NAMIBIA’S ELECTRICITY SECTOR

- A PRIMER

November 2012

Dr Detlof von Oertzen
PO Box 8168
Swakopmund, Namibia
Tel: +264 64 402 966
Mob: +264 81 314 9664
Fax: +264 88 624 989
Email: info@voconsulting.net
DISCLAIMER

The Consultants have endeavoured to ensure that all data and information used in this Report and the associated numerical models is correct and up to date. However, because of factors beyond the control of the Consultants, a number of assumptions had to be made in the compilation of this Report and the underlying models, and these assumptions have an impact on the reliability of the Report’s findings, results, the models and the Report’s conclusions.

The findings, recommendations, conclusions or interpretations arising from this Report rely on the information and data used, as well as the implicit and explicit assumptions made when drafting the Report, and the interpretation of such information and data as is implicitly or explicitly used in the numerical models.

Neither the Consultants nor any employee assume any responsibility in any way whatsoever to any entity, organisation and/or person(s) in respect of the information set out in this Report and the associated models, including any omissions and/or errors therein, arising through misinterpretation, negligence, or however otherwise caused.
1 Namibia’s Electricity Sector – A Primer

1.1 Introduction

Namibia’s electricity sector faces major challenges. Security of supplies, both nationally and regionally, are not guaranteed, demand is outstripping supplies faster than replacements can be brought on line, and strategic planning has failed to deliver tangible results. This concerns all Namibians.

This study focuses on aspects relevant to the country’s electricity sector only, even though electrical energy constitutes less than one-third of Namibia’s total annual energy consumption [3.1]. This does not imply that the electricity sector is considered more important than the liquid fuels sector. Rather, the structured development and rational management of both the liquid fuels and electricity sectors are equally important if vigorous development is to take place in Namibia.

The supply of electricity to Namibia’s consumers is increasingly under pressure. The country’s demand for electrical energy is outstripping the available supplies. In the past years, Namibia has substantially relied on importing electricity shortfalls from its neighbours. However, regional electricity supply capacities have become substantially constrained. Without adequate electrical energy, local and regional development ambitions cannot be realised.

NamPower, as Namibia’s monopoly electricity provider, faces particularly challenging times to ensure that the country’s lights remain on. Recent investments, such as the new Anixas power station in Walvis Bay (shown on the left) and the addition of a fourth turbine at Ruacana have been preceded by more than 3 decades of non-investment in local generation capacity. In a country with moderate economic growth, the delay of much-needed investments in generation capacity was known to lead to supply bottlenecks. Yet,
regional capacities were often sufficient to bridge short-term gaps, and low electricity prices from fully depreciated generation assets made new investments unattractive. South Africa’s erstwhile overcapacity may have helped prolong the belief that transmission systems alone would keep on powering the nation. Namibia’s almost unlimited reliance on South African electricity supplies had to come to an end eventually. Today it has.

Electricity prices have escalated significantly in the past years, and are expected to rise further for at least another few years, most likely at double-digit growth rates every year. This will continue to place pressure on consumers, especially those that are already struggling to make ends meet. Rapidly rising electricity prices will also negatively affect those that use electrical energy for productive purposes, and with it, exert a largely negative influence in the commercial, mining, industrial and manufacturing sectors.

However, the following developments and factors can be turned into definite socio-economic growth opportunities: Namibia’s electricity supply limitations and looming inability to meet the growing demand for electricity, the country’s envisaged industrialisation policy, Namibia’s to-be-revised energy policy, various green economy initiatives, and last but not least, the growing number of consumers and investors that recognise the increasing value of investments in RE and EE technologies. Individually, the above factors constitute a force that can create development opportunities that benefit from investments in Namibia’s substantial renewable energy resources. Cumulatively, these factors beckon to be used more deliberately to create societal benefits and sustainable growth, while at the same time, addressing and resolving the country’s energy security crisis. These are immense development opportunities.

This study aims to show that increasing electricity tariffs and the local and regional supply constraints offer significant opportunities, particularly for renewable energy and energy efficient technologies. Those who seize these opportunities, including suppliers and installers of RE and EE, investors, homeowners, electrical utilities, Independent Power Producers and institutions willing to provide funding for RE and EE investments, stand to benefit from revenue streams that were previously largely inaccessible. This is an exciting time for Namibia’s electricity sector, even if the current constraints seem daunting.
1.2 Units for Electrical Energy and Electrical Energy Generation Capacity

This section briefly explains some of the most common units and abbreviations used to express how much electrical energy is generated at power plants, and the units used to quantify the capacity of power plants.

<table>
<thead>
<tr>
<th>Unit</th>
<th>In words</th>
<th>In relation to other units</th>
<th>Illustrative example</th>
</tr>
</thead>
<tbody>
<tr>
<td>kWh</td>
<td>kilowatt-hour [kWh]</td>
<td>a basic unit of energy</td>
<td>It takes 1 kWh of electrical energy to heat 30 litres (roughly the amount of water required to take one shower) of water from 20°C to 48°C.</td>
</tr>
<tr>
<td>MWh</td>
<td>megawatt-hour [MWh]</td>
<td>1 MWh = 1,000 kWh</td>
<td>A household that uses 400 kWh of electrical energy per month will consume 12 x 400 kWh = 4,800 kWh or 4.8 MWh of electrical energy per year.</td>
</tr>
<tr>
<td>GWh</td>
<td>gigawatt-hour [GWh]</td>
<td>1 GWh = 1,000 MWh = 1,000,000 kWh</td>
<td>Windhoek consumed more than 784,000 MWh or 784 GWh of electrical energy in the financial year 2010/2011, refer to Table 5.</td>
</tr>
<tr>
<td>TWh</td>
<td>terawatt-hour [TWh]</td>
<td>1 TWh = 1,000 GWh = 1,000,000 MWh = 1,000,000,000 kWh</td>
<td>NamPower sold 3.543 TWh of electrical energy in the financial year 2010/2011 [3.5].</td>
</tr>
</tbody>
</table>

