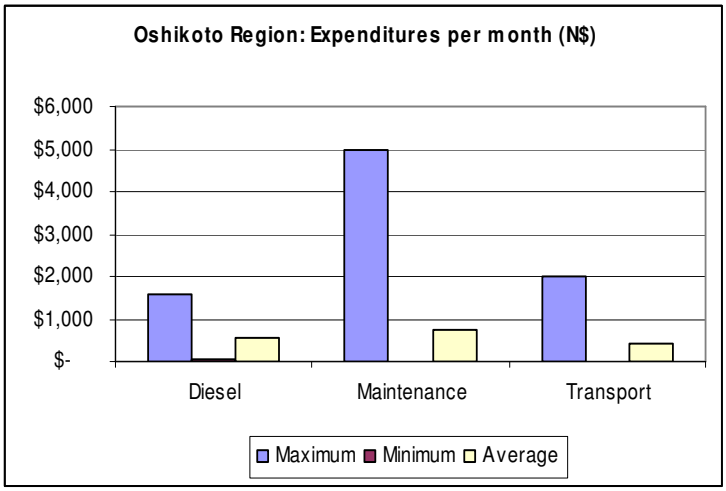


Figure 57: Expenditure Per Month in the Oshikoto Region

7.11.2.5 Awareness

Half the respondents indicated willingness to buy PVP technology and all are aware of the technology mostly through interactions with relatives and neighbouring villages, but also through radio. Although there is a high level of awareness about PVP, none of the respondents were aware of the HOME POWER Programme.

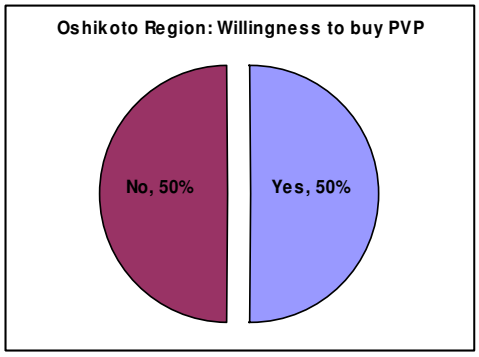
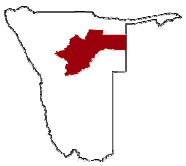


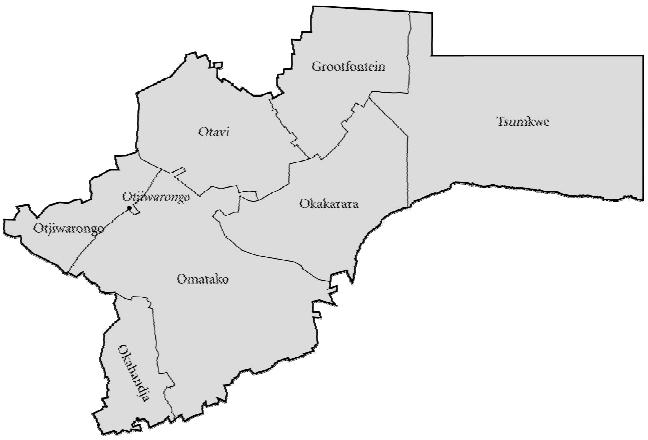
Figure 58: Willingness to Buy PVP

7.12 OTJOZONDJUPA[15]

7.12.1 Introduction



The Otjozondjupa Region covers an area of 105,328 km^2. The Kavango and Oshikoto Regions border the Region to the north. In the east it is bordered by the international boundary with Botswana and to the south by the Omaheke and Khomas Regions. To the west the Region is bordered by the Erongo and Kunene Regions. The Otjozondjupa Region consists of six constituencies: Grootfontein, Otavi, Okakarara, Otjiwarongo, Okahandja and Omatako. The main centres are Okahandja, Grootfontein, Otjiwarongo, Okakarara, Otavi and Kombat.



The climate of the Region can be described as mild sub-arid to sub-arid with hot summers and cool to warm winters. The annual mean temperature at Otavi is 20.3°C, at Otjiwarongo 20.4°C and at Grootfontein 21.0°C. The northern part has an average rainfall of 321-828 mm, the central part 255-710 mm and the southern part 179-587 mm.

The Region employs about 37% of its population within the agricultural sector, whose activities is generally hampered by land shortages, highly variable rainfall, overgrazing and bush encroachment. The Region has the largest number of cattle in Namibia and produces a variety of crops such as maize and cotton. The total commercial farm area of the Otjozondjupa Region is about 73,861.5 km^2. This comprises 77% of the region's total area with communal farm areas constituting the rest.

The Otjozondjupa Region has a population of almost 135,800 persons (about 7.2% of Namibia's population) living in about 25,400 households with an average household size of 4.3 people. The Region has an estimated population density of 1.3 people per km^2 with the most sparsely populated areas being in the western part of the Grootfontein constituency and the northern part of the Okakarara constituency. The area between Otavi and Grootfontein is the most densely populated area within the Region. In 1991, 37% of the Otjozondjupa population lived in settlements of 200 people or fewer, and 46% of the Region's population lived in urban areas.

The Region is served by 4 hospitals at Grootfontein, Okahandja, Okakarara and Otjiwarongo. The Mangetti Health Centre serves the Region in addition to 16 clinics. Of the 50 schools, 36 have hostel facilities, but less than 20% have access to electricity. There are about 139 identified unelectrified rural settlements in the Otjozondjupa Region, out of a total of 162 rural settlements. The unelectrified settlements include 7 agricultural extension offices, 6 health facilities, 7 schools and a number of various administration and public offices.

[15] Source: MME, *Rural Electricity Distribution Master Plan: Otjozondjupa Regional Report*, 2000
Source: NPC, *2001 Population and Housing Census National Report*, 2003

7.12.2 Survey Results

7.12.2.1 Respondents

Of the 10 respondents interviewed, 2 were women. The strong patriarchal culture demands that males make most decisions regarding the development of the households. This should be strongly considered when RE technologies are promoted in the Otjozondjupa Region. The level of formal education of the respondents is diverse and relatively low. Awareness campaigns through newspapers and other print media might be successful although demonstrations and more visual and audio approaches would be preferred.

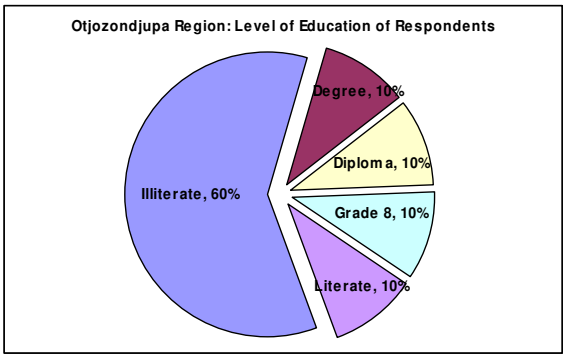


Figure 59: Level of Education in the Otjozondjupa Region

7.12.2.2 Livestock

Regarding livestock distribution in the Region, farming is dedicated mostly to cattle and goats. Exact livestock figures per household range between 10 and 340 heads of cattle, 30 to 150 goats and 15 to 260 sheep. Donkeys and horses are used for transport, and the latter are also useful for cattle herding in the dense bush. Major problems with livestock production were cited as a lack of sufficient water sources, lack of suitable grazing and range land, illegal fencing, overstocking, poisonous plants and the prevalence of livestock diseases such as urgenea. Cattle and sheep are kept primarily for meat and milk production and for selling, while goats provide a source for routine meat consumption.

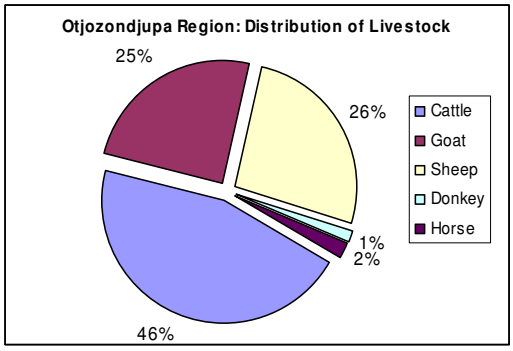


Figure 60: Distribution of Livestock in the Otjozondjupa Region

7.12.2.3 Water

Water sources are primarily boreholes and ground water levels vary between 45m to 75m. All boreholes are equipped with Diesel pumps and were, except for 2, which were installed and funded directly by the community, installed by DRWS. Distances to boreholes are reasonable, with traveling times of 10 to 30 minutes. All boreholes are managed by Water Point Committees, which appoint Water Point Caretakers. This position is voluntary and the person fulfilling this duty receives no remuneration. Apart from being responsible for the installation's maintenance, the Water Point Committee also has a treasurer responsible for collecting fees (calculated at a fixed daily price per head of cattle drinking at the water point, a lump sum or a fixed monthly contribution). This is situation lends itself to friction within the community. In view of a lack of remuneration, this position is susceptible to victimization or profiteering. None of the respondents operate a PVP.

7.12.2.4 Income and Expenditure

Diesel and maintenance account for the highest monthly expenditure for water points. In terms of household expenditure for energy, only one respondent had access to electricity while all respondents use wood fuel free of charge. Household income ranged between N$ 900 (farmer) to N$ 12,000 (farm manager with diploma) per month with an average income of about N$ 3,400 per month. Sale of livestock is more regular, as respondents participate in commercial monthly auctions in the Region.

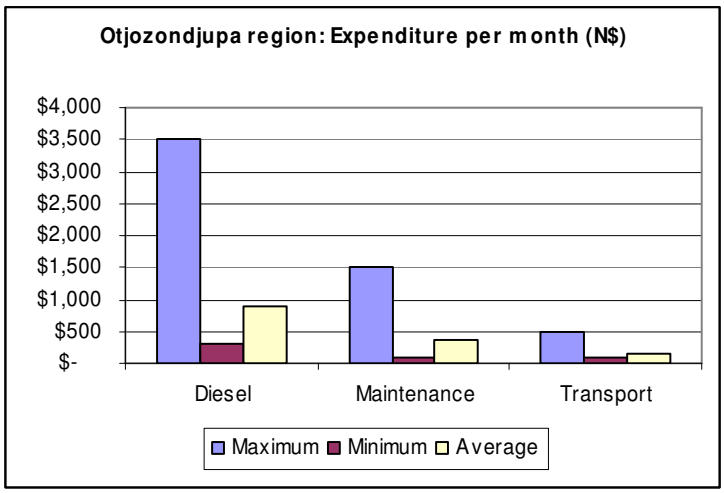


Figure 61: Expenditure Per Month in the Otjozondjupa Region

7.12.2.5 Awareness

None of the respondents were familiar with the technology. This might account for the low willingness to buy PVP technology. The low level of awareness about RE technologies is further demonstrated through the fact that none of the respondents were aware of the HOME POWER Programme.

