STRATEGIC PROGRAM TO PROMOTE RENEWABLE ENERGY AND ENERGY EFFICIENCY INVESTMENTS IN THE ELECTRICITY SECTOR OF SAO TOME AND PRINCIPE

MINIMUM ENERGY PERFORMANCE STANDARDS FOR LIGHTING, AIR CONDITIONERS AND REFRIGERATORS IN SAO TOME AND PRINCIPE

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SUMMARY

LIST OF ACRONYMS

AC	Air Conditioning
AFAP	Agência Fiduciária de Administração de Projectos em São Tomé e Príncipe
AfDB	African Development Bank
AGER	General Regulatory Authority
AENER	Santomean Association of Renewable Energies
ARP	Autonomous Region of Principe
ATEFER	Association of Cold Technicians and Renewable Energies
BSTPPTC	Brazil-São Tomé and Príncipe Professional Training Centre
CCI	Chamber of Commerce and Industry
DGA	Directorate General of Environment
DGRNE	General Directorate of Natural Resources and Energy
DRCAE	Directorate for Regulation and Control of Economic Activities
ECCAS	Economic Community of Central African States
EDP	Energias de Portugal (EDP)
ECGCF	Green Climate Fund
ECOWAS	Economic Community of West African States
EE	Energy Efficiency
EER	Energy Efficiency Rate
EMAE	Water and Electricity Company
IDDA	Industrial Development Decade for Africa
ISO	International Organization for Standardization
GEF	Global Environment Facility
INA	International Fund for Agriculture
LDCs	Least Developed Countries
LED	Light-Emitting Diode
MEPS	Minimum Energy Performance Standards
MIRN	Ministry of Infrastructure and Natural Resource
MNECC	Ministry of Foreign Affairs, Cooperation and Communities, São Tomé and Príncipe
NGO	Non-governmental organization
PANA	National Climate Change Adaptation Plan
PANEE	National Energy Efficiency Action Plan
PANER	National Renewable Energy Action Plan
PIQAC	Quality Infrastructure Programme for Central Africa
PNDS	National Sustainable Development Plan of the STP
RECs	Regional Economic Communities
RES	Renewable Energy Sources
SENAPIQ	National Service of Intellectual Property and Quality
SIDS	Small Island Developing States
SMEs	Small and Medium Enterprises
STP	Sao Tome and Principe
TESE	Association for Development
UNDP	United Nations Development Program
UNEP	United Nation Environment Program
UNIDO	United Nations Industrial Development Organization

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INTRODUCTION

São Tomé and Príncipe (STP) is a country consisting of two main islands situated in the Gulf of Guinea, that has an exclusive economic zone of 160,000 km^2 and is a member of the Economic Community of Central African States (ECCAS).

With an area of 1001 km^2, STP is part of the Small Island Developing States (SIDS), which means that STP is facing different challenges, due its size, its remoteness, its low economic development level, and part of the list of least developed countries (LDCs).

The country has developed the following documents to guide its economic growth:

- *2030 Vision: "São Tomé e Principe 2030: the country we need to build"*, which aims to develop a climate-resilient island, a blue economy, financial and touristic serviced.
- *National Development Plan (PNDs) 2020 – 2024*, which has the Government Program as the basis for its conception and elaboration and aligns with the United Nations 2030 Agenda for sustainable development, the accelerated implementation modalities of the Samoa Roadmap and the 2063 Africa We Want Agenda

The aim is to develop a climate resistant archipelago, and therefore it is necessary to develop its energy sector, especially the electricity sector, to develop renewable energy sources (RES) and improve energy efficiency.

The success of these policy documents depends heavily on a reform of the energy sector and a transformational shift of the entire energy system from an almost complete reliance on imported fossil fuels to renewable energy and energy efficiency. Such a transition will lead to a significant reduction in fossil fuel import costs and free up scarce monetary resources for social and economic development (e.g., education, health, transport, export diversification, development of Small and Medium Enterprises (SMEs) and adaptation to climate change). In addition, it will help the island's main industries and income generating activities (e.g., water supply, agriculture, food processing, tourism, fisheries and the blue economy in general) to become more productive and competitive.

