REPUBLIC OF RWANDA

MINISTRY OF ENVIRONMENT

NATIONAL COOLING STRATEGY

January 2019

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Acronyms

AC: Air Conditioner
BASE: Basel Agency for Sustainable Energy
EDCL: Energy Development Corporation Limited
EER: Energy Efficiency Ratio
ESSP: Energy Sector Strategic Plan
EUCL: Energy Utility Corporation Limited
GWP: Global Warming Potential
HFCs: hydrofluorocarbons
HP: Horse Power
HPMP: Hydrofluorocarbons Phase Out Management Plan
KCEP: Kigali Cooling Efficiency Program
Kw: Kilowatt
KWh: Kilowatt Hour
LBNL: Lawrence Berkeley National Laboratory
MoE: Ministry of Environment
MW: Megawatt
NCS: National Cooling Strategy
NDC: Nationally-Determined Contribution
ODP: Ozone Depleting Substances
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
U4E: United for Efficiency Initiative
UN: United Nations

FOREWORD BY THE HONORABLE MINISTER OF ENVIRONMENT

Improving energy efficiency is one of the fastest, cost effective and cleanest ways to unleash sustainable development. It makes it possible to free-up resources for useful purposes rather than being wasted. Optimising the use of energy is great for the health and well-being of the population, the flourishing of new industries, and for protecting natural resources.

It is critical to focus on areas that can unlock the most impactful savings. In addition to lighting, refrigerators and air conditioners are 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, but heretofore Rwanda has not had policies in place to guide the switch to better cooling products. As a result, outdated technologies have remained quite common.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 use of electricity.

Refrigerator and air conditioner sectors are growing rapidly in Rwanda and around the world. Now is the time to take action on moving to solutions that provide the cooling that we need without wasting electricity or excessively impacting the planet. It requires better approaches to the design, construction and operation of the places where we live and work. Minimising heat load - using shading, natural ventilation, insulation and beyond – will reduce the work that air conditioners and refrigerators need to do, and in some cases we can avoid air conditioners altogether.

This evolution will save consumers money on their electricity bills, prevent spikes in peak electricity demand, and enable us to reach many more households and businesses with generating capacity that is already available. It will enable farmers and grocers to better preserve crops that provide nutritious meals, and yield savings on fertilizer and irrigation for food that would otherwise spoil before getting to the dinner table. It will provide the conditions to keep medicines stable, operating rooms safe, classrooms comfortable so young minds can focus, and enable high-tech manufacturing facilities to flourish.

To achieve this, a holistic cooling strategy outlining a mix of policies, market-based mechanisms, awareness raising, recycling, capacity building, and robust enforcement is required. As a responsible steward of the environment with a desire to be a champion of sustainable development, Rwanda is committed to both striving for better energy efficiency while ensuring that the refrigerant gasses used in cooling products are good for the Ozone Layer and for the climate. This change in approach will provide a range of near-term positive benefits and make a lasting difference for generations to come. The government of Rwanda has already demonstrated leadership in this arena, with its capital as the namesake of the Kigali Amendment to the Montreal Protocol and as one of the first signatories of this vital international treaty.

This National Cooling Strategy brings together policy and programmatic considerations across a range of stakeholder groups. It will guide technology suppliers on requirements that must be met to sell cooling products in the Rwandan market, and help consumers distinguish the performance of air conditioners and refrigerators through product labels. Businesses, residents, civil society organisations, and the government must come together to realise the promise of energy-efficient and climate-friendly cooling.

ACKNOWLEDGEMENT

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.

1. Introduction

Purpose of the National Cooling Strategy

The National Cooling Strategy (NCS) provides context and identifies priorities to optimally address Rwanda's growing needs for space conditioning and refrigeration (jointly referred to as "cooling"), in keeping with Rwanda's Green Economy vision. The number of new households connected to the national grid has doubled over the last five years and is expected to reach 52% by the year 2024. 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 that is wasted from refrigerators and air conditioners, will help residents and business save money on their utility bills, which makes access and use of cooling 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 foods and medicine (which helps farmers, consumers and patients), enable business to be more productive, and help students better focus on their studies.

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 programs, among which an appropriate appliance standards and labelling scheme is recommended.* It is well recognized 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 practicable. 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 market assessment undertaken in 2018 on the cooling sector. With this context, section 6 provides recommendations for additional policies and programs to be undertaken for a comprehensive approach to energy-efficient and climate-friendly cooling.

As the recommendations in section 6 are addressed over time and the resulting policies or programs are approved by the government, they will be added to the Annex. Given the constant evolution in technology, the contents will be re-evaluated - and where needed it will be revised - at least once every five years. The NCS is a living document that will continue to guide the country's transition in the cooling sector.

2. Why Cooling Matters

Adequate space conditioning is key to sustainable economic development. Hospital operating rooms, high-technology factories, research laboratories, and data centres are just a few examples of the many facilities that require consistent, precise temperature and humidity control to function properly. 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 fertilizer. 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 for the 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 life.

Many cooling appliances in Rwanda are rather inefficient – with some wasting up to 80 per cent of their energy. Many use fluorinate 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 percent 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 addition, this is the dry season in Rwanda where hydropower

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

generation is significantly reduced due to low level of rainfall and the utility operator has to compensate generation with diesel generators.

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 air conditioners, 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 that is 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 so issues ranging from flammability and the ability to operate in a broader range of climactic conditions are much more pronounced.

As a relatively small market on the global scale, it is important that Rwanda pursue policies that are in keeping with the positive trends toward more energy-efficient and climate-friendly equipment seen in major markets such as China, Japan, and the European Union. As these and other countries move to ban outdated technologies, those lacking robust policies could become dumping grounds for models that are not allowed to be sold elsewhere.

