TECHNICAL MARKET REVIEW

Country Profile: Tanzania

Climate Technology Centre & Network

Revised Report
Date: 25th 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

Prepared by:	**Verified & Approved by:**
Annanda How, Gabriel Kroes DNV GL	Luisa Freeman, Joseph Lopes, Matthew Jones DNV GL

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Tanzania, Market Review, Energy Efficiency

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1 EXECUTIVE SUMMARY

This report reviews the potential for increasing the energy efficiency of products in Tanzania 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 intended to support Tanzania in achieving its sustainability goals.

Situation analysis

Just over one fifth of households in Tanzania have access to electricity, where it is used primarily for lighting, with biomass being readily available for other uses. The adoption of energy efficient technologies beyond lighting has consequently been low in Tanzania to date, where the priority in the residential sector is on expanding access to electricity. Opportunities for adoption of efficient products has been limited due to a range of reasons that include high levels of poverty and cultural factors, particularly in rural areas. The design and construction of efficient buildings has been impacted by the limited existence and enforcement of regulations, as well as an informal property market.

Underlying process

DNV GL conducted an initial desktop analysis before sending out data requests and conducting meetings with key local entities involved in the energy sector within Tanzania. These included the Tanzania Commission for Science & Technology, Tanzania Electric Supply Company (TANESCO) and other local stakeholders such as contractors, suppliers and installers of technologies. DNV GL attended an energy efficiency conference and participated in a seminar where Building Energy Efficiency regulations were discussed. Meetings and interviews were conducted by DNV GL during the visit to Tanzania and with follow-up communications conducted via email and phone. Key findings are highlighted below.

National Designated Entity (NDE) prioritisation

Based on the interviews conducted, power sector challenges, such as electrification and the urgent need of system maintenance, energy efficiency is a lower priority for the National Designated Entities (NDEs) in Tanzania. More pressing are such basic issues as expanding access to electricity, and improving food, water and housing conditions. Considering these priorities, little attention has been paid to the collection and maintenance of detailed data of interest to this study. Those with the authority to respond to the study team's requests for information were cooperative in seeking support and feedback from other government entities (e.g., revenue authorities, trade organizations, utilities, statistics bureau, etc.), with varying success in terms of timeliness, comprehensiveness and data quality. Nonetheless, the information obtained by the study team has been employed to the fullest extent in presenting the status of and opportunity for energy efficiency technologies in Tanzania.

Market Context

Due to high levels of poverty in Tanzania and the Southern African region in general, the equipment markets are extremely price sensitive, with few consumers being able to afford the first cost of equipment at all, let alone the incrementally higher cost of most energy efficient product options. Energy efficient products typically have a higher first cost and any additional costs have large impacts on short term cash flows. The concept of lower operating and maintenance costs, which can result in fairly attractive payback rates, is not widely promoted nor relevant due to limited capital for investment.

Africa constitutes less than 5% of all global electricity consumption. While there is significant growth potential, the expansion of the regional power sector, electrification and appliance and equipment markets are hampered by the number of independent countries with their own policies, regulations and economies, and by persistently high levels of poverty across much of the region. Research shows that appliance and equipment manufacturers are therefore understandably cautious in spending time and resources to invest in producing and shipping high efficiency products to the African market, which impacts availability to specific countries. In the absence of regional standards or harmonized policies to encourage energy efficiency, there is the potential for lower-cost low efficiency units to dominate the markets in countries like Tanzania, where first cost is the market driver.

Energy Policies

Tanzania's energy policy articulates efficiency goals at a very high level, whereas regulations designed to realize the goals are lacking, and, short of the application of South African standards for some equipment plus a limited effort at promoting high efficiency lighting, there is scant evidence of the promotion of the technologies of interest to this study. Government is more focused on fulfilling the basic needs of the population and improving the quality and availability of power in the energy sector. Departments responsible for trade, energy and economic indicators do not appear to devote resources to the research and maintenance of detailed data on electric equipment at more than highly aggregated levels.

Summary of Market Assessment Results

Despite the limitations and context that it faces, Tanzania has much to gain by adopting energy efficiency standards, regulations and technologies to ensure that, as it expands access to electricity, usage can be guided to be as efficient and affordable as possible. Ideally, such regulations and market levers would be harmonized with that of the larger Southern African region so as to have maximum impact on the technology market. 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 Tanzania when moving from the current state of technologies to Minimum Energy Performance Standards (MEPS) or to Best Available Technologies (BAT) are shown in Table 1 and Figure 1 below. More detail on the underlying approach used to arrive at these estimates 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.

The overall savings potential from the adoption of MEPS is expected to increase from 189 GWh (187t CO_2) per annum in 2025 to just over 300 GWh (305t CO_2) per annum in 2030. BAT projected savings for 2025 are estimated to be 335 GWh (332t CO_2) per annum while estimated savings in 2030 are projected to be 600 GWh (595t CO_2).

Table 1-1: Projected Energy Savings

	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

	GWh savings (2025)	GWh savings (2030)	MUSD savings (2025)	MUSD savings (2030)	GHG savings (2025)	GHG savings (2030)
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	168	5	6	40	47
Aircon	8	20	0	1	2	6
Refrigeration	28	85	1	3	8	24
Motors	5	10	0	1	1	3
Transformers	32	67	1	3	8	17
Total	**216**	**351**	**8**	**14**	**60**	**97**

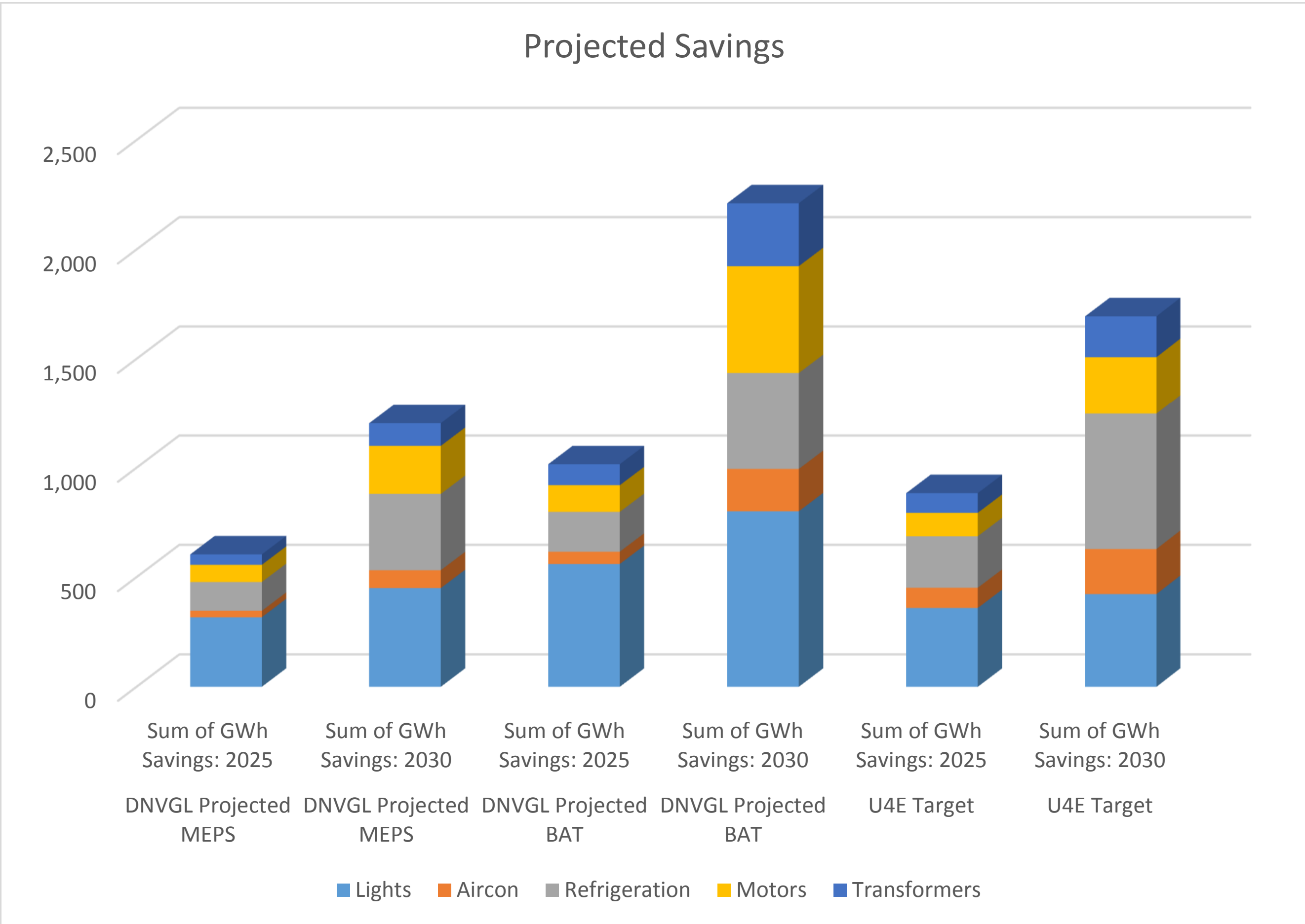


Figure 1-1: Projected Savings

2 INTRODUCTION

2.1 General Information about Tanzania

Tanzania is located in East Central Africa, bordered by Kenya, Uganda, Rwanda, Burundi, the Democratic Republic of the Congo, Zambia, Malawi, Mozambique, and the Indian Ocean. The United Republic of Tanzania includes the Indian Ocean islands of Pemba and Zanzibar.

