TECHNICAL MARKET REVIEW

Country Profile: Malawi

Climate Technology Centre & Network

Revised Report
Date: 14th May 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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Keywords:
Malawi, Market Review, Energy Efficiency

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1 EXECUTIVE SUMMARY

This report reviews the potential for increasing the energy efficiency of products in Malawi by providing a technical market assessment of current conditions and policies. Five specific product categories have been reviewed: 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 Malawi in achieving its sustainability goals. Within this context, DNV GL presents its best estimation of the technical potential for each product category for policy recommendations intended to achieve savings over standard equipment using assumptions based on the research undertaken during this project.

General remarks

Energy efficiency is not a primary policy priority in Malawi. Electrification, food, water, housing and other key issues understandably take precedence. Malawi's economy is growing, with improved living standards expected to result in increased energy demand. The state utility has made efforts at encouraging efficient lighting to replace incandescent bulbs. At the same time, significant barriers remain regarding expansion of access to electricity beyond present users and addressing a cultural shift from biomass to more modern fuels. Also, there are economic constraints in financing energy projects. Malawi has a limited number of trained personnel for large scale energy systems. In order to effect meaningful change in the adoption of energy using equipment and products, a regional strategy would likely have greater impact on product manufacturers and distributors, which in turn would eventually impact Malawian markets.

Underlying process

DNV GL conducted an initial desktop analysis before sending out data requests and setting up meetings with local entities within Malawi. These included the Malawi National Commission for Science and Technology, Ministry of Natural Resources, Energy and Environment, Electricity Supply Corporation of Malawi Ltd (ESCOM), Electric Generation Company (EGENCO) and other local stakeholders such as contractors, suppliers and installers of technologies. Meetings and interviews were conducted over several days within the country, as well as via email and phone. Some of the findings are highlighted below.

Power Sector Reform

Malawi is one of the first countries in Southern Africa to successfully unbundle the generation, transmission and distribution of its electricity sector. EGENCO is now solely responsible for the current generation plants while the Malawian Energy Regulatory Authority (MERA) and the Ministry of Energy guide the way forward through the Integrated Resource Plan. This is likely to include renewables (wind, solar and hydro) through Independent Power Producer (IPP) bid rounds, with coal to make up the baseload. Transmission and distribution is managed by ESCOM.

National Designated Entity (NDE) prioritisation

In light of the power sector reform, energy efficiency (and this project in particular) is not the primary priority of the NDEs. Electrification, food, water, housing and other more pressing and relevant issues understandably take priority. Thus, very little capacity remains to track or research the data required for this survey. Further to that, NDE's appear to receive very little support and feedback from the other entities within their countries (Revenue Authorities, Trade Organizations, Utilities, Stats bureau etc.), which resulted in very slow turnaround times with limited feedback and uncertain accuracy of the provided data.

Cost Sensitivity

Due to high levels of poverty in Southern Africa, the markets are extremely sensitive to upfront prices. Energy efficiency and lifecycle costing typically comes at a premium and any additional costs have large impacts on short term cashflows. For example, additional costs for a higher efficiency refrigerator must be secondary to filling the existing one.

Africa is a small market

The entire African content consumes less than 5% of all electricity in the world. 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 to if you look at the specific countries.

Energy Efficiency is perceived as a conflict of interest for utilities

Reducing the sales of electricity by promoting energy efficiency effectively reduces some potential revenue from the utility. In contrast, the current lack of sufficient capacity results in regular power outages, so reduced consumption could be redistributed. Since the utility is state owned, this enables the state to use the utility to drive energy efficiency roll outs despite the apparent conflict.

Subsidised electricity tariffs

Malawi electric charges are low compared to Europe at 0.085 USD per kWh for residential customers. These are government subsidised (therefore lower) tariffs, which result in longer payback periods for energy savings projects or energy efficient technologies than if full utility costs were charged. This will have negative impacts on the sales of higher efficiency units, compared to their cheaper but less efficient competitors. Unfortunately, the low average incomes prevent the state-owned utilities from increasing the tariffs to be fully reflective of generation costs, as many people would then not be able to afford electricity, which in turn would adversely affect both the economy and the uptake of electrification.

Energy Policies

Like several other countries in the region, Malawi has an energy policy in draft, but this is at a very high level, does not address any technologies, does not have any regulations, and provides no enforcement mandate.

Conclusions

Despite the limitations noted, including low population density and low incomes, Malawi has much to gain by adopting energy efficient standards and technologies. The market research, data collection and analysis conducted by DNV GL during this study has been able to provide insight into the five product categories of primary energy-consuming appliances and equipment covered (lighting, air conditioning, refrigerators, motors and transformers).

The projected energy savings for Malawi when moving from the current state of technologies to Minimum Energy Performance Standards (MEPS) or to the Best Available Technologies (BAT) are shown in Table 1.1 and Figure 1.1 below. More detail on the underlying approach used to arrive at these can be found in the sections of the report for each of the individual product categories. Section 2.6 presents more detail as to the assumptions used in the modelling process.

The overall savings potentially yielded by the adoption of MEPS are expected to increase from 189 GWh (187.2t CO_2) per annum in 2025 to over 300 GWh (305t CO_2) per annum in 2030. BAT projected savings for 2025 is projected as 335 GWh (332t CO_2) per annum while savings yielded in 2030 are projected as600 GWh (595t CO_2).

Table 1.1 Projected MEPS and BAT savings for Malawi.

	GWh savings (2025)	GWh savings (2030)	MUSD savings (2025)	MUSD savings (2030)	GHG savings (2025)	GHG savings (2030)
DNV GL Projected MEPS						
Lights	135	184	11	23	134	182
Aircon	1	4	0	1	1	4
Refrigeration	16	41	1	5	16	41
Motors	5	15	1	4	5	14
Transformers	31	64	5	18	30	63
Total	**189**	**307**	**18**	**51**	**187**	**305**
DNV GL Projected BAT						
Lights	239	329	19	42	238	326
Aircon	3	9	0	2	3	9
Refrigeration	22	53	2	7	22	53
Motors	8	32	1	9	8	32
Transformers	62	177	11	49	61	175
Total	**335**	**600**	**33**	**109**	**332**	**595**
U4E Targets						
Lights	143	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**

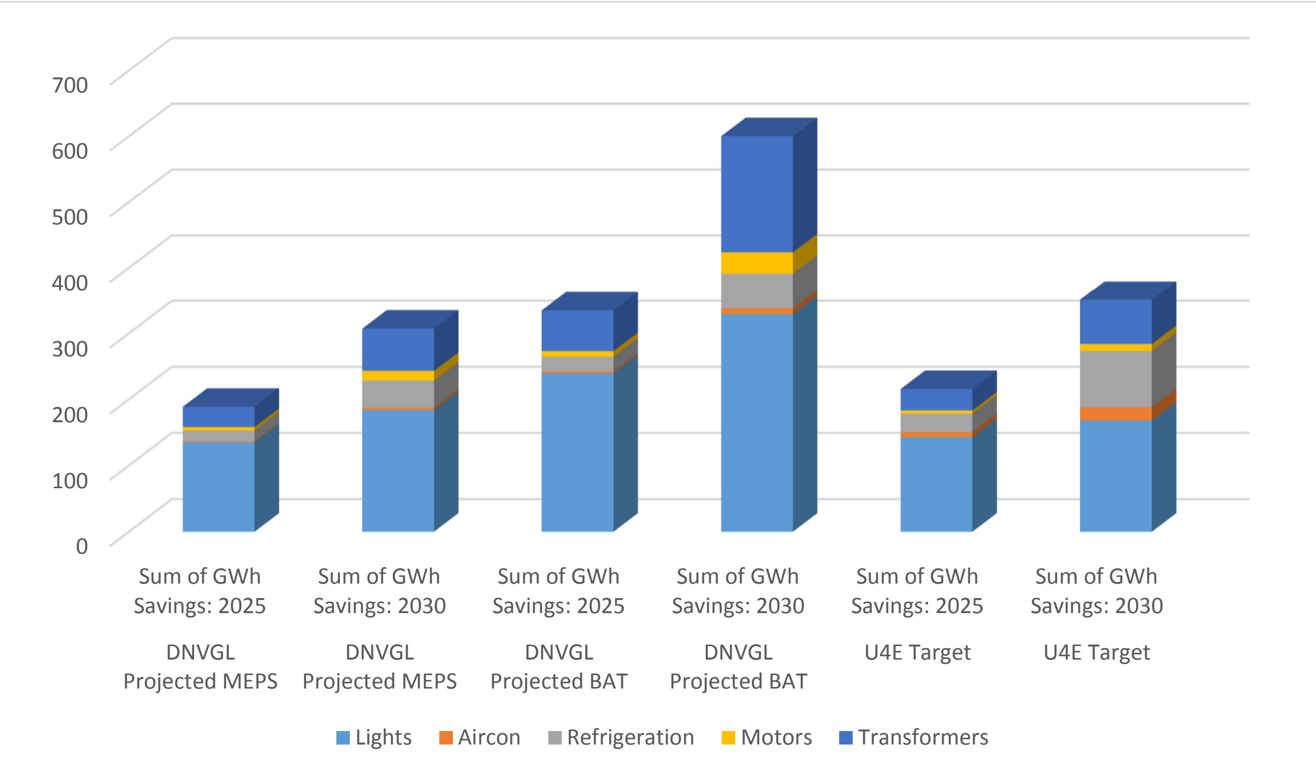

Figure 1.1 Projected annual energy savings for Malawi.

