RWANDA NATIONAL COOLING STRATEGY

2019

Ministry of Environment

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Acronyms

AC:	Air Conditioner
AEC:	Annual Energy Consumption
AV:	Adjusted Volume
BASE:	Basel Agency for Sustainable Energy
CAR:	Conformity Assessment Report
CSPF:	Cooling Seasonal Performance Factor
EDCL:	Energy Development Corporation Limited
EER:	Energy Efficiency Ratio
ESSP:	Energy Sector Strategic Plan
EUCL:	Energy Utility Corporation Limited
GWP:	Global Warming Potential
GoR:	Government of Rwanda
HCs:	Hydrocarbons
HFCs:	Hydrofluorocarbons
HP:	Horse Power
HPMP:	Hydrofluorocarbons Phase Out Management Plan
IEC:	International Electrotechnical Commission
ISO:	International Organisation for Standardization
IPCC:	Intergovernmental Panel on Climate Change
KCEP:	Kigali Cooling Efficiency Program
Kw:	Kilowatt
KWh:	Kilowatt Hour
LBNL:	Lawrence Berkeley National Laboratory
LED:	Light-Emitting Diode
MoE:	Ministry of Environment
MW:	Megawatt
MEP:	Minimum Energy Efficiency Performance Standards
MININFRA:	Ministry of Infrastructure

NCS:	National Cooling Strategy
NDC:	Nationally-Determined Contribution
ODP:	Ozone Depleting Substances
RAA:	Rwanda Revenue Authority
REG:	Rwanda Energy Group
REMA:	Rwanda Environment Management Authority
REP:	Rwanda Energy Policy
RSB:	Rwanda Standards Board
RSEER:	Rwanda Seasonal Energy Efficiency Ratio
RURA:	Rwanda Utilities Regulatory Agency
SEER:	Seasonal Energy Efficiency Ratio
SWG:	Sector Working Group
TWG:	Thematic Working Group
U4E:	United for Efficiency Initiative
UN:	United Nations

Foreword

Improving energy efficiency is one of the fastest, most cost-effective and cleanest ways of availing additional energy for sustainable development. While this approach is not usually seen in the context of environmental protection, sustainable economic development and poverty eradication, these are in fact the overarching national and global issues that energy efficiency aims to address.

The cooling sector is expected to grow rapidly worldwide, including in Rwanda. It is expected that space cooling, which is already the biggest consumer of household energy globally, will double by 2050. In the absence of greenhouse gas emission reductions, which contribute to global warming, the need for space cooling will grow exponentially - triggering more demanding for cooling and more energy consumption.

Transforming the Rwandan market towards energy efficient equipment that uses low Global Warming Potential (GWP) gases is imperative to guarantee sustainable economic development, the conservation of natural resources, protection of the environment that will provide citizens and generations to come a better country to live in.

The National Cooling Strategy (NCS) will complement existing efforts in environmental protection and climate change mitigation through the development of Minimum Energy Efficiency Performance Standards (MEPs), which will guide cooling technology suppliers and consumers on how to access the most energy efficient equipment.

It is critical to focus on areas that can unlock the most impactful savings. Refrigerators, air conditioners and cold rooms are among the top priorities, given the significant and growing amount of energy that these products consume and the essential services that they provide. High-performance models are available in many markets around the world, however, Rwanda has not yet established strategies to guide the transition to more efficient cooling equipment. As a result, outdated technologies remain common.

While the up-front cost of an inefficient model may be lower than energy-efficient alternatives, the total cost of ownership throughout the product life is much higher due to the excessive electricity use.

This National Cooling Strategy brings together policy and programmatic considerations across a range of stakeholders. It will guide technology suppliers on requirements to sell cooling products in the Rwandan market, and help consumers distinguish the performance of air conditioners and refrigerators through product labels. The private sector, public institutions, civil society organisations, and other end-users are encouraged to come together to implement the strategy. Doing so will improve both environmental and economic outcomes for Rwanda - today and into the future.

Vincent Biruta
Minister of Environment, Rwanda

Acknowledgements

The National Cooling Strategy is a result of the collaboration between the Ministry of Environment (MoE), the Ministry of Infrastructure (MININFRA), UN Environment's United for Efficiency Initiative (U4E), Rwanda Environment Management Authority (REMA), Rwanda Standards Board (RSB), Kigali Cooling Efficiency Program (KCEP), government officials, department heads, and experts from the Ministry of Environment, the Ministry of Infrastructure, the Basel Agency for Sustainable Energy (BASE) and Lawrence Berkeley National Laboratory (LBNL). The National Cooling Strategy was developed through the Rwanda Cooling Initiative, which was launched in 2018 by the Government of Rwanda and UN Environment's United for Efficiency Initiative.

Chapter One: Introduction

1.1 Purpose of the National Cooling Strategy

The National Cooling Strategy (NCS) provides context and identifies priority interventions to optimally address Rwanda's growing needs for space conditioning and refrigeration (jointly referred to as "cooling"), in keeping with Rwanda's green growth pathway.

The number of new households connected to the national grid has doubled over the last five years and is expected to reach 52% of all households by 2024, while ensuring universal access to electricity through off-grid and on-grid solutions.

Using a variety of approaches to meet cooling demand (beyond equipment alone, such as use of shading, better insulation, natural ventilation, and so on), while reducing the amount of electricity wasted from refrigerators and air conditioners, will help residents and businesses to save money on their utility bills, which makes cooling more affordable for more people. A strategic approach will free up electricity for more households and businesses to be connected to the grid using existing generating capacity, allow greater use of refrigeration to preserve food and medicine (which helps farmers, consumers and patients), enable business to be more productive, and provide a better learning environment for studies.

1.2 Scope and Overview

The NCS links to and builds upon existing policies and targets, including the Rwanda Energy Policy (REP) and the Energy Sector Strategic Plan (ESSP), which identified the need to develop energy efficiency strategies and regulations to preclude excess investment in new power generation. The ESSP specifically sets the objective to Save up to 10% of 2013 power output by implementing priority energy efficiency programmes, among which an appropriate appliance standards and labelling scheme is recommended. It is well known that energy efficiency is the fastest, cheapest and cleanest means to meet demand growth.

The NCS pays particular attention to room air conditioners and residential refrigerators, which are the predominant end-use cooling products in Rwanda. Nevertheless, it underscores the essential role in reducing heating-load and seeking natural solutions where practical.

After an overview of the challenges and opportunities related to cooling Section 2, existing policies and targets are highlighted in Section 3 to call attention to areas of complementarity and to avoid duplication. Section 4 provides an overview of Rwanda's energy sector. Section 5 reviews the findings from a cooling sector market assessment undertaken in 2018. With this context, Section 6 provides recommendations for additional policies and programmes to be undertaken for a comprehensive approach to energy-efficient and climate-friendly cooling.

Given the constant evolution in technology, this policy will be re-evaluated and, where needed, revised at least once every five years. The NCS aims to be a living document that guides the country's transition to clean cooling.

1.3 Why Cooling Matters

Adequate space conditioning is key to sustainable economic development. Hospital operating rooms, high-tech factories, research laboratories, and data centres are just a few examples of the many facilities that require consistent and precise temperature and humidity control to function. Moreover, healthcare, manufacturing, and science-related sectors that rely on such facilities are cornerstones of diversified economies. Air conditioners are an invaluable tool to help meet these needs and position Rwanda for continued economic development. In Rwanda, natural cooling can go a long way to meet general cooling needs.

Similarly, a robust cold-chain is essential to ensure that a farmer's produce, a fisherman's catch, and a pharmaceutical company's medicines can reach consumers without premature loss. Maintaining refrigeration at the appropriate temperatures for these goods benefits producers - who reap more stable revenues and can access additional markets - and consumers - who benefit from more affordable and nutritious foods and medicines.

Minimising the loss of food (around 40% is lost post-harvest due to spoiling) helps to reduce the demand for inputs that go into cultivation, such as irrigated water and fertilisers. A cold chain is a temperature-controlled supply chain of refrigerated storage from harvest through final distribution until the product is consumed. An unbroken cold chain significantly extends the useful life of products, keeping them safe for consumption well beyond what is otherwise possible. When it comes to cooling solutions, end-use equipment such as refrigerators and air conditioners are ubiquitous. Many typical refrigerators and air conditioners operate by way of a vapour compression system, which uses electricity to circulate a refrigerant gas through a loop so as to extract heat from one location to another.

Depending on the energy source used to generate the electricity required by the system, the process could be energy and water-intensive, highly polluting, and a major source of greenhouse gas emissions. Refrigerant gas (also required in the blowing foam insulation used in refrigerator walls and doors) can also have very adverse consequences, including causing damage to the Ozone Layer that protects the Earth from ultraviolet rays and trapping exorbitant amounts of heat in the Earth's atmosphere when the gasses leak during servicing or at the end of the product's life.