Size (km^2)	945,087
Population (Est, 2017) [1]	56,933,754

Dodoma has been the official capital city of the United Republic of Tanzania since 1996. The largest city is Dar Es Salaam, which also serves as the main port, dominant industrial centre, and the focus of government and commerce. [2] [3]

Tanzania is a member of the United Nations [4], the Commonwealth of Nations [5] and the Southern African Development Community (SADC) [6]. An estimated 46.6% of the population survives on less than US$1.90 a day (the international poverty line), based on 2011 statistics. In 2016, the World Bank classified Tanzania as a "low income" country because the annual gross national income (GNI) per capita levels is USD 1,045 or less. [7]

2.2 Climate and Topography

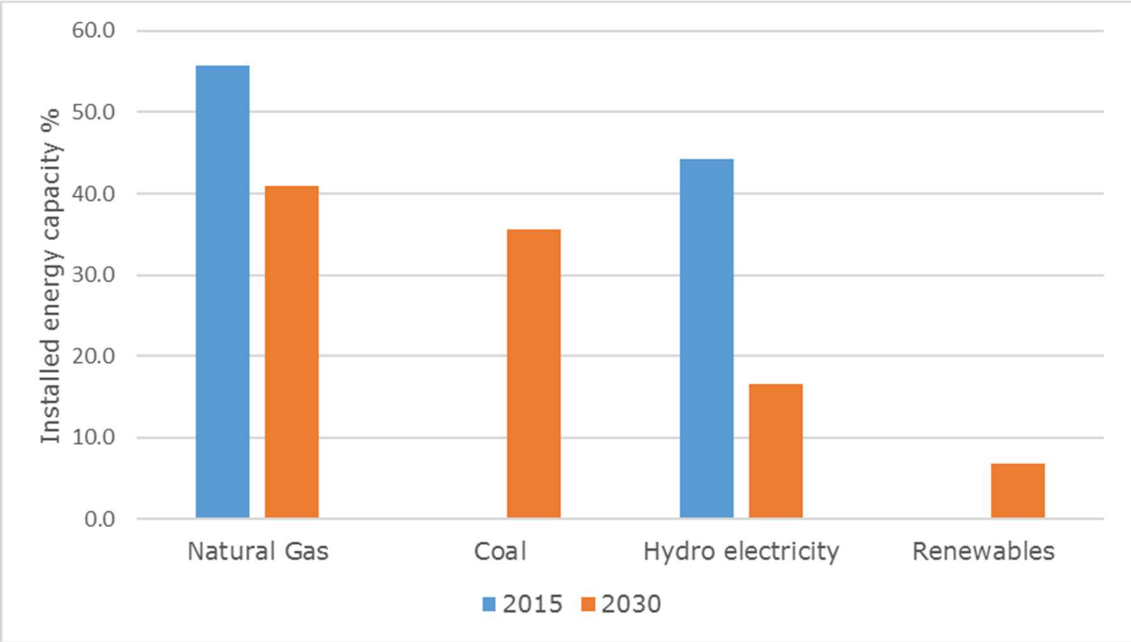
Tanzania is a tropical country with four main climatic zones: the hot, humid coastal plains; the hot, arid zone of the central plateau; high, moist lake regions; and temperate highlands. The climate is governed by two monsoon seasons. The northeast monsoon from December to March brings the year's hottest temperatures, after which the winds shift to the south from March to May, which bring the heavy intermittent rains of the southwest monsoon from June to September, bringing relatively cool, dry weather. A smaller wet season occurs in November and December. Rainfall varies from an annual average of 1,250mm in the wettest 3 % of the land area, the south-eastern slopes of the great volcanoes, to below 600mm in the central area of the country. [8]

The northeast is mountainous and is the location of Mount Kilimanjaro, at 5,897 metres above sea level the highest peak in Africa. The Great Lakes of Lake Victoria and Lake Tanganyika are in the north and west. A large plateau is situated in central Tanzania. The eastern shore's weather is hot and humid. Tanzania encompasses a variety of physical features; from a narrow coastal belt with tropical beaches to an extensive plateau covered by savannah and bush at an elevation of about 1,000 metres above sea level. The plateau region is fringed by narrow belts of forested highlands, which include the snow-capped Mount Kilimanjaro. Lakes Tanganyika, Nyasa and Rukwa partly occupy the floor of the Great Rift Valley system. At 358 metres below sea level, the floor of Lake Tanganyika is Africa's lowest point. [9]

2.3 Electricity Sector

In the IRENA document titled *Southern Africa Power Pool: Planning and Prospects for Renewable Energy*, the following graph displays the installed energy capacity for 2014 and projected for 2030.

Figure 2.1 INSTALLED ENERGY CAPACITY FOR 2014 AND 2030 [10]



Note: Renewables includes Solar PV, Solar Thermal, and Biomass

Tanzania is endowed with abundant energy resources, which include natural gas, hydro power (rapids and falls), coal, uranium, and other renewable sources of energy. In 2014 about 42% of power generated in Tanzania came from hydro, continuing a long-term trend. However, a lack of rain in the past few years resulted in a shortage of water for generating electricity. As a result, Tanzania initiated deliberate measures to forge an energy mix by promoting an increased use of renewable energy technologies. This was specifically: solar; wind; biomass; waste; and micro hydro, as well as other locally available energy sources, including natural gas, coal and geothermal. Proven natural gas reserves in Tanzania are estimated at more than 45 billion m³. Tanzania coal reserves are estimated at about 1,200 million tonnes, of which 304 million tonnes are proven.

Located in the 'solar belt', most parts of Tanzania have abundant solar resources throughout the whole year with the low point occurring in July. The lowest annual average is 15 MJ or 4.2 kWh/m2/day and the highest is 24 MJ or 6.7kWh/m2/day. With such high levels of solar energy resources, Tanzania is naturally suitable for the application of solar energy as a viable alternative source for modern energy services supply, in general, but especially for rural electrification. Most of the wind data recorded between the 1970s and 1990s is not reliable for electricity generation due to factors including unsuitable locations (airports) and height of data recording equipment (1.8-2m). It is expected that with the eastern coastline (about 800 km) with the Indian Ocean, some promising wind resources for energy production are possible. Areas along rift valleys, southern highlands and along Lake Victoria are reported to have potential wind sites, as well.

INSTALLED CAPACITY		
	GW	*Approx.*
2015		**1.4**
2025		**6.8**

In 2014 about 6.6% of consumed energy was imported; in 2030 this may increase.

An estimated 41% of the population have access to electricity. Of the mainland electrified households, 74.9% receive electricity from the grid, 24.7% by solar power and 0.3% of generate from private entity/individual owned sources (excluding solar). Current rural and urban households connected to grid electricity were 34.5% and 96.4%, respectively. It is expected that electricity demand will triple by 2020. Even though TANESCO and the Rural Electrification Authority (REA) are implementing grid extensions and adding a significant amount of new connections, the expected demand will continue to outpace supply. Currently, wood and charcoal are the main sources of energy in rural areas of Tanzania. In the future, wood and charcoal will be replaced by electric power, gas and petroleum products, in line with the expected urbanization of Tanzania. With the large percentage of the population living in poverty, this contributes to population not having access all of the basic needs, including energy services.

Tanzania 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. Tanzania is in the process of joining 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 Tanzania.