Table 1: Typical units to express the quantity of electrical energy demanded or supplied

<table>
<thead>
<tr>
<th>Unit</th>
<th>In words</th>
<th>In relation to other units</th>
<th>Illustrative example</th>
</tr>
</thead>
<tbody>
<tr>
<td>kW</td>
<td>kilowatt [kW]</td>
<td>1 kW = 1,000 Watt</td>
<td>The electrical generation capacity of small mobile petrol-powered generators typically ranges between 3 kW and 30 kW. Under ideal operating conditions, such power plants can generate 3 kWh and 30 kWh of electrical energy per hour, respectively.</td>
</tr>
<tr>
<td>MW</td>
<td>megawatt [MW]</td>
<td>1 MW = 1,000 kW</td>
<td>In 2012, Namibia’s Ruacana hydro-power station has an installed electrical energy generation capacity of 332 MW. The Anixas power station at Walvis Bay has an installed capacity of 22.5 MW.</td>
</tr>
</tbody>
</table>

Table 2: Typical units to express the capacity of power plants generating electrical energy
1.3 Namibia’s Electricity Sector in a Nutshell

Figure 1 illustrates the four main functions – i.e. generation, transmission, distribution and supply – on which the Namibian electricity industry is built.

![Figure 1: The four main functions of Namibia’s electricity industry](Image)

In Namibia, the electrical energy that is fed into the transmission grid is generated at four local power plants, in addition to the electrical energy imported from our neighbours:

**Ruacana** is a hydro-electric power station on the Kunene River, and has a generation capacity of 332 MW. It is a run-of-river power station, meaning that its ability to generate electricity remains dependent on continuous water flows from Angola. In the absence of sufficient water flow, Ruacana cannot generate and feed electrical energy into Namibia’s national electricity grid.

The coal-fired **van Eck** power station just north of Windhoek has a nameplate capacity of 120 MW. It was commissioned in 1972. Today it is expensive to operate, and due to ageing, it is no longer able to produce
electricity at rated capacity. Van Eck is only used to bridge short-term supply gaps, and is likely to be refurbished to gain a few more years of use before being retired.

**Paratus** power station in Walvis Bay uses heavy fuel-oil, and has an electrical generation capacity of 24 MW. Similar to the van Eck power station, Paratus is mainly used to match short-term demand peaks, and due to ageing, is no longer able to produce at full capacity.

**Anixas** is a heavy fuel-oil power plant located in Walvis Bay. NamPower commenced with operations of the plant on 21 July 2011. Anixas has an installed capacity of 22.5 MW. The power station is mostly used to ensure that short-term peak demand can be adequately met, and will remain an emergency standby electrical power plant for the foreseeable future.

In addition to the local power generation capacity, electricity is imported from South Africa, Zimbabwe, Mozambique, Zambia and other regional countries, and enters Namibia by way of a network of high-voltage transmission lines. Assuming that our neighbouring suppliers have sufficient capacity, the electrical interconnecting power lines to cross-border power stations have a south-north transmission capacity of some 600 MW. In addition, the Caprivi interconnector that links the Namibian transmission system with Zambia and Zimbabwe has a capacity of 300 MW. It allows NamPower to more readily trade electricity with our northern neighbours, and makes Namibia less dependent on imports from and wheeled through South Africa. As a risk mitigation measure, the Caprivi link reduces Namibia’s exposure and dependence on the South African transmission grid, as well as its current constraints.

In Namibia, the generation and transmission of electrical energy are NamPower’s exclusive responsibility. As the country’s ‘single buyer’, NamPower is also responsible for importing electrical energy as needed; NamPower also exports electricity to Botswana and Angola. In addition, NamPower is the overall electricity ‘system operator’, i.e. the entity that ensures that the prevailing
demand for electrical energy is met by sufficient supplies. The system operator ensures the stability of the Namibian electricity networks. This requires the careful balancing of all sources feeding into the national grid and matching them to those off-takers that take supply from the grid.

Namibia’s transmission grid is connected to various distribution stations, where high-voltage electricity is transformed to medium voltages. A substantial distribution network criss-crosses the country, operated by Namibia’s three regional electricity distributors, as well as NamPower, some local authorities and regional councils. These distribution entities are licensed operators, and responsible for the supply of commercial, industrial, institutional and domestic consumers in their areas of responsibility.

Electricity users pay for the supply of electricity, as well as for a portion of the electricity infrastructure required to provide such services. By the time that an individual user flicks on a switch to light her house, electricity has not only been generated, but has been transmitted, often over hundreds or even thousands of kilometres, has been transformed from high to low voltage, has been distributed, and has been supplied. Every one of these distinct electricity sector value chain elements is costly, and is only reliable, accessible and affordable if each link in the complete supply chain operates effectively. This is by no means trivial, and begins to explain why electrical energy has the price we are paying for it. Table 3 summarises the main responsibilities of some of the main electricity sector actors in Namibia.

