Kenya Room Air Conditioner Market Assessment and Policy Options Analysis

June 26, 2019

CLASP

This report has been produced by CLASP, RenCon Associates, and Joseph Njuguna, June 2019. Support was given by ClimateWorks Foundation and Heising Simons Foundation.

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Executive Summary

The world is poised to install 700 million new room air conditioners (RACs) by 2030 and 1.6 billion by 2050.[1] In Sub-Saharan Africa, three factors – increased electricity access, economic growth, and higher temperatures due to climate change – will lead to an increase in the access to and need for comfort cooling in homes and small businesses. This growth in the African RAC market will contribute to an increase in the region's share of global greenhouse gas (GHG) emissions. The Kigali Amendment to the Montreal Protocol, an ambitious international agreement to curb direct emissions from cooling equipment, and well-implemented and enforced energy performance standards for cooling products will play important roles in addressing the growing need for cooling while limiting global warming. According to a recent CLASP analysis, transitioning to energy-efficient RACs in 150 countries would cut 620 TWh of electricity and 480 MT of CO_2 annually in 2030, saving consumers $56 billion USD on their electricity bills.[2] A simultaneous hydrofluorocarbon (HFC) phasedown under the Montreal Protocol could avoid another 100 billion tons of CO_2 equivalent.[3]

The Kigali Cooling Efficiency Program (K-CEP) focuses on the energy efficiency of cooling to increase and accelerate the climate and development benefits of the Kigali Amendment to phase down HFCs. CLASP has received a grant to support the implementation of K-CEP in Kenya. The main objectives of CLASP's K-CEP Kenya program are to raise efficiency standards for RACs, provide training and other capacity building activities targeted to local needs, and implement national market transformation initiatives where appropriate.

CLASP, in collaboration with RenCon Associates, a local partner, conducted a comprehensive characterization of the RAC market in Kenya. RenCon collected product data for 103 models from 15 distributors/dealers and retail stores in four cities – Nairobi, Mombasa, Kisumu and Eldoret. To complement the field data, they conducted in-person interviews with supply chain actors and reviewed secondary literature to gather data on the energy sector, RAC market size, sales, and usage. CLASP analyzed various policy scenarios of increasing minimum energy performance standards (MEPS), and estimated potential energy savings, avoided emissions at the national level, and lifecycle costs (LCC) savings for end-users. This RAC market assessment and policy analysis provides the technical evidence to support a revision of MEPS in Kenya.

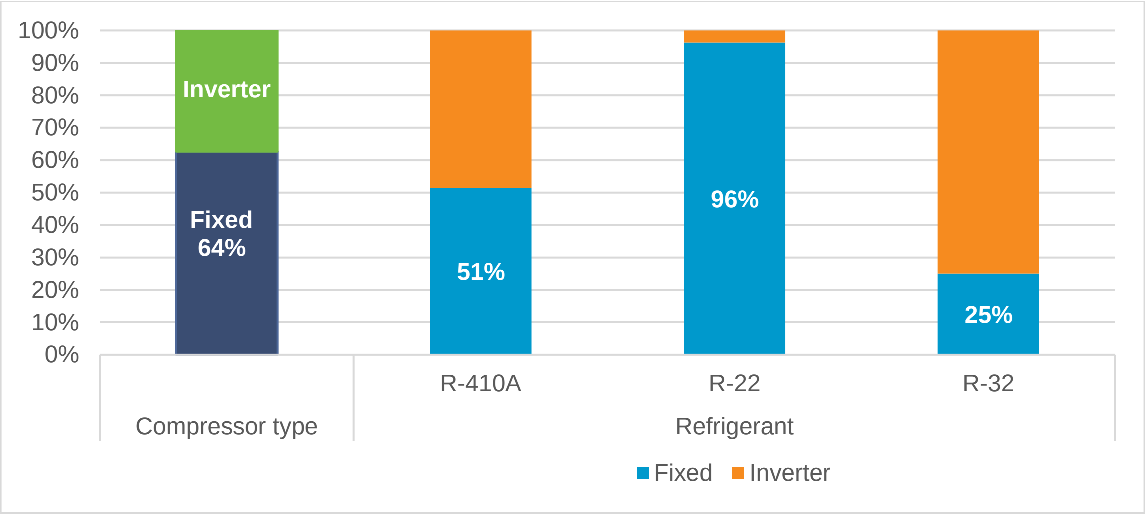
Key findings

The RAC market in Kenya is completely import-based. Imports from China make up the largest share of units imported into the country (up to 60% in some years) with some units coming from other countries such as Thailand, United Arab Emirates (UAE), and Malaysia. The Kenyan RAC market is estimated at between 24,000 and 43,000 units annually, based on import data.[4] Most RAC units are sold to commercial entities like office buildings and hotels as opposed to residential consumers.[5] The most common brands in the market are Japanese, South Korean, and Kenyan brands.

Single split RACs dominate the Kenyan market and fixed speed RACs are the most popular with a 64% market share. RACs with cooling capacities of 12,000, 18,000 and 24,000 Btu/hr are the most popular. While a significant number (27%) of RACs use R-22 as a refrigerant (a hydrochlorofluorocarbon), most RACs (69%) use R-410A (a hydrofluorocarbon), and the rest use R-32 (a hydrofluorocarbon).[6] Most of the units that use R-22 are fixed speed units (**Figure 1**).

1 Shah, N. et al., 2015. Benefits of Leapfrogging to Superefficiency and Low Global Warming Potential Refrigerants in Room Air Conditioning, http://eta-publications.lbl.gov/sites/default/files/lbnl-1003671.pdf
2 Accelerating the Global Adoption of Climate-Friendly and Energy Efficient ACs, https://united4efficiency.org/products/room-air-conditioners/
3 Harris, J. A Climate Victory in the Making. The Negotiations over the Montreal Protocol. Council on Foreign Relations.
4 Kenya Revenue Authority data. 2018
5 Interviews with industry
6 R-22 has 0.055 Ozone Depleting Potential (ODP) and 1810 Global Warming Potential (GWP), R-410A has zero ODP and 2088 GWP and R-32 has zero ODP and 675 GWP.

Figure 1: Compressor technology and refrigerant types

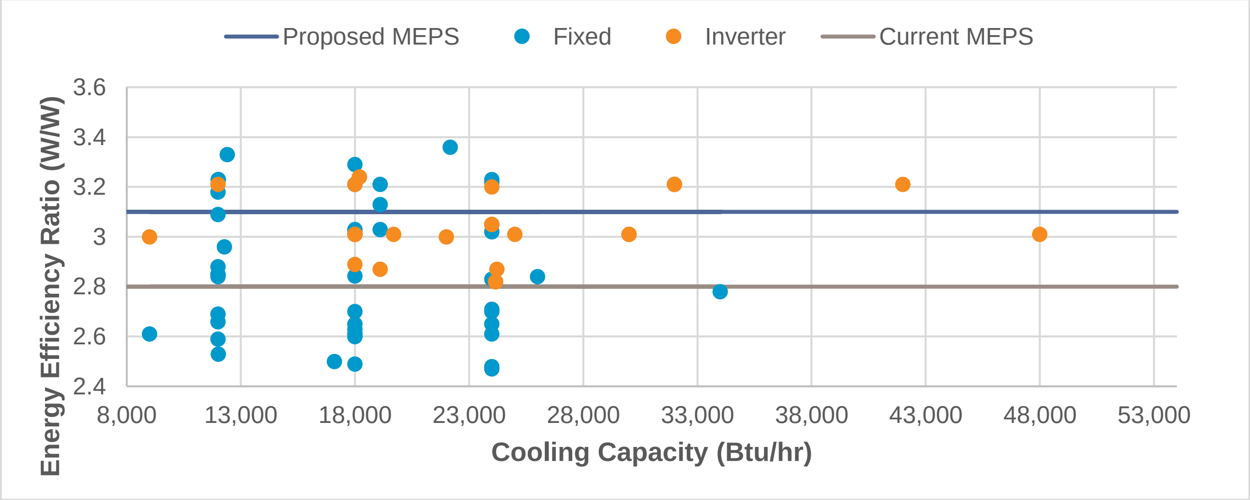


The efficiency levels in the Kenyan RAC market are relatively low. RAC units in the market have energy efficiency ratios (EER) of 2.4 W/W to 3.4 W/W. At the time of data collection, the Kenyan RAC MEPS had not come into effect, so there were units that were below the current 2.8 W/W efficiency threshold. These units were all fixed speed RACs.

The MEPS and labelling categories for RACs are currently under review. The Kenyan RAC MEPS that came into force in July 2018, in particular the testing method, received calls for revision from industry immediately after the implementation period began. In addition to amending the test method, the standards body has proposed an increase in the MEPS level and star rating categories.

Increasing the MEPS from 2.8 W/W to 3.1 W/W as proposed by the standards body, Kenya Bureau of Standards (KEBS), would lead to significant market transformation. Although the proposed MEPS would eliminate 73% of the models available in the 2018 market 2018 (**Figure 2**), Kenyan consumers of the higher efficiency RACs in the market would benefit from lifecycle cost savings of more than KES 6,000. Additionally, units with much higher efficiencies are currently available in international markets at comparable prices. The new MEPS levels would incentivize importers to bring in more efficient RAC units.

Figure 2: Cooling capacity vs. efficiency - current MEPS and proposed MEPS (N=71)



Key recommendations

Recommendation 1: Implement the MEPS proposed level of 3.1 W/W. Consumers will benefit from payback periods of less than three years on new RACs for all the popular cooling capacities. At the national level, the MEPS revision would lead to a 4% reduction in cumulative energy consumption between 2020 and 2030, equivalent to 321 GWh and 0.14 MT of CO_2. The avoidance of 0.03 MT CO_2 in 2030 translates to 0.07% of the intended target emissions reduction outlines in Kenya's Nationally Determined Contribution submitted to UNFCCC.[7]

Recommendation 2: Update the MEPS and labelling schedule every 2-3 years to continue market transformation. While the proposed MEPS levels are a great first step in increasing the overall efficiency of RACs in the market, periodic review would help avoid dumping of products as efficiency levels in other markets continue to increase. CLASP's analysis shows that a transition to the potential best available technology in the market (BAT in the policy scenarios) would not lead to a significant increase in the payback period for consumers and would increase the consumer life cycle cost savings significantly. It would also lead to significant energy savings (203.4 GWh in 2030) and emission reductions through 2030 of 0.46 MT CO2. The avoidance of 0.09 MT CO_2 in 2030 which translates to 0.21% of the intended emissions reduction according to the NDC.

Recommendation 3: Conduct a comprehensive consumer awareness program that sensitizes the public on the new labelling program for RACs. Since the S&L program is in the early stages of implementation, a consumer awareness program provides consumers with the chance to reap benefits from the program from the start. Consumers that are more aware of the energy use of the appliances they purchase, would drive the demand for more energy efficient RACs. A label allows consumers to make informed purchasing decisions by differentiating high efficiency products from average and low efficiency products. Additionally, a label incentivizes importers to bring more efficient products by helping them to market their high efficiency products, as the label provides unbiased evidence that their products are more efficient. Increased competition can drive down the prices of more efficient RACs.

[7] Government of Kenya. 2015. NDC. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Kenya%20First/Kenya_NDC_20150723.pdf . Accessed February 13, 2019

Market Assessment

1 Background and Introduction

The Kigali Cooling Efficiency Program (K-CEP) is a philanthropic initiative to support the Kigali Amendment of the Montreal Protocol. K-CEP focuses on the energy efficiency of cooling to increase and accelerate the climate and development benefits of the Kigali Amendment to phase down hydrofluorocarbons (HFCs). CLASP has received a grant to support the implementation of K-CEP in priority countries, including Kenya. CLASP has developed a strategy to deliver maximum CO_2 reductions through targeted policy and market interventions that are most likely to yield impacts and/or generate momentum for energy efficiency within the Montreal Protocol process. The goal of CLASP's K-CEP program is to raise efficiency standards, improve testing efforts, provide training and other capacity building activities targeted to local needs, and implement national market transformation initiatives where appropriate.

Kenya is currently on an ambitious path to universal electrification.[8] Furthermore, and similar to other countries in Sub-Saharan Africa, the Kenyan economy is poised to grow[9] and temperatures are also expected to rise due to climate change. These three factors mean that more people will seek comfort cooling and they will have the economic capacity and access to electricity necessary to purchase and run room air conditioning units. In addition to energy access, energy efficiency is a key priority in the Kenyan energy sector, with the Ministry of Energy implementing energy management policies for large electricity consumers[10] and efficiency standards and labelling for appliances.[11] Kenya is also in the process of ratifying the Kigali Amendment to the Montreal Protocol and working towards a 30% reduction of its business as usual greenhouse gas (GHG) – 143 MT CO_2 - by 2030.[12]

This market assessment and policy analysis provides a comprehensive characterization of the room air conditioner (RAC) market in Kenya and the technical evidence necessary to support the development of minimum energy performance standards (MEPS) for this product. It defines Kenya's efficiency baseline for RACs and evaluates impacts from various policy scenarios at the national level, to consumers, and to local industry. Government agencies can use this information to quantify potential energy and GHG emissions savings in support of national energy efficiency targets or NDC commitments, and estimate other potential benefits from revising the standards and labelling (S&L) program.