Many cooling appliances in Rwanda are rather inefficient – with some wasting up to 80 per cent of their energy. Many use fluorinated gases (F-gases) such as hydrofluorocarbons (HFCs) as cooling agents. Some F-gases (e.g. HFC-23) trap more than 10,000 times as much heat as an equivalent molecule of carbon dioxide. Such refrigerant gases could potentially contribute nearly 20% of global greenhouse gas emissions by 2050.[1]

Also, while refrigerators cycle on and off with a relatively smooth and consistent level of energy demand throughout the year, air conditioners pose a unique challenge in that they are used most when the temperatures are uncomfortably warm, with most units running over the same portion of summer days and causing a spike in electricity use during periods of peak demand. Providing electricity to meet this temporary surge is very expensive, as the necessary excess generating capacity is only utilised for short intervals. In Rwanda, warmer temperatures coincide with the dry season when hydropower generation is significantly reduced due to low levels of rainfall. As a result, the utility operator has to compensate using diesel generators.

1 Rwanda's New Cool Endeavour, UN Environment - United for Efficiency, 2018

Together, the indirect (from electricity use) and direct (from leaking refrigerant gases) emissions of cooling products can have profound impacts on the planet if left unchecked. Over the lifetime of an air conditioner, approximately 75% of the total greenhouse gas emissions are indirect and 25% are direct. For refrigerators, the ratio is approximately 60% indirect and 40% direct. These figures vary depending on the refrigerant gas used. By 2020, it is projected that 75% of new refrigerators produced globally will use hydrocarbon refrigerants (e.g. isobutane) which have no ozone depletion potential and negligible global warming potential.[2] There is a greater variety of refrigerants in use globally for air conditioners, as these products have a much larger charge size (amount of refrigerant used in the vapour compression system) than refrigerators. Therefore, issues ranging from flammability and the ability to operate in a broader range of climatic conditions are much more pronounced.

As a relatively small market, it is important that Rwanda pursue a strategy that is in keeping with the positive trend toward more energy-efficient and climate-friendly equipment seen in major global markets.

As the climate continues to warm, demand for cooling and refrigeration is expected to increase, particularly in densely-populated urban areas where the heat island effect pushes the temperature up by several degrees compared to neighbouring rural areas.

Rwanda was one of the first signatories to the Kigali Amendment to the Montreal Protocol, which calls for action on hydrofluorocarbons.

1.4 Existing Guiding Policies and Strategies on Cooling

The National Green Growth and Climate Resilience strategy for climate change and low carbon development was adopted by the Government of Rwanda in 2011 and calls for buildings to be designed to reduce the energy demand, low carbon urban systems and water and energy efficiency standards to be integrated into building codes. The strategy further highlights that implementation of low energy consumption standards in buildings and services in Rwanda could result in an 80% reduction in energy use.

The Paris Agreement entered into force on 4 November 2016, and the Kigali Amendment to the Montreal Protocol, which requires the phase down of hydrofluorocarbon gases, entered into force on 1 January 2019.

The Rwanda Energy Policy (REP, 2015) highlights measures that need to be undertaken to promote energy efficiency through a combination of approaches such as regulations, new codes and standards, introduction of economic incentives such as subsidies for installation of solar water heaters, industrial end-users undertaking energy efficiency audits, barrier removal programmes such as examining systemic disincentives or reducing split incentives for energy-efficient technologies in buildings and pursuit of bulk procurement strategies such as the importation of light-emitting diode (LED) lamps.

The Energy Sector Strategic Plan (2018/19 – 2023/24) sets energy sector targets to be achieved by 2024. It emphasises the need for energy efficiency across generation, transmission, distribution and end-user consumption.

2 Adapted from Accelerating the Global Adoption of Energy-Efficient and Climate-Friendly Refrigerators and Accelerating the Global Adoption of Energy-Efficient and Climate-Friendly Air Conditioners, UN Environment – United for Efficiency, 2018

Rwanda Utilities Regulatory Authority (RURA) guidelines published in 2013 provide recommendations on the best practices to promote energy efficiency. The average climatic conditions across the entire country is temperate tropical highland where daily temperature ranges between 12°C (54°F) and 27°C (81°F)[3]. This provides an opportunity to do away with the need for room air conditioning and employ natural ventilation, utilisation of shading and improvement in building technologies.

The Rwanda Building Code (2015) sets minimum building performance requirements to promote energy efficient utilisation technologies.

The Rwanda Standards Board undertakes conformity assessments involving a set of processes to show whether a product, service or system meets the standard. The main forms of conformity assessment are testing, certification and inspection[4].

1.5 Energy Sector Overview

Key Actors

The energy sector in Rwanda involves three main stakeholders: Ministry and Government Institutions including MININFRA, MoE, RURA, REG with its two subsidiaries, EUCL and EDCL, development partners and the private sector.

The Ministry of Environment oversees the development of environment and climate change policies and programmes. It has the mandate to oversee the transition away from Ozone Depleting Substances and high global warming potential refrigerants used in cooling appliances. This work is carried out through REMA.

The Ministry of Infrastructure is in charge of developing energy policies and strategies, and monitors their implementation. REG is in charge of implementing energy policies and strategies through its subsidiaries EUCL and EDCL, the former being the custodian of the national grid and the operations and sale of electricity, while the latter develops energy infrastructure projects. RURA regulates the utilities, among them, energy services, including electricity, petroleum and gas. There is no tax exemption for cooling appliances of all categories, hence Rwanda Revenue Authority (RRA) collects the taxes imposed on their importation at the port of entry. MoE, through REMA, led the development of this strategy in close collaboration with MININFRA.

Energy Sources and End-Uses

Affordable, reliable and sustainable energy is essential for Rwanda's vision to transition to a middle-income country. All sources of energy have important impacts on society and trade-offs when they are consumed, such as degrading air quality, water quality, and/or natural habitats. The burning of fossil fuels and biomass have serious health implications and they are a major source of Rwanda's greenhouse gas emissions. Hydropower and photovoltaics, if not well situated, can require vast tracts of land that might be better used for other purposes, and reliability may be problematic during droughts or abnormally cloudy weather. Regardless of the fuel source, minimising wasted energy helps a country make the most of its resources.

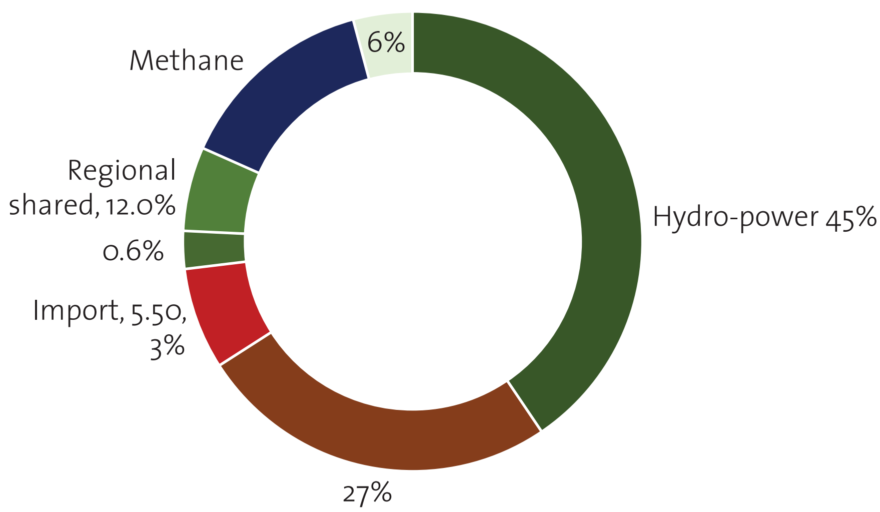
3 Source: meteoblue

4 https://www.iso.org/conformity-assessment.html

Although Rwanda has had considerable success over recent years in addressing environmental challenges - to the extent that it is one of only a few countries in Africa where there is not a major link between biomass use and the negative environmental effects of deforestation - social and health problems emanating from the use of biomass need to be solved.

Considering energy use broadly, the main consumers are households (82%), which mainly use energy in the form of traditional fuels such as biomass, followed by the transport sector (8%), industry (6%), and others (4%). Households are also the dominant consumers of electricity (51%), the bulk of which is used for lighting, refrigeration, air conditioning, ironing, cooking and water heating.

Figure 1: Source of power in % (Energy Sector SSP 2018)



The primary sources of electricity in Rwanda are hydro-power, methane gas, peat, diesel, solar PV, regionally shared hydro-power plants and imports. The total installed electricity generation capacity is on the rise, increasing from 160 MW in 2015 to 218 MW in 2017[5].

The current on-grid access to electricity is estimated at 31% (2017), up from 19% in 2014. The current average estimate of losses in the power system is around 18%.