<table>
<thead>
<tr>
<th></th>
<th>NamPower</th>
<th>Regional Electricity Distributors, or local authorities, or regional councils, or NamPower, or third-party supply entities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Generation</strong></td>
<td>Electricity is generated, e.g. in a hydro-electric power station such as Ruacana, or the coal-fired Van Eck power station outside Windhoek, or Paratus and Anixas in Walvis Bay.</td>
<td>In future, new power stations using renewable energy sources, such as solar, wind and biomass are likely to come into operation in Namibia.</td>
</tr>
<tr>
<td><strong>Transmission</strong></td>
<td>Electricity is fed into the national transmission grid and transported from the place of generation to the places where it is used.</td>
<td>Transmission takes place at high voltage to minimise losses.</td>
</tr>
<tr>
<td><strong>Distribution</strong></td>
<td>Closer to the places where electrical energy is consumed, electricity is transformed to low voltages, and distributed to commercial, industrial, institutional and domestic end-users.</td>
<td></td>
</tr>
<tr>
<td><strong>Supply</strong></td>
<td>End-users are connected to the electrical distribution network. They take delivery of electrical energy, which is supplied and sold by a distribution entity, such as CENORED, Erongo RED or NORED, or a local authority or regional council or their agents, or in some cases, NamPower.</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Key responsibilities of some of the main electricity sector actors
1.4 Roles and Responsibilities in Namibia’s Electricity Sector

The following entities – as shown in Figure 2 – have responsibilities in and for Namibia’s electricity sector:

- **Cabinet** has approved Namibia’s White Paper on Energy Policy of 1998;

- **Parliament** formalises relevant policies with appropriate legislation, amongst others the Electricity Act of 2007;

- **Ministry of Mines and Energy (MME)** is the custodian of Namibia’s energy sector, including the electricity sector, and principal energy policy initiator and implementer. The MME is responsible for overseeing and administering Namibia’s electricity sector, in accordance with applicable policies and laws. Specifically, the authority to grant electricity licences, including their issue, transfer and renewal, rests with the Minister of Mines and Energy, who exercises such authority on recommendation of the Electricity Control Board.

- **Electricity Control Board (ECB)** is Namibia’s statutory electricity sector regulator, and oversees the licensing, standard of service and supply of all electricity industry participants, and regulates the country’s electricity tariffs;

- **Ministry of Regional and Local Government and Housing and Rural Development (MRLGHRD)** oversees Namibia’s local authorities and regional councils. The Minister of MRLGHRD retains residual powers in regard to the electricity supply by local authorities and regional councils, and the ministry has a responsibility relating to the ongoing sustainability of these entities.

- **NamPower** is Namibia’s state-owned electricity generation and transmission entity, and is also responsible for all electricity trading into and across the borders, and acts as the country’s electricity system operator. NamPower is a shareholder of all Regional Electricity Distributors (REDS), and remains responsible for some residual electricity distribution activities in the country. As the single buyer, NamPower is solely responsible to source electricity outside Namibia and sell it in the country.

- **Regional Electricity Distributors (REDS) and other electricity distribution entities** are responsible for the supply and distribution of electricity in accordance with the provisions of the Electricity Act and residual regulations under the Local Authorities and Regional Councils Acts. Three REDS are operational at present, i.e. NORED, CENORED and Erongo RED. Other electricity distribution entities include some local authorities, e.g. the City of Windhoek and others, and regional councils and their agents, as well as select private entities, and in some cases, NamPower.
• **Electricity consumers** are end-users of electrical energy, and include local and regional authorities, institutional users, commercial and industrial users, and domestic users of electricity.

![Diagram](image-url)
The roles and responsibilities of the various electricity sector actors are supported and set out in the relevant legislation. On a national as well as local policy level however, the electricity sector is often plagued by confusion in regards to the duties and responsibilities of the different electricity sector entities. Examples of the ongoing uncertainties in the sector include the structural impediments faced by the sector as a whole, the multitude of challenges faced by the REDs, the long-overdue reform of the sector, the ongoing debacle over the local authority surcharge, and the lack of adequate local authority funding.

Who is obviously missing from the above list of local electricity sector actors? For one, it is noted that there are no Independent Power Producers (IPP) in Namibia. These are entities that, in addition to NamPower, generate electricity. Although Namibia’s White Paper on Energy Policy of 1998 is clear about the need to create a conducive investment climate in Namibia’s energy sector, there are still no IPPs doing business locally. This is an indicator that structural and institutional impediments continue to constrain the country’s electricity sector.

While a number of conditional electricity generation licenses have been issued by the Electricity Control Board, and a high-level IPP framework is in place, unresolved issues and barriers remain, and hinder the entry of additional power supply entities into the country. Of concern to would-be IPPs is the independence of the single buyer, and the inherent conflict of interest between NamPower as the single buyer on the one hand and NamPower as the country’s monopoly electricity generation entity on the other. For future IPPs, these considerations imply that power purchase agreements, as well as all aspects related to the access and use of the country’s transmission grid, and the trading of electricity all take place under NamPower’s direct control, and have to be negotiated before new electricity supply businesses can commence. Other IPP concerns, including the possible change of law and regulatory risks are also making entry into the market difficult.

Namibia’s system operator is also the country’s single buyer, and at the same time, holds the national electricity generation and transmission monopoly. This combination of tasks endows NamPower with enormous responsibilities, and influence. At the same time, Namibia’s electricity industry is structurally impeded by this constellation. Sector-wide leverage and bargaining powers should not be monopolised. Presently they are. Policy has to address this systemic weakness, or it will continue to burden the entry of new actors and supply sector participants, to the detriment of all electricity consumers in the country.

With the roles and responsibilities described we now ask how much electrical energy is actually required in Namibia. This will be covered in the next section.
1.5 Current and Future Demand for Electricity in Namibia

The total demand for electrical energy is determined by how much electricity all end-using consumers require at any point in time. Electricity users include large power users such as mines, end-users such as government ministries, commercial and industrial users, domestic users, farmers and rural dwellers connected to the country’s electricity grid.

The different electricity users – through their collective consumption of electrical energy – determine the total national electricity demand. Demand for electrical energy has steadily increased over the years. As Namibia’s economy grows, and the country’s development takes place, the demand for electrical energy will continue to grow, both in terms of the total electrical energy required, as well as the peak electricity demand. Using demand or load forecasting methods, the electrical energy that is likely to be required in future can be projected. This is regularly done by NamPower, and has also recently been undertaken as part of the development of Namibia’s Integrated Resource Plan [3.9].

