ENERGY SECURITY IN THE KHOMAS REGION

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ABSTRACT

Energy (electricity) is the backbone of an economy. However, Namibia is facing a serious deficit as far as energy generation is concerned. Globally, electricity is generated from different sources, essentially to make up for the shortage of resources which is in short supply like dams for hydro power and reactors for nuclear power. Being a developing country, Namibia is not in a financial position to have an independent electricity generation capacity to meet his demand.

The Khomas Region, being the industrial hub of Namibia is not excluded from the energy deficit. With a growing economy and rural-urban immigration of 600-1000 people according to a 2005 estimate, the demand for power is soaring. Conscious of the regional energy situation and multi-lateral cooperation on energy sharing as well as future plans for energy generation, the Khomas Region does not have any plans to achieve energy self-sufficiency. All power is centralized with NAMPOWER as the sole energy provider. NAMPOWER in turn receives a large portion of its power from the Electricity Supply Commission (ESKOM), South Africa. ESKOM, like NAMPOWER experiences a shortfall of power to satisfy domestic demand and cannot assure the pre-2006 guaranteed power supply hence leaving Namibia with no other option than to enter into regional agreements for power supply.

It is necessary for the Khomas Region to embark on the development of renewable energies which have an initial high capital or development costs but hold long term prospects. Worldwide there is a move away from carbon-based energy resources towards other environmental friendly sources of energy such as nuclear and wind energy.

This study started with a cluster sample through which a blanket 46 respondents were asked to complete questionnaires while the study aimed at obtaining information from the perspective of the participants in the research.

The study found that the Government of Namibia has embarked on the reform of the electricity sector, initiated an extensive rural electrification programme and attempted to get electrical appliances closer to the people by spreading energy shops throughout the country. The research showed that the Khomas Region has adopted a rather passive posture in the development of its energy self sufficiency. This could be attributed to the total monopoly of NAMPOWER and the lack of regulations or their enactment in respect of regions to develop their power infrastructure.

The study recommends that in addition to the present efforts of Renewable Energy and Energy Efficiency Institute (REEEI), Ministry of Mines and Energy (MME), and Barrier Removal to Namibian Renewable Energy Programme (NAMREP), the Khomas Regional Council should provide direct and indirect subsidy, both to entrepreneurs and consumers. The Region should furthermore consider utilization of an energy mix and encourage private entrepreneurs to invest in the development of renewable energies.

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I gratefully thank G.S. Hamutwe Jr and Cosmos Auckumeb for their constructive comments on this thesis. I am thankful that in the midst of all their other commitments, they accepted to attend to me when I knocked on their doors for consultations.

DECLARATION

I, John Ivan Robinson, declare hereby that this study is the true reflection of my own research, and that this work, or part thereof has not been submitted for a degree in any other institution of higher education.

Date:

John Ivan Robinson

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LIST OF ABBREVIATIONS AND ACRONYMS

AC - Alternating Current

Cft - Cubic Feet

ECB - Electricity Control Board

EDM - Electricidade de Moçambique

EKRC - Electrification under Khomas Regional Council

ESKOM	-	Electricity Supply Commission
GDP	-	Gross Domestic Product
GEF	-	Global Environment Facility
GRN	-	Government of the Republic of Namibia
GWh	-	Giga Watt Hour
GTZ	-	Deutsche Gesellschaft für Technische Zusammenarbeit GmbH
HDI	-	Human Development Index
kV	-	Kilo Volt
KW	-	Kilo Watt
KWh	-	Kilo Watt Hour
MME	-	Ministry of Mine and Energy
MW	-	Mega Watt
NAMCOR	-	Namibia Oil Corporation
NAMREP	-	Namibian Renewable Energy Programme
NEH	-	Northern Energy Highway
NPC	-	National Planning Commission
OGEMP	-	Off-Grid Energization Master Plan for Namibia
PPA	-	Power Purchase Agreement
PV	-	Photovoltaic
PVP	-	Photovoltaic Pumping
REEEI	-	Renewable Energy and Energy Efficiency Institute
REEIN	-	Renewable Energy and Environmental Information Network
REEECAP	-	Renewable Energy and Energy Efficiency Capacity Building Programme
RET	-	Renewable Energy Technology
SADC	-	Southern African Development Community
SAPP	-	Southern African Power Pool

SET	-	Solar Energy Technology
SNEL	-	Societe Nationale d'Electricite
SHS	-	Solar Home System
STEM	-	Short Term Energy Market
SWH	-	Solar Water Heater
SPV	-	Solar Photovoltaic
TJ	-	Terajoules
UNDP	-	United Nations Development Programme
W	-	Watt
WEH	-	Western Energy Highway
WPEP	-	White Paper on Energy Policy
ZESA	-	Zimbabwe Electricity Supply Authority
ZESCO	-	Zambia Electricity Supply Company
ZETCO	-	Zimbabwe Electricity Transmission Company

ENERGY SECURITY IN THE KHOMAS REGION

CHAPTER 1

INTRODUCTION

1.1 *Orientation of the study*

Electricity generation - all starts with a source of energy. In the developed countries most of their energy comes from fossil fuels, primarily coal, natural gas and oil. Other sources include nuclear power, which supply those countries' energy demands and to a lesser extent it is supplied by other sources such as hydro-dams, wind farms and solar panels. It is important to note that electricity is a secondary source of energy, meaning it relies on a primary source of energy to be created. These primary sources are the ones listed above, and can further be grouped up into renewable and non-renewable sources.

The making of electricity took a long walk before the technological know-how could be disclosed. In 1600 the English scientist William Gilbert first used the New Latin word electricus ("of amber" or "like amber", from ηλεκτρον [elektron], the Greek word for "amber") to refer to the property of attracting small objects after being rubbed. This soon gave rise to the English words "electric" and "electricity", in Sir Thomas Browne's Pseudodoxia Epidemica of 1646 (Randy, 2006).

Benjamin Franklin did extensive research on electricity in the 18th Century. He claimed that there was a relationship between lightning and static electricity. In the mid and late 17th Century, other personalities like Alessandro Volta (1745-1827), Michael Faraday (1791–1867), André-Marie Ampère (1775–1836), and Georg Simon Ohm (1789-1854) also made significant contributions to the development of electricity (http://answers.yahoo.com/question/index). Today, electricity has become such an integral part of our daily lives that it is almost impossible to imagine life without it. Electricity is being used for lighting, driving machines and operating electronic devices at home, industries and hospitals. In today's fast developing life, countries like Namibia have the urge to use reliable energy to progress in the sustenance of development and production of goods and services. It therefore becomes equally important to consider the current power supply situation in Namibia and specifically in the Khomas Region which is surrounded by the Hardap-, Erongo-, Otjozondjupa-, and Omaheke Regions.

Energy has determinant influences on the Human Development Index (HDI). The energy sector plays a pivotal role in Namibia's economy and national development. This is due to the high–energy

intensity of the Namibian economy as measured by the energy required to produce a unit of Gross Domestic Product (GDP). In comparison with the previous reporting period, the NAMPOWER Annual Report (2007, p 16) indicates that Namibia consumed 1.8% more energy while NAMPOWER produced 1.9% less energy. As a result, Namibia has to import 5.0% more electricity. Electricity demand peaked at 539 MW, 9.9% higher than the previous reporting period. For most countries of Namibia's level of socio-economic development, there is a strong positive link between energy and GDP. "Local coal power stations will not be able to compete with Eskom coal stations in the long run because of the high transport cost for coal which for van Eck doubles the coal price from the mine" (REEECAP, 2008, p 57). The low population density and related high transport costs combined with the reliance on energy intensive primary industries- especially mining and fishing- result in high energy consumption as a proportion of GDP. Namibia also has the highest per capita petroleum usage in Africa. The energy sector further makes a significant contribution to gross domestic fixed investment, due to the capital intensity of energy resources development. This study will elaborate on the status of energy security in the Khomas Region by critically reviewing the principle arguments in the subject related literature which includes renewable energies. It will furthermore discuss the modus operandi followed to do the study as well as the Government of Namibia's (GRN) policy responses to the energy status in Namibia. Some recommendations will be made based on the review of the existing body of knowledge.

1.2 *Background*

Namibia is now emerging as a growing economy. Not only will the economic growth levels be sustained but the growing needs for its population will have to be addressed too. In order to achieve the goal of sustainable energy security, Namibia must evolve a sustainable energy security pathway to enable it to meet the combined goals of energy security and national development as a whole. Augmentation of energy resources, especially environmental friendly sustainable energy resources, would have to be complemented with programmes of energy demand side management, increase in

energy efficiency, and reducing environmental pollution as components of a new integrated energy policy for Namibia.

The energy sector operates on the principle of a mixed economy, with state owned corporations and private sector companies participating in it. The Ministry of Mines and Energy (MME) is responsible for overseeing the general development of the sector, as well as drafting a legislative and policy framework governing all participants in the sector.

The national electricity utility, NAMPOWER, is responsible for electricity generation, transmission and some distribution. The function of the Namibia Oil Corporation (NAMCOR) which is the national oil company is to assist the MME in the promotion and development of local oil and gas resources.

The White Paper on Energy Policy (1998, p. 8) indicates the current energy situation in Namibia with own generation capacity which looks as follow:

- Ruacana generates hydro power of 249 MW.
- Van Eck Coal Fired Power Station generates 132 MW.
- A number of diesel plants.

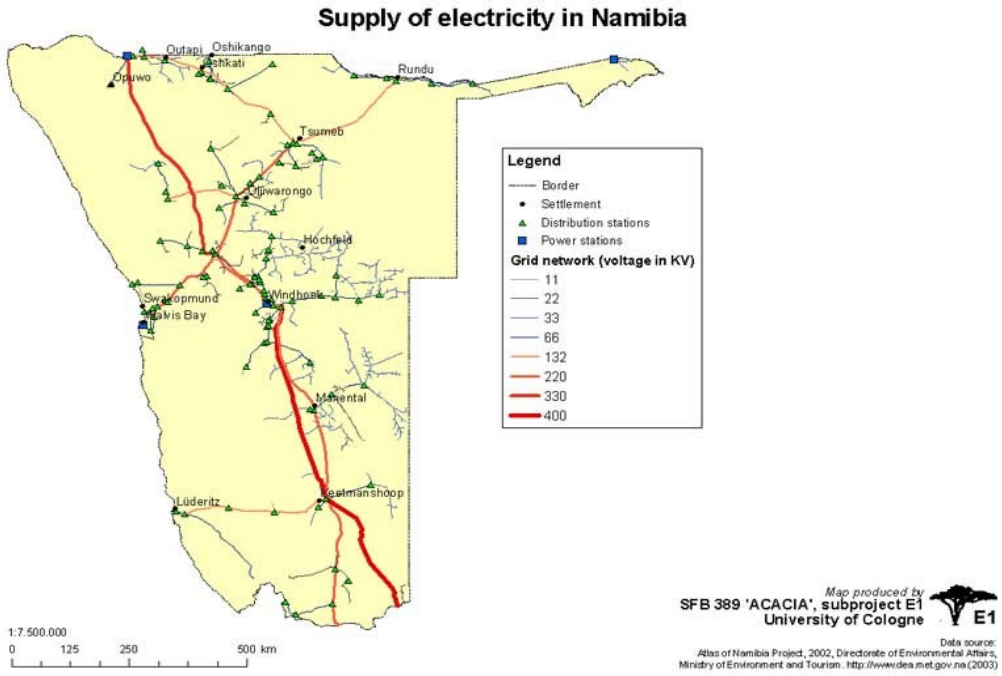
One of the diesel plants that could be singled out is the Paratus Diesel plant at Walvis Bay which generates 24 MW with four 4.6 MW diesel generators (Adinfo Reports, 2008).

The Government has put in place a policy framework that encourages the exploration and exploitation of the country's energy resources in a sustainable manner that will encourage local and foreign investment in the sector. The regulatory framework for the sector is complex and encompasses the following key documents: The Namibian Energy White Paper that was drafted during 1997/8 and promulgated by Parliament in May 1998. Parliament also promulgated the Petroleum Products and Energy Act in 1990 (amended in 1994 and 2000). The Petroleum Exploration and Production Act and the Petroleum Taxation Act were promulgated in 1991 and amended in 1998 and the Electricity Act and regulation were promulgated in July 2000. These laws form the basis of

the legal framework of the Namibian energy sector. The MME and NAMPOWER are actively engaged in an ongoing debate with other member states of the Southern African Development Community (SADC). Namibia is a member of the Common Power pool- Southern African Power Pool. In general ,the hierarchical structure of the energy sector as far as electricity is concerned flows smooth from the MME which put in place a regulatory body the Electricity Control Board (ECB), followed by NAMPOWER which in turn established Regional Electricity Distributors (REDs) to distribute electricity to municipalities.

Namibia's energy resource base can be broadly classified into two groups: commercial and traditional forms of energy. Commercial energy comprises liquid fuels, electricity and coal, and amount to 82 % of energy consumption of which 70% is related to petroleum fuels, while traditional fuels (wood, charcoal and animal waste) account for 18%. The Country is a net importer of energy, with only 30% of electricity being produced locally and all the country's petroleum products and coal imported. Imported electricity goes up to 60% depending on the season of the year.

Consumption of commercial energy resources in terajoules (TJ) has shown a significant increase in the period 1995-2007. Namibia has a good basic transmission network for electrical power. Electricity is distributed to towns, mines, commercial farms, communal centres and households. However, many rural areas are not yet connected to the national grid. The map below shows the power distribution network in Namibia.



Map 1: Supply of electricity in Namibia

Recognising the social and economic benefits of rural energy supply, the Government has been implementing an extensive programme of rural electrification to extend the grid to rural areas. In 2003/2004, 90% of rural households did not use electricity or gas as a source of energy for cooking while 13% of rural households used electricity for lighting (2003/2004 Namibia Household Income and Expenditure Survey, 2006, p 51). The Government has optimised the distribution of electricity in the Northern Regions through the contracting of a private company, Northern Electricity, to operate and maintain the system on its behalf. Similar agreements have been entered into with Southern Electricity for the Hardap and Karas Regions and with Erongo Red for the Erongo Region.

The national electricity transmission grid comprises high and low tension lines. In 2006 the high tension segment covered 289 km of 400 kV lines, 521 km of 330 kV lines (Ruacana to Omaruru), 1, 645 km of 220 kV lines, 1, 076 km of 132 kV lines and 11, 924 km of 66 kV lines, owned and operated by NAMPOWER. Katima Mulilo is linked to the Zambian grid by a 132 kV inter-connector (National Development Plan, NDP2, Vol. 1: 343).

Electricity is generated from the Ruacana hydroelectric station (240 megawatt (MW) of

installed capacity, the Van Eck coal-fired station (120 MW) in Windhoek, and the small diesel-powered stations at Walvis Bay (24 MW). The Ruacana hydroelectric station supplies up to 60% of the hydro electricity (White Paper on Energy Policy, 1998, p. 10) but it depends on the hydrological conditions. This supply decreases to 45% during dry years and the supply get further slowed down due to the absence of upstream regulations in the upstream Cunene (White Paper on Energy Policy 1998, p. 10). In addition to the local sources of electricity, Namibia is connected to the South African ESKOM grid for import and export of power through two inter-connectors, one 220 kilovolt (kV) double circuit line and one 400 kV power line.

The current crisis in meeting electricity demand in South Africa has meant that the Electricity Supply Commission (ESKOM) is no longer a reliable supplier of electricity to Namibia. Like other SADC countries that rely for their electricity on South Africa, ESKOM- due to rising national demand - is no longer able to deliver guaranteed energy for Namibia. Meeting the food and livelihood requirements of a growing population depends on harnessing the existing energy resources, which are finite and the excessive use of which will result in environmental catastrophe. Therefore, Namibians are now in the arduous quest for non-fossil fuel energy resources, and the use of which are sustainable and consistent with nature.

The Khomas Region has the strongest economy of all regions in Namibia with the highest energy consumption. It is the commercial and industrial hub of Namibia and it has the fastest economic growth of all regions. The Region is also the biggest trading entity and according to the Regional Poverty Profile it "has strong trade links with Namibia's neighbouring countries" (National Planning Commission, 2007, p. 7). Being located in a developing country, the Khomas Region despite showing decent economic growth is still relatively poor. This is fuelled by the migration trend from rural areas towards Windhoek whereby mostly the poor try to seize the opportunity to make a decent living. The Khomas Region faces difficulty in addressing the ever increasing need for energy supply to the fast growing settlements. The deficiency in service provision like electricity impedes the efforts of small enterprises in communities to have a stake in the market. The Regional Poverty Profile (2000, p. 12) indicates that "Both urban and rural communities in the Khomas Region identified

similar economic causes of poverty".

In the Khomas Region it is now felt that the consumption of energy will continue to increase further. Namibia signed and ratified the Kyoto Protocol on 4 September 2003 whereby she "has agreed to cap emissions in accordance with the Protocol 37 of the 39 Annex I parties have agreed to cap their emissions in this way, two others are required to do so under their conditions of accession into the EU, and one more intends to become an Annex I party" (List of Kyoto Protocol Signatories, 2008).

At present, coal accounts for a predominant share in the Khomas Region's energy basket. So, being a signatory to the Kyoto Protocol, the Khomas Region's burgeoning energy needs of urbanization, modernization and growth will have to be catered for with cleaner fuels. So far, no significant oil reserves could be found on Namibian soil. In recent times, the shares of gas and uranium are increasing, as mining products. With gas and uranium as resources but lacking sufficient new technological capacity to generate electricity for the country, the gap between availability of resources, the demand and delivery of energy and consequent imports are directly related to overall energy shortages, mounting exchange requirements and the question of energy security.