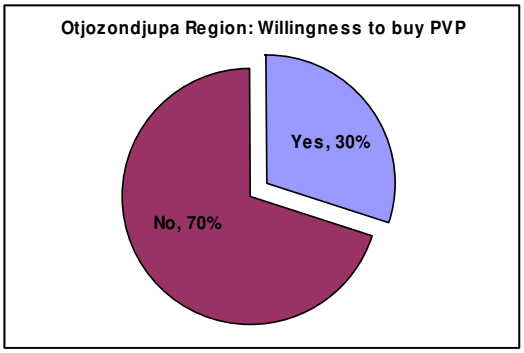


Figure 62: Willingness to Buy PVP

8 BARRIERS, INDICATORS AND RECOMMENDATIONS

8.1 BARRIERS

As discussed in Section 4, NAMREP is comprised of the following six components:

- Capacity Building
- Removal of Institutional Barriers
- Public Awareness and Social Acceptability
- Removal of Financial Barriers
- Removal of Technical Barriers
- Demonstrations and Pilots

The first five components are defined by the types barriers that they are to address. The elimination/reduction of the five types of barriers is also the focus of the recommendations of this report. The following are descriptions of the five types of barriers as formulated by the NAMREP Project Management Unit (PMU):

8.1.1 Barrier Type 1: Capacity Barriers

Capacity barriers are defined as a general lack of human capacity and resources by the private sector, NGO's and Government to identify, design, appraise, manage, advocate and implement solar technology projects. Capacity barriers are further defined for the private sector, NGO's and Government:

Private SectorCapacity Barriers:

- Lack of skilled technicians to assess, install, maintain and repair solar energy technologies (SET's).
- Spatial concentration of the SET industry in Windhoek, which is located far from the areas where SET's are most needed, and which contributes to high installation and maintenance costs.

Non-Govermental Organisation Barriers:

- Lack of adequate information/knowledge by NGO's regarding SET's which hinders them from performing meaningful advocacy and promotional work.
- Limited skills/knowledge to design, manage and evaluate SET projects, and to interpret energy policy directives.

Government Barriers:

- Limited knowledge/tools/skills to assess appropriate applications of SET's.
- Limited knowledge/tools/skills to assess compliance with standards and code of practice.
- Limited knowledge/tools/skills to develop and implement SET projects.

8.1.2 Barrier Type 2: Institutional Barriers

The following problems define institutional barriers:

- When selecting energy technologies to be utilised or promoted, institutions generally do not take into account the optimisation of recurrent and capital expenditures over the full life-cycle of the technologies under consideration.
- SET's are typically given very little consideration as an energy technology option
- There is a lack of institutional ownership of inter-sectoral policies regarding RET's.

- There is not a level playing field between grid electricity and SET's.

8.1.3 Barrier Type 3: Public Awareness and Social Acceptability Barriers

The following problems define public awareness and social acceptability barriers:

- Lack of information regarding life-cycle cost-benefits with which to compare SET's to established energy technologies.
- Lack of information on the performance and operation of the SET's.
- Lack of awareness of the availability of SET's.
- Lack of awareness regarding the Home Power revolving fund.
- Many people consider solar home systems to be inferior to grid electricity.

8.1.4 Barrier Type 4: Financial Barriers

The following problems define financial barriers:

- The initial capital costs of SET's are too high.
- Lack of well-marketed, affordable, and easily accessible financing for the purchase, installation and maintenance of SET's.
- Lack of knowledge by private sector credit institutions on how to evaluate credit applications for the purchase of SET's.
- Lack of skills to develop business plans for the supply and manufacture of SET's.
- Limited knowledge of local financiers about bulk lending facilities dedicated to clean development.
- Lack of confidence in the return on investment for end-users and loan performance for financiers.
- Uneven playing field between access to, and payment for, off-grid and grid electricity.
- Inadequate financial incentives for potential entrepreneurs to bulk procure, sell, install and maintain SET's.
- Inadequate guarantee mechanisms to service/replace faulty or failed SET's.

8.1.5 Barrier Type 5: Technical Barriers

The following problems define financial barriers:

- Non-existence of an independent SET training and testing facility.
- Lack of techno-economic data comparing different energy technologies for equivalent energy services.
- Non-existence of norms, standards and code of practice for performance, manufacturing, installation and maintenance of SET's.
- Limited empirical knowledge of the costs and benefits of SET's.
- Limited availability of adequately trained human resources within engineering, electricity, utility, academia, Government, financial institutions, and NGO's to undertake and provide least cost energy planning in the provision of energy services.

8.2 NAMREP INDICATORS

In addition to the identification of the above barriers, the NAMREP PMU has developed specific indicators (goals) that it would like achieved during the course of its five-year programme period. The programme period has two phases: Phase 1 and Phase 2. Phase 1 began in February 2004 and ends in August 2006 (21/2 year duration); and Phase 2 begins in September 2006 and ends in December 2008 (21/2 year duration). The following are the NAMREP indicators:

SET Usage/ Sales/Cost Indicators:

- Total number of household SET installations per year to be increased by 10% by the end of Phase 1, and 50% by the end of Phase 2.
- Total number of social sector (schools, clinics, etc.) SET installations per year to be increased by 10% by the end of Phase 1, and 50% by the end of Phase 2.
- Cost of SET's for end user to be reduced by 5% by the end of Phase 1, and 20% by the end of Phase 2.

Capacity-Related Indicators:

- 20% increase in RET suppliers located outside of Windhoek by end of Phase 1, and 100% increase by end of Phase 2.
- 50 new personnel from GRN, NGO's and private sector trained in SET activities by the end of Phase 1.
- Develop an SET master plan by the end of Phase 1.
- NAMREP PMU staff engaged, PMU offices and Resource Centre established and fully functioning by early 2005.

Institutional-Related Indicators:

- Line Ministries and the ECB have introduced at least two new policy measures in support of SET's by the end of Phase 1.
- Utilities and other institutions finance/implement at least two new projects in SET's by the end of Phase 1.

Public Awareness/Social Acceptability-Related Indicators:

- At least three thousand people reached through dissemination campaigns for educational and public awareness materials on SET's, and three hundred people through workshops and meetings – by the end of Phase 1.
- Number of customers enquiring information about SHS and SWH from local dealer shops increased by 20% by the end of Phase 1.
- One active network and/or association of stakeholders to be established by the end of 2005.

Financial-Related Indicators:

- At least one new strategy/policy to reduce the first cost of SET's established by the end of Phase 1.
- At least one effective financing scheme for SET's is available by the end of Phase 1.

Technical-Related Indicators:

- An REEE Institute is capacitated to fulfil its mandate by the end of Phase 1.
- At least one vocational training centre is capacitated and ready to provide technical training in SET's by the end of Phase 1.

In addition to the above indicators, the NAMREP PMU has emphasised that its efforts should focus on those who could benefit the most from SET's – namely, low-income, unelectrified households, and unelectrified institutions such as schools, clinics, etc.

8.3 RECOMMENDATIONS

A strong emphasis has been placed on obtaining the ideas and opinions of SET stakeholders during the development of the recommendations. Valuable ideas and opinions were obtained from suppliers, organisations and farmers during the surveys (interviews), and especially from the stakeholders who attended the workshop on 21 July 2005. A concerted effort was made by the Consultant and the NAMREP PMU to use the workshop as a platform for brainstorming and group discussions by stakeholders. Stakeholders were presented with the results of the baseline study and the NAMREP indicators, and then were split into two working groups and given approximately 2 hours to develop recommendations. After the brainstorming session was completed, the working groups presented their recommendations for comments by the other group.

The recommendations have been developed with the purpose of assisting NAMREP PMU to realise the goals that it has set for itself for Phases 1 and 2. As stated above, the PMU would like to achieve its goals while still focusing on low-income households and institutions that are most in need of SET's.

The recommendations generally include the seeds of ideas to be further developed by the PMU – they do not include detailed action plans. However, given that NAMREP has established its goals/indicators according to the schedule of Phases 1 and 2, the recommendations do indicate the phase during which they should be implemented.

The following are the recommendations:

8.3.1 Capacity-Related Recommendations

- A technical training curriculum in SET's should be developed and offered at all vocational training centres in Namibia. The training should be offered as an additional certificate to be obtained by persons following other training programmes, such as electricity, plumbing, etc. The training duration should not be excessive – perhaps 6 months – so that it more accessible to interested technicians.

  Timeframe:

  - Develop proposed SET curricula as soon as possible – by end of 2005.
  - Assist two vocational training centres - one in Ongwediva and one in Windhoek to establish SET training by the end of Phase 1.
  - Assist other vocational training centres to establish SET training by the end of Phase 2.

- A solar energy stakeholder association should be established.

Timeframe: Phase 1

- Assess the capacities of suppliers and make plans for assisting those who are less experienced and capable.

  Timeframe: Phase 1

- Assess in-house training that is provided by suppliers to technicians. Encourage suppliers to improve and expand training opportunities. Encourage suppliers to provide bursaries to technicians to attend future RE training curricula.

  Timeframe: Phase 1 and 2

- A survey of RE curricula that is available at higher education institutions in other countries should be performed so that appropriate and practical recommendations for new curricula can be proposed to the Polytechnic of Namibia.

  Timeframe: Phase 2

- A synopsis of donor-funded educational opportunities, inside and outside Namibia, should be performed.

  Timeframe: Phase 2

8.3.2 Institutional/Policy-Related Recommendations

- An SET Master Plan should be developed as soon as possible to provide strategic and detailed direction to the NAMREP PMU, MME, REEE, and other SET project/programme implementers. The Master Plan would provide an action plan for SET-related projects, over a set period of time (4-10 years).

  Timeframe: Phase 1

- Convince Government to adopt a policy that all schools, clinics and Government institutions must have access to electricity, even if those institutions are located off-grid.

  Timeframe: Phase 1

- Convince Government to adopt a policy that solar water heaters are compulsory for all public buildings (new buildings and replacement of broken electricity water heaters).

  Timeframe: Phase 2

- Convince Government to adopt a policy that 10% of the national power demand is supplied through RET's.

  Timeframe: Phase 2

- An energy desk should be established at all Government Ministries with appropriate platforms.

  Timeframe: Phase 2

- An incentive policy should be developed that rewards RET grid in-feeding.

  Timeframe: Phase 2

8.3.3 Public Awareness/Social Acceptability-Related Recommendations

- Launch regular awareness campaigns using radio, television, posters, trade fairs, public demonstrations, and testimonials by popular persons. Attempt should be made to use all Namibian languages. Target groups should include teachers, school children, communal farmers, resettled farmers, and commercial farmers.

  Timeframe: Phase 1 and 2

- Launch an aggressive awareness raising campaign on the existence of the solar energy revolving fund. The campaign should include the role of Konga Investment, the current administrator of the fund.

  Timeframe: Phase 1 and 2

- Cost comparisons of SET's versus grid electricity and diesel water pumps should be made widely available to potential SET users.

  Timeframe: Phase 1 and 2

- An in-depth study should be performed on the perspectives of rural persons regarding SET's. Perspectives on social status, ease-of-operation, technology capabilities, reliability, etc. should be obtained and evaluated to better identify the barriers hindering wider adoption of SET's by rural households.

  Timeframe: Phase 1 or 2

8.3.4 Financial-Related Recommendations

- Convince Government to reduce or eliminate duties on RET's and RET components that are imported from non-SACU countries.

  Timeframe: Phase 1

- The feasibility and possible advantages of trading carbon credits on the international market should be investigated. In order to become a player in carbon trading, a country needs to establish a Designated National Agency (DNA) which would provide a seal of approval to national RE projects eager to offer its carbon credits internationally.

  Timeframe: Phase 1

- Make the solar energy revolving fund accessible to community collectives.

  Timeframe: Phase 2

- Convince Government to introduce an energy tax levy in order to establish a renewable energy project/programme fund.

  Timeframe: Phase 2

- Introduce a scheme whereby SET suppliers are motivated to provide lines of credit to regional SET technicians/installers/retailers.

  Timeframe: Phase 2

8.3.5 Technical-Related Recommendations

Note that some of the capacity-related recommendations could also be included under technical-related recommendations.

- Assess the potential for value-adding in Namibia for different SET's. In some cases, the feasible value-adding activity may be limited to product assembly; in other cases complete manufacturing may be feasible. Produce business plans for each value-adding scenario.

  Timeframe: Phase 1

- Promote the funding of local SET product development and adaptation. For example, NAMREP may consider funding a relatively low-cost project for the development of a commercial-scale, solar bread oven.