For each calendar year in the period 1990 to 2010, Figure 3 shows the following:

a. blue bars depict the units of electrical energy provided by NamPower, in TWh, where one TWh is one billion kWh;

b. red bars depict the units actually sold by NamPower, in TWh; and

c. the black line depicts the units of electricity sold in Namibia, in TWh.

Several interesting features are evident from Figure 3:

a. the units of electricity provided by NamPower (blue bars) are always greater than those actually sold by NamPower (red bars). This is due to the losses in the electrical grid. Given Namibia’s very extensive transmission system
network, line losses cannot be avoided, and are of the order of 10% of the total energy supplied.

b. The units of electricity sold in Namibia (black line), especially from 2002 onwards, are substantially less than the units sold by NamPower. This is the result of electricity sales to Skorpion Zinc Mine, Orange River Projects, cross-border clients and line losses. Sales to the Skorpion Mine are usually separately dealt with because the mine’s power supply is arranged through a back-to-back power purchase agreement with Eskom, and not covered by NamPower’s usual power sourcing arrangements, as is the case for other electricity consumers in Namibia.

Units of electrical energy sold in Namibia between 1990 and 2010 grew by an average of 3.0% per year, while the system maximum demand (excluding the Skorpion Mine) grew by an average of 4.1% per year between 1999 and 2012 [3.10]. In contrast, in the period 1990 to 2010, Namibia’s gross domestic product (GDP) grew at an average of 4.1% per year, while Namibia’s population grew by an average of almost 2.1% per year [3.11].

In order to project the expected demand for electrical energy for the period between 2011 and 2031, Namibia’s Integrated Resource Plan assumes an annual growth rate of 4.25%. This implies that local electricity sales of almost 2.9 TWh in 2011 would increase to almost 6.6 TWh in 2031 [3.9]. In the same period, the country’s peak electricity demand is expected to grow at 4.05% per year, which implies an increase from 464 MW in 2011, to 1,021 MW in 2031 [3.9].

Figure 4 shows the projected demand for electrical energy between 2011 and 2031, expressed in TWh, based on a minimum annual average growth rate of 3.0% per year (black bars), a middle-of-the-road growth rate of 3.75% per year (combining black and green bars), and a maximum average annual growth rate of 4.5% per year (i.e. comprising the black, green and yellow bars).

![Figure 4: Projected demand for electrical energy in Namibia until 2031, in TWh [3.8]](image)
Similarly, for the period between 2011 and 2031, Figure 5 shows the outcome of an average annual low, medium and high peak demand growth of 3.5%, 4.0% and 4.5% respectively, in MW capacity required. Clearly, investments in generation capacity are urgently required if our lights are to remain on.

Based on a middle-of-the-road peak demand growth rate of 4.0% per year, as shown in the back-and-green bars in Figure 5, and assuming that Namibia’s population will continue to grow at some 2.05% per year, the country’s population and expected demand per person is calculated. Figure 6 shows that the electricity demand per capita will increase from approximately 0.22 kW in 2011, to some 0.32 kW per person in 2031. Most of this increase in demand is likely to be due to productive uses of electricity, such as by new mining and commercial ventures taking place, and less so from strictly consumptive uses, such as an increase in the domestic use of electrical energy.
It is instructive to contrast the electrical energy demand in select developing and industrialised countries in 2005 [3.12] and the demand per person in Namibia in 2011 expressed in kW, and the demand per Namibian as projected to 2031, based on an average peak demand growth rate of 4.0% per year between 2011 and 2031.

Figure 7: Demand per person in 2005, and Namibian demand per person in 2011 and 2031, [3.8] based on data from [3.12]

1.6 Sources of Electrical Energy

Electrical energy consumed in Namibia is generated locally at the Ruacana hydroelectric power station, the coal-fired van Eck power station near Windhoek, and Paratus and Anixas in Walvis Bay. The shortfall between the total electrical energy consumed and the quantity that can be generated locally is imported.

In the financial year 2010/2011, local generation capacity contributed some 1,430 GWh of electrical energy, or 36.6% of the total energy traded by NamPower in that period [3.5]. The relative contribution to the electrical energy generated at the four local power stations in FY2010/11 is shown in Figure 8, and emphasises the pivotal role played by the Ruacana power station.

Figure 8: Contribution of local generation to total electricity supplied in FY2010/11 [3.8]
The generation capacity of Ruacana depends critically on the availability of water in the Kunene River, which varies from month to month, and year to year. There is no large-scale dam at or near Ruacana; only a small reservoir is available to manage water over a 24-hour period. Consequently, there is no effective buffer that could ensure that water remains available or can be regulated during the dry period. This implies that electricity generated at Ruacana will remain dependent on rainfalls and water use in south-western Angola; this may change as a result of long-term climate change as well as new and additional uses of Kunene River water in Angola.

The contribution of the four local generation plant to Namibia’s electricity supply over the last decade is shown in Figure 9. Ruacana contributed between 88% and 99% of all local supplies, while van Eck’s contribution ranged from 0.1% to more than 10%, and Paratus contributed between 0.1% and 0.6% to local supplies in the period under consideration [3.10]. Anixas only became available in 2011, so its contributions are small.