In these circumstances, Namibia should choose to aggressively pursue all energy options such as improving of recovery rates of existing wells, enticing foreign investors in exploration and production, acquiring clean coal technology, exploring possibilities of accessing additional gas or oil reserves, exploiting new fields like gas hydrates and possible coal bed methane, and increasing the share of clean affordable and sustainable nuclear power in the country's energy basket.

Currently, Namibia does not have an integrated energy policy. However, the White Paper on Energy Policy developed by the Policy Committee of the Ministry of Mines and Energy was released in May 1998. This policy states energy goals like: Effective energy sector governance, security of supply, social upliftment, investment and growth, economic and competitiveness and efficiency, and sustainability.

1.3 *Statement of the problem*

Namibia is facing a serious energy deficit, which is forecast to continue for at least the next five years. During 2007, at peak times Namibia uses up to 550MW of electricity. Domestic generation cannot meet this demand. In early 2008, Namibia could only generate 240 MW from the Ruacana hydro electric power station at full capacity, about 120 MW from the coal-fired Van Eck power station in Windhoek and 24 MW from the Paratus diesel power station at Walvis Bay, leaving a shortfall of up to 166 MW (C. Auckumeb, personal communication, November 12, 2008). When Ruacana is not able to produce at full capacity due to seasonal factors, this shortfall is much higher. This shortfall has been covered mainly by ESKOM in South Africa and to a lesser extent by the power utilities in Zambia and Zimbabwe. The contract under which ESKOM guaranteed power supply to Namibia ended in 2006 and since then Namibia can no longer assume that ESKOM will cover most of the energy deficit. The situation will worsen and will have a direct effect on The Khomas Region's ability to distribute reliable electricity to its inhabitants, mines and industries. It is NAMPOWER's forecast that Namibia's electricity total demand will be around 550MW by 2012 (NAMPOWER, 2007, p. 42).

Taking into account the current situation, more particularly the reliability of electricity supply and local inadequate generating capacity, it is both pertinent and relevant to inquire into the development of energy policy (with special emphasis on electricity provision) and the history of energy planning in Namibia since independence. It is important to understand how Namibia has formulated its energy policies and chosen its generation and supply options. It is equally important to investigate how and what energy planning for electricity is now being undertaken and which key decisions the country will have to take to see it through the deficit period and establish -more secure sources of power for the long-term future.

1.4 Research question

Windhoek is facing more frequent unwanted power outages. The question should therefore be: "What policies exist that deal with energy provision in the Khomas Region and Namibia as a whole which

could indicate Namibia's stance towards energy security in the Khomas Region". For that reason, the study will discuss the reasons for the unsecured energy deliveries that are taking place. If the situation has a historical background, investigate on what were the events that lead to the conditions that caused the current state of affairs in energy supply. The study will further dwell on what counter measures were taken to resolve the short fall in supply of energy and what the effects of those measures were.

1.5 Research Objectives

The primary research objective of the study is to thoroughly analyse the energy situation in the Khomas Region with regard to the provision of electricity as an energy source for possible solutions to problems. Secondary to this, is to discuss the reasons for difficulties to generate electricity rather than importing it. Thereafter, a workable solution to improve the security of the country's energy supply could be recognized. The study therefore should be able to initiate informed consideration on the energy problem the Khomas Region faces and the most productive ways of tackling the problem.

1.6 Significance of the study

All aspects of the current energy situation with regards to the inadequate electricity generation and the stance on keeping pace with policy statements that frame the future plans in the Khomas Region is brought to light. It will therefore clear the uncertainties with regards to energy insecurity and contribute to the search for additional ways of tackling the energy question in the Khomas Region. The study will indicate why it was worth undertaking and what possible benefits it might have.

1.7 Limitations

A study of this nature and magnitude cannot be without limitations. Chief among them is the difficulty in road going which constrained one from visiting sparsely populated areas immersed in difficult terrain in the Khomas Region as well as the fact that most of rural Khomas is private owned land. This would have enabled one to verify and see or hear firsthand the situation on electricity availability and how possible the Energy Security Master Plan could be augmented. The selection of only a few areas in the study could give the impression that the energy situation all over the Region has the same nature, causes, effects and dimensions. This kind of generalization would be misleading. However, this method was adopted to show in general terms the various types of conditions the Region experiences in respect of energy security.

1.7 Conclusion

Consequently, the study focused on an overview of the Energy Policy. Nonetheless, the study has provided in-depth knowledge as to the causes, nature and effects of the energy situation in the Region. It has also widened the scope and tools of analysis in searching for an effective model in resolving the shortage of energy in the Khomas Region in the years ahead.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The aim of this chapter is to discuss the ideas obtained from the subject literature consulted. The outlook of the literature does have a direct bearing on the conditions experienced in Namibia and as such, the Khomas Region. Much of the rural areas in the rural Khomas are off the electricity grid (refer to Map 1). The Region also has a sparsely populated rural environment with a very dense populated urban area which makes it difficult to have an effective energy supply throughout the Region. The MME has come up with a White Paper on Energy Policy in 1998 to address the energy situation in Namibia. With 10 years after the submission of the final draft of the Policy, there are still areas throughout Namibia which have not yet been supplied with electricity.

2.2 Analysis on present electrification policy of Namibia

On the energy sector, the Government of the Republic of Namibia (GRN) is committed to ensure that secured energy is delivered at competitive prices to Namibians. However, the White Paper on Energy Policy indicates that "Generally, not enough is known about the problems and needs in this sector so national studies will be initiated as a basis for future policy development, including the pressing issue of sustainable biomass usage in rural areas and the role of women". Government has created the Namibia Renewable Energy Programme (NAMREP) in 1999 with financial support from the Global Environment Facility (GEF) and United Nations Development Programme (UNDP) in order to provide electricity to rural areas. But about 69.4 per cent Khomas households uses electricity for cooking (Central Bureau of Statistics, 2006, 61). In other words, it is assumed that less than 30 per

cent of the Khomas rural population does not enjoy the benefit of electricity in remote areas. With the current rate of electricity penetration in rural areas, it will take more than 10 years to reach only the population covered by the grid. If we take the case of the remote areas, not covered by the grid, where the population is scattered, it may be easily assumed that electricity will not reach them well beyond the national deadline of Vision 2030.

The present program of expansion of electricity will primarily benefit the existing electrified area that will further increase the imbalance. What is required is first to consider the electricity requirement for both the grid and off-grid areas separately. For grid areas, the primary reason for non-availability of electricity is poverty (inability to pay the cost of line connections to their homes), although rural populations are probably spending more money on kerosene and candles getting much less lumen (in terms of light intensity) as well as poor indoor air quality. For the off-grid areas (e.g. remote areas), the demand is not taken into consideration in the present planning process. To overcome this problem, two separate energy/electricity policies are required. One will meet the traditional growth of demand and other will deal with the basic needs of energy and electricity for the rural population.

Fortunately, electricity needs of the rural households are low and can be met locally without extending the transmission and distribution lines. Individual households could be electrified with the help of Solar Home System (SHS) where the individual requirement of power is so low that the consumers could pay back the electricity service charges in monthly instalments. If the government adopts a two dimensional energy/electricity policy, with a smaller investment/grant, it could benefit a larger number of people, including poor ones, living in off-grid areas.

The outcome of this policy will result in quick extension of minimum electricity to a large population with encouragement by the government and introduction of subsidy or soft term loan. Even though the White Paper on Energy Policy (WPEP) is not silent on the issue, the GRN acknowledges that “There are barriers impeding the provision of affordable loan finance to low-income rural households. “Government will strive to address these barriers through co-operation with

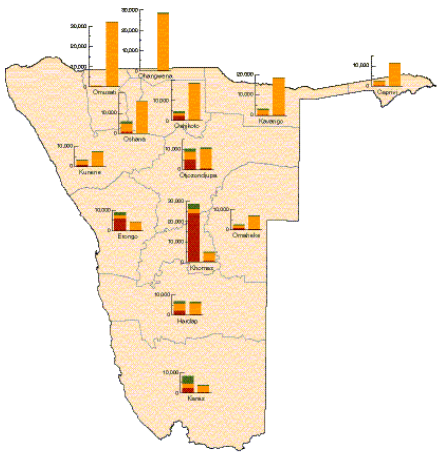
private- and public-sector financing institutions and the provision of revolving loan funds" (White Paper on Energy Policy, 1998, p. 46).

The WPEP indicates that these are the institutional and developmental challenges that need to be addressed to meet the policy objectives. As part of the principal development challenges, the Policy indicates a challenge of "achieving increased self-sufficiency, security of supply and sustainability in the electricity sector, through the use of renewable energy for electricity generation, and through rational use of energy measures"(White Paper on Energy Policy, p. 46). The concern for energy security is hereby acknowledged. Local entrepreneurs (private sector) could be encouraged to take part in this service, thus creating employment and introducing technical skills to them.

2.3 The energy security issue

Energy plays a vital role in the development process, responding to people's needs and fuelling the growth of the economy (O'Keefe and Munslow, 1984, p. 7). Economic activities use energy. It is therefore justified to know what the requirements for energy are in all spheres of such activities. In the case of hospitals, it is of utmost importance to have a reliable supply of energy to keep such institutions functioning. Other sectors need a secured supply of energy to ensure their growth and development. Electricity supply appears to be a problem in the world as well as in the Khomas Region. Goldemberg, Johansson, Reddy and Williams (1988, p. 13) mention that "There's an energy problem. Its chief components are the oil, the fuel wood and the electricity crises. It is serious and it is global".

The Khomas Region boasts with a high demand for energy in the industrial environment as compared to the rest of the country. The map below shows the comparison of fuel use amongst the different regions in Namibia.



Map 2: Fuel use per region.

The Khomas Region, like so many other regions in the developing world, cannot afford to deplete its vegetation without having the means to replenish or recover the lost natural resources. Energy needs to be secured for a nation to develop and prosper. But first, one should ask what energy security really means.

The following ideas on energy security explain the different ideologies behind the term *energy security*. It is said that "for many American leaders, energy security means producing energy at home and relying less on foreigners" (Mallaby, 2006). Another is that "For China, which isn't part of the G-8 but participates in some of its meetings, energy security means buying stakes in foreign oil fields" (Mallaby, 2006). The idea for the Russians is that "For Russia, which pushed energy onto the G-8 agenda, energy security has yet a third meaning: restrictions on foreign investment in domestic oil and gas fields." (Mallaby, 2006) Sebastian Mallaby posted an article in the Washington Post on 3 July 2006 whereby he said that "As Daniel Yergin has written recently in Foreign Affairs, real energy security requires setting aside the pipe dream of energy independence and embracing interdependence" (Mallaby, 2006). Considering the energy situation in the Khomas Region and the fact that the Region does not generate its own electricity and that it lacks the capacity to do so, one may argue that energy security could mean the interdependence with those who have the capacity to generate adequate electricity to power the Region's energy needs.

The current electricity situation indicates that Eskom remains indispensable in the regional power supply equation. According to a Republikein sponsored leaflet "It is responsible for 80% of generation in the region" NAMPOWER (April 2008, p. 2). NAMPOWER has entered into a bilateral agreement with Eskom which "guarantees availability of power when the supplier has sufficient capacity" NAMPOWER (April 2008, p. 2). The agreement also makes provision for normal and abnormal supply scenarios. One can therefore not claim that the agreement was breeched since the region turned into an abnormal scenario due to the shortage of electric power. Namibia has anticipated this situation and has therefore opted to augment its power resources with other "Power Purchase Agreements (PPAs)" NAMPOWER (2008, p. 2).

Urbanisation calls for the use of conventional energy for household purposes. This is easily accessible. However, areas in the immediate vicinity of towns in the Khomas Region and the City of Windhoek show considerable deforestation of the vegetation. One may assume that it is due to the collection of fuel wood. In this respect, Hamutwe-Jr (1998, p. 7) has pointed out that "Though the consumption of biomass for energy may not be the major cause of deforestation, it is a contributing factor. Using biomass efficiently and conservatively could have positive implications for the environment, as well as resulting in house hold savings, and ultimately in an improved standard of living". At the moment, there are no energy strategies to cater for deforestation, soil erosion, and desertification. As can be seen at the end of the each winter season, some farm areas are heavily over grazed and that soil erosion continues to increase especially with the first summer rains and little vegetation to retract the soil. This causes long term negative effects on the security of energy resources. Over a period of five years, Namibia has lost around 12% the equivalent of 1,101,000 hectares (Statistics Namibia, 2005) of its forest cover. Looking at the overall loss in the country by, "Measuring the total rate of habitat conversion (defined as change in forest area plus change in woodland area minus net plantation expansion) for the 1990-2005 interval, Namibia lost 9.3% of its forest and woodland habitat". (Statistics, Namibia, 2005). The Khomas Region is not exempted from this trend, since it is continuously under the pressure of urban-rural migration. However, except for the areas around urban settlements, the rest of the Khomas Region is commercially farmed and rugged

country and is less susceptible to the removal of vegetation compared to the south, north west, north and north eastern regions.

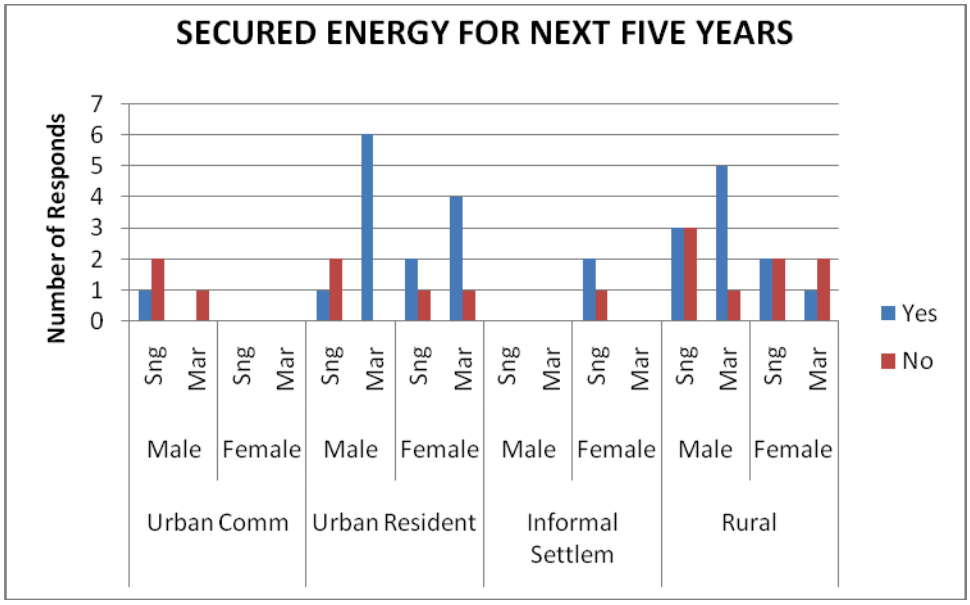
That being the case, one will not be surprised to notice that candles are the prime source of lighting fuel in rural areas of the Khomas Region. Hamutwe-Jr (1988, p. 131) indicated that 90.2% of urbanised citizens use electricity as the lighting fuel while 5.6% of rural citizens use candles in the Khomas Region. The absence of electricity in rural areas raised the demand for wood fuel. If 86% (Hamutwe-Jr, 1988, p. 17) of the 88% of urbanised citizens uses electricity for heating, and 95% (Hamutwe-Jr, 1988, p. 17) of the 12% rural citizens uses wood for heating, one may argue that the induction of conventional energy is a viable option in rural areas in the Khomas Region. Rural citizens spend less on energy than those in urban areas. If the solar schemes are accepted in the rural environment, the demand for conventional supply of energy would remain the same. Otherwise, the Khomas Region will increase its demand when future infrastructural development extends to rural areas. The White Paper on Energy Policy which was promulgated in May 1998 recognizes the importance of rural electrification where it is economically viable and the provision of solar power in off grid areas. The Paper stipulates that "Although the electricity grid will continue to be extended to rural area, it is not likely that the majority of rural households will have access to grid electricity".

High-energy intensity resulting from high consumption in the mining, transport and household sectors and the inefficient use of energy characterizes Namibia's economy (Hamutwe-Jr, 1998, p. 1). The Khomas Region has a relatively high population compared to other regions except for the central northern regions. According to the City of Windhoek brochure on urban demographics, the Khomas Region's urban population is 233,529 and the rural population is 16,733. This totals to 250,262. Of these, a calculated average of 67% has electrical connection. The significance of the population size in the Khomas Region is attributed to the capital which is the hub of administration in the country. It can be accepted that with such a relatively high population and the concentration of industries, the energy requirements will be higher than in other regions as well. The Khomas Region, despite having a low life expectancy of its citizens, shows a steady growth in population. Such population increase also comes with its natural demands of life's essentials - energy. The higher the

population of the Khomas Region, the higher the demand will be on the Khomas Region's energy supply. The Khomas Region shows sustained development through the past 18 years.