  Timeframe: Phase 1 and 2

- Encourage the above-recommended association of SE stakeholders to establish technical standards for SET's.

  Timeframe: Phase 1

9 BIBLIOGRAPHY

Initial National Communication to the United Nations Framework Convention on Climate Change, MET, 2002)

Rural Electricity Distribution Master Plan for Namibia - Volume 1 National Overview Report (NamPower, 2000)

Rural Electricity Distribution Master Plan for Namibia - Volume 2 Regional Planning Report for the Caprivi Region (NamPower, 2000)

Rural Electricity Distribution Master Plan for Namibia - Volume 4 Regional Planning Report for the Hardap Region (NamPower, 2000)

Rural Electricity Distribution Master Plan for Namibia - Volume 5 Regional Planning Report for the Karas Region (NamPower, 2000)

Rural Electricity Distribution Master Plan for Namibia - Volume 6 Regional Planning Report for the Kavango Region (NamPower, 2000)

Rural Electricity Distribution Master Plan for Namibia - Volume 8 Regional Planning Report for the Kunene Region (NamPower, 2000)

Rural Electricity Distribution Master Plan for Namibia - Volume 9 Regional Planning Report for the Ohangwena Region (NamPower, 2000)

Rural Electricity Distribution Master Plan for Namibia - Volume 10 Regional Planning Report for the Omaheke Region (NamPower, 2000)

Rural Electricity Distribution Master Plan for Namibia - Volume 11 Regional Planning Report for the Omusati Region (NamPower, 2000)

Rural Electricity Distribution Master Plan for Namibia - Volume 13 Regional Planning Report for the Oshikoto Region (NamPower, 2000)

Rural Electricity Distribution Master Plan for Namibia – Volume142 Regional Planning Report for the Otjozondjupa Region (NamPower, 2000)

Review of Greenhouse Gas Emission Factors for Namibia Draft Report (MET, 2005)

REEE 6/99 – Phase 1 Promotion and Macro-Economic Analysis of Solar Water Heating in Namibia (MME, 2001)

REEE 6/99 – Phase 2 Promotion and Macro-Economic Analysis of Solar Water Heating in Namibia (MME, 2002)

REEE 2/98 – Technical and Micro-economic comparison between Solar Water Heaters and Electrical Storage Water Heaters (MME, 1999)

Developing implementation guidelines for off-grid policies for sustainable electrification in Namibia (MME, 2001)

White Paper on Energy Policy in Namibia (MME, 1998)

Assessment of two Namibian Solar Home System Programmes - Socio-economic and technical evaluation, and comparison with grid electrification for the period of 1996 to 2001 (MME, 2003)

Regional Rural Water Services Development plan for the Karas area

APPENDICES

LIST OF APPENDICES

10. QUESTIONNAIRE FOR SUPPLIERS / TECHNICIANS

Questionnaire number	

1. GENERAL INFORMATION

Name of enumerator	
Name of respondent	
Position	
Gender of respondent	
Date	
Name of Company	
Contact details: P O Box: Tel: Fax: Email:	
Number of staff employed	
Year business was established	
Company mission statement	

2. Solar System Energy

Which type of Solar Systems have you sold and how many of each during the indicated years?

Solar Home System

Solar Home System	Household	Institutions (Clinic, School etc)	Commercial	Name of Town/ Region	Technician responsible	Financial mechanism	1999	2000	2001	2002	2003	2004
50 W												
100 W												
200 W												

Solar Water Heaters

Solar Water Heaters	Household	Institutions (Clinic, School etc)	Commercial	Name of Town/ Region	Technician responsible	Financial mechanism	1999	2000	2001	2002	2003	2004
100 *l*												
150 *l*												
200 *l*												
More than 200 *l*												

Photo Voltaic Pump

Photo Voltaic Pumps ***(depending on the capacity)***	**Household**	**Institutions (Clinics, Schools etc)**	**Commercial**	**Name of Town / Region**	**Technician responsible**	**Financial mechanism**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
60 W												
150 W												
250 W												
500 W												
700 W												

Solar Cooker

Solar Cookers	**Household**	**Institutions (Clinics, Schools etc)**	**Commercial**	**Name of Town / Region**	**Technician responsible**	**Financial mechanism**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Chicken size												
Goat size												
Parabolic												

FIND OUT THE PRICE FOR THE SYSTEM AND THE INSTALLATION COST PER YEAR IN THE REGIONS.

DESCRIBE THE AFTER SALES (GUARANTEE) SERVICE AND MAINTENANCE MECHANISMS THAT YOUR COMPANY HAS IN PLACE IF ANY?

WHAT PROBLEMS HAVE YOU BEEN FACING FROM YOUR CLIENTS?

Problems	Solar Home Systems	Solar Water Heaters	Photo-voltaic Pumps	Any comments
System failures				
Payment				
Overloading of appliances/misuse of systems				
Availability of technician				
Availability of systems/components				
Any other				

From which Company and country/town do you get your supply of equipment?

Training

How many technicians have you employed in your company?

Are your technicians adequately trained?

Yes	
No	

In which technologies are your technicians trained?

Systems	**Tick**	**Any comments**
Solar Home Systems		
Solar Water Pumps		
Photo-voltaic Pumps		

Do you need additional training for your technicians**?**

Yes	
No	

If yes, what type of training?

How many inquiries do you encounter per month/year and what are the most common type sizes do they ask?

Networking

Under which circumstances do you communicate with other Namibian suppliers?

Do you feel a need to establish a National Supplier Association for Renewable Energy Technologies?

Yes	
No	

If yes, would you like to be a member and what role would you like to play?

Revenue

What are the import duties, VAT and any other charges pay for the system/components you purchase from abroad?

Do you encounter any problems getting your products into the country?

Are you satisfied with government support / policy towards promoting renewable energy technologies?

Yes	
No	

If no, what would you recommend as additional policy intervention, GRN can introduce to promote RE in Namibia?

Marketing

How do you market your Systems?

Any other comments?

11. QUESTIONNAIRE FOR GOVERNMENT MINISTRIES, PARASTATALS, DONOURS AND PRIVATE SECTOR

1. General information

Name of enumerator	
Name of respondent	
Position	
Name of Ministry / Institution / Company	
Contact details: P O Box: Tel: Fax: Email: Contact person:	

What is your Ministry / Institution mission statement?

2. Policy

What Energy related policy document and guidelines in your Ministry / Institution are available and which would you like to recommend?

Existing Policies	Future Policies to be developed

What Policies are in place to promote the use of Renewable Energy System / Technologies?

Name of Policy	Line Ministry / Institution

What is the Namibian Policy concerning taxation of Renewable Energy System / Technologies?

Does GRN provide any subsidies for Renewable Energy System / Technologies?

Yes	
No	

If yes, please mention.

What problems / constraints does your Ministry / Institution face with respect to purchasing RET's?

Does your Ministry / Institution own and operate any RET's?

Yes	
No	

If yes, who is responsible for the maintenance of your systems?

What problems do you encounter with supplier / technicians?

3. Solar Energy System

Mention type and number of systems installed in your institutions?

Type of institutions	Type of Systems	Name of Supplier / Technician	Name of technician responsible for maintenance	Region / Town	1999	2000	2001	2002	2003	2004
Schools										
Vocational Training Colleges										
Clinics										
Hospitals										
Public buildings										
Rural Water Supply										
Extension residential buildings										
Agricultural Development Centres										
Namibia Wildlife Resorts										
Forestry Extension officers										
Forestry Extension Residential building										
Telecom										
MTC										
Namibia Broadcasting Cooperation										
NamPower										
Government Farms										
NamWater										
European Union										
GTZ										
AgriBank										
UNESCO										
Ministry of Finance										
Ministry of Mines and Energy										
Namibia Police Buildings										
Ministry of Works, Transport and Communication										
Ministry of Health and Social Services										
Ministry of Higher Education,Vocational Training and Employment Creation										
Any other institutions (Please mention)										

4. Technicians

How many trained technicians are in your Ministry / Institution and what is their gender?

_____

If you have technicians in your Ministry / Institution, do they need further training and in which related / type field?

_____

Are you aware of the Solar Revolving Fund, which is recently administered by Konga Investment?

Yes	
No	

12. QUESTIONNAIRE FOR COMMERCIAL AND COMMUNAL FARMERS

Questionnaire number	

1. General information

Name of enumerator	
Name of respondent	
Position on the farm	
Gender of respondent	
Date	
Name of area and region	
Duration on the farm	
Household head employment area	
Level of education	

Family

No. of	**M**	**F**	**Total**
Adults			
Children			
Head of family			

How many farm workers have you employed?

2. Income and Expenditure

Communal Farm

	Tick and write amount if possible
N$ 1 000.00	
N$ 1 0000.00 – N$ 2 500.00	
N$ 2 500.00 – N$ 5 000.00	
Other sources and more income	

Commercial farm

	Tick and write amount if possible
N$ 5 000.00	
N$ 5 0000.00 – N$ 7 000.00	
N$ 7 000.00 – N$ 10 000.00	
Other sources and more income	

What is your monthly expenditure for energy related activities for water pumping?

Activities	Monthly expenditure
Diesel	
Maintenance	
Transport	
Electricity	
Wood	

3. Livestock

What type of livestock do you own and how many of each?

Type of Livestock	Tick	How many	Usage
Cattle			
Goats			
Sheep			
Donkey			
Horses			
Other (Specify)			

Do you encounter problems / difficulties to sustain your livestock?

Yes	
No	

If yes, specify.

Problems	Season	Management technique

4. Water

What type of borehole do you operate on the farm?

Diesel	
Photo Voltaic Pump	

Who is responsible for the maintenance of the borehole?

What is the capacity of your borehole?

What is the depth of the water hole?

What is the distance from the water hole to the dam?

How did you finance your borehole system and how much did it cost including installation? If it was through a loan from whom?

Who make use of the water source (s)?

Source			
Borehole			
Communal tap			
Pipe / tap			
Hand dung swallow well			
Hand dung shallow well			
Other (specify)			

How far is the water source from you permanent resident?
Distance:

Time spent:

5. Photo Voltaic Pump

Have you ever heard about Photo Voltaic Pump?

Yes	
No	

If yes, specify media?

Do you own a PVP?

Yes	
No	

If yes, where did you buy your PVP system and who is responsible for the maintenance of the PVP?

What is the capacity of the PVP?

If no, are you interested in buying a Photo Voltaic Pump?

Yes	
No	

If the PVP is installed on your farm, who will be responsible for the following?

Activities	**Who**	**Reason**
Maintenance		
Operation		
Other		

Are you aware of the Solar Revolving Fund, which is recently administered by Konga Investment?