TABLE 2.1 ENERGY EFFICIENCY AND DEMAND-SIDE MANAGEMENT (DSM) ACTIVITIES IN SADC MEMBER STATES AND UTILITIES [11]

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
Tanzania	X	X		X						X	X	X	X	X

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

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 THE NATIONAL ENERGY EFFICIENCY TARGETED PROGRAMS [11]

TARGET TYPE	LIGHTING RETROFIT	REDUCE ELECTRICITY DISTRIBUTION LOSSES	IMPROVED COOKING DEVICES	LOAD MANAGEMENT	STANDARDS AND LABELLING	FINANCING	REVISED BUILDING CODES
Tanzania	X		X				

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

TABLE 2.3 below indicates Tanzania's targeted GWh savings per product type by 2030, assuming a successful implementation of the various Energy Efficiency strategies.

Table 2.3 TARGETS FOR ENERGY SAVINGS [12]

U4E PATHWAY TO ENERGY EFFICIENCY	TARGETED ANNUAL GWh SAVINGS BY 2030				
	LIGTHING	RESIDENTIAL REGRIGERATORSS	ROOM AIR CONDITIONEWRS	INDUSTRIAL ELECTRIC MOTORS	TRANSFORMERS
Tanzania	422.9	619.5	206.0	59.4	186.9

(Extracted from the U44E Country Assessment, December 2016)

[9] [13] [14] [15] [12] [16] [17] [18] [10] [19] [11] [20] [21]

2.4 Power Industry Regulation and Policies

The Power Sector Regulatory environment is illustrated below:

Organizations responsible for energy policies	Ministry of Energy and Minerals Tanzania Renewable Energy Association (TAREA) Rural Energy Agency (REA)
Energy Regulator	Energy and Water Utilities Regulatory Authority (EWURA)
Energy policy publications	Electricity Act of 2008 Energy and Water Utilities Regulatory Authority Act of 2001 Petroleum Act of 2008 Gas Bill of 2009 Rural Energy Agency Act of 2005 Environmental Management Act, 2004 National Energy Policy, 2015 National Environmental Policy, 1997 Feed-in-Tarif, 2008 Public Private Partnership Act No. 18 of 2010 Power System Master Plan (PSMP, 2016 update)
Main entities in the electricity market	Tanzania National Electric Supply Company (TANESCO) IPP's

The Energy and Water Utilities Regulatory Authority (EWURA) is an independent regulatory authority comprising different sections as established by the EWURA Act Cap 414 of the laws of Tanzania. It is responsible for the regulation of the electricity, petroleum, natural gas and water sectors in Tanzania on both technical and economic fronts. The Rural Energy Agency (REA) was established by Act No.8 of 2005 as an autonomous institution to promote and facilitate access to modern energy services in rural areas of Mainland Tanzania.

REA projects that were implemented in 2015/16 included Turnkey Phase II; Sustainable Solar Market Packages II; Lighting Rural Tanzania Competition (LRCT2014); Tanzania Domestic Biogas Development Programme; Low-Cost Design Standard for Rural Electrification; Backbone Transmission Investment Project (BTIP); Training and Capacity Building to Project Developers; Clean Development Mechanism Programme of Activities;11th EDFRural Electrification Programme and Densification Programme. Table 2.4 summarizes the current energy efficiency support policies in Tanzania's, as reported in 2016.

Table 2.4 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
Tanzania			X							

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

Although there is no comprehensive policy, instrument or strategy targeting Energy Efficiency (EE), the Government is beginning to address this issue through the implementation of programmes and projects at an institutional level and in cooperation with several Development Partners.

Table 2.5 RENEWABLE ENERGY SUPPORT POLICIES INITIATED BY 2016 [20]

POLICY TYPE	RENEWABLE ENERGY TARGETS	FEED-IN TARRIF / PREMIUM PAYMENT	ELECTRIC UTILITY QUOTA OBLIGATION	NET METERING / NET BILLING	TRANSPORT OBLIGATION / MANDATE	HEAT OBLIGATION / MANDATE	TRADING REC	TENDERING
Tanzania	O	O						

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

Table 2.6 RENEWABLE FISCAL INCENTIVES AND PUBLIC FINANCING INITIATED BY 2016 [20]

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
Tanzania	O		O	O	O

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

[9] [13] [14] [15] [12] [16] [17] [18] [10] [19] [11] [20] [21]

2.5 Key Challenges and Recommendations

Key challenges include inadequate data and power planning tools to integrate renewable options; incomplete policy and regulatory framework for renewable energy; and lack of incentives to develop mini-grid projects due to uncertainty of when grid expansion will reach the project area. Also, most of the projects proposed under PSMP 2012 Update have not yet been completed or even commenced as of December 2016. This delay is attributed to the:

(i) Lack of sufficient financing;
(ii) Lack of legal binding to implement a proposed project under private sector;
(iii) Long approval process;
(iv) Environmental and social issues which require consent from various stakeholders.

The Rural Energy Fund (REF) provides capital subsidies for the development of rural energy projects.

A number of programmes are in place to address these challenges, for example:

- The Tanzania Renewable Energy Programme - a Clean Development Mechanism (CDM) Programme of Activities (PoA) developed by the Agency in partnership with the World Bank's Carbon Partnership Facility (CPF) (to expand coverage of rural electrification);
- Tanzania Rural Electrification Expansion Projects (TREEP) - The Agency and the World Bank Prepared Programme Document and Operating Guidelines for a loan worth USD 200 Million from IDA and USD 9 Million grant from the Scaling Up Renewable Energy Program (SREP) to support rural electrification by using both on-grid and off-grid projects and financing mechanism will be Performance for Results (PforR);
- By mid-2016, REA had already financed 152 grid extension projects.

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 2.6 Energy Efficiency (EE) Opportunities and Recommendations

	OPPORTUNITIES	RECOMMENDATION
POLICIES	Processes and procedures to enforce and prioritize energy efficiency requirements should be put in place.	• Table 2.1 above, highlights policies for energy efficiency in buildings and energy efficiency audits 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. • Table 2.4 above, highlights building efficiency guidelines and voluntary business energy efficiency programmes may be considered.

	OPPORTUNITIES	RECOMMENDATION
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 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, as summarised in 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 assessment 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.

Increases in 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), which reduce less efficient products (below MEPS) by a 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

According to the information gathered from desktop research and during the site visit, Tanzania has just over 6 million lights installed.

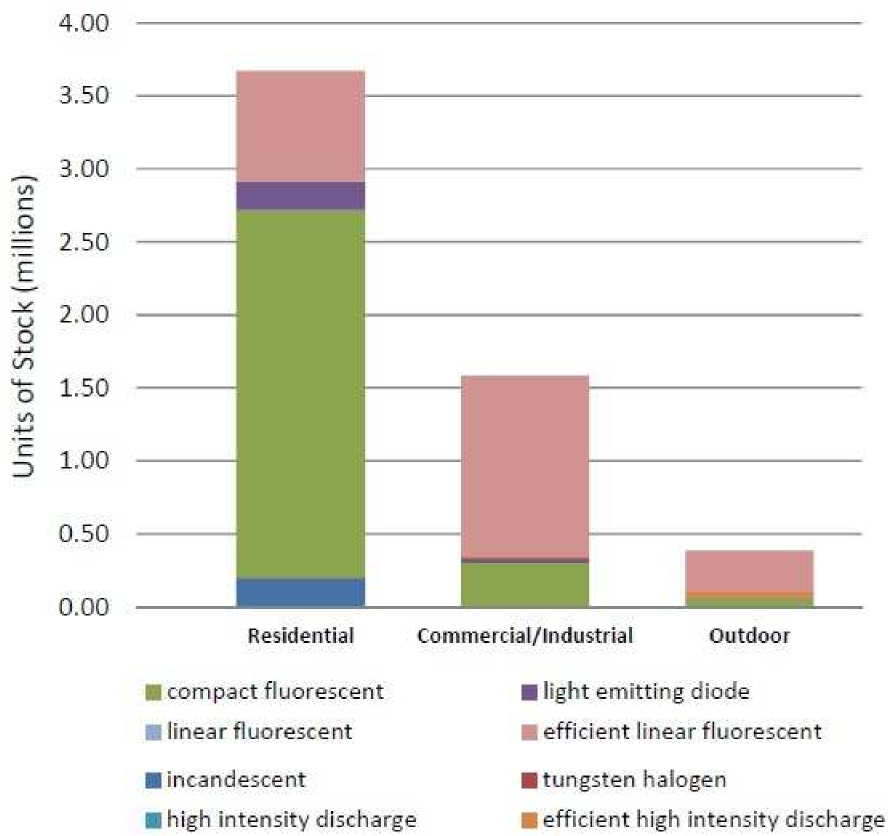


Figure 3-1: Units of Stock in different industries of Tanzania

As far as the implementation of energy efficient initiatives go, lighting has seen the highest adoption rates in comparison to other energy efficiency technologies in Tanzania. The relatively short time to market, large savings, scalability and low cost per item make lighting an attractive low hanging fruit for any energy consumer looking to cut down on consumption and costs.