2 INTRODUCTION

2.1 General Information about Malawi

Malawi is a landlocked country in southeast Africa and is bordered by Tanzania to the northeast, Zambia to the northwest, and Mozambique to the east, south, and west. Lake Malawi separates the country from most of Mozambique.

Lilongwe is the capital with Blantyre being the major commercial centre and largest city. All government ministries and the Parliament are in Lilongwe and the Supreme Court is seated in Blantyre [2] [3].

Malawi is a member of the United Nations [4], the Commonwealth of Nations [5] and the Southern African Development Community (SADC) [6]. 70.9% of the population survives on less than US$1.90 a day (the international poverty line), based on 2010 statistics. In 2016, the World Bank classified Malawi as a "low income" country because the annual gross national income (GNI) per capita levels is USD 1,045 or less [7].

Size (km²)	118,484
Population (Est, 2017) [1]	18,316,684

2.2 Climate and Topography

Malawi's climate is generally tropical with the rainy season lasting from November to March. The highlands and plateau in the north are temperate with temperatures averaging between 20 and 27 °C, with cool nights all year. Winter temperatures can however drop as low as 4 °C. In the lowland areas of the south it is more tropical and very hot during the rainy season with temperatures rising as high as 39 °C. Mean annual rainfall varies between 635 mm and 3,050 mm [8].

2.3 Electricity Sector

Malawi's total installed capacity is about 302 MW, of which 94% is generated by hydropower and the remaining 6% is thermal. There are 4 major hydro facilities located on the Shire River that provide the bulk of the electricity. Electricity and gas are only intermittently available and considered to be too expensive for cooking. Therefore, firewood and charcoal are the major cooking fuels, even in the urban areas [9].

10% of the population have access to electricity. Overdependence on traditional biomass has resulted in wood demand surpassing sustainable wood supply by more than 3.7 million tonnes per annum. Therefore, the national energy policy is focused on shifting energy use away from the current heavy reliance on traditional biomass to modern sources of energy like electricity, liquid fuels and renewable sources, but little progress has been achieved so far. In 2010, traditional biomass (firewood) made up 75% of the energy mix consumed, 10% from renewables and only 10% came from hydroelectricity. The Energy Policy aims to decrease biomass in the energy mix consumed to 50%, 30% from renewables, and to increase the hydroelectricity to 7% by 2020.

Malawi 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 economical electricity supply to consumers in SAPP member countries. Malawi also joined the International Renewable Energy Agency (IRENA) - a global initiative to promote and reduce barriers to the uptake of renewable energy.

Table 2.1 provides a summary of major energy efficiency and Demand-Side Management (DSM) activities in Malawi. In 2016 ESCOM rolled out an energy saving project where it has been replacing high energy consuming incandescent bulbs with very low energy consuming LED bulbs. The project, whereby ESCOM will install 1.2 million LED bulbs will see the corporation saving around 30 MW of power. Customers are also expected to benefit through reduced bills as LED bulbs last longer and consume less energy than other bulbs. The LED project is being implemented in two phases: The first phase will see ESCOM distributing the LED bulbs free of charge to high energy consuming and low-income areas in exchange for incandescent bulbs. In the second phase, ESCOM will be selling the LED bulbs at substantially subsidized price. ESCOM is now selling LED bulbs in Exchange of Compact Florescent Lamps or Incandescent Bulbs (IBs) to its customers, at K500 each. Terms & Conditions: Every Customer will be allowed to purchase a maximum of 10 LED bulbs only AND Bulbs will be bought against a Meter Number and in exchange for CFLs and IBs currently being used by customer.

Table 2.1 Energy efficiency and Demand-Side Management (DSM) activities[1] in Malawi [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
Malawi	X													

Table 2.2 below provides a summary of energy efficiency targets by type of programme. Because most targets are qualitative rather than quantitative, the table is simply an indication of whether a particular policy target has been, or soon will be, implemented.

Table 2.2 Malawi's national energy efficiency targeted programmes [10].

Target type	Lighting retrofit	Reduce electricity distribution losses	Improved cooking devices	Load management	Standards and Labelling	Financing	Revised building codes
Malawi	X		X				

Table **2.3** below indicates Malawi'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.

[1] Where 'X' indicates the presence of the listed policy type in the country.

Table 2.3 Malawi's committed targets for energy savings [11].

U4E Pathway to Energy Efficiency	Targeted annual GWh savings by 2030				
	Lighting	Residential refrigerators	Room air conditioners	Industrial electric motors	Transformers
Malawi	168.1	85.2	20.1	10.4	67.2

(Extracted from the U44E Country Assessment, December 2016)

2.4 Power Industry Regulation and Policies

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

Organizations responsible for energy policies	• Minister of Natural Resources, Energy and Mining • Department of Energy Affairs (DoEA)
Energy regulator	• The Malawi Energy Regulatory Authority (MERA)
Energy policy publications	• Energy Laws: Act 20, the Energy Regulation Act, 2004; Act 21, the Rural Electrification Act; Act 22, 2004; the Electricity Act, 2004; and Act 23, the Liquid Fuels and Gas (Production and Supply) Act; 2004 • Electricity (Amendment) Act, 2016 • National Energy Policy, approved in 2003 • Biomass Energy Strategy, 2009 • Forestry Policy, 1996 • Energy Regulation by Energy Regulation By-laws, 2008 • Rural Electrification Regulations, 2008 • Electricity By-laws, 2012 • Liquid Fuels and Gas (Production and Supply) Regulations, 2008 • Integrated Strategic Plan (ISP17), 2014 • IPP Framework • Malawi Rural Electrification Project (MAREP)
Main entities in the electricity market	• Electricity Supply Corporation of Malawi (ESCOM)

Table 2.4 Malawi's power sector regulatory environment.

The Electricity Supply Corporation of Malawi (ESCOM) is effectively a government-owned institution and is the main generator, distributor and retailer of electricity. It currently owns all of the main Malawian power plants and the national transmission grid. The oversight, development and delivery of energy policy in Malawi fall within the realm of the DoEA, which sits within the Ministry of Natural Resources, Energy and Environment (MNREE). The Malawi Energy Regulatory Authority (MERA) was established in December 2007. MERA regulates all the energy players (production and supply) in the country in collaboration with the Department of Energy Affairs and both entities report to the Ministry of Energy and Mines. MERA's work is predominantly focussed on oversight of generation, transmission and retail of electricity within the national grid. However, its regulatory powers do extend to off-grid generation, including the licensing of micro-generation and the certification of renewable energy technology installation and maintenance engineers.

Table 2.5 and
Table **2.**6 indicate the range of energy efficiency and renewable energy and support policies in Malawi, as of 2016.

Table 2.5 Energy efficiency support policies initiated by 2016 in Malawi [10].

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
Malawi			X						X	

Table 2.6 Renewable energy support policies initiated by 2016 in Malawi [19]. Note: R = revised (one or more policies of this type), ○ = existing national (could also include subnational).

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
Malawi	R				○			

Table 2.7 Renewable fiscal incentives and public financing initiated by 2016 in Malawi [11]**.** Note: ☐ = existing national (could also include subnational indicates the presence of the listed policy type in the country).