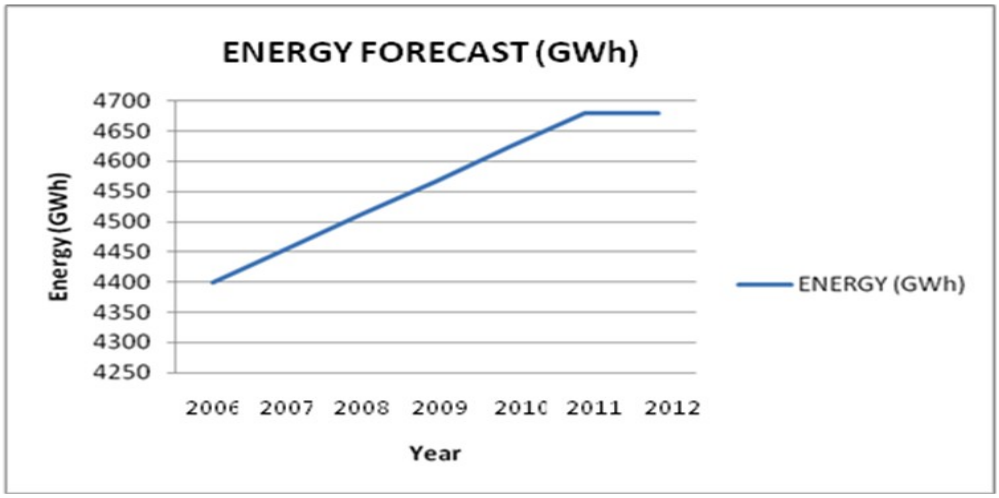
This situation will persist for ever unless the energy demand become so great that definite alternative means should be sought for independent energy sources. The Region is not well endowed with both exhaustible and renewable energy resources. Additional power is sourced from the inter-linked grid. Other non-conventional sources of energy such as wind and solar is either not located in the Region or in a development stage. Coal and hydro power (both South African import and Ruacana hydel power) was by far the largest source of energy for the Khomas Region. However, with the increase of energy demand and the energy shortage experienced in South Africa, concern about secured energy in the Khomas Region is justified. South Africa, being Namibia's major supplier of electricity is experiencing massive local power shedding between the months of January and April 2008. This was due to the increase in demand for energy as the economy grew and the world demand for coal. It is forecasted by the Government of South Africa that the following two years which is 2009 and 2010 will remain critical to the power industry.

Considering the problems faced by Namibia's major power supplier, the Khomas Region therefore will need to prepare for possible power shortages if the SAPP supply will not be adequate. Through research done in 2008 in the Khomas Region, a sample was taken from individuals in urban commercial, industrial, residential and informal settlements as well as from the rural communities. The graph below explains the views of the different persons taken from a broad spectrum of respondents on how they feel about secured energy in the Region for the next five years.



Graph 1: Secured Energy for the next five years

The population of the Khomas Region is expanding especially in the Windhoek area, as can be seen from the number of shacks in informal settlements that increases by the month. NAMPOWER forecasted an increase in demand for power in general. It could therefore be concluded that the increase in demand for the Khomas Region is inevitable. According to the SAPP Annual Report (2006, p. 30), the forecast for the annual energy generation estimated for 2006 through 2012 for Namibia as shown in the graph 2.



Graph 2: Energy Forecast in GWh

The Khomas Region has the capital city of Windhoek as the major urbanized area. There are almost no settlements except Dordabis that could be considered as an urban settlement. The rest of the Region is covered by mostly commercial farms. The Khomas Region does not generate electricity for local use. It could have been a possibility if the resources for conventional energy were abundant in the Khomas Region. NAMPOWER as the bulk service provider is the sole provider of electricity to the Khomas Region. It remains responsible for the generation, distribution and bulk supply of electricity to the Region. Hamutwe-Jr (1998, p. 5) pointed out that "The distribution of electricity is decentralized, with local government and authorities and municipalities supplying power to urban and peri-urban consumers, and the Ministry of Local Government and Housing and NAMPOWER serving most of the rural areas". Since NAMPOWER is the sole provider of electricity, the Khomas Region will always be dependent on it.

In many African countries, one of the key bottlenecks preventing the development of the power sector turns out to be the economy (Khalema-Redeby et al, (1998, p. 5). The Khomas Region has mines and industries that depend heavy on reliable energy supply. Windhoek with its administrative functions and dominance over the national economy cannot be excluded. There are some rural areas in the Khomas Region that are not covered by the electricity grid. The country imports all its fossil fuel requirements, and about half of the total electricity consumed (Hamutwe-Jr 1988, p. 1). Namibia has little capability for generating energy by own means. Therefore, the ability to generate energy by conventional means is rather limited in Namibia. The biggest obstacle is the availability of the necessary funds to establish the production of energy.

The major commercial energy resources of Namibia are hydropower, natural gas, and uranium. Coal is being used to drive the power station in the Khomas Region which in turn supplies other parts of the country with energy. It is a resource that is being imported from South Africa. The then Minister of Mines and Energy, Hon Jesaya Nyamu in his Budgetary Speech (2002-2003, p. 7) indicated that "There is no doubt that Namibia needs additional electricity generation capacity as the consumption and demand increases proportionally. The present energy situation in the Country requires a careful approach as by the year 2005 we might be faced with a serious electricity shortage".

The above forecast made by the Honourable Minister was made only two years before the forecasted problem would take effect. It will not be wise to rest on one's accomplishments until the demand rise again. Since the current electricity situation in the Khomas Region is not yet of immediate concern, it will take time to address the problem of power shortage when the time comes. This, notwithstanding the time it takes to acquire the resources and build the necessary facilities, requires enough time for planning which means that two or three years lead time will not be effective at all. The Republikein (2008, p. 1) indicates that ESKOM issued a warning in the week of 25 July 2008 that possible unannounced power cuts or power shedding will occur after two units of the Koeberg Power Station was shut off because of technical faults. The same paper four days after on 29 July 2008 indicated that Namibia remains "vulnerable" because of the situation at Koeberg (Republikein 29 July 2008, p. 3). The cooperation on Kudu Gas with ESKOM does not bode well. ESKOM management had certain problems with the KUDU Project due to disagreement on the purchasing price from the envisaged gas-fired power plant near Oranjemund (Weidlich, 2008). This insecurity has a direct impact on the Khomas Region; and so evokes the idea of improving the level of energy security. It appears that most countries develop their energy capacity as the requirement increases through the years. These results in additional nuclear power plants, dams and other forms of energy generation being build continuously.

Reference was made to the increasing demand for electricity especially by the mining sector with its newly established uranium mines (Simasiku, 2008). Increasingly, solar collectors, wind machines, bio gas digesters, and other renewable energy technologies (RETs) are becoming practical every day devices used throughout the world (Deutney and Flavin, 1983, p. xi). Now, the Khomas Region is dependent on NAMPOWER for its electricity since independence. The Khomas Region does not have an independent source to develop energy. NAMPOWER is the major generator and transmitter of energy in the country.

Few attempts have been made on the improvement of Namibia's self sufficiency on energy. Attempts to drill for oil were made which until now have shown little hope for its commercial viability. In the absence of oil, Namibia cannot bargain on its gas and uranium reserves as a long term

security for energy alone. Several studies in the energy sector have been conducted in Namibia. The most important are the development of renewable energy and setting up of a nuclear energy plant. Deutney and Flavin (1983, p. xii) pointed out that "Great progress has been made in thinking about energy in the last decade… More than a dozen renewable energy resources have been explored, and many harnessed".

It does look if progress has been made in the use of renewable energy in the world. Renewable energy sources are available to the Khomas Region and if prove to be viable, in the long term, one could easily reason that renewable energy will outlast energy drawn from fossil fuels. It seems that this new technology does not introduce itself from the onset. It does take time to sort out possible flaws before an invention could be successfully commercialised. With limited technological skills in the Khomas Region, it would be necessary to introduce these energy saving measures meticulously.

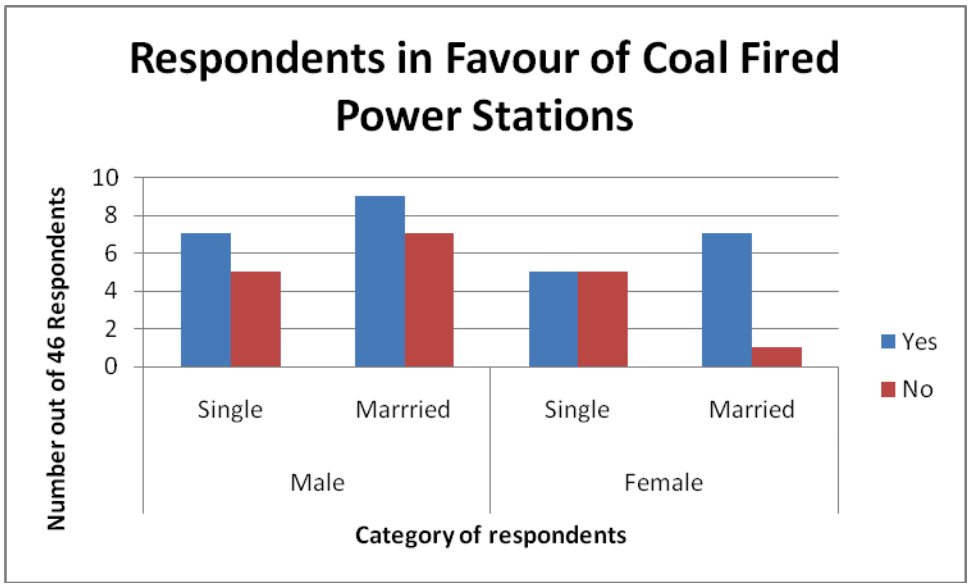
The larger a region is the better its chances to use the expanse of its territories for the generation of renewable energy depending on the renewable energy source that is sustainable in the region. The Khomas Region will in comparison with the Erongo and Karas Regions, not be that competitive with the introduction of wind energy since the windy conditions at the coastal areas are more favourable for such type of energy generation. The Karas and Erongo Regions experiences good windy conditions and it will be the ideal location to put up wind farms. To put up wind generators is a costly exercise. Unlike along coastal areas, the hilly areas of the Khomas Region could provide windy conditions favourable for generating wind energy. There are however no recorded wind power resources for commercial generation of electricity in the Khomas Region. The idea of wind energy does not look that promising in the Khomas Region with its geographical disadvantages if one should venture on an initial opinion. Karekezi and Ranja (1983, p. 83) indicated that "Since wind energy converters work only during the windy periods, they lie idle during less windy months… furthermore, once a wind pump is standing still, it needs a rather high wind speed to get it going".

On the other hand, it became easier for the Khomas Region to adopt new technology because of the fast moving technological inventions due to economic competition throughout the world. Since the Khomas Region has good buying power because of its industrial supremacy, a survey could be done to establish the affordability of renewable energy. The switch from an old energy resource to the use of or new invention is a sign of hope that the possibility for energy security is promising. The idea of moving towards more sustainable use of energy makes it possible for the gradual implementation and even transition from the one to the other. However, if the demand for the vibrancy of hydro-, nuclear-, coal and diesel fuel driven generators is increasing, the transition to renewable energy will be disrupted.

Now, considering the side effects of the utilization of the above mentioned energy generators, whether environmental damage or negative health impact, it would be favourable to turn to renewable energy. However, the costs, skill and expertise to develop renewable energy and implement the use of it are a disadvantage against the easy availability of the older means of energy provision. The current hike in oil prices on the other hand keeps the prospects of renewable energy alive. Bohi and Toman (1996, p. 92) illustrated that "The rapid increase in the cost of fuel inputs in electricity generation will necessitate an increase in electricity rates, either because of higher generating costs or because of the higher cost of wholesale power, and lead to a corresponding reduction in the quantity of electricity demanded".

Coal on the other hand, has been around for a long time. It kept on being used to fire coal energy stations. It is not yet listed as a resource that is about to face depletion. Coal however, contributes greatly towards air pollution. As it can be observed especially in the morning hours when driving from Okahandja to Windhoek, the smoke from the chimneys of the Van Eck Power Station hangs heavily over Windhoek and the visual extend of the smoke could easily cover a distance of 15 – 20 Km. Deudney and Flavin (1983, p. 23) pointed out that "Coal would hold more promise if it could be converted into a liquid or gaseous fuel cheaply and effectively. But while coal chemistry is still sophisticated after more than a century of research, coal-conversion processes remain complex and inherently energy inefficient".

The Van Eck Power Station in Windhoek uses up to 12000 tonnes of coal per annum (White Paper on Energy Policy, 1998, p. 9). With the availability of coal, one may assume that coal generated power will be existing deep into the future. Looking at Windhoek which is the societal hub of the Khomas Region and having the coal fired power station in the City, the air quality will remain poor. Knowing that the Van Eck Power Station is a key energy generator in the region, the existence of the facility is accepted with mixed feelings. Van Eck is also very expensive to operate since the station is very old and the coal used to be railed upward from the coast to Windhoek. The majority of respondents when reacting to the question on the reason why they would not like coal fired power stations is that it pollutes the air. A sample on how people feel about coal fired power stations is taken from personalities in rural and urban Khomas. Smaller towns like Dordabis do not render the variety of personalities that Windhoek offers. However, the perspectives from the small communities are as valuable. The questionnaire handed out in the urban areas included perspectives from individuals in the industrial and commercial sectors as well as households. There is a strong indication that the biggest disadvantage of coal power stations is the polluting effect of the air as well as the environment as a whole. Other optimistic reasons include the fact that since coal is in abundance, the resource would last for long hence the justification for the prevalence of coal power stations. The graph below gives a clear indication on what people in the Khomas Region think whether coal fired power stations should prevail or not.



Graph 3: Respondents in favour of coal fired power stations

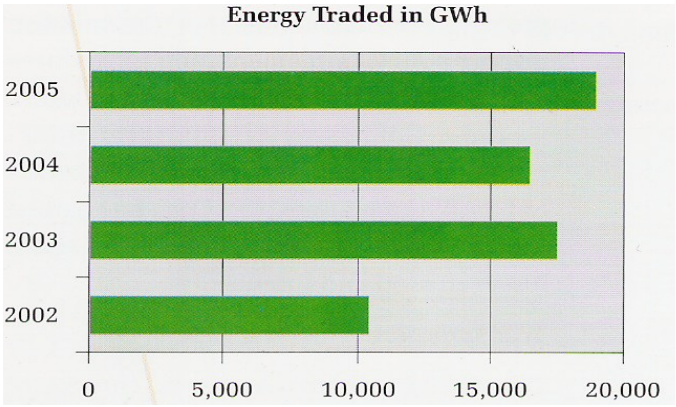
To date, the widening debates on alternative energy possibilities have had no significant results. Except for the ideas on wind and solar energy, the hydro power capability along the Cunene River seems to be the most attractive. The Republikein (March 6, 2008) made mention of a fourth turbine at Ruacana with an additional 85 Mega Watt (MW), a turbine at Ondorusso of 60 MW, and a 350 MW power station at Baynes. Such an electricity generation capability will give the Khomas Region through NAMPOWER adequate energy security for decades to come. The Namibian Government plans to broaden the electricity supply base to meet the local demand and thereby enhancing the security of energy supply. The White Paper on Energy Policy (May 1998, p. 24) indicates that "Government will facilitate the establishment of new high voltage interconnections to neighbouring countries to increase Namibia's possibilities of engaging actively in regional electricity trading".

The First Draft of the Third National Development Plan NDP3 (2007, p. 85) indicates that the first programme on the Security of Energy Supply aims at increasing Namibia's energy generation capacity while the Energy Regulation, Transmission and Distribution Programme will improve the generation, regulation and distribution frameworks. The third programme on Renewable Energy and Energy Efficiency came up with an Off Grid Energization Master Plan to start exploiting renewable energy possibilities. The fourth programme on Fossil Fuels cleared the issuing of 14 new licenses to foreign and local companies for exploration. If these ideas will be realized, the Khomas Region would then be able to plan further development of its electrification plans.

The Khomas Regional Headquarters has other problems hampering its development plans. According to the Regional Development Plan (2001/2-2005/6, p. 32) mention is made that: "A huge concern from the side of the Regional Council is the lack of payment for electricity services delivered to people. The poor payment for electricity deprives the Regional Council of much needed capital to improve and expand their services throughout the Region".

The 2007 NAMPOWER Annual Report (2007, p. 8) mentioned that the electricity demand in Namibia peaked at 539 MW. This came about when the mining sector expanded and required more electricity. The Khomas Region consumes roughly 155.1 MW of which 127 MW is consumed by Windhoek alone. It could therefore be said that the Khomas Region used 28.7% of the peak power demand. The Report further indicated that "In 1996, Namibia consumed 1,707 GWh of electricity, with a peak load of approximately 320 MW" (The White Paper on Energy Policy, 1998, p. 8). Compare that with the consumption of 3,219 GWh during 2006 – 2007 (NAMPOWER Annual Report, 2007, p. 16), NAMPOWER could only produce 1.576 GWh, which is 1.643 GWh less than the demand. The remainder demand is augmented through imports. One could therefore argue that the Khomas Region does have secured energy but is not self- sustained. The Region will remain dependent on the national provider NAMPOWER for a long time to come. Namibia buys power from Mozambique's Electricidade de Moçambique (EDM), South Africa's ESKOM and Zimbabwe's ZETCO.

SADC countries need capital and energy to propel economic growth and improve the quality of life in an environmentally responsible manner. The region is endowed with untapped energy resources but their development, efficient distribution and utilization will require cooperation and trade among the countries in this region. This is reflected in various hydro electric and other projects jointly undertaken by the Southern African Power Pool (SAPP) member countries. NAMPOWER does not remain inactive in the energy sphere. It indicates in its 2007 Annual Report a good number of projects the organization will continue with. These projects are as discussed below. Energy trading actively participates in the short term energy market (STEM) of the SAPP. The energy is traded from three control areas which is Eskom, Zimbabwe Electricity Supply Authority (ZESA) and ZESCO. Trade is made known the day before the trade should be done. The SAPP Annual Report (2006, p. 15) indicates that energy traded since 2002 shows a general increase as can be seen from the graph below.