![Figure 9: Electricity provided by local generation plant during past decade, GWh/a, [3.8]](image)

The difference between the demand for electrical energy and what local generation sources can supply has to be imported. Figure 10 shows the percentage of electrical energy that NamPower had to import from cross-border suppliers in the past decade. The percentage of imports has been increasing for 8 out of ten years in the period 2001/02 to 2010/11 [3.10]. This illustrates that electricity imports are critically important, and that local generation capacity is desperately needed unless Namibia can identify regional suppliers willing and able to offer long-term supply contracts to Namibia. However, regional electricity supply capacities are stretched to the limit, and it becomes increasingly challenging to secure sufficient external supply contracts. This is a strategic risk, and may increasingly constrain the country’s development.
Figure 11 illustrates the contributions that all suppliers have made to Namibia’s total electricity supply [3.10]. During the past decade, the single largest external contributor to Namibia’s electricity supplies was Eskom, i.e. South Africa’s electricity utility, contributing between 38% and almost 53% to the total electrical energy sold by NamPower. This illustrates Eskom’s pivotal role as critical supply partner. Yesteryear’s preferential supply agreements with Eskom are no longer in place. Current supply agreements with Eskom include strict stipulations in regard to the timing, quantity, seasonal cost and load curtailment requirements to be adhered to by NamPower, and these aspects have dramatically changed the regional playing field in which NamPower operates.
The Zimbabwe Electricity Supply Authority (ZESA) provides up to 150 MW of base load power from the coal-fired Hwange station. The current supply contract runs between October 2008 and October 2013; and has just been extended to 2014. In 2009/2010, ZESA provided 23.7% of Namibia’s total supplies, thus contributing significantly to Namibia’s security of electricity supplies [3.10].

NamPower has a supply contract for up to 30 MW of supply with Mozambique’s Electricidade de Moçambique (EDM), which operates substantial hydro-power plants in the country. The contract is reviewed annually. EDM’s maximum energy contribution amounted to 2.5% of total Namibian supplies in 2009/2010 [3.10].

NamPower’s latest power supply agreement with the Zambia Electricity Supply Corporation Limited (ZESCO) came into effect in January 2010, and is for a 10-year duration for firm capacity of 50 MW. ZESCO has contributed between 0.3% and 8.2% of Namibia’s total electricity supplies, with a maximum of 637 GWH in 2010/2011 [3.10].

Occasionally and when available, NamPower acquires electrical energy on the short-term energy market (STEM) offered through the Southern African Power Pool (SAPP) [3.13]. STEM contributed up to 3.2% of the total electrical energy required in 2006/2007, but trading is constrained by a lack of sufficient power supply capabilities in the region, as well as the availability of adequate regional transmission capacities [3.10].

1.7 Domestic Use of Energy in Namibia

The Namibian Census of 2001 reported that 68% of consumers living in urban areas used electricity for lighting; only 10% of rural households used electricity [3.14].

The Namibian Household Income and Expenditure Survey of 2009/2010 found that almost 42% of households used electricity for lighting while some 38% of respondents used candles [3.15]. Findings of the 2001 and 2009/2010 assessments are compared in Figure 13, Figure 14 and Figure 15 below.

Figure 12: Candles for lighting remain essential for more than 38% of Namibians [3.16]
Figure 13 to Figure 15 show that the use of electricity for lighting, cooking and heating has increased as a percentage of households interviewed in 2001 and 2011 respectively. This increase has occurred in rural as well as urban areas.

Figure 13: Energy for lighting - % households using different forms of energy [3.8]

Figure 14: Energy for cooking - % households using different forms of energy [3.8]

Figure 15: Energy for heating - % households using different forms of energy [3.8]
1.8 Electricity Use in Namibia

In the financial year 2010/2011, abbreviated FY2010/11, NamPower fed a total of 3.91 TWh\(^1\) into the national system [3.5]. Of this, 2.48 TWh or 63.4% were imported from cross-border suppliers. Eskom was the single largest supplier, providing some 1.52 TWh or almost 39% of the total electricity going into the Namibian system in that year [3.5]. In the same period, the country’s total electricity consumption amounted to 2.65 TWh, including rural consumption and mining, but excluding Skorpion Mine (0.69 TWh), Orange River projects (0.13 TWh) and exports to neighbouring countries (0.07 TWh). Losses, including transmission losses and electricity not sold to end-users amounted to ~0.37 TWh / 9.4% in 2010/2011 [3.5].

![Figure 16: Total electricity use of 3.91 TWh in 2010/2011, in TWh and % [3.10]](image)

The total electrical energy consumed in the various distribution and supply areas is summarised in Table 4 for 2010/2011, while Table 5 summarises the same for 2011/2012.

<table>
<thead>
<tr>
<th>SUPPLY AUTHORITY</th>
<th>Unit</th>
<th>Total electricity consumption [MWh]</th>
<th>Domestic consumption [MWh]</th>
<th>Commercial consumption [MWh]</th>
<th>Bulk/LPU consumption [MWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windhoek</td>
<td></td>
<td>752,392</td>
<td>328,604</td>
<td>148,916</td>
<td>274,872</td>
</tr>
<tr>
<td>Erongo RED</td>
<td></td>
<td>375,508</td>
<td>149,667</td>
<td>56,815</td>
<td>169,026</td>
</tr>
<tr>
<td>NORED</td>
<td></td>
<td>206,145</td>
<td>110,520</td>
<td>31,926</td>
<td>63,699</td>
</tr>
<tr>
<td>NamPower Distribution</td>
<td></td>
<td>196,766</td>
<td>0</td>
<td>82,659</td>
<td>114,107</td>
</tr>
<tr>
<td>CENORED</td>
<td></td>
<td>148,455</td>
<td>39,283</td>
<td>55,974</td>
<td>53,198</td>
</tr>
<tr>
<td>Southern regions</td>
<td></td>
<td>135,541</td>
<td>56,560</td>
<td>27,761</td>
<td>51,219</td>
</tr>
<tr>
<td>Oshakati Premier Electric</td>
<td></td>
<td>50,221</td>
<td>11,263</td>
<td>9,993</td>
<td>28,965</td>
</tr>
<tr>
<td>Central regions (excl. Windhoek)</td>
<td></td>
<td>49,330</td>
<td>21,111</td>
<td>8,069</td>
<td>20,150</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>1,914,357</td>
<td>717,008</td>
<td>422,113</td>
<td>775,236</td>
</tr>
</tbody>
</table>

Table 4: Electricity consumption in distribution and supply areas in 2010/2011 [3.17]

---

\(^1\) TWh – terawatt-hour, which is one million megawatt-hour (MWh) or one billion kilowatt-hour (kWh).
Table 4 shows that the total electrical energy consumed in the 8 main distribution and supply areas in 2010/2011 amounted to 1.91 TWh. NamPower sold less than 0.74 TWh to transmission clients, including select large power users and other bulk users who have direct off-take arrangements with the utility. Such users include mines, water pumping schemes and select commercial and industrial consumers. For 2011/2012, the total electrical energy consumed in the 8 main supply areas increased to 2.01 TWh.