3.1 Status and Trends of Lighting Products

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

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

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 Lighting

Short life expectancies lead to high replacement frequencies which are opportunities to change to newer, more efficient technologies. 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) have lights on for roughly 3000 hours per annum. In South Africa, residential lights (lighting in and around private dwellings) are often on for only 4 hours in the evening and two hours in the morning all year round, totaling 2190 hours per annum.

Current prices found during the shop visits in Tanzania show that halogen lamps are still the cheapest (since banning of incandescent) and a 60W lamp costs between 1 – 2 USD. A CFL lamp with comparable output (typically 15W) is in the range of 2 – 3 USD, while the equivalent LED (6W) would cost just under $5.

Light bulbs, lamps or just "lights" are generally available in supermarkets and retail stores all over Tanzania. The bulk of stock is split between CFLs and LEDs, with limited quantities of halogen and other types of lighting available. See images in Appendix D as example.

3.1.2 Local manufacturers, suppliers, retailers and other stakeholders

Except for the initial project phases during construction, lighting products are mostly purchased by households and small businesses from retail outlets, including general supermarkets. 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

Of the roughly 6.5 million lights in Tanzania, just over half are imported from South Africa. China covers about 46% (2007 – 2016) while the remaining 2% are from other countries, as shown in the figure below.

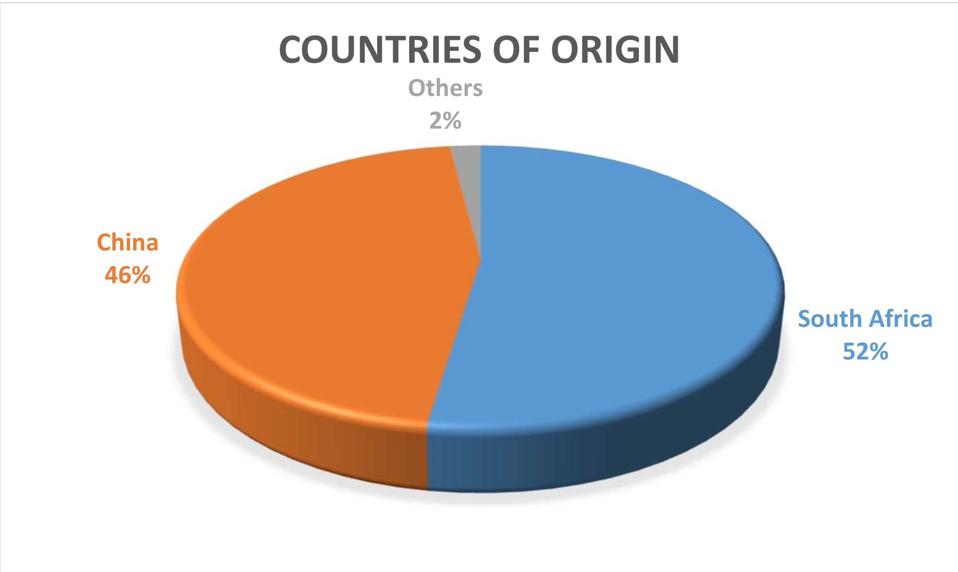


Figure 3-3: Countries of origin of lights imported by Tanzania

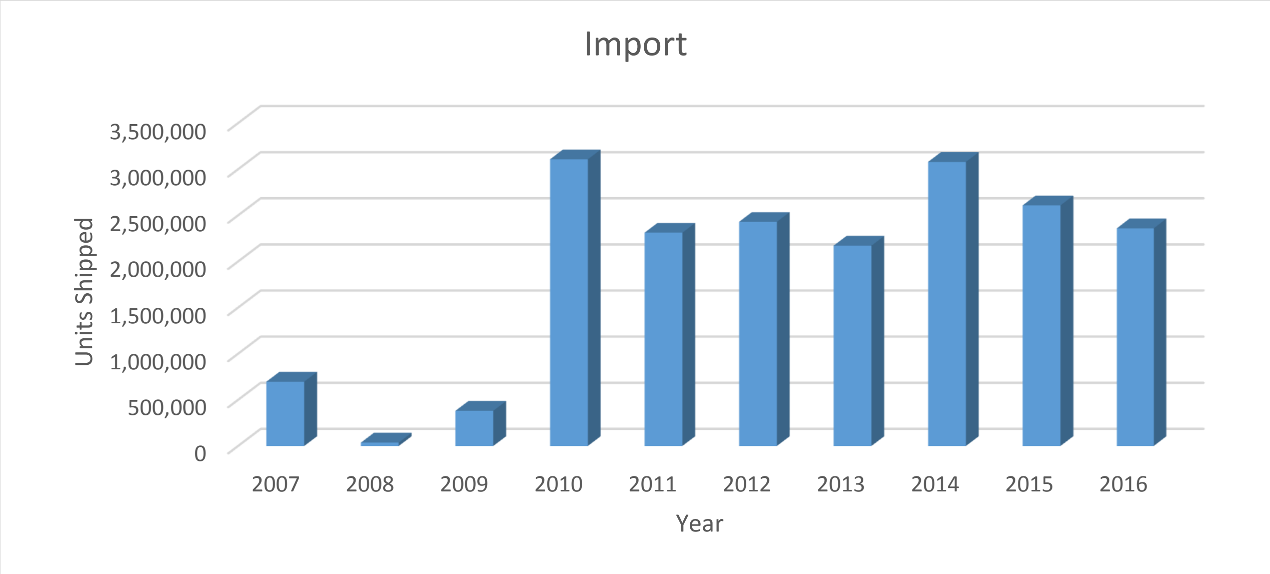


Figure 3-4: Units imported per year

3.1.4 Barriers to overcome

Cost

Due to the low average income per household, consumers are very sensitive to costs. The typical consumer will likely not be able to justify the additional short-term expenses to gain energy efficiency and even long-term cost savings, even for lighting.

Education

During the country visits, it become apparent that consumers are not aware of environmental and cost impacts of buying low efficiency products.

Import duty & tax

There is no reduction or waivering of import duty or taxes on energy efficient lights (CFL or LED). This is strange since there is no local manufacturing market to protect. 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 a stand-alone unit, rather than to replace inefficient lights for use in fixtures.

3.1.5 New vs. Used equipment

Lights are mainly replaced on burn-out. 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.	3 535 169	4 434 516	-10%	7 033 619	-20%	9 916 512
Business as Usual	QTY CFL & FL	2 085 066	2 615 507	14%	5 261 931	13%	10 502 079
Business as Usual	QTY LED	583 525	731 974	10%	1 418 987	50%	3 751 110
DNV GL Projected MEPS	QTY Halo, Inc etc.	3 535 169	4 434 516	-50%	3 907 566	-20%	5 509 173
DNV GL Projected MEPS	QTY CFL & FL	2 085 066	2 615 507	79%	8 258 986	0%	14 568 409
DNV GL Projected MEPS	QTY LED	583 525	731 974	20%	1 547 986	50%	4 092 120
DNV GL Projected BAT	QTY Halo, Inc etc.	3 535 169	4 434 516	-80%	1 563 026	-20%	2 203 669
DNV GL Projected BAT	QTY CFL & FL	2 085 066	2 615 507	122%	10 216 529	-6%	16 850 883
DNV GL Projected BAT	QTY LED	583 525	731 974	50%	1 934 982	50%	5 115 149

Data & Assumptions:

- *Exchange Rate: 1 TZA = 12.45 ZAR = 2282.10 USD.*
- *Average Residential Marginal Electricity Tariff: 0.021 USD/kWh.*
- *Average Industrial Marginal Electricity Tariff: 0.050 USD/kWh.*
- *Electricity Cost Increase: 10% per annum.*
- *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 are projected under the MEPS and BAT scenarios, see Table 3.3. 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	317	450	58	134	86	121
DNV GL Projected BAT	560	801	103	238	151	216
U4E Targets	359	423	31	36	107	126

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 and drive promotion of energy efficient lighting technologies.

