TECHNICAL MARKET REVIEW

Country Profile: Namibia

Climate Technology Centre & Network

Revised Report
Date: 9th April 2018

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Overall Task and Objective of project:
Review of potential for implementation of energy efficiency policies and strategies in Southern Africa for lighting, refrigerators, air-conditioning, motors and transformers

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1 EXECUTIVE SUMMARY

This report looks at the potential for increasing the energy efficiency of products in Namibia by providing a technical market assessment of current conditions and policies. Five specific product categories have been looked at: lighting, air conditioning, refrigerators, motors and transformers. Research conducted by DNV GL during 2017 provides context and insight in relation to the barriers and opportunities along with a set of recommendations to support Namibia in achieving its sustainability goals.

General Conclusion

The limited level of electrification that currently exists in Namibia, combined with high levels of poverty, low population density and relatively high costs of electricity for those with access all present significant challenges to an energy efficiency market transformation strategy. Nonetheless, the country is experiencing significant growth in electricity demand – approximately 5% per year - and while generation sources are expanding, pressures to meet the increased demand are significant. Currently installed generating capacity does not meet the demand requirement, and power is mostly imported. While encouraging the adoption of more energy efficient equipment and products amongst users is an important opportunity and a logical strategy, it faces significant barriers and is not a high priority at present. Given the fact that there is virtually no indigenous manufacturing of these products, a regional market transformation strategy combined with in-country educational campaigns and utility support is most likely the best approach to the achievement of meaningful change in Namibia.

Within this context, DNV GL presents its best estimation of technical potential for each product category for policy recommendations to achieve savings over standard equipment using assumptions based on the research undertaken during this project.

The story behind the story

DNV GL conducted an initial desktop analysis before sending out data requests and setting up meetings with local energy sector stakeholders within Namibia. These included the Namibian Department of Environment Affairs, South African Development Communities Regional Centre for Renewable Energy and Energy Efficiency (SACREEE), Namibia University of Science and Technology, Namibian Standards Institute (NSI), NamPower and other local stakeholders such as transmission & distribution companies, contractors, suppliers and installers of technologies. Meetings and interviews were conducted in-country over several days, via email and telephone. Some of the findings are highlighted below.

Lack of population density

Namibia's population of just over 2 million people is distributed thinly over a very large area with extensive areas of completely uninhabited land. Thus, Namibia is one of the least densely populated countries in the world. The absence of any significant population density places a real barrier to the justification of projects such as the extension of distribution grids, let alone energy efficiency schemes or incentives.

National Designated Entity (NDE) prioritisation

In the light of the above, energy efficiency (and indeed, the project being described here) is considered to not be a key priority of the NDE in Namibia. Electrification, food, water, housing and other more pressing and relevant issues understandably take precedence. Thus, very little capacity to track or dig for the data required in this project's survey has been available. Further to that, the NDE received very little support and feedback from other entities within Namibia (e.g. Revenue Authorities, Trade

Organizations, Utilities, Statistics bureau, etc.) which resulted in very slow turnaround times with limited feedback and accuracy issues with the data provided.

Cost Sensitivity

Due to high levels of poverty in Southern Africa, its markets are extremely price sensitive. Energy efficient products such as those being investigated in this study typically come at a premium cost over standard models, and any additional costs have large impacts on short term cashflows.

Africa is a small market

The entire African continent consumes less than 5% of all electricity globally. Therefore, it is understandable that manufacturers have little interest in spending time and resources to invest into, let alone track the African market, and even less so if you look at specific countries.

Subsidised electricity tariffs

Namibia's electricity tariffs are the highest in the region, at 0.142 USD per kWh for residential consumers and 0.145 USD for industrial consumers. Even so, these tariffs are still relatively low when compared to Europe because they are heavily subsidized by government. The lower costs to the consumer result in longer payback periods for energy savings projects or and technologies. The low average incomes of households combine with political pressures prevent the state-owned utilities from increasing the tariffs to be cost reflective of generation. This is a confounding situation as higher rates, while encouraging efficiency, would cause many people to then not be able to afford electricity, and in turn would negatively impact both the economy and the uptake of electrification.

Energy Policies

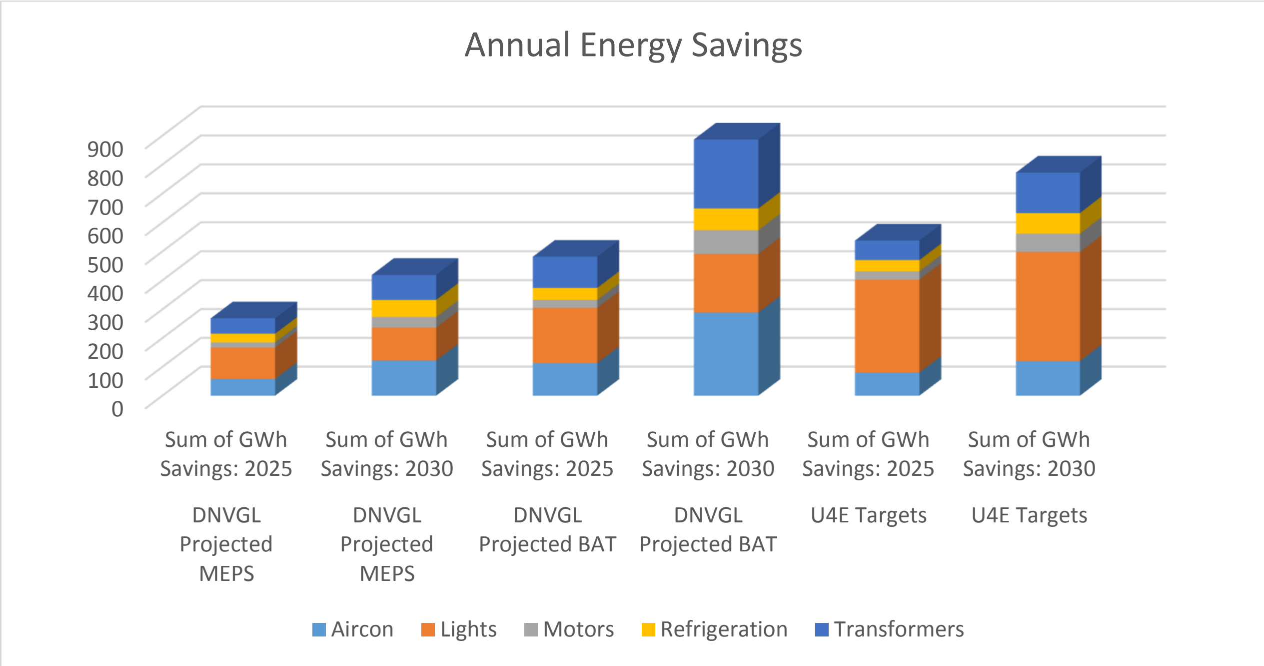
Namibia's latest energy policy was formulated in 2016 and released in July 2017. It highlights several key issues and addresses these issues at a high level, together with mandates to resolve these issues. Therefore, the nature of this high-level document is not to address any specific technology issues, but rather to present an overall approach as to how Namibia will addressing their current lack of energy efficiency throughout the country.

Finally

Despite the limitations of low population density and limited incomes, Namibia has much to gain by adopting energy efficiency standards and technologies as a strategy for controlling the rate of growth in peak demand for electricity that continues to put pressure on the electric grid. Enacting policies and pursuing aggressive programs in conjunction with expanding access to electricity in the country may help mitigate the negative impacts of growth to a considerable extent. Without such measures, there will continue to be considerable pressure on electricity supply and imports to meet the needs.

To that aim, DNV GL was provided with assumptions (gathered from local representatives during in country fieldwork, which are considered by DNV GL to be relatively aggressive assumptions) that have been applied to a series of product models to estimate the potential for country-wide energy savings above a base year of 2017.

The market research and data collection conducted by DNV GL provides insight into the five product categories of primary energy-consuming appliances and equipment. The projected energy savings when moving from the current state of technologies to Minimum Energy Performance Standards (MEPS) or to the Best Available Technologies (BATs) are shown in the two figures below. More detail on the underlying approach used to arrive at these two figures can be found in the sections of the report related to each of the individual product categories. Section 2.6 presents more detail as to the assumptions used in the modelling process.



	GWh savings (2025)	GWh savings (2030)	MUSD savings (2025)	MUSD savings (2030)	GHG savings (2025)	GHG savings (2030)
Namibia						
DNV GL Projected MEPS						
Lights	109	114	29	44	6	6
Aircon	59	122	16	48	3	6
Refrigeration	30	59	8	23	2	3
Motors	18	37	5	15	1	2
Transformers	53	86	14	34	3	4
Total	**269**	**419**	**71**	**164**	**14**	**21**
DNV GL Projected BAT						
Lights	192	203	50	78	10	10
Aircon	113	289	30	114	6	15
Refrigeration	42	75	11	29	2	4
Motors	28	82	7	32	1	4
Transformers	107	238	29	94	5	12
Total	**482**	**887**	**128**	**347**	**25**	**45**
U4E Targets						
Lights	323	378	46	54	18	21
Aircon	80	120	11	17	5	7
Refrigeration	39	71	6	10	2	4
Motors	28	63	4	9	2	4
Transformers	67	140	10	20	3	7
Total	**537**	**773**	**76**	**110**	**30**	**43**

2 INTRODUCTION

2.1 General Information about Namibia

Namibia is situated on Africa's south-western seaboard. Its neighbouring countries are Angola to the north, Botswana and a small part of Zimbabwe to the east and South Africa to the south. The country is bordered by the Atlantic Ocean in the west. The Caprivi Strip / Okavango Strip (formerly known as Itenge), is a narrow protrusion of Namibia eastwards from the Kavango Region for about 450 km, between Botswana to the south, and Angola and Zambia to the north. Caprivi is bordered by the Okavango, Kwando, Chobe and Zambezi rivers.

Size (km^2)	825,292
Population (Est, 2017) [1]	2,570,454

The capital and largest city is Windhoek, situated in the country's central highlands. Agriculture, herding, tourism and the mining industry – including mining for gem diamonds, uranium, gold, silver, and base metals – form the basis of its economy.

Namibia is a member of the United Nations, the Commonwealth of Nations and the Southern African Development Community (SADC). 22.6% of the population survives on less than US$1.90 a day [2] (the international poverty line), as per 2009 statistics. In 2016, the World Bank classified Namibia as an "upper-middle income" country because the annual gross national income (GNI) per capita levels is USD 4,126 to USD 12,735.

2.2 Climate and Topography

The climate in Namibia is mostly warm with hot days and cool to cold nights and with frequent prolonged periods of drought. During the summer months, the evergreen Caprivi Strip average temperature lies at 35° C during the day, dropping to about 20° C at night. In winter the day temperature rises to 28° C, but at night the temperature can drop to 1° - 7° C. Rainfall is low and irregular whilst evaporation rates are high, and is largely confined to the summer months (November to March). Humidity is low, and average rainfall varies from almost zero in the coastal desert to more than 600 mm in the Caprivi Strip. Due to the cold and nutrient-rich Benguela current that flows up from the Antarctic waters, the country's coastline is cooler than the rest of the country, with frequent sea fog. Efundja, the annual seasonal flooding of the northern parts of the country, often causes not only damage to infrastructure but loss of life. As the area behind the coast is a desert, winds can develop into sandstorms, leaving sand deposits in the Atlantic Ocean that are visible on satellite images. [3] [4] [5] [6] [7].

The country has three broad zones: the Namib Desert to the west; the Kalahari Desert to the east; and the Central Plateau. The plateau, made up of mountains, rocky outcrops, sand-filled valleys and undulating upland plains, covers over 50 % of the land area. It includes Windhoek, the capital, and slopes eastward to the Kalahari Basin and northward to the Etosha Pan, the largest of Namibia's saline lakes. The Skeleton Coast, from Swakopmund to the northern border, is a waterless stretch of high sand dunes pounded by a high surf, much celebrated in tales of the sea. The Kaokoveld Mountains run parallel, covering 66,000 km2. Shifting sand dunes of the Namib Desert spread inland for 80–130 km, covering 15 % of the land area. This topography has resulted in Namibia being overall one of the least densely populated countries in the world.

2.3 Electricity Sector

As per the IRENA document entitled Southern Africa Power Pool, 67% of the electricity produced in Namibia is based on hydro sources, with droughts impacting the energy generation capacity. The country relies heavily on energy imports from neighbouring countries to meet its demand, with 68% of the electricity being imported in 2016 from Southern African Power Pool (SAPP) members, primarily Zimbabwe and South Africa, with more recent connections with Botswana and Zambia being added.

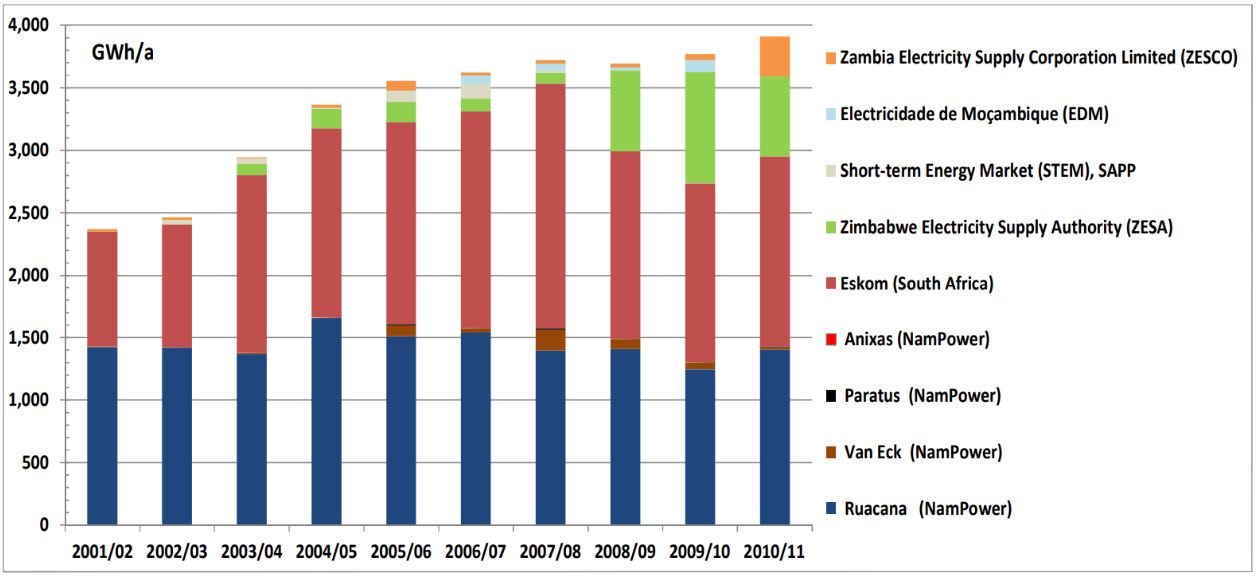


Figure 2.1 Sources of Namibia electricity supply (2001-2011) [8].