To answer these challenges, several projects are also on the way, for instance the Global Environment Facility (GEF) project *"Strategic program to promote renewable energy and energy efficiency investments in the electricity sector of São Tomé and Príncipe"*. A Green Climate Fund (GCF) funded by the UNIDO project *"Building institutional capacity for a renewable energy and energy efficiency investment programme for Sao Tome and Principe"*, is currently under final approval.

This UNIDO project aims to decrease electricity demand-side losses, thanks to the introduction of a well-proof mechanism, **the MEPS (Minimum Energy Performance Standards) and energy labels, for three main electric appliances: lighting, air conditioning (AC) and refrigeration.**

The promotion of energy efficiency measures can offer great opportunities early on, to reduce overall electricity demand and peak electricity demand. It will also enable electricity to reach out to a greater proportion of the population and improve the economic activities in the country.
It is expected that the successful implementation of minimum energy performance standards (MEPS) and a corresponding labeling scheme will:

- Reduce electricity peak demand and thereby reduce the pressure on the electricity network. Also, the new electrification plans being developed will reach a higher percentage of the population, and consequently reduce government future public expenditures;
- Reduce overall electricity consumption and bills for consumers, who will spend a smaller fraction of their incomes on energy. This is especially important for low-income households, for which the high price of electricity is a barrier to meeting their basic needs;
- MEPS and labeling of household appliances can serve as a powerful tool to inform consumers about differences in energy performance. This will direct consumers towards purchase of more efficient appliances.

The overall objective of the project is to contribute to increasing national capacity to uptake energy efficient appliances in compliance with quality standards.

1 SUMÁRIO EXECUTIVO

The project aims to decrease electricity demand-side losses in São Tomé and Príncipe, thanks to the introduction of a well-proof mechanism, the Minimum Energy Performance Standards (MEPS) and energy labels, for three main electric appliances: lighting, air conditioning and refrigeration.

This report presents the Minimum Energy Performance Standards (MEPS) for lighting, air conditions, and refrigerators in STP.

O projeto visa diminuir as perdas do lado da procura de eletricidade em São Tomé e Príncipe, graças à introdução de um mecanismo bem provado, as Normas Mínimas de Desempenho Energético (MEPS) e etiquetas energéticas, para três aparelhos elétricos principais: iluminação, ar condicionado e refrigeração.

Este relatório apresenta os Padrões Mínimos de Desempenho Energético (MEPS) para iluminação, condições do ar e refrigeradores em STP.

2 OBJECTIVES OF THE REPORT

This report presents the Minimum Energy Performance Standards (MEPS) for lighting, air conditioners, and refrigerators in STP. Provision of regular updates of these standards is incorporated in the process.

The MEPS are based on international best practices and were presented for adoption. The elaboration of the MEPS considers experiences applied at the regional level (Central Africa, SADC, EAC) and particularly lusophone countries (e.g., Portugal, Cape Verde, Brazil).

The MEPS consider the specific socio-economic and cultural island context of STP and ensure long-term sustainability and inclusiveness. The latter includes aspects regarding the “ability and willingness to pay” and potential opportunities for value creation through local assembling and servicing.

Depending on the product, different norms could be taken as a reference. For instance, in lighting: IEC (International Electrotechnical Commission), ANSI (American National Standards Institute), CIE (Commission Internationale de l'Eclairage). And other relevant information has been consulted in IGQPI (Institute for Quality Management and Intellectual Property), CISPR (Comité International Spécial des Perturbations Radioélectriques),IES (Illuminating Engineering Society), ARSO (African Standards), etc.

The development of mandatory MEPS shall be agreed upon with the Technical Committee (TC). The consultant together with the TC will define the adaptation period for the market.

The results of the workshops regarding MEPS

Two validation workshops have been organized for validation and harmonization of MEPS and labeling program. A report is dedicated to the presentation of the results of the workshops. We simply present in this report the main conclusions:

- **On the matter of MEPS, all of the groups agree that EU MEPS should be adopted, for the reasons that they are well proved and well established in an advanced market, there is available documentation on the standards and the appliances that the MEPS are developed for have been tested in accredited laboratories.**

The objectives of this report are to present:

1. The survey regarding MEPS implementation
2. The three (3) harmonized MEPS
3. The results of the workshops regarding MEPS

3 DEVELOPMENT OF MEPS FOR APPLIANCES

Minimum Energy Performance Standards (MEPS) are very important for the successful penetration of energy efficient products in the STP market. These standards should be an optimum combination of at least the following:

- State of the art equipment (lights, ACs and refrigerators) worldwide,
- Foreseeable developments in Energy Efficiency,
- Price of EE equipment,
- Local factors (market, average income, cost of electricity, degree of market penetration, etc.),
- Worldwide experience from application of MEPS.