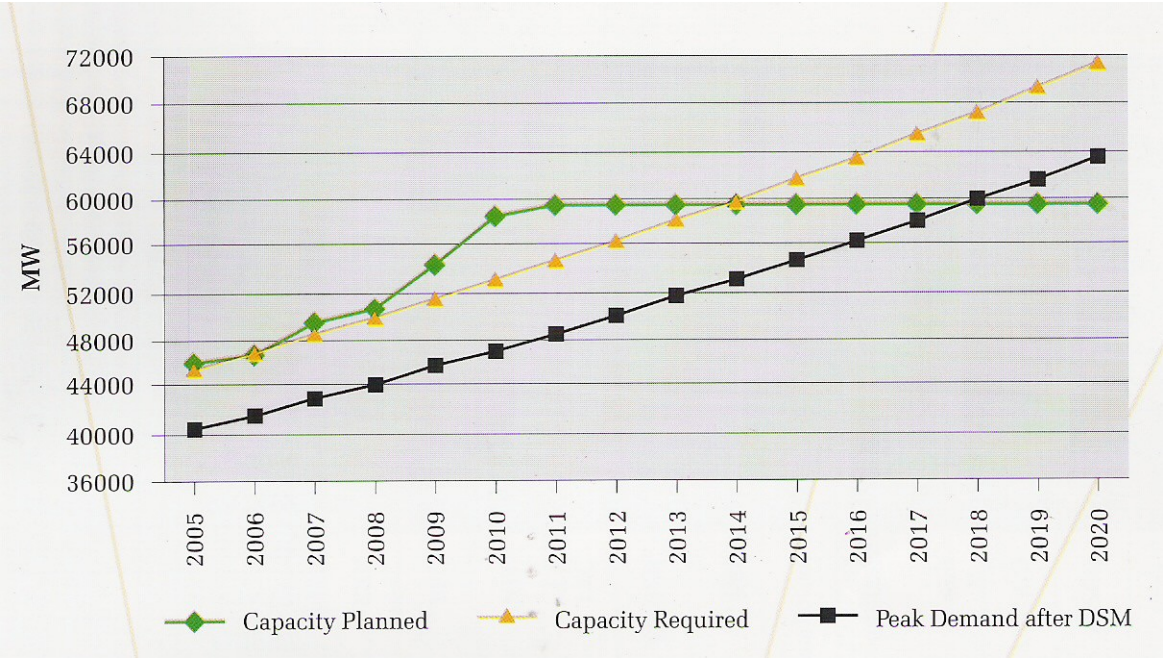
Graph 4: Energy traded in GWh

The STEM is working well but does not operate without mishaps. The table below indicates major system faults that occurred in 2005 for instance (SAPP Annual Report, 2006, p. 17).

No	Member Country	Major Disturbances	Main Cause of Disturbance
1	BPC, Botswana	2	Line faults on the Pokoje-Matimba line in Botswana
2	EDM, Mozambique	2	Transformer tap-changer fault and broken junction of line conductor
3	ESKOM, South Africa	4	Problem with transformer, fault on reactor and fire under transmission line
4	SNEL, DRC	3	Collapsed towers and broken conductors
5	ZESCO, Zambia	5	Landslides due to heavy rains and thunderstorms
	Total	**16**	

Table 1: SAPP Major System Faults in 2005

In the mean time, the energy demand supply is forecasted to rise substantially as indicated by the SAPP Annual Report (2006, p. 27). Graph 5 below gives an indication as to how much power the SAPP envisaged to supply over fifteen years starting in 2005 (SAPP Annual Report, 2006, p. 27).



Graph 5: SAPP Demand Supply Situation

The Report does not make mention of how much power Namibia use to draw from the SAPP but indicates that the SAPP continues to face a shortage of electricity generation (SAPP Annual Report, 2007, p. 22). The Rural Electrification, Renewable Energy Development, the Kudu Gas project with its pipe line to South Africa's Eskom Power Station at Ankerlig, and Baynes Hydropower project are all either commensurate or in their planning phases. The Hwange Power Station in Zimbabwe has good capacity to share power with Namibia but first had to undergo extensive rehabilitation before it could be utilized. In terms of an agreement of 28 February 2007 (Annual Report, 2007, p. 23), Namibia will be set for a firm 150 MW for a minimum period of five years depending on the successful completion of the rehabilitation.

Western Corridor Power Company with the Inga project aspirations is another promising project Namibia could benefit from. The Inga Dam is located in the Democratic Republic of the Congo (DRC) on the Congo River. With a projected potential of 39000 MW (Inga Dam, 2008), much of Africa could be offered electricity. Wikipedia (2008) make mention that there is an Inga II,

-II and III. The Inga III would produce 4,500 MW of energy. This alone is substantial to augment the SAPP.

The Inga III is important to Namibia because of the interconnections with Angola, Botswana, Namibia and South Africa. This is a good indication that the SAPP will have secured reserves for a long time. If the Inga project could kick off, the energy sources for Namibia and ultimately for the Khomas Region will be so diversified that failure of generation from one would not drastically affect the output of the other.

The DRC however, saw the great potential of the Inga projects and wants to expand the Inga hydro potential beyond Inga III. After being built, the Grand Inga will be able to generate 39,000 MW of power. This will enable the DRC to bring besides the Western Energy Highway (WEH), the Northern Energy Highway (NEH) to reality. The Northern Energy Highway (NEH), will pass through Congo, the Central African Republic, Sudan to Egypt (Energy Information Administration, 2002). Since it has greater generating capacity and will blanket a larger client area, the DRC's Societe Nationale d'Electricite (SNEL), is suddenly interested to build the Grand Inga before the Inga III. No mention is made by the Energy Information Administration as to the quantity of power that will be relayed to the SAPP. This implies that Namibia has to wait longer for the Inga III power. All said and done, it appears that with the Inga projects underway, the DRC is about to become the proverbial “light bulb” of Africa.

The SAPP is a sound and important multilateral project in the energy field. In 1995, the SADC Countries initiated the SAPP to address the disparities in energy resources. According to the Energy Information Administration (EIA), with this the SADC member countries “confirmed the region's commitment to expanding electricity trade, reducing energy costs and providing greater supply stability for the region's 12 national utilities” (Energy Information Administration, 2002). With agreements on mutual respect and joint planning to achieve the goals and objectives of the entity, the SAPP member countries crafted a bright future for sustained energy security in the region. Other projects of the Government of the Republic of Namibia (GRN) are the Caprivi link Connector,

a Fourth Unit at Ruacana Power Station and a Demand Side management project as part of the national efforts to manage the increasing demand.

In the process of development, the Khomas Region may consider the much spoken about possible nuclear reactor(s) that could be erected. Since Namibia is endowed with uranium, an important part of nuclear fuel, the Khomas Region might as well reconsider the implementation of other expensive projects like solar power projects that might turn redundant when nuclear energy make its presence known.

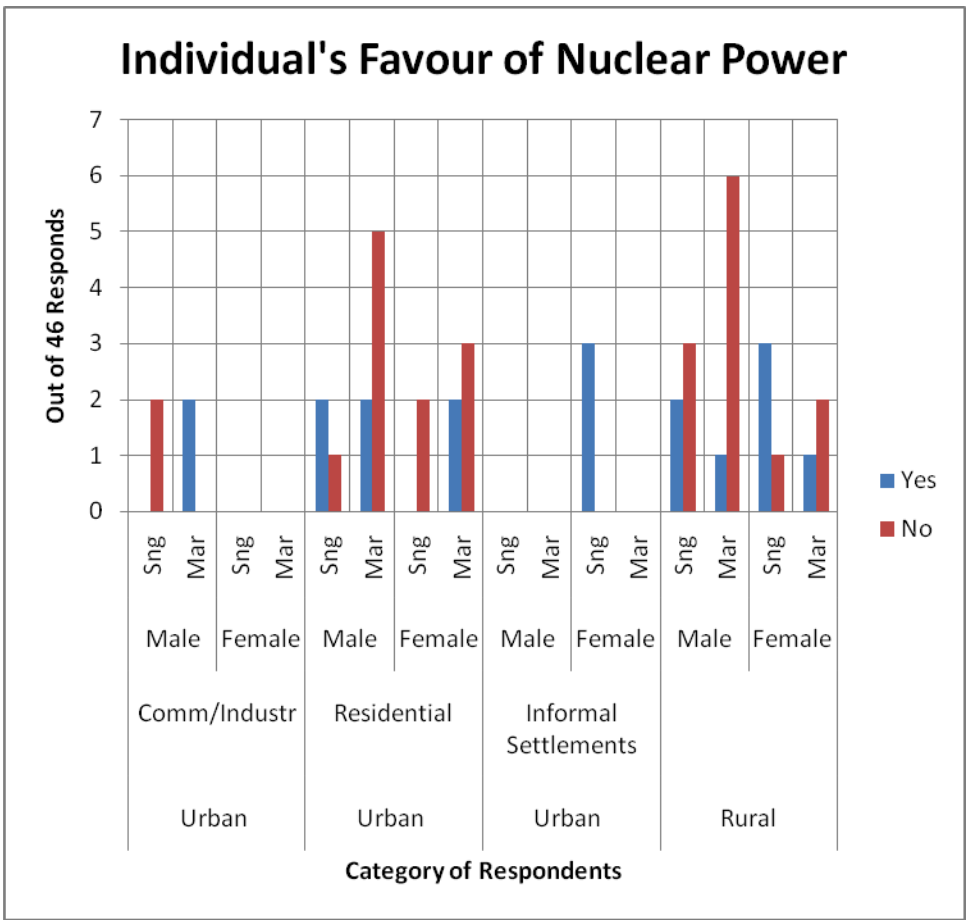
There are talks of Namibia planning to have nuclear reactors for generating of nuclear energy. It is not yet known what type of nuclear reactors the Namibian Government will finally resort to. The online Wikipedia says that “The reactor is used to convert nuclear (inaccurately also known as 'atomic') energy into heat.” (List of Reactor Types, 2008). Nuclear reactors operate in different conditions with different requirements. Nuclear energy operates in an air environment friendly atmosphere. The workings of the types of nuclear reactors will not be discussed but the types of nuclear reactors are; the Radioisotope Thermoelectric generators and the Nuclear Fission Reactors. They are further broken down into different types all of which are having much different approaches in their operation to generate energy. However, the safest of them all appears to be the Pressurized Water Reactor (List of Reactor Types, 2008).

While the people of the Khomas Region could breathe clean air during the operation of a nuclear reactor, the waste it produces is hazardous. The nuclear waste drawn from nuclear reactors is toxic in the sense that it is radioactive. It does take very long for radio activity to slow down and eventually it becomes inactive. The issue is that these wastes should be kept in a secure and remote confinement. Such locations are having an effect on the immediate environment in that it continuously emits radio activity. Nuclear waste could be kept in the same place for years to slowly allow the waste to lose its harmful activity, in other words, it could be kept in containment. Another option is to have the natural processes disperse it in a harmless way. That means that the disposal is not done in a concentrated form but it becomes diluted and eventually dispersed. It is a resource not

easily denied, but citizens might have second thoughts on such reactors. Schrader-Frechette (1991, p. 29) pointed out that “From the beginning, plans for the final disposal of radioactive wastes have raised new and challenging issues for society largely because of the long time scales over which safety has to be assured for some types of waste”.

In a reaction to the March 2008 cabinet decision to opt for uranium enrichment in Namibia as well as the construction of a nuclear power plant, the organisation Earthlife Namibia said it was "absolutely shocked" about the decision (The Namibian, March 10, 2008). Comfort and entertainment of the human being will naturally take precedence if a choice should be made on what means of energy must be used. These choices can only be made by the governing body of the Khomas Region. Staff reporters of the Economist said that the chairperson of Earth Life Namibia, Bertchen Kors, said that “It would be far too dangerous and would put untold coming generations into serious jeopardy” (Nuclear Power, 2008)). The Report continues by indicating that “Kohrs said nuclear power generation requires extremely high technological capacity and skills”. Considering the statements made by Kors and the fact that nuclear technology is totally new in the Namibian expert field, the shortage of expertise in the field of nuclear technology would need serious consideration well before the Khomas Region considers such an alternative. Accidents that happened in the past at Chernobyl in the former USSR in 1986, Three mile Island in the US in 1979 as well as Wind scale in the UK in 1957 (Schrader-Frechette, 1991, p. 56) showed that even the developed world is not exempted from such disasters. Such accidents come from human error and technological failure. The consequences of these accidents could be far reaching in the Khomas Region considering that the Region’s disaster management capabilities have not been put to the test yet. Despite these negative consequences that nuclear power plants have almost, about 41.8% of respondents in the Khomas Region who were asked whether they were in favour of nuclear energy said “yes”. Respondents in the informal settlements in Windhoek area considered nuclear reactors as an option above the coal thermal stations. It is obvious that they were deterred by the amount of pollution caused by the coal-fired power station hence the longing for cleaner energy. It is interesting to see that married males in rural Khomas had strong feelings against nuclear power. Firstly, it could be that some of them are

used to make their living without being connected to the national electricity grid and therefore did not really see the difference that nuclear power would make. Secondly, they are aware of the long term consequences of nuclear waste. Below is a graph showing the responses on the question as to whether they were in favour of nuclear energy or not.



Graph 6: Individual's favour of nuclear power

The use of nuclear power is more common in the developed world. It could arguably be said that the developing world would imitate developing countries in order to keep up with the global urge for development. It would therefore be justified to assume that the industrial nations account for most of nuclear power capacity. The extent of the difference in the use of nuclear power could be minimised as developing countries acquire nuclear power facilities. This trend could be retarded in the African context where economic growth remains very low. Mounfield (1991, p. 41) said that "However, the low population density of the African continent, the limited number of large towns,

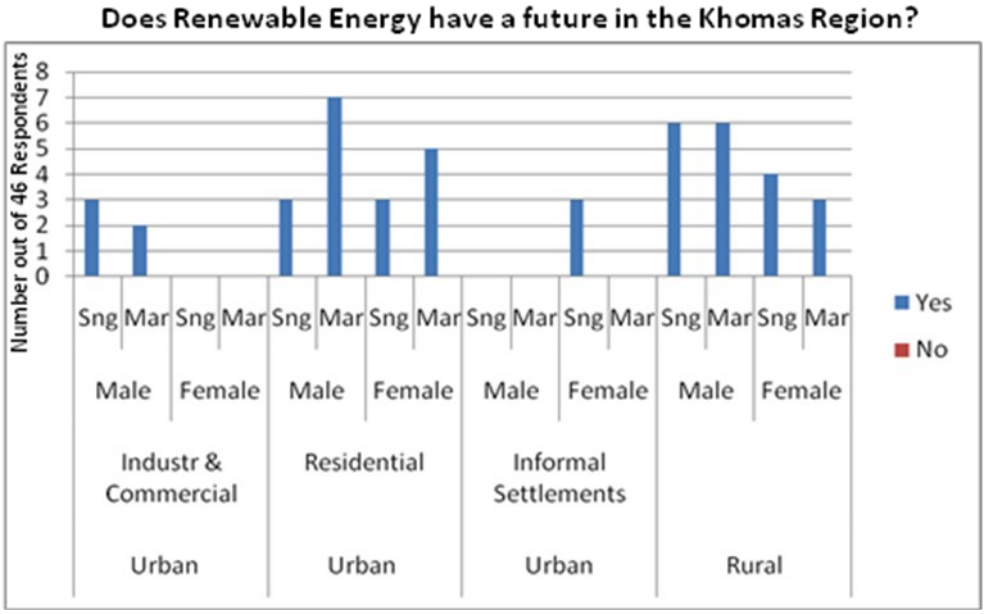
the small and scattered populations, and the shortage of industrial markets all combine to provide a poor economic environment for building large power plants of any kind". Nuclear reactors do enjoy favour from all over the world knowing the toxic radioactive waste they produce. With the shortage of hydro potential in many parts of the world and especially the developing world, the nuclear option offers an attractive alternative to high volumes of energy outputs in comparison to lower resources input. Mounfield further commented that with the per capita energy use in the developing world an increase of 125 per cent of energy supply could be anticipated between 1988 and 2030. Looking at the Khomas Region with Namibia as part of a developing Africa, the" energy famine plaguing the third world" (Mounfield, 1991, p. 41) could hamper the speed at which nuclear power could become realistic in the Region. Other non conventional energy resources like wind energy, solar energy, and bio-gas and biomass potentialities, are thought about but have yet to be developed for full commercial use. The solar power station close to Windhoek is an attempt one may consider as a pilot project if one considers the small scale of the site. Similar sites are set up in remote areas throughout the country. The emphasis on the use of solar energy is put on the households where there could be significant savings on energy usage. The renewable energy bases that are potential options for the Khomas Region will be discussed below.

2.4 Solar Energy

The Khomas Region is situated between 22°13′-23°40′ south latitude and 15°52′-17°50′ east longitude, which is an ideal location for solar energy utilization. Daily average solar radiation varies up to 3100 Kilowatt-hour (KWh) per square meter per year (White Paper on Energy Policy, p. 43). Maximum amount of radiation is available in the months of November - March and minimum in April – October.

Thermal energy has been used in Namibia for drying crops and fish decades ago. Therefore, the sun as energy source has spawned our technological advancement into the development of solar power. Its utilization is being accepted day by day but its slow progress, due to high initial cost, low

operation time in a day and low efficiency. The cost scenario of Solar Photovoltaic (PV) is a very important parameter, which determines its market penetration in developing parts like the Khomas Region. The price of Photovoltaic (PV) Module dropped considerably to USD 3.75 per W_{peak} (REEECAP, 2008, p. 304) since its initiation some years ago. This is evident in the current trend of its popularity in the Khomas Region and Namibia as a whole, hence indicating a real impressive cost-reduction. One may therefore conclude that the future of renewable energy in the Region is solar. This conclusion seems credible through the research survey made for this paper in the graph below whereby single and married individuals were interviewed on the future of renewable energy in the Khomas Region.



Graph 7: Does Renewable Energy have a future in the Khomas Region

Options for PV Technology.