The Kigali Amendment to the Montreal Protocol, to which Rwanda was one of the first signatories, calls for action on both direct and indirect emissions. The Government of Rwanda, whose capital Kigali is the namesake of this landmark treaty, intends to serve as an exemplar when it comes to cooling in a manner that is good for business, people and the planet. 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.

3. Existing Policies

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

Rwanda Utilities Regulatory Authority (RURA) guidelines published in 2013 aimed at providing recommendations of the best practices to promote energy efficiency. The average climatic condition 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

[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

[3] Source: meteoblue

need for room air conditioning and employ natural ventilation, utilisation of shading and improvement in building technologies.

The implementation of the Montreal Protocol on Substances that Deplete the Ozone Layer was designed to reduce the production and consumption of ozone depleting substances to reduce their abundance in the atmosphere, and thereby protect the earth's fragile ozone Layer. One such example is the implementation of the HCFC Phase-out Management Plan (HPMP) being implemented through the Rwanda Environment Management Authority (REMA). Rwanda was one of the first countries to ratify the **Kigali Amendment to the Montreal Protocol, which requires** the phase down of Hydrofluorocarbons gases. It entered into force on 1 January 2019. The Kigali Amendment adds momentum to global energy and climate efforts, such as the Paris Climate Agreement which entered into force on 4 November 2016, as it calls for improvements to energy-efficiency while transitioning to less harmful refrigerant gasses.

The National Green Growth and Climate Resilience strategy for climate change and low carbon development of the Government of Rwanda, 2011 highlighted that buildings should be designed to reduce the demand of energy, low carbon urban systems and to adopt water and energy efficiency standards 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.

Rwanda Standards Board (RSB) conformity assessment is carried out at the port of entry. Conformity assessment involves a set of processes that show whether a product, service or system meets the requirements of a standard. The main forms of conformity assessment are testing, certification, and inspection.[4]

4. Energy Sector Overview

Key actors

The energy sector in Rwanda involves four main stakeholders: The Ministry of Infrastructure (MININFRA); the Ministry of Environment (MoE); the Rwanda Utilities Regulatory Agency (RURA); the Rwanda Energy Group (REG) with its two subsidiaries, Energy Utility Corporation Limited (EUCL) and Energy Development Corporation Limited (EDCL).

MoE oversees the development of environmental policies and programs. 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.

MININFRA is in charge of developing energy policies and strategies, and it monitors their implementation. REG is in charge of implementing the 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

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

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 as part of the *Rwanda Cooling Initiative*.

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 the country make the most of its resources.

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 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 (91%), which mainly use energy in the form of traditional fuels such as wood, followed by the transport sector (4%), industry (3%), and public services (2%). Households are also the dominant consumers of electricity (51%), the bulk of which demand is primarily used for lighting, refrigeration, air conditioning, ironing, cooking and water heating.

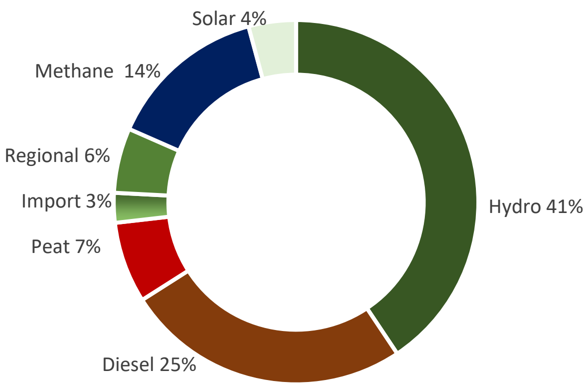

Figure 1: Source of power in % (2017)

The primary sources of electricity in Rwanda are: Hydro, Methane gas, Peat, Diesel, Solar PV, regional shared hydro power plants and imports. The total installed electricity generation capacity is on its rise increasing from 150MW in 2015 to 210 MW in 2017.

The average cost of generation is 15 US cents per Kilowatt hour (2018), a significant reduction from 17.6 US cents per Kilowatt hour in 2014. The current on-grid access to electricity is estimated at 31% (2017) from 19% in 2014 of households with connections representing 750,000 customers in 2017 and 460,000 consumers 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 heavily subsidized. 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.
Rwanda has a pronounced peak demand load, which is both a key factor for power disruptions, because the existing power reserve margin is low, and a key driver for new generation capacity investment. 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.
Energy efficiency challenges are similar across major areas of infrastructure, such as water, sanitation, and transportation. Challenges include:

(i) Insufficient incentives, including financing mechanisms to invest in modern technologies which require a higher initial investment;
(ii) Low awareness among energy-end users about energy conservation and energy efficiency opportunities and benefits;
(iii) Dominance of legacy technologies and entrenched practices, including subsidies that do not reflect the true cost of energy supply;
(iv) Lack of consistent approaches to encourage behavior change

Electrification Plans

Electricity access underpins all aspects of the economy. Significant progress has been made with electrification, and much work remains to be done. The coverage of the national electricity grid has rapidly increased, doubling in size in less than 5 years from 19% to 31% (2017) of on-grid connections. Off-grid electrification also rose from 1% to 11% (2017) in 3 years. In addition to lighting, ensuring that refrigerators and air conditioners are energy efficient will go a long way toward freeing-up electricity for more productive use - either by others seeking cooling that do not yet have sufficient electricity, or for other needs.

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 mega Watts [MW] (2018). Energy efficiency programs 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 the existing power lines as well as the demographics of the area have influenced the new National electrification plan that indicates 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 are characterised by low consumption of electricity, coupled with the cost of extending the network to every house has led areas in this category to be prioritised for off-grid solution.