CLASP worked with a local team, RenCon Associates and Joseph Njuguna, to conduct this work. RenCon Associates collected product-level data during in-person visits to retail stores, conducted a review of government reports and reached out to relevant stakeholders, such as manufacturers, importers, end-users, and representatives from government agencies. The market assessment includes a detailed account of the RAC market size, product characteristics, usage, and the energy sector. Joseph Njuguna reviewed government policies and regulations relevant to the RAC sector. CLASP defined the current efficiency baseline and estimated potential energy savings and avoided emissions at the national level, and lifecycle cost (LCC) savings for consumers from various policy scenarios.

The report is divided into two parts, *Market Assessment*, and *Policy Options and Impacts Assessment*.

Sections 1 through 5 of the report discuss the activities and findings related to the RAC market assessment:

- **Section 1** provides an introduction, background and objectives for the project;
- **Section 2** describes the approach including the scope and key activities;

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[8] Government of Kenya. 2018. Kenya National Electrification Strategy: Key Highlights

[9] Africa's Pulse, Spring 2018: *Analysis of Issues Shaping Africa's Economic Future (April*), World Bank, Washington, DC.

[10] The Energy (Energy Management) Regulations, 2012. https://renewableenergy.go.ke/downloads/policy-docs/the_energy_management_regulations_2012.pdf. Accessed March 20, 2019

[11] The Energy (Appliances' Energy Performance and Labelling) Regulations, 2016.

[12] Government of Kenya. 2015. NDC. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Kenya%20First/Kenya_NDC_20150723.pdf Accessed Feb 13,2019.

- **Section 3** provides a market overview including a discussion of the supply chain and key players;
- **Section 4** describes the market assessment findings; and
- **Section 5** provides background information on the power sector.

Sections 6 through 11 focus on evaluating different policy scenarios and assessing their long-term impacts:

- **Sections 6** provides an overview of energy policies and frameworks in Kenya;
- **Section 7** provides an overview of the S&L policies and program for RACs;
- **Section 8** provides methodology for analysis of different scenarios;
- **Section 9** discusses different policy options and results of the analysis;
- **Section 10** discusses impacts to consumers, importers/dealers, and at the national level under two scenarios; and
- **Section 11** concludes the report and provides recommendations.

2 Methodology

Understanding the market size, types, characteristics, and energy performance of RACs available on the market is fundamental to designing appropriate appliance efficiency policy in Kenya. CLASP engaged a local partner, RenCon, to conduct on-the-ground data collection activities, provide insights on the RAC market, and establish the baseline technical parameters and characteristics of RACs. The approaches used to gather quantitative and qualitative data and information on RACs included desk research, stakeholder interviews, and field surveys. The type of data collected includes:

- Key stakeholders, sources of RACs, and supply chain;
- RAC market size and characteristics;
- RAC types, cooling capacities, and performance;
- Costs associated with RAC purchase, installation, operation and maintenance; and
- Energy sector and other economic data for evaluating energy, environmental, and economic impacts of RAC utilization in Kenya

Desk research

A literature review, including reports from Government Agencies and state corporations, and importation statistics from Kenya Revenue Authority (KRA) provided information related to market size.

Stakeholder interviews

Kenya does not manufacture RACs so the local team conducted stakeholder interviews with the local representative offices of manufacturers and brand owners, importers, and dealers. The team from RenCon Associates asked stakeholders to indicate or estimate the market share of their RACs and to provide annual turnover[13] of their appliances broken down by the models found in the market. KRA importation statistics were used to validate data obtained from dealers and importers.

Obtaining the annual turnover by model, type, or capacity turned out to be one of the major challenges encountered during the survey. Local companies consider sales and financial data confidential. To estimate market share, the main dealers (including three RAC dealers and two international brand sales offices) were asked to provide estimates of their market share to complement the retailer data.

The local team obtained prices, installation and maintenance costs, and after sales services information from dealers and contractors in face-to-face interviews. However, product characteristics including prices and efficiency levels of units sold to bulk purchasers (for instance, to hotel project developers) could not be obtained since the dealers were unwilling to share this data.

Field surveys

Kenya has three climatic zones - the hot and humid region (Nyanza and Coast) represented by Mombasa, the cool highlands represented by Nairobi, and the hot and dry parts of northeastern Kenya.

Since it was deemed likely that some RACs marketed and in use in Nairobi, the Coastal regions (Mombasa), the Nyanza region (Kisumu), and the Rift Valley region (Eldoret) would differ in technical characteristics and performance, surveys were conducted in these four cities. Access to RACs in northeastern Kenya is very limited due to limited access to electricity.

The local team visited RAC distributor/dealer display centers and some retail stores in these four cities to gather information on brands available on the market, including RAC characteristics and prices. For most products, comprehensive technical data is provided on the product nameplates. Hence, during the field survey, model numbers, power ratings, capacities, energy efficiency indicators, climate class, refrigerants, and other data were obtained from product nameplates on RAC samples displayed on the shop-floor. In other instances, dealers or

[13] Annual turnover here means number of products sold annually

contractors provided catalogues with models marketed locally. In a few cases, model numbers and brands were used to search for technical information from manufacturers' websites and online shops.

CLASP gathered product information for 103 models, of which 99 are unique models.

In some cases, some of the product attributes were not reported, and as a result, analysis of particular product attributes excludes models without that particular attribute.[14]

Table 1: Stores covered by retail survey

No.	Store	Number of RAC Models
1	Lecol	15
2	Shankar Electronics Ltd	15
3	LG	13
4	Daikin	9
5	Hotpoint	8
6	Nyali Airconditioners	7
7	Ramtons Showroom	6
8	Allied Plumbers	5
9	Coolpoint	5
10	Crossflow	5
11	Universal	5
12	Armco Godown	3
13	Nakumatt Prestige	3
14	Opalnet	3
15	Armco Showroom	1
	Total	**103**

To supplement the primary data and to get a more comprehensive picture of the RAC market, secondary data was collected from the sources listed in **Table 2** below.

Table 2: Sources of secondary data

Sources of secondary data	Data collected
Kenya Revenue Authority	Market size: Data on imports of RACs; 2012-2017.
Energy Regulatory Commission	Energy: Electricity tariffs, energy sector power-planning data.
Kenya Power and Lighting Company Ltd	Energy: Consumer electricity prices
National environmental Management Authority	Energy: Grid emission factor
Kenya Electricity Generating Company Ltd	Energy: Generation mix and grid emission factor estimate
Kenya National Bureau of Statistics	Economy: Commercial lending/discount rates
Central Bank of Kenya	Economy: Commercial lending /discount rates
United Nations Development Programme	Product characteristics: Related studies on performance and costs of RACs and Refrigerators

[14] For all of the figures in this market assessment, the number of models for which relevant data was available is reported using the format: (N = ##).

Sources of secondary data	Data collected
Ministry of Industrialization and Enterprise Development	Products characteristics: Related studies on performance and costs of RACs and Refrigerators
CLASP	Products and market info: Africa Air Conditioner Market Scoping Study[15] and some market players

Market assessment findings and impact analysis

Data collected by RenCon formed the basis of the market assessment and policy options and impacts analysis. The policy options and impacts analysis was carried out using the Policy Analysis Modeling System (PAMS). For the policy analysis, data collected for this market assessment was complemented by data collected from the World Bank on economic indicators. The methodology for PAMS analysis is outlined in detail in **Section 8.**

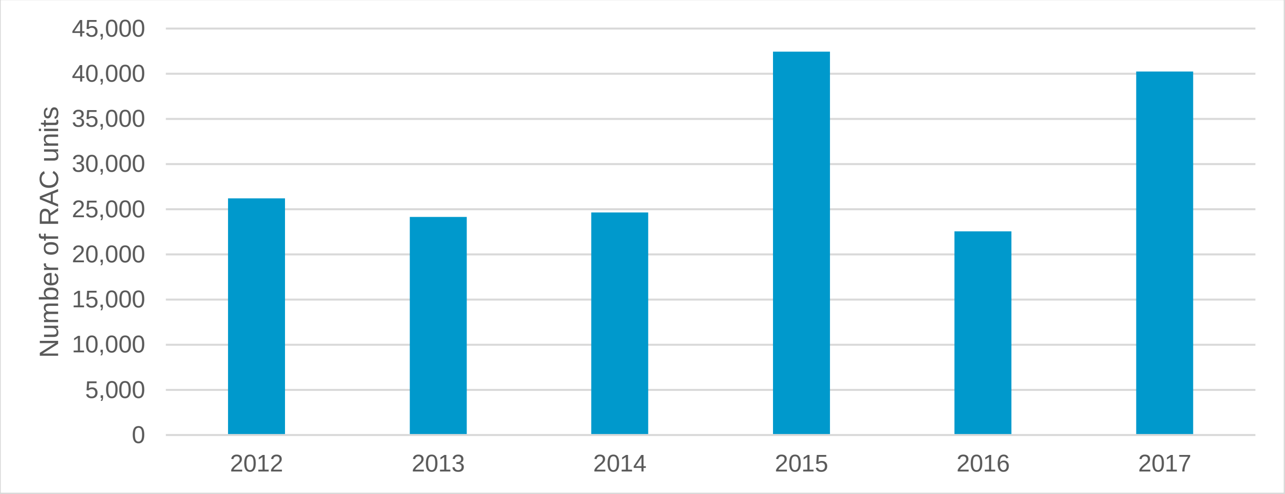
[15] CLASP. (2018). *African Air Conditioner Market Scoping Study*. Washington: CLASP. https://clasp.ngo/publications/scoping-study-of-african-air-conditioner-markets

3 RAC Industry at a Glance

3.1 Supply Chain Analysis

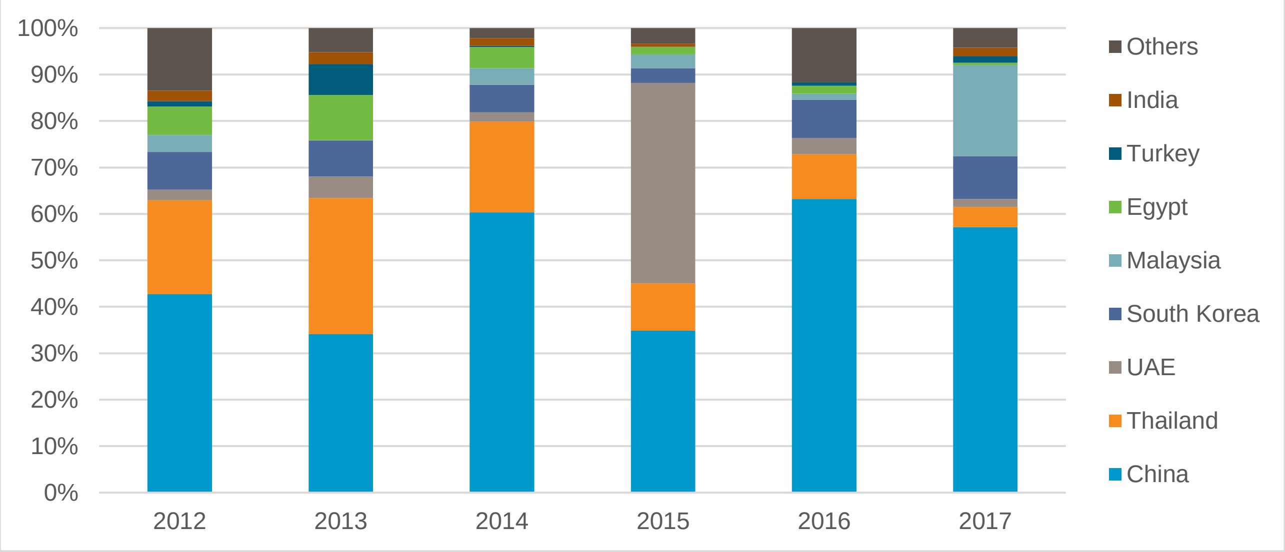
The majority of RACs are imported into the country through the Mombasa port; some products may enter the country through Eldoret International airports, but this is highly unlikely.[16] The data on RAC imports that was recorded by the customs body, the Kenya Revenue Authority, shows that annual imports range from 24,000 to 43,000 units per year (Figure 3).

Figure 3: RACs imported into the Kenyan market[17]



From 2012 to 2017, most RACs were imported from China, except for in 2015, when more units came from the United Arab Emirates (**Figure 4**). RACs from Thailand also make up a significant share of RACs imported into the country.

Figure 4: Country of origin of RACs in the Kenyan market from 2012 to 2017[18]



[16] Interviews conducted with RAC industry stakeholders
[17] Kenya Revenue Authority data. 2018
[18] Kenya Revenue Authority

The RAC supply chain involves foreign manufacturers, shipping, clearing, distributors, dealer/contractors, installers, and customers or end-users. The supply chain is illustrated in **Figure 5**.