3.3 Status of Policies and Initiatives

Several lighting initiatives provide standalone solar lighting solutions to rural off-grid communities, these do not result in reduced loads on the grid. A pilot CFL roll out was conducted in Dar Es Salaam, but the government's ambitious 3.2 million CFL rollout is yet to come to realisation.

3.3.1 Standards and regulations

No specific standards related to energy efficiency and performance standards have been adopted or are listed for lighting, other than the standards enforced by the countries of origin.

3.3.2 Supporting Policies – Labelling and consumer awareness campaigns

Awareness of the impacts of energy efficient lighting is primarily driven by Tanesco. Some donor funded schemes included [22] the Danish Industry supporting the CTI with a capacity development programme that ran throughout 2014-2015 which consists of awareness raising and seminars related with EE. In addition, the Embassy of Sweden assisted with the formulation of the "National Energy Efficiency Report". In terms of capacity building and awareness raising this will support the development of the Energy Efficiency Programme with the following objectives:

- Developing a project/programme aiming at capacity development, education, information and awareness in the field of EE;
- Strengthening the capacity of MEM and other institutions in EE issues and put systems in place for coordination, measurement, reporting and verification of EE initiatives; and
- Developing a communication strategy and national information campaigns and a government promotional package on EE.

3.3.3 Financial Mechanisms

Even though Tanesco distributed free CFLs, there is no mechanism that provides access to financing for the implementation of energy efficient lighting.

3.3.4 Monitoring, Verification and Enforcement

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

3.3.5 Environmentally Sound Management

Currently, no environmental policies are in place in Tanzania related to lighting.

3.3.6 Other on-going projects/initiatives

No ongoing initiatives are currently in place.

4 AIR-CONDITIONING

The use of air conditioning units in Tanzania homes is negligible, and units are almost exclusively used in commercial buildings (offices and shops). 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 by cooling capacity (e.g. 9’000 btu/h, 12’000 btu/h and 18’000 btu/h).

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 to 20 years.

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 Tanzania are Class A or better, mostly since the bulk 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 Tanzania. Stakeholders include importers, distributor and installers, most of which are part of the building industry.

4.1.4 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.

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 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 are 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	208 904	262 049	-6%	434 111	-7%	711 498
Business as Usual	Class B - Class A	162 481	203 816	4%	372 535	2%	667 512
Business as Usual	Class A+ & Above	92 846	116 466	7%	219 621	11%	429 622
DNV GL Projected MEPS	Lower than Class B	208 904	262 049	-28%	332 510	-19%	474 657
DNV GL Projected MEPS	Class B - Class A	162 481	203 816	24%	445 400	1%	791 241
DNV GL Projected MEPS	Class A+ & Above	92 846	116 466	21%	248 356	24%	542 733
DNV GL Projected BAT	Lower than Class B	208 904	262 049	-35%	300 183	-33%	354 447
DNV GL Projected BAT	Class B - Class A	162 481	203 816	14%	409 994	-14%	624 169
DNV GL Projected BAT	Class A+ & Above	92 846	116 466	54%	316 089	49%	830 015

Data & Assumptions:

- *Exchange Rate: 1 TZA = 12.45 ZAR = 2282.10 USD.*
- *Average Residential Marginal Electricity Tariff: 0.021 USD/kWh.*
- *Average Industrial Marginal Electricity Tariff: 0.050 USD/kWh.*
- *Electricity Cost Increase: 10% per annum.*
- *Operating hours: 8 hours per day x 125 days per annum = 1 000 hours.*
- *Average cooling capacity: 3.5kW.*

The quantity and adoption rates of technologies are based on information from stakeholder interviews.

Assuming the adoption rates are accurate, the following savings are projected (3) 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.

	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	29	82	5	23	8	22
DNV GL Projected BAT	56	194	10	53	15	52
U4E Targets	92	206	8	18	27	61

4.2.2 Job creation or elimination from energy efficient products.

There is no direct impact on the Tanzania market expected, as the bulk of units are imported. Jobs may include AC technicians, installation and repair services, trading, and supply.

4.3 Status of Policies and Initiatives

4.3.1 Standards and regulations

Tanzania's Ministry of Energy and Minerals, in conjunction with SE4All, compiled an action agenda for energy in December 2015. Some of the recommendations include: "Defining Minimum Energy Performance Standards (MEPS), and provide adequate support for its implementation and oversight, including the development of voluntary agreements for efficient refrigerators and air conditioners."

4.3.2 Supporting Policies – Labelling and consumer awareness campaigns

No policies or awareness campaigns are in place.

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

Environmental management is currently not in place in Tanzania related to air conditioners.

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

An estimation of the percentage of households with a refrigerator in the home is 12%, mainly with one unit per house. [8.7]

5.1 Status and Trends of Refrigeration Products

5.1.1 Markets and Drivers

The average life expectancy for a properly maintained refrigerator is between 14 and 17 years depending on the model and size. Compact refrigerators typically last 14 years on average, while a standard size refrigerator will last 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. [23]

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, with some also from large retailers. Most refrigerators have 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

No local manufacturing of refrigerators takes place in Tanzania.

5.1.4 Import/Export

Most household appliances in the Southern regions of SADC are either manufactured in, or distributed by, South African companies. However, since Tanzania sits further North of South Africa, South African presence in this market has been mitigated by aggressive importing of cheaper appliances from China, which has reached almost half the market.

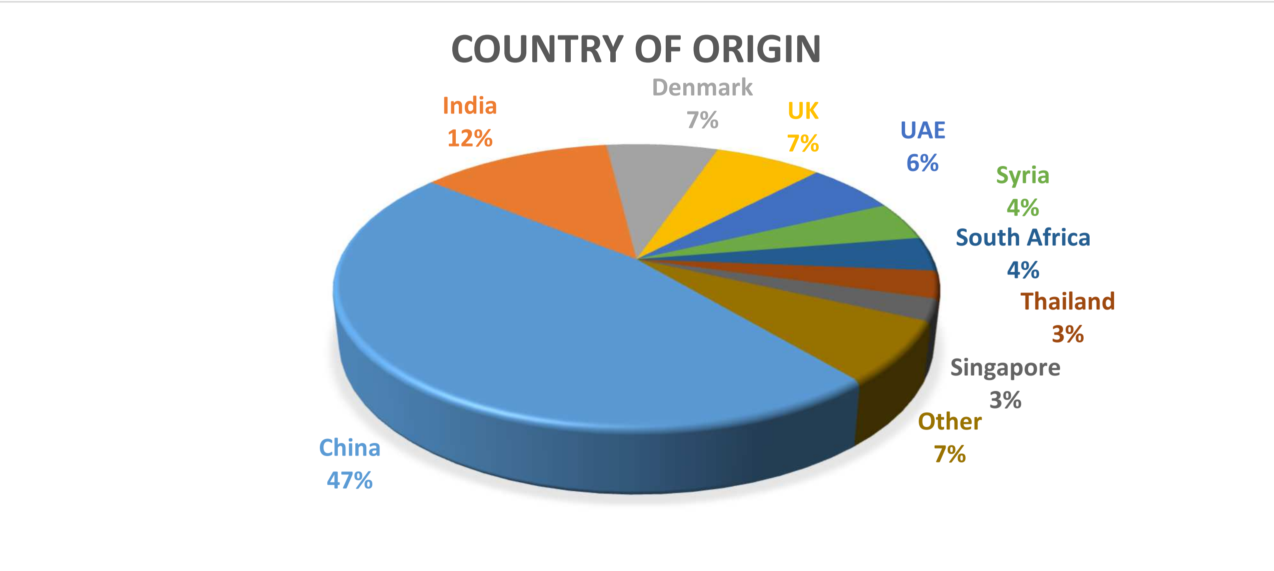


Figure 5-1: Country of origin of refrigerators

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 Tanzania after their warranty period. A minor repair industry 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 Tanzania requires fridges to be at least of Class B. 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. [24] 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 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	909 177	1 140 471	-5%	1 909 405	-7%	3 129 472
Business as Usual	Class B - Class A	325 675	408 527	9%	782 661	10%	1 522 656
Business as Usual	Class A+ & Above	122 128	153 198	14%	307 785	17%	634 634
DNV GL Projected MEPS	Lower than Class B	909 177	1 140 471	-52%	964 752	-61%	663 087
DNV GL Projected MEPS	Class B - Class A	325 675	408 527	128%	1 643 618	27%	3 671 582
DNV GL Projected MEPS	Class A+ & Above	122 128	153 198	45%	391 481	38%	952 094
DNV GL Projected BAT	Lower than Class B	909 177	1 140 471	-69%	623 069	-80%	219 612
DNV GL Projected BAT	Class B - Class A	325 675	408 527	165%	1 904 305	6%	3 543 372
DNV GL Projected BAT	Class A+ & Above	122 128	153 198	75%	472 478	83%	1 523 782

Data & Assumptions:

- *Exchange Rate: 1 TZA = 12.45 ZAR = 2282.10 USD.*
- *Average Residential Marginal Electricity Tariff: 0.021 USD/kWh.*
- *Average Industrial Marginal Electricity Tariff: 0.050 USD/kWh.*
- *Electricity Cost Increase: 10% 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 (s are also shown as benchmarks.