The cost of electricity is currently not cost reflective and it is subsidised. The diesel fuel and heavy fuel oil required to run petroleum-based power plants to curb the peak demand represents a large share of the total national import burden and is one factor driving the high cost of electricity and currency depreciation. Such power plants are also heavy polluters.

Measures that encourage efficient end-use technologies, optimally timed energy consumption practices, and other demand-side management activities will play a critical role in shaving peak demand and maintaining the affordability and reliability of energy services.

5 Energy Sector SSP

Energy efficiency challenges include:

i. Limited technical capacity and knowledge at both personal and institutional levels - hence the urgent need of developing standards and labelling

ii. Insufficient incentives, including financing mechanisms to invest in modern technologies which require a higher initial investment

iii. Low awareness among energy-end users about energy conservation and energy efficiency opportunities and benefits

iv. Dominance of obsolete technologies and entrenched practices, including subsidies that do not reflect the true cost of energy supply

v. Lack of consistent approaches to encourage behavioural change

Medium-Term Electrification Plan

By 2024, the grid extension will cover 52% of the population versus 48% off-grid electrification.

To keep pace with the increased demand for electricity, the government is ensuring increased electricity generation capacity above the current capacity of 216 MW (2018). Energy efficiency programmes as well as diversifying away from diesel generation will lower utility bills while enabling the utility to maintain a cost reflective tariff and the government to eradicate subsidies.

The priority is to extend the network to allow productive and heavy users of electricity across the country to connect to the grid. Electricity consumption capacity, distance from existing power lines as well as the demographics of the area have influenced the new national electrification plan that indicates the specific type of electrification for each settlement. Productive use areas and trading centres make more economic justification of grid extension, organised settlements and trading centres situated significantly away from the national grid will be prioritised for mini-grid deployment. Scattered settlements characterised by low consumption of electricity, coupled with the cost of extending the network to every house, have led areas in this category to be prioritised for off-grid solution.

1.6 Refrigerator and Air Conditioner Market Assessment

Methodology

Elaboration of the NCS was informed by a market assessment to understand the cooling market in Rwanda and opportunities to transform it with more energy-efficient and climate-friendly solutions. The target audience was dealers in cooling equipment and consumers. The results were based on a combination of desktop research, questionnaires and face-to-face interviews to provide a clear understanding of the market. The market assessment focused on:

i. Facilities with attractive energy efficiency improvement opportunities

ii. Technologies expected to be dominant in the market for the foreseeable future

iii. Key players influencing the cooling market, ranging from technology suppliers and stores to their residential, commercial, and government customers

iv. Financing practices, challenges, and areas of untapped potential

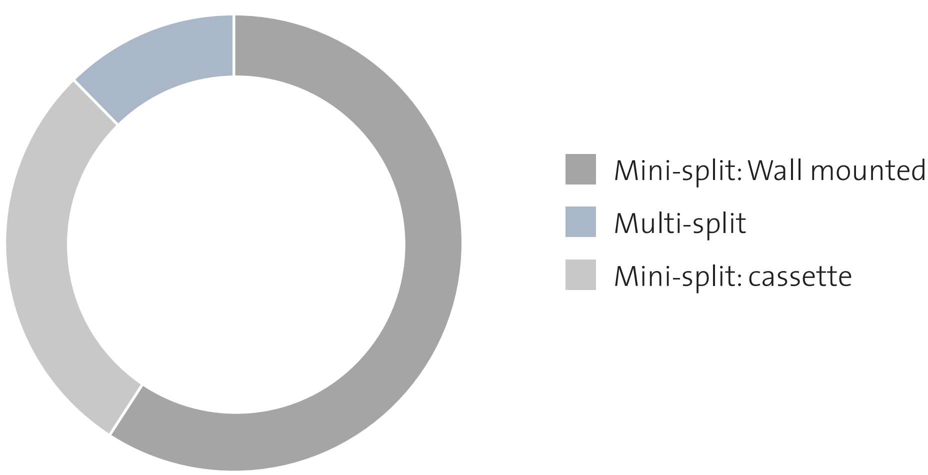
v. Levels of awareness among consumers on the benefits of energy-efficiency and how to make informed purchasing decisions.

Key Findings

Rwanda has an estimated 75,000 refrigerators and 50,000 air conditioners. As the economy continues to grow at an average annual rate of 7.5%, the population expands and electrification continues, a sharp increase in the use of cooling products is expected. The main actors in the cooling sector are technology suppliers categorised into importers, major brand representatives who import larger quantities of products, and retailers who purchase their stock locally and resell them on the retail market.

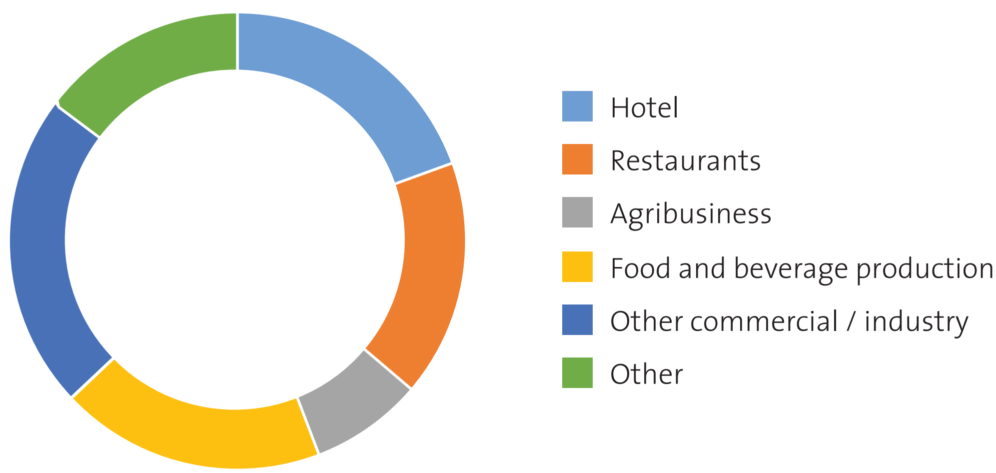
The main air conditioning technology in Rwanda, in terms of number of units sold, is the Wall-Mounted Mini-Split system, as shown in Figure 2. This is one of the easier systems to install and remove due to the limited amount of ducting work required. 92% of Mini-Split systems sold in Rwanda are non-inverter (fixed-speed) systems, which are a simpler design and therefore less expensive to purchase but more expensive to own and operate since they waste more electricity than inverter (variable-speed) systems. Many key markets in the world are rapidly transitioning to inverter systems due to their superior performance.

Figure 2: Segmentation of the Mini-Split Market



85% of refrigerator sales are to the residential sector, and the remaining 15% are to the commercial sector. Within the commercial sector, there is a relatively even distribution among market segments, as shown in Figure 2.

Figure 3 : Refrigerator sales by sector



The average efficiency of air conditioners is estimated to be approximately energy efficiency ratio (EER)[6] 3.0 which is consistent with the average in other countries in Africa - estimated to be between 2.8 and 3.4.[7] However, there is a wide range in performance and these figures are not always conclusive, as different vendors may take different approaches in test methodologies. Performance claims listed on a product label for one country do not necessarily translate in another country's context, given differences in test conditions and climate-specific efficiency calculation. Moreover, Rwanda currently lacks protocols to verify performance claims. Given product lifetimes that are typically over 10 years, short-term actions, such as implementation of standards and financial incentives, will have long-term impacts.

While Rwanda is beginning to see some of the technology innovations that are permeating more developed markets, the pace of change is slow and there is no clear demand signal to help orient suppliers on the types of energy-efficient and climate-friendly solutions that the country needs.

6 The ratio of the total cooling capacity to the effective power input to the device at any given set of rating conditions.

7 CLASP Africa Air Conditioner Market Scoping Study Report, 2018.

Chapter Two: Strategic Framework

2.1 Overall Objectives

- To guide implementation of Rwanda's target to promote a low carbon economy focusing on reducing emissions from the refrigeration and air conditioning sector.
- To support Rwanda in meeting its obligations underlined in the Kigali Amendment to the Montreal Protocol related to phasing out HFCs.

2.2 Specific Objectives

2.2.1 Objective 1: Establish minimum energy performance standards for cooling equipment

Government will restrict importation of cooling equipment and refrigerants which do not conform to the requirements below.

2.2.1.1 Requirements for Air conditioners and their refrigerants

These requirements apply to all electrical single-phase, non-ducted, self-contained, through-the-wall-and-window, and single-split air conditioners and reversible heat pumps, and portable air conditioners with a rated cooling output at or below 16 Kilo-Watts (kW) placed on the market in the Republic of Rwanda.