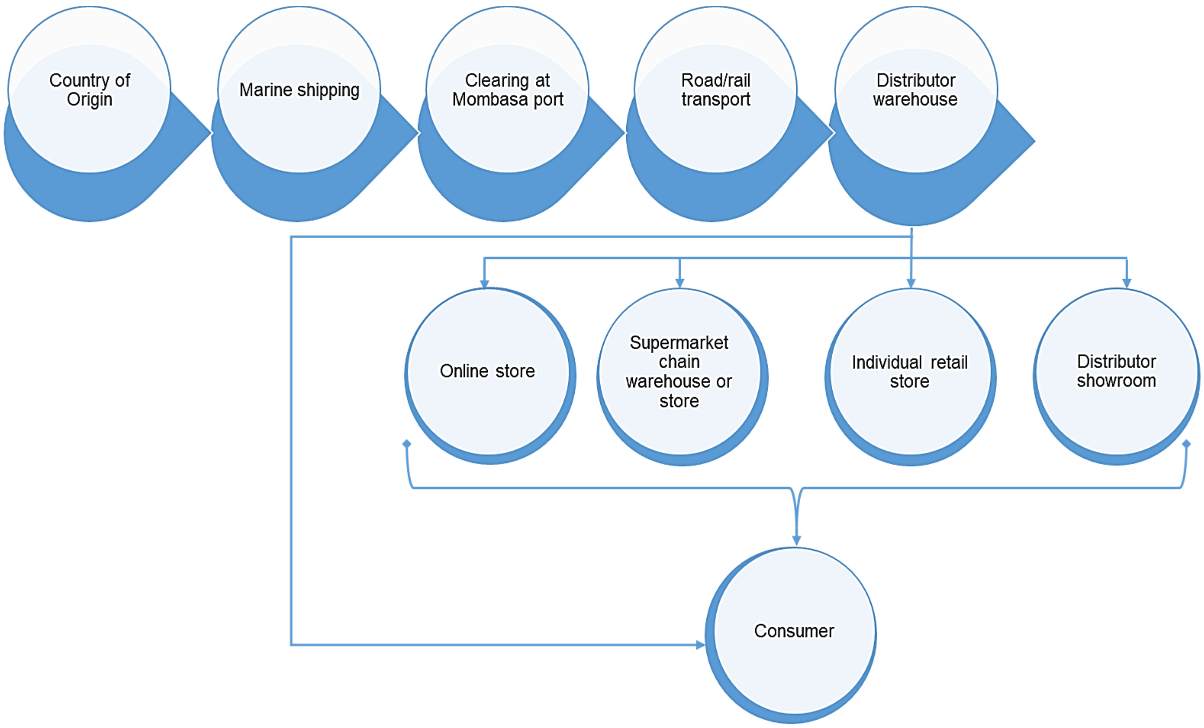
Local businesses identify manufacturers or suppliers around the world and enter into business partnerships. In most cases, the local business is appointed as the sole local distributor, importing RACs into the country and distributing them directly to consumers or through dealers. RACs are marketed primarily through importers and dealers directly, or through contractors who undertake installation and maintenance.

Distributors have to procure in bulk to benefit from economies of scale and volume discounts from manufacturers. Distributor stores are mainly display centers and are very few, with most located in major towns like Nairobi, Mombasa and Kisumu. Most distributors and dealers undertake the installation work themselves, as they have internal technical departments that undertake engineering work. Some distributors and dealers sub-contract installation and maintenance work to freelance air conditioning technicians, especially where a single unit is being installed. Hence, in most cases, the distributor, dealer, and installer are the same company.

Online shops sell very few RACs and do not hold any stocks, but have warehouses where they receive items from distributors and dealers, consolidate, and organize delivery. After delivery, the customer has to hire an installer independently.

The majority of the RACs in the Kenyan market are sold to commercial enterprises like offices, banks and hotels and not for residential purposes. These consumers purchase RACs directly from the dealers/distributors although a few purchase RACs from retail stores like supermarkets or online retailers. Therefore, most of the stores listed in **Section 2 Table 1** are distributors or dealers, which only have a few display RAC units. This explains the sample size of only 103 units. However, these units can be considered as a good representation of the market as they are mostly the unique models offered for sale to the commercial customers.

Figure 5: Supply chain for RACs



3.2 Key Players

The main stakeholders in the Kenyan RAC market are government agencies, manufacturers, importers/distributors, dealers and installers.

Government agencies are involved in the formulation of standards and codes of practice, rules, and regulations. Government is also responsible for regulatory enforcement and overseeing the market to ensure that there is an orderly, ethical, and conducive business environment. The key government agencies relevant to the RAC market include the Ministry of Energy, the Kenya Bureau of Standards (KEBS), the Energy Regulatory Commission (ERC), Kenya Power and Lighting Company (KPLC), Kenya Electricity Generating Company Ltd (KenGen), and the Kenya Revenue Authority (KRA).

- The Ministry of Energy formulates relevant energy sector policies pertaining to appliance energy consumption.
- KEBS and ERC set and enforce appliance standards and regulations including energy performance ratings.
- KenGen and KPLC are electricity utilities that generate and distribute electric power respectively.
- KRA is the customs body.

Few authorized distributors of foreign manufacturers dominate the local RAC market. Only two manufacturers, LG and Samsung, have local liaison offices, which do not sell directly to consumers but offer technical and marketing support to their appointed distributors. The key market players include the **main importers and distributors** who are the appointed or authorized local distributors of the manufacturers, and the **dealers** who are mostly air conditioning contractors and freelance installers.

Table 3: Key importers/distributors and dealers/contractors

Importer/distributors
Daikin Kenya
Opalnet – LG authorized distributor
Samsutech Kenya – Samsung authorized distributor
HotPoint Appliances Ltd – Von Hotpoint, LG and Samsung Distributor
Armco – Armco brand distributor
Ramtons Kenya – Ramtons distributor
LECOL – Unionaire and GREE distributor
Shankar – General and Samsung distributor
Nyali Refrigeration – Toshiba and Westpoint distributor
Allied Plumbers – Mitsubishi distributor

Dealers/contractors
Opalnet
Samsutech Kenya
HotPoint Appliances Ltd
Armco Kenya
Ramtons
LECOL
Shankar
Nyali Refrigeration
Allied Plumbers
Cool Point
Universal
Crossflow

All importers/distributors in **Table 3** are also dealers and contractors. In the RAC business, brand loyalty is prevalent, as distributors and dealers often promote a specific brand.

3.3 Prevailing Brands

Kenya does not manufacture RACs but some manufacturers have representative offices in Kenya as mentioned in **Section 0**. RenCon found twelve brands on the market. Based on interviews with industry players, five of these brands hold 80% of the market share (highlighted in bold below):

- Japanese brands: **Daikin**, **Toshiba**, General, Mitsubishi
- South Korean brands: **Samsung**, **LG**
- Kenyan brands: **Hotpoint, Ramtons**, Armco
- Chinese brands: Gree
- European brands: Westpoint (France)
- Egyptian brand: Unionaire

Since most units found in the display centers/retail stores were unique models, **Figure 6** below is a reflection of how many models each RAC brand has in the market as opposed to the market share of each brand. Daikin, LG, General, Gree, and Samsung have the highest number of RAC models in the market.

Although the majority of RACs in the market are Japanese, South Korean, and Kenyan brands, most of the RACs in the market are manufactured in China, and a significant number of units are manufactured in other Asian countries like Malaysia and Thailand (**Figure 7**).

Figure 6: Number of models of the major RAC brands in Kenya (N=103)

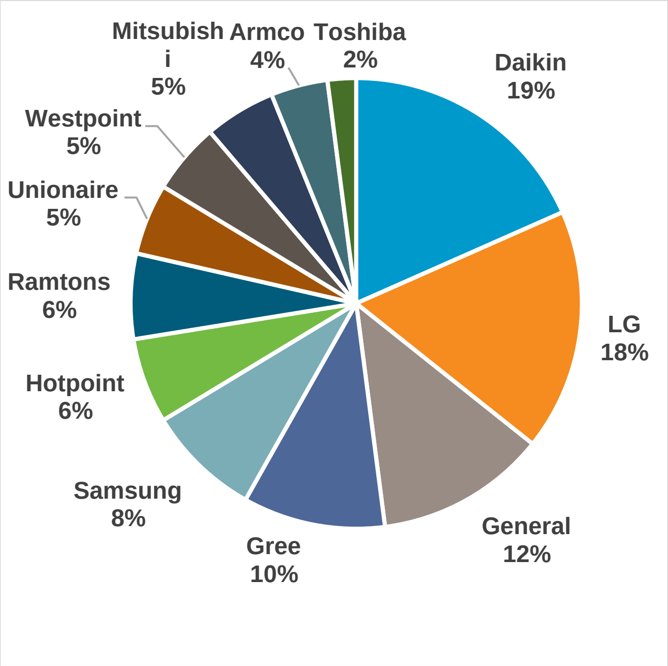
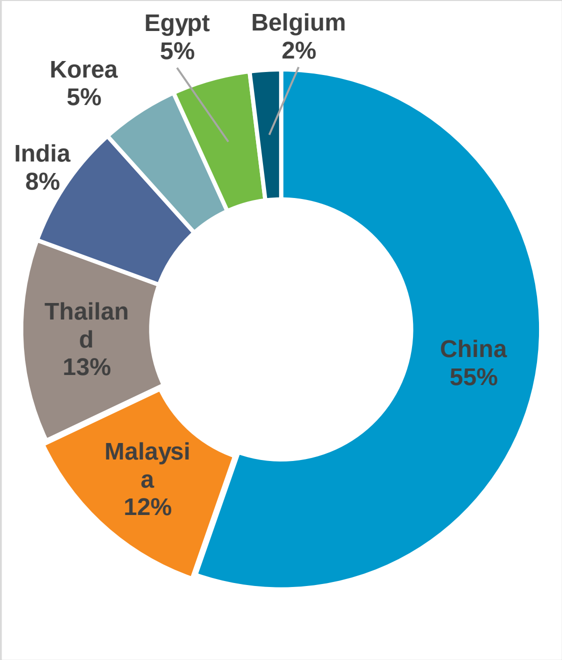


Figure 7: Country of manufacture for RACs in the Kenyan market (N=103)

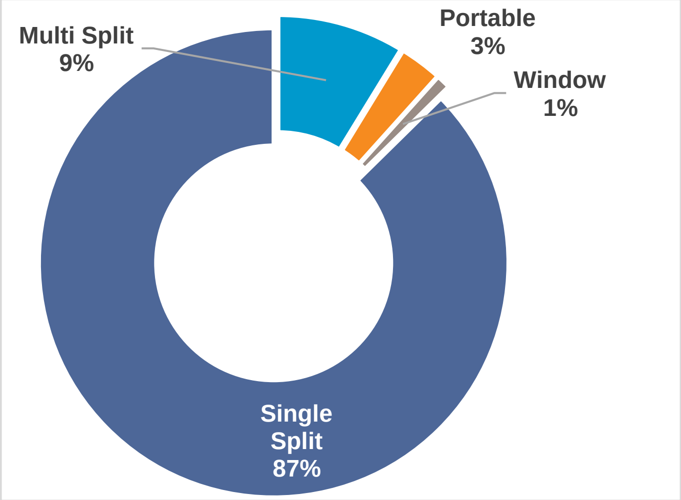


4 RAC Market Characteristics

4.1 RAC Types Available

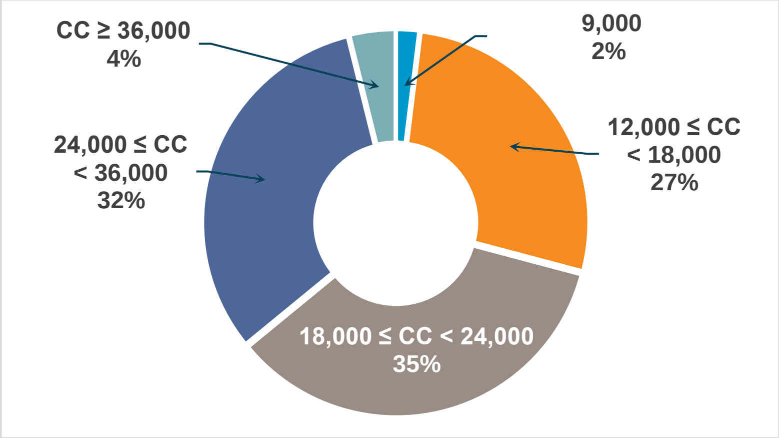
In Kenya, the most common RACs are single split units, with a few multi split models and even fewer portable and window RACs. At least 17 of the 90 single split models found in the market are ceiling cassette units while at least 59 are wall-mount units.

Figure 8: RAC types (N=103)



The most popular RACs have cooling capacities between 18,000 and 24,000 Btu/hr, while those between 24,000 and 36,000 Btu/hr come in a close second. This finding differs from the finding of CLASP's earlier RAC market scoping study[19] - based on online retailers - which found that 12,000 Btu/hr units were the most popular in Kenya. This would imply that the RAC units displayed in physical stores are different from those displayed online. The units displayed in the physical stores may be geared towards larger customers like hotels and office buildings, who are the main customers for RACs in Kenya, while the units displayed online may be targeted at consumers that require smaller RAC capacities like households or small businesses.

Figure 9: RAC capacities (N=103)



[19] CLASP. (2018). Africa Air Conditioner Market Scoping Study. Washington: CLASP. https://clasp.ngo/publications/scoping-study-of-african-air-conditioner-markets

4.2 Refrigerants and Inverter Technology

The most common refrigerant used in RACs available in the Kenyan market is R-410A (**Figure 10**). However, a significant number of RACs still use R-22, a hydrochlorofluorocarbon (HCFC). Out of the 99 units with refrigerant information available, only four units used R-32, which has significantly lower global warming potential than R-410A. Most of the units in the Kenyan market that use R-22 are fixed speed RACs.