Figure 2.1 shows the sources of electricity supply for Namibia in GWh. The rate of growth in electricity usage in Namibia is 3.5% for all energy and 5.5% for electricity as of April 2014 (source World Bank).

Namibia's energy sector has been restructured and split into generation (NamPower) and about a half-dozen distribution companies, including the Municipality of Windhoek. NamPower, a state-owned entity, is responsible for supply. Distribution companies deliver power, maintain the distribution system, read meters, and issue bills which include supply charges passed on from NamPower. NamPower aims to increase integration of renewables into Namibia's power supply, with a goal to add around 171 MW of renewable electricity into the national grid by the end of 2018. A National Integrated Resource Plan, Renewable Energy Policy, Independent Power Producer Policy, and a National Energy Policy are being drafted to address the increase in demand for electricity and to increase the use of renewable energy. In addition, the current electricity import rate of 50% (2014) is expected to drop to about 10% by 2030.

About 32% of the population has access to electricity, with lower access to modern energy services for rural areas (about 17%) as compared to urban areas (about 50%) [9] which remains a concern.

Namibia is a member of the Southern African Power Pool (SAPP), which began in 1996 as the first formal international power pool in Africa with a mission to provide reliable and economic electricity supply to consumers in SAPP member countries. Namibia has also joined the International Renewable Energy Agency (IRENA) a global initiative to promote and reduce barriers to the uptake of renewable energy.

Namibia's per-capita annual electricity usage is somewhat low at about 1584 kWh (as per 2014 World Bank statistics, Figure 2.2 below) which reflects the presence of comparatively few appliances.

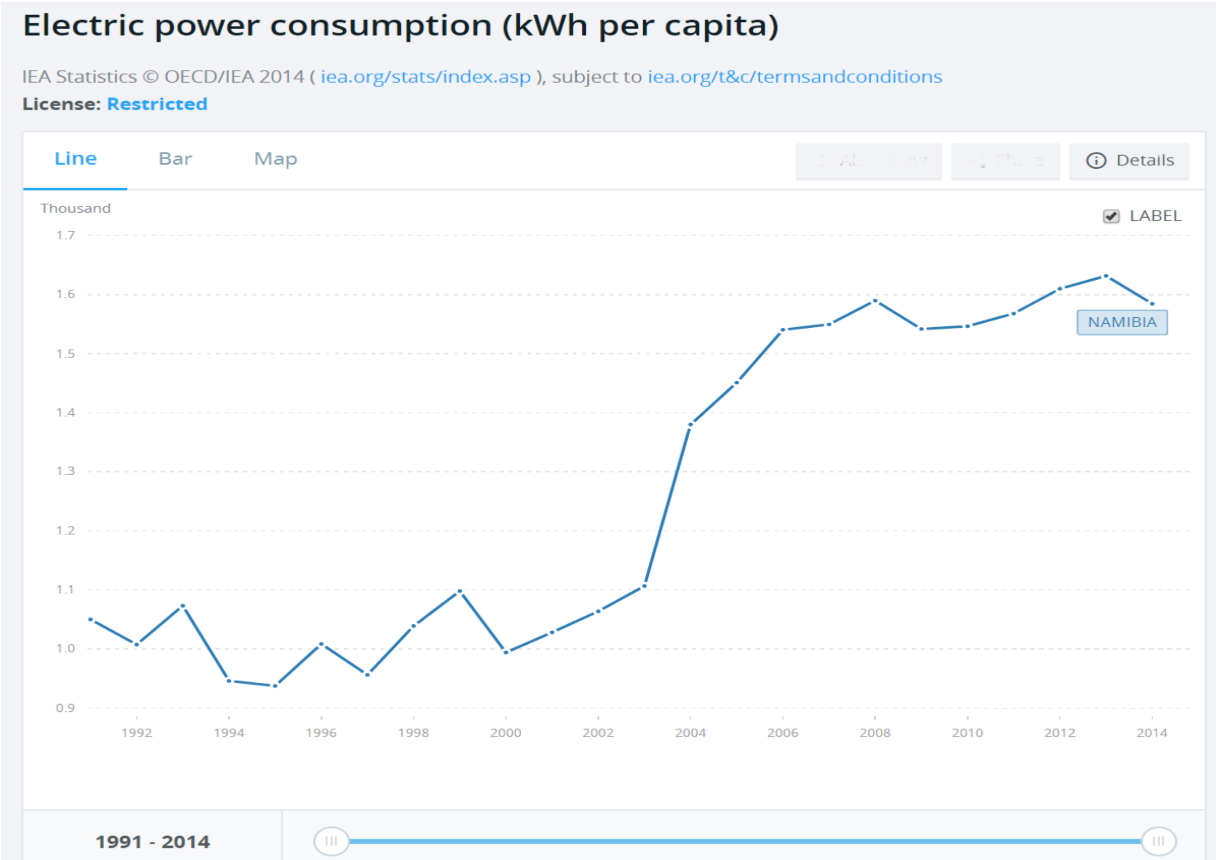


Figure 2.2 Per-capita annual electricity consumption by year (1991-2014) [World Bank].

The significant increase in electricity consumption (since 2003) combined with increased electrification, explains the significantly increased demand for power supply over the past 15 years in Namibia, and the prompting of concerns on energy efficiency.

Table 2.1 indicates the extent of significant energy efficiency and Demand Side Management (DSM) activities in Namibia.

Table 2.1 Energy efficiency and Demand-Side Management (DSM) activity in Namibia [10].

PROGRAMME TYPE	CFL EXCHANGE	ENERGY-SAVING AWARENESS	DEMAND MARKET PARTICIPATION	TIME-OF-USE TARIFF	HOT WATER LOAD CONTROL	SOLAR WATER HEATING	ENERGY EFFICIENCY IN BUILDINGS	ENERGY EFFICIENCY AUDITS	PREPAID METERS	GENERAL REHABILITATION	TRANSMISSION LINE UPGRADE	POWER FACTOR CORRECTION	DISTRIBUTION LOSS REDUCTION	STANDARDS AND PRODUCT LABELLING
Namibia	X	X	X	X	X	X	X	X		X		X		X

Table 2.2 below indicates Namibia's targeted GWh savings per product type by 2030 as identified and proposed by United4Efficiency (U4E), assuming a successful implementation of the various energy efficiency strategies.

Table 2.2 Targets for energy savings [12].

U4E PATHWAY TO ENERGY EFFICIENCY	TARGETED ANNUAL GWh SAVINGS BY 2030				
	LIGHTING	RESIDENTIAL REFRIGERATORS	ROOM AIR CONDITIONERS	INDUSTRIAL ELECTRIC MOTORS	TRANSFORMERS
Namibia	378.0	71.4	120.2	63.3	139.6

(Extracted from the U44E Country Assessment, December 2016)

Namibia formed an Energy and Environment Partnership with Southern and East Africa (EEP S&EA) in March 2010 to help provide for seed financing for projects related to renewable energy and energy efficiency.

In February 2015, the Southern African Power Pool (SAPP) members have agreed to prioritise lighting, refrigerators, air conditioners, water heaters and distribution transformers as high-impact opportunities that offer the most cost-effective and fastest means to save energy in the region.

Specifically, in Namibia, NamPower launched an exercise in 2016 to distribute one million power saving bulbs to households in the country. The campaign, known as the 1 Million Light Emitting Diode (1mLED), focused on replacing incandescent light bulbs used for domestic lighting with LED bulbs, for free. NamPower has also contracted NamEnergy Resources and Lex Technologies (PTY) Ltd to execute and distribute the 1mLED campaign by implementing a door-to-door replacement programme, using local installers in the respective towns across the country.

Most household appliances in the SADC region are either manufactured in, or distributed by, South African companies. Although the South African presence in this market has been mitigated somewhat by aggressive importing of cheaper appliances from China and South Korea, there is a tendency to enforce the South African standards of labelling for importers and exporters.

References: [13] [8] [14] [10] [11] [12] [15] [16] [17] [18] [19] [20] [21] [22] [23] [24] [25].

2.4 Power Industry Regulation and Policies

An overview of the Power Sector Regulatory environment is set out below in
Figure 2.3.

Organizations responsible for energy policies	• Ministry of Mines and Energy (MME) • RE & Energy Efficiency Institute (REEEI)
Energy regulator	• The Electricity Control Board (ECB)
Energy policy publications	• Electricity Regulation Act, 2006 • Act 4 of 2007 Electricity Act • Draft Energy Regulator Bill • Draft Electricity Bill, 2006 • Electricity Safety Code, 2009 • Electricity Act 2007 • RERA regulatory guidelines for cross border power trading in Southern Africa (SADC region), 2010 • The Namibian Grid Code.
Main entities in the electricity market	• Namibia's electricity utility NamPower • Regional Electricity Distributors (REDS), including Windhoek.

Figure 2.3 Namibia's power sector regulatory environment.

The structure of the electricity sector in Namibia is illustrated below in Figure 2.4.

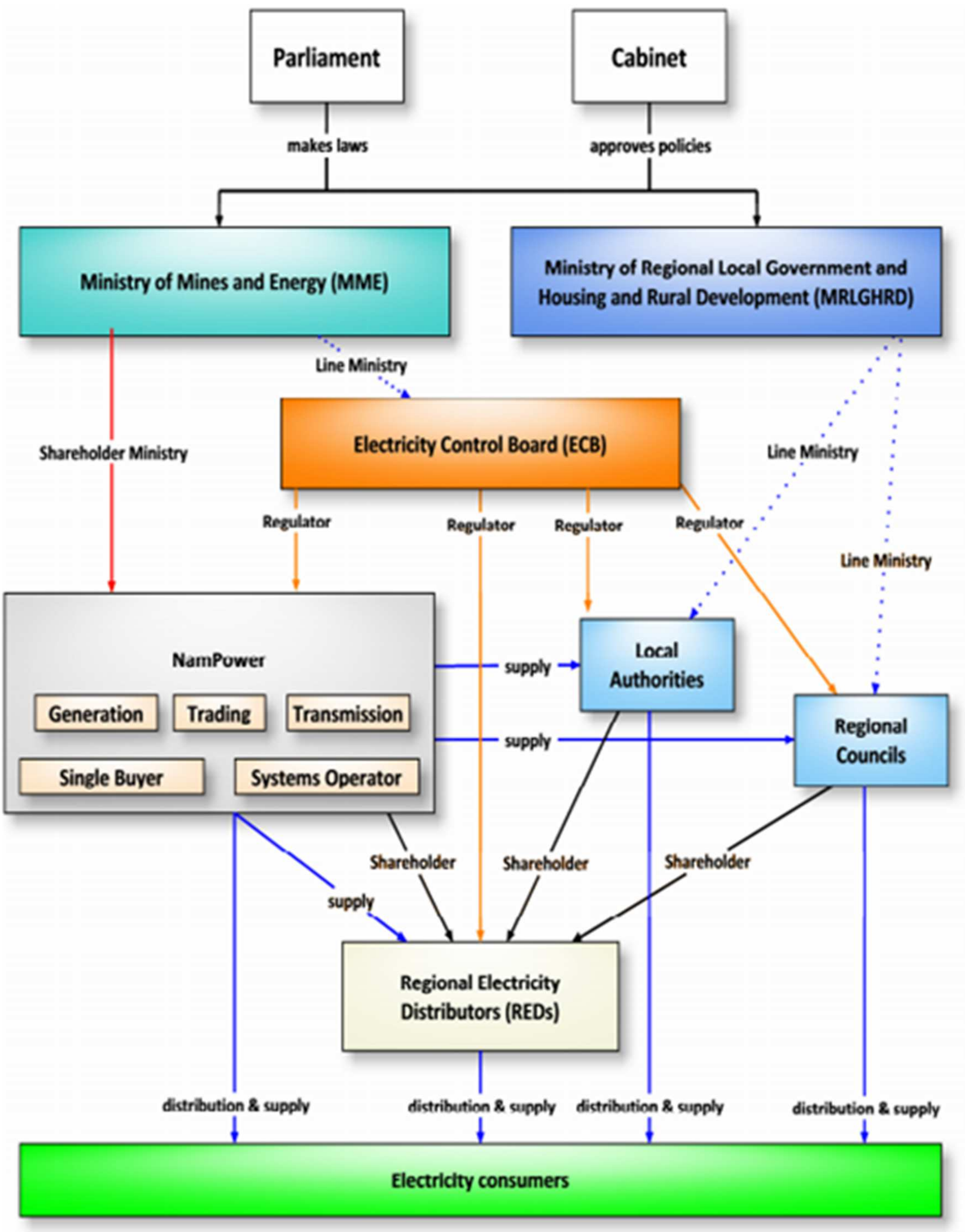


Figure 2.4 Namibia electricity sector structure [8].

The Minister of the Ministry of Mines and Energy (MME) has executive responsibility for the electricity industry and the MME is the policy recommendation body. The Electricity Control Board (ECB) has a statutory responsibility to advise the Minister on electricity matters and it is instrumental in developing subordinate legislation such as regulations, codes, standards and guidelines etc. under the Act. The ECB executes its statutory functions through the Technical Secretariat headed by the Chief Executive Officer.