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.

	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	131	349	24	103	35	94
DNV GL Projected BAT	182	441	34	131	49	119
U4E Targets	236	620	20	53	70	184

Quantity and adoption of new technologies is based on information from stakeholder interviews (DEFY, Hisense, KIC, Whirlpool & others).

5.2.2 Job creation

The adoption of energy efficiency has no specific impact on the local job market. Jobs may include technicians, installation and repair services, trading, and supply of equipment.

5.3 Status of Policies and Initiatives

5.3.1 Standards and regulations

Tanzania's Ministry of Energy and Minerals, in conjunction with SE4All, compiled an action agenda for energy in December 2015. Some of the recommendations include: "Defining Minimum Energy Performance Standards (MEPS), and provide adequate support for its implementation and oversight, including the development of voluntary agreements for efficient refrigerators and air conditioners."

5.3.2 Supporting Policies – Labelling and consumer awareness campaigns

No supporting mechanisms were found in Tanzania 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

No proper environmental management of old refrigerators is being enforced within Tanzania.

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, they can last 15 years or more. [25] 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, usually 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. [26]

With respect to 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).

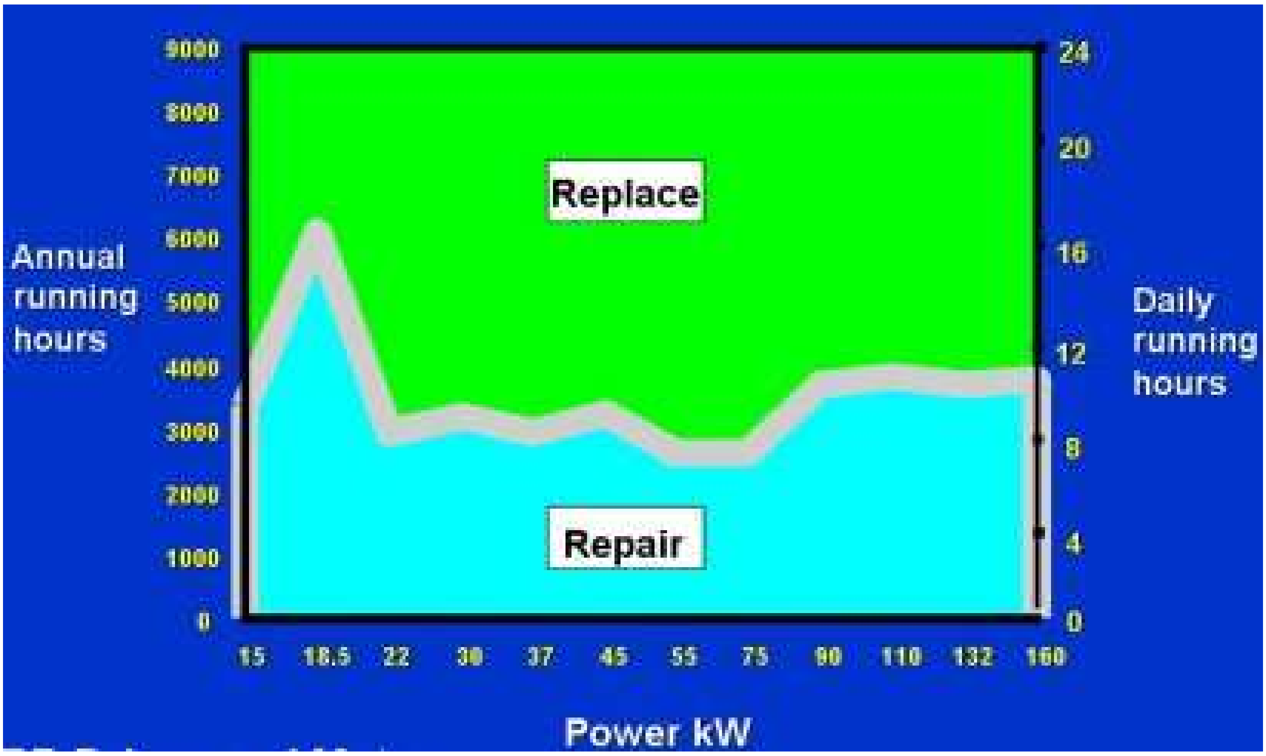
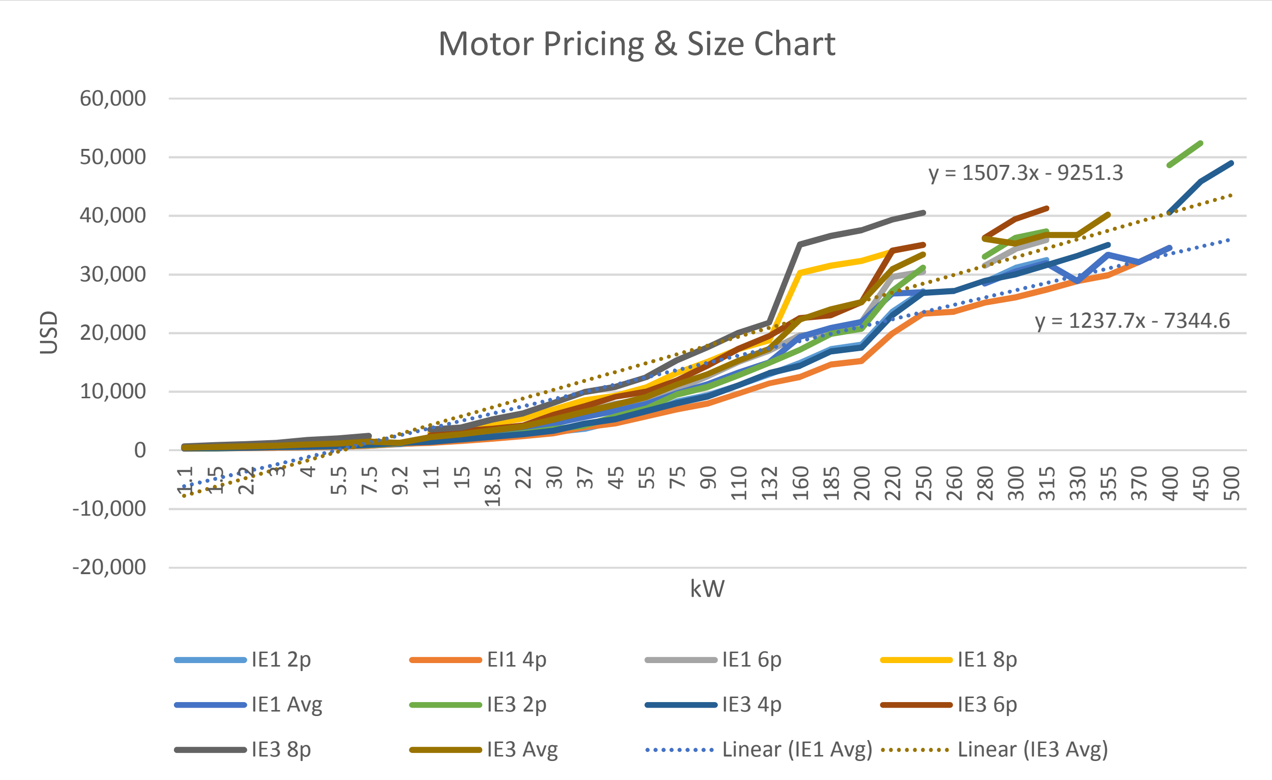


Figure 6-1: Repair or Replace [27]

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 the chart 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.

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 provider 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 Tanzania and the lack of industries to maintain such businesses, no manufacturing of motors takes 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

Tanzania is almost exclusively an importer of motors.

6.1.6 Barriers to overcome

Overall Inefficient Systems

Due to the low (subsidized) historical price of electricity in Tanzania, most industrial and commercial systems and processes (which include electrical motors) were designed for low installation costs, which do 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, and optimal efficiencies are hardly ever reached.