Yes	
No	

13. LIST OF SOLAR SUPPLIERS IN NAMIBIA IN 2004

Company name	NAME	Position	Contact details
Electro Amwele **Description:** Photovoltaic energy systems, components, sales, services and installations	Mr Phillipus Amwele	Managing Director	P O Box 401 Ondandwa, Namibia Tel: + [264] 65 240414 Fax: + [264] 65 240154 Email: elamwele@iway.na
Kalahari Sun Technology **Description:** Photovoltaic energy systems, Solar Water Heaters, components, sales, services and installations	Mr Rolf Seiferth and Prof. Mburumba Kerina	Managing Director and Director for Projects and International Affairs	P O Box Windhoek, Namibia Tel: + [264] 61 260338 Fax: + [264] 61 260338 Email: solar@mweb.com.na
Namibia Engineering Corporation **Description:** Distributor, supplier of Photovoltaic, solar thermal products and installations	Mr Julius Kotze and Nico Bruckner	Product Engineer Director	P O Box 5052 Windhoek, Namibia Tel: + [264] 61 236720 Fax: + [264] 61 232673 Cell: 0811244996 jkotze@namencor.com.na nbruckner@namencor.com.na
Siemens **Desription:** Photovoltaic components wholesaler	Mr Derek Phillips	Manager: Energy and Industry	P O Box 23125 Windhoek, Namibia Tel: + [264] 61 278716 Fax: + [264] 61 278701 Cell: 0811277716 Email: Derek.phillips@siemens.com
Solar Age Namibia **Description:** Photovoltaic energy systems and components; manufacture, sales, services and installations	Mr Conrad Roedern	Managing Director and Proprietor	P O Box 9987 Windhoek, Namibia Tel: + [264] 61 215809 Fax: + [264] 61 215793 www.iafrica.com.na
Solar Stove Project **Description:** Manufacture of Solar Cookers, sales and services	Ms Kristina Hishidimbwa	Project Supervisor	P O Box 3438 Windhoek, Namibia Tel: + [264] 65 231463 Fax: + [264] 65 231463 Cell: 0812746467
SOLTEC **Description:** Photovoltaic energy systems, Solar Water Heaters and components, sales, services and installations	Mr H. Steuber	Sole member & Director	P O Box 315 Windhoek, Namibia Tel: + [264] 61 235646 Fax: + [264] 61 250460 Email: h.steuber@soltech .com.na
TERRASOL **Description:** Photovoltaic pumping systems manufacturing sales and services and installation	Mr Werner Schultz	Owner	P O Box 6036, Windhoek, Namibia Tel: + [264] 61 239454 Fax: + [264] 61 239454
Willard Batteries **Description:** Photovoltaic components wholesaler	Mr Peter Walbaum	Director	P O Box 5919 Windhoek, Namibia Tel: + [264] 61 234023/4 Fax: + [264] 61 225990 Cell: 0811289746 Email:pwalbaum@willard.co.za

13.1 LIST OF TECHNICIANS / POTENTIAL SUPPLIERS IN NAMIBIA IN 2004

NAME	Company name	Position	Contact details
Mr Abraham Hangula	EMCON	Technician	P O Box 1900 Windhoek, Namibia Tel: + [264] 61 224725 Fax: + [264] 61 233207 Email: emcon@emcon.com.na
Mr Matheus U. Nyambali	MU Electric	Owner	P O Box 2333, Ondangwa, Namibia Tel: + [264] 65 245882 Fax: + [264] 65 240240 Email: angulada@iway.na
Mr Albert Awene	Multi-Construction Electrical	Project Manager	P O Box 15504 Oshakati, Namibia Tel: + [264] 65 2204363 Fax: + [264] 65 220226 Email: menc@iway.na
Mr Imanuel N Shipanga	PIM Electric cc T/atommy	Manager	P O Box 2681 Oshakati, Namibia Tel: + [264] 65 231456 Fax: + [264] 65 231456 Cell: 0811277249 / 0811292356
Mr P Kalimba	Kalimba Home Power	Owner	P.O.Box 1784 Oshakati, Namibia Tel: + [264] 65 221907 Fax: + [264] 65 220975
Mr F Jeremiah	Otjiwa Electric	Technician	P.O.Box 106 Tsandi, Namibia Tel: + [264] 61 234023/4 Fax: + [264] 61 225990

14. LIST OF DOCUMENTATIONS AVAILABLE

No.	Title	Consultant	Year
1.	FINESSE: Namibia country study	Energy & Development Group	1998
2.	Solar pumping for communities	Energy & Development Group	1998
3.	Performance testing the Namibian JUWA PVP system	Renewable Energy Consortium	2000
4.	Financial Management of Rural Water Supply	NEPRU	1997
5.	Comparison of technical standard for Solar Home Systems	University of Marbrid, Spain	1997
6.	Assessment of the potential of PVP in Namibia	GTZ	1996
7.	Knowledge is power: Empowering household with energy information	Energy Development and Research Centre, South Africa	1996
8.	Farm worker families: Towards equitable and adequate energy provision	Energy Development and Research Centre, South Africa	
9.	Economic appraisal criteria for electric power project	Polytechnic of Namibia	1993
10.	Load research for the assessment of energy demand patterns by urban households		2001
11.	Technical and Micro-economic comparison between solar water heaters and electrical storage water heaters	EMCON	
12.	Simulation and monitoring of solar and electric water heating system	EMCON	2000
13.	Promotion and micro-economic analysis of solar water heating in Namibia – Phase 1	DRFN	2002
14.	Promotion and micro-economic analysis of solar water heating in Namibia – Phase 2	DRFN	2002
15.	Comparison between grid, solar and unelectrified households	Lucy Wamukonya and Mark Davis	1999
16	South African Standard: Domestic solar water heaters		1992
17.	Employment potential of renewable energy in South Africa	SECCP	2003
18.	Preparation for the establishment of a laboratory for the testing of renewable energy and energy efficiency technologies and devices in Namibia	EMCON	1999
19.	Developing implementation guidelines for off-grid policies for sustainable electrification in Namibia	VO Consulting cc	2001
20.	Solar Water Pumping loan scheme and revolving fund		
21.	Initial National Communication to the United Nations Framework Convention on Climate Change		2002
22.	Rural Electricity Distribution Master Plan for Namibia - Volume 1 National Overview Report		2000
23.	Rural Electricity Distribution Master Plan for Namibia - Volume 2 Regional Planning Report for the Caprivi Region		2000
24	Rural Electricity Distribution Master Plan for Namibia - Volume 3 Regional Planning Report for the Erongo Region		2000
25.	Rural Electricity Distribution Master Plan for Namibia - Volume 4 Regional Planning Report for the Hardap Region		2000
26.	Rural Electricity Distribution Master Plan for Namibia - Volume 5 Regional Planning Report for the Karas Region		2000
27.	Rural Electricity Distribution Master Plan for Namibia - Volume 6 Regional Planning Report for the Kavango Region		2000
28.	Rural Electricity Distribution Master Plan for Namibia - Volume 7 Regional Planning Report for the Kavango Region		2000
29.	Rural Electricity Distribution Master Plan for Namibia - Volume 8 Regional Planning Report for the Khomas Region		2000
30.	Rural Electricity Distribution Master Plan for Namibia - Volume 9 Regional Planning Report for the Ohangwena Region		2000
31.	Rural Electricity Distribution Master Plan for Namibia - Volume 10 Regional Planning Report for the Omaheke Region		2000
32.	Rural Electricity Distribution Master Plan for Namibia - Volume 11 Regional Planning Report for the Omusati Region		2000
33.	Rural Electricity Distribution Master Plan for Namibia - Volume 12 Regional Planning Report for the Oshana Region		2000
34.	Rural Electricity Distribution Master Plan for Namibia - Volume 13 Regional Planning Report for the Oshikoto Region		2000
35.	Rural Electricity Distribution Master Plan for Namibia – Volume142 Regional Planning Report for the Otjozondjupa Region		2000
36.	Review of Greenhouse Gas Emission Factors for Namibia Draft Report		2005
37.	White Paper on Energy Policy in Namibia (MME, 1998)		1998

38.	Assessment of two Namibian Solar Home System Programmes - Socio-economic and technical evaluation, and comparison with grid electrification for the period of 1996 to 2001	EMCON & NEPRU	2003
39.	Energy Efficiency and conservation in Namibia	G S Hamutwe & L Wamukonya	1998
40.	Gender and Sustainable Energy: Namibia's Background Paper	Wamukonya	1999
41.	Performance evaluation of the NDC revolving Credit Fund: 1996-2000	VO Consulting	2000
42.	Market Assessment of Alternative Fuels for cooking and heating	Muwonge	1998
43.	Study on Energy Consumption Patterns of Rural and Peri-urban households in Namibia		1997
44.	Proposal for LPG Market Study and distribution strategy	Southern Consultants Closed Corporation	1998
45.	Socio-economic impact of Rural Electrification in Namibia: Comparison between grid, solar and unelectrified households	Wamukonya	1999
46.	Environmental Impact Assessment for a Wind Park at Luderitz	Interconsult	2001
47.	Assessment of Wind Pumps in Namibia (REEE 10/99)	PARKMAN Namibia	1999
48.	Technical study on Potentiality for the manufacture of Deep Dischargeable batteries in Namibia	MRCC	1999
49.	Appropriate energy supply for the Gobabeb Training and Research Centre	Axel Schole	2000
50.	Assessment of Solar and Wind resources in Namibia		
51.	Emissions Scenarios and Mitigation Options for Namibia	DRFN	1997
52.	Study on Climate Change: An overview of Namibia's vulnerability of Climate Change	DRFN	1997
53.	Project studies for the Wind Parks in Walvis Bay and Luderitz	Decon	1999
54.	The future of the Solar Electrification Revolving Fund: Issues and Options	VO Consulting	2000
55.	Consultancy Sevices for a Study on Namibian REEE Institute (REEE 8/99)	Bicon	1999
56.	Study for the Electricity Master Plan in Namibia	Japan International Cooperation Agency	1998
57.	Study of Restructuring of the Namibian Electricity Supply Industry - Phase II Evaluation of ESI Restructuring Option	SAD-ELEC	
58.	Off-Grid Electrification for Namibian villages – Photovoltaic Hybrid systems to supply Mini - Grids	Conrad Roeden	2000
59.	Regional Rural Water Services Development Plan for the Karas area	AFRICON NAMIBIA / STEWART SCOTT NAMIBIA	2001