The Final Draft of the Ministry of Mines and Energy National Policy is dated 9 December 2016. It includes a section on energy efficiency and Demand Side Management which implies that standards generation is still in its infancy and that adopting international standards for energy efficient technologies may suffice. The current Energy Policy is consistent with the policy articulated in the White Paper on Energy Policy of 1998 (WPE). It contains specific policies about renewable energy that have guided MME initiatives over the last few years. Between 2007 and 2010, the Namibian Renewable Energy Program (NAMREP) was developed. Similarly, the Renewable Energy and Energy Efficiency Capacity Building Program (REEECAP) was implemented to generate information for the implementation of renewable energy and energy efficiency policies formulated in the WPE. The Energy Policy sets six specific national goals for the energy sector and one of the goals relates to National Building Codes to Incorporate Renewable Energy Technologies and Energy Efficiency Principles.

In 2006 the MME in collaboration with Polytechnic of Namibia (PoN) created the Renewable Energy and Energy Efficiency Institute (REEEI) to serve as a national information resource base for sustainable energy use and management. In 2007 the Off-Grid Energization Master Plan (OGEMP) program was initiated which placed an emphasis on energy technologies and appliances that utilise renewable energy and energy efficiency. REEEI has played a major role in the coordination of programs like OGEMP, REEECAP and NAMREP. However, the institute has its own limitations such as a lack of human resource (5 full-time staff) and a rather low independency. The Centre for Renewable Energy and Energy Efficiency (CREEE) is a continuation of the work done by the REEEI on renewable energy technologies and their use, energy efficiency practices, policy and regulation development and climate change mitigation studies.

The Namibia Energy Efficiency Programme in Buildings (NEEP) is the major programme in the country which aims to promote the use of energy efficient technologies and practices in Namibia’s commercial and residential building sector. NEEP is co-funded by the GEF and UNDP under the Framework for Promoting Low Greenhouse Gas Buildings. This is a three-year programme that is being implemented by the MME and REEEI at the Polytechnic of Namibia. The NEEP project’s objective is geared towards the reduction of Namibia’s energy-related GHG emissions through the nationwide adoption of energy-efficient technologies and practices in the commercial and residential building sector, with a focus on government buildings, hospitals, hotels, schools and possibly a sample of residential buildings.

Namibia started an Energy and Environment Partnership with Southern and East Africa (EEP S&EA) in March 2010 and this provides seed financing for projects related to renewable energy and energy efficiency.

In 2016, the SADC energy ministers gave approval in principle to the formation of a SADC Centre for Renewable Energy and Energy Efficiency (SACREEE), and Namibia was selected as the host country.

The current set energy efficiency support policies in Namibia are shown in Table 2.3 (as of 2016), while the policy support that renewable energy receives is shown in Table 2.4. Table 2.5 shows financing incentives for energy efficiency and renewable energy projects.

Table 2.3 Energy efficiency policies initiated by 2016 [11].

POLICY TYPE	INDUSTRIAL COMMERCIAL LOAD REDUCTION	RESIDENTIAL INCENTIVES (LIGHTING, HOT WATER LOAD CONTROL)	SUPPORT FOR EFFICIENT COOKING AND HEATING	BUILDING EFFICIENCY GUIDELINES	SOLAR WATER HEATER SUBSIDIES	MANDATORY ENERGY MANAGEMENT FOR INDUSTRY AND BUILDINGS	REDUCED DISTRIBUTION LOSSES	TRANSPORT EFFICIENCY STANDARDS	BIOFUELS PRODUCTION INCENTIVES/ TAX CREDITS	VOLUNTARY BUSINESS ENERGY EFFICIENCY PROGRAMMES
Namibia	X	X	X	X						

Note: The "X" indicates the presence of the listed policy type in the country.

Table 2.4 Renewable Energy support policies initiated by 2016 [10].

POLICY TYPE	RENEWABLE ENERGY TARGETS	FEED-IN TARIFF / PREMIUM PAYMENT	ELECTRIC UTILITY QUOTA OBLIGATION	NET METERING / NET BILLING	TRANSPORT OBLIGATION / MANDATE	HEAT OBLIGATION / MANDATE	TRADING REC	TENDERING
Namibia	**R**					☐		

*Note: The **R** "REVISED (one or more policies of this type)"and ☐ "EXISTING NATIONAL (could also include subnational)", indicates the presence of the listed policy type in the country.*

Table 2.5 Renewable fiscal incentives and public financing initiated by 2016 [10].

POLICY TYPE	CAPITAL SUBSIDY, GRANT, OR REBATES	INVESTMENT OR PRODUCTION TAX CREDITS	REDUCTIONS IN SALES, ENERGY, VAT OR OTHER TAXES	ENERGY PRODUCTION PAYMENT	PUBLIC INVESTMENT, LOANS OR GRANTS
Namibia					☐

Note: The ☐ "EXISTING NATIONAL (could also include subnational indicates the presence of the listed policy type in the country.

References: [13] [8] [14] [10] [11] [12] [15] [16] [17] [18] [19] [20] [21] [22] [23] [24] [25].

2.5 Key Challenges and Recommendations

The present key challenges in Namibia's energy sector include: the high cost of energy supply (i.e. *the cost of electricity increased by 33% in 2016*); cost/accessibility and security of funding; inability to meet electric demand (*droughts continue to cause a decrease in the dispatch from NamPower's flagship hydro power station at Ruacana*) causing an urgent need to develop local generation capacity and expand the national grid; execution of planned maintenance and refurbishment of existing assets and skills development. This resulted in significant tariff increases for 2017/18 and 2018/19 to offset the under-recovery for supply incurred by NamPower in 2015/2016 [25]

SACREE (see Appendix A) works towards addressing SADC country challenges in relation to renewable energy and energy efficiency. Funding available to the SADC countries for energy efficiency is listed in Appendix B.

Table 2.6 Energy Efficiency opportunities and recommendations.

	OPPORTUNITIES	RECOMMENDATIONS
POLICIES	Processes and procedures to enforce and prioritize energy efficiency requirements should be put in place.	• Evaluate reasons why financing is not targeted at energy efficacy programmes and determine what policies are required to enable this. • As per Table 2.3 above, voluntary business energy efficiency programmes may be considered.
ECONOMIC AND FINANCIAL	Some funding is already available regionally for energy efficiency (see Appendix B). These may need to be supplemented by providing affordable financing for energy efficiency investment and/or by leveraging funding from public (government and development partners) and private stakeholders. There may be limited exposure of local Financial Institutions to RE/EE investment projects and limited experience on special purpose soft loans for RE/EE projects for SMEs and low income sections of the population.	• Clarify if any funding is currently used for EE. • Determine what barriers exist preventing use of available funding (Appendix B). • Harmonize donor support by source affordable financing for energy efficiency investment. • Develop guarantee funds to cover for deflationary risk.
INFORMATIONAL	Limited information and knowledge about the benefits of energy efficiency. Expertise on energy efficiency opportunities and benefits assessments is currently inadequate.	• Provide funding to promote energy-saving awareness. • Provide funding to strengthen local capacities and to support RE/EE entrepreneurship.

Note: Recommendations should be considered after checking with SACREE on any new initiatives that might have been initiated.

2.6 Methodology for Modelling & Savings Projections

For a simple savings calculation, each of the technologies have been grouped into three categories:

1. Substandard efficient units (low efficiencies, old technologies, etc.)
2. Standard efficiencies that comply with or fall within industry accepted Minimum Energy Performance Standards (MEPS).
3. Best Available Technologies (BAT).

Tariffs

Residential tariffs were used for lighting and refrigerators, as the en.lighten country lighting assessments indicated that the bulk of lights are found in residential dwellings and the U4E identified the focus area for refrigerators as residential (0.142 USD/kWh).

Industrial tariffs were used for motors, transformers and air conditioning units, as these are primarily found in commercial and industrial buildings (0.145USD/kWh).

All Scenarios

For all the scenarios of all the technologies, an average annual increase in the electrification of the country was used with 2017 as the base year. This average was extrapolated from data provided by several sources including electricity utilities and other published research.

Where necessary, conservative interpretations of this data was used by DNV GL. For Namibia, the increase is calculated to be 5.5% for households based on the World Bank's increase in kWh per capita (as seen in Figure 2.2 above).

Technology Adoption Rates

Uptake of technologies and increases or decreases of the quantities of units are based on information gathered from various sources during several meetings that took place as part of the country visits. The numbers were interpreted, averaged and rounded.

BAU

The Business-as-Usual case assumes that the current adoption rate of energy efficiency technologies continues at the same trend due to the normal rate of rising costs of electricity (average of 8% annual increase across all tariffs, which is in line with current increases) and increased public awareness.

The information gathered during the country visits indicated an adoption of efficient technologies (MEPS & BAT) reducing less efficient products (below MEPS) by specific percentage of the current market share by 2025 and 2030.

MEPS

If Minimum Energy Performance Standards are to be implemented by means of regulations or incentives, an increased adoption of both the MEPS and BATS will take place. Current stock in the market is assumed to be sold, but no new stock of lower standard technologies will be allowed into the market. Currently, installed units are expected to last their normal operating lifetime, after which they will be replaced with MEPS or BAT.

BAT

Best Available Technology implementation assumes that all implementation of new lighting is driven towards BAT standards while allowing MEPS and disallowing new sub-MEPS installation and sales.

Results

The information gathered during the country visits included the expected adoption of efficient technologies (MEPS and BAT) and reducing less efficient products (below MEPS) by a specific percentage of the current market share by 2025 and 2030. The resultant quantity of lights and market shares are shown in the following sections.

3 LIGHTING

The Namibian Census of 2001 reported that 68% of consumers living in urban areas used electricity for lighting and only 10% of rural households. 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. The findings of the 2001 census and the 2009/2010 assessment are compared in Figure 3.1.

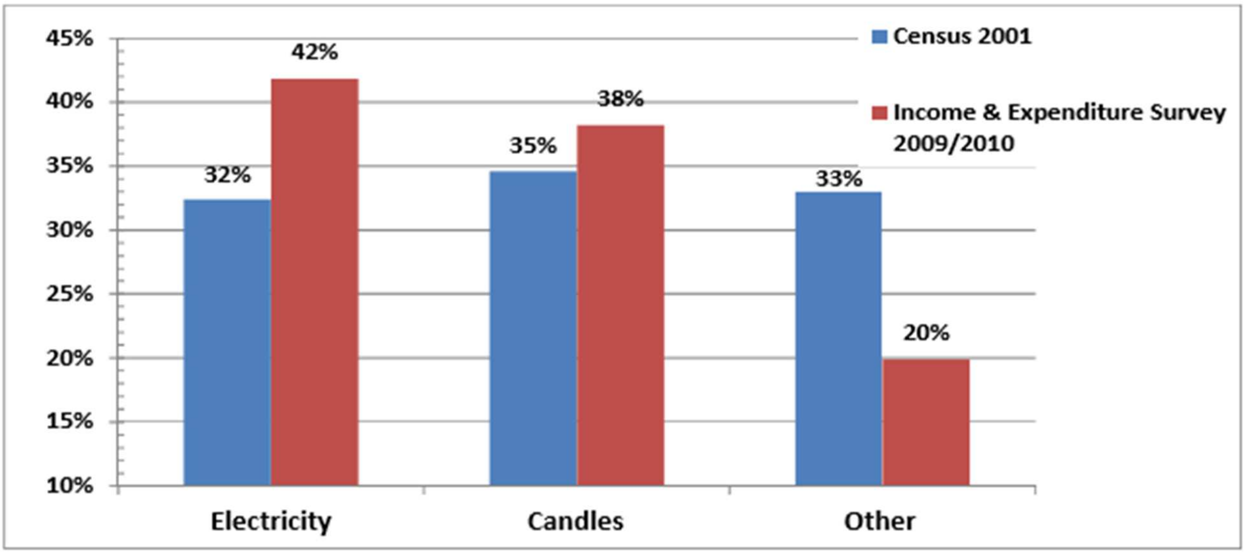


Figure 3.1 Energy for lighting in Namibia (% households using different forms of energy).

Based on information gathered from desktop research and the in-country visit, DNV GL estimates the number of installed lights to be around 6.5 million units as of 2017, of which around half are in residential buildings and the rest in commercial, industrial or other types of installations.

The population of roughly 2.5 million people live in around 250 000 households with around 3.24 million residential lights, which translates to approximately 12 to 13 lights per household.

3.1 Status and Trends of Lighting Products

3.1.1 Stock, sales, sale price, lifetime, projected growth rates and time of use.

As indicated below in Table 3.1, lights have a relatively short life expectancy compared to the other electrical equipment considered in this project.

Table 3.1 Life Expectancy of Lights [26].

Average Rated Lifetime Hours					
	INCANDESCENT	FLUORESCENT	CFL	HALOGEN	LED
TYPICAL RANGE (HOURS)	750-2,000	24,000-36,000	8,000-20,000	2,000-4,000	35,000-50,000

Short life expectancies lead to high replacement frequencies which are opportunities to change to newer, more efficient technologies within lighting. The small size of individual lights, quick adoption of new technologies and the sheer volume of sales continually drive down the costs of both old and new types of lights.

Currently, the lighting trade market in Namibia includes electric lamps, filament lamps (tungsten halogen), fluorescent lamps (hot cathode), discharge lamps, other than ultra-violet lamps, NES and mercury or sodium vapour lamps. On the consumer side, especially in households, incandescent lamps take the lead. Incandescent lamps include standard tungsten lamps or tungsten reflector lamps.

Lighting is generally available in supermarkets and large retail stores. The bulk of stock is made up of CFLs, with limited quantities of halogen and LED lighting available.