5. Refrigerator and Air Conditioner Market Assessment

Methodology

Elaboration of the NCS was based on a thorough market assessment aimed at understanding the cooling market in Rwanda and opportunities to transform it with more energy-efficient and climate-friendly solutions. The results were based on a combination of desktop research, questionnaires and physical 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.

A variety of suppliers were interviewed using a standard questionnaire. The suppliers' questionnaire revolved around total annual sales volumes and projections to give an understanding of the market size and its projected growth, the companies' annual turnover, dominant types of air conditioners and refrigerators, market segmentation, country of origin of their products, cooling capacity, energy efficiency, and refrigerant gases in the products.

A variety of customers were also interviewed using a standard questionnaire. They were divided into two groups: hotels and "others". There over 1000 hotels in Rwanda of various star ratings, a big number being Two- and Three-star facilities. Rwanda Development Board (RDB)'s campaign to foster better service delivery in the tourism sector has increased demand for cooling products in this sector. It was realised that new and bigger hotels tend to source their cooling products directly from suppliers outside of Rwanda.

"Others'' represents a mix of government offices, banks, embassies, Non-Government Organisations (NGOs), super markets, restaurants and hospitals. Although this category is hard to generalize given its diversity, a sample was drawn from each. Their assessment assessed financing needs, awareness of demand for energy-efficient products, operation and maintenance practices, and warranty considerations.

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%, 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 of the key markets in the world are rapidly transitioning to inverter systems due to their superior performance.

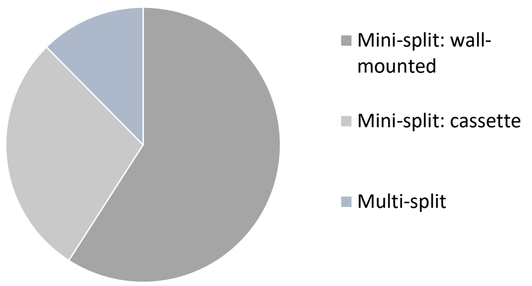

Figure 2: Segmentation of the Mini-Split Market

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

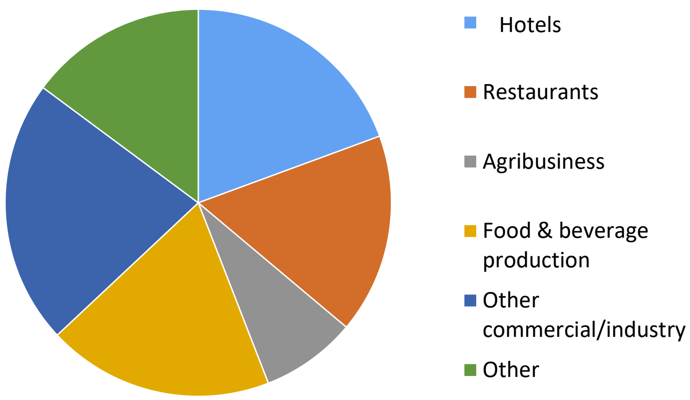

Figure 3 : Refrigerator sales by sector

The average efficiency of air conditioners is estimated to be approximately energy efficiency ratio (EER)[5] 3.0 which is consistent with the average in other parts of Africa estimated to be between 2.8 and 3.4.[6] 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, such short-term actions as implementation of standards and financial incentives will have long-term impacts.

While Rwanda is starting 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. Strategic actions

6.1 Well-defined and enforced **air conditioner regulations** are fundamental for transforming the Rwandan market for cooling products. Products that do not meet all requirements in the regulations by the time that these come into effect shall not be imported into the country. Regulations that include MEPS, refrigRRerant gas global warming potential and ozone depletion potential limits, test procedures, product labelling levels, and other relevant aspects are included in annex A1.

6.2 Well-defined and enforced **refrigerator regulations** are fundamental for transforming the Rwandan refrigeration products market. Products that do not meet all requirements in the regulations by the time that these come into effect shall not be imported into the country. Regulations that include MEPS, refrigerant gas global warming potential and ozone depletion potential limits, test procedures, product labelling levels, and other relevant aspects are included in annex A2.

6.3 To set and maintain impactful policies and programs, the Rwandan Government needs timely, robust data beyond the findings of the original market assessment. A **national product registration system** will be established to capture information on all products sold in the Rwandan market. It will serve as an initial compliance gateway that incorporates best practices that are in use globally. The scheme shall be defined and launched in advance of the regulations' entry into force and will become an integral part of this strategy as annex A3.

6.4 An **awareness campaign** with appropriate methods (e.g. use of television and radio advertisements, SMS broadcast, road shows, information sharing during village-level *umuganda,* etc.), design of a product label for refrigerators and air conditioners, and roles for key actors shall be defined and launched in advance of the regulation's entry into force and will become an integral part of this strategy as annex A4.

[5] The ratio of the total cooling capacity to the effective power input to the device at any given set of rating conditions

[6] CLASP Africa Air Conditioner Market Scoping Study Report, 2018.

6.5 A **capacity building program** with appropriate methods (e.g. use of vocational training institutes) for engaging target audiences (e.g. installation and maintenance technicians, inspectors, sales representatives that help consumers understand product labels) shall be defined and launched in advance of the regulation's entry into force and outlined in annex A5.

6.6 An End-of-product-life **recycling and processing scheme** is to be developed for refrigerators and air conditioners. The Rwanda E-waste dismantling and recycling facility operated by Enviroserve Rwanda is currently piloting recycling of some products, but a long-term business model (e.g. perhaps including a recycling fee on the purchase of new products) is to be identified to avoid the proliferation of a secondary market. The scheme shall be defined in annex A6 and implemented as soon as practicable.