There are three PV technology options for electricity supply:

- **SHS**. SHS is the most decentralized approach and provides only the basic electricity supply for lighting and operating a radio or cassette player. It is able to compete economically with lighting by kerosene, candle, dry cell battery and car battery used in non-automotive

applications. It is an option for supplying electric power to private households in remote rural areas and islands. The introduction of SHS leads to noticeable improvement in user's quality of life, such as:

- Constant and reliable supply of energy is ensured and significantly better light is available, with benefits such as reduced eye strain.
- Fire and smoke hazards in the home that are associated with indoor light sources such as candles and oil lamps are eliminated.
- Improved light makes it possible for the household members to engage in more productive activities during evening.
- Service life of automotive battery is prolonged when it is operated as part of the SHS, as rapid charge and deep discharge are avoided. They are designed for fast charge/discharging. This is the opposite of solar batteries which in turn are deep cycle charging/discharging batteries. It therefore means that solar batteries will be able to endure longer periods of discharging than automotive batteries, hence rendering longer hours of battery powered energy. However, looking at costs, the poor will opt to obtain automotive batteries rather that the solar ones.

- **Battery Charging Station**. Battery charging stations are decentralized facilities for customers to recharge automotive batteries, providing limited electric power for lighting and running home appliances. Powerstream, (2008) confirms that " Solar PV charge controllers take the uncertain voltage from a solar panel and condition it to safely charge lead acid batteries"
- **Central Station Power Supply (mini grid and grid connected)**. The Central Station Power Supply is usually designed to provide 220/240 volt alternating current (AC) supply through a village distribution grid. Due to the modular nature and inherent portability, the start-up period of PV system is considerably lower than other type of power projects. It will be a major step toward an ecological and sustainable energy system in the Khomas Region.

The poorest as well as rural Khomas will have a chance to benefit from one of the most advanced technologies. The big issue here is with storage systems for system operation after hours.

Diversification.

Apart from rural home use, the PV can be used for water pumping, especially for rural water supply by using solar deep-well pumps. Other major diversification like PV-Diesel, PV-Biomass and PV-Wind hybrid systems could be very appropriate for rural areas and coastal belts of Namibia/Khomas Region; as such systems offer better 'System Reliability'. The White Paper on Energy Policy (1998, p. 48) indicates that "Reliable water supply is probably the highest priority basic need amongst rural dwellers in Namibia" and "Photovoltaic (PV) pumps require much less attention and maintenance and have very low operating and maintenance costs..."

Practical Applications for PV.

- **Electrification under the Khomas Regional Council (EKRC)**. The Regional Council should be proud to boast with a higher number of commercial farming activities in comparison with some regions that are not so fortunate. Rural Khomas as far as commercial farming is concerned, does not benefit from the Government Rural Electrification Programme in its entirety. Even smaller communities that reside within reach of the availed electricity, do not have the financial capacity to connect to the grid. Some areas in the Region rely on private initiatives to obtain licences from NAMPOWER to distribute electricity to farms. Once again, the costs involved to connect to such a line deter some farmers in the Region to make

use of such facilities. It is surprising to discover that such an initiative from farmers also occurs across the borders of regions. One such line runs from Klein Aub in the Hardap Region through Nauchas in the Khomas Region and connects about 25 farms. The line stops at farms about 10 kilometres west from Windhoek. Considering the importance of revenue generating entities, it would be good for the Khomas Regional Council to pursue the Government of Namibia to avail subsidies to such entities in order to speed up development of rural Khomas. The same accounts for other communities which do not have the financial power to connect to the national power grid made available through the Rural Electrification Programme.

- **Solar PV System by the Renewable Energy and Energy Efficiency Institute (REEEI)**. REEEI is a pioneer organization engaged in research and promotion of RE since 2006 in Namibia. The Institute provides advisory services to both Government institutions and private individuals. The focus of the Institute is to provide knowledge and information on the operation and capabilities of RE resources and technologies in Namibia.

2.5 *Wind Energy*

Wind resources over the country are generally low, according to Meteorological Department data. The systematic wind speed study at the coastal site close to Lüderitz was carried out at a height of 10m above flat water surface by Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). They have found a fair wind speed between 5-10 m/s and made an analysis of available meteorological data and established that wind speeds are higher in coastal areas. The GTZ come a long way with Namibian authorities to assist in developing renewable energy capacity in the country. "Initial efforts to define and implement off-grid strategies started during the early 1990s in collaboration with the German

GTZ. These efforts resulted in the initial introduction of an Off-Grid Electrification Fund, called the Solar Revolving Fund (SRF)" (REEECAP, 2008, p. 2)

Some of the specific projects that could be undertaken as pointed out by the Wind Energy Study (WEST) Projects that could be developed are as follows:

- There is a 250 KW peak wind turbine in Walvis Bay operated by ERONGORED since December 2007. It can be linked to existing 24MW diesel power stations at Walvis Bay to continue study the performance of a hybrid wind-diesel system.
- A demonstration wind power generating plant at Lüderitz may be set up and connected to the existing grid, to study the performance and efficiency of such a system.
- Some wind-PV generators (100 W to 2 KW) may be set up at remote locations to charge battery systems for specific users.

Practical Applications for wind energy.

NAMPOWER could install a number of small wind pumps/turbines on the coastal site in the area of Lüderitz to target groups to improve their quality of life? Such systems could only work for water pumping in the Khomas Region since the environment is not so conducive for large applications.

- As for the output power from the wind, the turbines with a rotor diameter of 27m has a theoretical output of 225 KWh a wind speed of 15 m/sec.

2.6 *Hydro Power*

Khomas Region is a mountainous region with the Auas Mountains as the main feature. Numerous ephemeral rivers flow across the Region, which are mostly dry during the year. There is no part in the Region that could offer the potential for a dam big enough to provide hydro electricity. The rivers in the Region have a very low flow rate for about 1 to 2 months during the rainy season, which is substantially reduced, firstly by soil dams all over in the farming areas and lastly by a long dry winter.

Some of the Khomas Region's rivers originate inside the Region which implies that it is difficult to generate high flow of water if at all the rain will fall in such high volume. With the high ground existing in the Region, it is wishful thinking that any hydro electric energy could have been harnessed but the major limitation on hydropower generation is the low rainfall. However, there are small hydro potential areas in other regions, which are briefly described below:

- **Small and Medium Hydro Potential**. Several attempts have been made in the past to establish the potential of small-hydro power generation, which is believed to be more environmentally or ecology friendly in comparison to large hydro projects with dams. At present only 240 MW of peak hydropower (K. Ndhlukula, personal communication, December, 1, 2008) is utilized in the Ruacana Hydro Station, which is the only hydro-electric power plant operated by Namibia's NAMPOWER. This output varies throughout the year due to the seasonal flow of the rivers feeding the dam at Ruacana. The Government of Namibia is considering extension of its hydro electricity capabilities by another 360 MW capacity at Baynes on the Cunene River to realize in 2017 (REEECAP, 2008). Apart from Baynes, two other prospective sites for hydropower generation exist at Epupa and Divundu/Popa Falls. The latter is located at the Okavango River. Some of the previous studies in different parts of the country are described in the following headings:

    - **Baynes Project**. This would be a new project with a peak generating capacity of about 360 MW However, this project needs a detailed environmental, social and economic impact assessment.

    - **Divundu Project**. The Divundu Project would be a new project of 24 MW capacity (NAMPOWER Technical Report, n.d.).

2.7 *Biomass*

Biomass is defined as all organic matter produced by a photosynthesis process, especially the in plant kingdom. Depending upon their characteristics and quality, biomass resources are used as food, fodder, building materials, fuel and manure. Only a fraction of total biomass is used as fuel. In Namibia/Khomas Region, biomass fuels could be obtained from three sources namely, tree bushes (e.g. wood fuels), field crops (e.g. agricultural residues), food wastages from the capital's high number of hotel and restaurants as well as livestock (e.g. animal dung). It is not known what problems rural households experience due to the scarce availability of fuel wood. The White Paper on Energy Policy, (1998, p. 15), stated that "Government will investigate the status and use of biomass in the different regions of Namibia in order to determine which rural people are most affected by woodland depletion, as well as the nature of the problems experienced by rural people". Only upon gathering the nature of the problems, a biomass strategy for addressing these problems could be planned. In each year, thousands of tons of fuel woods are consumed in Namibia/Khomas Region for cooking purpose only. The image below explains the cycle through which fuel from biomass could be produced (US Department of Energy, n.d.).

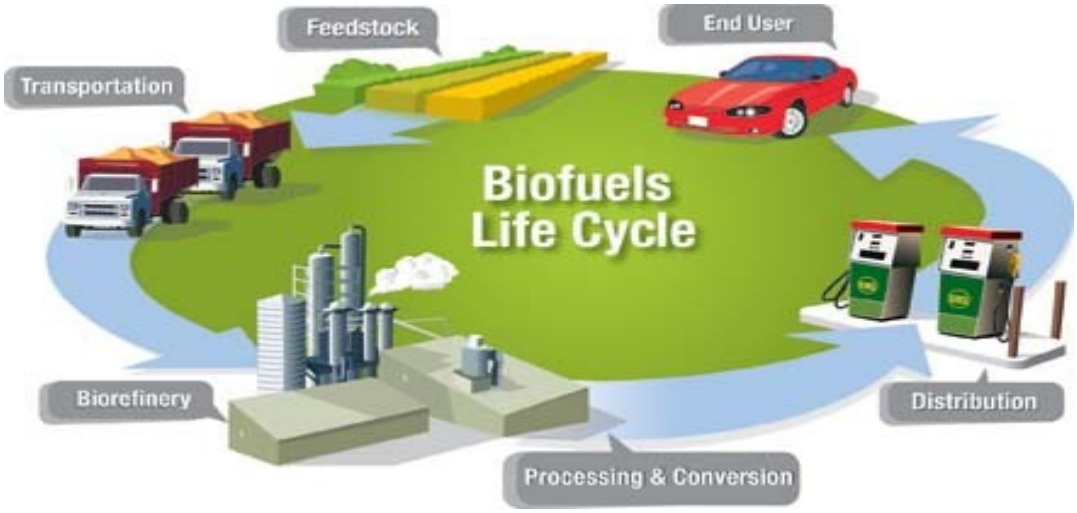


Figure: 1 Biomass Fuel Processing Cycle

At present biomass fuels contribute 7.4 per cent of the total energy needs of the Khomas Region and 59.6 per cent for Namibia (http://howstuffworks.com/wind-power4.html, 2009). Due to the use of inefficient stoves, and the high number of informal settlements in the Khomas Region, the consumption of biomass fuel increased considerably. As a result, the forest reserve of the Region has decreased significantly, especially in the vicinities of the urban areas. Due to acute deforestation, the ecological balance is also threatened. However, by using improved stove, similar output can be obtained with fewer amounts of biomass fuels.

Traditional Stoves/fireplace in the Khomas Region.

The traditional stoves commonly used in the Khomas Region are open fires with make-shift stands for cooking utensils to rest on. In many cases this way of cooking causes unnecessary heat loss for the following reasons:

- The stoves/fireplaces are too open and in some cases because of either too short or large distance between the pot and the fuel bed, heat transfer to the cooking pot is very low, resulting in low efficiency.
- Because of the large size of the flue-gas exits between the cooking pot and the stove, much of the flue-gas get out of the stove without coming in contact with the cooking pot, thus lowering convectional heat transfer.
- Since air cannot reach the bottom of the stove, considerable amounts of cooking fuel accumulate at the bottom as charcoal.

The efficiencies of these stoves vary depending on the distance to the fire and to cooking utensil. Apart from low efficiency, these stoves emit smoke, which affect the health of the users and make the kitchen dirty. Because of incomplete combustion of biomass fuel in traditional stoves/fireplaces, appreciable quantities of irritants, toxins and carcinogens are released in the kitchen environment and these pose a major threat to the respiratory system of the users. In general, the

combustion products of wood are carbon dioxide, water vapour, carbon monoxide, and polycyclic organic matters. These are known to be pollutants and hazardous to human health.

Improved Stoves.

The White Paper on Energy Policy, (1998, p. 16) indicates that "The Government will promote fuel efficient technologies in rural areas". The old cast iron stoves are no more readily available and if so, these would be too expensive for the poorer section of society. Various companies such as Vesto and the Volombola Stoves Project have designed and are marketing improved stoves (eg. Tsotso stoves) as well as the solar stove- normally called solar box/solar cooker (K. Ndhlukula, personal communication, December, 1, 2008). These are suitable for domestic cooking and to a certain degree for industrial heating purposes. These solar stoves will if made available at affordable prices, hold many advantages to users and the environment.

Biomass Briquetting in Khomas Region.

Utilization of biomass fuel resources is largely inefficient and wasteful. The introduction of biomass briquetting in the Khomas Region has attempted to address this problem in the recent past. Much of the briquettes are made from encroaching bush which complements the process of encroaching bush control. Biomass briquetting is a relatively new technology in Namibia/Khomas Region. It also has an advantage by being densified hence having fuel in a compressed form.

2.8 *Biogas*

Organic matter such as animal and human excreta and agricultural and industrial waste, when fermented under an anaerobic condition, produces a combustible gas called biogas. It is a renewable source of energy and can be used as fuel for cooking, lighting, running vehicles and generators among

others. Biogas technology is not yet introduced in the Khomas Region (REEECAP, 2008, p. 6). With a relatively low population, it could be argued that the biogas resources could be too small but it will complement the existing energy use. A household for instance needs to have enough organic waste resources to operate the bio digester almost indefatigably. In other words, an in inexhaustible resource like a hog or cattle kraal would be ideal.

Uses of Biogas Residues.

Biogas residue can be used for the following purposes:

- Improved organic fertilizer.
- For mushroom cultivation.
- Aquaculture.
- Poultry, fish foods.
- Seeds fermentation.

Advantages of Biogas Technology.

Using of biogas technology provides the following advantages:

- Produces pollution free bio fuel.
- Improved organic fertilizer.
- Controlled degeneration of methane as carbon dioxide which has lower global warming potential.

Affordability.

Biogas is a proven technology; there is no risk of failure if proper design and supervision can be ensured. Biogas digesters can be so small that households can also embark on such a project. A 100 cubic feet (cft) capacity biogas digester can meet the cooking energy needs for a five-member family. The Khomas Regional Council could in conjunction with the Government arrange for subsidies for family size biogas digesters, which can be used for cooking and lighting.

Impact on Health and Environment.

Biogas could play a role in reducing carbon dioxide emissions. As the slurry remains in the digester for 30-40 days in anaerobic condition, the effluent becomes pathogen free and the output is smell-free combustible gas. The residue is an organic fertilizer that improves the environment and prevents diseases. Large-scale bio energy development in the Khomas Region could bring significant environmental benefits. Sustainable bio-energy development could:

- Reduce levels of deforestation.
- Reduce net greenhouse gas emissions.
- Improve air quality and reduce acid deposition.
- Improve soil quality and reduce erosion.
- Reduce land filling by adding value to residues.
- Improve sanitation condition.

Potential of Biogas in Khomas Region.

An agriculture based country like Namibia has huge potential for utilizing biogas technologies. Large quantities of waste could be obtained from the livestock of the country, which is equivalent to large quantities of kerosene if one could consider that one kg of dung can produce 0.037 cum of Biogas, i. e. 220 million kg cattle dung can produce $2.97XIO^{9}$ cum of gas which is equivalent to $1.52X10^{6}$ tons of kerosene or $3.04X10^{6}$ tons of coal (Renewable Energy and Environmental Information Network, (nd). Apart from this, it is also possible to get biogas from human excreta, poultry dropping and waste. If each family in the Khomas Region can be associated with a biogas plant, then only human excreta will give substantial amounts of biogas. "Data collected shows that 1 Kg waste gives between 50 to 60 liters of biogas" (Singh, 2008). This also implies that the informal settlements in the Khomas Region and especially in the greater Windhoek will put less strain on sewage wastage hence improving the hygienic conditions of those areas. There is a need to have good management practice for domestic waste to be used for biogas production due to the detergents used in households. Detergents kill the bacteria which in turn have to digest on the waste to produce gas.

Practical Applications.

A great number of biogas digesters could be installed all over the Region. Most of the beneficiaries could meet their energy demand from biogas digesters. The popularity of this technology is currently an illusion but it could gradually be introduced by major players like the Khomas Regional Council through the Government of Namibia and Earth Life Namibia. To meet the energy demand of the immediate future, elaborate programmes should be undertaken to supply biogas to the doorsteps of the common people of the Region. One should keep in mind that bio digesters require lots of water to function properly. It is confirmed that bio digesters require 1 litre of water for every 1 litre of waste (K. Ndhlukula, personal communication, December, 1, 2008).

Areas suggested for applications for (RE)

There are certain areas in the Khomas Region suitable for renewable energy application for household's needs. These are:

- Remote villages or communities in the Region.
- Informal settlements in the Region especially those near Windhoek.

For the above mentioned areas, a concept of setting up micro-utilities in rural markets with the help of renewable energy, as well as SHS in individual households. This also implies that individual households could make use of bio digesters to decrease their dependency on the conventional energy supply line.

The electricity from such a decentralized system like Photovoltaic (PV) and wind power will be generated at the users end. These systems will be owned by the individual customers and will also be maintained by them. There will be no generation loss, no transmission and distribution loss, no system loss and very minimal if at all environmental risks. Pressure on the national grid, i.e. by the more essential sector during the peak-hours, will be reduced. So, huge losses caused by potential load shedding in the industrial and other sectors could also be reduced. The availability of electricity from these resources will suit the consumption pattern of rural areas best. Very often the initial cost of electricity from the renewable energy is higher but the Life-Cycle-Cost are comparable to costs of conventional systems. Thus the adoption of these decentralized sources of energy can significantly reduce the financial requirements of the power sector of the country, since NAMPOWER and the Government at large already find it difficult to cater for the energy needs of the society and industry.