Incandescent lights, for example, have a very low efficiency of about 14 lumen/Watt. For this reason, their distribution is not allowed in many countries of the world. LED lights on the other hand, currently produce more than 100 lumen/Watt with a foreseen limit of well above 200 lumen/watt. Their price is decreasing with time, but it is still higher than incandescent lamps.

ACs on the other hand are turning from “luxury” equipment to “necessary” equipment. They are accounting for a continuously and rapidly increasing percentage of electricity consumption worldwide. Energy efficiency (Energy Efficiency Ratio – EER) of equipment produced is constantly improving. Currently Room ACs of major manufacturers have an EER well above 3.0.

For refrigerators, the energy efficiency is strongly influenced by climate: for the tropical climate, specific MEPS and labels have been developed, for the Europe Union, for the oversea territories, to consider higher external temperatures. We will look to MEPS and labels for refrigeration in similar climates as the one of STP.

3.1 MEPS calculation method

For a better understanding of the following chapters, we present in this part the methodology for calculating MEPS. The equipment concerned by these MEPS are also specified in this chapter.

3.1.1 Air conditioners

Definition of the appliances

The equipment concerned are residential and commercial air conditioners such as:

- Mobile air conditioners
- Monoblocks
- Split systems
- Centralized air conditioners, whether single or double duct, mobile or otherwise.

This applies to equipment up to 20 kW. These are devices designed to be powered by the electrical network. Appliances powered by non-electrical energy sources are excluded from the scope of the study.

Explanation of concepts

An "**air conditioner**" is a device capable of cooling indoor air by a vapor compression cycle generated by an electric compressor, including in particular, on the one hand, air conditioners equipped with additional functions, such as dehumidification, air purification or ventilation and, on the other hand, appliances that can use water (either water from condensation at the evaporator or water from an external source) to evaporation at the condenser, provided that the appliance is also able to operate without an external source of water, i.e. using only air.

A "**Monoblock system**" is an air conditioner, installed directly in a window or on the opening of a wall. All the elements of the unit are contained in a single box, with a motor that circulates the air in the air conditioner.

A "**split system**" is an air conditioner that is split into an outdoor unit, which contains the compressor and condenser, and an indoor unit, which contains the evaporator.

A "**multi-split system**" is an air conditioning system that includes multiple indoor units, all of which are connected to a single outdoor unit. This type of system allows the air temperature to be controlled separately by each indoor unit.

"**Mobile air conditioners**" are air conditioners that can be moved from one room in the building to another and are not fixed in the structure.

The "**EER - Energy Efficiency Ratio**" of an air conditioner corresponds, for an air conditioning requirement defined under reference conditions, to the cooling capacity (kW) divided by the electrical power (kW) required for the service to be done.

EER= (Cooling capacity in watts) ÷ (Electrical power in watts)

Air conditioners with "**inverter**" are variable speed compressors, which allow the air conditioning unit to operate at partial load for better efficiency.

"**Rated capacity**" measures the cooling capacity of the air conditioning unit under reference conditions.

"**Standard reference conditions**" are those of the specific combination of indoor and outdoor temperature and humidity level, which describes the operating conditions to set the rated capacity and EER of the air conditioner.

The "**power**" is the maximum power of a piece of equipment, indicated by the manufacturer.

"**Off mode**": situation in which the air conditioner is connected to the mains and does not provide any function.

"**Standby mode**": situation in which the equipment is connected to the mains, depends on the mains power supply for normal operation and performs only the following functions, which may persist for an indefinite period of time: a function of reactivation, or a reactivation function and only an indication showing that the reactivation function is activated, and/or the display of information or of a state.

"**Global Warming Potential (GWP)":** measurement aimed at determining the contribution to global warming (in kg CO_2eq.), over a period of 100 years, of one kg of refrigerant during the vapor compression cycle.

Energy efficiency ratio (EER) calculation

The EER is the cooling capacity in Watt divided by the electrical energy required in Watt, under conditions of outdoor temperature of 35°C, indoor temperature of 27°C and humidity of 50%.