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
Malawi			☐		☐

2.5 Key Challenges and Recommendations

Key challenges in the energy sector include:

- Malawi's economy is growing, and improved living standards have resulted in increased energy demand;
- There are economic constraints in financing energy projects;
- Malawi has a limited number of trained personnel for development, implementation, operation and maintenance of large scale energy systems;
- The Electricity Supply Corporation of Malawi shuts down its turbines every year to de-silt its dam; part of the siltification could be because of unregulated and/or unmonitored cultivation along the river banks;
- Malawi also loses about USD 16 million annually due to power outages. Many years of under-investment in transmission and distribution infrastructure, with frequent failures, especially during the rainy season, and generally poor quality and unreliable supply contribute to these outages.

To address these challenges, the SAPP's 2013 Annual Report, the Mozambique-Malawi Interconnection was identified as a high priority project. The Mozambique-Malawi 400KV Interconnection Project's Environmental and Social Impact Study (for the Malawi Section) was finalised in July 2017.

SACREE is the SADC Centre for Renewable Energy and Energy Efficiency and, as per details in Appendix A, it works towards addressing SADC country challenges with respect to renewable energy and energy efficiency. Funding available to the SADC countries for energy efficiency are listed in Appendix B.

Table 2.8 Energy efficiency opportunities and recommendations for Malawi.

	OPPORTUNITIES	RECOMMENDATION
Policies	Processes and procedures to enforce and prioritize energy efficiency requirements should be put in place.	• As per Table 2.1 above, policies for energy efficiency in buildings, energy efficiency audits and standards & product labelling should be implemented. • Table 2.2 indicates 'Financing' is not an EE targeted program. Evaluate reasons why not and determine if policies are required to initiate this. • As per Table 2.4 above, building efficiency guidelines and voluntary business energy efficiency programmes may be considered.
Economic and financial	Some funding is already available regionally for energy efficiency, as per 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	• Clarify if any funding is currently used for EE. • Determine what barriers exist preventing use of available funding, as summarised in Appendix B. • Harmonize donor support by source affordable financing for energy efficiency investment.

	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.	• 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 if any new initiatives have started.

2.6 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).

All Scenarios

For all the scenarios, an average increase in the electrification of the specific country per year was used. These are long-term averages for the specific countries as provided by the electric utilities and conservative interpretations of this data was used by DNV GL.

Increases in the quantities of units were used in direct correlation with the increase in electrification. Increases and decreases in adoption rates were taken from the country visits, averaged and rounded.

BAU

The "Business as Usual" case assumes that the current adoption rate of energy efficient technologies continues the same trend due to the normal rate of rising costs of electricity 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 & BAT) reducing less efficient products (below MEPS) by specific percentages 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

Figure 3.1 shows that of the roughly 1.5 million lighting units in Malawi, most are fluorescent or compact fluorescent. A survey conducted by UNEP indicated a high penetration of CFLs within households, while linear fluorescent tubes are prevalent in industrial and commercial sectors.

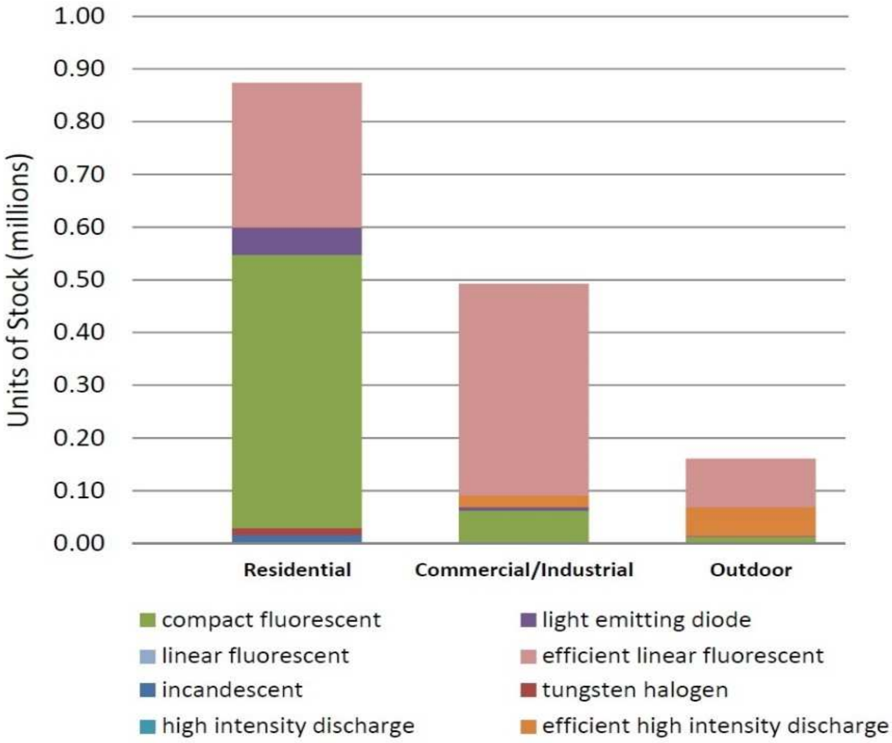

Figure 3.1 Units of lighting stock within Malawi [12].

3.1 Status and Trends of Lighting Products

3.1.1 Market Drivers

Lights have a relatively short life expectancy compared to other electrical equipment considered in this project.

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

Figure 3.2: Life Expectancy of Lights [23].

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

Offices, factories and other operations that require light during daytime (Mon-Fri, 07h00-19h00) would have lights on for roughly 3000 hours per annum. In Malawi, residential lights are often on for 4 hours in the evening and two hours in the morning all year around, totalling 2190 hours per annum.

The report published in 2014 from U4E and for the SADC countries also presents the average lamp wattage for various technologies. The values differ for different types of users, as well, regarding the locations. As an example, Incandescent lamps, which are the most energy consuming of all, can be found in the range of 45-100W depending on whether they are for residential, professional or outdoor use. On the other hand, efficient LED lights can be found in the range of 5-25W depending on the type of the lamp.

3.1.2 Local manufacturers, suppliers, retailers and other stakeholders

Lighting products are mostly purchased by households and small businesses from retail outlets, including general supermarkets and international chain stores such as Pick & Pay, Checkers and OK. Online purchases are negligible in volume. Most popular brands include Phillips, OSRAM and EUROlux. Feedback from the survey indicates that 60% of the products represent unknown brands while 40% are from established brands.

3.1.3 Import/Export

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 increasingly aggressive importing of cheaper appliances from China, there is a tendency to enforce the South African standards of labelling for importers and exporters.

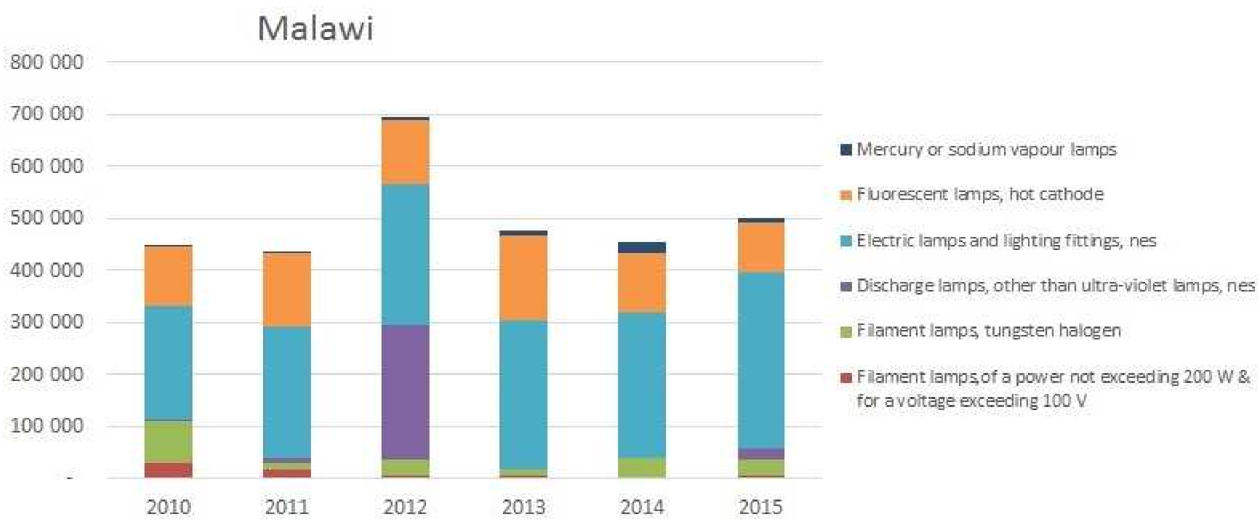

Figure 3.3 Botswana annual light unit imports during 2010 to 2015 [14].