6.7 Innovative financial mechanisms are needed to scale-up the adoption of superior technologies that are inhibited by first-cost barriers and risk perceptions. **Financial mechanisms** are to be developed to facilitate the flow of financing for relevant technology solutions and address untapped market potential. It will identify the conditions to mobilize investments in new technologies by residential, commercial, industrial and/or public entities. Special attention must be paid to small and medium-sized enterprises that make up the vast majority of businesses in Rwanda and that have more trouble than large firms in accessing finance. Financial mechanisms shall be defined in annex A7 and implemented as soon as practicable.

6.8 With the off-grid sector a sizable proportion of the Rwandan economy, it is essential that **off-grid cooling plan** be developed. 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. The off-grid cooling plan should identify opportunities related to the cold chain, space conditioning and vaccine storage for clinics, and related refrigeration and space conditioning needs. The plan shall be included in annex A8 and implemented as soon as practicable.

6.9 Preparation of the **HPMP Stage II and Enabling Activities**, with support from the Multilateral Fund of the Montreal Protocol, should align with the refrigerant gas requirements in the regulations for refrigerators and air conditioners, and the overall emphasis of the NCS on transitioning to refrigerant gasses with lower global warming potential while improving the energy efficiency of cooling products that utilize these gasses. These plans and activities shall be included in annex A9 and implemented in the timeframe set in these documents.

6.10 Rwanda's 2015 **Nationally-Determined Contribution (NDC)** to the Paris Climate Agreement is built upon Rwanda's National Strategy for Climate Change and Low Carbon Development Strategy. The NDC prioritises GHG emissions reduction through the promotion of renewable energy, resilient transport systems, green industry promotion, low carbon urban systems, and adoption of energy and water efficiency standards into the building codes and urban carbon planning. A revised NDC is due to the UN Framework Convention on Climate Change by 2020, and subsequent revisions are required every five years thereafter. The revised NDC should identify energy-efficient and climate-friendly cooling's estimated contribution to the mitigation of greenhouse gas emissions. The revised NDC shall be included in annex A10 and implemented according to the timeframe set in the NDC.

6.11 Rwanda should adopt a **building energy code** that comprehensively addresses whole-building energy efficiency opportunities. A variety of approaches can reduce heating loads, such as the use of solar reflective coatings, proper building orientation, insulation, use of natural ventilation, shading, and beyond. Ensuring the right-sizing of cooling equipment during the design-phase, commissioning after new construction and major retrofits, and proper operations and maintenance thereafter will help ensure that buildings perform as intended.

ANNEX

A1. Regulation for Energy-Efficient and Climate-Friendly Air Conditioning

This document provides authorities the means to transition to the sale of air conditioners that have higher energy efficiency that use lower global warming potential (GWP) refrigerants based on the UN Environment United for Efficiency (U4E) Air Conditioner Policy Guide *"Accelerating the Global Adoption of Energy-Efficient and Climate-Friendly Air Conditioners"*.[7]

Policy action can be accelerated by coordinating across institutions with jurisdiction over environment, energy, and enforcement and related responsibilities. Policy solutions exist for overcoming the technological, economic, institutional, and informational barriers to higher energy efficiency and lower global warming potential (GWP) refrigerants by:

(i) implementing low-GWP criteria when establishing energy efficiency standards and labels,

(ii) harmonizing national standards with international standards to harness proven approaches and tap into economies of scale for products already made to satisfy such requirements, and

(iii) linking incentives, outreach and other support to encourage more widespread adoption of the very best products.

This regulation covers 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 address the ozone depletion potential (ODP) and GWP of refrigerants and sets an upper limit for each performance tier.

A Rwanda Seasonal Energy Efficiency Ratio (RSEER), developed 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. A well-defined and enforced policy will enable Rwandans to benefit from lower electricity bills, greater reliability of the electricity grid (freeing capacity so others can gain access), reduced air pollution and GHG emissions, and reduced trade barriers with other economies that mandate similar policies. Rwanda will also avoid becoming a dumping ground for used or outdated products that are banned for sale elsewhere.

[7] United for Efficiency Air Conditioner Policy Guide. https://united4efficiency.org/wp-content/uploads/2017/06/U4E-ACGuide-201705-Final.pdf

Article 1. Scope of Covered products

Scope

This regulation applies to all single-phase, non-ducted, self-contained, through-the-wall and window, and single-split air conditioners and heat pumps, with a rated cooling output at or below 16 Kilo-Watts [kW] offered for sale, sold, or installed in the Republic of Rwanda.

Exemptions

All water-cooled and absorption-driven units are exempt. Newly manufactured products sold outside the Republic of Rwanda or new products manufactured outside of the country and sold at wholesale inside the country for final retail sale and installation outside of the country are exempt.

Article 2. Terms & Definitions

Below are the definitions of the relevant terms in this document. Unless otherwise specified, these definitions are harmonized 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) - The 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 possibility to change its capacity.

Global Warming Potential (GWP) - How much heat an emitted refrigerant traps in the atmosphere relative to carbon dioxide over a 100-year period.

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) - amount of degradation to the stratospheric ozone layer an emitted refrigerant causes relative to trichlorofluoromethane (CFC-11).

Refrigerant - 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 CSPF with a Rwanda outdoor temperature distribution.

Split Air Conditioner (single) - A type of air conditioner that is comprised of an indoor unit and outdoor unit. It consists of a compressor, heat exchangers, fan motors and air handling system installed in two separate cabinets. The split air conditioner is designed to provide conditioned air to an enclosed space, room or zone (conditioned space) and includes a prime source of refrigeration cooling and dehumidification and means for the circulation and filtering of air.