If policies, like the extension of current subsidies (like for rural pump price subsidy for generator fuel, by the National Energy Fund, cross subsidies for poor rural households, schools and clinics) and channelling of international assistance to systems using renewable energy technologies

(RET) are adopted, achievement of the target of rural electrification may exceed the expectations of most experts. The use of renewable energy resources is ideal for electricity generation in rural areas because of the following reasons:

- These are clean with no pollution as in fossil fuels power systems.
- These are locally available and renewable sources of energy.
- These can provide employment to local people.
- These augment rural demand for electricity systems and make them self-reliant.
- Centrally supplied electricity is in some cases not available or is becoming expensive.
- A centralized system of distribution involves a very high transmission and distribution loss as well as costs.
- Electricity is more reliable because voltage fluctuations are small during the supply hours.
- Khomas Region is a mountainous and mostly rural Region in which the extension of the national grid to some remote areas is too expensive.
- Khomas Region is an arid Region where the prospects of solar and wind energies are very bright.
- Some rural communities and commercial farms are spread throughout difficult accessible areas where small electricity supply systems, including renewable energy, would be the best option.

2.9 *Secured RE supply and poverty alleviation: The linkage*

Since secure energy will inevitably contribute to national development in the Khomas Region, if RETs could be applied selectively to various rural applications. It would then generate income, improve health, educational quality and labour productivity. However, such potential benefits arising from RETs may be realized only through a process that

appropriately harnesses the social and financial context of village life. By utilizing renewable energy, the overall development of the Khomas Region can be achieved in the following fields:

- **Foreign Exchange Savings**. Under normal circumstances the community would have used imported diesel/kerosene for domestic purposes. This expenditure can be drastically curtailed by using the micro power systems.
- **Community Development**. Provision of house lighting, potable water and communications (radio/television/telephone) is essential for development of the community. Introduction of renewable energy can contribute for enhancement of the standard of living of the population.
- **Employment Generation/Empowerment of Women**. The Khomas Region does not have the extent of domestic work like the regions in the north of Namibia. However, the use of electricity would release women from domestic tasks such as fetching of drinking water, thereby contributing the saved time for handicraft/stitching of clothes/agriculture and for literacy programmes.
- **Economic Considerations**. The following would contribute to economic development:
  - Poverty alleviation and community development due to development of small rural industries.
  - Income generation and employment opportunities would be created.
  - By avoiding the cost of extension of the national grid, the fund could be spent for other purposes.

- **Environmental Impact**. Use of renewable sources of energy for production of electricity would cause no harm to the ecology and hence conserve the environment for the benefit of humanity.
- **Cultural Aspects**.Saving of time from agro-processing, fetching of drinking water and collection of firewood could be put to good use by conducting literacy programmes. Availability of electricity facilities could mean the use of evenings for social development such as health care, nutrition, family planning etc.

The awareness of the environmental friendly way of using solar energy in the household has deepend. However, the costs of obtaining the solar systems for different uses are high and the financing period is long before the system can prove cost effective. According to "Spark", the ECB news letter (2007) a comparison between the use of SWH and electrical geyser- the relative cash flow for the two alternatives when financed through a commercial home loan look as follows (SPARK, 2006, p. 1):

Graph 8: Comparison of total costs for SWH and EWH financed via a home loan

Consideration is made to motivate rural as well as urban households to use more environmental friendly means of energy consumption like natural gas. Yaron et al (1994, p. 7) argues that 'The cost of buying new appliances combined with a relatively good supply of bottled gas makes switching unattractive'.

This might result in acquiring more costly means of energy usage will be delayed even though electrification could bring significant benefits. Solar energy could be the answer for the Khomas Region's off grid areas if electrification would be considered too expensive. Therefore it is not expected to have a valid reason for not having solar power in off grid areas. There are a number of uses for solar energy on the market now. (PV) power is the technology that converts sunlight into electricity (Yaron et al, 1994). It is within these cells that solar energy is converted into electricity. The output of solar generated energy is lower than that of diesel for instance. One may therefore argue that for heavy commercial use, solar would not be the answer. That could wait for better technological breakthrough in the area of solar technology.

The Khomas Region could very well make use of the different solar power applications. These are: centralized PV power stations, rechargeable battery systems, and solar home systems. It all depends on the willingness to pay for the initial high costs of these systems. If the Khomas Regional Council would consider a subsidised scheme to introduce the use of solar power in their desired areas of concern, the project could take off. It would therefore be reducing the burden in exploitation of the environment and ease the load of conventional energy supply.

With the growth in population and the higher demand due to national development, energy security remains a concern that could not be simply ignored by policy makers. The position in which South Africa is finding itself currently on the short supply of energy could be the situation Namibia will find itself in future if all possible energy resources are not harnessed for optimal usage, hence securing its energy sustainability. The current situation of the Khomas Region's energy security is of great concern. The provision of electricity by foreign sources where the supplier NAMPOWER sources from has become erratic. This situation will inevitably worsen in the immediate future. The ECB and NAMPOWER are well aware of the concern regarding reliable energy supply in the Khomas Region. To conserve energy and use it efficiently in the Khomas Region, need proper strategic planning. As Hamutwe-Jr (1998, p. 1) found "There is a need first to understand the prevailing situation in terms of…" One of these conditions is "the public opinion on the most effective ways to remove these barriers".

The careful use of biomass as mentioned earlier by Hamutwe would benefit the energy production business since it could be recycled for concurrent uses in the same plant. Karekezi and Ranja (1998, p. 19) pointed out that "Biomass such as bagasse (sugarcane fibre) is used to fuel the thermodynamic machine that heats up steam which then drives a turbine to produce electricity. The steam that is raised form low to high pressure is not all used up in power generation but is also available for processes in the plant".

Biomass can also produce a variety of other products that is used in everyday life. With the potential that Windhoek has by accommodating the highest density of educated people, the Khomas Region could easily embark on ventures that are based on the potential of ethanol. Karekezi and Ranja (1998, p. 23) pointed out that "Ethanol from biomass is a major renewable energy source that offers an alternative to fossil fuels. It is also used as an alcoholic beverage (vodka and gin, for example) and as an intermediate chemical in toiletries, cosmetics and pharmeutical preparations".

The scant use of electricity in the Khomas Region would inevitably contribute to the conservation of the resource. Windhoek Municipality encouraged the use of energy savers in households. The commercial sector did not turn a total blind eye on their responsibility to conserve energy. Some of them do make use of energy savers in their work areas. Karekezi and Mackenzie (1993, p. 5) announced that "…energy efficiency is the key to supplying energy to more consumers without increasing adverse environmental effects. In some respects, energy efficiency can be considered an environmentally sound option".

Energy efficiency starts with the individual user at home. Despite the fact that one could maybe afford electricity bills, it became clear that the authorities in the Khomas Region initiated measures to save energy. Therefore, it could be a justified assumption that the responsibility to use energy efficiently lies with everybody in the Khomas Region. If the trend of energy consumption is far from efficient, it could be justified that it will have an adverse effect on the cost of energy supply. This tendency will have a domino effect of the cost of other services too. The Khomas Regional Council should assume responsibility to continue with energy efficiency programmes. The capital

city, being located in the Khomas Region, is the focal point for high energy consumption entities. The bulk of the Khomas Region's power allocation is directed to Windhoek. For that reason, energy efficiency, once applied in Windhoek, would contribute enormously to Regional energy security.

2.10 *Conclusion*

There are a number of options the Khomas Region could explore in order to ensure reliable electricity supply to its inhabitants. The technological capability required to apply some of these options is not adequate or in some cases not available in the Region. It will be premature if the Khomas Region were to embark on an independent programme to generate power in any other form than the current supply systems. With the projects that are in place, there is little sign that the MME and NAMPOWER will relinquish their monopoly in the energy sector.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The aim of this chapter is to discuss the sampling method that was used for the study, the research instruments that were used, how the data collection was done, and the primary and secondary data used in the study.

The constraints that surfaced during the research included the verity that not all outlying areas could be reached. The technical challenge however, was the fact that besides the management cadre in the power sector, little expert knowledge on the subject exists to explore technical issues of concern.

It will therefore be necessary to delve into the technicalities to become acquainted with energy security in the Khomas Region. Expert advice on the technical aspects of the topic could then be sought during sampling. This will enable a focus on aspects of qualitative research for framing the research question.

3.2 *Sampling*

A systematic sample which is a form of cluster sampling was undertaken in the Khomas Region only. Cluster sampling is a sampling technique where the entire population is divided into groups, or clusters and a random sample of these clusters are selected. All observations in the selected clusters are included in the sample (Cluster Sampling, 2009).

With advice from the Regional Council, persons such as policy makers and the management cadre in the energy sector in the Khomas Region were sampled. To have an appropriate analysis, rural sites selected for sampling were located as far as possible from urban areas. This naturally suggested a cluster sample.

A number of primary units from the population were chosen at random in a specific populated area. These primary units formed the cluster which in turn resulted in the actual sample entity of that specific area where the sample was taken. This way, it displayed the general public opinion of a specific area. The advantage of this method is that the entire population of the study area could be covered. The most convenient area was Windhoek which presented different conditions in an enclosed vicinity. Under-developed sites in rural areas were the ideal places to do sampling. It became problematic to have a well representative sample from rural Khomas due to the sparse population and the difficulty in negotiating routes especially in the Khomas Hochland area. However, far-off settlements with acceptable numbers of people were visited for sampling.

3.3 *Research instruments*

Forty-six respondents in both rural and urban settings were interviewed. The respondents were indiscriminately selected over a broad spectrum of society. The reason for this choice was to understand the feeling of people of all walks of life as far as their position towards the electricity situation in the Khomas Region was concerned. These respondents were all people who were home owners, family men and women hence directly affected by the electricity supply. Included in the forty-six respondents were eight personnel of the management cadre in the electric power component of the energy sector were also interviewed. These are members of the MME, ECB, National Planning Commission (NPC) and NAMPOWER which included members of the renewable energy sector of the organization. The reason for selecting these personnel was to have first hand information on how they felt about energy security in Namibia in general, and the Khomas Region in particular. The management cadre would give enlightening information on the financial aspects, policy issues and professional capabilities of NAMPOWER.

The research instruments took the form of questionnaires, interviews, observations, and documentation. Interviews were done individually. Again, here the respondents were treated with respect and issues that they considered too sensitive were not pursued. On the onset of approval of the proposal, a general observance of the frequency of power failures were done. Where available, all relevant literature that addresses the topic was reviewed, analysed and read and valid points drawn from it. This included books, reports, journals, pamphlets, policies, brochures, and the internet. The questionnaires included 15 subject related questions. Multiple answer questions were included. The questionnaire is attached as Annex 1. The questionnaire for interviews is attached as Annex 2.

3.4 Data Collection

To find the answer to the research question primary and secondary data were used. Primary data collection was mainly through discussions and interviews with people who work and reside in Khomas. They include respondents throughout the different levels of the social sphere in the Region

and included people living in informal settlements, proclaimed residential areas, commercial and industrial areas and government officials. Secondary data were obtained from published and unpublished books, journals, magazines, newspaper reports, library documents, electronic data bases, the internet as well as information from a seminar presentation.

Secondary Data

To conduct the literature review in an acceptable form, books, periodicals, articles, journals, and on-line databases were used to collect data. The following criteria guided the literature research:

- Firstly, the degree to which the topic was defined clearly.
- Secondly, lists of key areas and location were developed for approaching the secondary data.
- Thirdly, the search started using several books, periodicals, articles, journals, and online databases.
- Lastly, literature found was compiled, studied and findings were evaluated to see if these would complement the statement of the problem.

After completing the secondary data, primary data collection was conducted in order to get the relevant information. However, continuous reference was made to secondary data to confirm issues that were not clearly evident with findings of the primary data.

Primary Data:

The individuals living in the City of Windhoek, its surrounding suburbs, small town and settlements in the Khomas Region as well as selected farms in the distant vicinity of Windhoek off the main grid line in the Region were interviewed concerning their opinion on the quality of electricity supply from NAMPOWER. From the research population, forty six respondents were drawn as a sample from all the above mentioned areas.

The respondents were upon questioning approached and the general purpose of the survey was explained. In many cases, the researcher and respondent had to work together to fill in the questionnaire. The main purpose of such interactive way of questioning was merely due to the need to explain technical terminology regarding energy security. Essentially, the objective was to gain the respondent's co-operation in an accurate and honest way as possible. Respondents were told that the questionnaire was self-administered and meant only for academic purposes. Two types of questionnaires were used. One was an anonymous questionnaire meant for any individual and the second was meant specifically for the managerial cadres and was done through personal interviews.

Each interview started by explaining the objectives of the research and individuals were asked to willingly co-operate by providing information. Then, the questions from the questionnaire were read to them and their answers were recorded. During the personal/face-to-face communication interview, the interviewer created a conducive environment by controlling the topic and pattern of discussion to obtain and improve the depth and quality of the information.

3.5 *Data analysis.*

The data obtained through the survey was systematically grouped and verified for consistency. By using computer software, statistics were recorded accurately to interpret the data in a more systematic manner. Continuous revision and adjustments where necessary during the questionnaire filling and interviews, to ensure realistic sampling.

The field study was conducted from October 2008 to January 2009 in which the survey coincided with Namibia's summer months where the day temperatures were high. The objective of the study was to assess the extent to which energy security was ensured in the Khomas Region. During this period, questionnaire-based surveys were conducted in 6 localities across the Khomas Region. It focussed on rural, small settlements and peri-urban communities. Localities visited were Seeis, Hosea Kutako Airport, Dordabis, Nauchas, Claratal, informal settlements in the Windhoek area, Windhoek urban residential and commercial areas. A total of 46 questionnaires were completed

and analysed. The data was not analysed as per locality since the responses from all localities were reflecting a similar pattern. However, a distinction was made between single and married men and women. Instead of analysing the individual localities, the localities were grouped under rural, informal settlements, urban commercial and industrial, and urban residential.

The desktop study was conducted by the author during the same period as the survey and included a literature survey of energy (electricity) efficiency, its practices, new technologies and a review of the current policy on energy as well as the current programmes regarding energy.

During the survey numerous encounters with uninformed respondents were experienced which called for extensive explanations on energy security before accurate responses could be recorded. Differences between the informed managerial cadres of the energy sector and the rest of the respondents became apparent during the survey. The managerial cadres adopted a mostly positive stance towards a problem free power sector while the other respondents had doubts on the secured supply of power in the future. This perhaps resulted from various negative publications by the media and the frequent power failures that occur in Windhoek.

The literature survey, showed that the future of electricity in the Khomas Region as well as the rest of the Sub-Saharan Region does look promising provided the numerous projects and multilateral agreements on power sharing would be developed to the stage that it starts working.

3.6 Validity and reliability of data

3.6.1 Validity

The study was aimed at obtaining information from the perspective of the participants in the research. For this reason, the study attempted to portray the issues from the participant's views.

Responses from individuals who did the questionnaire were in general very similar. As a result, the findings could be generalized. If the survey were to be conducted again in order to confirm the validity of the data, the same result will not be obtained due to the change in context in which the research occurs. As developments in multi-lateral negotiations come about, the whole scenario as far as energy supply will be affected. This in turn will therefore affect the validity of the data.

The degree to which the results could be confirmed or corroborated depends on who the critics were. As mentioned earlier, the management cadre in NAMPOWER is of the opinion that the provision of electricity from NAMPOWER operates in a problem free environment in which the power sector does not experience difficulties to provide the required services. This thought might engage in a possible contradiction against some of the results that emanated from the data because the ordinary man experiences that the services from NAMPOWER comes with uncertainty.

3.6.2 *Reliability*

The study was done in a way to maintain consistency in order to achieve a good quality of measurement of the data. However, a measure of random errors was discovered due to the state of mood some of the respondents were. For example, those respondents who felt that they are negatively affected by the polluting smoke emitted by the chimneys of the Van Eck Power Station, reacted with a great feeling of resentment than those who were not directly affected. The same apply to individuals in the rural areas where connection to nearby power lines is too costly. Their depressed moods were inflated which resulted in different responses to the questionnaire. In many cases, these appearances

came from educated groups of people which in turn indicate that their honest responses could have been more authentic.

Unrecorded feedback from respondents regarding the severity of the effects of the situation upon them gave an indication as to whether the situation contributed to their temperament. So, in order to reduce measurement errors, respondents were educated to a certain extent on the terminologies regarding the topic and capabilities of Namibia and the Khomas Region without influencing their responses by laying answers in their mouths. Collected data for the study were also double-checked.

3.7 Ethics of the research

Leedy & Omrod (2005, p. 101) argued that "Most ethical issues in research fall into one of four categories: protection from harm, informed consent, right to privacy, and honesty with professional colleagues". To comply with the ethics of research, the researcher ensured that no physical or psychological harm was imposed on the research participants. Leedy & Omrod (2005, p. 101) further said "Research participants should be told the nature of the study" and "Any participation in a study should be strictly voluntary". Here again, the researcher ensured that the prospective research participants were fully informed about the procedures and risks involved in the research for them give their consent to participate. The prospective research participants were not coerced into participating in the research. Leedy & Omrod (2005, p. 102) further said "Any research should respect participant's right to privacy". The researcher applied two standards to protect the privacy of research participants. The researcher guaranteed the confidentiality of the prospective participants in that they were assured that possible identifying information will not be made available to anyone who is not directly involved in the study. The researcher believed that the principle of anonymity should be maintained throughout the study hence no identification was taken from respondents who filled in the questionnaires. During interviews with the management cadre, however, identifying information was obtained with the consent of the interviewee. Leedy & Omrod (2005, p. 102) said "Researchers must

report their findings in a complete and honest fashion...". The researcher endeavoured to interpret the data as accurate as possible and where statements were taken from other authors, the necessary acknowledgements were done. No data was fabricated to support the arguments in the study.

3.8 *Conclusion*

The difficulty in educating the target audience on a survey of this nature presented additional problems because it became time consuming to the researcher. Data on energy security is available in Government archives but many of the plans on the use of alternative energy technology are still under construction.