Figure 3.3 presents a summary of imports and exports for the years 2010-2015. Of the imported numbers, roughly 78% are imported from China, while only 13% are imported from South Africa, with the remaining 8% from multiple other countries.

3.1.4 Barriers to overcome

Cost

Electricity is perceived to be expensive, even though Malawi has some of the lowest tariffs in Africa. Availability of power lines (and general access to electricity) is valued over energy efficiency. This is amplified by the lack of funding, resulting in the purchase of the cheapest options, rather than efficient items. Due to the low average income per household, consumers are very sensitive to upfront costs. The typical consumer will likely not be able to afford or justify the additional short-term expenses to gain energy efficiency and even long-term cost savings.

Education

During the country visits, it became apparent that consumers are not aware of environmental and cost impacts of buying low efficiency products and do not consider overall lifecycle costing.

Import duty & tax

There is no reduction or waivering of import duty or taxes on energy efficient lights (CFL or LED). The result is that buyers are paying a premium for energy efficient products.

Emergency lighting

LEDs are often only seen as emergency lighting solutions, rather than energy saving solutions. In this case, the LED would come paired with a battery as stand-alone unit, rather than to replace inefficient lights in fixtures.

Quality of LEDs

Lastly, a general perception of poor quality products in the market discourage people from changing from current, trusted technologies to newer technologies.

3.1.5 New vs. Used equipment

Lights are mostly replaced on burn-out and with life expectancies of around 2 years on average, there is practically no market for used equipment. One scenario where lights are re-used is when lights are replaced for energy savings reasons and the old lights are donated to organizations that rely on public funding or charities such as hospitals, schools or libraries.

3.2 Potential Savings from Energy-Efficient Lighting

Modelling of the different scenarios are explained 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

Table 3.1 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.	1 598 993	1 970 119	-10%	2 987 789	-20%	4 027 679
Business as Usual	QTY CFL & FL	841 807	1 037 191	15%	2 003 969	9%	3 681 827
Business as Usual	QTY LED	364 783	449 449	10%	833 082	50%	2 105 687
DNV GL Projected MEPS	QTY Halo, Inc etc.	1 598 993	1 970 119	-50%	1 659 883	-20%	2 237 600

Scenario	Description	QTY (2017)	QTY (2020)	Tech. Adopt (2025)	QTY (2025)	Tech. Adopt (2030)	QTY (2030)
DNV GL Projected MEPS	QTY CFL & FL	841 807	1 037 191	86%	3 256 141	-4%	5 280 481
DNV GL Projected MEPS	QTY LED	364 783	449 449	20%	908 817	50%	2 297 114
DNV GL Projected BAT	QTY Halo, Inc etc.	1 598 993	1 970 119	-80%	663 953	-20%	895 040
DNV GL Projected BAT	QTY CFL & FL	841 807	1 037 191	130%	4 024 866	-11%	6 048 761
DNV GL Projected BAT	QTY LED	364 783	449 449	50%	1 136 022	50%	2 871 395

Data & Assumptions:

- *Exchange Rate: 1 MWK = 0.0191 ZAR = 0.0014 USD.*
- *Average marginal Residential Electricity Tariff: 0.037 USD/kWh.*
- *Average marginal Industrial Electricity Tariff: 0.080 USD/kWh.*
- *Electricity Cost Increase: 8% per annum.*
- *Electrification Rate: 11%*
- *Operating hours: 2 hr in morning (6-8am) and 4hr in the evening (6-10pm), 365 days per annum.*

Assuming these adoption rates are accurate, the following savings (Table 3.2) are projected to be achieved under the MEPS and BAT scenarios. The U4E targets are also shown as benchmarks.

Table 3.2 Projected savings for lighting under MEPS And BAT scenarios.

	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	135	184	11	23	134	182
DNV GL Projected BAT	239	329	19	42	238	326
U4E Targets	143	168	5 279	6 219	40	47

3.2.2 Job creation or elimination from energy efficient products

Lighting surveys, retrofits, supply (importing, exporting, distribution) and the energy efficiency industry in general will benefit from the promotion of energy efficient lighting technologies.

3.3 Status of Policies and Initiatives

'Lighting Malawi' is a Light Foundation initiative that started up when a team travelled through the country in October 2014, to meet with clinicians, community elders, and beneficiaries to assess the lighting needs of medical clinics, schools and orphanages in villages located along the shores of Lake Malawi.

The aim of the initiative was to strengthen partnerships with people on the ground, to trial new solar products, begin a pilot program, and undertake preliminary steps to establish a women's economic development initiative [25].

Further to that, ESCOM sells LEDs at massively discounted rates of K500 in exchange for old CFL and incandescent lights (maximum of 10 per metered point) [26].

3.3.1 Standards and regulations

A list of Malawi's lighting standards/regulations are shown below.

- MS-IEC 60598-1: 2003 ed. 6 Luminaires - Part 1: General requirements and tests Edition: 6.0
- MS-IEC 60598-2-1: 1979 ed. 1 Luminaires – Part 2: Particular requirements – Section One – Fixed general-purpose luminaries
- MS-IEC 60598-2-2: 2002 ed. 2 Luminaires – Part 2: Particular requirements –Section 2: recessed luminaires
- MS-IEC 60598-2-3: 2002 ed. 3 Luminaires – Part 2-3: Particular requirements – Luminaires for road and street lighting
- MS-IEC 60598-2-4: 1997 ed. 2 Luminaires – Part 2: Particular requirements – Section 4: Portable general-purpose luminaries
- MS-IEC 60598-2-5: 1997 ed. 2 Luminaires – Part 2-5: Particular requirements – Floodlights
- MS-IEC 60598-2-6: 1994 ed. 1 Luminaires – Part 2: Particular requirements – Section 6: Luminaires with built-in transformers for filament lamps
- MS-IEC 60598-2-7:1982 ed. 1 Luminaires – Part 2: Particular requirements – Section Seven – Portable luminaires for garden use
- MS-IEC 60598-2-8: ed. 2 Luminaires – Part 2-8: Particular requirements – Handlamps
- MS-IEC 60598-2-9: 1987 ed. 2 Luminaires – Part 2: Particular requirements – Section Nine – Photo and film luminaires (non-professional)

3.3.2 Supporting Policies – Labelling and consumer awareness campaigns

Awareness of the impacts of energy efficient lighting is driven by ESCOM (Malawi Power Corporation).

3.3.3 Financial Mechanisms

Even though the ESCOM handed out several CFLs for free, there are no mechanism that provide access to financing for the implementation of energy efficient lighting.

3.3.4 Monitoring, Verification and Enforcement

Other than the standard ports authorities that check the compliance to import and export regulations, very little is done to verify or enforce the adoption of energy efficient lighting.

3.3.5 Environmentally Sound Management

Malawi 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".

3.3.6 Other on-going projects/initiatives

No ongoing initiatives are currently in place.

4 AIR-CONDITIONING

Room air-conditioning units in Malawi are almost exclusively used in non-residential buildings. There is a variety of types of air conditioning systems used in buildings, with room air conditioning being the most dominant. Room air conditioners can be segmented into window air conditioners, portable air conditioners and at least 3 sub-categories of split systems per cooling capacity (e.g. 9’000 btu/h, 12’000 btu/h and 18’000 btu/h).

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.

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-maintained indoor units can last 15-20 years.

4.1.2 Purchase of air-conditioning products, including source and availability of energy efficient products

Air-conditioning units are not “of-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.

4.1.3 Local manufacturers, suppliers, retailers and other stakeholders

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

4.1.4 Import/Export

Most 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 (25% of market share between 2012 – 2015), there is a tendency to enforce the South African standards of labelling for importers and exporters.

4.1.5 Barriers to overcome

Lack of proper maintenance often results in early system failure or significant decreases in efficiency. The perception that the cost of services outweighs the benefits, which often results in little to no regular maintenance on air-conditioning units.