A Rwanda Seasonal Energy Efficiency Ratio (RSEER), presented in the Annex 1 using ISO's Cooling Seasonal Performance Factor (CSPF) with a Rwanda outdoor temperature distribution, provides efficiency tiers to establish minimum energy performance requirements and labels. Sale or installation of cabinet units not identified as a matched pair is not recommended.

2.2.1.2 Energy Efficiency Requirements

2.2.1.2.1 Ductless Split Air Conditioners

Cooling performance for all split air conditioners within the scope of this document should meet or exceed the energy efficiency levels in Table 1, represented by the RSEER (equivalent to ISO 16358 defined CSPF) metric coupled with the outdoor temperature bin hours specified in Annex 5.

Table 1. Minimum Requirements for RSEER

Capacity	Compressor Type	
	Fixed	Variable
Rated Cooling Capacity ≤ 4.5 kW	3.80	4.60
4.5 kW < Rated Cooling Capacity ≤ 9.5 kW	3.50	4.30
9.5 kW < Rated Cooling Capacity ≤ 16.0 kW	3.20	3.90

2.2.1.2.2 Self-Contained Air Conditioners

Cooling performance for all unitary self-contained air conditioners within the scope of this standard should meet or exceed the energy efficiency levels in Table 2.

Table 2. Minimum Requirements for RSEER of Self-Contained Air Conditioners

Capacity	Fixed	Variable
Rated Cooling Capacity ≤ 16.0 kW	3.50	4.00

For a product to meet the higher performance tiers, the levels of performance shall be selected per Table 2. A label indicating the performance will be fixed to the unit.

Table 3. Labelling Requirements for RSEER

Grade		Rated Cooling Capacity ≤ 4.5 kW	4.5 kW < Rated Cooling Capacity ≤ 9.5 KW	9.5 kW < Rated Cooling Capacity ≤ 16.0 KW
A		6.90 ≤ RSEER	6.40 ≤ RSEER	5.90 ≤ RSEER
B		6.33 ≤ RSEER < 6.90	5.91 ≤ RSEER < 6.40	5.36 ≤ RSEER < 5.90
C		5.75 ≤ RSEER < 6.33	5.38 ≤ RSEER < 5.91	4.88 ≤ RSEER < 5.36
D		5.18 ≤ RSEER < 5.75	4.84 ≤ RSEER < 5.38	4.39 ≤ RSEER < 4.88
	Variable (split)	4.60 ≤ RSEER < 5.18	4.30 ≤ RSEER < 4.84	3.90 ≤ RSEER < 4.39
E	Fixed (split)	3.80 ≤ RSEER < 5.18	3.50 ≤ RSEER < 4.84	3.20 ≤ RSEER < 4.39
	Variable (unitary)	4.00 ≤ RSEER < 5.18	4.00 ≤ RSEER < 4.84	4.00 ≤ RSEER < 4.39
	Fixed (unitary)	3.50 ≤ RSEER < 5.18	3.50 ≤ RSEER < 4.84	3.50 ≤ RSEER < 4.39

2.2.1.2.3 Functional Performance Requirements

All units shall be tested at 230 V, as described in ISO 5151.

All units shall operate appropriately with the rated voltage with surge protection +/- 15%.

2.2.1.2.4 Refrigerant Requirements

Refrigerants used in air conditioners must comply with requirements on their ODP[8] and GW[9] according to the limitations listed in Table 4.

Table 4. Requirements for Refrigerant Characteristics (numbers shown are upper limits)

Product Class	GWP	ODP
Self-Contained system	150	0
Split system	750	0

8 Per Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer, Seventh Edition, annexes A, B, C and E.

9 Per Climate Change 1995, The Science of Climate Change: Summary for Policymakers and Technical Summary of the Working Group I Report, page 22.

2.2.1.3 Energy-Efficient and Climate-Friendly Refrigerators

2.2.1.4 Scope of Covered Products

The requirements apply to refrigerating equipment of the vapour compression type, with a rated volume at or above 10 litres and at or below 1,500 litres, powered by electric mains and offered for sale or installed in Rwanda.

2.2.1.5 Exemptions

Refrigerators, refrigerator-freezers, and freezers with a total volume exceeding 1,500 litres, other products that do not meet the definition of a refrigerator, refrigerator-freezer, or freezer are exempt from this requirement and other types than vapour compression units are exempt from this requirement.

2.2.1.6 Maximum Energy Use Requirements

Energy performance for all refrigerating appliances within the scope of this document should meet or exceed the energy consumption requirements described in table 5 below.

Table 5. Maximum Annual Energy Consumption (AECMax)

Reference Ambient Temperature	Product Category	AEC_{Max} (kWh/year)
25°C	Refrigerators	0.183AV+120
	Refrigerator-Freezers	0.268AV+190
	Freezers	0.238AV+193

Details and examples of calculations are shown in the Annex 2.

2.2.1.7 Labelling Requirements

Table 6. Labelling Requirements for Refrigerating Appliances

Grade	Refrigerators	Refrigerator-Freezers	Freezers
A	2.00 ≤ R	2.00 ≤ R	2.00 ≤ R
B	1.75 ≤ R < 2.00	1.75 ≤ R < 2.00	1.75 ≤ R < 2.00
C	1.50 ≤ R < 1.75	1.50 ≤ R < 1.75	1.50 ≤ R < 1.75
D	1.25 ≤ R < 1.50	1.25 ≤ R < 1.50	1.25 ≤ R < 1.50
E	1.00 ≤ R < 1.25	1.00 ≤ R < 1.25	R < 1.25

2.2.1.8 Functional Performance Requirements

The temperature inside the fresh food compartment of the refrigerating appliance shall be adjustable to +4°C, as described in IEC 62552-3. The temperature inside the freezer compartment of the refrigerating appliance shall be adjustable to -18°C, as described IEC 62552-3. Refrigerating appliances shall be tested at 230V and 50Hz, as described in IEC 62552-1. All units shall operate appropriately with the rated voltage, with surge protection +/- 15%.

2.2.1.9 Refrigerant Requirements

Refrigerants and foam-blowing agents used in refrigerating appliances must comply with requirements on their Ozone Depletion Potential (ODP) and Global Warming Potential (GWP) according to the limitations listed in Table 7.

Table 7. Requirements for Refrigerant and Foam-Blowing Agent Characteristics (numbers shown are upper limits)

Product Class	GWP	ODP
All types	20	0

Product shall be constructed in accordance with IEC 60335-2-24:2010/AMD: 2017, or the latest version at the time the regulation is effective, on the safe use of hydrocarbon (HC) refrigerants.

Table 8. Refrigerant Charge Size Limits for Hydrocarbons (HCs)

Product Class	Maximum Charge
All types (domestic refrigeration)	kg

2.2.1.10 Entry into Force

The requirements set out in section 2.2.1 shall take effect from January 1, 2021.

2.2.1.11 Labelling

The original equipment manufacturer shall provide a label to the importer, product retailer, or installer before the product enters the market. The label shall indicate:

i. Model name and number

ii. Country where the product was manufactured

iii. Volume of the different compartments and an indication of whether they are frost-free

iv. Rated performance grade (A to E)

v. Yearly energy consumption in KWh (All representations of energy performance shall indicate that the performance rating is an indicative value not representative of true annual energy consumption.)

vi. Refrigerant and foam-blowing agent name, ODP and GWP.

vii. The label shall be affixed on the product in a location that is readily visible for the consumer.

2.2.1.12 Revision

These requirements should be strengthened by a simple administrative rulemaking based on an updated market assessment conducted on the cost and availability of new technologies once every five years after this strategy enters into force.

The top performance tier is expected to become the maximum annual energy consumption requirement when this document is next revised, which should occur based on the findings of an updated market assessment, but no later than seven years after these requirements enter into force.

2.2.2 Objective 2: Ensure availability and access to information of cooling equipment

To set and maintain impactful cooling policies and programmes, the government will develop and implement a national cooling equipment registration system to capture information on all cooling equipment produced, imported or exported on the Rwandan market. It will serve as an initial compliance gateway that incorporates best practices in use globally. A product labelling system will be introduced to provide quick visual information to consumers on the energy efficiency of cooling products in stores for sale.

2.2.3 Objective 3: Improve community awareness to adopt efficient cooling technology

Private operators such as industries, importers, retailers and professional bodies like the Association of Engineers and Architects will be mobilised through various fora to adopt efficient cooling technologies. Awareness campaigns will be conducted to encourage the transition to environmentally friendly cooling equipment and proper management including end of product life disposal. The Rwanda E-waste Dismantling and Recycling Facility is currently piloting the recycling of cooling products. The facility currently recycles the metal parts of the cooling products, recovers the gases and sends them out of the country for recycling, and ensures that the rest of the components are properly disposed of or recycled. The government will mobilise further investment for the disposal and recycling of cooling products.