Figure 10: Refrigerants contained in RACs (N=99)

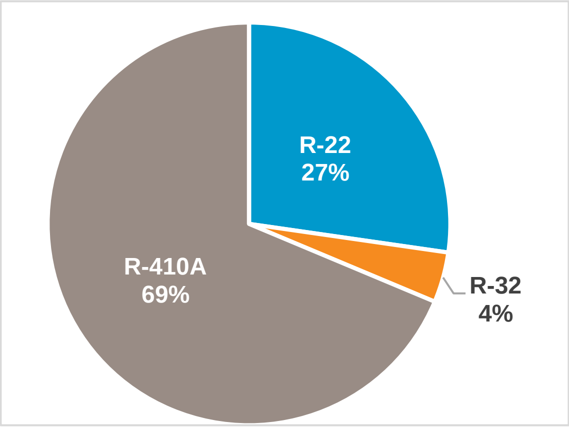
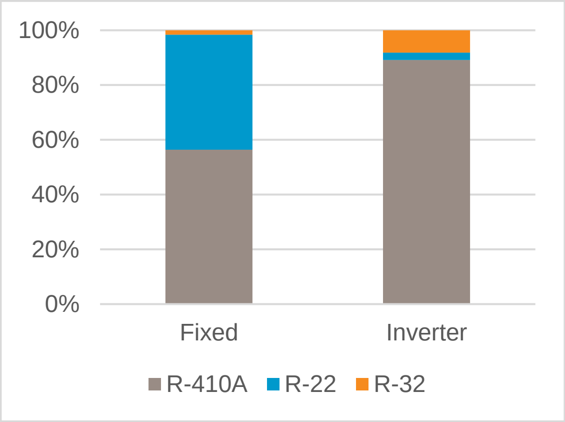
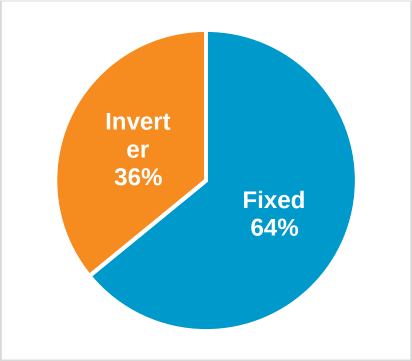


Figure 11: Share of fixed vs. inverter RACs by refrigerant type (N=99)



Fixed speed RACs are more common than inverter RACs in the Kenyan market. However, this new survey of physical stores shows that the penetration of inverter RACs is 26% higher than was indicated during CLASP's previous study of units available for sale though online retailers.[19]

Figure 12: Compressor technology in RACs found in the Kenyan market (N=103)

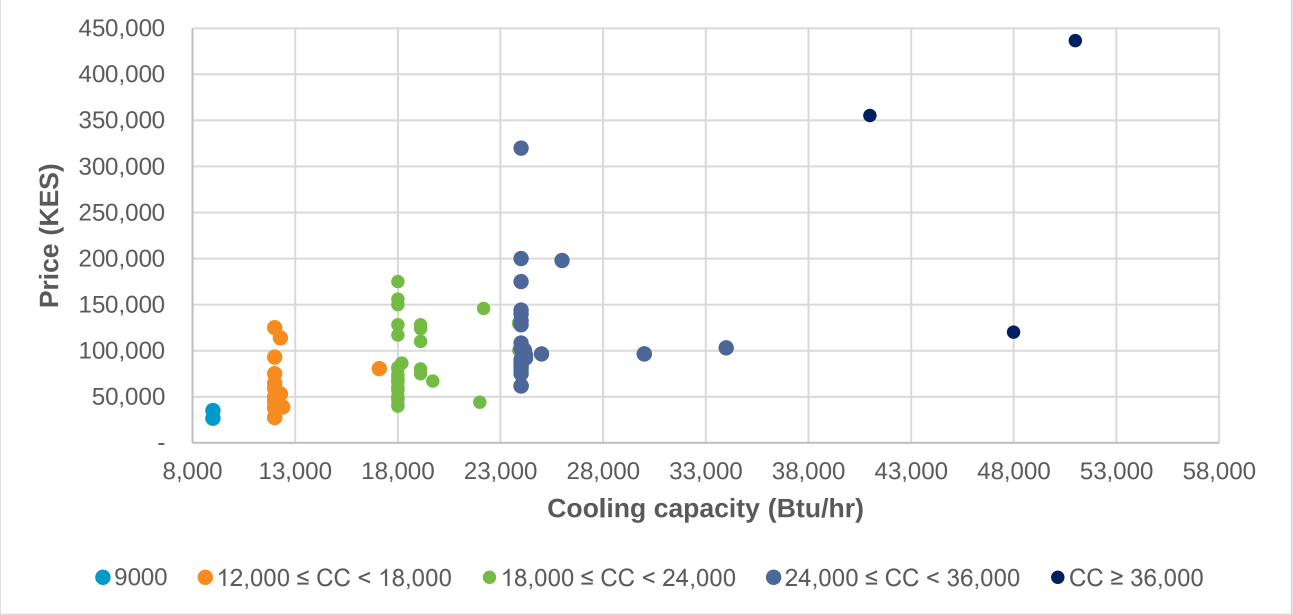


4.3 Prices

Overall, the cost of a RAC in the Kenyan market increases with cooling capacity. However, there is a lot of variation in the price of units with the same cooling capacity (**Figure 13**), implying that other features of RACs determine the price of a unit, not just the cooling capacity delivered. In addition, the price of an RAC unit is dependent on whether the unit is part of a larger consignment - therefore benefiting from economies of scale - or part of a small consignment, and thus more expensive. Since the retail market for RACs in Kenya is small, many importers bring in large consignments when they have contracts for large projects (for instance, construction of a hotel), but bring in smaller consignments for their retailers.

Data on the pricing and product characteristics of the units brought in for large projects (which are the majority of the sales by distributors/importers) is difficult to obtain. RenCon collected price data from display centers and the retailers' catalogues. The lack of data on the prices offered for large orders resulted in the price data being insufficient to draw conclusions on the relationships between RAC prices and other product characteristics.

Figure 13: Cooling capacity vs. price (N=86)



The data set also showed that fixed speed RACs had higher average prices compared to inverter units (**Figure 14** and **Figure 15**) suggesting dealers are not differentiating between the two RAC types in their retail pricing. This is not the case in other markets where the average prices of inverter RACs are consistently higher than those of fixed speed RACs.

Figure 14: Price ranges of fixed RACs (N=57)

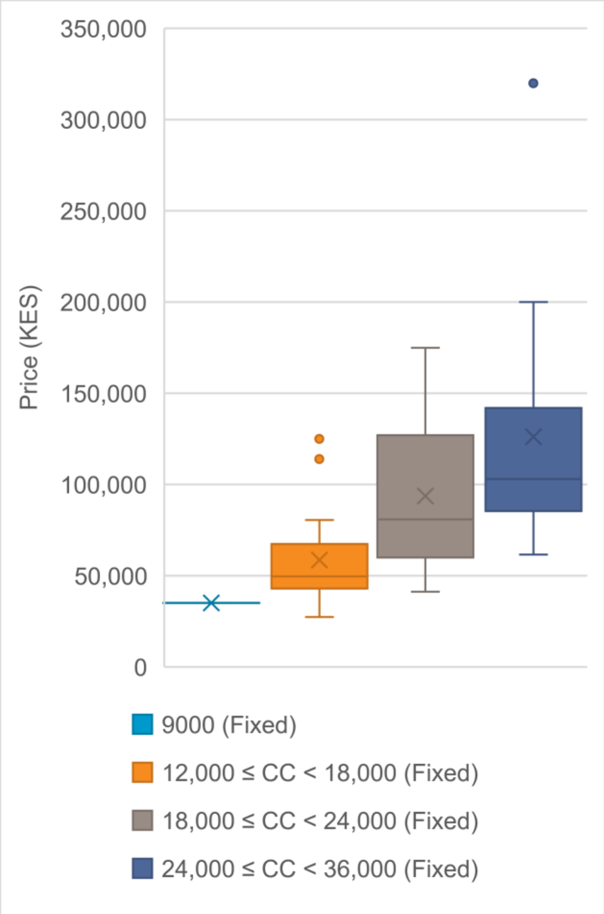
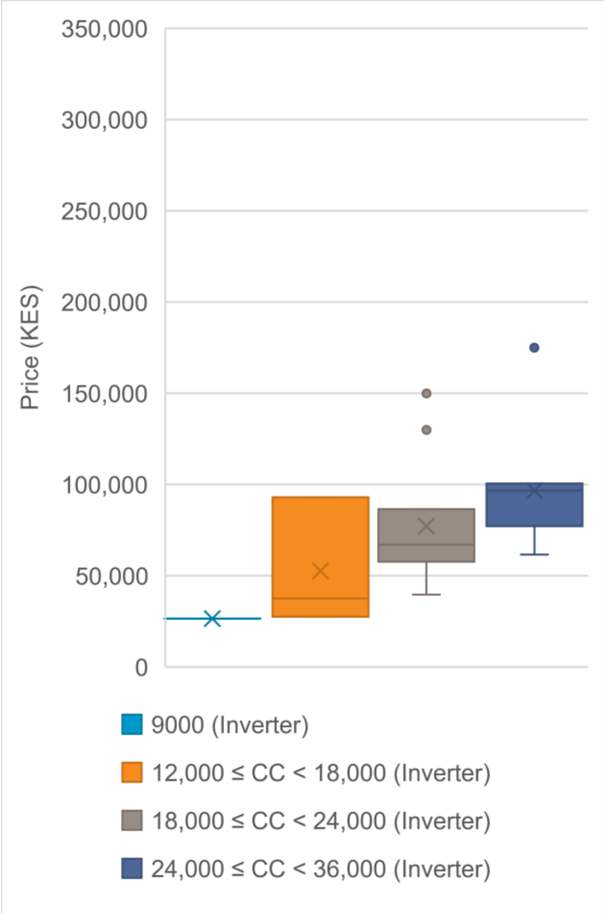


Figure 15: Price ranges of inverter RACs (N=30)



Interestingly, in some cases there are significant price differences between cassette units and wall-mount units delivering the same cooling capacity. For example, a 24,000 Btu/hr wall mount fixed speed unit with a 2.65 W/W EER costs KES 102,000 while a ceiling cassette unit of the same capacity and compressor type and a 2.71 W/W EER costs KES 200,000.

4.4 Energy Efficiency and Energy Labelling Practices

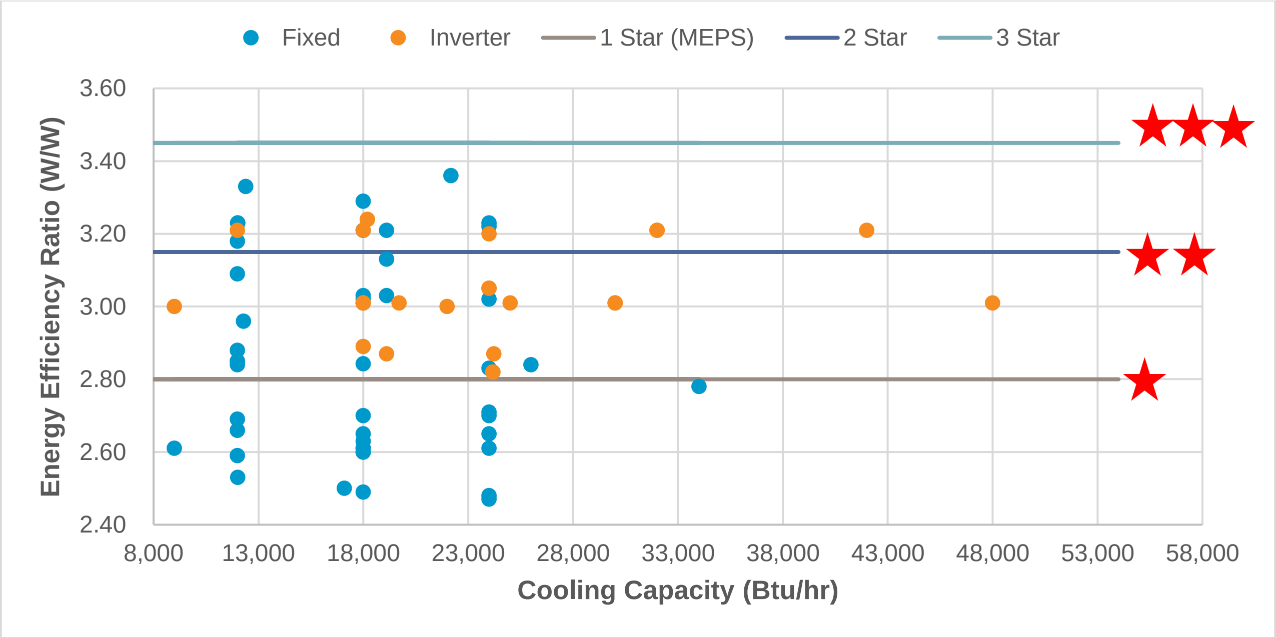
The energy efficiency ratings for RACs in the Kenyan market are based on the Energy Efficiency Ratio (EER). The Kenyan MEPS and energy labelling for air conditioners came into effect in July 2017 for imported units and July 2018 for all retail units.[20] Since the MEPS and energy label came into effect during the data collection period for this study, none of the units the contractors collected data on had the Kenyan energy label. The energy efficiency data was therefore collected from the manufacturers' labels. Since it was not mandatory to display the efficiency information, data on energy efficiency was only available for 71 out of the 103 models. Nevertheless, this efficiency data is the first-of-its-kind and lays a good foundation for tracking market transformation now that the standards and product labelling are mandatory.