4.1.6 New vs. Used Equipment

Information gathered from observing local trends suggests that air-conditioning units are typically installed in a fixed location and not removed or resold as second hand.

4.2 Potential Savings from Energy-Efficient Air-conditioning

Modelling of the different scenarios has been explained in Section 2.

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	10 733	13 224	-6%	20 946	-7%	32 825
Business as Usual	Class B - Class A	8 348	10 285	4%	17 975	2%	30 795
Business as Usual	Class A+ & Above	4 770	5 877	7%	10 596	11%	19 819
DNV GL Projected MEPS	Lower than Class B	10 733	13 224	-28%	16 044	-19%	21 898
DNV GL Projected MEPS	Class B - Class A	8 348	10 285	24%	21 490	1%	36 502
DNV GL Projected MEPS	Class A+ & Above	4 770	5 877	21%	11 983	24%	25 038
DNV GL Projected BAT	Lower than Class B	10 733	13 224	-35%	14 484	-33%	16 352
DNV GL Projected BAT	Class B - Class A	8 348	10 285	14%	19 782	-14%	28 795
DNV GL Projected BAT	Class A+ & Above	4 770	5 877	54%	15 251	49%	38 291

Data & Assumptions:

- *Exchange Rate: 1 MWK = 0.0191 ZAR = 0.0014 USD.*
- *Average Marginal Residential Electricity Tariff: 0.037 USD/kWh.*
- *Average Marginal Industrial Electricity Tariff: 0.080 USD/kWh.*
- *Electricity Cost Increase: 8% per annum.*
- *Electrification Rate: 11%*
- *Operating hours: 8 hours per day x 125 days per annum = 1 000 hours.*
- *Average cooling capacity: 3.5kW.*

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

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

Table 4.2) to be achievable 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.

	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	1	4	0	1	1	4
DNV GL Projected BAT	3	9	0	2	3	9
U4E Targets	8	20	293	746	2	6

4.2.2 Job creation or elimination from energy efficient products.

No direct impact on the Malawi market, as the bulk of units are imported. Jobs may include AC technicians, installing and repairing, trading, supply.

4.3 Status of Policies and Initiatives

4.3.1 Standards and regulations

Malawian catalogue of standards does not explicitly state that there are no current regulations regarding air-conditioning units, but no applicable standards are listed.

4.3.2 Supporting Policies – Labelling and consumer awareness campaigns

No policies or awareness campaigns are in place, likely due to the low number of units in the market.

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

Due to the lack of standards, no monitoring, verification or enforcement can take place.

4.3.5 Environmentally Sound Management

Malawi 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".

4.3.6 Other on-going projects/initiatives

There are no current projects or initiatives to drive the adoption of energy efficient air-conditioning units instead of standard efficiency units.

5 REFRIGERATORS

5.1 Status and Trends of Refrigeration Products

5.1.1 Markets and Drivers

General indications of the average life expectancy for a properly maintained refrigerator is between 14 and 17 years depending on the model and size. Compact refrigerators typically run for 14 years on average, while a standard refrigerator will run up to 17 years. The life expectancy of refrigerators is affected by how well it is maintained and its construction. Some models may last only about 10 years, while others may run for up to 19 years [29].

5.1.2 Purchase of refrigeration products, including where and availability of energy efficient products

Refrigerators are typically sold at furniture or white good stores, with some by large retailers. Most refrigerators have standard energy efficiency labels displayed on the outside front, with a variety of efficiencies available at all the stores, ranging from MEPS (Class B) to BAT (Class A+++).

5.1.3 Local manufacturers, suppliers, retailers and other stakeholders

No local manufacturing of refrigerators takes place in Malawi.

5.1.4 Import/Export

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, there is a tendency to enforce the South African standards of labelling for importers and exporters.

5.1.5 Barriers to overcome

High costs of energy efficient units drive consumers to purchase lower quality, entry level units at the expense of efficiency.

5.1.6 New vs. Used

Refrigerators are very seldom repaired in Malawi after their warranty period. Some 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

Modelling of the different scenarios are explained in Section 2.

5.2.1 Benefits of 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	117 421	144 675	-5%	231 596	-7%	362 935
Business as Usual	Class B - Class A	53 898	66 408	5%	117 936	7%	211 691
Business as Usual	Class A+ & Above	21 174	26 089	14%	50 116	17%	98 805

Scenario	Description	QTY (2017)	QTY (2020)	Tech. Adopt (2025)	QTY (2025)	Tech. Adopt (2030)	QTY (2030)
DNV GL Projected MEPS	Lower than Class B	117 421	144 675	-52%	117 017	-61%	76 900
DNV GL Projected MEPS	Class B - Class A	53 898	66 408	96%	218 887	22%	448 301
DNV GL Projected MEPS	Class A+ & Above	21 174	26 089	45%	63 744	38%	148 229
DNV GL Projected BAT	Lower than Class B	117 421	144 675	-69%	75 574	-80%	25 469
DNV GL Projected BAT	Class B - Class A	53 898	66 408	121%	247 142	-1%	410 728
DNV GL Projected BAT	Class A+ & Above	21 174	26 089	75%	76 933	83%	237 235

Data & Assumptions:

- *Exchange Rate: 1 MWK = 0.0191 ZAR = 0.0014 USD.*
- *Average Marginal Residential Electricity Tariff: 0.037 USD/kWh.*
- *Average Marginal Industrial Electricity Tariff: 0.080 USD/kWh.*
- *Electricity Cost Increase: 8% per annum.*
- *Electrification Rate: 11%*
- *QTY and adoption of new technologies based on information from stakeholder interviews.*

Assuming these adoption rates are accurate, the following savings are projected () to be achievable 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.

	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	16	41	1	5	16	41
DNV GL Projected BAT	22	53	2	7	22	53
U4E Targets	28	85	1 031	3 151	8	24

5.2.2 Job creation

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

5.3 **Status of Policies and Initiatives**

5.3.1 Standards and regulations

Malawian catalogue of standards does not mention any current regulations regarding refrigerator units, nor are any applicable standards listed.

5.3.2 Supporting Policies – Labelling and consumer awareness campaigns

No supporting mechanisms were found in Malawi related to refrigerators.

5.3.3 Financial Mechanisms

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

5.3.4 Monitoring, Verification and Enforcement

Due to the lack of standards, no monitoring, verification or enforcement can take place.

5.3.5 Environmentally Sound Management

Malawi 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".

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 adoption and efficiency of motors, particularly life expectancy. These factors include input power problems, improper mechanical installations, malfunctions in the load, and 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, they can last 15 years or more. [30] 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 a 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 [31].

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.

A rough guide for when to repair or when to replace is given in Figure 6.1 below (provided by ABB).