Capacities of market players will be strengthened to support the transition to efficient cooling equipment. A capacity building plan with appropriate methods (e.g. use of vocational training institutes) for engaging target audiences (e.g. installation and maintenance technicians, inspectors, and sales representatives that help consumers understand product labels) shall be developed to support the market transition.

2.2.4 Objective 4: Promote new and innovative financial mechanisms to scale up adoption of efficient cooling technologies

Innovative financial mechanisms are needed to scale up the adoption of clean cooling technologies that are inhibited by first-cost barriers and risk perceptions. The main challenges include:

i. Higher up-front costs of energy efficient equipment

ii. Limited knowledge of the benefits of energy efficiency

iii. High perceived risks, or lack of trust in new technologies and promised energy savings

iv. Competing investment priorities that present more familiar risk-return profile for investors

v. Limited credit capacity or limited access to finance

vi. Split incentives, when the entity responsible for paying energy bills, is not the same entity that is making the capital investment decisions

The Government of Rwanda will engage private operators in the financial sector to develop innovative instruments that will support the transition to efficient cooling technologies. Options include guaranteed performance models ("Energy Savings Insurance"), on-bill financing schemes, service-oriented models ("Pay per use" or "pay-as-you-go"), shared savings energy performance contract models, leasing schemes, sale-and-leaseback models, bulk procurement programmes among others. One such example of a lease facility has been developed by the Business Development Fund (BDF) in partnership with the Rwanda Green Fund (FONERWA). The facility will provide affordable loans to beneficiaries of cooling products and registered suppliers will supply the product and guarantee its quality during operations.

2.2.5 Objective 5: Harmonisation with other environment protection programmes

The preparation of the HPMP Stage II and enabling activities and revision of the Nationally Determined Contribution (NDC) should align with the refrigerant gas requirements in this document for refrigerators and air conditioners, and the overall emphasis of the National Cooling Strategy on transitioning to refrigerant gases with lower global warming potential while improving the energy efficiency of cooling products that utilise these gases. The revised NDC shall identify energy-efficient and climate-friendly cooling's estimated contribution to the mitigation of greenhouse gas emissions.

2.2.6 Objective 6: Scale up Cold Chain and Off-Grid Cooling Infrastructure to support productive sectors

Agriculture is one of the cornerstones of the Rwandan economy, and comprehensive cold chain using energy-efficient and climate-friendly cooling solutions should be established. Various refrigerated storage technologies exist in Rwanda, ranging from grid-connected brick and mortar cold rooms to off-grid solar-powered facilities. Different business models are being tested (e.g. pay per use and leasing, targeting groups of small and medium-sized agribusiness farmers), and refrigerated transport options are being piloted.

Energy-efficient and climate-friendly cooling solutions are required to support various sectors of the economy including;

1. Agriculture (i.e. prevention of agriculture post-harvest losses, fisheries, horticulture among others)
2. Trade and exports (i.e. conservation of perishable produce)
3. Health (preservation of vaccines, drugs, mortuary among others)
4. The Government of Rwanda will mobilise investors to develop and operate energy efficient cooling facilities and solutions to meet these demands.

Chapter Three: Implementation Arrangement

The oversight function for implementing the National Cooling Strategy lies with the Ministry of Environment. It will provide policy guidance and strategic orientation.

The oversight function will be supported by different structures that include Environment and Natural Resources Sector Working Group, Environment and Climate Change Thematic Working Group, and the Energy Sector Working Group, among others.

The delivery of the National Cooling Strategy will be implemented through relevant ministries and agencies' annual plans and budgets, and Imihigo (performance contracts). The monitoring and evaluation functions shall follow the guidelines stipulated in the Results Based Management (RBM) policy which provides for the M&E frequency as well as roles and responsibilities for each stakeholder.

Table 9: Detailed Roles and Responsibilities

Institutions	Roles and Responsibilities
Ministries of Environment and Infrastructure	• Monitor and evaluate performance through results-based management frameworks. • Build partnerships required to implement the strategy including mobilisation of resources. • Engage with regional peers to harmonise with the requirements regionally.
Sector Working Groups (ENR, Energy and related Thematic Working Groups)	Monitor progress of the Sector Strategic Plans (SSP), which are informed by subsector strategies such as the National Cooling Strategy.
Rwanda Environment Management Authority	• Coordination of all implementation activities, monitoring and reporting. • Conduct trainings of importers on cooling equipment, and inspectors on how to identify energy-efficient equipment and refrigerants.
Rwanda Standards Board and Rwanda Revenue Authority	• Control the entry of non-conforming equipment. • Implement a labelling system for the products to provide information to consumers on the energy consumption of each product.

Rwanda Standards Board	• Develop a product registration system to support certification, surveillance and testing to check compliance with these requirements and survey the market for noncompliance. This process should include details on sample size, lab accreditation requirements (ISO/IEC 17025 certified), and a challenging process that manufacturers can utilise if the initial testing of their product is found to be out of compliance. • Enforcement activities that include potential assessment of fines and barring the ongoing sale of non-compliant products in the country Annex 3. • Adopt the referenced standards into national standards and the relevant test procedures. All testing for compliance and market surveillance testing purposes shall be done using the measurement and calculation methods set out in Annex 1. • Verify the Conformity Assessment Report prior to making the product available for sale.
Private Sector	• Mobilise finance for importation and sale of clean cooling products. • Public awareness on the availability of top tier energy-efficient products on the market.
Development Partners	• Mobile funding for the implementation of the National Cooling Strategy. • Partner with the government on awareness raising with different stakeholders. • Support the government in ensuring regional harmonisation of the regulations.

Monitoring activities for the National Cooling Strategy will be carried out on a regular basis. The Rwanda Environment Management Authority will coordinate the overall reporting.

During the monitoring and reporting of the National Cooling Strategy implementation, MoE shall track the progress of the country's obligations under the Kigali Amendment to the Montreal Protocol. Result-based evaluation will focus on the assessment of planned, ongoing, or completed interventions to determine relevance, efficiency, effectiveness and impact of clean cooling technologies.

A monitoring and evaluation framework for the National Cooling Strategy shall be developed by Rwanda Environment Management Authority during the first year of implementation to facilitate evidence-based reporting.

3.1 Implementation Plan

Table 10: Detailed Roles and Responsibilities

Implimentation Plan — 2018/19, 2019/20, 2020/21, 2021/22, 2022/23 (Q1–Q4, months 1 2 3)

Lead = Lead; ◊ = Support

	Activities	MoE	MININFRA	RSB	RURA	MINEACOM	RDB	REG	REMA	MINECOFIN	MINEDUC	RRA	MINISANTE	BRD	BDF	FONERWA	RHA	MINAGRI	Cost ($)
1	Establishment of minimum energy performance requirements for cooling equipment																		
1.1	Creation of an enabling environment/staffing	◊	◊	Lead					◊										100,000
1.2	Adoption of the standards with in National Standards			Lead															10,000
1.3	Verification of comformity			Lead	◊							◊					◊		150,000
1.4	Surveillance of complience	◊		◊	Lead														100,000
1.5	Incorporate MEPS in public procurement	◊	◊	◊	◊	◊	◊	◊	Lead	◊	◊	◊	◊	◊	◊	◊	Lead		-
2	Ensure availability and access to information of cooling equipment																		
2.1	Develop the National Product Registration System	◊	◊	Lead					◊										20,000
2.2	Develop and approve the label design	◊	Lead	◊					◊										5,000
2.3	Insert labels on the products			Lead															30,000
2.4	Monitor, track and report market transformation			◊					Lead										15,000
2.5	Monitor, evaluate and report energy saving		◊					Lead											15,000
2.6	Monitor, evaluate and report HFCs phase down	◊							Lead										15,000
3	Improve community sensitization to adopt efficient cooling technology																		
3.1	Impliment the capacity building (Policy makers, private sector and consumers)	Lead	◊					◊	◊		◊								70,000

3.2	Impliment awareness outreach campaigns	◊	◊	◊	◊			◊	•	◊									100,000
3.3	Design an end of life disposal and recycling mechanism for cooling products	◊				•	◊			◊						◊			20,000
3.4	Mobilise funding to impliment the disposal and recycling plan	◊					◊			◊						•			300,000
4	Promote new innovative Financing Mechanisms to scale up adoption of efficient cooling technologies																		
4.1	Oversight and development of financial mechanisms	◊					◊			◊						•			20,000
4.2	Pilot the leasing mechanism under development between BRD and BDF	◊								◊				•	•	•			2,000,000
4.3	Polit the on-bill financing with REG							•		◊				•		◊			4,000,000
4.4	Revise the HPMP and NDC's to ensure harmonisation with this strategy	•							•										10,000
4.5	Coordination and mobilization of donor funds	◊					•			◊						•			30,000
4.6	Accessing international climate finance	•							•										30,000
4.7	Appropriating funiding to different activities	•								◊									10,000
5	Scale up Cold Chain and Off-Grid Cooling Infrastructure to support productive sectors																		
5.1	Mobile resources to support the development of the cold room and off-grid cooling infrastructure	◊					◊			•						◊		◊	20,000
5.2	Design an implimentation road map for cold chain development	◊					◊			◊								•	10,000
5.3	Select sites for developing cold rooms and mobilise funding	◊					◊			◊								•	1,000,000