At all RAC capacities, there were varying levels of efficiency from 2.4 W/W to 3.4 W/W for all the identified unique RAC models (**Figure 16**). However, only fixed speed RACs had EERs that were below the Kenyan MEPS (2.8 W/W).

[20] The current Kenyan standard for air conditioner MEPS is KS 2463:2013 - Non-ducted air conditioners - Testing and rating performance

The Kenyan energy label is a comparative label with a 5-star categorization - the more stars, the higher the efficiency. Based on the energy efficiency ratings of the RACs identified, at least 30% of the models that were in the market do not meet the current MEPS while the majority of those that do would be either 1 or 2 stars based on the current star ratings.

Figure 16: Cooling capacity vs. energy efficiency (EER) by compressor type (N=71)



4.5 Consumer Practices and Preferences

The information on customer practices was collected through interviews with the supply chain actors including retailers and installers. Most consumers in the Kenyan market purchase RACs from physical stores operated by dealers or distributors. A few purchases are made online where the consumers can pay via credit card or mobile money and have the unit delivered. For most consumers, the upfront cost of the unit is the main determinant in RAC selection and not the efficiency or refrigerant type. However, for RAC users in regions where the temperatures are high for most of the year, like the coastal regions, efficiency is also a factor that is considered when purchasing a RAC.

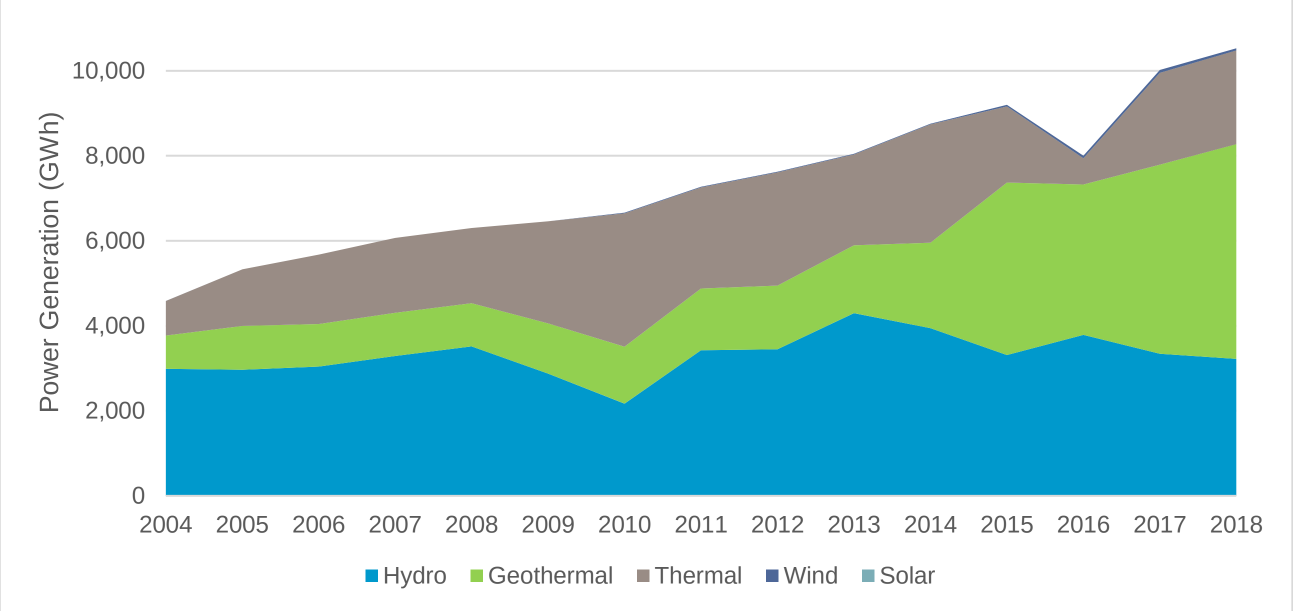
For commercial entities, RACs are operated during the offices' operating hours (from 8 a.m. to 5 p.m.). For entities in the hospitality sector like hotels, usage of RACs coincides with room occupancy. Additionally, in areas where the temperatures are not always high enough to justify the use of an RAC, the units are switched off during colder months or cooler periods of the day.

5 Power Sector

5.1. Power Generation & Consumption

Kenya has a total installed power generation capacity of 2,351 MW.[21] In the year 2017/2018, the country consumed 8,459 GWh of electricity, with transmission and distribution losses amounting to 21%[22] of the total energy purchased by the national utility, Kenya Power. Geothermal sources contributed 47% to the total energy mix, with hydro contributing 30%, and 21% from thermal sources. The contribution of geothermal sources to Kenya's energy mix has increased consistently over the years **(Figure 17**) from 17% in 2004 to the current 47%. The share of thermal energy on the other hand has remained significant for most of the 14 years, going above 30% in some years like 2014. Most of the thermal energy comes from two medium speed diesel power plants in the coastal region owned by the Kenya's main power producer, the Kenya Electricity Generating Company (KenGen).

Figure 17: Kenya electricity generation sources (2004 - 2018)



The government expects the electricity demand to increase by more than double by 2030.[23] To cater to this increased demand, installed capacity is expected to increase by 6,168 MW. The majority of the new power plants will be geothermal, wind or solar power plants. However, there are plans to build three coal power plants with a total capacity of 981 MW in Lamu.

Due to the increase in the portion of energy that comes from renewable sources in Kenya, the grid emissions factor is relatively low at 0.533 kg/kWh. With the planned phase out of medium speed diesel power plants, emissions from power generation are expected to fall significantly, almost to zero, in the short term, but will go up again in 2024 if the Lamu coal power plants come online.[24]

5.2. Power Distribution & Electricity Rates

The Kenya Power and Lighting Company Limited (KPLC) is the main electricity distributor and retailer in Kenya, supplying electricity to over 6 million customers across the country. The Kenya Electricity Transmission Company (KETRACO) builds, operates, and maintains the high voltage transmission system. The transmission

[21] Kenya Power. 2018. Annual Report Financial Statements for The Year Ended 30th June 2018.
[22] These are both technical and non-technical losses.
[23] Energy Regulatory Commission. 2018. Updated Least Cost Power Development Plan (2017-2022).
[24] Ibid

and distribution network's circuit length has increased four-fold since 2012.[25] This is partly due to the government's aggressive national electrification strategy, which has seen the electrification rate more than double from 2014 to 2018 to the current estimated 75% (as of February 2018).[26] In 2013, the government decided to accelerate the rate of electrification in order to achieve universal electrification by 2022.

Peak electricity demand has also increased annually at an average rate of 5% per year over the past ten years to a current peak of 1,802 MW.[25] Domestic and small commercial consumers currently account for 45% of total demand while large commercial and industrial consumers account for 54%. KPLC has carried out some demand side management programs such as offering its customers compact fluorescent bulbs as replacements for incandescent bulbs.[27]

The Energy Regulatory Commission sets, reviews, and approves electricity tariffs. The most recent tariff review was approved and gazetted in August 2018. The review eliminated the fixed monthly charge applied to all consumers and increased the energy charge instead. The tariff charged by KPLC is a tiered tariff based on customer category: domestic, small commercial, and commercial and industrial consumers (**Table 4**). The categorization is based on both the power supply type/voltage and/or the maximum monthly consumption.

Table 4: Energy charges for various consumer categories

Consumer type	Power supply voltage	Maximum monthly consumption	Energy Charge per kWh (KES)
Domestic consumer (Lifeline)	240/415 volts	100 kWh	10.00
Domestic Consumer (Ordinary)	240/415 volts	15,000 kWh	15.80
Small Commercial	240/415 volts	15,000 kWh	15.60
Commercial and Industrial (CI1)	415 volts	15,000 kWh	12.00 (on-peak) 6.00 (off-peak)
Commercial and Industrial (CI2)	11,000 volts	-	10.90 (on-peak) 5.45 (off-peak)
Commercial and Industrial (CI3)	33,000 volts	-	10.50 (on-peak) 5.25 (off-peak)
Commercial and Industrial (CI4)	66,000 volts	-	10.30 (on-peak) 5.15 (off-peak)
Commercial and Industrial (CI5)	132,000 volts	-	10.10 (on-peak) 5.05 (off-peak)

In addition to the energy charge, all consumers are also charged pass-through costs (fuel cost charge, forex levy and inflation adjustment), levies and taxes which include value added tax, ERC levy and the rural electrification program levy. Additionally, for commercial and industrial customers, a demand charge of between 220 KES/kVA and 800 KES/kVA is applied.

[25] Kenya Power. 2018. Annual Report Financial Statements for The Year Ended 30th June 2018.
[26] Government of Kenya. 2018. Kenya National Electrification Strategy: Key Highlights.
[27] Ibid

Policy Options and Impacts Assessment

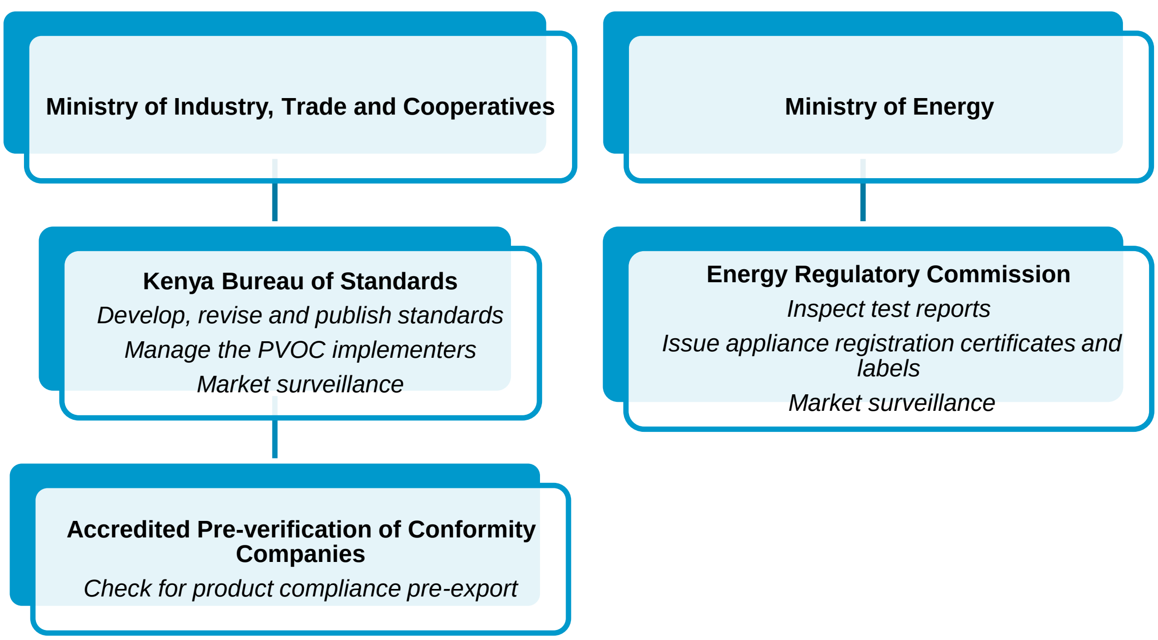
6 Legal & Regulatory Framework Overview

The Ministry of Energy (MoE) in Kenya is responsible for formulating energy policies. The Energy Act (2006) laid the legal groundwork necessary to formulate and implement energy efficiency programs including the standards and labelling program for equipment or appliances. The Act also led to the formation of the Energy Regulatory Commission (ERC), an independent government agency responsible for regulation of the energy sector agencies, oversight, coordination and preparation of Least Cost Power Development Plans (LCPDPs), and monitoring and enforcement of sector regulations. These regulations include *The Energy (Appliances' Energy Performance and Labelling) Regulations* passed in 2016, which made MEPS for RACs mandatory. The regulations lay out the guidelines for compliance with the standards and labelling program. Under the new Energy Act, 2019 the Energy and Petroleum Authority (EPRA), formerly ERC, still has the responsibility of making recommendations to the Cabinet Secretary on development of regulations relating to appliance and equipment energy efficiency.

The Ministry of Industry, Trade and Cooperatives is the parent ministry for the Kenya Bureau of Standards (KEBS), the national standardization body established in 1974. KEBS provides standards, metrology, and conformity assessment services and is in charge of formulation of quality and performance standards for appliances, including minimum energy performance standards (MEPS). KEBS also manages the pre-export verification of conformity (PVoC) program. The PVoC program began in 2005 and is backed by Legal Notice No.78 of 2005 issued by the Ministry of Trade.[28] It is implemented by accredited third party inspection companies who check products for conformity with Kenyan standards and regulations in exporting countries before the products are shipped to Kenya. Since most of the appliances sold in the Kenyan market are imported, the PVoC program serves as a key component of ensuring compliance to and enforcement of Kenyan standards.