6.1.7 New vs. Used

Motors are typically used at their point of installation until 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. A common observation during the country visit was that 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 are explained in Section 2.

Current minimum energy performance standards in Tanzania require motors to be at least of Class IE1. 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, 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	521 396	654 039	-5%	1 095 008	-7%	1 794 694
Business as Usual	Class IE3	405 530	508 697	2%	913 147	1%	1 627 356
Business as Usual	Class IE4	231 731	290 684	8%	553 267	12%	1 092 051
DNV GL Projected MEPS	Class IE1 & below	521 396	654 039	-11%	1 025 850	-13%	1 572 871
DNV GL Projected MEPS	Class IE3	405 530	508 697	7%	956 691	9%	1 839 428
DNV GL Projected MEPS	Class IE4	231 731	290 684	13%	578 882	8%	1 101 803
DNV GL Projected BAT	Class IE1 & below	521 396	654 039	-13%	1 002 797	-20%	1 413 817
DNV GL Projected BAT	Class IE3	405 530	508 697	4%	933 639	6%	1 745 514
DNV GL Projected BAT	Class IE4	231 731	290 684	22%	624 987	23%	1 354 772

Data & Assumptions:

- *Exchange Rate: 1 TZA = 12.45 ZAR = 2282.10 USD.*
- *Average Residential Marginal Electricity Tariff: 0.021 USD/kWh.*
- *Average Industrial Marginal Electricity Tariff: 0.050 USD/kWh.*
- *Electricity Cost Increase: 10% 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.*

Assuming 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.

	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	79	220	13	61	21	59
DNV GL Projected BAT	122	489	21	135	33	132
U4E Targets	107	259	9	21	32	77

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 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 Tanzania, however IEC standards are expected to take precedent.

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

Environmentally Sound Management is not driven in the Tanzanian motor industry.

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 Tanzania is owned and operated by the Tanzanian Electricity Supply Company, commonly referred to as TANESCO. The power networks are mostly distributed at the endpoints by pole mounted distribution transformers. Most of them date back to around 20 – 30 years.

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 [28]:

- 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 Tanesco. 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

Due to the close proximity of India and the fact that India has a large transformer manufacturing industry, no local manufacturing is necessary or feasible and therefore currently doesn't takes place in Tanzania.

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

Roughly 65% of the transformers that come into Tanzania are from India, with China an additional 17%. The balance is distributed among several countries, including Turkey and Japan.

7.1.5 Barriers to overcome

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 very slow adoption of energy efficient transformers in Southern Africa in general, as is the case in Lesotho. Further to that, the long-life expectancy of typical transformers further reduces the potential uptake of energy efficient units.

7.1.6 New vs. Used

Based on discussions with TANESCO, DNV GL believes that transformers are typically installed in position and operated in that installation until end-of-life, primarily due to the size, nature of use and the fact that these are generally owned and operated by the distribution and transmission utilities. Therefore, there is little to no market for second hand distribution transformers.

7.2 Potential Savings from Energy-Efficient Transformers

Modelling of the different scenarios is explained in Section 2.

Due to the daily variable load on distribution transformers driven by the end users, it is very hard to accurately model a hypothetical simulation to ascertain or predict how many transformers will be operating at certain percentages of full load, at what points of their efficiency curves, and for how long. 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[1] 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	2 374	2 978	-8%	4 828	-20%	6 807
Business as Usual	SEAD Tier 3 or similar	6 821	8 556	-5%	14 357	-14%	21 725
Business as Usual	SEAD Tier 5 or similar	4 695	5 889	11%	11 520	26%	25 581
DNV GL Projected MEPS	Not Rated	2 374	2 978	-46%	2 834	-25%	3 746
DNV GL Projected MEPS	SEAD Tier 3 or similar	6 821	8 556	-1%	14 898	-27%	19 045
DNV GL Projected MEPS	SEAD Tier 5 or similar	4 695	5 889	25%	12 973	37%	31 322
DNV GL Projected BAT	Not Rated	2 374	2 978	-63%	1 942	-66%	1 164
DNV GL Projected BAT	SEAD Tier 3 or similar	6 821	8 556	-20%	12 054	-73%	5 834

[1] 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).

Scenario	Description	QTY (2017)	QTY (2020)	Tech. Adopt (2025)	QTY (2025)	Tech. Adopt (2030)	QTY (2030)
DNV GL Projected BAT	SEAD Tier 5 or similar	4 695	5 889	61%	16 709	60%	47 115

Data & Assumptions:

- *Exchange Rate: 1 TZA = 12.45 ZAR = 2282.10 USD.*
- *Average Residential Marginal Electricity Tariff: 0.021 USD/kWh.*
- *Average Industrial Marginal Electricity Tariff: 0.050 USD/kWh.*
- *Electricity Cost Increase: 10% 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.*

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	48	104	8	29	13	28
DNV GL Projected BAT	96	288	16	79	26	78
U4E Targets	90	187	8	16	24	51

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 local service industry.

7.3 Status of Policies and Initiatives

7.3.1 Standards and regulations

Power efficiency is generally an efficiency level 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. Tanzania does not specifically require IEC standards, but these are expected to take precedence.

7.3.2 Supporting Policies – Labelling and consumer awareness campaigns

There is no labelling scheme in Tanzania 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 Tanzania.

7.3.4 Monitoring, Verification and Enforcement

No specific regulations are enforced.

7.3.5 Environmentally Sound Management

No environmental management drives are in place to promote energy efficient transformers.

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

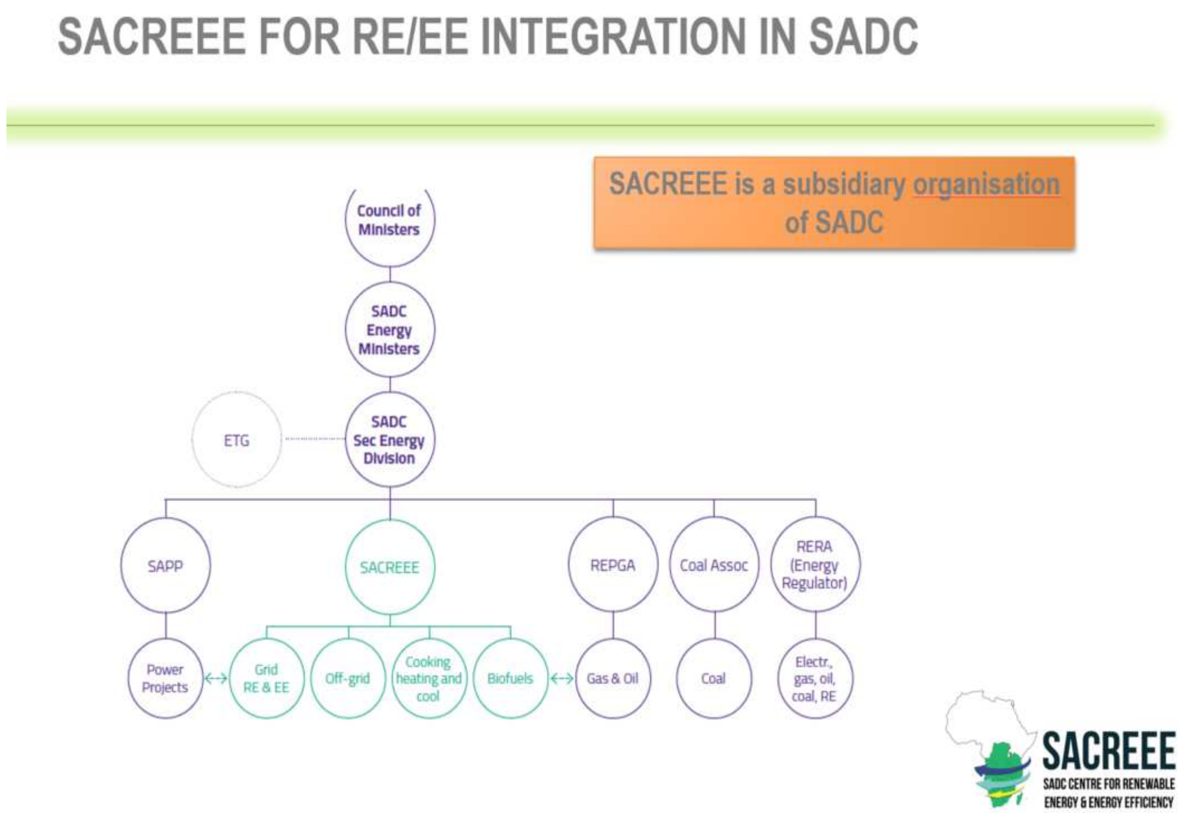
Extracted from the SACREEE_GNSEC_VEF2017.ppt