3.2 Monitoring and Evaluation Plan

Table 12: Monitoring and Evaluation Plan

M&E Matrix

S/N	Activities	Indicator(s)	Base-line	High Level Targets				Total	Reporting
			2018 /19	2019 /20	2020 /21	2021 /22	2022 /23		
1	Improvement of energy efficiency and reduction of Co2 emissions								
1.1	Energy savings	Amount of energy saved	0	0	16	24	33	73	Yearly
1.2	CO2 emissions avoided	Co2 emissions avoided	0	0	2	2	4	8	Yearly
1.3	Verification of conformity	Number of products verified			1,000	1,000	1,000	3,000	Biannual
2	Public access to information on cooling equipment								
2.1	Products registered in the Registration System	Report registered products	0	all	all	all	all	All	quarterly
2.2	Products with efficiency labels	Report registered products	0	0	all	all	all	All	quarterly
2.3	Reporting HFC gases imported and registered	Report registered products	0	all	all	all	all	All	quarterly
3	Capacity building								
3.1	Training policymakers, private sector and consumers	Number of people trained	0	50	50	50	50	200	quarterly
3.2	Implement awareness campaigns	Percentage of the population reached	0	10	10	10	10	40	quarterly
3.3	Design an end of life disposal and recycling mechanism for cooling products	Number of products recycled	0	0	1,000	1,000	1,000	3,000	quarterly
4	New and innovative financial mechanisms to scale up adoption of efficient cooling technologies								

4.1	Financial mechanisms	Number of Households/ firms benefiting	0	0	100	100	100	300	quarterly
4.2	Pilot the on-bill financing with REG	Number of households/ firms benefiting	0	0	1,000	1,000	1,000	3,000	quarterly
5	Scale up Cold Chain and Off-Grid Cooling Infrastructure to support productive sectors								
5.1	Select sites for developing cold rooms and mobilise funding	Number of sites ready for development	10	0	20	20	20	60	Yearly

Annexes

Annex 1 - Requirements for Energy-Efficient and Climate-Friendly Air Conditioning

These requirements cover the types of room air conditioners – so-called "Ductless Split Systems," also known as "Mini-Split" and unitary types – used commonly in residential and light commercial applications. It calls for the use of a "seasonal" energy efficiency rating – one that approximates the energy performance of air conditioners across a range of load and temperature conditions. It includes energy efficiency requirements and addresses the Ozone Depletion Potential (ODP) and GWP of refrigerants and sets an upper limit for each performance tier.

Scope of Covered Products

This guide applies to all electrical single-phase, non-ducted, self-contained, through-the-wall-and-window, and single-split air conditioners and reversible heat pumps, and portable air conditioners with a rated cooling output at or below 16 Kilo-Watts (KW) placed on the market in Rwanda.

Terms and Definitions

Below are the definitions of the relevant terms in this document. Unless otherwise specified, these definitions are harmonised with definitions in ISO 16358:2013 Air-cooled air conditioners and air-to-air heat pumps — Testing and calculating methods for seasonal performance factors (Part 1, 2, and 3), and ISO 5151:2017 Non-ducted air conditioners and heat pumps – Testing and rating for performance.

Annual Performance Factor (APF)
Ratio of the total amount of heat that the equipment can remove from, and add to, the indoor air during the cooling and heating seasons in active mode, respectively, to the total amount of energy consumed by the equipment for both seasons.

Conformity Assessment Report (CAR)
The documentation prepared by the manufacturer or importer of the product which contains the compliance declaration, the evidence and the test report to demonstrate that the product is fully compliant with all applicable regulatory requirements.

Cooling Seasonal Energy Consumption (CSEC)
The total amount of energy consumed by the equipment when it is operated for cooling during the cooling season.

Cooling Seasonal Performance Factor (CSPF)
The ratio of the total annual amount of heat that the equipment can remove from the indoor air when operated for cooling in active mode to the total annual amount of energy consumed by the equipment during the same period.

Cooling Seasonal Total Load (CSTL)
The total annual amount of heat that is removed from the indoor air when the equipment is operated for cooling in active mode.

Energy Efficiency Ratio (EER)
The ratio of the total cooling capacity to the effective power input to the device at any given set of rating conditions.

Fixed Capacity Unit
The type of equipment that does not have the possibility to change its capacity.

Global Warming Potential (GWP)
A measure of the radiative forcing of a pulse of emissions of a given greenhouse gas relative to the radiative forcing caused by an equal mass of carbon dioxide in the atmosphere. GWPs in this document refer to those measured in the IPCC's Fourth Assessment Report over a 100-year time horizon.

Heat Pump
An encased assembly or assemblies designed primarily to provide delivery of conditioned air to an enclosed space, room or zone and includes a prime source of refrigeration for heating.

Indoor Unit
The cabinet of a split system that is located indoors and provides the evaporation and air movement mechanism located on a floor, wall or ceiling.

Outdoor Unit
The cabinet of a split system that is located outdoors and provides capacity to condense refrigerant.

Ozone Depletion Potential (ODP)
The amount of degradation to the stratospheric ozone layer an emitted refrigerant causes relative to Trichlorofluoromethane (CFC-11).

Refrigerant
A substance or mixture, usually a fluid, used in a heat pump and refrigeration cycle.

Rwanda Seasonal Energy Efficiency Ratio (RSEER)
The seasonal cooling energy efficiency developed using ISO and CSPF with a Rwanda outdoor temperature distribution.

Split Unit (single)
A type of air conditioner or heat pump that is comprised of an indoor unit and outdoor unit, with the indoor unit mounted on the floor or wall or ceiling. It consists of a compressor, heat exchangers, fan motors and air handling system installed in two separate cabinets.

Self-Contained Unit
A type of air conditioner or heat pump that consists of an encased assembly designed as a self-contained unit primarily for mounting in a window or through the wall or as a console ducted to the outdoors. It consists of a compressor, heat exchangers and air handling system installed in one cabinet and is designed primarily to provide free delivery of conditioned air to an enclosed space, room or zone (conditioned space).

Ton of Refrigeration
Used as a measure of cooling or heating capacity, one RT is the rate of heat transfer that results in the melting of 1 short ton of ice at 0°C in 24 hours.

Variable Capacity Unit
A type of air conditioner or heat pump where the capacity is varied by two steps (2-stage), 3-4 steps (multi-stage), or five or more steps (true variable capacity).

Requirements

Air conditioners falling within the scope of this document shall meet the energy efficiency requirements. For ductless split systems, manufacturers shall identify pairs of indoor and outdoor units that jointly comprise the rated product and shall independently represent each of those pairs for compliance with this guide. Sale or installation of cabinet units not identified as a matched pair is not recommended.

Test Methods and Efficiency Calculation

Compliance with the energy efficiency requirements shall be tested according to ISO 16358:2013, Air-cooled air conditioners and air-to-air heat pumps — Testing and calculating methods for seasonal performance factors ("ISO 16358") which refers to ISO 5151, Non-ducted air conditioners and heat pumps — Testing and rating for performance ("ISO 5151").[10]

Table 4. Cooling Capacity Rating Conditions

	Temperature of air entering indoor side. dry-bulb / wet-bulb	Temperature of air entering outdoor side. dry-bulb / wet-bulb [a]
ISO 16358-1 (T1 moderate climate) Standard cooling capacity	27 °C / 19 °C (ISO 5151 T1)	35 °C / 24 °C (ISO 5151 T1)
ISO 16358-1 (T1 moderate climate) Low temperature cooling capacity	27 °C / 19 °C	29 °C / 19 °C

[a] The wet-bulb temperature condition shall only be required when testing air-cooled condensers which evaporate the condensate.

Products shall be represented according to the calculation of a seasonal performance factor as prescribed in ISO 16358. Determining the CSPF requires testing products according to ISO 16358 and calculating the efficiency performance by using outdoor temperature bin data specified in the Regulation Annex 5. Reference test standards may be found in Table 5.