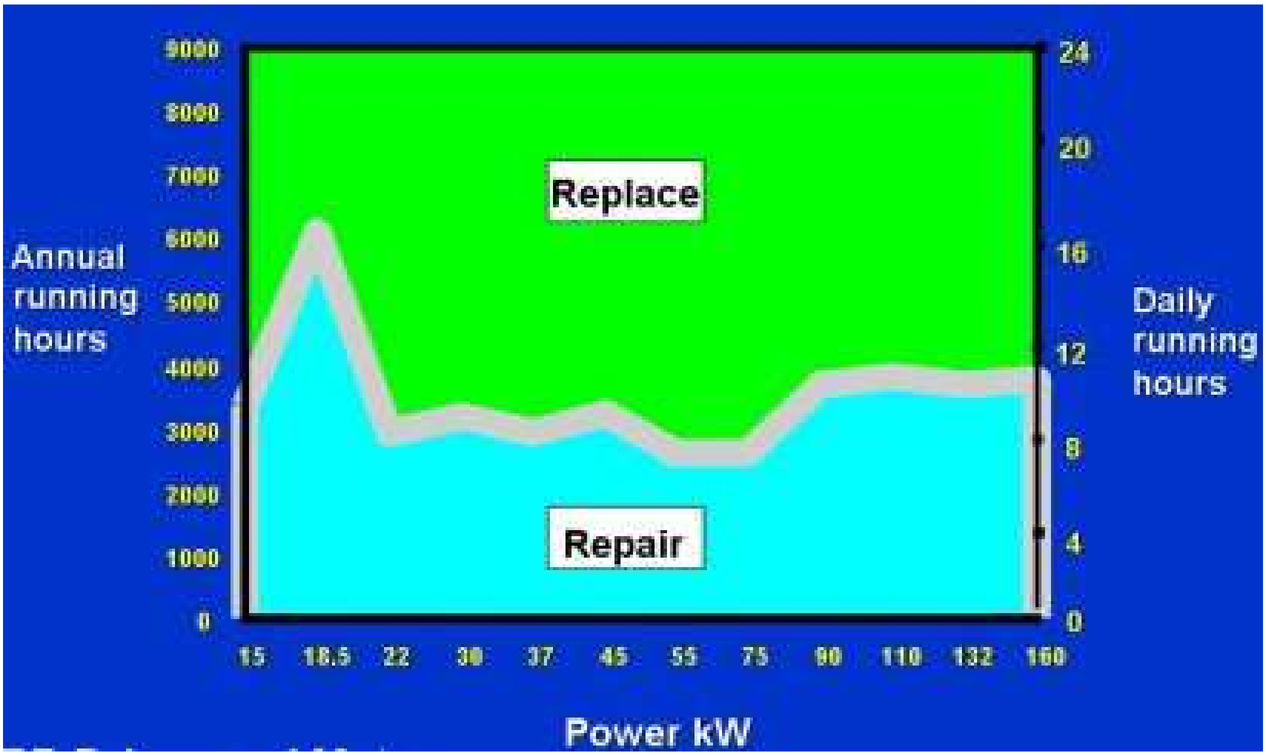

Figure 6.1 Repair/Replace power-time chart [32].

6.1.2 Price

Motors are categorized as IE1 (least efficient), IE2 (more efficient) and IE3 (most efficient). A list of comparative motor prices is shown in **Error! Reference source not found.** below. 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 overall cost, additional costs are one of the biggest market barriers in countries where initial capital plays a major factor.

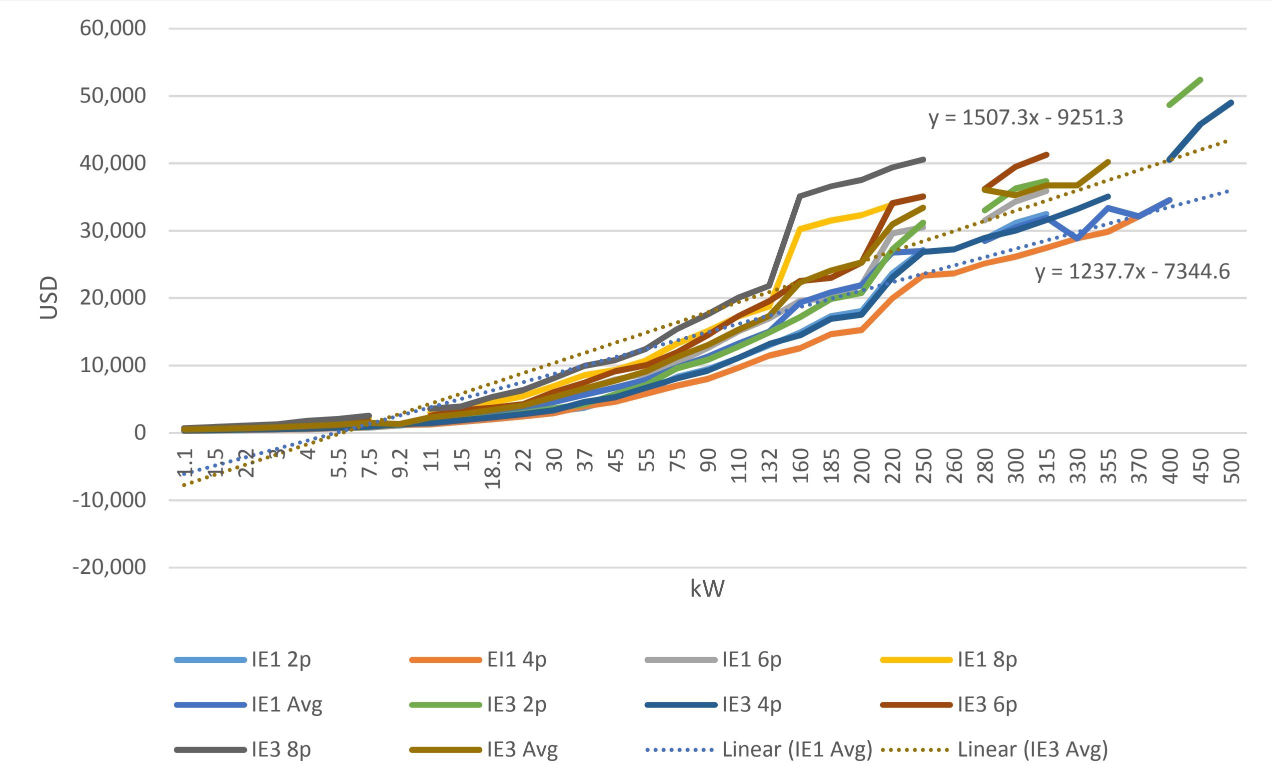

Figure 6.2 Motor pricing versus size.

6.1.3 Purchase of motors, including where and availability of energy efficient products

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 directly with the OEM suppliers or other local service companies to maintain the motors.

6.1.4 Local manufacturers, suppliers, retailers and other stakeholders

Due to the small market size of Malawi and the proximity to South Africa, no manufacturing of motors take place in the country. 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 per 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.

6.1.5 Import/Export

Malawi is almost exclusively an importer of motors with South Africa and China being the primary suppliers.

6.1.6 Barriers to overcome

Overall Inefficient Systems

Due to the low (subsidized) historical price of electricity in Malawi, 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 expense, there is a general perception that the savings from high efficiency motors are negligible when added to an overall inefficient system.

Rewinding Perception

Further to the above, the fact that motors can be rewound to perform at the same efficiency reduces the drive to buy new equipment. However, very few rewinders actual perform the rewinding to the same standards, so optimal efficiencies are hardly ever reached.

6.1.7 New vs. Used

Motors are typically used at their point of installation until a 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 the end of life. Therefore, there is little to no second-hand electrical motor industry to speak off.

6.2 Potential Savings from Energy-Efficient Motors

Modelling of the different scenarios has been explained in Section 2.

Even though Malawi does not explicitly list any motor standards, the country general prescribes to or adopts IEC standards and therefore the suite of IEC 60034 standards for motors are likely to prevail. The tables below consider the current scenario (BAU-Business as Usual) as well as the adoption of improved MEPS and best available technologies (BAT) 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 – 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	38 499	47 434	-5%	75 933	-7%	118 995
Business as Usual	Class IE3	29 944	36 893	2%	63 321	1%	107 898
Business as Usual	Class IE4	17 111	21 082	8%	38 366	12%	72 407
DNV GL Projected MEPS	Class IE1 & below	38 499	47 434	-11%	71 137	-13%	104 287
DNV GL Projected MEPS	Class IE3	29 944	36 893	7%	66 341	9%	121 960
DNV GL Projected MEPS	Class IE4	17 111	21 082	13%	40 143	8%	73 055
DNV GL Projected BAT	Class IE1 & below	38 499	47 434	-13%	69 538	-20%	93 740
DNV GL Projected BAT	Class IE3	29 944	36 893	4%	64 742	6%	115 732
DNV GL Projected BAT	Class IE4	17 111	21 082	22%	43 340	23%	89 827

Data & Assumptions:

- *Exchange Rate: 1 MWK = 0.0191 ZAR = 0.0014 USD.*
- *Average Marginal Residential Electricity Tariff: 0.037 USD/kWh.*
- *Average Marginal Industrial Electricity Tariff: 0.080 USD/kWh.*
- *Electricity Cost Increase: 8% per annum.*
- *Electrification Rate: 11%*
- *Operating hours: 8 hours per day x 125 days per annum = 1 000 hours.*
- *Average cooling capacity: 3.5kW.*
- *QTY and adoption of technologies based on information from stakeholder interviews.*

If these adoption rates are accurate, the following savings are projected (Table 6.2) to be achieved under the MEPS and BAT scenarios. The U4E targets are also shown as benchmarks.

Table 6.2 Projected savings for air conditioning under MEPS And BAT scenarios.

	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	5	15	1	4	5	14
DNV GL Projected BAT	8	32	1	9	8	32
U4E Targets	5	10	0.4	0.8	1	3

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, although that industry is considered small. 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

No standards or regulations were found for motors in Malawi, however IEC standards are expected to take precedence, as is the case with several other industries in Malawi.