Figure 17 shows the domestic, commercial and bulk/large power use in 6 distribution and supply areas in 2010/2011; while Figure 18 shows the percentage use in the same year.

---

**Table 5: Electricity consumption in distribution and supply areas in 2011/2012 [3.17]**

<table>
<thead>
<tr>
<th>SUPPLY AUTHORITY</th>
<th>Unit</th>
<th>Total electricity consumption [MWh]</th>
<th>Domestic consumption [MWh]</th>
<th>Commercial consumption [MWh]</th>
<th>Bulk/LPU consumption [MWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windhoek</td>
<td></td>
<td>784,570</td>
<td>341,266</td>
<td>179,933</td>
<td>263,371</td>
</tr>
<tr>
<td>Erongo RED</td>
<td></td>
<td>392,390</td>
<td>153,881</td>
<td>58,519</td>
<td>179,990</td>
</tr>
<tr>
<td>NORED</td>
<td></td>
<td>237,916</td>
<td>116,420</td>
<td>34,358</td>
<td>87,138</td>
</tr>
<tr>
<td>NamPower Distribution</td>
<td></td>
<td>200,132</td>
<td>0</td>
<td>72,644</td>
<td>127,488</td>
</tr>
<tr>
<td>CENORED</td>
<td></td>
<td>149,279</td>
<td>39,620</td>
<td>56,194</td>
<td>53,465</td>
</tr>
<tr>
<td>Southern regions</td>
<td></td>
<td>143,732</td>
<td>65,222</td>
<td>27,909</td>
<td>50,600</td>
</tr>
<tr>
<td>Oshakati Premier Electric</td>
<td></td>
<td>52,521</td>
<td>11,676</td>
<td>10,432</td>
<td>30,413</td>
</tr>
<tr>
<td>Central regions (excl. Windhoek)</td>
<td></td>
<td>49,593</td>
<td>18,728</td>
<td>9,533</td>
<td>21,332</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>2,010,133</strong></td>
<td><strong>746,813</strong></td>
<td><strong>449,522</strong></td>
<td><strong>813,797</strong></td>
</tr>
</tbody>
</table>

---

2 There are inevitable losses in both the transmission and distribution networks. In practice this implies that NamPower has to acquire at least 10% more electrical energy than can eventually be sold.

3 For 2010/2011, the total national electricity consumption amounted to 2.65 TWh, which excludes Skorpion Mine, the Orange River Projects, exports and network losses. A consumption of 1.91 TWh in distribution and supply areas leaves 2.65 – 1.91 = 0.74 TWh of electrical energy that NamPower supplied directly to transmission clients, excluding associated network losses.
1.8 Domestic Electricity Consumption in Namibia

The domestic electrical energy consumption in FY2010/11 is graphically depicted in Figure 19, while Figure 20 shows the percentage domestic consumption of total electrical energy consumption per supply area.
Namibia’s domestic electricity consumption amounted to 37.5% of the total electrical energy consumed in 2010/2011, while commercial consumption constituted some 22% of the total consumption. Bulk/large power consumption provided by the supply and distribution authorities consumed 40.5% of the total electricity used in these supply and distribution areas. It is evident that Namibia’s domestic consumption of electrical energy – at some 37.5% of the total electricity used – is an important component of the total electricity consumed nationally.

Figure 21: Main uses of electricity in supply & distribution areas in FY2010/11

Excluding NamPower’s direct supplies to bulk and large power users, such as mines and water pumping schemes.
At almost 50% of the total domestic consumption of electricity in Namibia in 2010/2011, the City of Windhoek was the most significant user of domestic electrical energy in that year. If the city’s domestic users were to be supplied by a dedicated power plant, such a hypothetical plant would have to have a capacity of almost 50 MW when operated throughout the year \(^5\). Similarly, if the country’s total domestic electrical energy consumption of 717,008 MWh in 2010/2011 was to be generated by a single power plant, such a generator would require an installed capacity of almost 110 MW if it was operated throughout the year \(^6\).

The domestic sector accounts for more than one-third of Namibia’s total electricity consumption in urban areas in Namibia. It is therefore important to consider how the consumption in the domestic sector will change as a result of rural-to-urban migration, the delivery of formal housing having grid or grid-like electricity connections, as well as changing household incomes and the resultant increase in the uptake of electrical appliances in the years to come. This is the topic covered in the next section.

1.10 Energy Efficiency Potentials in Namibia’s Domestic Electricity Sector

Past and projected future electricity demand trends were discussed in section 1.4. Considerable energy efficiency opportunities exist in the domestic sector. These can cost-effectively reduce the consumption of electrical energy on a household level, and thereby contribute to mitigate the increases in domestic energy expenditure and use. Here, the use of energy efficient appliances and greener technologies are of particular importance, and hold considerable domestic electricity savings potentials, while cost-effectively enhancing the services from energy efficient appliances.

Informed by international and local experience with the introduction of energy efficient technologies, potential domestic electricity savings often lie between 20% and 60% of the total consumption, without the loss of amenities or comfort [3.18]. The introduction and use of such technologies however depends critically on the awareness and willingness of domestic users to systematically identify and embrace technologies and activities that have energy savings potentials.

---

\(^5\) A hypothetical 50 MW power plant with a capacity factor of 75% would supply some 328 GWh per year. It is to be noted however that domestic consumption has a load factor of less than 75%, because most consumption is during the evening peak period with limited consumption during the remainder of a typical day.