Table 5. Reference Standards for Test Methods and Energy Efficiency Calculations

Temperature and humidity conditions and default values for cooling efficiency test [a]	ISO 16358-1 Table 1
Test methods for cooling efficiency	ISO 16358-1 Chapter 5
Cooling efficiency calculations [b]	ISO 16358-1 Chapter 6 Clause 6.4 (fixed capacity units) Clause 6.7 (variable capacity units)

ISO 16358 requires a full capacity test for fixed-speed units at low-temperature conditions (outdoor dry bulb 29°C). This standard allows the use of a default value by setting it as an

10 The ISO 5151 testing standard specifies how to measure the cooling capacity and efficiency of air conditioners using stipulated test conditions.

optional test. Cooling full capacity at T1 temperature condition = 1.077× Cooling full capacity at outdoor temperature 29°C Cooling full power input at T1 temperature condition = 0.914 × Cooling full power input at outdoor temperature 29°C.

Compliance Certification and Surveillance Testing

The evaluated efficiency in CSPF shall not be less than 95% of the published or reported value. All other tolerances of tests conducted shall meet the requirements in ISO 5151 and ISO 16358. Models that exceed the minimum allowable energy efficiency levels contained in this regulation by less than 5% are deemed to be noncompliant.

Declaration of Conformity

Compliance with these requirements and any additional optional claims should be demonstrated in the Conformity Assessment Report (CAR). The CAR shall:

- Demonstrate that the product model fulfils the requirements of this regulation
- Provide any other information required to be present in the technical documentation file
- Specify the reference setting and conditions under which the product complies with this regulation

If the CAR for the designated model is approved, it shall be listed in the product registration system, and the model may be sold in the market. A CAR is valid for the designated model for 24 months. If the CAR is rejected, a written explanation will be provided to the submitter. All aspects will be addressed in a revised CAR. Until the CAR is approved, the product is ineligible for sale in the market. An updated CAR must be submitted to RSB at least 90 days prior to the expiration of the current CAR.

Annex 2 - Refrigerators, and Energy-Efficient and Climate-Friendly Refrigerators

Terms and Definitions

Below are the definitions of the relevant terms in this document. Unless otherwise specified, these definitions are harmonised with IEC 62552:2015 *Household refrigerating appliances – Characteristics and test methods (Part 1, 2, and 3)*.

Ambient Temperature
Temperature in the space surrounding the refrigerating appliance under test or assessment.

Adjusted Volume (AV)
Volume for the storage of foodstuff adjusted for the relative contribution to the total energy consumption according to the different temperatures of the storage compartments. AV shall be calculated on the basis of the storage volume.

Compartment
An enclosed space within a refrigerating appliance, which is directly accessible through one or more external doors, which may itself be divided into sub-compartments.

Fresh food compartment
Compartment for the storage and preservation of unfrozen foodstuff.

Freezer compartment
Compartment that meets three-star or four-star requirements (In certain instances, two-star sections and/or sub-compartments are permitted within the compartment.)

Frozen food compartment
Any of the following compartment types (one-star, two-star, three-star, four-star):

One-star compartment -	Compartment where the storage temperature is not warmer than –6 °C.
Two-star compartment -	Compartment where the storage temperature is not warmer than –12 °C.
Three-star compartment -	Compartment where the storage temperature is not warmer than –18 °C.
Four-star compartment -	Compartment where the storage temperature meets three-star conditions and where the minimum freezing capacity meets the requirements of Clause 8 of IEC 62552-2:2015.

Conformity Assessment Report - Documentation prepared by the manufacturer or importer of the product which contains the compliance declaration, the evidence and the test reports to demonstrate that the product is fully compliant with all applicable regulatory requirements.

Foodstuff - Food and beverages intended for consumption.

Freezer
Refrigerating appliances with only frozen compartments, at least one of which is a freezer compartment.

Frost free refrigerating appliance
Refrigerating appliance in which all compartments are automatically defrosted with automatic disposal of the defrosted water and at least one compartment is cooled by a frost-free system.

Global Warming Potential (GWP)
A measure of the radiative forcing of a pulse of emissions of a given greenhouse gas relative to the radiative forcing caused by an equal mass of carbon dioxide in the atmosphere. GWPs in this document refer to those measured in the IPCC Fourth Assessment Report over a 100-year time horizon.

Ozone Depletion Potential (ODP)
Amount of degradation to the stratospheric ozone layer an emitted refrigerant causes relative to Trichlorofluoromethane (CFC-11).

Refrigerating Appliance
Insulated cabinet with one or more compartments that are controlled at specific temperatures and are of suitable size and equipped for residential or light commercial use, cooled by natural convection or a forced convection system whereby the cooling is obtained by one or more energy-consuming means.

Refrigerant
Fluid used for heat transfer in a refrigerating system, which absorbs heat at a low temperature and at a low pressure of the fluid and rejects heat at a higher temperature and at a higher pressure of the fluid, usually involving changes of the phase of the fluid.

Refrigerator
Refrigerating appliances intended for the storage of foodstuff, with at least one fresh food compartment. A refrigerator may include a compartment for the freezing and storage of food at temperatures below 0°C, but does not provide a separate low temperature compartment designed for the freezing and storage of food at temperatures below -12°C.

Refrigerator-Freezer
Refrigerating appliance having at least one fresh food compartment and at least one freezer compartment.

Requirements

Refrigerating appliances falling within the scope of Section One shall meet the energy efficiency requirements of Section Three.

Climate Classes

Refrigerating appliances conforming to this regulation are classified into one (or more) of four climate classes. The range of ambient temperatures in which the appliances are intended to be used, and for which the required storage temperatures are to be met (see Table 2 of IEC 62552-2:2015), shall be as specified in Table 1.

Table 1. Climate Classes

Description	Class	Ambient Temperature Range (°C)
Extended Temperate	SN	+10 to +32
Temperate	N	+16 to +32
Subtropical	ST	+16 to +38
Tropical	T	+16 to +43

Test Requirements and Methods

Compliance with the energy efficiency requirements shall be tested according to IEC 62552:2015, Household refrigerating appliances – Characteristics and test methods (IEC 62552). Energy consumption is determined from measurements taken when tested as specified in a medium temperature of 16°C and a high ambient temperature of 32°C.

Table 2. Reference Ambient Temperature and Coefficients a and b for Equation 2

Reference Temperature (°C)	*a*	*b*
25	0.5	0.5

Table 3. Maximum Annual Energy Consumption (AECMax)

Reference Ambient Temperature	Product Category	AEC_{Max} (kWh/year)
25°C	Refrigerators	0.183AV+120
	Refrigerator-Freezers	0.268AV+190
	Freezers	0.238AV+193

where AV is Adjusted Volume, as calculated per Equation 3

Equation 3. *Adjusted Volume (AV)*= $\sum^{n}(i=1)$ (*Storage Volume*$i \times Ki \times Fi$)

where Ki is volume adjustment factor, as calculated per Equation 4 and Fi is frost adjustment factor

Equation 4. $K= (T1\text{-}Tc)/(T1\text{-}T2)$

for fresh food compartments, K=1

for other compartments, T_1 is reference ambient temperature (25°C), T_2 is temperature of fresh-food compartment (4°C), and T_c is the temperature of the individual compartment concerned.

F=1.1 for frost-free (automatic defrost) is applied only to frozen food compartments. F=1.0 is applied to all other compartments and manual defrost frozen food compartments.

Table 4. Examples of Volume Adjustment Factor (K) Calculation

Ambient Temperature	Fresh food compartment	Frozen food compartment	
T_1=25°C	K=1 (T_2=4°C)	T_c=-6°C	K=1.48
		T_c=-12°C	K=1.76
		T_c=-18°C	K=2.05

AV shall be calculated in accordance with significant digits and rounding. The AECMax calculation shall be rounded off to the nearest kilowatt-hour (kWh) per year. If the calculation is halfway between the nearest two kWh per year values, the AECMax shall be rounded up to the higher of these values.

A label indicating the performance (calculated using the methodology above) of the product must be applied to indicate the performance level. The higher levels of performance discriminated by this approach shall be as follows.

Equation 5. R= AECMax/AEC

Examples of Energy Consumption Calculation

Example 1. Refrigerator

A given refrigerating appliance is a manual defrost refrigerator with a fresh food storage compartment only.

Step 1: Adjusted Volume

At reference ambient temperature 25°C

	Volume (L)	Volume Adjustment Factor (K)	Adjusted Volume (L)
Fresh food storage	92		
Frozen food storage	-	-	

Step 2: Annual Energy Consumption

Ambient temperature		16		32	
Temperature control settings		5.5	5.0	5.9	5.7
Temperature in fresh food compartment		3.3	5.1	3.7	4.9
Temperature in frozen food compartment		-	-	-	-
Energy consumption per 24h	kWh/24h	0.259	0.223	0.874	0.785
Energy consumption by interpolation*	kWh/24h	0.245		0.852	
Daily energy consumption at 25°C (EC_{25})	kWh/24h	0.245×0.5+0.852×0.5=0.549			
Annual energy consumption at 25°C (AEC_{25})	kWh/ year	200			

* Multiple tests using different temperature control settings can be conducted to obtain values of energy consumption measurement and multiples values for interpolation calculation to estimate the energy consumption for a point where all compartments are at exactly +4°C. Reference IEC 62552: 2015, part 3, Annex I (Worked examples of energy consumption calculations), section I.3.2.2 (Single compartment example) for detailed calculation methodology.