Currently, KEBS and the Kenya Industrial Research and Development Institute (KIRDI) have performance testing facilities for lighting and motors but none for air conditioners.

Figure 18: Organizations that implement the appliance standards and labelling program in Kenya



[28] Kenya Bureau of Standards. (2019). "PVoC Overview." Quality Assurance and Inspectyion. Accessed Feb. 14, 2019. https://www.kebs.org/index.php?option=com_content&view=article&id=87&Itemid=344

Kenya ratified the Montreal Protocol in 1988 and has ratified four of the five amendments to that Protocol (**Table 5**). To regulate the importation, manufacture and use of ozone-depleting substances, Kenya passed The Environmental Management and Co-ordination (Controlled Substances) Regulations in 2007. Under these regulations, the list of controlled substances includes chlorofluorocarbons (CFC), hydro-chlorofluorocarbons (HCFCs) and methyl bromide. The regulations give the mandate to the National Energy Management Authority (NEMA) to license any person that wishes to manufacture, import, export and transit any of the substances covered by the regulation. NEMA is also required to monitor the activities of the licensees and disposal of the controlled substances. However, the regulations do not cover ozone depleting substances (ODS) contained in appliances like RACs, enabling the importation of RACs containing R-22 (a HCFC) without the licensing requirement. NEMA is currently in the process of revising these regulations.[29]

Table 5: Status of ratification of the ozone-related protocols[30]

Convention / Protocol / Amendments	Date of Ratification / Accession / Acceptance / Approval
Montreal Protocol on Substances that Deplete the Ozone Layer	November 1988
London Amendment to the Montreal Protocol (1990)	September 1994
Copenhagen Amendment to the Montreal Protocol (1993)	September 1994
Montreal Amendment to the Montreal Protocol (1997)	July 2000
Beijing Amendment to the Montreal Protocol (1999)	October 2013
Kigali Amendment to the Montreal Protocol (2016)	The process of ratification commenced in January 2017. Currently the Attorney General's office is reviewing the Cabinet Memo.[31]

[29] Interview with NEMA official.
[30] Ozone Depleting Substances (ODS) Alternatives Survey Report. 2017
[31] Interview with Ministry of Environment official.

7 RAC Policy Framework (S&L)

Kenya published the first minimum energy performance standards in 2013. These standards cover RACs, refrigerators, three-phase cage induction motors, double-capped fluorescent lamps, ballasts for fluorescent lamps, and compact fluorescent lamps.

The current Kenyan standard for air conditioners - *KS 2463:2013 - Non-ducted air conditioners — testing and rating performance* - applies to single-split air conditioners and sets the MEPS level at 2.8 W/W. This standard became mandatory for all imports in 2017 and for all units sold in the country in 2018. Immediately after the MEPS came into force, there were calls for revision from the industry, since the standard's testing requirements were not well suited to the Kenyan climate. The standard is therefore under revision. The main draft revisions are changing the testing conditions from T3 to T1 and increasing the MEPS levels. The revised standard is expected to be published in 2019.

Table 6: Current star ratings for RACs

Star Rating	EER (W/W)
1 Star (MEPS)	≥ 2.8
2 Star	≥ 3.15
3 Star	≥ 3.45
4 Star	≥3.75
5 Star	≥4.0

All importers of appliances covered by the S&L regulations have to register the appliances they intend to import with ERC. Registration involves submission of a test certificate and test report from an accredited laboratory showing that the appliance meets the Kenyan MEPS and payment of a registration fee. Once ERC scrutinizes the documents, they issue a registration certificate and a soft copy of the appropriate energy label.

The energy label is mandatory and must be affixed to all air conditioners offered for sale in Kenya. The label contains information on the manufacturer, model number, EER, refrigerant, cooling capacity, annual energy consumption, and the applicable Kenyan standard.

ERC has the powers to carry out inspections on distributor warehouses, or any other premises where they suspect appliances are stored, to check for compliance with the S&L regulations. If the products do not comply with the regulations, ERC may require that the products are re-tested. If the offender does not rectify the non-compliance then a KES 100,000 fine is applied. Additionally, ERC is required to maintain a publicly available database of all registered appliances under the S&L program. However, since the current standard is under revision, ERC has not yet begun enforcing the S&L program for RACs and none of the RACs in the market have been registered. Once the standard is published, ERC will begin enforcement of the MEPS and labelling and will provide a list of registered RACs, similar to the one currently maintained for residential refrigerators.[32]

[32] The residential refrigerator database can be accessed online here https://www.erc.go.ke/services/renewable-energy-2/energy-audit-firm-register/

8 Methodology for Policy Analysis

CLASP evaluated policy scenarios to assess impacts from increasing the RAC MEPS to various efficiency levels using the Policy Analysis Modelling System (PAMS) developed by CLASP and Lawrence Berkeley National Laboratory to help policymakers assess the costs and benefits of S&L programs.[33]

PAMS is an easy-to-use tool that helps policymakers assess the benefits of S&L programs and identify the most attractive targets for MEPS levels. It is an Excel workbook designed to give first-order policy impacts projections with minimal preparatory research on the part of local policymakers. The model can also be used to perform robust technical analysis to support the development of MEPS, by customizing the tool with any country-specific data that is available.

PAMS can estimate savings potential from implementing policies that improve the energy efficiency of products in any economy. The impacts are examined from two perspectives – the consumer and national perspective:

- **At the consumer level,** savings are estimated using the life-cycle cost (LCC) metric - the total costs of owning the appliance, including the purchase price and the electricity cost throughout its life. Savings are measured between business-as-usual and improved policy scenarios.
- **At the national level,** energy savings are expressed in terms of the reduction in national energy consumption due to more efficient appliances as well as in terms of avoided CO_2 emissions resulting from reduced electricity consumption.

In this analysis, CLASP used the market assessment findings to customize the tool with relevant data for Kenya, and evaluated the impacts to consumers as well as impacts at the national level for selected policy scenarios. Additionally, CLASP estimated the impacts to importers/distributors by calculating the number of models eliminated from the market under more stringent MEPS.

8.1 Cost Efficiency Relations

The best way to develop an accurate cost efficiency curve is through an engineering analysis where the efficiency improvement of each RAC component and its associated cost is taken into consideration. Generally, several factors may affect the price of an RAC unit such as brand, refrigerant, functionalities, and appearance. In Kenya, as mentioned in the market assessment, while these factors contribute to the prices of RAC units, the pricing of the units available in display centers were also influenced by whether the unit came in as a single unit or as part of a larger batch. As a result, the price data collected during the market study was considered unreliable since it showed an improbable inverse relationship between cost and efficiency; an increase in efficiency leading to a decrease in unit cost. As a result, the cost-efficiency curves from other similar economies were analyzed to find one that matched closely with the pricing in the Kenyan market. The most appropriate cost-efficiency curve was that from the Caribbean Community (CARICOM). Similar to the Kenyan market, CARICOM RAC markets are small import economies.

The relationship between cost and efficiency from the CARICOM markets was established by performing a multiple regression analysis on the EER, cooling capacity, and price of RAC models from the market assessment carried out by CLASP in 2017.[34] The regression model used data from 194 observations to approximate the linear relationship between the dependent variable, price, and the two independent variables, EER and cooling capacity. The R square value of the regression model was 0.5, which indicates that the linear model using cooling capacity and EER explains approximately 50% of the variation in price. However, the p-values for both independent variables are less than 0.01 indicating that the relationship between both variables and the prices is highly significant.

The relationship, derived from the CARICOM analysis, between the three variables in the Kenyan market can be represented by the following equation:

[33] The Policy Analysis Modelling System (PAMS) is available online at https://clasp.ngo/tools/policy-analysis-modeling-system
[34] CLASP. 2017. CARICOM Regional S&L Policy Roadmap For Air Conditioners, Refrigerators and Lighting

$$Price = -317.63 + 151.34(EER) + 0.0375(Cooling\ Capacity)$$

Where: Price is in USD/unit, EER is in W/W, and Cooling Capacity is in Btu/hr.

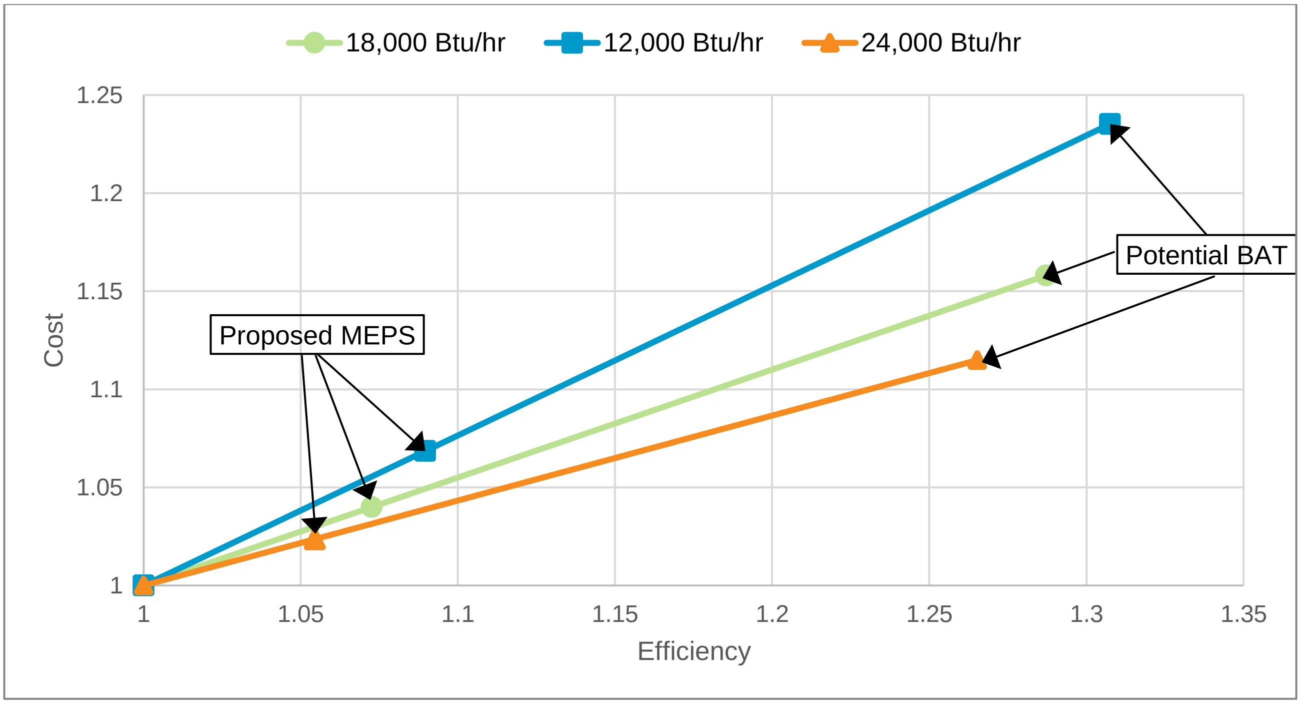
The three most popular cooling capacities in the Kenyan market are 12,000 Btu/hr, 18,000 Btu/hr and 24,000 Btu/hr. CLASP identified the baseline models by finding the median EER for the 12,000 Btu/hr, 18,000 Btu/hr and 24,000 Btu/hr units from the Kenyan market data. Their prices were modelled using the CARICOM regression equation and a comparison made between the modelled price and the price of a unit with a similar cooling capacity and EER from the Kenyan market data (**Table 7**). The modelled prices for each of the capacities and EER levels used in the analysis were then adjusted by the percentage difference between the modelled price and price data from the Kenyan market study, e.g. -3% for the 12,000 Btu/hr unit.

Table 7: Baseline models selected for PAMS analysis

Baseline Cooling Capacity (Btu/hr)	Baseline EER (W/W)	Modelled Price (USD)	Baseline price from market data (USD)	% difference in price
12,000	2.85	563.10	581.82	-3%
18,000	2.89	794.99	701.12	13%
24,000	2.94	1,027.64	1,380.59	-26%

Using the adjusted prices and selected efficiency levels, CLASP calculated cost and efficiency factors and plotted a cost-efficiency curve for each of the three popular cooling capacities (**Figure 19**). The starting point for the cost and efficiency factors are the baseline figures for each capacity identified in **Table 7** above. The cost-efficiency curve for the 12,000 units is steeper than that of the larger units, which means a change in efficiency of the smaller units is more costly.