Unitary Air Conditioner - A type of air conditioner 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. It consists of 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). The unitary air conditioner includes a prime source of refrigeration for cooling and dehumidification and means for the circulation and filtering of air and shall include means for exhausting air, and for heating, humidifying, or inducting fresh air.

Variable Capacity Unit - The type of equipment where the capacity is varied by five or more steps to represent continuously variable capacity.

Article 3. Requirements

Air conditioners and heat pumps falling within the scope of Article 1 shall meet the energy efficiency requirements of Article 3.

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 these requirements. Sale or installation of cabinet units not identified as a matched pair is not allowed.

Article 3.1 Energy Efficiency Requirements

Article 3.1.1 Split Air Conditioners and Heat Pumps

Cooling performance for all split air conditioners and heat pumps within the scope of this document must meet the energy efficiency levels in Table 1.

Table 1. Minimum RSEER

Capacity	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

The requirements are based on the outdoor temperature bin specified in the Appendix.

Article 3.1.2 Unitary Air Conditioners and Heat Pumps

Cooling performance for all unitary air conditioners and heat pumps within the scope of this standard must meet the energy efficiency levels in Table 2.

Table 2. Minimum Requirements for RSEER of Unitary Air Conditioners

Capacity	Fixed	Variable
Rated Cooling Capacity ≤ 16.0 kW	3.50	4.00

A label indicating the performance must be affixed to the unit (calculated using the methodology in section 3.4). The levels of performance shall be discriminated per Table 2.

Table 2. Labelling Requirements for RSEER

<table>
<tr><th colspan="2">Grade</th><th>Rated Cooling Capacity ≤ 4.5 kW</th><th>4.5 kW < Rated Cooling Capacity ≤ 9.5 KW</th><th>9.5 kW < Rated Cooling Capacity ≤ 16.0 KW</th></tr>
<tr><td colspan="2">A</td><td>6.90 ≤ RSEER</td><td>6.40 ≤ RSEER</td><td>5.90 ≤ RSEER</td></tr>
<tr><td colspan="2">B</td><td>6.33 ≤ RSEER < 6.90</td><td>5.91 ≤ RSEER < 6.40</td><td>5.36 ≤ RSEER < 5.90</td></tr>
<tr><td colspan="2">C</td><td>5.75 ≤ RSEER < 6.33</td><td>5.38 ≤ RSEER < 5.91</td><td>4.88 ≤ RSEER < 5.36</td></tr>
<tr><td colspan="2">D</td><td>5.18 ≤ RSEER < 5.75</td><td>4.84 ≤ RSEER < 5.38</td><td>4.39 ≤ RSEER < 4.88</td></tr>
<tr><td rowspan="4">E</td><td>Variable (split)</td><td>4.60 ≤ RSEER < 5.18</td><td>4.30 ≤ RSEER < 4.84</td><td>3.90 ≤ RSEER < 4.39</td></tr>
<tr><td>Fixed (split)</td><td>3.80 ≤ RSEER < 5.18</td><td>3.50 ≤ RSEER < 4.84</td><td>3.20 ≤ RSEER < 4.39</td></tr>
<tr><td>Variable (unitary)</td><td>4.00 ≤ RSEER < 5.18</td><td>4.00 ≤ RSEER < 4.84</td><td>4.00 ≤ RSEER < 4.39</td></tr>
<tr><td>Fixed (unitary)</td><td>3.50 ≤ RSEER < 5.18</td><td>3.50 ≤ RSEER < 4.84</td><td>3.50 ≤ RSEER < 4.39</td></tr>
</table>

Article 3.2 Functional Performance Requirements

All units shall operate appropriately with voltages from 220 – 240 V, with surge protection +/- 15%.

Article 3.3 Refrigerant Requirements

Refrigerants used in air conditioners and heat pumps must comply with requirements on their ODP[8] and GWP[9] according to the limitations listed in Table 3.

Table 3. Requirements for Refrigerant Characteristics (numbers shown are upper limits)

name	GWP	ODP
Unitary system	150	0
Split system	750	0

Article 3.4 Test Requirements and Methods

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*

[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.

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 / 24 °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 and the APF requires testing products according to ISO 16358 and calculating the efficiency performance by using outdoor temperature bin data specified in the Appendix, or country-specific temperature bins developed by the country. 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)

a. ISO 16358 requires a full capacity test for fixed-speed units at the low temperature condition (outdoor dry bulb 29°C). This standard allows use of a default value by setting it as an optional test.
b. This regulation sets t_0 (outdoor temperature at 0 % load) as 20°C, which is consistent with ISO 16358.

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

Article 3.5 Compliance Certification and Surveillance Testing

To verify compliance of a product model with the requirements in this document, the designated authority shall apply the following procedure:

(1) Test a sample of the same model from the same manufacturer, randomly selected.

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

a. The values in the Conformity Assessment Report (CAR), and 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 measurements;
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 file, including in the test reports; and
c. when the measured average parameters and the values calculated from these measurements across the test sample are within the respective tolerances.

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

Government authorities shall use the measurement and calculation methods set out in this document. All tolerances used in surveillance testing shall be consistent with the tolerances prescribed in this document and all references testing standards.

Article 4. Entry into Force

The product and information requirements set out in Article 3 shall take effect from January 1, 2021.

Article 5. Declaration of Conformity

Compliance with the requirements of Article 3 and any additional optional claims should be demonstrated in the Conformity Assessment Report (CAR). The CAR shall: (1) demonstrate that the product model fulfils the requirements of this regulation, (2) provide any other information required to be present in the technical documentation file, and (3) specify the reference setting and conditions in which the product complies with this regulation.