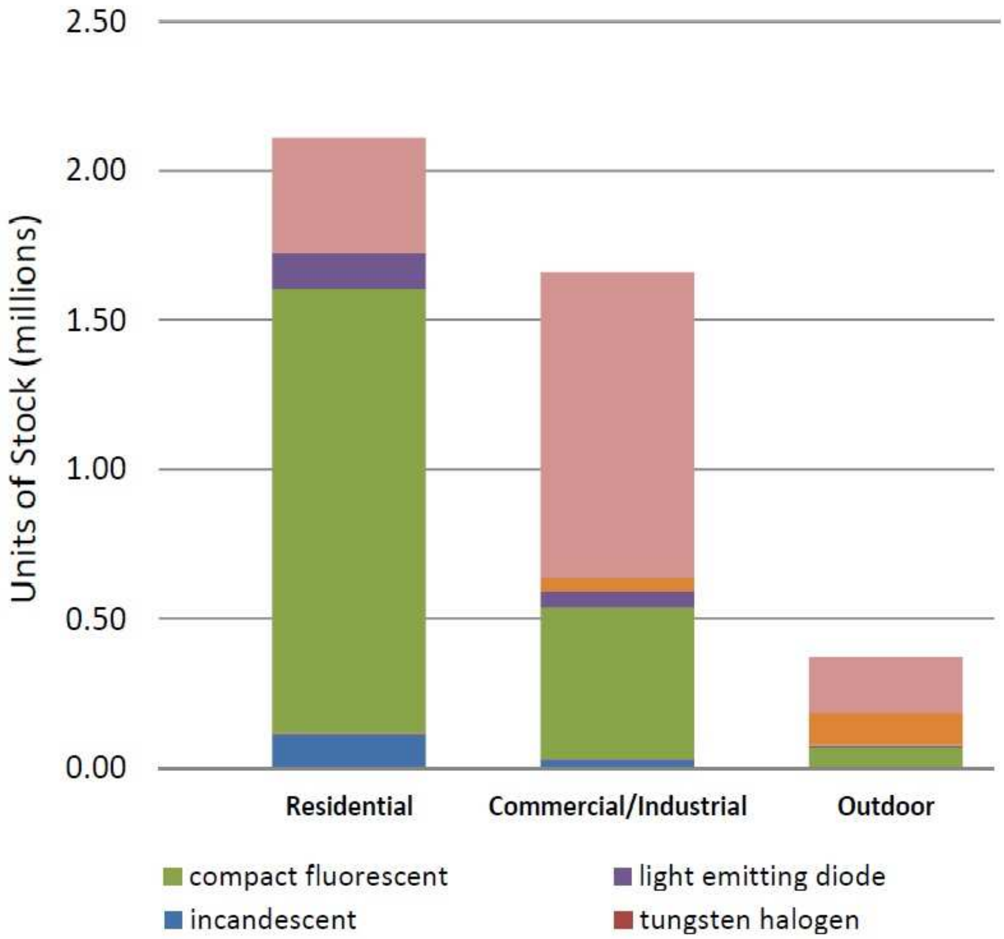


Figure 3.2 Installed light stock in Namibia.

3.1.2 Local manufacturers, suppliers, retailers and other stakeholders

No manufacturing of lighting takes place in Namibia. The Namibian market strongly relies on imports from South Africa. Brands include Pick & Pay, Philips, Eurolux and Ellies with other brands (Chinese imports) taking up a comparatively small portion of shelf space in stores.

There are a couple suppliers and distributors who are involved in lamps and bulbs trading in the area of Namibia including Magnetize Investment CC, Namgem Diamond Manufacturing Company, Shenzhen Guanke Technologies Co. Ltd, Swakop Electrical Supplies cc and others. Their main activity includes importing, distributing, trading, exporting as well as manufacturing light bulbs, fluorescent lamps, desk lamps, ceiling lights, laser lighting, garden lighting and LED lighting.

3.1.3 Import/Export

As stated above, no manufacturing takes place in Namibia. Therefore, all products are imported. The bulk of products are imported from South Africa. The figures shown below in Figure 3.3 are sales volumes per the comtrade database.

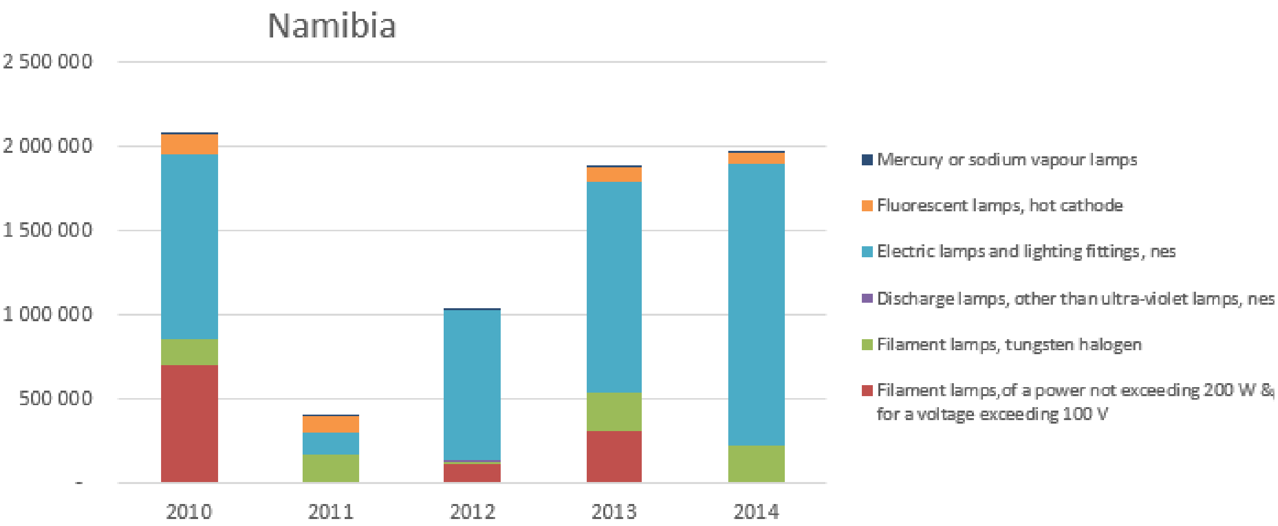


Figure 3.3 Lights imported to Namibia [27].

3.1.4 Barriers to overcome

Availability of power lines (and general access to electricity) often trumps energy efficiency. This is amplified by the lack of funding, resulting in the purchase of cheapest items, rather than energy efficient items. Lastly, a general perception that LEDs are of poor quality (as sometimes found in the market) discourages people to change from current, trusted technologies to newer technologies.

3.1.5 New vs. used equipment

Lights are mostly replaced on burn-out, and there is limited to no use for old equipment. Where lighting retrofits happen, old lights should be disposed, but this does not generally happen. Old lights are often sold or donated to schools/charities.

3.2 Potential Savings from Energy-Efficient Lighting

The process for the modelling of the different scenarios has been described in Section 2. For a simple savings calculation, lights have been grouped into three categories:

1. All lights except: Fluorescent (FL), Compact Fluorescent (CFL) & LEDs
2. Fluorescent (FL) & Compact Fluorescent (CFL)
3. LEDs.

3.2.1 Benefits of Energy Efficiency 3 Scenarios

For the Business-As-Usual (BAU), Minimum Energy Performance Standards (MEPS) and Best Available Technologies (BAT), the starting quantities are the same and indicates the current estimate quantities installed. The percentages indicate the increase or decrease rates of the technologies during BAU, if MEPS are enforced or if BAT is pursued.

For example, the BAU scenario shown below in Table 3.2 considers that the adoption of LED technology will increase by 10% between 2020 and 2025 and with a further 50% from 2025 to 2030 while further also growing at the rate of increase in electrification of the country.

Table 3.2 BAU, MEPS, BAT scenarios for lighting.

Scenario	Description	QTY (2017)	QTY (2020)	Tech. Adopt (2025)	QTY (2025)	Tech. Adopt (2030)	QTY (2030)
Business as Usual	QTY Halo, Inc etc.	3 692 933	4 110 327	-10%	4 834 830	-20%	5 055 144
Business as Usual	QTY CFL & FL	2 178 117	2 424 299	14%	3 616 993	13%	5 353 650
Business as Usual	QTY LED	609 566	678 462	10%	975 395	50%	1 912 203
DNV GL Projected MEPS	QTY Halo, Inc etc.	3 692 933	4 110 327	-50%	2 686 017	-20%	2 808 413
DNV GL Projected MEPS	QTY CFL & FL	2 178 117	2 424 299	79%	5 677 135	0%	7 426 545
DNV GL Projected MEPS	QTY LED	609 566	678 462	20%	1 064 067	50%	2 086 040
DNV GL Projected BAT	QTY Halo, Inc etc.	3 692 933	4 110 327	-80%	1 074 407	-20%	1 123 366
DNV GL Projected BAT	QTY CFL & FL	2 178 117	2 424 299	122%	7 022 728	-6%	8 590 082
DNV GL Projected BAT	QTY LED	609 566	678 462	50%	1 330 084	50%	2 607 550

Current Data & Assumptions:

- *Exchange Rate: 1 NAD = 1 ZAR = 13.5 USD.*
- *Average Residential Electricity Tariff: 0.142 USD/kWh.*
- *Average Industrial Electricity Tariff: 0.145 USD/kWh.*
- *Electricity Cost Increase: 8% per annum.*
- *Operating hours: 2 hr in morning (6-8am) and 2hr in the evening (7-9pm), 365 days per annum.*

If these adoption rates are accurate, the following savings (Table 3.3) are projected to be achieved under the MEPS and BAT scenarios. The U4E targets are also shown as benchmarks.

Table 3.3 Projected savings for lighting under MEPS And BAT scenarios.

Row Labels	Sum of GWh Savings (2025)	Sum of GWh Savings (2030)	Sum of Million USD Savings (2025)	Sum of Million USD Savings (2030)	Sum of GHG Savings (2025)	Sum of GHG Savings (2030)
DNV GL Projected MEPS	109	114	29	44	6	6
DNV GL Projected BAT	192	203	50	78	10	10
U4E Targets	323	378	46	54	18	21

3.2.2 Job creation/ elimination from Energy Efficient products.

Lighting surveys, retrofitting, supplying (importing, exporting, distribution) and the energy efficiency 'industry' in general would benefit from and drive economic activity related to promotion of energy efficient lighting technologies.

3.3 **Status of Policies and Initiatives**

NamPower's energy efficiency in households' initiative has seen the achievement of significant savings through its 1mLED project. Phasing out the import and commercialisation of incandescent light bulbs has resulted in further savings and increase uptake in energy efficient technologies.

The utility is looking at several ways to sustain LED uptake by lobbying for removal of VAT on LEDs.

3.3.1 Standards and regulations

Namibian lighting Standards are in general mostly the same as South African standards [28].

3.3.2 Supporting Policies – Labelling and consumer awareness campaigns

NamPower drives the 1mLED Campaign, which is one of NamPower's energy saving initiatives aimed at reducing electricity usage in the residential areas during peak times (6:00 am - 9:00am and 18:00pm - 21:00pm) by replacing one million incandescent bulbs with light emitting diode (LED) bulbs. This is necessary, because the demand for electricity in Namibia has increased drastically and has exceeded supply. The situation has prompted NamPower to implement various solutions to address the shortage of electricity of which the 1mLED Campaign is an initiative. The 1mLED Campaign is aimed at reducing electricity usage in residential areas during peak times. LED bulbs last longer and use far less electricity compared to other bulbs [29].

3.3.3 Financial Mechanisms

Even though NamPower is handing out several LEDs for free, there are no mechanisms that provide access to financing for the implementation of energy efficient lighting beyond this limited initiative.

3.3.4 Monitoring, Verification and Enforcement

Due to the large amount of imports from South Africa, SANS standards are expected to prevail and are acceptable to the local authorities.

3.3.5 Environmentally Sound Management

Namibia is bound by the SADC Protocol on Energy 1996, which states that: "Energy efficiency and conservation applications have minimal adverse impact on the environment, relative to other energy applications". The handling of redundant replaced energy units, like lighting, is addressed in the Environmental Management Act 7 of 2007 and related regulations.

3.3.6 Other on-going projects/initiatives

The Southern African Power Pool (SAPP) started developing a specific programme for Utilities with respect to CFL replacement and commercial lighting retrofits. NamPower started promoting and distributing CFLs to customers free of charge in 2007, even before the SAPP programme, targeting mainly households, schools and eventually lodges and hostels and spending around USD 1.08 million. The main regional driver behind efficient lighting has been SAPP, which has focused on CFL replacement as one of several means for SADC utilities to reduce demand. September 2016 – the State-owned Namibian power utility NamPower embarked on the installation of one-million LED lightbulbs to replace power-intensive incandescent lightbulbs as part of a project aimed at cutting down household power consumption in the capital Windhoek, at a cost of around USD 9.59 million.

4 AIR-CONDITIONING

To strengthen, manage, measure and protect the refrigeration and air conditioning industry, the Namibian Institute of Refrigeration and Air Conditioning (NIRAC) was formulated [30]. Even so, very little information about the total number of air-conditioning unit sales or estimates of installed units is available.

Commercial and Industrial Air Conditioning Efficiency and Load Control [31]

It is estimated that air conditioning accounts for up to 70% of the electrical load of office buildings, with commercial buildings and hotels having a similar profile. This implies that significant gains can be made by improving the efficiency of air conditioners and possibly controlling their loads. Commercial load contributes a large part of the daytime national peak, so efficiency gains made here will increase opportunities for electric water heater (EWH) ripple control for the evening peak. According to the comtrade database, the number of room air-conditioners sold during the past 10 years are estimated to be in the vicinity of 280 000 units, while the expected lifespan of 20 years or longer extrapolates to the value of around 710 000 units currently installed and operational.

4.1 Status and Trends of Air-conditioning Products

4.1.1 Market Drivers

General industry trends have seen replacement cycles of typically around 10 years for outdoor units exposed to elements such as sun and rain, while well looked after indoor units can last up to 20 years or longer.

4.1.2 Purchase of air-conditioning products, including where and availability of Energy Efficient products

Air-conditioning units are not "off-the-shelf" items, as these are typically supplied and installed by a solution or service provider. Most of these service providers will partner with one or a few brands and act as local distributors and installers. A wide variety of brands provide almost all sizes and performance ratios available.