Figure 19: Cost-efficiency curves for the three most popular capacities



8.2 PAMS Inputs

Data input and Assumptions

Underlying macroeconomic data:

- CLASP used UN Population statistics for historical and projected population[35] and urbanization[36] in Kenya.
- We assume a deposit interest rate of 8.22% (as the consumer discount rate)[37] and a real interest rate of 4.63% to estimate cost savings at the consumer and national level. [38]
- We assume a real income growth rate of 2.26%.[39]

Underlying power sector data:

- We assume a transmission and distribution (T&D) Loss Factor of 21%.[40]
- We assume a grid emissions factor of 0.332297783 kg/kWh. [41]
- We assume an electricity price for Kenya of 20.18 KES/kWh, which is equivalent to approximately 0.199 USD/kWh. This is obtained from the Energy Regulatory Commission's public notice on the new electricity tariffs effective August 2018.[42]

AC Market Data

- We used RAC imports data obtained from the Kenya Revenue Authority. We compared this with the RAC sales data from Euromonitor and decided to use the more conservative imports data. The geometric mean compound annual growth rate of imports from 2010 to 2017 was calculated and used to model sales data from 1980 to 2009 and from 2018 to 2030.
- We assume an average RAC lifetime of 7 years, which was the average of the figures provided by the major dealers. We also assume 973 operating hours per year, which assumes the RACs operate for a third of the days in a year for eight hours each day. These operational assumptions are based on discussions with industry.
- Annual unit energy consumption was calculated based on the baseline values identified in **Table 7** using the formula:

$$UEC = \frac{Cooling\ Capacity\ (Btu/hr) \times 0.29307107}{EER\ (W/W)\ \times 1000} \times Annual\ operating\ hours$$

- The exchange rate used for conversion to and from KES and USD was 0.00986138 KES/USD.[43]
- The analysis year was set at 2018 and policy year at 2020. The policy impacts are assessed from 2020 to 2030.

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[35] United Nations, Department of Economic and Social Affairs, Population Division (2017). World Population Prospects: The 2017 Revision

[36] United Nations, Department of Economic and Social Affairs, Population Division (2018). World Urbanization Prospects: The 2018 Revision. https://population.un.org/wup/Country-Profiles/

[37] Kenya National Bureau of Statistics. 2018. The Economic Survey 2018

[38] World Bank. 2017. Real Interest rate (%) available at: https://data.worldbank.org/

[39] World Bank. 2017. GDP per capita growth (%) is available at: https://data.worldbank.org/

[40] Kenya Power and Lighting Company. 2018. Annual Report And Financial Statements for The Year Ended 30th June 2018

[41] Econometrica. Electricity-specific emission factors for grid electricity. Accessed at https://ecometrica.com/assets/Electricity-specific-emission-factors-for-grid-electricity.pdf on June 24, 2019.

[42] ERC. 2018. Clarification on the Reviewed Retail Electricity Tariffs for the 2018.19 Tariff Control Period. https://www.erc.go.ke/clarification-on-the-retail-electricity-tariff-review-for-the-2018-19-tariff-control-period/ Accessed Feb 4 2019.

[43] Accessed from https://www.centralbank.go.ke/forex/ on Jan 24 2019.

9 Policy Options & Results

9.1. Policy Options

Increasing MEPS to levels proposed by KEBS

In October 2018, the Kenya Bureau of Standards proposed a revision of the current MEPS and star categories for air conditioners. The revised MEPS and star categories are the basis for the first scenario CLASP evaluated. The revision proposes to increase the current MEPS from an EER of 2.8 W/W to 3.1 W/W which represents an 11% increase. **Table 8** below shows the proposed star categorization. This policy scenario was selected in order to support evidence-based policy making in Kenya.

Table 8: Proposed MEPS and star ratings increase

Star Rating	EER (W/W)
1 Star (MEPS)	≥ 3.1
2 Star	≥ 3.3
3 Star	≥ 3.5
4 Star	≥4.0
5 Star	≥4.5

Potential Best Available Technology (BAT)

The second policy scenario under consideration is if consumers in the Kenyan market only used units that are 20% above the proposed MEPS. This assumes that if the proposed MEPS are implemented, the best available technology - in the short term - will be units with efficiency ratings of 3.75 W/W, which would fall under the four-star categorization according to the current regulation and 3-star categorization on the revised scale. This is a conservative scenario since there are RACs with much higher efficiencies currently available in many markets around the world. **Table 9** summarizes the adjusted modelled prices for the three most popular cooling capacity units in the Kenyan market under this scenario.

Table 9: Prices for the potential BAT for the three most popular RAC capacities

Cooling Capacity	Potential BAT	Adjusted Modelled Price (KES)	Adjusted Modelled Price (USD)
12,000	3.75 W/W	KES 72,875	719 USD
18,000	3.75 W/W	KES 82,331	812 USD
24,000	3.75 W/W	KES 156,082	1,539 USD

9.2. PAMS Outputs

Table 10, Table 11, and **Table 12** summarize the outputs of the PAMS analysis under the two policy scenarios for the three most popular RAC capacities in the market. The payback period is calculated at the unit level while the cost/benefit ratio is calculated at the national level, hence the difference in the figures. Overall, both policy scenarios provide benefits to RAC users and at the national level for all RAC capacities.

Table 10: PAMS output summary for the 12,000 Btu/hr RACs

PAMS Summary for 12,000 Btu/hr RAC	Proposed MEPS EER 3.1	Potential BAT EER 3.72
Consumer Benefits		
Payback Period (years)	2.02	2.43
LCC savings (USD)	62	154
LCC savings (KES)	6,287	15,637
National Benefits		
Total Electricity Cost Savings through 2030 (millions of USD)	14.4	40.5
Total Electricity Cost Savings through 2030 (millions of KES)	1,460	4,110
Cost/Benefit Ratio	2.42	2.02
Site Energy Savings in 2030 (GWh)	15	42
Site Energy Savings through 2030 (GWh)	80	226
CO_2 Emissions Mitigation through 2030 (Mt CO_2e)	0.03	0.10

Table 11: PAMS output summary for the 18,000 Btu/hr RACs

PAMS Summary for 18,000 Btu/hr RAC	Proposed MEPS EER 3.1	Potential BAT EER 3.72
Consumer Benefits		
Payback Period (years)	1.17	1.40
LCC savings (USD)	96	297
LCC savings (KES)	9,708	30,103
National Benefits		
Total Electricity Cost Savings through 2030 (millions of USD)	22.5	73
Total Electricity Cost Savings through 2030 (millions of KES)	2,286	7,440
Cost/Benefit Ratio	4.18	3.49
Site Energy Savings in 2030 (GWh)	23	76
Site Energy Savings through 2030 (GWh)	126	410
CO_2 Emissions Mitigation through 2030 (Mt CO_2e)	0.05	0.17

Table 12: PAMS output summary for the 24,000 Btu/hr RACs

PAMS Summary for 24,000 Btu/hr RAC	Proposed MEPS EER 3.1	Potential BAT EER 3.72
Consumer Benefits		
Payback Period (years)	1.36	1.63
LCC savings (USD)	91	344
LCC savings (KES)	9,234	34,833
National Benefits		
Total Electricity Cost Savings through 2030 (millions of USD)	20.7	83.2
Total Electricity Cost Savings through 2030 (millions of KES)	2,097	8,432
Cost/Benefit Ratio	3.59	3.00
Site Energy Savings in 2030 (GWh)	21	86
Site Energy Savings through 2030 (GWh)	115	464
CO_2 Emissions Mitigation through 2030 (Mt CO_2e)	0.05	0.20

10 Impacts Assessment Results

10.1 Impacts to Consumers

We assessed the impacts to RAC consumers under two policy scenarios:

- **MEPS increase proposed by KEBS -** Under this scenario, the LCC savings are highest for the 18,000 and 24,000 Btu/hr units at KES 9,708 and KES 9,234 respectively. Additionally, the payback period for the 12,000 Btu/hr units is longer than the payback period for the 18,000 Btu/hr units by almost one year. Overall, an increase of the MEPS to the level proposed by KEBS would have positive impacts on consumers of all three popular RAC capacities, with the consumers that purchase 18,000 Btu/hr units benefiting the most.
- **Potential Best Available Technology (BAT) -** Similar to the first scenario**,** this scenario predicts higher LCC savings and a shorter payback period for the larger capacity units. However, the difference in payback periods between the first scenario and the second is minimal for all capacities, while the LCC savings are significantly higher for the second scenario. This implies that if consumers were able to afford the upfront cost of both the units with 3.1W/W and 3.75W/W, then they would be better served by purchasing the higher efficiency units since the benefits over the appliance's lifetime would be higher.

Sensitivity Analysis

To analyze further the impacts on consumers under the first scenario – MEPS increase proposed by KEBS – CLASP conducted a sensitivity analysis on the LCC savings by varying the unit price, appliance lifetime and electricity tariff. The results of the sensitivity analysis are shown in **Figure 20**, **Figure 21**, and **Figure 22**.

For all three cooling capacities, a 20% decrease in the lifetime of the RACs and a 20% increase in the electricity tariff have the largest effects on the LCC savings. An increase in the electricity tariff would lead to a 33% increase in LCC savings for the 12,000 Btu/hr units and a 40% increase in LCC savings for the 18,000 and 24,000 Btu/hr units.

Figure 20: LCC savings sensitivity analysis for 12,000 Btu/hr RACs

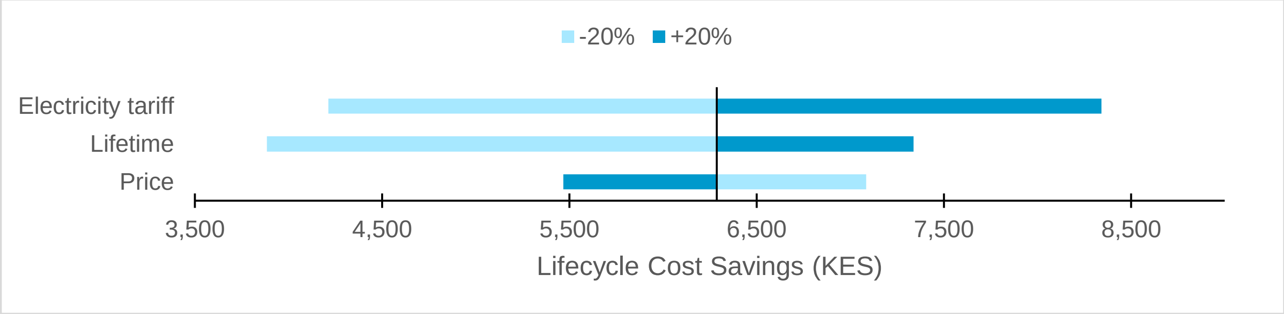


Figure 21: LCC savings sensitivity analysis for 18,000 Btu/hr RACs

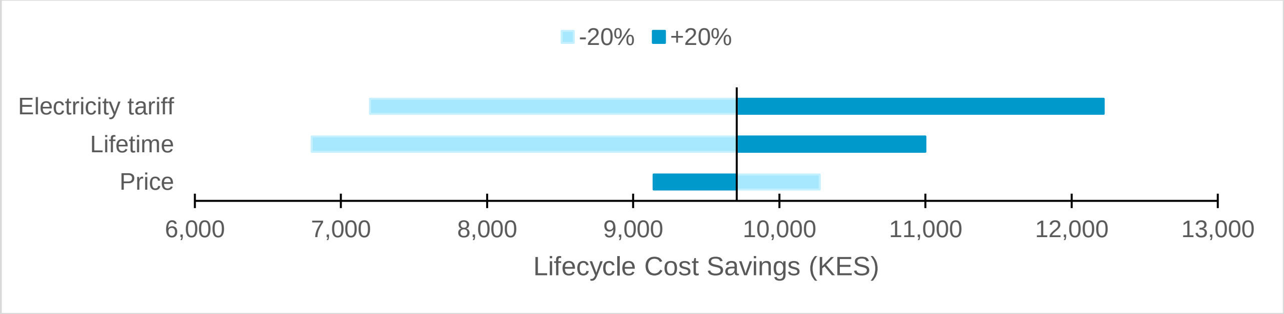
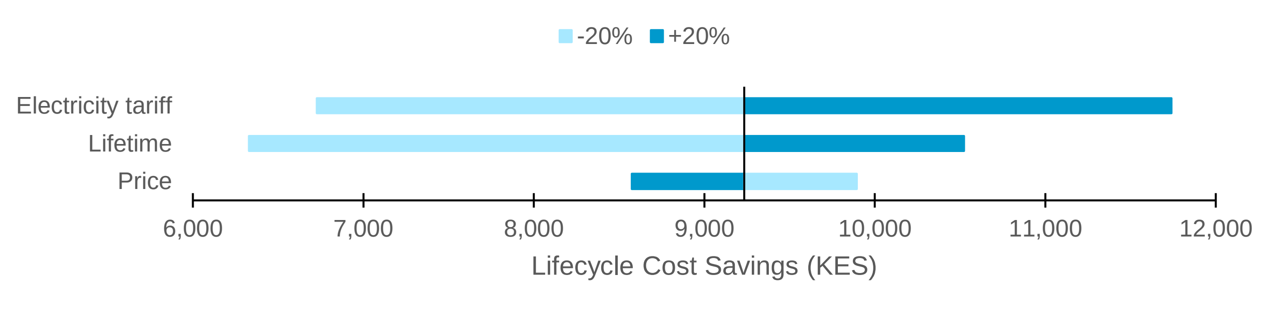


Figure 22: LCC savings sensitivity analysis for 24,000 Btu/hr RACs



10.2 Impacts to Importers and Dealers

Any increase in the MEPS would eliminate models that are not compliant from the market and increase the overall efficiency of RACs in the Kenyan market. The current MEPS level already eliminates 30% of all the RAC models that were in the market in 2018 (**Table 13**). All the RACs eliminated from the market with the current MEPS level are fixed speed RACs.