CHAPTER 4

PLANNING FOR ENERGY SECURITY

4.1 *Introduction*

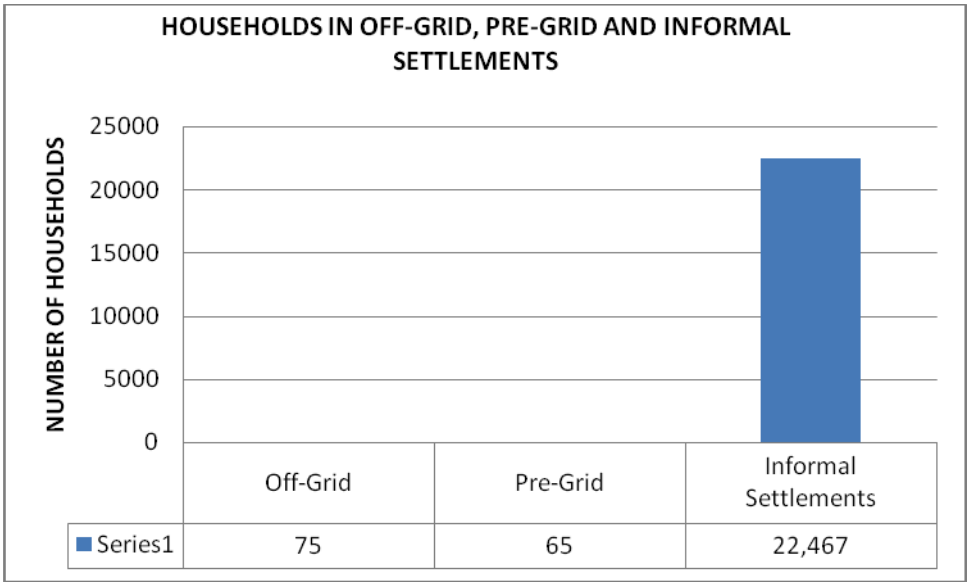
The aim of this chapter is to discuss the reaction of the GRN on the electric power situation in Namibia and focus more especially on the Khomas Region. The Government is concerned with the previously neglected areas as far as electricity is concerned. These areas include poor urban and rural households where the GRN proposed policies for widening access to electricity. This required a focus on rural electrification. As stated in the White Paper on Energy Policy (1998, p. v), "Government has embarked on the reform of the electricity sector and a study has been commissioned to look at possible rationalisation and restructuring, as well as competition and ownership changes. At the same time, an Electricity Act is being drafted which will put in place an electricity regulator to govern the industry".

Together with this, the GRN also considers the development of a downstream gas sector, renewable energy sector, and the hydel project cooperation with neighbouring countries as well as the SAPP. All the regulations regarding the above plans are accompanied by the necessary enactments.

4.2 *Plans to bring electricity service closer to the people*

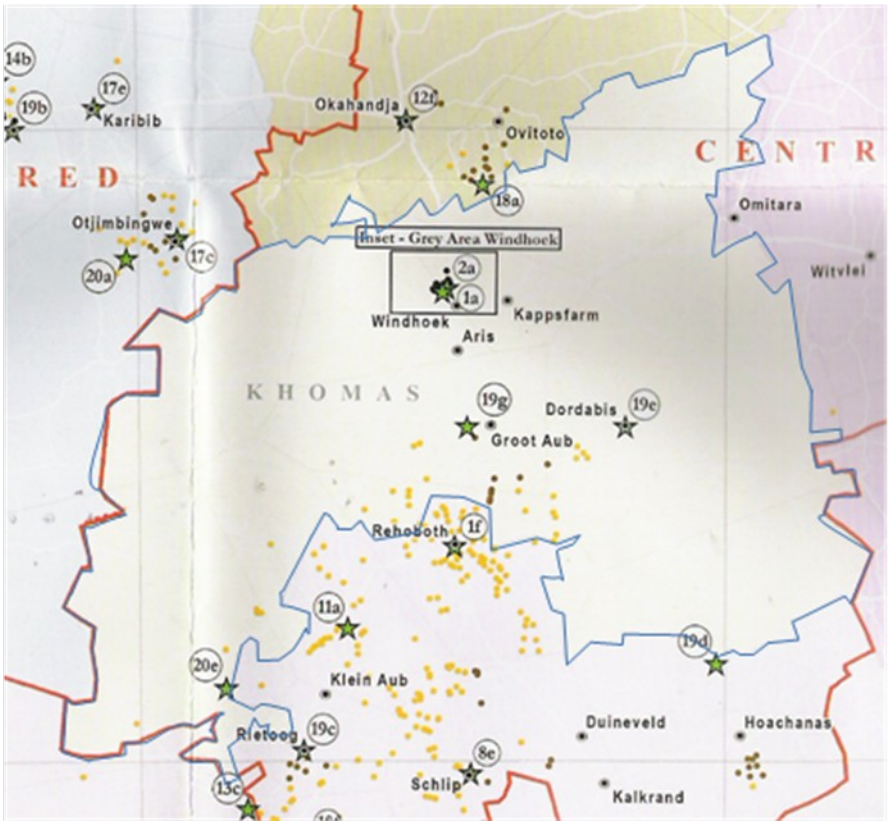
As it is with all the regions that are widely populated, the GRN embarked on an Off-Grid Energization Master Plan (OGEMP) to cater for those who are not covered by the national grid. The GRN thought it best to have energy shops established all over the country within a planning period of twenty years in order to have renewable electricity service available for those in rural areas as well as an urban cover. The appliances will also include energy saving appliances. There are a total of 5,858 unelectrified rural settlements in Namibia. Of these, only 1,543 are scheduled for electrification within the next 20 years (REEECAP, 2008, p. 3).

The Khomas Region will have two of the energy shops established within the first two years of the twenty year period. The remaining three energy shops are planned to be established in the last two years of the planning period. The Khomas Region will therefore have three energy shops established over a period of twenty years. According to the OGEMP, the Khomas Region has a total number of 22,607 households that correspond to the market areas for the energy shops. Given that only five energy shops will be established in the Khomas Region, the ratio would then be 4521 households to 1 energy shop (Ministry of Mines and Energy, 2007, p. 12). Informal settlements in the Khomas Region continue growing at a much higher rate than other off-grid and pre-grid areas. This situation demands an increased surge of available electricity services. The following table shows the ratio of households in energy short areas in the Khomas Region.



Graph 9: Number of Households in off-grid, pre-grid and informal settlements in the Khomas Region

A map depicting the location on energy shops in the Khomas Region is shown below (Ministry of Mines and Energy, 2007):



Map 3: Off-Grid Energization Master Plan for Khomas Region 2006

For Namibia, the general proximity of households to these planned Energy Shops is 99.6% within a radius of 10 kms, 99.5% within 20kms and 99.9% within the reach of 30kms (Ministry of Mines and Energy, 2007, p. 11). As can be seen from the map, little of rural Khomas is covered by the availability of energy shops. What really matters, is that the people in the far north east, far east, far south west and western areas in the Khomas Region are relatively far from any planned energy shops whether in or outside the Region. This is an area that the Regional Council should keep in mind when the rollout of the Off-Grid Master Plan takes place.

4.3 *Concept of Energy Independence.*

Unidirectional efforts to achieve energy security by any nation in today's energy intensive environment will result in crisis. The problem is further compounded when energy harnessing technologies are picked up off the shelf from the world market, because these may not be appropriate or optimal to exploit the local resources. This mismatch once occurred will take a long time to reverse. With this assumption, and if the resource analysis of Namibia to meet the demands is done, in the context of the available/likely to be available industrial base, the result would be far from flattering. In understanding the importance of industrialization to national security it is necessary to consider two aspects. The first is the capacity for the autonomous production of domestically produced hardware and food production. As Namibia discovered after independence, not all hardware and other produce which is conceived in Namibia is available 'off-the-shelf'.

However, acquiring prefabricated nuclear plants off-the-shelf from France is an option provided that funds are available. China is acquiring the same capability too and Namibia has the resources to fuel nuclear plants that could sustain the country for many years. The same applies to cleaner coal technology. Even though Namibia does not have economically viable coal deposits, the

plentiful availability of coal from South Africa and elsewhere implies that Namibia could consider long term use of coal fired power stations by making use of clean coal technology. It will benefit the country in various ways. “Enter substitute natural gas (SNG), the product of coal gasification, an established technology that has been around for a century and currently in use throughout the world. SNG facilities can now be made “carbon storage ready” to take advantage of emerging technologies in CO2 capture, leading the way to a virtually emission free use of coal” (Clemente, 2008) if Namibia want to decrease its environmental foot print as far as decreasing pollution is concerned.

Potentially essential items such auto mobiles, computers and new technological driven appliances are most of the time considered a need to be regarded as developed if produced indigenously. Without a significant industrial capacity, countries remain at the mercy of international discriminatory hardware sales policies and thereby potentially in an inferior position of reliability. The second aspect of industrialization that needs to be considered here is the outright commercial productivity of industrialized economies and the effect of any regional disparities in national security. The Chinese as an example, are flooding the Khomas Region with inferior commodities being traded within their consignments. Considering the above reasons, it once again becomes imperative that the Khomas Region being the hub of the industrial sector in Namibia requires the security of its energy resources, hence total independence on energy supply.

Forecasts of national energy requirements by 2030, when Namibia’s population may exceed the 3 million mark, there could be indications that demand from the energy sector will increase sharply. This assumes a rather high energy growth for the Khomas Region for instance. This study suggests that an integrated approach needs to adopted to evolve a model to optimally utilize the energy from those sources which are the country’s or the Region’s strength. Necessary technologies to achieve this objective should be developed, with a view to achieve sustained energy security in the long run and certain immediate measures be taken to avoid crisis in the interim. The following approach could be considered:

- Concentrate on four sources of energy, namely; Hydro, coal, nuclear, and renewable energy sources and set targets for the electricity generation from them. Adequate attention should also be given to wind and solar energy farms to draw sufficient power from them.
- The energy mix envisaged the use of hydro and coal on availability, solar power using high efficiency PV cells, uranium based nuclear reactors and bio fuel for transportation.
- Embark on a programme in solar energy systems and technologies for both large, centralized applications as well as small decentralized requirements concurrently, for applications in both rural and urban areas. The power generated through renewable energy technologies has to increase to 25 % against the current nearly 0%.
- A coordinated plan for achieving a calculated amount of bio-diesel production by 2010, which could be 5% of the present import of fuel, is proposed. Systems should be evolved to realize the production of 20% of the anticipated fuel consumption in 2030,
- Accelerated work in operationalizing the production of energy from the Baynes/Epupa Hydro Projects is to be done.
- Furthermore, in respect of foreign sources, an accelerated work in operationalizing the production of energy from the coal through the Hwange - Caprivi Link and energy from the Inga Hydro Project is to be secured and finally,
- Achieve a target for power generation by ensuring an efficient transmission and distribution system and minimize losses on account of poor efficiency of systems and material.

4.4 *Energy Security Plan for the Khomas Region*

Energy Security is a function of the inter play of a number of tangible, intangible and environmental factors like: resources, technology, finances, infrastructural development, politics, demands of the

economy, growing aspirations of consumers and many more. There is a need for a multiple solution in terms of time, technology and economics to address the obstacles that hinders sustained energy security. The OGEMP for instance is definitely a positive force towards an energy security plan in Namibia which has a direct effect on energy security in the Khomas Region.

4.5 *Planning Parameters*

Within the planning parameters, the following should be considered:

- Maximize the sustained availability of the energy, upgrade technology continuously for the most efficient & optimal utilization of the available resources and ensure to minimize or economize the consumption.
- An optimal energy mix needs to be time range specific ie; short term (up to 2015), medium term (up to 2025) and long term (beyond 2030). The following resources need to be considered:-
    - **Coal**. Even though it is available in abundance, it is of qualitatively poor quality. In spite of causing environmental pollution, it remains a major source of energy. There is a need for cleaner technologies.
    - **Hydroelectric Power**. Sufficient potential for further accretion of hydro electric power exists. Problem areas in using hydroelectric power are; a long gestation period, high costs of projects and environmental activism which affects the decision making of the government. Another issue is that the sources of hydro power are on the national borders of Namibia which need consent of neighbouring countries for its development. There is a need for a mechanism for quicker implementation of these projects, and fair, just and timely rehabilitation of the affected personnel.
    - **Nuclear, Renewable and Bio Energy**. Presently low capacities, a long gestation period, and the need for development of economic technologies. In case of

nuclear and wind energy, heavy capital investment is needed. Large scale utilization feasible only in a delayed time frame. However, looking at the snail pace of obtaining additional hydro power, one may say that renewable energies could have a low gestation period.

- **Frontier Technologies**. A number of new technologies are in various stages of technological development and though scientific feasibility exists but these can be introduced only once the appropriate technology gets fully developed-introduction can be thought of only in long term. Technological change will be gradual. The older one will be phased out once the new technology becomes fully functional and proves the old technology redundant. Some of these technologies include tidal wave technology, wind farming, bio-fuel and bio-gas.

Efforts to achieve energy security should be a national endeavour, consisting of technical, financial and diplomatic efforts. A feed-back loop will need to be added to the planning process to keep a watchful eye on the pros and cons of the decisions made on the specific direction the planners desire to take.

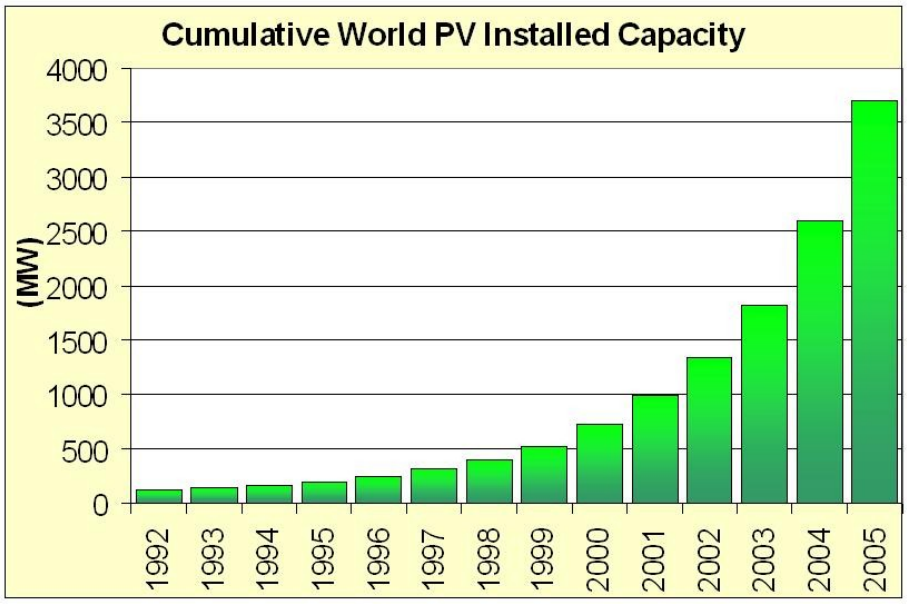
4.6 *The future of energy in the Khomas Region*

The level of dedication given by the MME to the environmentally sustainable development of the energy sector in Namibia cannot be overemphasized. As it is stipulated in the White Paper on Energy Policy (1998, p. 61) in that "the Ministry seeks to prioritise the policies contained in this White Paper and translate those priorities into strategies". These strategies are in the developmental stage and will take time to be realized. However, in the mean time the energy demand is rising and diversification of energy supply should enjoy the highest priority.

Taking into consideration the OGEMP's map of energy shop localities, it is clear that the Khomas Region will still have relatively large areas uncovered. Namibia will have secured energy supplies in the distant future but the present situation in the Khomas Region requires attention to be

given to the extension of rural electrification. The instability (regular fluctuations) in fuel prices does not guarantee peace of mind as far as cheap fuel is concerned but cast dark clouds over the future of petrol and diesel power. This requires the electric power grid to be extended to the areas not covered within the immediate planning phase.

Despite the high costs of renewable energy appliances, the future of energy security in the Khomas Region does not look dim at all. According to the Polytechnic of Namibia (2007, p. 35), "The market for photovoltaic cells is presently growing at over 30% per year, and the cost of panels is declining continuously in real terms, due to both new technologies and mass production". Therefore, a predilection of growing investment opportunities in renewable energy appliances is not an illusion but a promising path to future energy security. The figures in the graph below indicate that worldwide, the popularity of renewable energy is increasing at a fast rate.



Graph 10: World PV Installations up to 2005

Even though the Khomas Region does not have favourable conditions for wind energy in comparison with the coastal regions for instance; the focus should be on the investment in PV installations.

Namibia negotiated agreements with neighbouring countries to draw energy on a need basis from the SAPP. There are also separate negotiations with Zimbabwe and the DRC on power supply. If the Inga Projects are complete, the power situation in the Southern African region (SADC) will look promising. Other domestic projects like the Baynes Project with Angola is another source that will augment energy supply in the future. All these imply that energy will be secured in the distant future.

There are a number of feasible generation options (REEECAP, 2008, p. iv) for energy supply considered by Namibia. These are:

- Baynes Hydro-Electric Power Generation
- Coal-Fired Power Generation
- Natural Gas Power Generation
- Nuclear Power Generation
- Electricity Generation from Biomass
- Concentrating Solar Thermal Power Plants
- Solar Photovoltaic Power Plants
- Wind Energy Power Generation
- Integrated Solar Combined Cycle Plant

4.7 *Conclusion*

With the poor socio-economic state in which the inhabitants of the Khomas Region and especially the majority of the Namibians find themselves, it became difficult for the ordinary citizen to reach retail shops within reasonable distances. The idea of Energy Shops is excellent. Energy harnessing technologies are now more available than ever before but the poor economic situation of Namibia and especially the Khomas Region itself makes it difficult to harness these technologies in good time.