MEPS require all air-conditioning units to be at least Class B. However, the bulk of units available in Namibia are Class A or better, mostly since roughly 75% are supplied from South Africa.

4.1.3 Local manufacturers, suppliers, retailers and other stakeholders

No local manufacturing of air-conditioning units takes place in Namibia. Stakeholders include importers, distributor and installers, most of which are part of the building industry.

4.1.4 Import/export

The average number of units to enter Namibia each year between 2007 and 2016 is roughly 20 000 units, of which 75% is imported from South Africa. The annual imports (according to the comtrade database) are shown below in Figure 4.1 and Figure 4.2.

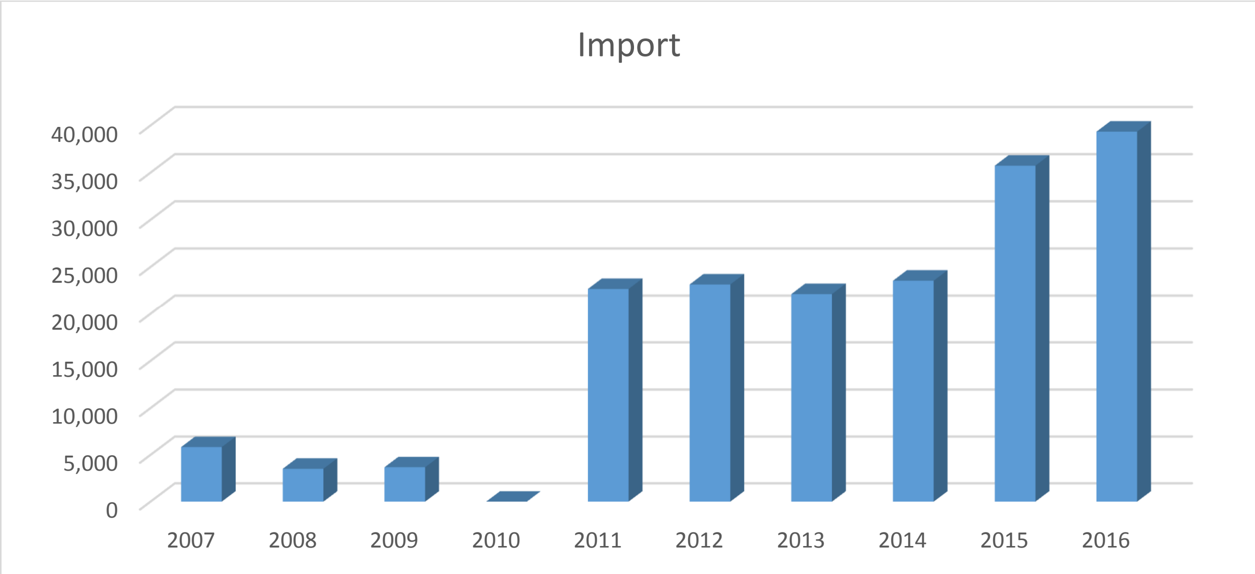


Figure 4.1 Aircon unit imports to Namibia per year.

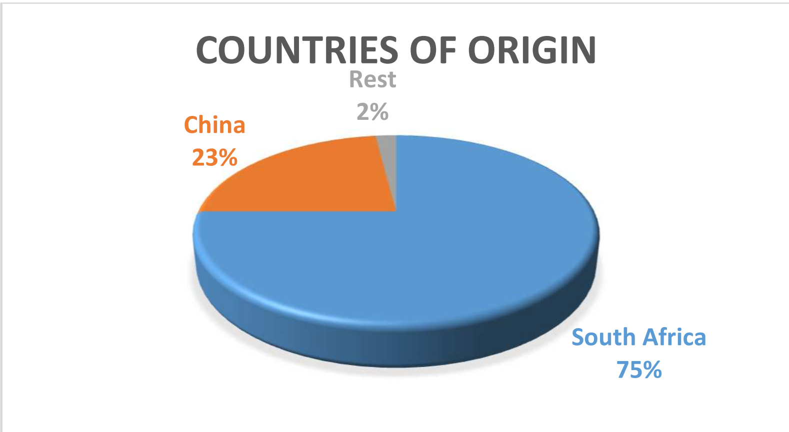


Figure 4.2 Aircon units in Namibia countries of origin.

Due to the historic trade relationships and proximity to South Africa, it is not surprising that 75% of the units are imported from there. China is an obvious but distant second, competing mostly on pricing for the lower end market. The most prominent brands are LG, DAIKIN, SAMSUNG, Carrier, Fujitsu and Mitsubishi.

4.1.5 Barriers to overcome

Low average household incomes and poverty in general leads to decision-making that is very sensitive to cashflow and therefore against high fist cost of energy efficient equipment, even though the lower overall lifetime cost may be well known. This often results in the purchase of cheapest items, rather than energy efficient items.

Due to this mindset, the distribution and retail companies bring in products to satisfy the perceived needs of the clients, resulting in a lack of energy efficient options (variety & stock) available on the market.

4.1.6 New vs. used equipment

Not applicable to air-conditioning units, as the units are typically installed in a fixed location and the costs and effort of dismantling and relocating is likely to be more than 50% of a new unit.

4.2 Potential Savings from Energy-Efficient Air-conditioning

For a simple savings calculation, units have been grouped into three categories:

1. Below Class B.
2. Class B – A.
3. Class A+ and better.

4.2.1 Benefits of Energy Efficiency – 3 Scenarios

Table 4.1 BAU, MEPS, BAT scenarios for air-conditioning.

Scenario	Description	QTY (2017)	QTY (2020)	Tech. Adopt (2025)	QTY (2025)	Tech. Adopt (2030)	QTY (2030)
Business as Usual	Lower than Class B	319 570	355 689	-6%	436 979	-7%	531 136
Business as Usual	Class B - Class A	248 560	276 653	4%	375 004	2%	498 311
Business as Usual	Class A+ & Above	142 000	158 050	7%	221 025	11%	320 647
DNV GL Projected MEPS	Lower than Class B	319 570	355 689	-28%	334 707	-19%	354 333
DNV GL Projected MEPS	Class B - Class A	248 560	276 653	24%	448 352	1%	590 677
DNV GL Projected MEPS	Class A+ & Above	142 000	158 050	21%	249 944	24%	405 067
DNV GL Projected BAT	Lower than Class B	319 570	355 689	-35%	302 166	-33%	264 596
DNV GL Projected BAT	Class B - Class A	248 560	276 653	14%	412 711	-14%	465 954
DNV GL Projected BAT	Class A+ & Above	142 000	158 050	54%	318 110	49%	619 478

Current Data & Assumptions:

- *Exchange Rate: 1 NAD = 1 ZAR = 13.5 USD.*
- *Current Average Electricity Price to consumer: 0.142 USD/kWh.*
- *Operating hours: 8 hours per day x 125 days per annum = 1 000 hours.*
- *Average cooling capacity: 3.5kW.*
- *Electricity Cost Increase: 8% per annum.*

QTY and adoption of technologies based on information from stakeholder interviews.

If these adoption rates are accurate, the following savings are projected (

Table 4.2) to be achieved under the MEPS and BAT scenarios. The U4E targets are also shown as benchmarks.

Table 4.2 Projected savings for air conditioning under MEPS And BAT scenarios.

Row Labels	Sum of GWh Savings (2025)	Sum of GWh Savings (2030)	Sum of Million USD Savings (2025)	Sum of Million USD Savings (2030)	Sum of GHG Savings (2025)	Sum of GHG Savings (2030)
DNV GL Projected MEPS	59	122	16	48	3	6
DNV GL Projected BAT	113	289	30	114	6	15
U4E Targets	80	120	11	17	5	7

4.2.2 Job creation or elimination from Energy Efficiency products

No direct impact on the Namibian market, as the bulk of units are imported.

4.3 Status of Policies and Initiatives

4.3.1 Standards and regulations

Based on the history with South Africa, Namibian Standards are mostly the same as South African standards.

4.3.2 Supporting Policies – Labelling and consumer awareness campaigns

Namibia followed South Africa after 2015 by developing an appliance and equipment labelling and standards programme. As stated above, compulsory specification for Energy Efficiency and Labelling of electrical and electronic apparatus (VC 9008), dated 28 November 2014 includes air conditioners. Companies are encouraged to manufacture and sell appliances which are energy efficient i.e. Samsung and Phillips have already signed the voluntary accord and other companies are following suit. Air conditioners shall comply with SANS 941, and shall have a minimum energy efficiency rating of Class B.

4.3.3 Financial Mechanisms

No financial mechanisms are available to consumers, manufacturers or importers to drive the adoption of energy efficient models.

4.3.4 Monitoring, Verification and Enforcement

The National Regulator for Compulsory Specifications (NRCS) GG 944 specification states under section 4, 4.1 that "Air conditioners and heat pumps shall comply with SANS 941, shall have a minimum energy efficiency rating of Class B."

4.3.5 Environmentally Sound Management

Namibia is bound by the SADC Protocol on Energy 1996, which states that: "Energy efficiency and conservation applications have minimal adverse impact on the environment, relative to other energy applications". The handling of redundant replaced energy units, like air conditioning, is addressed in the Environmental Management Act 7 of 2007 and related regulations.

4.3.6 Other on-going projects/initiatives

No current projects or initiatives exist to drive the adoption of energy efficient air-conditioning units rather than standard efficiency units.

5 REFRIGERATORS

The Namibian Institute of Refrigeration and Air Conditioning (NIRAC) was initially formulated and is committed to strengthen and protect the industry of refrigeration, air conditioning and the allied arts of sciences; to encourage and persevere with the scientific research and the study of principles and methods in the fields of refrigeration, air conditioning [30].

5.1 Status and Trends of Refrigeration Products

5.1.1 Market Drivers

Namibia has an estimated number of under 480 000 refrigerators installed. The average life expectancy of a refrigerator is determined by the quality of construction and how the item is cared for. A properly maintained refrigerator can last between 14 and 17 years, depending on model and size. *Source: Stakeholder interviews: DEFY, Whirlpool.*

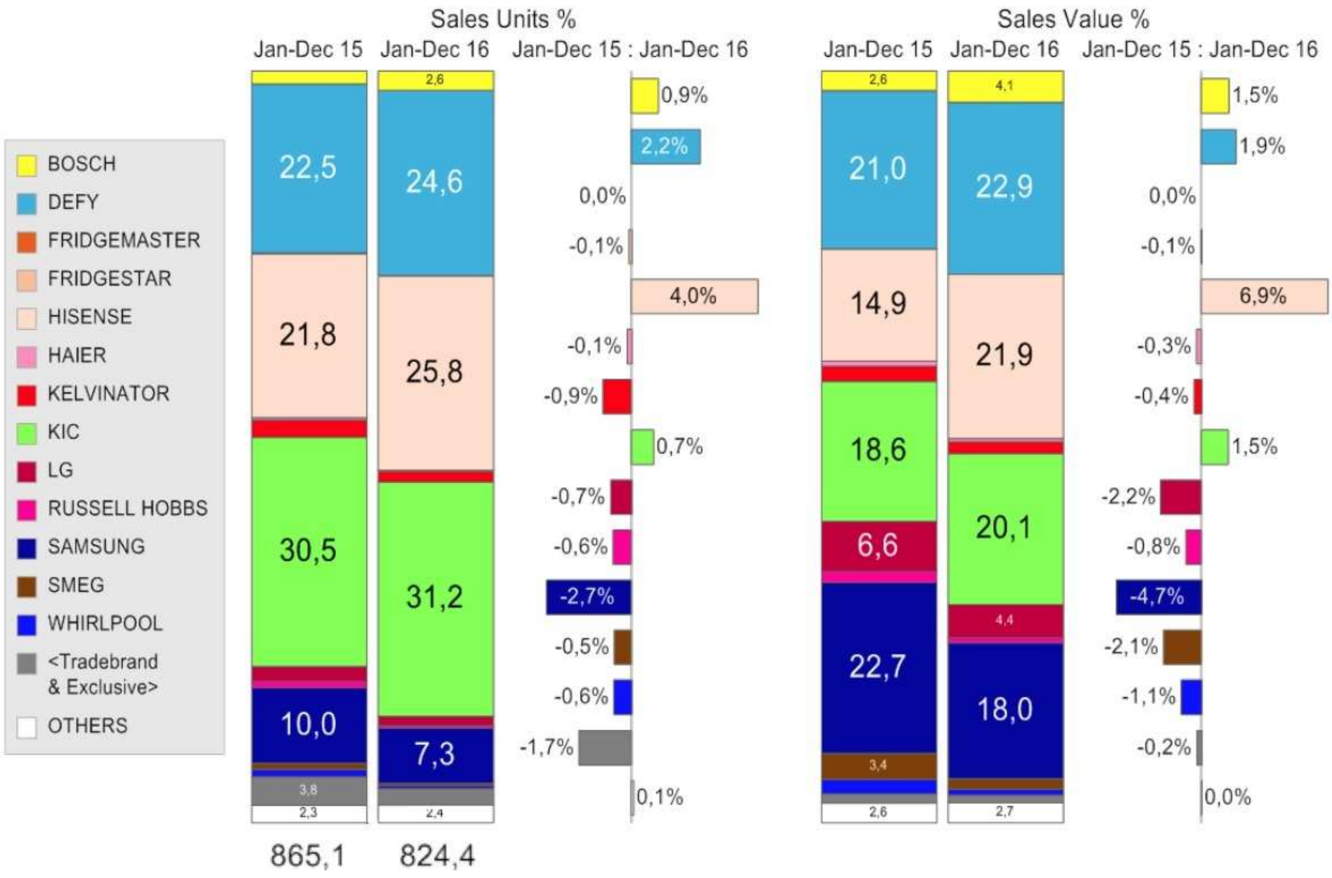
Considering that according to the 2011 census, roughly 42% of the 464 839 [32] households have electricity, the 195 000 households have an average of more than 2 fridges per home. The lower income homes are likely to have one each, with middle to high income households having several units per home with some owning more than one dwelling. The projected increased access to grid electricity, especially in rural areas, is likely to result in a significant increase in this value.