\(^6\) A hypothetical 110 MW power plant with a capacity factor of 75% would supply some 722 GWh per year; also refer to the previous footnote.
It is recognised that Namibia has a substantial stock of existing residential properties, as well as consistent housing backlog in both urban and peri-urban areas [3.19]. These create a demand for housing development, which in turn necessitate that new domestic construction adds thermally and light-efficient buildings to reduce costs arising from unnecessary or easily avoidable expenditures on energy. The timing and factors that most significantly influence the demand for electrical energy consumption in the domestic sector in Namibia are summarised in Table 6 below.

<table>
<thead>
<tr>
<th>Timing</th>
<th>Key factors influencing the demand for electricity in the domestic sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>• electric water heater</td>
</tr>
<tr>
<td></td>
<td>• number of members in the household</td>
</tr>
<tr>
<td>Evening</td>
<td>• number of rooms in the household</td>
</tr>
<tr>
<td></td>
<td>• cooking habits, and cooking technology</td>
</tr>
<tr>
<td></td>
<td>• use and setting of electric water heater</td>
</tr>
<tr>
<td></td>
<td>• air conditioner use in summer, and electric heating in winter</td>
</tr>
<tr>
<td>All-day consumption</td>
<td>• floor area of the household</td>
</tr>
<tr>
<td></td>
<td>• user behaviour</td>
</tr>
<tr>
<td></td>
<td>• use of fridge/freezers</td>
</tr>
<tr>
<td></td>
<td>• use of air conditioners, pool pumps and other semi-permanent loads</td>
</tr>
</tbody>
</table>

Table 6: Domestic factors influencing household electrical energy consumption [3.18]

International experience (see for example [3.19]) shows that the most effective approaches to energy efficiency in the domestic sector include:

- energy efficiency awareness programmes, including ready access to information
- housing design, and specifically the thermal efficiency of houses
- regulatory requirements for energy efficiency planning approvals for new and refurbished housing stock
- energy labelling of appliances
- energy efficiency and demand side management programs, and
- a supportive regulatory environment, enabling supply authorities to set electricity tariffs based on energy efficiency performance rather than traditional consumption-based revenues only.

However, while energy efficient technologies are important in the domestic sector, the uptake and productive use of energy efficient technologies in the commercial and industrial sector is often more readily achieved, and often also holds more savings opportunities than those witnessed in the domestic sector [3.19]. This is mainly because
1) commercial/industrial facilities are often characterised by their larger and more concentrated electrical energy consumption patterns, while domestic consumers are more numerous and have smaller individual energy consumption requirements;

2) the financial and economic benefits of energy efficient technologies are often more pronounced and readily demonstrated for commercial buildings and industrial settings than they are for individual domestic users; and

3) commercial and industrial entities often have better access to finance to allow for technology upgrades yielding energy savings.

1.11 Electricity Prices in Namibia

This section briefly describes the electricity tariffs that are paid by end consumers in Namibia.

End-user tariffs are regulated by the ECB, and are calculated using the ECB’s electricity tariff determination methodology [3.20]. To this end, electricity distribution entities, who sell electrical energy to end-users, compile an ‘operating and reporting manual’ (ORM). The ORM summarises the entity’s total sales, costs and revenues, and is the basis from which the revenue requirement necessary to ensure the entity’s sustainable operations is calculated. Based on the calculated revenue requirement and a given regulated return on investments in electrical infrastructure, each utility and distribution entity determines end-user electricity tariffs. These are submitted to the ECB, who assess the entity’s tariff application. If the proposal meets the ECB’s requirements, the end-user tariffs as submitted by the distribution entity are approved, and published by the utility.

The above electricity tariff determination methodology applies to all distribution and supply entities that provide electricity to end-users, i.e. all REDs, local authorities, regional councils, NamPower distribution as well as private entities undertaking electricity distribution and supply functions in Namibia.

Figure 22 shows the average end-user electrical energy prices in N$ per kWh between 2008/09 and 2012/13, for post-paying domestic clients using conventional electricity meters in select distribution areas [3.21]. The electricity price shown excludes any additional charges such as demand, basic, capacity, rental, ECB levy and other charges, as may appear on an end-user’s electricity bill, and are therefore energy charges only.
Figure 22: Price per unit of electricity for post-paying electricity users, in N$ per kWh [3.8]

Figure 23 shows the average electrical energy price in N$ per kWh for pre-paying domestic users having pre-paid electricity meters, in select distribution areas, between 2008/09 and 2012/13. The pre-paid tariff for electricity as shown in Figure 23 includes all charges levied by the distribution entity, except the ECB levy which amounts to an additional N$ 0.014 per kWh in 2012/13.

Figure 23: Price per unit of electricity for pre-paying electricity users, in N$ per kWh [3.8]
Each distribution entity’s operating circumstances are unique [3.22]. Factors that significantly influence an entity’s end-user tariffs include:

- the condition of the electricity distribution and supply network, and investments requirements for its upkeep
- the scale of network extensions, upgrades and ongoing maintenance required
- the growth of the energy consumption in a specific supply area
- the amount of energy sold per network kilometre
- the required average network length required per customer, and
- the energy sales per customer.

As shown in Figure 22 and Figure 23, the price paid by end-users for electrical energy has (in many instances) almost doubled in the past five years. Tariff increases by distribution entities are mainly determined by:

- the annual NamPower tariff increases, as approved by the ECB and passed through to electricity distribution entities;
- systematic increases to achieve cost-reflective tariffs; and
- network maintenance and upgrade costs [3.22].

It is instructive to consider the total monthly electricity bill that a domestic user would have to pay. Assuming an electricity consumption of 300 kWh per month through a conventional credit meter, with a 30 Ampere circuit breaker (if relevant), the total monthly cost including energy charge, ECB levy, local authority surcharge (if applicable), basic monthly service charge and circuit breaker charge for select distribution areas in 2012/2013 is shown in Figure 24.