A label shall be affixed by the original equipment manufacturer at the point of final assembly to the product indicating the energy use, refrigerant ODP and refrigerant GWP.

Article 6. Revision

Article 3 requirements should be strengthened by a simple administrative rulemaking based on updated market assessments conducted every 5 years on the cost and availability of new technologies, such as an example represented in the Appendix. The top performance tier must become the energy efficiency requirement when appropriate based on the findings of updated market assessments, but no later than 7 years after the adoption of the maximum annual energy consumption requirements in this document.

Regulation Appendix - Benchmark Models: Highest-efficiency AC & 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.

Regulation appendix - Outdoor Temperature Bin Hours

Outdoor temperature (℃)	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:

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

A2. Regulation for Energy-Efficient and Climate-Friendly Refrigerators

Article 1. Scope of Covered products

Scope

This regulation applies to refrigerating appliances of the vapor compression type, with a rated volume at or above 30 Litres [L] and at or below 1,500 L, powered by electric mains and offered for sale or installed in Rwanda.

Products that meet the definition of a Refrigerator or Refrigerator-Freezer specified in Article 2 shall be covered by the Rwanda Minimum Energy Performance Standards (MEPS) and labels.

Exemptions

Refrigerators and Refrigerator-Freezers, with a total volume exceeding 1,500 L, wine refrigerators or other products that do not meet the definition of a Refrigerator or Refrigerator-Freezer shall be exempt.

Other types than vapor compression units are exempt.

Newly locally manufactured products sold outside Rwanda or new products manufactured outside the country and sold at wholesale inside the country for final retail sale and installation outside the country are exempt.

Article 2. Terms & Definitions

Below are the definitions of the relevant terms in this document. Unless otherwise specified, these definitions are harmonized with definitions in 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.

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, as described in Article 3.

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

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 appliance with only frozen compartments.

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) - Amount of heat an emitted refrigerant traps in the atmosphere relative to carbon dioxide over a 100-year period.

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 phase of the fluid.

Refrigerator - Refrigerating appliance 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

Article 3. Requirements

Refrigerating appliances falling within the scope of Article 1 shall meet the energy efficiency requirements of Article 3.

Article 3.1 Climate Classes

Refrigerating appliances conforming to this regulation are assumed to be classified into N that represents "Temperate" climate 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

Article 3.2 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. Temperature and Humidity Conditions

Test	Ambient Temperature [°C]	Relative humidity [%]	Reference Standard
Volume measurement	-	-	IEC 65552-3: 2015, Annex H
Steady-state operation test – High ambient temperature	32 ± 0.5	≤ 75	IEC 62552-3:2015
Steady-state operation test – Low ambient temperature	16 ± 0.5	≤ 75	IEC 62552-3:2015

Article 3.3 Energy Use Requirements

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

Annual Energy Consumption (AEC), as calculated per Equation 1, shall be less than or equal to Maximum Annual Energy Consumption (AEC_{Max}), as R per Table 3.

Equation 1. $AEC = EC_{25} \times (365/1000)$ in kWh per year

where EC_{25} is energy consumption in Wh per 24 hours based on ambient temperature 25°C, as calculated per Equation 2 and rounded to nearest whole number.

Equation 2. $EC_{25} = 0.5 \times EC_{16} + 0.5 \times EC_{32}$ in Wh

where EC_{16} is energy consumption measured at ambient temperature 16°C and EC_{32} is energy consumption measured at ambient temperature 32°C, per IEC 62552-3.

Note:

1. Refrigerating appliances for household use are typically designed to be located in an ambient temperature of 16°C or greater. Some appliances may be located in environments with lower ambient temperatures down to 10°C. For all refrigerating appliances, this regulation requires energy consumption to be measured at +16°C and +32°C as specified in IEC 62552-3:2015 and use one of the ambient temperature 25°C for establishing energy use requirements.
2. Weight factor 0.5 for coefficients *a* and *b* is mathematically representative of 24°C. However, this should give the same energy consumption as a test at 25°C would have given, because energy consumption trend between 16 and 32 °C is non-linear (increasing slope at higher ambient temperatures), hence linear relation overestimates the energy consumption.

Table 3. Maximum Annual Energy Consumption (AEC_{Max})

Product Category	AEC_{Max} (kWh/year)
Refrigerators	0.183×AV+120
Refrigerator-Freezers	0.268×AV+190
Freezers	0.238×AV+193

where AV is Adjusted Volume, as calculated per Equation 3

Equation 3. $Adjusted\ Volume\ (AV) = \sum_{i=1}^{n}(Storage\ Volume_i \times K \times F)$

where *K* is volume adjustment factor, as calculated per Equation 4 and *F* is frost adjustment factor

Equation 4. $K = \frac{T_1 - T_c}{T_1 - T_2}$

for fresh food compartments, *K*=1

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

F=1.0 for manual defrost and *F*=1.2 for frost-free (automatic defrost)

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=0°C	K=1.19
		T_c=-6°C	K=1.48
		T_c=-12°C	K=1.76
		T_c=-18°C	K=2.05

The AEC_{Max} 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 AEC_{Max} 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 (see further description of labelling requirements in Article 5). The higher levels of performance discriminated by this approach shall be as follows.

Equation 5. $R = \frac{AEC_{Max}}{AEC}$

Table 5. Labeling 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	1.00 ≤ R < 1.25

Article 3.4 Functional Performance Requirements

All units shall operate appropriately with voltages from 220-240 V, with surge protection +/- 15%.

Article 3.5 Refrigerant Requirements

Refrigerants and foam-blowing agents used in refrigerating appliances must comply with requirements on their Ozone Depletion Potential (ODP)[11] and Global Warming Potential (GWP)[12] according to the limitations listed in Table 6.