5.1.2 Purchase of refrigeration products, including where and availability of Energy Efficient products

Refrigerators are sold at typical furniture or white good stores. Some of the large retailers include GAME, BEARS, Furniture City, Morkels, Russel's, House & Home and HiFi Corporation. Most refrigerators have the standard energy efficiency markings displayed on the outside front and a variety of efficiencies were available at all the stores, ranging from MEPS (Class B) to BAT (Class A+++).

5.1.3 Local manufacturers, suppliers, retailers and other stakeholders

Defy is the largest manufacturer of refrigerators in Southern Africa and holds a market share of 24.6%. Other strong competitors include Hisense and KIC, both of which come in at a cheaper price. Figure 5.1 provides a representation of refrigerator market share (for 2015-2016).



Provided by DEFY; initial source: GFK.

Figure 5.1 Refrigerator Market Share.

5.1.4 Import/export

South Africa is the main supplier of refrigerators to Namibia, covering 86% of the overall sales over the past 10 years, with China taking up a mere 11% of the market. Namibia also exports small quantities to Angola, with the overall exports number sitting at just over an estimated 100 000 units.

5.1.5 Barriers to overcome

Some old model refrigerators were undoubtedly built to last. Therefore, some very old units are still in operation throughout South Africa and the users are typically not willing to let these go. When new refrigerators are bought, old units are often kept as "backup" but are left running in the basement or attic. Alternatively, old refrigerators are given to friends or family who do not have the financial means to purchase their own units. The result is that these inefficient units are not removed from the system and the purchase of new units simply increase the overall number of refrigerators in the market.

5.1.6 New vs. used equipment

Refrigerators are very seldom repaired in Southern Africa after their warranty period. A very small refrigerator repair industries can be found in low income areas, but accurate data is not available.

5.2 Potential Savings from Energy-Efficient Refrigeration Products

Current minimum energy performance standards in Namibia requires fridges to be at least of Class B. The tables below consider the current scenario (BAU) as well as the adoption of improved Minimum Energy Performance Standard and Best Available Technologies if these were to be driven by policies and regulations [32]. For a simple savings calculation, fridges have been grouped into three categories:

1. Below Class B.
2. Class B – A.
3. Class A+ and better.

5.2.1 Benefits Energy Efficiency – 3 scenarios

Table 5.1 BAU, MEPS, BAT scenarios for refrigerators.

Scenario	Description	QTY (2017)	QTY (2020)	Tech. Adopt (2025)	QTY (2025)	Tech. Adopt (2030)	QTY (2030)
Business as Usual	Lower than Class B	317 721	353 631	-5%	439 072	-7%	533 680
Business as Usual	Class B - Class A	113 810	126 673	9%	179 974	10%	259 663
Business as Usual	Class A+ & Above	42 679	47 503	14%	70 776	17%	108 227
DNV GL Projected MEPS	Lower than Class B	317 721	353 631	-52%	221 847	-61%	113 079
DNV GL Projected MEPS	Class B - Class A	113 810	126 673	128%	377 952	27%	626 125
DNV GL Projected MEPS	Class A+ & Above	42 679	47 503	45%	90 023	38%	162 366
DNV GL Projected BAT	Lower than Class B	317 721	353 631	-69%	143 276	-80%	37 451
DNV GL Projected BAT	Class B - Class A	113 810	126 673	165%	437 897	6%	604 261
DNV GL Projected BAT	Class A+ & Above	42 679	47 503	75%	108 648	83%	259 857

Current Data & Assumptions:

- *Exchange Rate: 1 NAD = 1 ZAR = 13.5 USD.*
- *Average Electricity Price to consumer: 0.093 USD/kWh.*
- *Electricity Cost Increase: 8% per annum.*
- *QTY and adoption of new technologies based on information from stakeholder interviews.*

If these adoption rates are accurate, the following savings are projected (

Table 5.2) to be achieved under the MEPS and BAT scenarios. The U4E targets are also shown as benchmarks.

Table 5.2 Projected savings for refrigerators under MEPS And BAT scenarios.

Row Labels	Sum of GWh Savings (2025)	Sum of GWh Saving (2030)	Sum of Million USD Savings (2025)	Sum of Million USD Savings (2030)	Sum of GHG Savings (2025)	Sum of GHG Savings (2030)
DNV GL Projected MEPS	30	59	8	23	2	3
DNV GL Projected BAT	42	75	11	29	2	4
U4E Targets	39	71	6	10	2	4

5.2.2 Job creation/ elimination from energy efficiency products

The adoption of energy efficiency has no real specific impact(s) on the local job market. Jobs may include technicians, installing and repairing, trading, supply of equipment, but these are currently in operation.

5.3 Status of Policies and Initiatives

5.3.1 Standards and regulations

Standards in Namibia are similar to South African standards [28].

5.3.2 Supporting Policies – Labelling and consumer awareness campaigns

The compulsory specification for Energy efficiency and labelling of electrical and electronic apparatus (VC 9008, dated 28 November 2014) includes refrigerators. Companies are encouraged to manufacture and sell appliances which are energy efficient, e.g. Samsung and Phillips have already signed the voluntary accord and other companies are following suit. Refrigerators need to comply with SANS 941 and have a minimum energy efficiency rating of Class B.

5.3.3 Financial Mechanisms

No financial mechanisms are currently in place in Namibia to promote the adoption of energy efficient refrigerators.

5.3.4 Monitoring, Verification and Enforcement

MEPS standards in are monitored and enforced on imported and locally manufactured items by ensuring compliance to SANS.

5.3.5 Environmentally Sound Management

Namibia is bound by the SADC Protocol on Energy 1996, which states that: "Energy efficiency and conservation applications have minimal adverse impact on the environment, relative to other energy applications". The handling of redundant replaced energy units, like refrigerators, is addressed in the Environmental Management Act 7 of 2007 and related regulations.

5.3.6 Other on-going projects/initiatives

There are no ongoing projects or initiatives to drive the improvement of energy efficiency in the refrigerator market.

6 MOTORS

Many factors affect the life expectancy of an electric motor. These factors include input power problems, improper mechanical installations, malfunctions in the load, environmental factors, among others.

6.1 Status and Trends of Motors

6.1.1 Life expectancy

If motors are operated under normal conditions, sized correctly for the application and within the manufacturer's design requirements, it can last 15 years or more [33]. Failure of motors can generally be grouped into electrical failure (windings, drives, etc.) and mechanical failure (bearings, mountings, etc.)

Repair of electrical failures can be done by rewinding the motor. This typically only takes place after catastrophic failure in the motor's insulation and winding, which usually happens due to a thermal breakdown. Motors are frequently replaced rather than rewound due to costs, convenience and the claim that rewinding may reduce the motor's efficiency [34].

When looking at the mechanical failures, motor bearings or mountings might fail due to improper mechanical installation causing undesirable forces acting on the bearings and mountings, or simply due to poor maintenance.

An indicative guide of when to repair or when to replace a motor is depicted below in Figure 6.1 (provided by ABB).

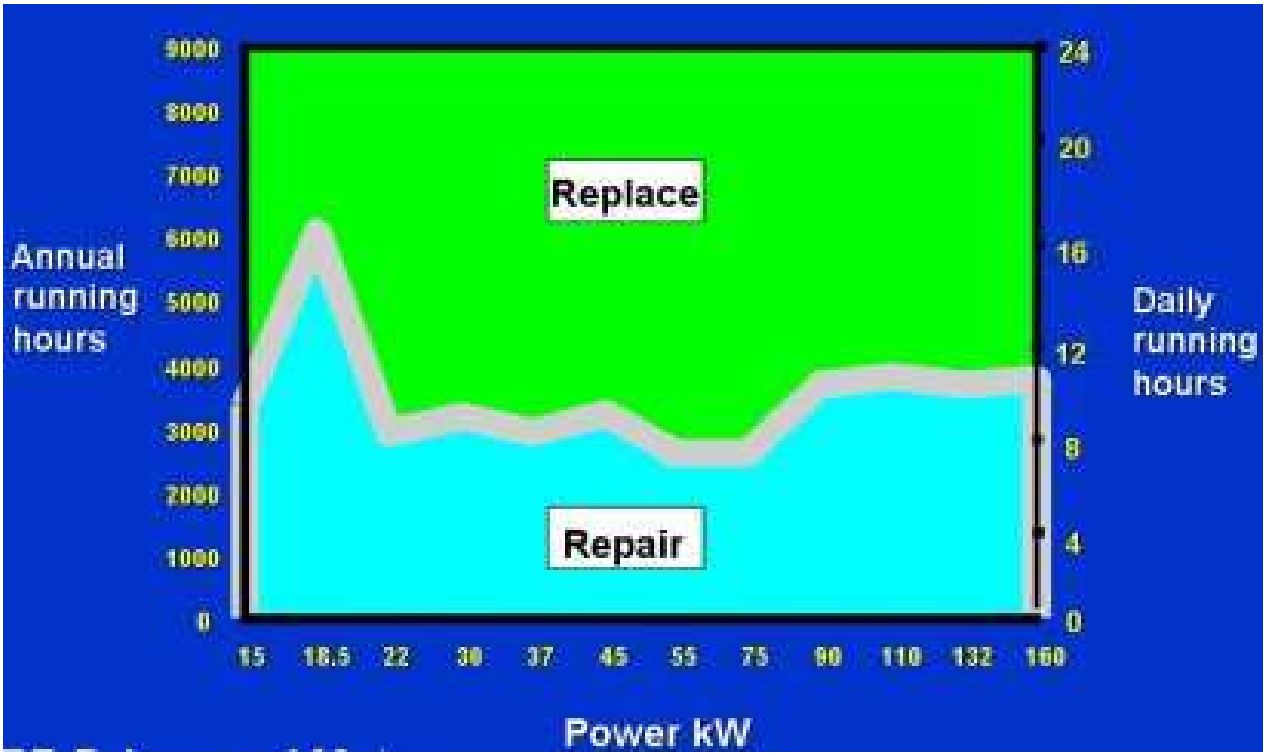


Figure 6.1 Repair or Replace [35].

6.1.2 Price

A list of comparative motor prices is shown in Figure 6.2 below.

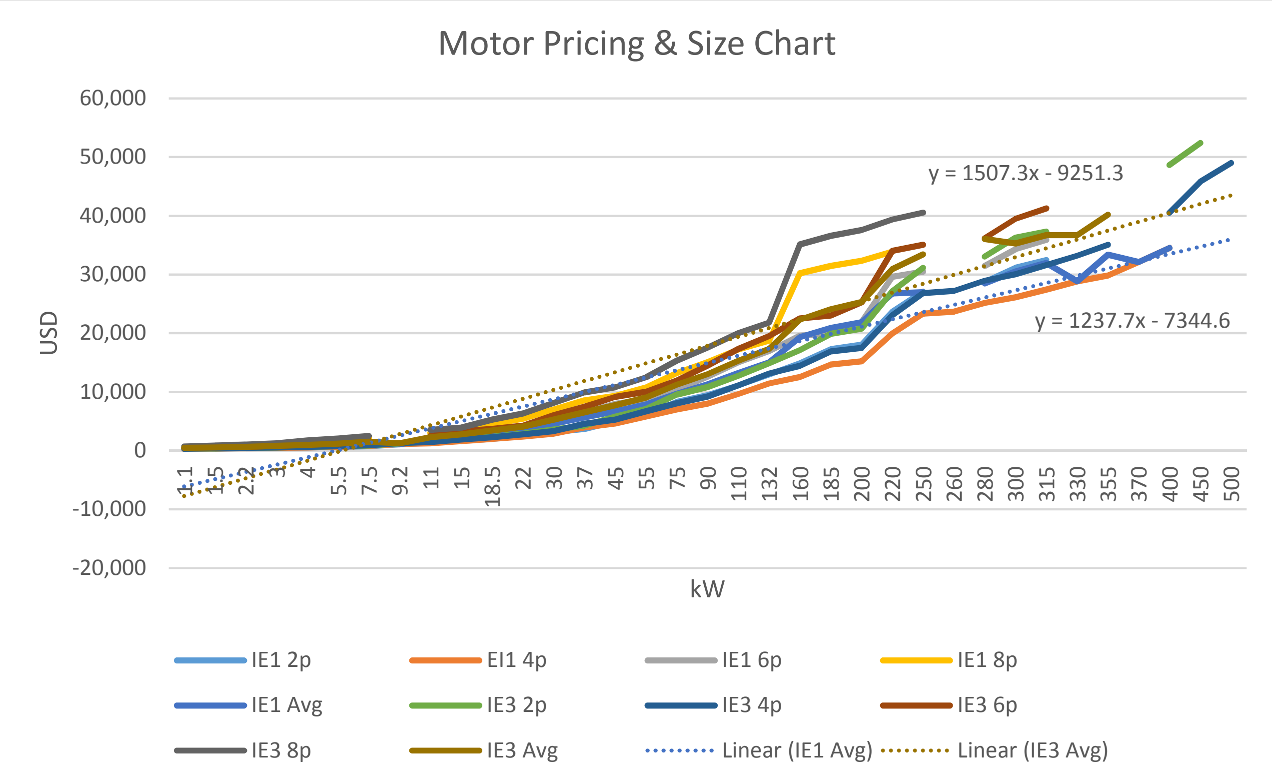


Figure 6.2 Motor Prices vs Size.

IE3 motors are typically between 15 – 20% more expensive than their IE1 counterparts. Even though the operating costs of a typical motor is roughly 50% of the annual cost, in countries where initial capital plays a major factor, this is one of the biggest market barriers.

Electrical motors are generally available from a wide variety of distributors and installers and include anything from old rewound motors to new premium efficiency motors.

Motors are not "off the shelf" items and are usually sold as part of a project, machine or installation. Therefore, the end user is often not in direct contact with the motor manufacturer or supplier during new installations. The motors are typically procured by a "project company" or solution providing selling the motor as part of a solution to the end user. The project companies are likely to provide "back to back" guarantees as provided by the motor manufacturers and are likely to administrate the service, repair and replacement of these motors on behalf of the client.