![Figure 24: Total monthly electricity charge for post-paying consumers, 300 kWh/mo [3.8]](image-url)
For end-users having a pre-payment electricity consumption meter, the total monthly electricity bill when using 300 kWh of electrical energy per month is shown in Figure 25.

![Figure 25: Total monthly electricity bill for a pre-paying consumer, for 300 kWh/mo](image)

Southern African electricity tariffs have historically been far below cost-reflectivity. The recent shortage of electricity, massive investment requirements in the electricity sector and the drive towards cost-reflectivity of tariffs has resulted in a substantial escalation of end-user electricity prices. At about the same time as regional supply gaps emerged, Namibia’s REDs were established. This has contributed to the widely-held view that the REDs have been a major reason for hefty electricity price increases. There is little evidence that supports such allegations.

While arguments that the REDs have contributed to the rapid escalation of end-user electricity prices have provided political mileage for some, such debates have often conveniently ignored the fundamental challenges faced by Namibian electricity utilities. The principal challenge facing Namibia is a shortage of electricity generation capacity, coupled to historically low consumer tariffs that are inadequate to ensure that electrical infrastructure can be adequately maintained and extended.

Figure 26 shows that the average price per unit of electricity sold by NamPower has escalated from 10.98 cents per kWh in 1993/94, to some 90 cents per kWh in 2012/13.
Figure 26: Average NamPower electricity price in the past two decades, in N$/kWh [3.10]

Figure 27 shows the Namibian consumer price index, and the index for NamPower’s average price of electricity relative to the base year 2000/01. While inflation has brought about a doubling (factor 2) of the cost of a basket of goods, electricity prices have escalated by factor 3.4 in the period 2000/01 to 2010/11. Wholesale electricity prices are, and will continue to be, a significant price driver, quite irrespective of the distribution entity that supplies end users.

Figure 27: Consumer (blue) and NamPower price index (red) relative to 2000/01 [3.10]

In the years to come, Namibia’s electricity prices will continue to escalate substantially. NamPower expects that the wholesale price of electricity will increase from the current N$ 0.90/kWh in the financial year 2012/2013, to an estimated N$1.60/kWh in 2016/2017 [3.5]. The expected path for the wholesale price of electricity is shown in Figure 28, assuming an annual price increase of 15.5% on the previous year’s cost per kWh.

Figure 28: Expected wholesale electricity price increase [3.5]
Based on the increase of the wholesale electricity price shown in Figure 28, the end-user tariffs in coming years can be estimated. End-user tariffs are always higher than the wholesale price charged by NamPower, because the distribution of electricity incurs additional costs which are not part of the electricity tariffs charged by NamPower (unless the supply is taken directly from NamPower).

In 2011/12, end-user electricity tariffs charged in Namibia broadly ranged between a few percentage points and more than 80% higher than the average wholesale price charged by NamPower, which was N$ 0.78/kWh. This illustrates the substantial price difference per kWh between the different distribution entities, and highlights the important cost contribution to the wholesale price introduced through the distribution function. One can therefore comfortably assume that the future price increases anticipated by NamPower will – at least on average – be passed through to the end consumer.

The median pre-payment consumer price of the various distribution entities discussed in this section amounts to N$ 1.44/kWh in 2012/2013. Based on this end-user energy price, three price escalation scenarios are formulated:

- a sub-par 10% increase per year price escalation scenario, which will successively under-recover the increases due to projected wholesale price increases
- a simple cost pass-through price escalation of 15.5% per annum, to ensure that the NamPower price increases are at least covered, and
a high price escalation scenario, in which the end-user tariff is escalated at 20% each year until the financial year 2016/2017.

The three separate scenarios discussed above are depicted in Figure 29. For the low escalation scenario the graph shows a cumulative escalation of more than 46% between 2012/13 and 2016/17. End-user electricity prices more than double if an annual end-user price escalation rate of 20% per year occurs between 2012/13 and 2016/17.

![Figure 29: End-user electricity prices in low, med and high growth scenarios [3.8]](image)

It is recognised that end-user prices are not only dependent on the wholesale price, and other cost drivers are expected to increase in tune with the prevailing inflation rate. However, the scenarios above illustrate the sobering fact that Namibian end-users of electrical energy will be facing steep electricity price increases in the years to come. This will not be popular. At the same time, rapidly increasing electricity prices present significant opportunities to introduce a sustainable energy future based on renewable energy technologies to Namibia.

**References**


[3.3] Photo by VO Consulting, [www.voconsulting.net](http://www.voconsulting.net), info@voconsulting.net
[3.6] Artwork by Jenny Beresford, Vocal-Motion, Graphic Design and Illustrations, Swakopmund, Copyright VO Consulting, info@voconsulting.net
[3.7] Photo from NamPower, showing a new high-voltage transmission line between Zambia and Namibia that allows electricity imports from countries including Zambia, the DRC and Mozambique to Namibia, www.nampower.com.na, accessed on 1 August 2012
[3.8] Image by VO Consulting, copyright VO Consulting, info@voconsulting.net
[3.10] based on analysis and information contained in NamPower’s Annual Reports, refer to www.nampower.com.na
[3.11] At Independence the National Planning Commission estimates the number of Namibians to be 1,377,500, while they were some 2,066,000 Namibians in 2010. This equates to an annual average population growth rate of 2.05 % per year over the 20-year period between 1990 and 2010. www.npc.gov.na/census/index.htm
United States Census Bureau (International Database), www.census.gov/population/international/data/idb/informationGateway.php
accessed on 29 June 2012
[3.16] Photo provided by Harald Schütt, Amusha Consultancy Services
[3.18] Estimates are based on work by VO Consulting, info@voconsulting.net
[3.21] Data provided by the Electricity Control Board, www.ecb.org.na
[3.22] Discussions with Uli von Seydlitz, Emcon Consulting Group, are gratefully acknowledged.