3.1.2 Lighting

Definition of the appliances

The equipment concerned is products that provide domestic lighting in the residential and tertiary sectors, on the network. For network lighting, these include, but are not limited to,

i. The lamps for specific uses indicated below are excluded:

- Lamps with the following chromatic coordinates x and y
  - $x < 0{,}200$ or $x > 0{,}600$
  - $y < -2{,}3172\ x^2 + 2{,}3653\ x - 0{,}2800$ or $y > -2{,}3172\ x^2 + 2{,}3653\ x - 0{,}1000$;
- Directed lamps;
- Lamps with a luminous flux of less than 60 lumens or greater than 12,000 lumens;
- Lamps with the following characteristics
  • 6% or more of total radiation from the 250-780 nm range in the 250-400 nm range,
  • A radiation peak between 215 and 400 nm (UVA) or between 280 and 215 (UVB);
- Fluorescent lamps without built-in ballast;
- High intensity discharge lamps;
- “Special purpose lamps”, which means a lamp not intended for the illumination of a room of a household, because of its technical parameters or because the information on the product indicates that it is not suitable for the illumination of a household room. Special purpose lamps include, for example, oven lamps which are often designed to operate under extreme conditions (high temperatures).

Explanation of concepts

The "**ballast**" is a device interposed between the power supply and one or more discharge lamps and used to limit the current of the lamp(s) to the required value; a ballast may also comprise a supply voltage transformer, a luminous flux dimmer, power factor correction elements and may, alone or in combination with a starting device, ensure the conditions required for starting of the lamp(s).

“**Color rendering**” is the effect of an illuminant on the chromatic aspect of the objects it illuminates, this aspect both consciously or unconsciously compared to that of the same objects illuminated by a reference illuminant.

A "**compact fluorescent lamp**" is a lamp which cannot be dismantled without being damaged beyond repair, provided with a base and incorporating a fluorescent lamp as well as all the additional components necessary for ignition and stable operation of the lamp.

The "**correlated color temperature** (Tc[K])" is the temperature of the Planckian radiator (black body) whose perceived color most closely resembles, under specified viewing conditions, that of a given stimulus of the same brightness.

A "**lamp**" is a source constructed to produce optical radiation, usually visible.

A "**directed lamp**" is a lamp in which at least 80% of the emitted light is in a solid angle of π sr (corresponding to a cone with an angle of 120°).

A "**discharge lamp**" is a lamp in which the light is produced, directly or indirectly, by an electric discharge in a gas, a metallic vapor or a mixture of several gases and vapors.

A "**filament lamp**" is a lamp in which the light is produced by a filiform conductor heated to incandescence by the passage of an electric current. The lamp may or may not contain gases that influence the glowing process.

A "**fluorescent lamp**" is a low-pressure mercury vapor lamp in which most of the light is emitted by one or more layers of phosphors excited by ultraviolet radiation from the discharge.

A "**high-intensity discharge lamp**" is a discharge lamp in which the arc which produces the light is stabilized by the thermal effect of its enclosure whose surface power is greater than 3 watts per square centimeter.

An "**incandescent lamp**" is a lamp with a light which is produced by an element heated to incandescence by the passage of a current.

The "**lamp base**" is the part of the lamp which allows the connection to the power supply by means of a socket or a connector and, in most cases, which also serves to hold the lamp in the socket.

“**The efficiency of a lamp**” is equal to the quotient of the luminous flux emitted (Φ) by the power consumed by the lamp (Plamp): ηlamp = Φ / Plamp (units: lm/W)

“**Lamp On Time**” is the time it takes after the power is turned on for the lamp to turn on and stay on.

"**Lamp warm-up time**" is the time it takes for the lamp, when switched on, to emit a defined proportion of its luminous flux stabilizes.

A "**light-emitting diode or LED**" is a semiconductor device that directly converts electrical energy into light.

The “**power factor**” is the ratio of the absolute value of the active power P to the apparent power in periodic regime.

The rated “life” of the lamp is the lamp life noted on the lamp, or declared by the manufacturer/responsible seller.

Lamp "**wattage rating**" is the wattage noted on the lamp, or declared by the responsible manufacturer/seller.

A "**special purpose**" lamp is a lamp not intended for the illumination of a room of a household, because of its technical parameters or because the product information indicates that it is not suitable for the illumination of a room of a household.