After the initial maintenance period provided by the motor supplier/installer, the client would typically take ownership of maintenance of the motor and might deal with the OEM suppliers or other local service companies to maintain the motors.

6.1.3 Import/export

Namibia imports over 80% of its electric motors from South Africa, with other countries making up the remaining percentage [37]. South Africa also acts as the primary point of entry into the African market for many manufacturers and distributors and therefore exports a large amount of motors to its neighboring countries.

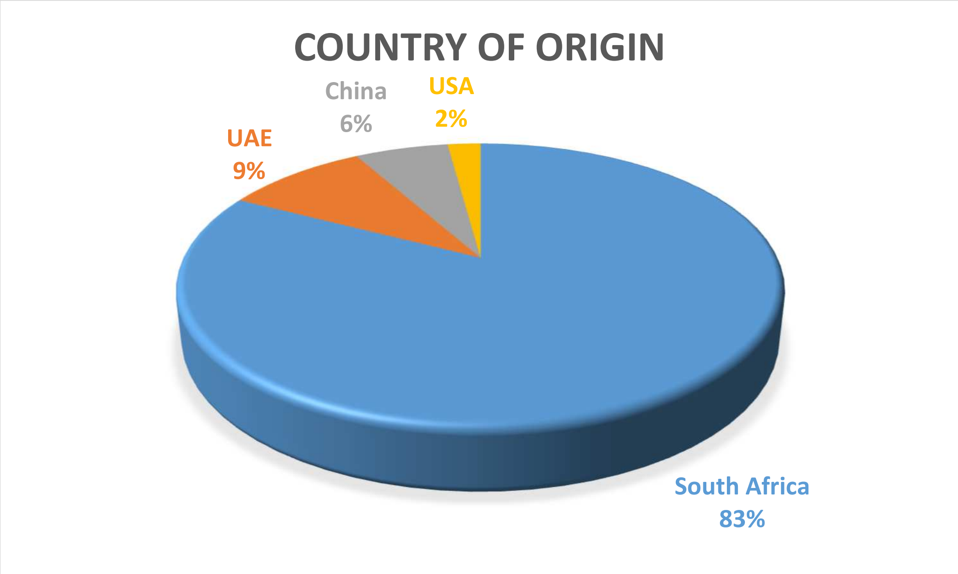


Figure 6.3 Country of origin of imported motors.

Roughly 35 000 motors flow across the borders into Namibia annually and the total number of installed and operational units are estimated to be in the vicinity of 400 000.

6.1.4 Local manufacturers, suppliers, retailers and other stakeholders

Although many local and international companies in South Africa claim to be motor manufacturers, very little actual manufacturing of motors take place in South Africa. Some isolated parts of motors are manufactured locally, primarily for very specific types of industries where typical motors do not meet the requirements of the local clients. In some instances, motors are assembled locally according to the needs of the local clients. However, this is a negligible amount and for all practical purposes, one can say that all motors are imported [36].

The three largest motor suppliers in South Africa are:

- WEG (approx. 44%)
- MOTORELLI (approx. 21%)
- ACTOM (approx. 19%).

6.1.5 Barriers to overcome

Overall Inefficient Systems

Due to the low historical price of electricity in Namibia, most industrial and commercial systems and processes (which include electrical motors) were designed for low installation costs which did not necessarily take efficiency into consideration.

Negligible Savings

Apart from the fact that more efficient motors are more expensive, there is a general perception that the savings from high efficiency motors are negligible when added to an overall inefficient system.

Rewinding Perception

Motors can be rewound to perform at the same efficiency [38] this reduces the drive to buy new equipment.

6.1.6 New vs. used equipment

Motors are typically used at their point of installation until catastrophic failure occurs. In the cases where repair or rewinding takes place, motors are mostly re-installed in their initial position and will continue to be used there until end of life. Therefore, there is little to no second hand electrical motor industry to speak of.

6.2 **Potential Savings from Energy-Efficient Motors**

Current minimum energy performance standards in Namibia requires motors to be at least of Class IE1. The tables below consider the current scenario (BAU) as well as the adoption of improved Minimum Energy Performance Standards and Best Available Technologies if these were to be driven by policies and regulations. For a simple savings calculation, motors have been grouped into three categories:

1. IE1 and below.
2. IE3.
3. IE4 and premium.

6.2.1 Benefits of Energy Efficiency products – 3 scenarios

Table 6.1 BAU, MEPS, BAT scenarios for motors.

Scenario	Description	QTY (2017)	QTY (2020)	Tech. Adopt (2025)	QTY (2025)	Tech. Adopt (2030)	QTY (2030)
Business as Usual	Class IE1 & below	178 914	199 136	-5%	247 250	-7%	300 526
Business as Usual	Class IE3	139 155	154 883	2%	206 185	1%	272 503
Business as Usual	Class IE4	79 517	88 504	8%	124 925	12%	182 865
DNV GL Projected MEPS	Class IE1 & below	178 914	199 136	-11%	231 634	-13%	263 381
DNV GL Projected MEPS	Class IE3	139 155	154 883	7%	216 017	9%	308 015
DNV GL Projected MEPS	Class IE4	79 517	88 504	13%	130 708	8%	184 497
DNV GL Projected BAT	Class IE1 & below	178 914	199 136	-13%	226 429	-20%	236 747
DNV GL Projected BAT	Class IE3	139 155	154 883	4%	210 812	6%	292 289
DNV GL Projected BAT	Class IE4	79 517	88 504	22%	141 119	23%	226 857

Current Data & Assumptions:

- *Exchange Rate: 1 NAD = 1 ZAR = 13.5 USD*
- *Current Average Electricity Price to consumer: 0.142 USD/kWh*
- *Electricity Cost Increase: 8% per annum*

- *Average Motor Size: 10kW (Source: ESKOM DSM Energy Efficient Motor Program)*
- *Average Operating Hours: 8 hours per day, 5 days per week, 50 weeks per annum.*

If these adoption rates are accurate, the following savings are projected to be achieved under the MEPS and BAT scenarios. The U4E targets are also shown as benchmarks.

Table 6.2 Projected savings for motors under MEPS And BAT scenarios.

Row Labels	Sum of GWh Savings (2025)	Sum of GWh Savings (2030)	Sum of Million USD Savings (2025)	Sum of Million USD Savings (2030)	Sum of GHG Savings (2025)	Sum of GHG Savings (2030)
DNV GL Projected MEPS	18	37	5	15	1	2
DNV GL Projected BAT	28	82	7	32	1	4
U4E Targets	28	63	4	9	2	4

6.2.2 Job creation/elimination from energy efficient products

Strict implementation of high EE standards might result in a reduced amount of motors being rewound. This will have a negative impact on the local motor rewinding industry. On the other hand, this will drive the import of new, high efficiency motors, which in turn will result in jobs in the distribution and sales sectors.

6.3 **Status of Policies and Initiatives**

6.3.1 Standards and regulations

IEC International Standards have been adopted in Namibia [32].

6.3.2 Supporting Policies – Labelling and consumer awareness campaigns

All electric motors are required to comply with IE/SANS labelling standards.

6.3.3 Financial Mechanisms

Currently, no funding mechanisms are in place to drive minimum energy performance standards.

6.3.4 Monitoring, Verification and Enforcement

Verification of motor specification compliance is enforced by the SABS.

6.3.5 Environmentally Sound Management

Namibia is bound by the SADC Protocol on Energy 1996, which states that: “Energy efficiency and conservation applications have minimal adverse impact on the environment, relative to other energy applications”. The handling of redundant replaced energy units, like motors, is addressed in the Environmental Management Act 7 of 2007 and related regulations.

6.3.6 Other on-going projects/initiatives

There are no on-going initiatives to enhance the adoption of efficient motors.

7 TRANSFORMERS

The Namibian power networks are mostly distributed at the endpoints by pole mounted distribution transformers.

7.1 Status and Trends of Transformers

7.1.1 Stock, sales, sale price, lifetime, projected growth rates, repairs and time of use.

NamPower provided information leading to believe that they have roughly 24 000 distribution transformers on their distribution network.

7.1.2 Purchase of transformers, including where and availability of EE products

Transformers are ordered or purchased directly from the manufacturers and are often part of competitive tender processes, especially when being bought by NamPower. Very low standards (compared to other international standards) for energy efficiency of transformers were enforced by SANS. Thus, there was no drive to adopt or produce energy efficient transformers.

7.1.3 Local manufacturers, suppliers, retailers and other stakeholders

Due to the close proximity of South Africa and the fact that South Africa has a large transformer manufacturing industry, no local manufacturing is necessary or feasible and therefore currently does not take place in Namibia.

7.1.4 Import/export

Most electrical equipment in the SADC region are either manufactured in or distributed by, South African companies. This statement holds true for transformers with almost 87% coming from South Africa over the past 10 years. Quantities imported range in the hundreds with high years touching on just over a thousand transformers.

The costs of energy efficient transformers are still significantly higher than standard efficiency units and the relatively low cost of electricity combined with a general acceptance of system losses results in the very slow adoption of energy efficient transformers in Southern Africa. Further to that, the long life expectancy of typical transformers further reduces the potential uptake of energy efficient units.

7.1.5 Barriers to overcome

Costs of energy efficient transformers are still significantly higher than standard efficiency units and the relatively low cost of electricity combined with a general acceptance of system losses results in very slow adoption of energy efficient transformers in Namibia. Further to that, the relatively long life expectancy of typical transformers further reduces the potential uptake of energy efficient units.

7.1.6 New vs. Used

Due to the nature of transformer installations, transformers are typically not resold and there is therefore little to no market for second hand distribution transformers.

7.2 **Potential Savings from Energy-Efficient Transformers**

Due to the variable load on distribution transformers, it is very difficult to build a hypothetical simulation. However, an attempt has been made below.

The tables below consider the current scenario (BAU) as well as the adoption of improved Minimum Energy Performance Standards and Best Available Technologies if these were to be driven by policies and regulations. For a simple savings calculation, transformers have been grouped into three categories:

1. Not Rated.
2. SEAD Tier 3 or similar.
3. SEAD Tier 5 or similar.

7.2.1 Benefits of Energy Efficiency – 3 scenarios

Table 7.1 BAU, MEPS, BAT scenarios for transformers.

Scenario	Description	QTY (2017)	QTY (2020)	Tech. Adopt (2025)	QTY (2025)	Tech. Adopt (2030)	QTY (2030)
Business as Usual	Not Rated	4 034	4 490	-8%	5 399	-20%	5 645
Business as Usual	SEAD Tier 3 or similar	11 590	12 900	-5%	16 053	-14%	18 015
Business as Usual	SEAD Tier 5 or similar	7 977	8 879	11%	12 881	26%	21 212
DNV GL Projected MEPS	Not Rated	4 034	4 490	-46%	3 169	-25%	3 106
DNV GL Projected MEPS	SEAD Tier 3 or similar	11 590	12 900	-1%	16 658	-27%	15 792
DNV GL Projected MEPS	SEAD Tier 5 or similar	7 977	8 879	25%	14 506	37%	25 974
DNV GL Projected BAT	Not Rated	4 034	4 490	-63%	2 171	-66%	965
DNV GL Projected BAT	SEAD Tier 3 or similar	11 590	12 900	-20%	13 478	-73%	4 838
DNV GL Projected BAT	SEAD Tier 5 or similar	7 977	8 879	61%	18 683	60%	39 069

Current Data & Assumptions:

- *Exchange Rate: 1 NAD = 1 ZAR = 13.5 USD*
- *Current Average Electricity Price to consumer: 0.142 USD/kWh*
- *Electricity Cost Increase: 8% per annum*
- *Average Transformer Size: 315 kVA, 11kV/0.4kV*
- *Average Operating Hours: 24 hours per day, 365 days per annum.*
- *QTY and adoption of new technologies based on information from stakeholder interviews.*

If these adoption rates are accurate, the following savings are projected (Table 7.2) to be achieved under the MEPS and BAT scenarios. The U4E targets are also shown as benchmarks.

Table 7.2 Projected savings for transformers under MEPS And BAT scenarios.

Row Labels	Sum of GWh Savings (2025)	Sum of GWh Savings (2030)	Sum of Million USD Savings (2025)	Sum of Million USD Savings (2030)	Sum of GHG Savings (2025)	Sum of GHG Savings (2030)
DNV GL Projected MEPS	53	86	14	34	3	4
DNV GL Projected BAT	107	238	29	94	5	12
U4E Targets	67	140	10	20	3	7

7.2.2 Job creation / elimination from EE products

The implementation of strict energy efficiency standards might result in an increase in replacement rates of current distribution transformers, which in turn would result in job creation in local manufacturing industries.

7.3 Status of Policies and Initiatives

7.3.1 Standards and regulations

IEC International Standards have been adopted in Namibia [32].

7.3.2 Supporting Policies – Labelling and consumer awareness campaigns

There is no labelling scheme in Namibia to differentiate between the performances of transformers based on rating.

7.3.3 Financial Mechanisms

There are no visible and effective state or industry-funded programmes or initiatives to drive the adoption of energy efficient distribution transformers in Namibia.

7.3.4 Monitoring, Verification and Enforcement

SANS 780:2009 specifies energy performance standards for distribution transformers and is enforced by the NSI.

7.3.5 Environmentally Sound Management

Namibia is bound by the SADC Protocol on Energy 1996, which states that: "Energy efficiency and conservation applications have minimal adverse impact on the environment, relative to other energy applications". The handling of redundant replaced energy units, like transformers, is addressed in the Environmental Management Act 7 of 2007 and related regulations.

7.3.6 Other on-going projects/initiatives

No ongoing initiatives or projects are currently in place to drive the adoption of energy efficient transformers.