Table 13: Compliance and star rating distribution under current MEPS

	All	Fixed	Inverter
Non-compliant	30%	46%	0%
1 Star	45%	33%	68%
2 star	25%	22%	32%
3 Star	0%	0%	0%

Increasing the MEPS further to 3.1W/W would eliminate 73% of the RAC models available on the market in 2018 (**Table 14**). The majority of the fixed speed and inverter RACs would be eliminated, and only a few of the compliant models would get a 2-star rating. None of the models in the market in 2018 would meet the MEPS if it was increased to the potential BAT.

Table 14: Compliance and star rating distribution under MEPS proposed by KEBS

	All	Fixed	Inverter
Non-compliant	73%	76%	68%
1 Star	24%	20%	32%
2 star	3%	4%	0%
3 Star	0%	0%	0%

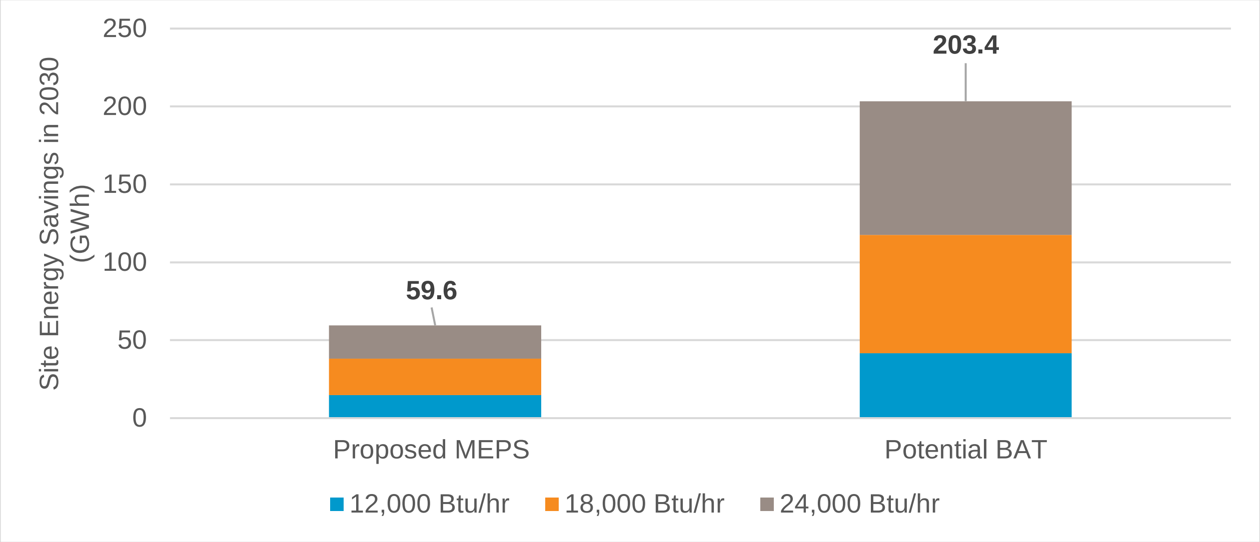
10.3 Impacts at the National Level

Energy Savings

In a business as usual scenario, where the efficiencies of RACs in the Kenyan market remain at current levels, RACs will consume 972 GWh of electricity in 2030. This is approximately 3 – 5% of the projected total electricity demand in 2030.[23]

- Under the proposed MEPS scenario, implementing the revised MEPS would lead to savings of 59.6 GWh in 2030. Over ten years from 2020 to 2030, the cumulative savings from this scenario would be 321 GWh.
- The potential BAT scenario would lead to savings of 203.4 GWh in 2030 and 1,100 GWh cumulative savings over ten years.

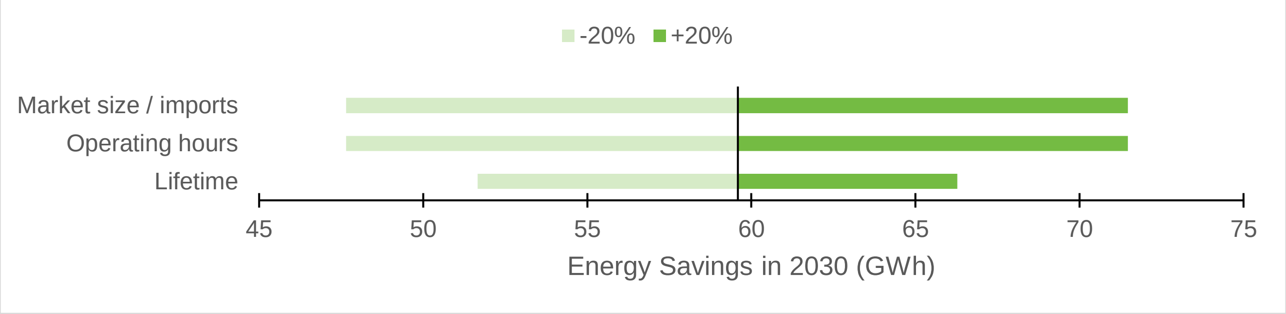
Figure 23: Energy savings in 2030 under two policy scenarios



Sensitivity analysis on energy savings

CLASP carried out a sensitivity analysis on the energy savings by varying the RAC operating hours, lifetime and sales/imports by +/- 20%. The analysis shows that energy savings are most sensitive to operating time and the sales/imports (**Figure 24**). A 20% change in these two parameters leads to a 20% change in the site energy savings and a 20% change in the product lifetime leads to an 11 – 13% change in the savings.

Figure 24: Sensitivity analysis on site energy savings in 2030



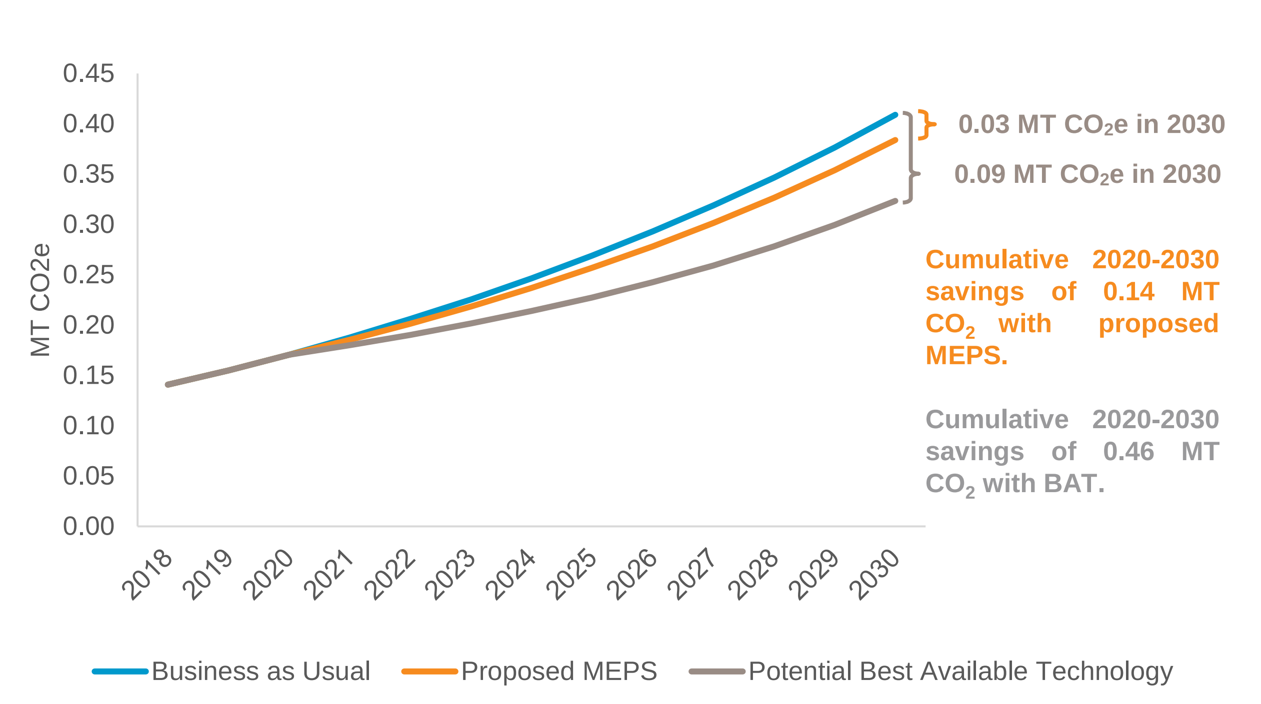
Emissions reductions

In the business-as-usual scenario, in 2030, electricity consumption by RACs will lead to 0.409 MT of CO_2 emissions.[44]

CLASP estimates the following emissions savings under the two policy scenarios:

- The MEPS increase proposed by KEBS would lead to emissions savings of 0.03 MT CO_2 in 2030 and a 6% (0.14 MT) reduction in cumulative emissions through 2030.
- The potential BAT scenario would lead to 0.09 MT CO_2 emission savings in 2030 and a 21% (0.46 MT) reduction in cumulative emissions through 2030.

Figure 25: Avoided CO_2 emissions over time and in 2030



[44] Direct emissions from refrigerants are not included

11 Conclusions and Recommendations

The *Kenya Room Air Conditioner Market Assessment and Policy Options Analysis* provides the technical evidence to revise the MEPS for RACs. It also provides a baseline for future tracking of the impacts of the standards and labelling program for RACs, since the data collection process occurred just before and during the period that the MEPS came into effect in 2018. Government agencies can use this analysis to define the efficiency levels for RACs, quantify potential energy savings and GHG emissions reductions in support of energy efficiency targets or NDC commitments, and track market transformation after implementation of the MEPS.

The analysis in this report is based on product characteristics data for 103 models from 15 stores in four cities – Nairobi, Mombasa, Kisumu and Eldoret. The product data analysis is limited to the data collected primarily from distributor or dealer display stores and retail stores. This analysis provides evidence of the positive impacts of revision of the Kenyan RAC MEPS to more stringent levels.

Main findings

All Kenyan RACs are imported, with Japanese, South Korean and Kenyan brands dominating the market. However, most RACs are manufactured in China, Malaysia and Thailand. This means that increasing MEPS levels would not impact any local manufacturers/importers and would encourage importers to source higher efficiency units that are already readily available at comparable costs in foreign markets.

Efficiency levels for RACs in the Kenyan market are generally low although inverter RACs take up 36% of the market. As the efficiency levels in countries that export RACs to Kenya improve (i.e., China and Thailand), Kenya risks becoming a dumping ground for older models with lower efficiencies. The significant market share of inverter units implies a familiarity with the technology and therefore potential for higher efficiency levels with enforcement of MEPS, since inverter units can attain higher levels of efficiency.

Revising the current MEPS to the proposed level would lead to significant market transformation. Increasing the MEPS level to 3.1 W/W would eliminate 73% of the RACs available in the market in 2018. Under the revised MEPS, the highest efficiency units would only qualify for 2-star categorization. However, enforcement of the labelling program and consumer awareness would encourage competition and incentivize importers to introduce higher efficiency units into the market.

Based on the policy impacts analysis carried out on the Kenyan RAC market, CLASP recommends the following:

Recommendation 1: Implement the MEPS proposed level of 3.1 W/W. Consumers will benefit from payback periods of less than three years on new RACs for all the popular cooling capacities. At the national level, the MEPS revision would lead to a 4% reduction in cumulative energy consumption between 2020 and 2030, equivalent to 321 GWh and 0.14 MT of CO_2. The avoidance of 0.03 MT CO_2 in 2030 translates to 0.07% of the intended target emissions reduction outlines in Kenya's Nationally Determined Contribution submitted to UNFCCC.[45]

Recommendation 2: Update the MEPS and labelling schedule every 2-3 years to continue market transformation. While the proposed MEPS levels are a great first step in increasing the overall efficiency of RACs in the market, periodic review would help avoid dumping of products as efficiency levels in other markets continue to increase. CLASP's analysis shows that a transition to the potential best available technology in the market (BAT in the policy scenarios) would not lead to a significant increase in the payback period for consumers and would increase the consumer life cycle cost savings significantly. It would also lead to significant energy savings (203.4 GWh in 2030) and emission reductions through 2030 of 0.46 MT CO2. The avoidance of 0.09 MT CO_2 in 2030 which translates to 0.21% of the intended emissions reduction according to the NDC.

Recommendation 3: Conduct a comprehensive consumer awareness program that sensitizes the public on the new labelling program for RACs. Since the S&L program is in the early stages of implementation, a consumer awareness program provides consumers with the chance to reap benefits from the program from the start. Consumers that are more aware of the energy use of the appliances they purchase, would drive the

[45] Government of Kenya. 2015. NDC. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Kenya%20First/Kenya_NDC_20150723.pdf . Accessed February 13, 2019

demand for more energy efficient RACs. A label allows consumers to make informed purchasing decisions by differentiating high efficiency products from average and low efficiency products. Additionally, a label incentivizes importers to bring more efficient products by helping them to market their high efficiency products, as the label provides unbiased evidence that their products are more efficient. Increased competition can drive down the prices of more efficient RACs.