Despite the growing ambitions of the consumers, the demands of the economy and development of expertise stand in direct contrast to the attempts to secure energy in the Region.

There are no diverse energy mix resources to make use of in order to complement the short coming of the other. These are efforts that have to be harnessed with energy by the main players in the energy sector which are the MME and NAMPOWER.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 *Introduction*

The aim of this chapter is to consolidate the main ideas surrounding the energy situation in Namibia and especially the Khomas Region and to make some recommendations for improved energy security in the latter.

Namibia is one of the least developed countries in the world in terms of per capita energy consumption. It is primarily a rural and agro-based country augmented by mining. The majority of the population lives in the rural areas, some of which are very remotely located. These conditions have a direct impact on the development of the Khomas Region. A small percentage of the population enjoys the benefit of electricity in remote areas. The basic reason for slow growth of electricity is the distance and remoteness of many rural areas. It is uneconomic to extend the electricity distribution line to the hilly and rural isolated areas, where consumer density is very low. As such, renewable energy can greatly address the energy problem of remotely located rural people and contribute to sustainable development of the country.

5.2 *Conclusions*

With the current rate of electricity penetration in rural areas, it will take several decades to reach only the population covered by the grid. If we take the case of the remote areas, not covered by the grid, where the population is sparse but substantial, it may be assumed that electricity will not reach them well beyond the targets of Vision 2030. As such, two separate energy/electricity policies are required. One to meet the traditional growth of demand, and the other to deal with the basic needs of energy and electricity for the rural population. Electricity needs of the rural households are low and can be met by renewable energy resources without extending the transmission and distribution lines.

There are many resources of renewable energy. Out of these, solar, wind, biomass and biogas have good prospects in the Khomas Region. The Khomas Region is an ideal location for solar energy utilization. Daily average solar radiation varies from 5.4 to 6.2 KWh per square meter per day (Electricity Supply and Management Options for Namibia, 2008, p. 194). The global capacity of SPV has been increasing; at the same time the price of PV module is decreasing day-by-day. As such, there is a bright prospect for applications of solar thermal and photovoltaic systems in the country. Different organizations like the MME and projects like REEECAP and NAMREP have facilitated the installation of many PV systems all over the country for home lighting, pumping, and rural market electrification. Rural people are benefiting from such solar electrification systems.

Another potential renewable energy in the Khomas Region is wind energy. Wind speeds in the mountain sites are not so high which shows little promise for adequate electricity generation. The only difficulty is that most parts of the Region one covered by commercial farms which imply that the potential wind farms might fall into private owned areas. Again, only micro wind turbines are feasible in the Region.

Hydro power is one of the renewable energy resources, but its potential in the Khomas Region is limited due to inadequate or no water flow. Biomass as a renewable energy contributes

mostly to the total energy needs of Khomas rural as well as informal settlements. Utilization of biomass fuel is largely inefficient and wasteful due to the use of inefficient open-type stoves/fireplaces. The efficiency of these stoves/fireplaces is low and depends on how effectively households use it. Apart from low efficiency, these stoves/fireplaces emit smoke, which affect the health of the users and make the kitchen dirty. Introduction of biomass briquetting and the tsotso stoves, has attempted to address this problem which is suitable for domestic cooking. These devices can save on fuel as compared with the traditional ones. Biomass briquetting is a new technology in the Khomas Region. Further work and research are needed.

Biogas is another potential renewable energy resource in the Khomas Region. Its technology is not yet introduced in the Region hence an absence of policy in this regard. Various raw materials can be used to construct the biogas plant. An agriculture based region like Khomas has huge potential for utilizing biogas technologies. Enough biogas can be obtained from the livestock in the Region which could be comparable to certain amounts of kerosene in use today. Apart from this, it is also possible to get biogas from human excreta, poultry droppings, and industrial and household waste. If each family in the Region can be associated with a biogas plant, then only human excreta will give substantial quantities of biogas.

Biogas residue can be used as improved organic fertilizer, for mushroom cultivation, aquaculture, poultry and fish foods, among others. It is a proven technology; there is no risk of failure if proper design and supervision can be ensured. The Khomas Region through the Government of Namibia could render subsidies for family size biogas digesters, which can be used for cooking and lighting. Large-scale bio energy development in the Khomas Region could bring significant environmental benefits. REEEI/MME could consider the realization of biogas digesters in the Khomas Region.

Remote communities of the Khomas Region are suitable for renewable energy application. A concept of mini energy generating mechanisms can be introduced in the above mentioned areas for setting up micro-utilities in rural markets with the help of renewable energy as well as SHS in

individual households. After being implemented, these mechanisms could reduce pressure on the national grid, i.e. on the more essential sector during the peak-hours. Huge losses caused by load shedding in the industrial and other sectors will also be reduced. Thus the adoption of these decentralized sources of energy can significantly reduce the financial requirements of the power sector of the Region.

If RETs can be selectively applied to various rural applications, it could achieve success in generating income, improving health, educational quality and labour productivity. By utilizing renewable energy, the overall improvement of the Khomas Region can be achieved in the fields of foreign exchange savings, community development, and employment generation/empowerment of women, economic growth, environmental development, and cultural practices. Not only will development take place but secured energy will be provided through the use of renewable energy.

5.3 *Recommendations*

Based on the previous analysis, the following principal recommendations are made:

- Government should adopt a separate policy, plan and constitute a separate budget for electrification of remote areas and encourage local bodies or the private sector to participate in its formulation and implementation.

- In addition to the present efforts of REEEI, MME, and NAMREP, the Khomas Regional Council should provide direct and indirect subsidy, both to entrepreneurs and consumers.

- The Khomas Regional Council also needs a policy on renewable energies.

- A dedicated team, preferably from the Honourable Prime Minister's Office may be created to plan, promote, coordinate, monitor and fund of RET activities in conjunction with the MME.

Other recommendations include:

- **Energy Mix**. Careful consideration should be given to the appropriate energy mix. The use of coal, hydropower, nuclear and other non conventional sources of energy be vigorously encouraged and the use of bio fuels should only be restricted to sectors like transport etc. The energy mix, which is a function of availability, should be reviewed from time to time with a view to introduce new technologies on becoming commercial. For the present the following mix is recommended:-

    - Short Term (up to 2015) – Hydro, coal, gas, and solar energy in the form and quantity available and the accretion that occurs during the interim. Efforts to be made to embark on cleaner coal technology to meet the requirements of the future generation.

    - Medium Term (up to 2025) – Technologies recommended to be introduced are- Bio fuels (*jatropha* and to a lesser efficiency due to meagre resource availability - ethanol based), clean coal technologies, coal gasification, combined cycle gasification, gas hydrates, nuclear energy percentage of renewable energy be enhanced. However present technologies should be continued wherever technically and economically feasible.

- Long Term (beyond 2030) – Technologies, which can be introduced at that point in time, subject to their becoming commercial are; nuclear energy thermonuclear energy, renewable energy with enhanced span, sea wave and tidal energy and any other source that may come up by that time.

- **Energy Mapping of the Khomas Region**. A data base be generated, in terms of availability of energy-type and quantity, location , demand and time.

- **Research and Development**. Following areas need immediate attention:-

  - Development of Technologies. Efforts be expedited to develop necessary technology at affordable cost for exploration of the deep sea mining of gas hydrates, tapping of geothermal, ocean thermal, sea wave and tidal energy.

  - Design of Components. Investigation on the adaptability of engines for generation purposes for using bio fuel in order to make an early estimate on the effectiveness of such projects.

  - Advanced Research. A concerted bid be made to complete the research on Hydrogen as a fuel/ fuel cells to drive power generators etc.

  - Frontier technologies like ocean energy should be brought to a logical conclusion at the earliest.

- Efficiency of the Systems. Improvement in the efficiency of the PV systems (introduction of based PV cells), better materials for the manufacture of the efficient and effective components be progressed on priority to make renewable energy local commercially viable. Efficiency in generation, transformation and use of electrics is required.

- **Upgradation of Technology.** Introduction of high efficiency technologies for energy conversion, transmission and distribution can lead to a reduction in the energy intensity of the economy. Furthermore, to improve efficiency, beneficiation of cleaner coal technology for power generation and coal gasification will help, besides ensuring better environment and improved competitiveness of indigenous coal.

More efficient transmission lines. There is a possibility to transmit power from far distances like the DRC through High Voltage direct current systems. There is a need to evolve an economical and efficient system to achieve that.

As far as bio fuels is concerned, a comprehensive policy initiative should be launched to examine the techno economic viability of large scale production of jatropha as a feedstock, for it to become a supplement to diesel. Jatropha is a plant that can withstand harsh conditions and growths in waste lands or even in saline ground. This makes the Namibian soil ideal to plant jatropha as a potential bio fuel and the residue to be used to fire thermal power stations therefore providing a continuous fuel source. As indicated by the Wikipedia Free Encyclopedia (Jatropha, 2008) that "When jatropha seeds are crushed, the resulting jatropha oil can be processed to produce a high-quality biodiesel that can be used in a standard diesel car, while the residue can also be processed into biomass to power electricity plants" Private investment should be institutionalised to take this option forward.

- **Conservation and Efficiency Enhancement.** The following enhancement measures could be taken:

    - Power System Loss Reduction. Immediate action should be taken to reduce any loss to a recommendable level by close monitoring of the losses, improving efficiency, and increasing the power factor through modern technology. By this one action alone, good savings of high amounts of Namibian Dollars could be achieved.

    - Fuel Efficiency. Continuous efforts should be made to improve the fuel efficiency of power generators in the Region.

    - Bench Marking the Systems to International Norms. Efforts should be made to benchmark the efficiency parameters of the energy sub-sectors with the International Standards. This will enable any end user to operate implements with acceptable results and safety hence the immense savings that such systems hold.

    - Rehabilitation and resuscitation of the existing hydroelectric and coal sectors should be expedited to enhance the production of energy.

- **Economic Issues. The following economic issues could be considered:**

- Enhancing the joint ventures with other regions or in the case of Namibia, with other countries to trade in bio fuel resource material such as sugarcane as one of the components to derive ethanol from should be taken up as a matter of policy. Besides, developing strong linkages, it will also be good for the development of the local industry with attended benefits for the locals. Some progress can be made in this regard, ie; a fertilizer plant in the Khomas Region.

- System of Subsidy. Subsidy in the power sector may be introduced only for those communities as well as those who are in remote areas that find it difficult to connect to the electricity grid that was built as part of the rural electrification programme. Second consideration could be given to the commercial farms which are part of the economic hub of the Khomas Region.

- Economic Pricing. Proper economic pricing of alternative energy sources will influence energy consumption, which will lead to energy efficiency.

- **Strategic Steps. The following strategic steps could be considered:**

  - Encourage Public- Private Partnership for exploration, refining and distribution in the Khomas Region and the rest of the country bi fuel products that could be made.

- Strategic Reserve. Additional research should be done to determine the Khomas Region's or the national energy needs in the long term in order to settle on a strategic reserve of say 30-40-days. The storage of so much fuel to cater for a possible black out due to sabotage or any disaster could be estimated and establishment of such facilities be effected.

- Maritime Protection. Namibia needs to invest in its maritime protection capabilities. This does not only affect the protection of the off shore Kudu gas facilities but will also augment the other marine assets and the sea lanes of communications in the Atlantic Ocean region against sabotage and the terrorist threat.

- **Infrastructural Development. The following measures for instructural development could be considered:**

  - Development of National Grid. Expedite its completion to facilitate transfer of power within and across the Region with reliability, security and economy, on sound commercial principles. When ready it would enhance cumulative inter-regional power transfer capacity since some parts of the Khomas Region is already supplied from other regions.

- Energy infusion in other sectors specially rural be expedited to improve their efficiency.

- **Management and Organisational Related Issues. The following management and organizational related issues could be considered:**

  - Demand and Supply Management. Appropriate demand/supply side management strategies to minimise any gap that might have evolved. To enhance supply, accretion in indigenous production, development of renewable sources of energy and diversification of import sources should be resorted to.

  - Systems' Approach. This approach should be adopted to achieve synergy in planning, execution and feed back of Demand/Supply management, conservation, improvement in efficiency of the technology utilized/the equipment used.

  - Regulatory Authority. An apex regulatory authority for the gas, hydro, coal and environment sector should be formed to monitor the overall growth of energy production (up and down stream), its optimum utilization, reduction/economy in consumption, standardizing equipment and environment protection in a coordinated manner.

- **Strategies Specific to SAPP to Ensure Energy Security.** Having identified the SADC region as the main source of **e**nergy for Namibia, there is a need to

formulate a specific strategy to deal with the issue in totality. Some of the additional suggested measures are as follows:-

- Dependence versus Interdependence. Excellent relations exist with the SADC countries. Most of the reasons for this multilateral cooperation is about trade. The bilateral trade between Namibia and other SADC countries has been rising steadily over the years. For Namibia being a net importer, the dependence from others is as great as the security Namibia could offer to the Organization. This situation makes Namibia quite vulnerable to disruption at the will of the supplier countries. Point to take note of, at this stage, is that these presently energy generating economies are also growing and would like to diversify to make them broad based. This can be seen from the fact that the Inga III is put secondary to the Grand Inga Project, leaving Namibia's bid on energy pending. The Khomas Region should learn from this by using a strategy to convert her dependence into interdependence by making use of more indigenous method to energy self sustenance. Care should be taken not to shift own capacity to develop the energy base by accepting the much easier offers from economic giant of signing in to binding contracts for aid to develop the energy base.

- Long Term Contracts versus Short Term Contracts. Hydel and coal supply contracts should be long term. Such contracts would be mutually beneficial because while they will give Namibia reasonable degree of assurance of continued supply, they will also look after the long term business interests of the supplying countries.

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ANNEX 1

QUESTIONNAIRE

RESEARCH THESIS: ENERGY SECURITY IN THE KHOMAS REGION

Student/Interviewer: **John Robinson.**

Institution: **University of Namibia (Faculty of Economics and Management Science).**

Purpose: **Masters Degree in Security and Strategic Studies.**

Study year: **2008.**

***Notice**: This questionnaire is meant for survey research purposes only. Kindly answer the questionnaire as honest as possible and to the best of your knowledge. You may tick an appropriate box for your preferred answer or write a short answer in a space where such provision is made. If you feel uncomfortable with a question, you may simply skip the answer.*

1. Marital status:

Married ☐

Single ☐

2. Gender:
   Male ☐

   Female ☐

3. Do you think that the Khomas Region will be able to provide secured energy to its citizens for the next five years?
   Yes ☐

   No. ☐

4. Do you think that Namibia has enough energy resources to provide sustained energy for the next five years to the Khomas Region?
   Yes ☐

   No ☐

5. Do you think that the Khomas Region is financially in a position to maintain energy security for the next five years?
   Yes ☐

   No ☐

6. Do you think that the Khomas Region has the ability to use unconventional means like wind energy, solar energy and biogas to generate electricity?
   Yes ☐

   No ☐

7. I learnt that NAMPOWER supports the current propagation on energy saving. Is it a control measure to ensure that energy should be used more sparingly?
   Yes ☐

   No ☐

8. South Africa has difficulties in supplying electricity to its citizens. Does this have a negative impact on the Khomas Region?
   Yes ☐

   No ☐

9. In what way does unreliable electricity supply from NAMPOWER affects the Khomas Region?
   Negatively ☐

   No effect. ☐

10. Is the idea of building an additional hydro station at Epupa or Baynes viable?
   Yes ☐

   ☐
   No

11. What would you say – how long will it take the Khomas Region to produce energy from biomass?

☐	☐	☐	☐	☐
10 Years	15 Years	20 Years	25 Years	30 Years

12. Are you in favour of nuclear energy in the Khomas Region?
   Yes ☐

   No ☐

13. If yes, why would you prefer nuclear energy?

_____

_____

_____

14. Are you aware that nuclear reactors produce hazardous waste that will have a negative effect on our health as well as the environment?
   Yes ☐

   ☐
   No

15. Are you in favour of using coal fuelled energy generators?
   Yes ☐

   ☐
   No

   If NO, why would you not prefer coal fuelled energy generators?

16. Do you think that renewable energy has a future in the Khomas Region?

Yes ☐

No ☐

If NO, what would you say could be the reason?

ANNEX 2

QUESTIONNAIRE FOR INTERVIEWS

Student/Interviewer	**John Robinson**
Institution	**University of Namibia (Faculty of Economics and Management Science)**
Purpose	**Masters Degree in Security and Strategic Studies**
Study year	**2008**
Name of interviewee	Male / female
Organization (interviewee)	

***Notice**: This questionnaire is meant for survey research purposes only. Kindly answer the questions as honest as possible and to the best of your knowledge. You may be asked an inappropriate question which may not be relevant to what you do. If so, kindly inform the examiner accordingly or answer in a way it may be to the best of your convenience. If you feel uncomfortable with a question, you may simply skip the answer.*

1. Are you married?

2. Where are you residing?

3. What company are you working for?

4. What is your position title and description?

5. How long do you work in this position?

6. Are you aware of any policies existing that deal with the energy provision in the Khomas Region?

7. Do those policies facilitate energy security in the Khomas Region?

8. Do you know of any events that lead to the current energy state of affairs? I so, can you name some that you might remember?

9. Are you aware of any counter measures that were taken to resolve the short supply of energy?

10. What do you think are the effects of those measures?

11. Are there any alternatives considered to counter the shortage of energy in the Khomas Region. If there are, could you name them?

12. What are the most preferred ideas that are considered for a solution to the situation?

13. What would you say is the biggest accomplishment/ failure of NAMPOWER?

14. What do you think will be the most prominent difficulties NAMPOWER will experience in the near future?

15. What in your opinion would you say will the energy situation in Namibia/Khomas Region look like in the near future?