Step 3: Energy Consumption Index – R

Ambient Temperature (°C)	25°C
Storage Volume (L)	Fresh food compartment (92)
AV (L)	92
EC (kWh/d)	0.549
AEC (kWh/y)	0.549×365=200
R	(0.183×92+120)/200 =0.68

Example 2. Refrigerator-Freezer

A given refrigerating appliance is a frost-free (automatic defrost) refrigerator-freezer with a fresh food storage compartment and a freezer compartment.

Step 1: Adjusted Volume

At reference ambient temperature 25°C

	Measured volume (L)	Volume Adjustment Factor (K)	Adjusted Volume (L)
Fresh food storage	137	(25-4)/(25-4)=1.00	(137×1.00+63×2.05×1.2)=292
Frozen food storage	63	((25-(-18)))/(25-4) =2.05	

Step 2: Annual Energy Consumption

Ambient temperature		16		32	
Temperature control settings	(Graduated dial)	5.0	4.1	4.9	4.6
Temperature in fresh food compartment		3.6	4.1	3.7	4.9
Temperature in frozen food compartment		-20.9	-19.3	-21.6	-20.4
Energy consumption per 24h	kWh/24h	0.475	0.432	0.739	0.679
Energy consumption by interpolation*	kWh/24h	0.441		0.724	
Daily energy consumption at 25°C (EC_{25})	kWh/24h	0.441×0.5+0.724×0.5=0.583			
Annual energy consumption at 25°C (AEC_{25})	kWh/year	213			

* Multiple tests using different temperature control settings can be conducted to obtain values of energy consumption measurement and multiples values for interpolation calculation to estimate the energy consumption for a point where all compartments are at exactly +4°C. Reference IEC 62552: 2015, part 3, Annex I (Worked examples of energy consumption calculations), section I.3.2.2 (Single compartment example) for detailed calculation methodology.

Step 3: Energy Consumption Index – R

Ambient Temperature (°C)	25
Storage Volume (L)	Fresh food compartment (137) Frozen food compartment (63)
AV (L)	319
EC (kWh/d)	0.583
AEC (kWh/y)	0.583
R	(0.268×292+190)/213 =1.29

Example 3. Freezer

A given refrigerating appliance is a frost-free (automatic defrost) freezer with a freezer compartment only.

Step 1: Adjusted Volume

At ambient temperature 25°C

	Volume (L)	Volume Adjustment Factor (K)	Adjusted Volume (L)
Fresh food storage	—	—	(295×2.05)×1.2=726
Frozen food storage	295	((25-(-18)))/(25-4)=2.05	

Step 2: Annual Energy Consumption

Ambient temperature		16		32	
Temperature control settings		3.7	3.4	3.5	3.0
Temperature in fresh food compartment		—	—	—	—
Temperature in frozen food compartment		-18.7	-17.8	-18.4	-17.7
Energy consumption per 24h	kWh/24h	0.691	0.665	1.330	1.294
Energy consumption by interpolation*	kWh/24h	0.671		1.309	
Daily energy consumption at 25°C (EC_{25})	kWh/24h	0.671×0.5+1.309×0.5=0.990			
Annual energy consumption at 25°C (AEC_{25})	kWh/year	361			

* Multiple tests using different temperature control settings can be conducted to obtain values of energy consumption measurement and multiples values for interpolation calculation to estimate the energy consumption for a point where all compartments are at exactly +4°C. Reference IEC 62552: 2015, part 3, Annex I (Worked examples of energy consumption calculations), section I.3.2.2 (Single compartment example) for detailed calculation methodology.

Step 3: Energy Consumption Index – R

Ambient Temperature (°C)	25°C
Storage Volume (L)	Frozen food compartment (295)
AV (L)	726
EC (kWh/d)	0.990
AEC (kWh/y)	0.990
R	(0.238×726+193)/361 =1.09

Annex 3 - Compliance Certification, Surveillance Testing and Conformity

In the context of verifying compliance of a product model with the requirements in this Regulation, the government authority in charge shall apply the following procedure:

1. Test through verification measurement a sample of the same model from the same manufacturer, randomly selected and taken from the market, applying IEC 62552-3 and setting the compartment temperatures as specified in section 3.4.

2. The model shall be considered compliant if all the following are met:

   a. If the values in the Conformity Assessment Report (CAR), and energy efficiency as declared on the label, where appropriate the values used to establish those values that are calculated, are not more favourable for the manufacturer or importer than the respective results of the verification measurements performed by the authorities;

   b. If the values used to determine the compliance of the sample, and where appropriate the values used to establish those values that are calculated are not more favourable for the manufacturer or importer than the values in the technical documentation of the manufacturer related to the product, including in the test reports of the manufacturer or a third-party that is accredited to carry out tests according to IEC 62552;

   c. If the measured average parameters and the values calculated from these measurements across the test sample are within the respective tolerances; and

   d. If this is not within the prescribed tolerances, three additional units taken from the market will be evaluated and the arithmetical mean of the determined values must comply with the respective verification tolerances.

3. All tolerances used in surveillance testing shall be consistent with IEC 62552.

4. If the results referred to in point 2(a), 2(b), 2(c), and 2(d) are not achieved, the model does not comply with this Regulation and shall be barred from sale in the country.

Government authorities shall use the measurement and calculation methods set out in this document.

Declaration of Conformity

Compliance with these requirements and any additional optional claims should be demonstrated in the Conformity Assessment Report (CAR). The CAR shall:

- Demonstrate that the product model fulfils the requirements of this regulation
- Provide any other information required to be present in the technical documentation file
- Specify the reference setting and conditions under which the product complies with this regulation

If the CAR for the designated model is approved, it shall be listed in the product registration system, and the model may be sold in the market. A CAR is valid for the designated model for 24 months. If the CAR is rejected, a written explanation will be provided to the submitter. All aspects will be addressed in a revised CAR. Until the CAR is approved, the product is ineligible for sale in the market. An updated CAR must be submitted to RSB at least 90 days prior to the expiration of the current CAR.

Annex 4 - Benchmark Models: Highest-efficiency AC and Heat Pumps (HP) in Major Markets

Region	AC or HP	Cooling Capacity	Metric	MEPS or least stringent label	Most efficient label	Efficiency of Best Available product
		RT (nominal)		Wh/Wh		
China	HP	0.75	China APF	3.50	4.50	5.45
	HP	1.0		3.50	4.50	5.05
	HP	1.5		3.30	4.00	4.50
	HP	2.0		3.10	3.70	4.40
EU	HP	0.75	EU SEER	4.60	8.50	10.5
	HP	1.0		4.60	8.50	10.0
	HP	1.5		4.60	8.50	8.60
	HP	2.5		4.30	8.50	6.80
India	AC	1.0	ISEER	3.10	4.50	6.15
	AC	1.0		3.10	4.50	5.80
	AC	1.5		3.10	4.50	5.20
	AC	2.0		3.10	4.50	4.80
Indonesia	HP	0.75	Indonesia EER	2.64	3.05	6.16
	HP	1.0		2.64	3.05	5.68
	HP	1.5		2.64	3.05	5.11
	AC	2.0		2.64	3.05	4.77
Japan	HP	0.75	Japan APF	6.60	6.60	7.60
	HP	1.0		6.00	6.00	7.60
	HP	1.5		4.90	4.90	6.80
	HP	2.0		4.40	4.40	6.30
South Korea	AC	0.75	Korea CSPF	3.5	6.36	7.10
	AC	1.0		3.5	6.36	7.80
	AC	1.5		3.15	8.20	8.00
	AC	2.0		3.15	8.20	9.60
US	HP	0.75	US SEER	4.10	5.27	12.30
	HP	1.0		4.10	5.27	8.90
	HP	1.5		4.10	5.27	7.20
	HP	2.0		4.10	5.27	6.40

Note: A regional seasonal energy efficiency must be appropriately translated to other regions based on different energy performance due to differences across regions in efficiency metrics, climate, and operating conditions.

Source: Updated from Park et al. (2017). Assessment of commercially available energy-efficient room air conditioners including models with low global warming potential (GWP) refrigerants. Lawrence Berkeley National Laboratory. LBNL-2001047.

Annex 5 - Outdoor Temperature Bin Hours

Outdoor temperature (ᴥ)	Bin hours
21	728
22	658
23	585
24	511
25	435
26	353
27	250
28	141
29	61
30	24
31	6
32	1
Total	3753

Note: The outdoor temperature bin is based on the City of Kigali.

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