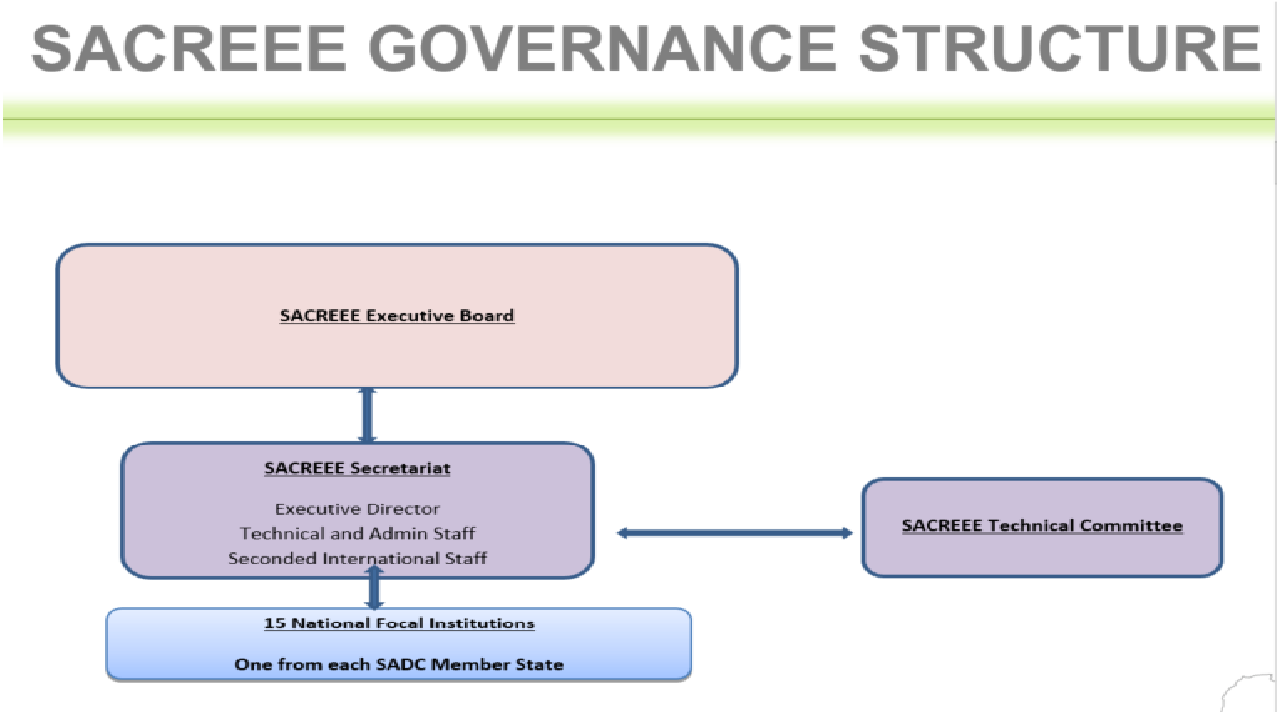
SACREEE is the **SADC CENTRE FOR RENEWABLE ENERGY AND ENERGY EFFICIENCY** – for market-based adoption of renewable energy and energy efficiency. SACREEE was established in 2016 by the SADC Energy Ministers and endorsed by 35th SADC Council of Ministers Meeting.

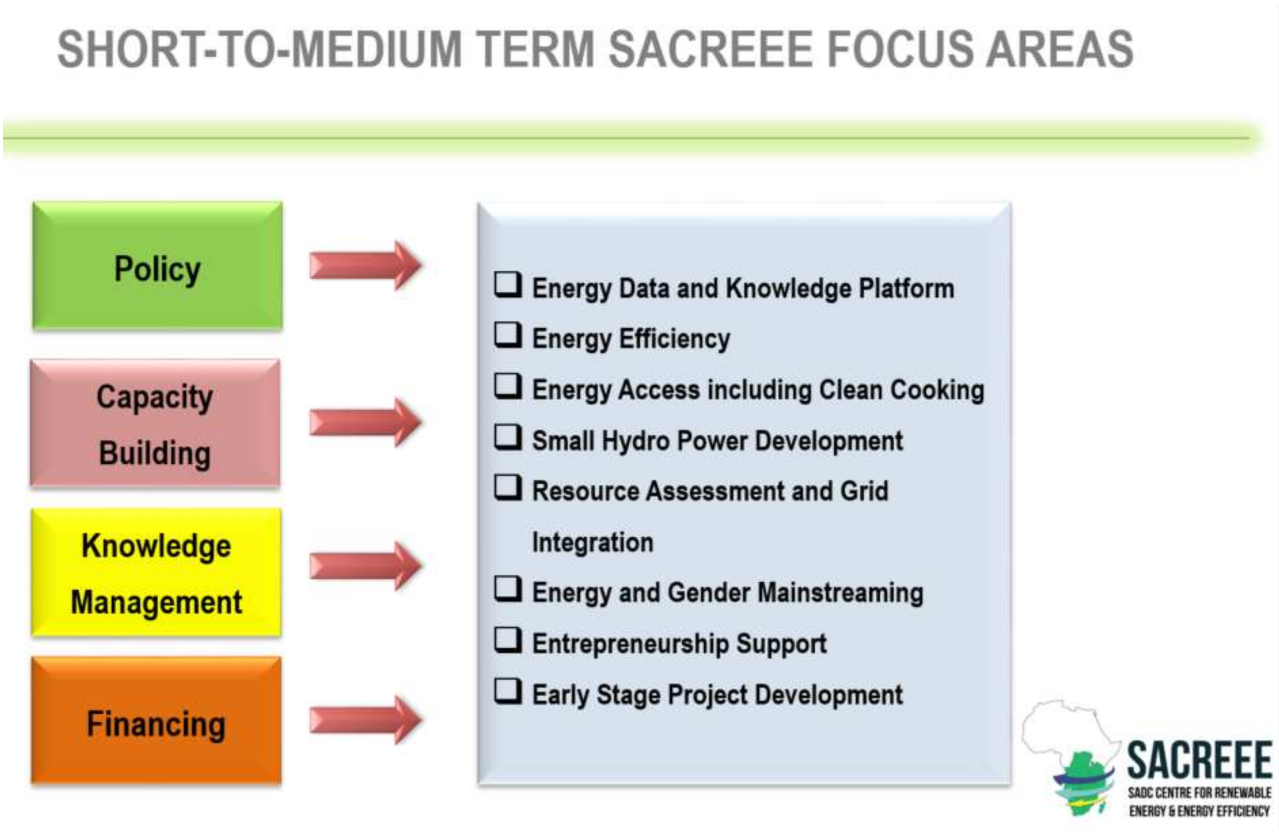
SACREEE's mandate is to implement the Regional Renewable Energy and Energy Efficiency Strategy and Action Plan (REEESAP) through the promotion of market-based adoption of renewable energy and energy efficient technologies and energy services

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

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

SACREE CONTACT DETAILS:

- AUSSPANN PLAZA NO. 1, NO. 11 DR. AGOSTINHO NETO STREET, AUSSPANNPLATZ, WINDHOEK, NAMIBIA
- www.sacreee.org
- **MR. KUDAKWASHE (KUDA) NDHLUKULA,** EXECUTIVE DIRECTOR
- EMAIL: kuda.ndhlukula@sacreee.orG, TEL: +264 818407702

APPENDIX B: ENERGY EFFICIENCY FUNDING INITIATIVES IN SADC REGION [21]

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.

The Climate Centre and Network (CTCN) fosters technology transfer and deployment at the request of developing countries through three core services: technical assistance, capacity building and scaling up international collaboration. The Centre is the operational arm of the UNFCCC Technology Mechanism, it is hosted and managed by the United Nations Environment and the United Nations Industrial Development Organization (UNIDO) and supported by more than 300 network partners around the world.

CTCN
CLIMATE TECHNOLOGY CENTRE & NETWORK

CTCN contact details:

Climate Technology Centre and Network

UN City, Marmorvej 51

DK-2100 Copenhagen, Denmark

+45 4533 5372

www.ctc-n.org

ctcn@unep.org

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.