15. LIST OF TECHNICIANS

REGIONAL DISTRIBUTION OF TRAINED SOLAR TECHNICIANS

TECH NO.	NAME	REGION	TEL #	FAX #	PV
32	Mr Josty Lubinda	Caprivi	0677-3948		1,3
48	Mr Osbert Sankombo	Caprivi			1
53	Mr Francis Sisamu	Caprivi	0677-2528	0677-3862	3
66	Mr Beaven Mwala	Caprivi	0677-3948		3
4	Mr Rolf Barth	Erongo	064-570264	064-570339	1
76	Mr Reinhold de Waal	Erongo	064-530834	061-263321	4
9	Mr Hennie de Wet	Erongo	064-208212	064-208206	1
82	Mr Richard Khachab	Erongo	064-204510	064-204514	4
34	Mr Gerald McCullough	Erongo	064-570651	064-570516	1
94	Mr Raphael Shivute	Erongo	064-203351	064-206523	4
74	Mr James Basson	Hardap	063-251190		4
6	Mr Martinus Brendel	Hardap	0621-522031		1
83	Mr Gert Kooper	Hardap	063-240905	063-240527	4
31	Mr Gilroy Lehmann	Hardap	061-213277		3
45	Mr Adriaan Philander	Hardap	0627-522790		1,3
97	Mr Noel van der Hoven	Hardap	0811246228	0627-524033	4
75	Mr Helmuth Beukes	Karas	063-224295	063-223758	4
10	Mr Dries Engela	Karas	063270-466		1
79	Mr Johannes Jacobs	Karas	063-270542		4
55	Mr JL Smit	Karas	0632-22804		1
95	Mr Edmund Swartbooi	Karas	063-280025		4
5	Mr Bernhard Beyer	Khomas			1
8	Mr Willem Dax	Khomas	061-224531		1
77	Mr Moses Geingob	Khomas	061239454	061-239454	4
12	Mr Manie Gradigde	Khomas	061-238350		1
13	Mr Leon Greyton	Khomas	061-235646		3
18	Mr Noddy Hipangelwa	Khomas	2848111/8205	061-238643	1
20	Ms Helvi Ileka	Khomas	215809	061-215793	1
68	Mr Christoph Jatamunua	Khomas	061-261434		4
69	Mr John Kauaria	Khomas	061-239850	061-225630	4
27	Mr Severinus Kaulinge	Khomas	061-224685	061-258312	3
29	Mr Hermann Kleinert	Khomas	061-241080	061-225629	1
30	Mr Willem Kaputu	Khomas	061-215809	061-215793	3
84	Ms Anna Lyamine	Khomas	061-230882		4
35	Mr Ignecious Mukela	Khomas	0677-3752		3
36	Mr Willy Munenguni	Khomas	061-214800	061-212379	1
71	Mr Mesag Muruko	Khomas	061-2042039	061-22042092	4
37	Mr Pehari Muundjo	Khomas			3
87	Mr Sackarias Namadhila	Khomas	061-2022036	061-229961	4
91	Mr Robert Schultz	Khomas	061-239454	061-239454	4
93	Ms Elizabeth Shikomba	Khomas	061-261634		4
50	Mr Mathew Shikomba	Khomas	061-214800		1
56	Mr Wilfried Somseb	Khomas	061-264952		3
58	Mr Ronaldt Swartz	Khomas	061-211242		3
96	Mr Prescott Tjamburo	Khomas	061-2913172	061-262346	4
59	Mr Bartholomeus Tjivikua	Khomas	061-265176	0611-2902494	3
64	Mr Ferdie van As	Khomas	061-253105		1
98	Ms Lucy Wamukonya	Khomas	0811272536	061-238643	4
67	Mr David Xamseb	Khomas	061-215120		3
46	Ms Ndeshihafela Ruben	Kunene	06758-53		2,3
47	Mr S Samupofu	Kunene	065712-61		1
65	Mr Peter Wilson	Kunene	06562-76	06562-14	3
14	Ms Albertina Halweendo	Ohangwena	06751-30480		
43	Mr Fredreck Nghipandulwa	Ohangwena	081121515	061-258312	3
90	Mr Leonard Sakaria	Ohangwena	2837283	253865	4
17	Mr Alfredo Hindimbwasha	Okavango	067-255671	067-255364	3
81	Mr Bernhard Kavera	Okavango	067-256445	067-256444	4
89	Mr Erastus Ntusi	Okavango	067-256743	067-256183	4

92	Mr Frans Shifura	Okavango	067-255189	067-255710	4
54	Mr Blasius Siyemo	Okavango	067-255690	067-255685	3
26	Mr Phillipus Katamelo	Omaheke	0681-3329		3
70	Mr Emmanuel Matjila	Omaheke	061-563850	061-563122	4
85	Mr Alfred Meyer	Omaheke	0811248044	061-561650	4
86	Mr Gideon Murangi	Omaheke	061-568607		4
60	Mr Nico Tlhabanelo	Omaheke	0681-563871	0681-562432-	1,3
61	Mr Judah Tuahuku	Omaheke	061-223249		2
2	Mr Titus Ainima	Omusati	06751-51271		2
11	Mr Jeremia Festus	Omusati	06751-51136	06751-51136	3
16	Mr Nestor Heita	Omusati	061-2803242	061-226121	2
33	Ms Helen Marcus	Omusati	0675120481		2
38	Mr Onesmus Nakwalondo	Omusati			2
39	Mr Thomas Nangutuwala	Omusati	06751-60003		2,3
62	Ms Maartha Uuwanga	Omusati	06751-60020		2,3
1	Mr Herman Aina	Oshana	06751-21152		2
3	Ms Lydia Alfeus	Oshana	06751-20117		
72	Mr Sheela Amwele	Oshana	06756-40100	06756-40520	4
19	Ms Hilia Imalwa	Oshana	06756-30430		2
21	Mr Epafras Kaafuli	Oshana	06751-21848	06751-21292	2,3
24	Mr Peter Kalimba	Oshana	06751-21197	06751-20957	3
25	Mr Martin Kapunda	Oshana	06751-60020		3
28	Mr Isak Kayofa	Oshana	06751-31284/3		3
88	Mr Wilbard Nangombe	Oshana	06756-40653	06756-40693	4
40	Mr Albin Ndafenongo	Oshana	06756-40092	06756-40268	2,3
42	Mr Willem Nghilinganye	Oshana	06751-40491		2
49	Mr Timotheus Shaanika	Oshana			2
51	Ms Laina Shikongo	Oshana	06751-70047	06751-70033	3
52	Mr Herman Shiningayamwe	Oshana	06751-21083		2
63	Ms Elizabeth Uunona	Oshana	06751-511031		2
73	Mr John Awene	Oshikoto	061-247022	061-220013	4
15	Mr Simon Hanga	Oshikoto	067-20709		2
41	Mr Laurentius Ndjukuma	Oshikoto	067-220172		2
7	Mr Gerrit Cilliers	Otjozondjupa	06738-8321		1
22	Mr Leonard Kaangundue	Otjozondjupa	0652-317269		1
23	Mr Elwid Kaapehi	Otjozondjupa	0652-317184	0652-317112	3
80	Mr Ismael Kaura	Otjozondjupa	0621-519022	061215531	4

16. COST BENEFIT ANALYSIS BETWEEN PVP AND DIESEL

A Cost Benefit Analysis with the aim of assessing the amortisation rate between various PV and Diesel water pumps was conducted. Quotations were obtained from various suppliers according to predetermined borehole and water delivery specifications. Suppliers were also requested to indicate the fuel consumption and maintenance requirements and expenses where applicable. The table below indicates the pumps investigated and compared.

DIESEL	Total Head (m)	Water Delivery per day (litres)	SOLAR	Total Head (m)	Water Delivery per day (litres)
Grundvos SP14A-10 380V Submersible AC Electric Pump with 15kVA, 380V Diesel Generator	50	80,000	Grundfos SGF 2.5-2 Submersible AC Electric Pump with 3,3kWp PV panels	50	40,000
GW0501 Orbit Positive Displacement Pump (Mono-type) with 4.5 kW Diesel Engine	50	50,000	Grundfos SQFlex Submersible AC or DC Electric Pump with 540 Wp PV panels	50	15,000
Grundvos SQ3-55 280V Submersible Electric Pump with 5kVA, 230V Diesel Generator	50	24,000	ETA HR 07 Submersible DC Electric Pump with 320 Wp PV panels	50	7,000
GW0202 Orbit Positive Displacement Pump (Mono-type) with 4.5 kW Diesel Engine	50	15,000	Grundfos SQFlex AC or DC Electric Pump with 2,200W PV panels	100	16,000
GW0102 Orbit Positive Displacement Pump (Mono-type) with 4.5 kW Diesel Engine	50	7,000	ETA HR 07 DC Electric Pump with 1,200W PV panels	100	12,000
GW0502 Orbit Positive Displacement Pump (Mono-type) with 7 kW Diesel Engine	100	50,000	ETA HR 07 DC Electric Pump with 880W PV panels	100	8,000
GW0202 Orbit Positive Displacement Pump (Mono-type) with 4.5 kW Diesel Engine	100	15,000	Grundfos SQFlex AC or DC Electric Pump with 770W PV panels	150	7,000
Monostroom with BP4M Element (Mono-type) with 6 HP Diesel Engine	100	15,000	ETA HR 04H DC Electric Pump with 1,200W PV panels	150	8,500
GW0102 Orbit Positive Displacement Pump (Mono-type) with 4.5 kW Diesel Engine	100	7,000	ETA HR 04H DC Electric Pump with 1,200W PV panels		5,400
GW0504 Orbit Positive Displacement Pump (Mono-type) with 7 kW Diesel Engine	150	50,000			
GW0102 Orbit Positive Displacement Pump (Mono-type) with 4.5 kW Diesel Engine	150	15,00			
Monostroom with BP4H Element (Mono-type) with 6 HP Diesel Engine	150	15,000			
GW0102 Orbit Positive Displacement Pump (Mono-type) with 4.5 kW Diesel Engine	150	7,000			

The Cost Benefit Analysis assumes ideal operating conditions for all investigated technologies. This implies that expenses to the investigated technology, related to unforeseen external factors, were not considered. These factors include, but are not limited to:

- Sand, roots and other obstructing and corroding particles in the water
- High acidity of water and corrosion due to galvanic currents
- High water temperatures that could damage pump seal rings
- Theft of technologies and or components thereof
- Lighting strikes or other high atmospheric electric charges
- Weather conditions such as dust storms, cloud cover and hail storms

The above factors may lead to increased wear and tear and maintenance of all or some of the investigated technologies.

16.1 Assumption

This Cost Benefit Analysis makes primarily four assumptions on which calculations are based:

- Assumes a 4% discount rate. This implies that increases in inflation and fuel expenses (at 10% per annum) is off-set by commercial interest rates (at 6% per annum), should moneys unspent be invested with banks.
- Assumes that expenses for regular maintenance to be conducted every 2-3 years are spread evenly throughout the respective maintenance periods. E.g. if an engine overhaul is due every 3 years and would cost N$ 10,000, the Cost Benefit Analysis assumes an "annual" maintenance expense of N$ 10,000 / 3 = N$ 3,333.33.
- Assumes a Diesel fuel price of N$ 3.961 per litre, which is the Windhoek Depot price. Commonly, farmers purchase "Farmer Diesel" directly from fuel depots, which is less expensive than Diesel from ordinary filling stations. The price per litre though various between different geographic locations. As such, the prices as from 27 April 2005 for "Farmer Diesel" are:

Place purchased	N$ per litre
Windhoek	3.961
Tsumeb	4.013
Keetmanshoop	4.089

- Assesses operation costs only and does not assumes the replacement costs of any major components. This assumption applies to both Diesel or Solar water pumps since the technologies are primarily similar, but only use different fuel sources.

16.2 Diesel Water Pump Expenses

Total Head of 50 m

The below tables indicates the capital and annual maintenance costs (inclusive of VAT) for diesel water installations 50 m total head:

DIESEL (80,000 litres water per day)	N$		
Grundvos SP14A-10 380V Submersible Electric Pump	17,423.65		
15KVA, 380V Diesel Generator	92,000.00		
TOTAL N$	109,423.65		
Operation and Maintenance Expenses	**N$**	**N$ per annum**	**Note**
Engine overhaul	25,000.00	7,142.86	Every 3 -4 years
Fuel Consumption (Farmer Diesel price) per hour	17.82	52,047.54	Consumption: 4.5 litres per hour
General Engine Service	3,500.00	24,500.00	Serviced 7 times per annum

DIESEL (50,000 litres water per day)	N$		
GW0501 Orbit Positive Displacement Pump (Mono-type)	20,418.40		
Kirloskar TAF 4.5 kW Diesel Engine	18,096.18		
TOTAL N$	38,514.58		
Operation and Maintenance Expenses	**N$**	**N$ per annum**	**Note**
Engine overhaul	5,000.00	2,000.00	Every 2 -3 years
Fuel Consumption (Farmer Diesel price) per hour	3.961	11,566.12	Consumption: 1 litres per hour
General Engine Service (Materials only)	320.00	1,600.00	Serviced 5 times per annum

DIESEL (24,000 litres water per day)	N$		
Grundvos SQ3-55 280V Submersible Electric Pump	8,217.90		
5KVA, 230V Diesel Generator	11,500.00		
TOTAL N$	19,717.90		
Operation and Maintenance Expenses	**N$**	**N$ per annum**	**Note**
Engine overhaul	10,000.00	5,000.00	Every 2 years
Fuel Consumption (Farmer Diesel price) per hour	10.69	31,228.52	Consumption: 2.7 litres per hour
General Engine Service (Materials only)	1,666.00	14,994.00	Serviced 9 times per annum