Table 6. Requirements for Refrigerant and Foam-Blowing Agent Characteristics (numbers shown are upper limits)

Product Class	GWP	ODP
All types	20	0

Table 7. Refrigerant Charge Size Limits for Hydrocarbons (HCs)

Product Class	Maximum Charge
All types (domestic refrigeration)	0.15 g

a. 3.6 Compliance Certification and Surveillance Testing

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:

b. Test a sample of the same model from the same manufacturer, randomly selected.
c. The model shall be considered compliant if all the following are met:

[11] Per *Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer, Seventh Edition* (Annexes A, B, C and E).

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

d. the values in the Conformity Assessment Report (CAR), and 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 measurements;
e. 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 file, including in the test reports; and
f. when the measured average parameters and the values calculated from these measurement(s) across the test sample are within the respective tolerances.

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

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

All tolerances used in surveillance testing shall be consistent with the tolerances prescribed in this document and all references testing standards.

Article 4. Entry into Force

The product and information requirements set out in Article 3 shall take effect from January 1, 2021.

Article 5. Declaration of Conformity

Compliance with the requirements of Article 3 and any additional optional claims should be demonstrated in the Conformity Assessment Report (CAR).

The CAR shall: (1) demonstrate that the product model fulfils the requirements of this regulation, (2) provide any other information required to be present in the technical documentation file, and (3) specify the reference setting and conditions in which the product complies with this regulation.

A label shall be affixed by the original equipment manufacturer at the point of final assembly to the product indicating the energy use, refrigerant and foam-blowing agent ODP and refrigerant and foam-blowing agent GWP. [Labelling guidance will be included in the Awareness Campaign in annex A4].

Article 6. Revision

Article 3 requirements should be strengthened by a simple administrative rulemaking based on updated assessments conducted every 5 years on the cost and availability of new technologies.

The top performance tier must become the maximum annual energy consumption requirement when appropriate based on the findings of updated market assessments, but no later than 7 years after the adoption of the maximum annual energy consumption requirements in this document.

Regulation Appendix - 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 ambient temperature 25°C

	Volume (L)	Volume Adjustment Factor (K)	Adjusted Volume (L)
Fresh food storage	92	$\frac{25-4}{25-4} = 1.00$	$(92 \times 1.00) = 92$
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	$0.441 \times 0.5 + 0.724 \times 0.5 = 0.549$			

* 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)	$0.549 \times 365 = 200$
R	$\frac{0.183 \times 92 + 185}{200} = 0.93$

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 ambient temperature 25°C

	Measured volume (L)	Volume Adjustment Factor (K)	Adjusted Volume (L)
Fresh food storage	137	$\frac{25-4}{25-4}=1.00$	$(137\times 1.00+63\times 2.05)\times 1.2 = 319$
Frozen food storage	63	$\frac{(25-(-18))}{25-4}=2.05$	

Step 2: Annual Energy Consumption

Ambient temperature	℃	16		32	
Temperature control settings		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	$0.441\times 0.5+0.724\times 0.5 = 0.583$			

* 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)	$0.583\times 365 = 213$
R	$\frac{0.268\times 319+190}{213}=1.29$

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	-	$-$	$(295 \times 2.05) \times 1.2 = 726$
Frozen food storage	295	$\frac{(25-(-18))}{25-4} = 2.05$	

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	$0.671 \times 0.5 + 1.309 \times 0.5 = 0.990$			

* 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$\times 365 = 361$
R	$\frac{0.238 \times 726 + 193}{361} = 1.01$

A3. National Product Registration System

The national registration system will be developed at a later stage as a tool to monitor the implementation of this strategy.

A4. Awareness Campaign

An awareness campaign will be developed at a later stage targeting policy makers, technology suppliers and consumers as tool to efficiently implement the strategy.

A5. Capacity Building Program

The capacity building program will be designed and implemented a later stage for the implementing agencies to allow a smooth and efficient implementation of the strategy.

A6. Recycling and Processing Scheme

A recycling and processing scheme already exists in Rwanda. A program to ensure that cooling products as well as their refrigerants will be developed and implemented.

A7. Financial Mechanisms

Need for a financial mechanism

To scale-up the adoption of energy-efficient and climate-friendly cooling solutions, investments through effective market-based solutions are essential. An innovative financial strategy will drive demand, facilitate the flow of financing for relevant technology solutions and address the large untapped market potential. During the development of the strategy, the project team is considering the technical, financial, institutional, legal, and social barriers to investment. The aim is to enable the conditions required to mobilize investments by residential, commercial, industrial and/or public entities to replace outdated existing systems and purchase solutions that are well suited for new construction. Special attention must be paid to small and medium-sized enterprises (SMEs) that make up the majority of businesses in the Rwanda and that have more trouble than large firms in accessing finance.

Context

Energy consumption from cooling systems constitutes a substantial proportion of production costs for many enterprises hence investments in energy efficiency may represent an opportunity for improvement in productivity and modernisation. Investments in new efficient cooling technologies present attractive returns, and have the potential to generate the cash flow to allow the investor to recover their investment in a reasonable period of time, while also improving productivity/efficiency and reducing emissions as well as costly energy waste. However, despite the economic benefits of energy efficient cooling systems, these investments are not happening at the scale expected. The money saved on energy can then be used to grow the business, and thereby Rwanda's economy. Energy efficiency in the residential sector offers significant benefits to households, as it reduces monthly expenses on electricity and therefore increases purchase power.

The three key stakeholders directly involved in energy efficiency investments are consumers, technology providers, and financial institutions. The local authorities and development funds are also very important stakeholders to unlock such investments.