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9 APPENDICES

APPENDIX A: SACREE DETAILS

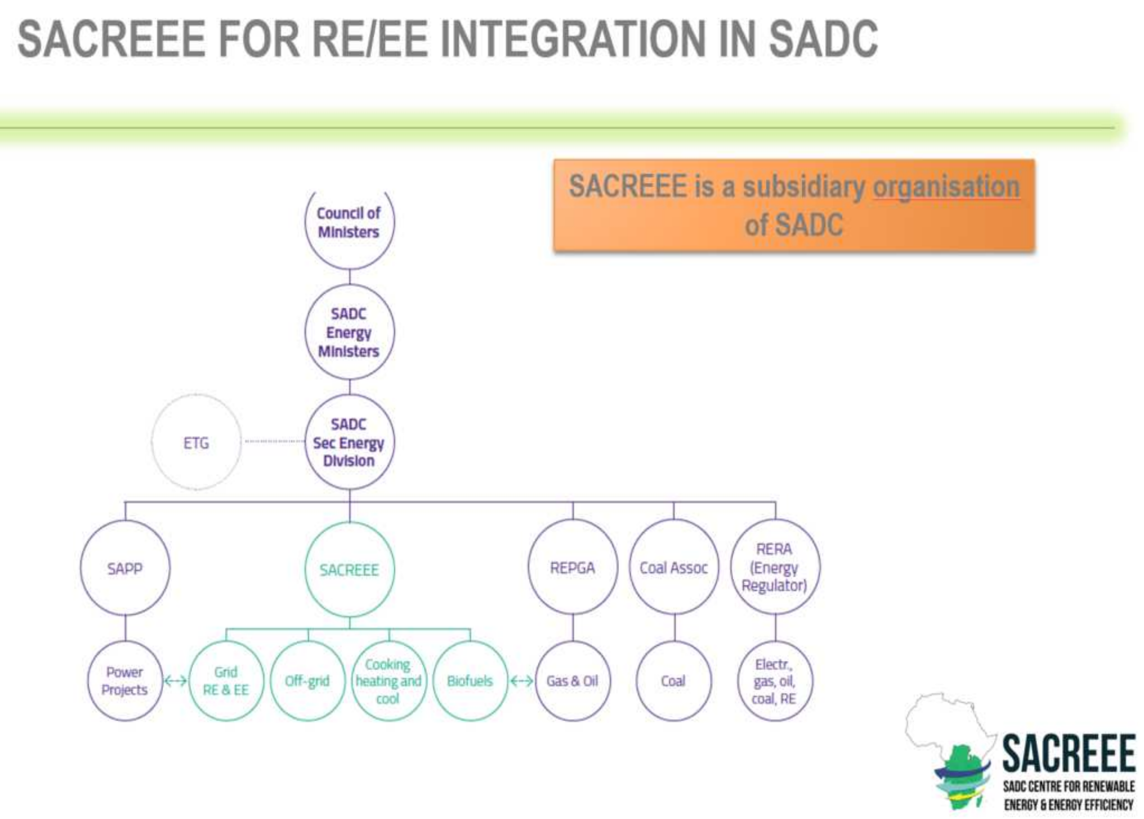
Extract from SACREEE_GNSEC_VEF2017.ppt

SACREEE is the **SADC CENTRE FOR RENEWABLE ENERGY AND ENERGY EFFICIENCY** – for market-based adoption of renewable energy and energy efficiency. SACREEE was established in 2016 by the SADC Energy Ministers and endorsed by 35th SADC Council of Ministers Meeting.

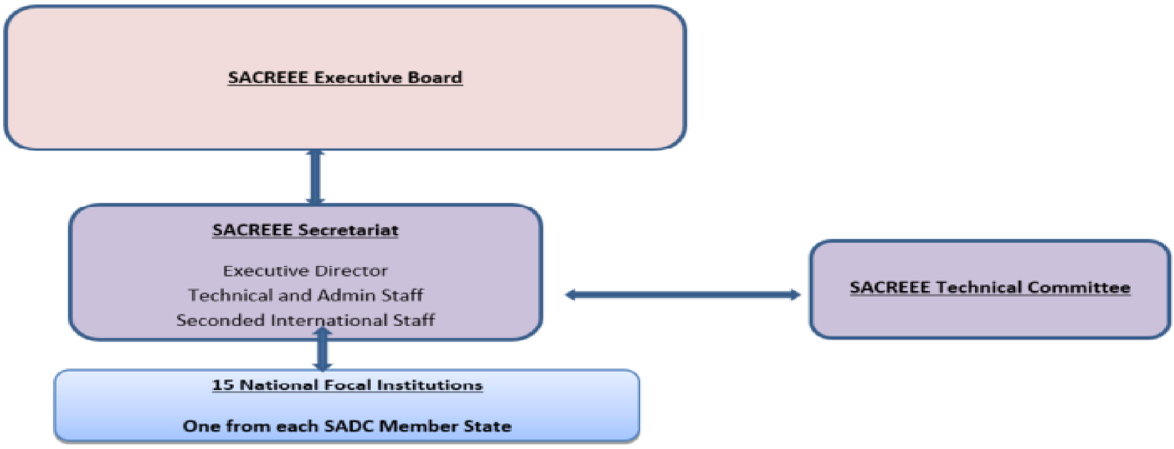
SACREEE's mandate is to implement the Regional Renewable Energy and Energy Efficiency Strategy and Action Plan (REEESAP) through the promotion of market based adoption of renewable energy and energy efficient technologies and energy services

SACREEE is established on a sustainable basis through the following sources of support:

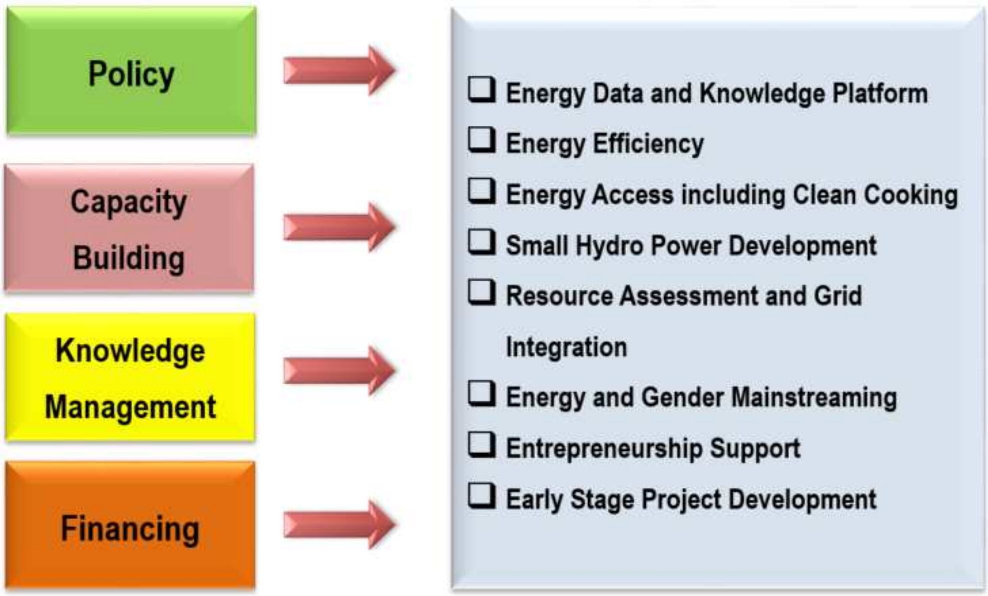
- Member States contributions
- Donor funding
- Cost recovery from services offered to projects.
- SACREEE Secretariat is based in Windhoek, Namibia.



SACREEE GOVERNANCE STRUCTURE



SHORT-TO-MEDIUM TERM SACREEE FOCUS AREAS



SACREEE
SADC CENTRE FOR RENEWABLE ENERGY & ENERGY EFFICIENCY

PROVIDING REGIONAL SUPPORT TO NATIONAL ACTIONS - SACREEE ACTIVITIES

SACREEE develops and executes regional programs and projects in order to support SADC Member States

- To increase access to sustainable energy services;
- To develop sustainable energy markets;
- To improve the legal and regulatory framework and ensure policy coherence and alignment of RE & EE activities with national/regional and international policies;
- To align the national actions with international commitments and climate change actions (e.g. NDCs)
- To support donor harmonization, coordination and to create synergies with other ongoing initiatives;
- To strengthen local capacities through capacity building activities
- To foster networks between research and training institutions (*Network of Energy Excellence for Development (NEED), SOLTRAIN, etc*) as well as organize train-the-trainers workshops;
- To improve the availability of quality energy data and information for sound decision making on policy and investment

9

SACREEE
SADC CENTRE FOR RENEWABLE ENERGY & ENERGY EFFICIENCY

SADC Industrial Energy Efficiency Programme (SIEEP)

SIEEP contributes to the competitiveness of the industrial sectors of SADC Member States by building their capacity to adopt, invest and utilise energy efficient technologies and practices.

Target group are medium and large scale industries.
SIEEP is in line with the SADC Industrialization Strategy and Roadmap, 2015-2063.

Current Activities (in cooperation with the European Union)

- Assessment of EE potential in Industries
  - potential on electricity energy saving opportunities,
  - potential for renewable energy heating and cooling applications in industry,
  - capacity to implement energy and efficiency measures
  - capacity of industries on implementing ISO 50001
- Development of a regional program for Industrial Energy Efficiency to be endorsed by the Member States

SACREEE
SADC CENTRE FOR RENEWABLE ENERGY & ENERGY EFFICIENCY

SADC CENTRE FOR RENEWABLE ENERGY AND ENERGY EFFICIENCY – SACREEE

MAIN CHALLENGES IN THE SADC REGION:

POLICY AND REGULATION

- Lack of enabling policies and regulations that stimulate markets for RE and EE
- Energy policy developed in isolation with regional and international trends leading to disharmony
- Standards and labeling of equipment are not harmonized across the region to allow an integrated market
- Need to integrate into the post- 2015 Inclusive and Sustainable Industrial Development (ISID) agenda highlighting the importance of energy

TECHNICAL

- Weak and limited electricity grid infrastructure that limits possible grid connection of RE generated electricity
- Knowledge and experience not shared across borders
- Low local content of technology leading to high RE equipment maintenance costs

CAPACITY

- Limited capacity and awareness of the technical and economic possibilities of RE/EE technologies and their applications
- Low R&D capacity and funding and little regional cooperation between R&D institutions
- Technical capacity for installation, and operation and management of RE systems is limited
- Limited capacity to initiate, implement and manage Public- Private Partnership (PPP) projects effectively
- Limited capacities to identify, develop, and implement innovative RE/EE projects

MARKETS

- Limited information on availability of RE resources on which to base decision to invest
- Potential EE improvement technologies not widely known in the Region
- Limited information on the social and environmental impacts and acceptability of the technology
- Markets for RE/EE technologies and energy services fragmented along national boundaries
- Lack of knowledge at vocational and university level

FINANCING

- Limited support available for bankable project preparation
- Limited exposure of local Financial Institutions to RE/EE investment projects
- Limited experience on special purpose soft loans for RE/EE projects for SMEs and low income sections of the population.
- Perceived risky nature of the RE/EE projects

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APPENDIX B: ENERGY EFFICIENCY FUNDING INITIATIVES IN SADC REGION [23]

a) **EREF ECOWAS Renewable Energy Facility -** TANZANIA

b) **EU-Africa Infrastructure Trust Fund (ITF) / Africa Investment Facility (AfIF) -** Sub-Saharan Africa

   Attract and leverage financial resources and technical expertise to support infrastructure investments in Sub-Saharan Africa - Grants in the energy sector are for example used for: geothermal, hydropower, solar power and wind power plants, transmission lines, improvement of energy efficiency and energy savings, etc.

c) **European Development Finance Institutions (EDFIs) Private Sector Development Facility -**
   Sub Saharan African countries that are committed in reaching the Sustainable Energy for All (SE4ALL) objectives, except South Africa
   The Facility aims to contribute to poverty reduction and economic development in Sub-Saharan Africa through the mobilisation of resources for projects in the sector of energy. In particular, the Facility aims to increase access to modern energy services and investments in renewable energy and energy efficiency, by promoting private sector investments and providing additional dedicated financial resources to African countries committed to meet the objectives of the SE4All initiative.

d) **Regional Technical Assistance Programme (RTAP) -** Tanzania
   Make renewable energy and energy efficiency financing a standard business model that can be adopted by the local banks to support and diversify their revenue stream. RTAP is the TA component of a credit line established by AFD for financing renewable energy and energy efficiency projects

e) **Africa-EU Energy Partnership (AEEP) -** European and African member states –
   AEEP 2020 includes energy efficiency (increase energy efficiency in all sectors)

f) **World Bank Energy Sector Management Assistance Program (ESMAP) - Africa Renewable Energy Access Program (AFREA I & II) -** Mozambique, Tanzania and Zambia
   Promoting increased access to energy, with an emphasis on renewable energy, energy efficiency and energy access.

g) **ACP-EU Energy Facility -** Most countries in sub-Saharan Africa
   To increase access to modern, affordable and sustainable energy services in rural and peri-urban poor areas by focusing on renewable energy solutions and energy efficiency measures; To improve governance and framework conditions in the energy sector at regional, national and local levels, in particular in respect of promoting access to energy services, renewable energy and energy efficiency;

h) **Clean Technology Fund (CTF) -** South Africa (and DPSP – Mozambique)
   Highly concessional resources to scale up the demonstration, deployment, and transfer of low carbon technologies in renewable energy, energy efficiency, and sustainable transport.

i) **Global Energy Efficiency and Renewable Energy Fund (GEEREF)** - Sub-Saharan Africa (African Renewable Energy Find L.P.)
   Increase access to, capital for and the share of renewable energy and energy efficiency project developers and companies in developing countries and economies in transition;

j) **AREF - Africa Renewable Energy Fund -** GEEREF has committed USD 19.6 million to THE AFRICA RENEWABLE ENERGY FUND, MANAGED BY BERKELEY ENERGY
   AREF is a private equity fund focusing on renewable energy infrastructure investments across Sub-Saharan Africa, excluding South Africa.

APPENDIX C: PRICE LIST

See:

http://www.zestweg.com/assets/documents/product-categories/electric-motors/invicta-vibrator-motors/Zest-WEG-Group-Motor-Price-List-2016.pdf

Incledon Pricelist:

http://www.incledon.co.za/pricelist/99E.html

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.