DIESEL (15,000 litres water per day)	N$		
GW0202 Orbit Positive Displacement Pump (Mono-type)	19,838.19		
Kirloskar TAF 4.5 kW Diesel Engine	17,581.91		
TOTAL N$	37,420.10		
Operation and Maintenance Expenses	**N$**	**N$ per annum**	**Note**
Engine overhaul	5,000.00	2,000.00	Every 2 -3 years
Fuel Consumption (Farmer Diesel price) per hour	3.961	11,566.12	Consumption: 1 litres per hour
General Engine Service (Materials only)	320.00	1,600.00	Serviced 5 times per annum

DIESEL (7,000 litres water per day)	N$		
GW0102 Orbit Positive Displacement Pump (Mono-type)	19,176.95		
Kirloskar TAF 4.5 kW Diesel Engine	17,581.91		
TOTAL N$	36,758.86		
Operation and Maintenance Expenses	**N$**	**N$ per annum**	**Note**
Engine overhaul	5,000.00	2,000.00	Every 2 -3 years
Fuel Consumption (Farmer Diesel price) per hour	3.96	11,566.12	Consumption: 1 litres per hour
General Engine Service (Materials only)	320.00	1,600.00	Serviced 5 times per annum

Total Head of 100 m

The below tables indicates the capital and annual maintenance costs (inclusive of VAT) for diesel water installations at 100 m total head:

DIESEL (50,000 litres water per day)	N$		
GW0502 Orbit Positive Displacement Pump (Mono-type)			
Kirloskar TAF 7 kW Diesel Engine			
TOTAL N$	26,724.11		
Operation and Maintenance Expenses	**N$**	**N$ per annum**	**Note**
Engine overhaul	5,000.00	2,000.00	Every 2 -3 years
Fuel Consumption (Farmer Diesel price) per hour	9.903	28,915.30	Consumption: 2.5 litres per hour
General Engine Service (Materials only)	320.00	1,600.00	Serviced 5 times per annum

DIESEL (15,000 litres water per day)	N$		
GW0202 Orbit Positive Displacement Pump (Mono-type)			
Kirloskar TAF 4.5 kW Diesel Engine			
TOTAL N$	24,890.89		
Operation and Maintenance Expenses	**N$**	**N$ per annum**	**Note**
Engine overhaul	5,000.00	2,000.00	Every 2 -3 years
Fuel Consumption (Farmer Diesel price) per hour	7.922	23,132.24	Consumption: 2 litres per hour
General Engine Service (Materials only)	320.00	1,600.00	Serviced 5 times per annum

DIESEL (7,000 litres water per day)	N$		
GW0102 Orbit Positive Displacement Pump (Mono-type)			
Kirloskar TAF 4.5 kW Diesel Engine			
TOTAL N$	24,890.89		
Operation and Maintenance Expenses	**N$**	**N$ per annum**	**Note**
Engine overhaul	5,000.00	2,000.00	Every 2 -3 years
Fuel Consumption (Farmer Diesel price) per hour	7.92	23,132.24	Consumption: 2 litres per hour
General Engine Service (Materials only)	320.00	1,600.00	Serviced 5 times per annum

DIESEL (15,000 litres water per day)	N$		
Monostroom with BP4M Element			
Kirloskar TAF 6 HP Diesel Engine			
TOTAL N$	43,601.00		
Operation and Maintenance Expenses	**N$**	**N$ per annum**	**Note**
Engine overhaul	5,000.00	2,000.00	Every 2 -3 years
Fuel Consumption (Farmer Diesel price) per hour	7.92	11,453.35	Consumption: 2 litres per hour
General Engine Service	320.00	1,600.00	Serviced 5 times per annum

Total Head of 150 m

The below tables indicates the capital and annual maintenance costs (inclusive of VAT) for diesel water installations at 100 m total head:

DIESEL (50,000 litres water per day)	N$		
GW0504 Orbit Positive Displacement Pump (Mono-type)			
Kirloskar TAF 7 kW Diesel Engine			
TOTAL N$	36,319.16		
Operation and Maintenance Expenses	**N$**	**N$ per annum**	**Note**
Engine overhaul	5,000.00	2,000.00	Every 2 -3 years
Fuel Consumption (Farmer Diesel price) per hour	11.883	34,698.36	Consumption: 3 litres per hour
General Engine Service (Materials only)	320.00	1,600.00	Serviced 5 times per annum

DIESEL (15,000 litres water per day)	N$		
GW0102 Orbit Positive Displacement Pump (Mono-type)			
Kirloskar TAF 4.5 kW Diesel Engine			
TOTAL N$	30,355.53		
Operation and Maintenance Expenses	**N$**	**N$ per annum**	**Note**
Engine overhaul	5,000.00	2,000.00	Every 2 -3 years
Fuel Consumption (Farmer Diesel price) per hour	7.922	23,132.24	Consumption: 2 litres per hour
General Engine Service (Materials only)	320.00	1,600.00	Serviced 5 times per annum

DIESEL (7,000 litres water per day)	N$		
GW0102 Orbit Positive Displacement Pump (Mono-type)			
Kirloskar TAF 4.5 kW Diesel Engine			
TOTAL N$	30,355.53		
Operation and Maintenance Expenses	**N$**	**N$ per annum**	**Note**
Engine overhaul	5,000.00	2,000.00	Every 2 -3 years
Fuel Consumption (Farmer Diesel price) per hour	7.92	23,132.24	Consumption: 2 litres per hour
General Engine Service (Materials only)	320.00	1,600.00	Serviced 5 times per annum

DIESEL (15,000 litres water per day)	N$		
Monostroom with BP4H Element			
Kirloskar TAF 6 HP Diesel Engine			
TOTAL N$	72,612.60		
Operation and Maintenance Expenses	**N$**	**N$ per annum**	**Note**
Engine overhaul	5,000.00	2,000.00	Every 2 -3 years
Fuel Consumption (Farmer Diesel price) per hour	7.92	11,453.35	Consumption: 2 litres per hour
General Engine Service	320.00	1,600.00	Serviced 5 times per annum

16.3 PV Water Pump Expenses

Total Head of 50 m

The below table indicates the capital and annual maintenance costs (inclusive of VAT) for PVP water installations at 50 m total head:

Note: The PVPs listed below do not have operating expenses and do not require any regular maintenance, except to clean the PV panels from time to time.

SOLAR (40,000 litres water per day)	**N$**
Grundfos 3-phase stainless steel centrifugal pump and DC/AC inverter	
3,300W PV panels, stand, cables, installation materials, etc	213,325.00
TOTAL N$	**213,325.00**

SOLAR (15,000 litres water per day)	**N$**
Grundfos SQFlex AC or DC	
540W PV panels, stand, cables, installation materials, etc.	39,719.85
TOTAL N$	**39,719.85**

SOLAR (7,000 litres water per day)	**N$**
ETA HR 07 DC and controller	7,500.00
320W PV panels, stand, cables, installation materials, etc	15,848.04
TOTAL N$	**23,348.04**

Total Head of 100 m

The below table indicates the capital and annual maintenance costs (inclusive of VAT) for PVP water installations at 100 m total head:

Note: The PVPs listed below do not have operating expenses and do not require any regular maintenance, except to clean the PV panels from time to time.

SOLAR (16,000 litres water per day)	**N$**
Grundfos SQFlex AC or DC	
2,200W PV panels, stand, cables, installation materials, etc.	213,325.00
TOTAL N$	**213,325.00**

SOLAR (12,000 litres water per day)	**N$**
ETA HR 07 DC and controller	
1,200W PV panels, stand, cables, installation materials, etc	79,740.15
TOTAL N$	**79,740.15**

SOLAR (8,000 litres water per day)	**N$**
ETA HR 07 DC and controller	
880W PV panels, stand, cables, installation materials, etc	56,282.17
TOTAL N$	**56,282.17**

SOLAR (7,000 litres water per day)	**N$**
Grundfos SQFlex AC or DC	
770W PV panels, stand, cables, installation materials, etc.	61,820.55
TOTAL N$	**61,820.55**

Total Head of 150 m

The below table indicates the capital and annual maintenance costs (inclusive of VAT) for PVP water installations at 150 m total head:

Note: The PVPs listed below do not have operating expenses and do not require any regular maintenance, except to clean the PV panels from time to time.

SOLAR (8,500 litres water per day)	**N$**
ETA HR 04H DC and controller	
1,200W PV panels, stand, cables, installation materials, etc	82,333.40
TOTAL N$	**82,333.40**

SOLAR (5,400 litres water per day)	**N$**
ETA HR 04H DC and controller	
1,200W PV panels, stand, cables, installation materials, etc	62,310.59
TOTAL N$	**62,310.59**

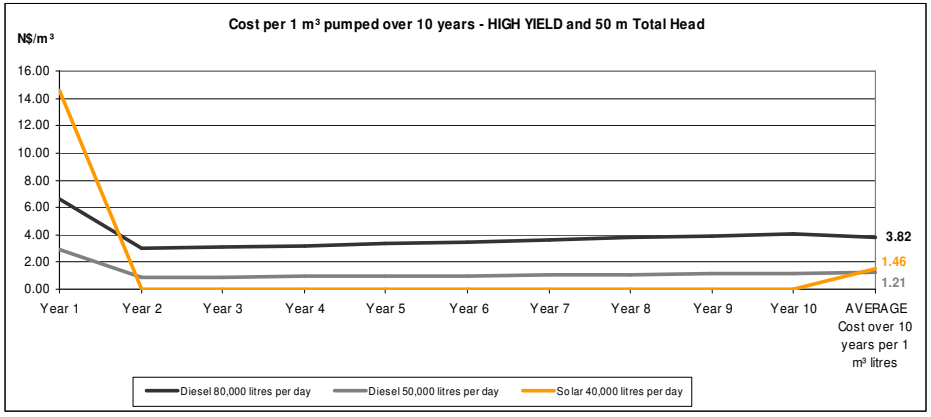
17. COST BENEFIT ANALYSIS

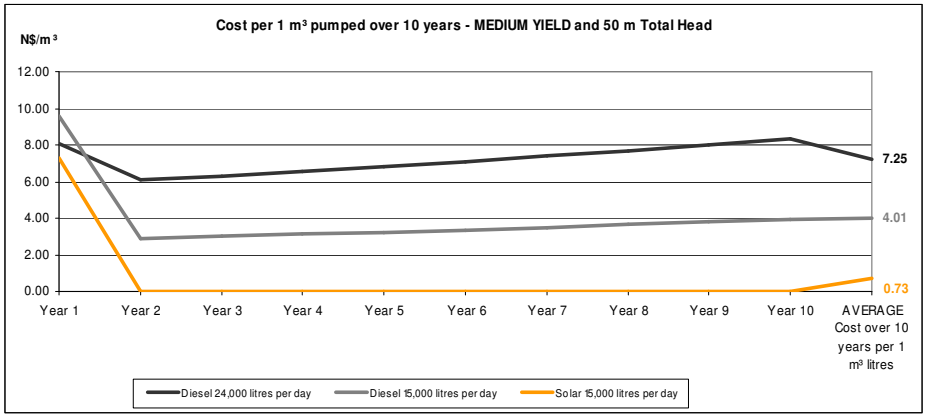
For this analysis a division is made between HIGH (50m³ per day and above), MEDIUM (15m³ per day to 24m³ per day) and LOW (up to 7m³ per day) water yields.