6.3.2 Supporting Policies – Labelling and consumer awareness campaigns

All electric motors are expected to, but not 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

Due to the lack of regulations, no monitoring, verification or enforcement can take place.

6.3.5 Environmentally Sound Management

Malawi 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".

6.3.6 Other on-going projects/initiatives

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

7 TRANSFORMERS

7.1 Status and Trends of Transformers

The power network in Malawi is owned and operated by the "Electricity Supply Company", commonly referred to as "ESCOM". The power networks are mostly distributed at the endpoints by pole mounted distribution transformers, some of them dating back to the mid 1900's. Distribution transformers built with amorphous iron cores have 70 % lower no-load losses compared to the best conventional designs, achieving up to 99,7 % efficiency for a 100-kVA unit. High efficiency transformers not only yield a net economic gain, but are advantageous to the environment, reducing greenhouse gas emissions [40].

7.1.1 Markets and Drivers

When a Transformer is operated under ANSI / IEEE basic loading conditions (ANSI C57.96), its normal life expectancy is about 20 years. The ANSI / IEEE basic loading conditions for Transformer are [34]:

- The Transformer is continuously loaded at rated kVA and rated Voltage.
- The average temperature of the ambient air during any 24-hour period is equal to 30°C (86 °F) and at no time exceeds 40°C (104 °F).
- The height where the transformer is installed does not exceed 3300 feet or 1000 meters.

7.1.2 Purchase of transformers, including where and availability of energy efficient products

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

7.1.3 Local manufacturers, suppliers, retailers and other stakeholders

Low prices from Chinese manufactures plus a strong manufacturing industry in South Africa combined with the very small local market in Malawi, results in limited sales volumes and very low feasible for the local manufacturing industry. Therefore, the local transformer manufacturing quantities in Malawi is negligible.

7.1.4 Import/export – Principle ports of entry and primary sources of products

Most transformers in the SADC region are either manufactured in or distributed by, South African companies. The same is true for transformers with almost 98% coming from South Africa.

Costs of energy efficient transformers are still significantly higher than standard efficiency units and the relatively low (subsidized) 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 New vs. Used

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

7.2 Potential Savings from Energy-Efficient Transformers

Modelling of the different scenarios has been explained in Section 2.

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

The tables below consider the current scenario (BAU- Business as Usual), as well as the adoption of improved minimum energy performance standards (MEPS) and best available technologies (BAT) 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[2] 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	1 624	2 001	-8%	3 102	-20%	4 182
Business as Usual	SEAD Tier 3 or similar	4 665	5 748	-5%	9 222	-14%	13 343
Business as Usual	SEAD Tier 5 or similar	3 211	3 956	11%	7 399	26%	15 709
DNV GL Projected MEPS	Not Rated	1 624	2 001	-46%	1 821	-25%	2 301
DNV GL Projected MEPS	SEAD Tier 3 or similar	4 665	5 748	-1%	9 570	-27%	11 697
DNV GL Projected MEPS	SEAD Tier 5 or similar	3 211	3 956	25%	8 333	37%	19 237
DNV GL Projected BAT	Not Rated	1 624	2 001	-63%	1 248	-66%	715
DNV GL Projected BAT	SEAD Tier 3 or similar	4 665	5 748	-20%	7 743	-73%	3 583
DNV GL Projected BAT	SEAD Tier 5 or similar	3 211	3 956	61%	10 732	60%	28 934

Data & Assumptions:

- *Exchange Rate: 1 MWK = 0.0191 ZAR = 0.0014 USD.*
- *Average Marginal Residential Electricity Tariff: 0.037 USD/kWh.*
- *Average Marginal Industrial Electricity Tariff: 0.080 USD/kWh.*
- *Electricity Cost Increase: 8% per annum.*
- *Electrification Rate: 11%*
- *Average Transformer Size: 315 kVA, 11kV/0.4kV*

[2] The Super-Efficient Equipment and Appliance Deployment (SEAD) Initiative is a voluntary collaboration among governments working to promote the manufacture, purchase, and use of energy-efficient appliances, lighting, and equipment worldwide. SEAD is an initiative under the Clean Energy Ministerial (CEM) and a task of the International Partnership for Energy Efficiency Cooperation (IPEEC).

- *Average Operating Hours: 24 hours per day, 365 days per annum.*
- *QTY and adoption of new technologies based on information from stakeholder interviews.*

Assuming 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.

	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	31	64	5	18	30	63
DNV GL Projected BAT	62	177	11	49	61	175
U4E Targets	32	67	1	3	8	17

7.2.2 Job creation/elimination from EE products

Implementation of strict energy efficiency standards might result in an increase in replacements of current distribution transformers, which in turn will result in jobs in the regional manufacturing and local support industry.

7.3 Status of Policies and Initiatives

7.3.1 Standards and regulations

Power efficiency is generally determined by the instantaneous load power and the power losses in a system. However, in the IEC transformer standards, the transformer rating is based on the rated input (primary side) parameters and not load side parameters or load side measurements. Malawi does not specifically require SANS 780 or its equivalent IEC standard, but due to the import from South Africa and China, the transformers are expected to comply with these standards.

7.3.2 Supporting Policies – Labelling and consumer awareness campaigns

There is no labelling scheme in Malawi 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 Malawi

7.3.4 Monitoring, Verification and Enforcement

No specific regulations are enforced.

7.3.5 Environmentally Sound Management

Malawi 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".

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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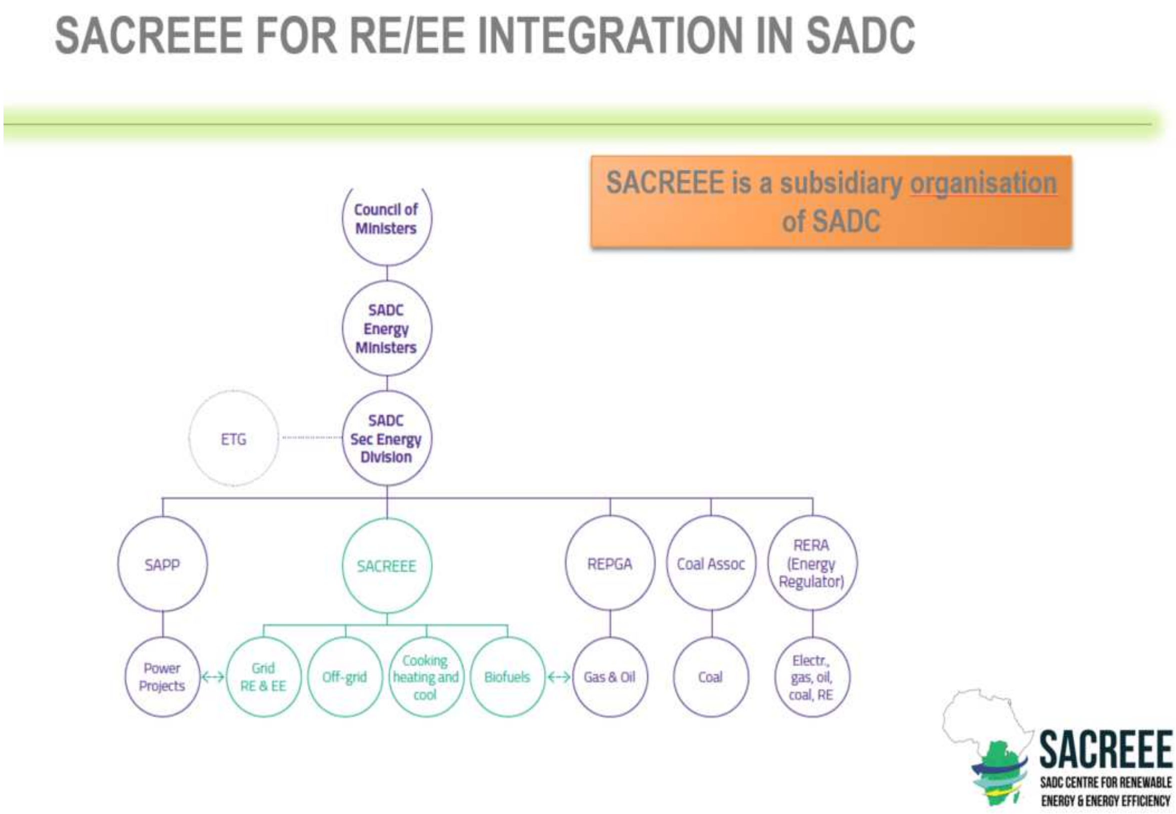
APPENDICES