Barriers

There several barriers that hinder investments in environmentally friendly and energy efficient technologies. These include, for the clients:

(i) higher up-front costs
(ii) limited knowledge of benefits of energy efficiency resulting in high perceived risks
(iii) other investment priorities
(iv) limited credit capacity or access to finance
(v) lack of trust in the performance of new and unknown technologies.

This makes it difficult for investors to evaluate the real costs and benefits of advanced and innovative technologies, and affects the prioritisation of this type of project, which compete with other investment opportunities that present a better, or more familiar risk-return profiles for investors.

Technology providers face significant challenges in selling energy efficient equipment, since the price of such equipment is higher and it is hard to gain trust with respect to promised future benefits (savings). Therefore, the technology providers have to compete with companies offering cheaper and less efficient equipment, in which clients often prefer to invest.

Financial institutions are also confronted with barriers when it comes to lending money for energy efficiency projects. First, there is a limited visibility of green investment opportunities. Financial institutions are typically not familiar with the return and risk curve linked to such investments, and have no systematic evaluation and monitoring process to identify and track green investments. In addition, it is complicated to finance SMEs due the high collateral requirements.

Development of programs to implement the financial mechanism

Specific programs to impliment the financial mechanism will be developed to overcome the barriers stated above. The design of financial mechanisms largely depends on redistributing risks and implementing business models that are feasible for implementation, financially self-sufficient, aligned with the NCS and engage all key stakeholders. Some examples 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, and many more. Each of these has different advantages and uses a different path to overcome specific barriers. Among others, these include the reduction of the burden of the initial investment and the reduction of the client's risk perception. These models need to be combined with financial and non-financial risk mitigation mechanisms, and tailored to local conditions. Their success heavily depends on a thorough understanding of the market, a strong engagement of the key stakeholders, the successful creation of an environment of trust and a well-designed model offering a sustainable solution by creating value for all involved players.

Main stakeholders

To develop a leasing product for energy efficient air conditioning in Rwanda, some important private and public stakeholders should be involved. This section requires feedback to complete the list.

- Local authorities - The support of REMA, MININFRA, and the Rwanda Revenue Authority (RRA) is essential. RRA has been supporting the improvement of the legal and tax environment to facilitate leasing as an alternative financing mechanism and participated in the development of the new leasing law which entered into force in 2015.[13]
- Financial Institutions - A collaboration with one or several financial institutions is key to the success of such a leasing product. For the financial institutions readily offering leasing, the conditions and requirements must be analysed. For the financial institutions, which do not offer leasing, the main barriers and missing elements should be identified. Requirements should be investigated including risk tolerance and duration of such a leasing contract. Policy and taxation support shall also be discussed, as well as the potential for integration with existing financial products readily offered by the financial institution. For instance, the IFC study previously mentioned found that the average lease period in Rwanda is three years:" The banks have found this period most comfortable for the lessee to pay back according to their cash flow." It should be investigated whether a longer period, such as 5 years, would be an appealing option.
- Development Funds - Funds such as the BDF and FONERWA would play a key role when structuring a financial risk mitigation mechanism, such as the energy efficiency guarantee fund described previously. Conditions and needs from the development funds to structure such a guarantee are to be discussed.
- Technology providers - To implement a leasing product or any other financial mechanism to drive adoption of energy efficient equipment, the technology providers must be open to test new business models and provide support in its development. Among others, the ability to provide risk mitigation measures for the financial institutions, such as with the reallocation of seized equipment, shall be explored.

Leasing

One potential mechanism to explore is leasing. A lease is an arrangement in which one party (the lessor) conveys the use of an asset (a parcel of land, building, service, or in this case an air conditioning system) to another party (the lessee) for a specified period of time in exchange for periodical payments. There are two basic forms of leasing; the operating leasing and the financial leasing. Difference between the operating and finance lease are mainly on the basis of who owns the leased asset, what accounting and tax treatment, who bears the expenses and running costs, whether purchase option is there or not and how long the lease term is. A leasing facility for cooling technology will require risk mitigation mechanisms such as a guarantee fund, as well as the engagement of the technology providers to

[13] https://www.newtimes.co.rw/section/read/109417

facilitate credit request and to support the lessor with the reallocation of the equipment in case of default.

On-bill financing

An on-bill financing scheme is another model that will be investigated to finance cooling equipment for the residential and SME sector. More than 85% of sales of refrigerators are within the residential sector.

The on-bill financing model is an innovative scheme and, although applicable both to the commercial and the residential sector, has been proven very effective for smaller investments and would thus likely be developed for households. The model enables clients to pay their credit back through their monthly utility bill. The most prominent advantage of this model is a very low default rate since households do not want their electricity access to be cut, which is a consequence of failing to process the monthly loan repayment. There are several ways to structure such an on-bill financing model. Both need strong support by the utility, Energy Utility Corporation Limited (EUCL). In all cases the on-bill scheme has demonstrated to open a new business opportunity for utilities: the financial business.

A8. Off-Grid Cooling Plan

With the increased efficiency in off-grid appliances technologies, the rate of off-grid electrification set to cover 48% of the population by 2024, a cooling plan for the off-grid segment of the population will be developed. The plan will also take into account off-grid cooling for agricultural use.

A9. HPMP Stage II and Enabling Activities

As the HPMP stage II is enabling activities are set to be developed, it is important that it is harmonise with this strategy. This annex will ensure that priorities in the strategy are captured in the development of stage II of HPMP.

A10. NDC Revision

Rwanda's NDCs are set to be revised in the near future. The revised NDC's shall take into consideration priorities as set in this strategy and shall form this annex.