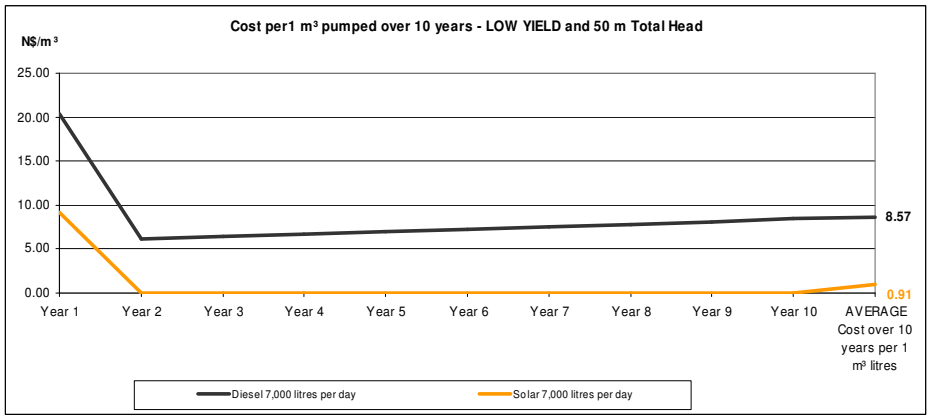
17.1 Cost per m³ on 50 m Total Head

The table and graphs below indicates the annual costs per m³ of water pumped over a 10 year period. Year 1 includes the capital costs and maintenance and operating costs, while subsequent years only consider operating and maintenance costs. The graphs below indicate the annual cost per m³ of water pumped over a 10 period. The last data point is the average cost over this 10 year period.

Total Head 50m											
Cost per m³ (1,000 litres) pumped over 10 years	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**AVERAGE Cost over 10 years per 1 m³ litres**
High Yield											
Diesel 80,000 litres per day	6.61	2.98	3.10	3.22	3.35	3.49	3.63	3.77	3.92	4.08	**3.82**
Diesel 50,000 litres per day	2.94	0.86	0.90	0.93	0.97	1.01	1.05	1.09	1.14	1.18	**1.21**
Solar 40,000 litres per day	14.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.46**
Medium Yield											
Diesel 24,000 litres per day	8.10	6.08	6.32	6.58	6.84	7.11	7.40	7.69	8.00	8.32	**7.25**
Diesel 15,000 litres per day	9.60	2.88	3.00	3.12	3.24	3.37	3.51	3.65	3.79	3.94	**4.01**
Solar 15,000 litres per day	7.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.73**
Low Yield											
Diesel 7,000 litres per day	20.32	6.17	6.42	6.68	6.94	7.22	7.51	7.81	8.12	8.45	**8.57**
Solar 7,000 litres per day	9.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.91**



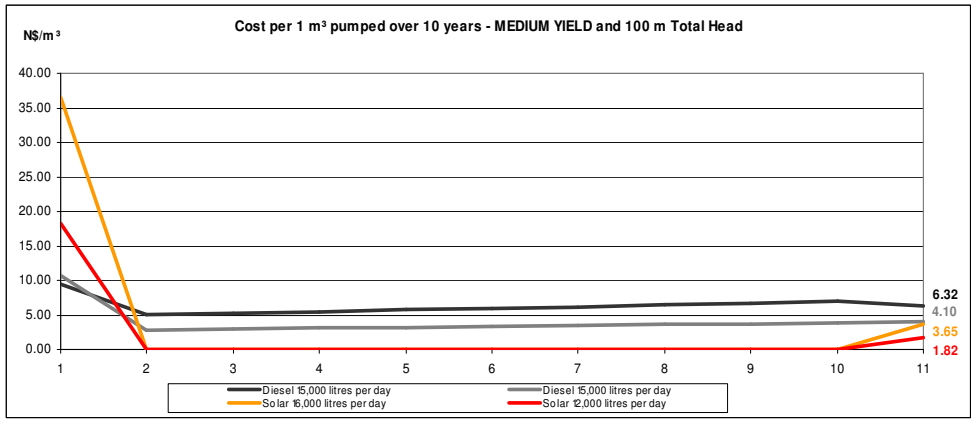

Cost per 1 m³ pumped over 10 years - MEDIUM YIELD and 50 m Total Head
N$/m³
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
Year 10
AVERAGE Cost over 10 years per 1 m³ litres
7.25
4.01
0.73
Diesel 24,000 litres per day
Diesel 15,000 litres per day
Solar 15,000 litres per day

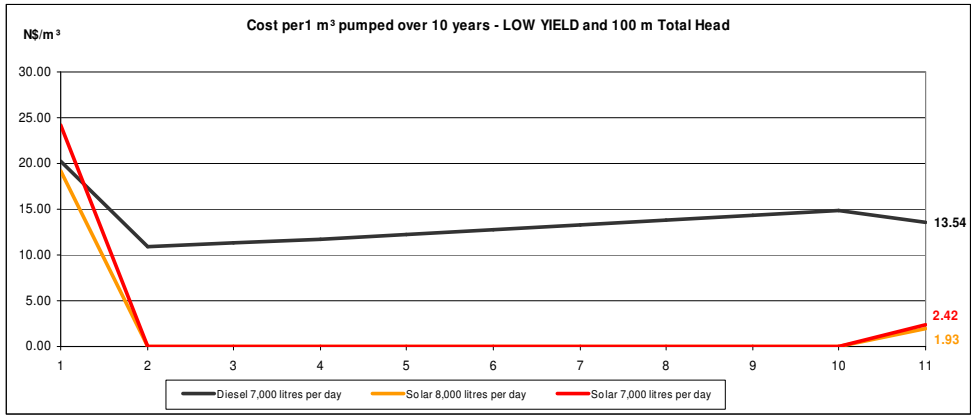

Cost per1 m³ pumped over 10 years - LOW YIELD and 50 m Total Head
N$/m³
25.00
20.00
15.00
10.00
5.00
0.00
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
Year 10
AVERAGE Cost over 10 years per 1 m³ litres
8.57
0.91
Diesel 7,000 litres per day
Solar 7,000 litres per day

17.2 Cost per m³ on 100 m Total Head

The table below indicates the annual costs per m³ of water pumped over a 10 year period. Year 1 includes the capital costs and maintenance and operating costs, while subsequent years only consider operating and maintenance costs. The graphs below indicate the annual cost per m³ of water pumped over a 10 period. The last data point is the average cost over this 10 year period.

Total Head 100m											
Cost per m³ (1,000 litres) pumped over 10 years	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**AVERAGE Cost over 10 years per 1 m³ litres**
High Yield											
Diesel 50,000 litres per day	2.93	1.52	1.58	1.65	1.71	1.78	1.85	1.93	2.00	2.08	**1.91**
Medium Yield											
Diesel 15,000 litres per day	9.43	5.08	5.28	5.49	5.71	5.94	6.18	6.43	6.68	6.95	**6.32**
Diesel 15,000 litres per day	10.71	2.86	2.97	3.09	3.22	3.35	3.48	3.62	3.76	3.91	**4.10**
Solar 16,000 litres per day	36.53	-	-	-	-	-	-	-	-	-	**3.65**
Solar 12,000 litres per day	18.21	-	-	-	-	-	-	-	-	-	**1.82**
Low Yield											
Diesel 7,000 litres per day	20.20	10.88	11.32	11.77	12.24	12.73	13.24	13.77	14.32	14.89	**13.54**
Solar 8,000 litres per day	19.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.93**
Solar 7,000 litres per day	24.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**2.42**

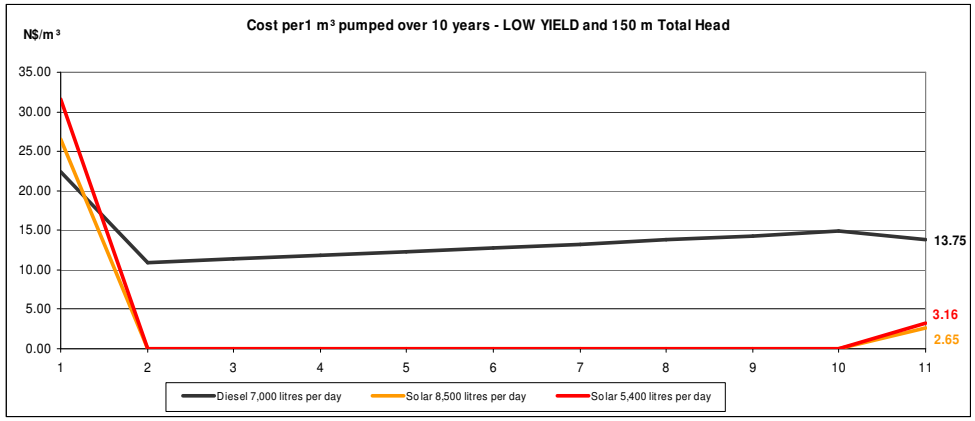




17.3 Cost per m³ on 150 m Total Head

The table below indicates the annual costs per m³ of water pumped over a 10 year period. Year 1 includes the capital costs and maintenance and operating costs, while subsequent years only consider operating and maintenance costs.
The graphs below indicate the annual cost per m³ of water pumped over a 10 period. The last data point is the average cost over this 10 year period.

Total Head 150m											
Cost per m³ (1,000 litres) pumped over 10 years	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**AVERAGE Cost over 10 years per 1 m³ litres**
High Yield											
Diesel 50,000 litres per day	3.45	1.52	1.58	1.65	1.71	1.78	1.85	1.93	2.00	2.08	**1.96**
Medium Yield											
Diesel 15,000 litres per day	10.43	5.08	5.28	5.49	5.71	5.94	6.18	6.43	6.68	6.95	**6.42**
Diesel 15,000 litres per day	16.01	2.86	2.97	3.09	3.22	3.35	3.48	3.62	3.76	3.91	**4.63**
Low Yield											
Diesel 7,000 litres per day	22.34	10.88	11.32	11.77	12.24	12.73	13.24	13.77	14.32	14.89	**13.75**
Solar 8,500 litres per day	26.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**2.65**
Solar 5,400 litres per day	31.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**3.16**



17.4 Life Cycle Cost on 50 m Total Head

The table below indicate the capital costs and maintenance and operating costs for Year 1 and only operating and maintenance costs per subsequent years. The shows the total cost of the installation.

Total Head 50m											
Life Cycle Cost over 5 years	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Total LCC after 10 years**
High Yield											
Diesel 80,000 litres per day	193,114.05	87,038.01	90,519.53	94,140.31	97,905.93	101,822.16	105,895.05	110,130.85	114,536.09	119,117.53	**1,114,219.52**
Diesel 50,000 litres per day	53,680.70	15,772.76	16,403.68	17,059.82	17,742.22	18,451.90	19,189.98	19,957.58	20,755.88	21,586.12	**220,600.64**
Solar 40,000 litres per day	213,325.00	-	-	-	-	-	-	-	-	-	**213,325.00**
Medium Yield											
Diesel 24,000 litres per day	70,940.42	53,271.42	55,402.28	57,618.37	59,923.11	62,320.03	64,812.83	67,405.35	70,101.56	72,905.62	**634,701.01**
Diesel 15,000 litres per day	52,586.22	15,772.76	16,403.68	17,059.82	17,742.22	18,451.90	19,189.98	19,957.58	20,755.88	21,586.12	**219,506.16**
Solar 15,000 litres per day	39,719.85	-	-	-	-	-	-	-	-	-	**39,719.85**
Low Yield											
Diesel 7,000 litres per day	51,924.98	15,772.76	16,403.68	17,059.82	17,742.22	18,451.90	19,189.98	19,957.58	20,755.88	21,586.12	**218,844.92**
Solar 7,000 litres per day	23,348.04	-	-	-	-	-	-	-	-	-	**23,348.04**

17.5 Life Cycle Cost on 100 m Total Head

The table below indicate the capital costs and maintenance and operating costs for Year 1 and only operating and maintenance costs per subsequent years. The shows the total cost of the installation.