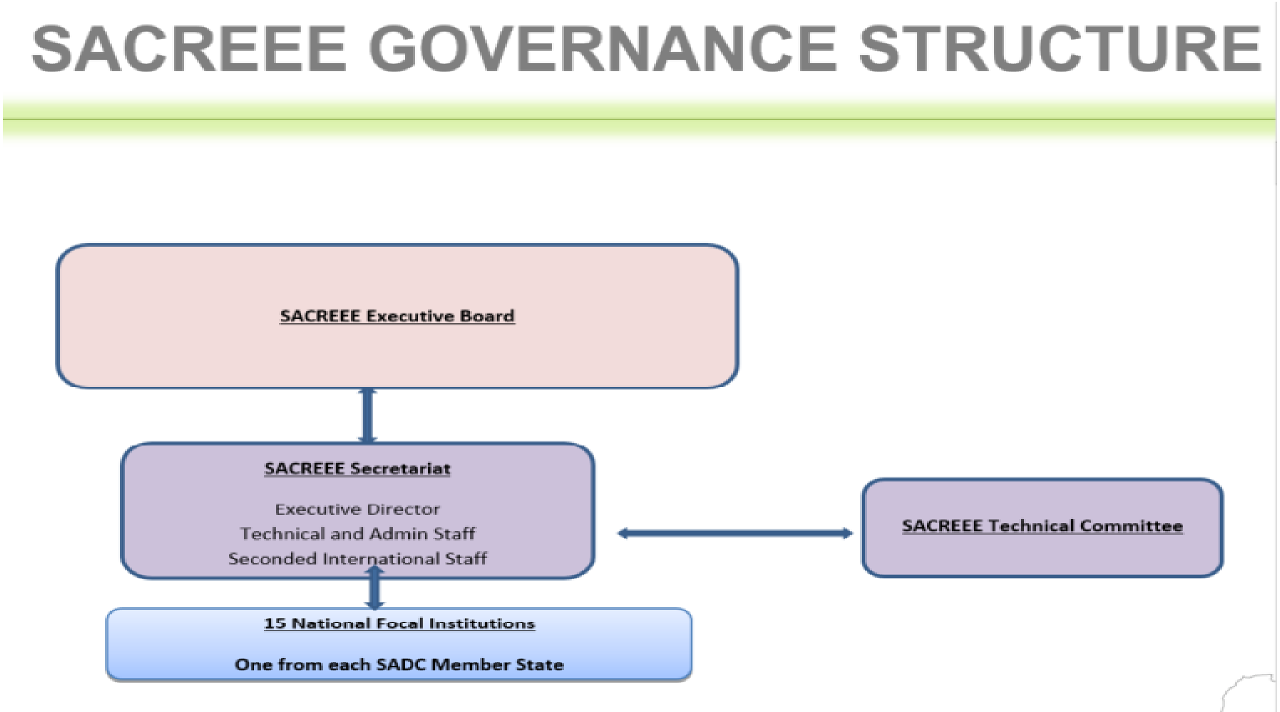
A. SACREE

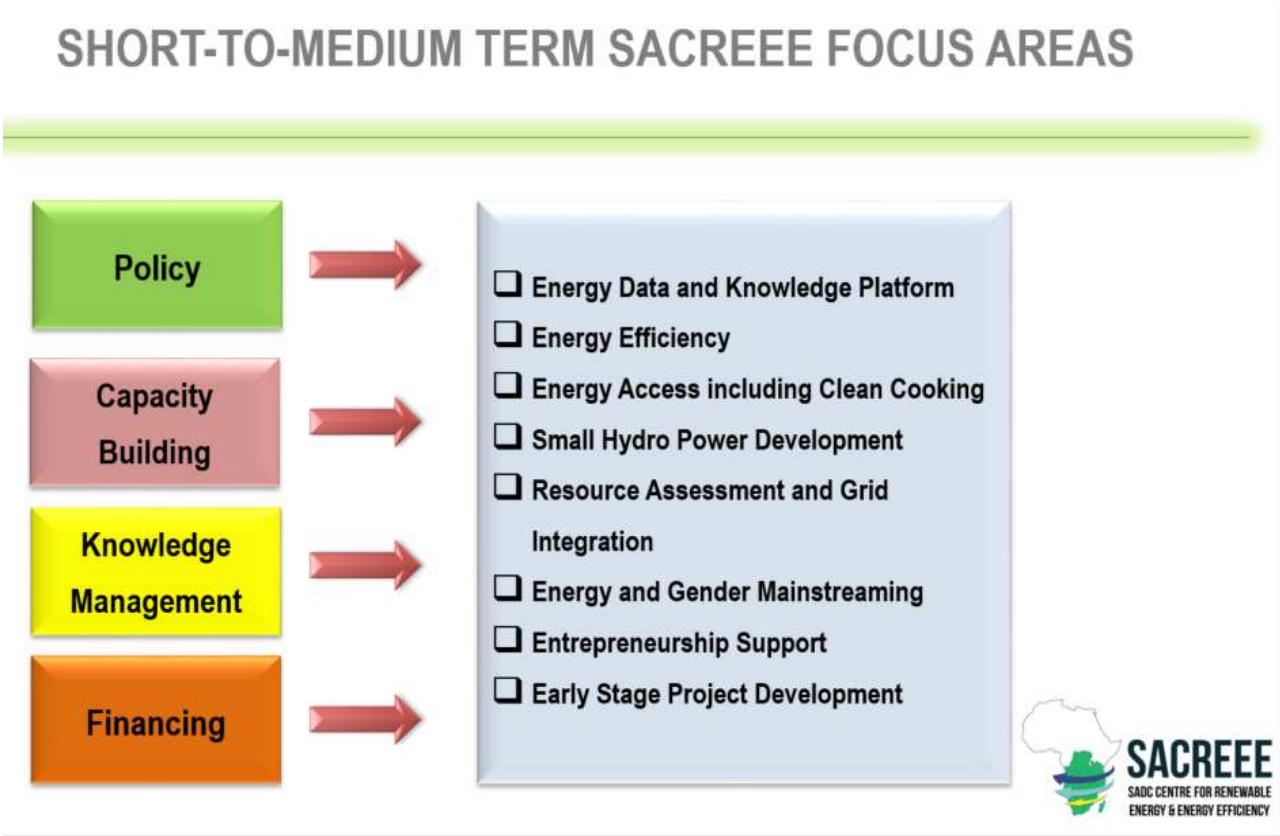
(Extracted from the SACREEE_GNSEC_VEF2017.ppt)

*"… **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
SACREEE Executive Board
SACREEE Secretariat
Executive Director
Technical and Admin Staff
Seconded International Staff
SACREEE Technical Committee
15 National Focal Institutions
One from each SADC Member State


SHORT-TO-MEDIUM TERM SACREEE FOCUS AREAS
Policy
Capacity Building
Knowledge Management
Financing
Energy Data and Knowledge Platform
Energy Efficiency
Energy Access including Clean Cooking
Small Hydro Power Development
Resource Assessment and Grid Integration
Energy and Gender Mainstreaming
Entrepreneurship Support
Early Stage Project Development
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

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 labelling 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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B. Energy Efficiency funding initiatives in SADC region

EREF ECOWAS Renewable Energy Facility - Tanzania

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.

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. 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.

Africa-EU Energy Partnership (AEEP) - European and African member states

AEEP 2020 includes energy efficiency (increase energy efficiency in all sectors)

World Bank Energy Sector Management Assistance Program (ESMAP)

"… Promoting increased access to energy, with emphasis on renewable energy, energy efficiency and energy access.

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;

Clean Technology Fund (CTF)

"… Highly concessional resources to scale up the demonstration, deployment, and transfer of low carbon technologies in renewable energy, energy efficiency, and sustainable transport.

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;

AREF - Africa Renewable Energy Fund

"… AREF is a private equity fund focusing on renewable energy infrastructure investments across Sub-Saharan Africa, excluding South Africa.

C. Price lists

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

Incledon Motors 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.