Total Head 100m											
Life Cycle Cost over 5 years	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Total LCC after 10 years**
High Yield											
Diesel 50,000 litres per day	53,456.35	27,801.53	28,913.59	30,070.13	31,272.94	32,523.86	33,824.81	35,177.80	36,584.92	38,048.31	**347,674.25**
Medium Yield											
Diesel 15,000 litres per day	51,623.13	27,801.53	28,913.59	30,070.13	31,272.94	32,523.86	33,824.81	35,177.80	36,584.92	38,048.31	**345,841.03**
Diesel 15,000 litres per day	58,654.35	15,655.48	16,281.70	16,932.97	17,610.29	18,314.70	19,047.29	19,809.18	20,601.55	21,425.61	**224,333.14**
Solar 16,000 litres per day	213,325.00	-	-	-	-	-	-	-	-	-	**213,325.00**
Solar 12,000 litres per day	79,740.15	-	-	-	-	-	-	-	-	-	**79,740.15**
Low Yield											
Diesel 7,000 litres per day	51,623.13	27,801.53	28,913.59	30,070.13	31,272.94	32,523.86	33,824.81	35,177.80	36,584.92	38,048.31	**345,841.03**
Solar 8,000 litres per day	56,282.17	-	-	-	-	-	-	-	-	-	**56,282.17**
Solar 7,000 litres per day	61,820.55	-	-	-	-	-	-	-	-	-	**61,820.55**

17.6 Life Cycle Cost on 150 m Total Head

The table below indicate the capital costs and maintenance and operating costs for Year 1 and only operating and maintenance costs per subsequent years. The shows the total cost of the installation.

Total Head 150m											
Life Cycle Cost over 5 years	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Total LCC after 10 years**
High Yield											
Diesel 50,000 litres per day	63,051.40	27,801.53	28,913.59	30,070.13	31,272.94	32,523.86	33,824.81	35,177.80	36,584.92	38,048.31	**357,269.30**
Medium Yield											
Diesel 15,000 litres per day	57,087.77	27,801.53	28,913.59	30,070.13	31,272.94	32,523.86	33,824.81	35,177.80	36,584.92	38,048.31	**351,305.67**
Diesel 15,000 litres per day	87,665.95	15,655.48	16,281.70	16,932.97	17,610.29	18,314.70	19,047.29	19,809.18	20,601.55	21,425.61	**253,344.74**
Low Yield											
Diesel 7,000 litres per day	57,087.77	27,801.53	28,913.59	30,070.13	31,272.94	32,523.86	33,824.81	35,177.80	36,584.92	38,048.31	**351,305.67**
Solar 8,500 litres per day	82,333.40	-	-	-	-	-	-	-	-	-	**82,333.40**
Solar 5,400 litres per day	62,310.59	-	-	-	-	-	-	-	-	-	**62,310.59**

17.7 Hidden Expenses

In terms of calculating the expenses for Diesel water pumps, several "hidden expenses" were not considered. These expenses apply only to Diesel pumps and, if quantified, will have a negative effect on the cost effectiveness of Diesel water pumping installations. The below scenario assist with identifying these "hidden costs"

Assumption	Expense	Cost Calculation	N$
A farmer farms 200km from Windhoek, which is the closest town. He owns a 1 tonne 70 kW Diesel bakkie (pickup) which satisfies most of his transport needs.	Travel: 400 km per return trip. 11 litres (no load) per 100 km at N$ 3.96 per litre	Fuel consumption: 400 km at N$ 0.44 per km	N$ 176 per return trip
He collects Diesel in 200 litre metal barrels. He loads 4 barrels, which equals 800 litres (about 0.8 tonnes). His Diesel water pump consumes 1.5 litres per hour, pumping about 2 m³ of water per hour (16 m³ per day).	Travel: 530 hours worth of pumping, pumping about 1,060 m³ over 66 days	Fuel consumption: 6 trips to depot per annum at 400 km per trip equals 2,400 km	**N$ 1,056 per annum**
About 150 km between the farm and Windhoek is gravel road. He carries minimal load travelling to Windhoek, but maximum load returning to the farm. The expense does neither consider increased wear and tear due to off-road travelling nor the increased load on the return trip.	Vehicle wear and tear (AA rates 2005): N$ 0.37 per km services and repairs and tyres	Wear and Tear: 400 km at N$ 0.37 per km	**N$ 888 per annum**
The borehole is situated 10 km from the farm house. The farmer starts the pump in the mornings and pumps for 8 hours. In order to save 1 trip daily, the farmer allows the fuel tank to run empty, which automatically turns the pump off. The farmer needs to travel to the borehole every day to refuel.	Travel: 20 km return trip for 365 days equals 7,300 km per annum	Fuel consumption and wear and tear: 7,300 km per annum at N$ 0.81 per km	**N$ 5,913 per annum**
Additional "hidden expenses" per annum (EXCLUDING inflation and fuel price increases)			**N$ 7,857**
Additional cost per m³ of water pumped per annum at 16 m³ per day			**N$ 1.34**

18. CONCLUSIONS

The cost effectiveness of a PVP compared to a diesel water pump depends on the required yield and total pumping head. As such, the following conclusions are made based on the varying total heads and calculated over a 10 year period:

50m Total Head

- PVP is the most cost effective choice up to water deliveries of 24.000 litres per day.
- Some PVP technologies are already cheaper in capital costs than Diesel water pumps for deliveries of up to 15.000 litres per day.
- PVP and Diesel water pumps are equally cost effective for deliveries between 30.000 and 40.000 litres per day over a 10 year period. However, PVP is more cost effective beyond this 10 year period.
- For water deliveries of more than 50.000 litres per day, Diesel water pumps are more cost effective. This is currently the technical limitation for PVP technologies in Namibia.

100m Total Head

- PVP is the most cost effective choice up to water deliveries of 16.000 litres per day.
- For water deliveries of more than 16.000 litres per day, Diesel water pumps are more cost effective. This is currently the technical limitation for PVP technologies in Namibia.

150m Total Head

- PVP is the most cost effective choice up to water deliveries of 8.000 litres per day.
- For water deliveries of more than 10.000 litres per day, Diesel water pumps are more cost effective. This is currently the technical limitation for PVP technologies in Namibia.

The table below illustrates the cost effectiveness of Solar and Diesel water pumps, calculated over a 10 year period.

Cost Effectiveness over 10 years				
		Total Pumping Head		
		50 m	100 m	150 m
Litres per day	5.000	Solar	Solar	Solar
	7.000	Solar	Solar	Solar
	8.000	Solar	Solar	Solar
	12.000	Solar	Solar	Diesel
	15.000	Solar	Solar	Diesel
	16.000	Solar	Solar	Diesel
	24.000	Solar	Diesel	Diesel
	40.000	Solar / Diesel	Diesel	Diesel
	50.000	Diesel	Diesel	Diesel
	80.000	Diesel	Diesel	Diesel

19. LIST OF STAKEHOLDERS SURVEYED

Organization	Contact person	Contact
Ministry of Mines and Energy Directorate of Energy	Ms Hendrina Hasheela	P / Bag 12397, Windhoek Tel: 61 – 2848111 Fax: 61 – 2848200 Email: hhasheela@mme.gov.na
Ministry of Prison and Correctional Services	Mr James Adams	P / Bag 1328, Windhoek Tel: 61 – 2559324 Fax: 61 – 256324 Email: jadams@mpcs.gov.na
Ministry of Women Affairs and Child Welfare	Ms Rosina Maseke-Mabakeng	P / Bag 13359 Tel: 61 – 2833111 Fax: 61 – Email: mwacw@mwacw.gov.na
Ministry of Higher Education, Training & Employment Creation	Mr Patrick Haingura	P / Bag 13391, Windhoek Tel: 61 – 27065111 Fax: 61 – 245939 Email: phaingura@mhevtst.gov.na
Ministry of Basic Education, Sport and Culture	Ms Asnath K. Kaperu	P / Bag 13186, Windhoek Tel: 61 – 2933340 Fax: 61 – 2933933 Email:
Ministry of Agriculture, Rural Water Supply and Forestry Directorate of Rural Water Supply	Mr H.W.R. Koch	P / Bag 13193, Windhoek Tel: 61 – 2087266 Fax: 61 – 2087304 Email: kochh@mawrd.gov.na
Ministry of Finance Directorate of Inland Revenue Directorate of Customs and Excise	Mr Jack Re Roux Mr Erastus Amosho	P / Bag 13185, Windhoek Tel: 61 – 2092506 Fax: 61 – 231177 Email: Tel: 61 – 2092006 Fax: 61 – 254510
NamWater	Mr Jacques Esterhuizen	P / Bag 13389, Windhoek Tel: 61 – 712266 Fax: 61 – 713266 Email: Esterhuizenj@namwater.com.na
City of Windhoek	Mr Ralph A !Goaseb	P O Box 5011, Windhoek Tel: 61 – 2902337 Fax: 61 – 2902494 Email: - rag@windhoekcc.org.na
Telecom Namibia	Mr H. J. Gustav Jung	P O Box 297, Windhoek Tel: 61 – 2012354 Fax: 61 – 235777 Email: jungg@telecom.na
Namibia Wildlife Resort LTD	Mr Peter Mietzner	P / Bag 13378 Tel: 61 – 2857121 Fax: 61 – 256715 Email: pro@nwr.com.na
Mobile Telecommunication Limited	Mr Jochen Traut	P O Box 23051, Windhoek Tel: 61 – 2802004 Fax: 61 – 2802124 Email: jtraut@mtc.com.na
Namibian Broadcasting Corporation	Mr Uvatera Kahorere	P O Box 321, Windhoek Tel: 61 – 2913169 Fax: 61 – 262346 Email: ukahorere@nbc.com.na
Independent Consultant	Mr Robert Schultz	P / Bag Tel: 61 – 268 222 Fax: 61 – 268 201 Email: energy@r3e.org
Habitat Research and Development Centre	Mr Andreas Wienecke	P O Box 63036 Tel: 61 – 268211 Fax: 61 – 268102 Email: andreas_hrdc@yahoo.com

SchoolNet	Mr Joris Komen	P O Box 7102, Katutura, Windhoek Tel: 61 – 212973 Fax: 61 – 213655 Email: joris@schoolnet.na
Gobabeb Research & Training Centre	Dr Joh Henschel	P O Box 953, WalvisBay Tel: 64 – 694199 Fax: 64 – 694197 gobabeb@iafrica.com.na
The Research Foundation of Namibia	Mr John Pallet	P O Box 20232, Windhoek Tel: 61 – 377500 Fax: 61 – Email: johnp@drfn.org.na
GTZ	Ms Christiane Kalle	P O Box 8016, Bachbrecht, Windhoek Tel: 61 – 222447 Fax: 61 – 222427 GTZ-Namibia@gtz.de
European Union	Ms Jutta Pomoell	P O Box 24443, Windhoek Tel: 61 – 2026000/6226 Fax: 61 – 2026224 Email: jutta.pomoell-segurola@cec.eu.int
United Nations Educational, Scientific and Cultural Organization	Mr Alexandros K. Makarigakis	P O Box 24519, Windhoek Tel: 61 - 2917000 Fax: 61 – 291 220 Email: a.makarigakis@unesco.org
Global Environmental Facility / Small Grant Project	Mr Nickey Gaseb	P O Box 245 Tel: 61 - 248345 Fax: 61- 24844
AgriBank	Mr Regan Mwazi	P O Box 13208, Windhoek Tel: 61 - 20742