A "**halogen lamp**" is a filament lamp in which the filament is made of tungsten and is surrounded by a gas containing halogens or halogen compounds.

"**Capacity or capacity of a cell or battery**" means the amount of electricity (electrical charge), usually expressed in ampere-hours (Ah), that a fully charged battery can deliver under specific conditions.

“**IP Class or IP Rating**” means Ingress Protection, the degree of protection provided by barriers for electrical equipment against ingress of foreign objects or dust/water.

“**Mobile products or subsystems**” are portable when two or more of the major components (power source, power storage, and light source) are connected, making the product or subsystem easily transportable.

In "**integrated products**" the solar module is inserted in the same enclosure as the other components or is connected to the other components via a cable short enough to allow the solar module to collect external energy while the other components of the product remain inside.

In "**separate products**", no solar module is present or the solar module is connected to components through a cable long enough for the module to collect external energy while the other components of the product remain inside.

Energy efficiency calculation

Lamps must have a minimum efficiency, measured in lumens per watt (lm/W).

3.1.3 Refrigerators

Definition of the appliances

The equipment is combined refrigerators and appliances, having a maximum storage volume of 1,500 liters.

For refrigerators, freezers and combined appliances, the following categories are concerned:

- Refrigerator with one or more fresh food storage compartments

- Refrigerator with cellar compartment, cellar and wine storage device
- Refrigerator with compartment for highly perishable foodstuffs and refrigerator with starless compartment
- Refrigerator with “one star” compartment
- Refrigerator with “two star” compartment
- Refrigerator with “three star” compartment
- Fridge Freezer
- Upright freezer
- Chest freezer
- Multi-purpose and other type refrigeration appliances.

Explanation of concepts

A "**household refrigeration appliance**" is an insulated cabinet comprising one or more compartments, used to refrigerate or freeze foodstuffs, or to store refrigerated or frozen foodstuffs, cooled by one or more energy-consuming processes.

A "**refrigerator**" is a refrigeration appliance intended for the conservation of foodstuffs, comprising at least one compartment suitable for the storage of fresh foodstuffs and/or drinks.

A “**fridge-freezer**” is a refrigeration appliance comprising at least one compartment for the storage of fresh foodstuffs and at least one other compartment suitable for freezing fresh foodstuffs and for storing frozen foodstuffs under storage conditions “three stars" (the food freezing compartment).

A "**refrigerator with cellar compartment**" is a refrigeration appliance which has at least one compartment for storing fresh foodstuffs and a cellar compartment, but which does not include a compartment for storing frozen foodstuffs, a compartment for highly perishable foodstuffs or an ice-making compartment.

A “**multipurpose appliance**” is a refrigeration appliance which exclusively comprises one or more multipurpose compartments.

A "**frozen food storage compartment**" is a low temperature compartment designed specifically for the storage of frozen foods and classified according to its temperature as follows:

(i) "one-star" compartment: compartment for storing frozen foodstuffs in which the temperature is not higher than -6°C,

(ii) "two-star" compartment: compartment for storing frozen foodstuffs in which the temperature is not higher than -12°C,

(iii) "three-star" compartment: compartment for storing frozen foodstuffs in which the temperature is not higher than -18°C,

(iv) “food freezing compartment” (or “four-star compartment”): compartment suitable for freezing at least 4.5 kg of food per 100 l of storage volume – and under no circumstances less than 2 kg – for a temperature range from ambient to –18°C over a 24 hour period, also suitable for storing frozen foodstuffs under “three-star” storage conditions, and may include areas "two star",

(v) “starless compartment”: compartment for storing frozen foodstuffs in which the temperature is below 0°C and which can also be used for the production and storage of ice but which cannot be used for the storage of foodstuffs highly perishable foods.

A "**chest freezer**" is a food freezer whose compartment(s) are accessible from the top of the appliance or which has both top-opening and front-opening compartments, but in which the gross volume of the top-opening compartment(s) exceeds 75% of the total gross volume of the device.

A “**top-opening”** or **“chest**” appliance is a refrigeration appliance whose compartment(s) are accessible from the top of the appliance.

The “**annual energy consumption**” (kWh/year) corresponds to the calculated annual energy consumption taking into account the conditions of use in STP.

The “**Baseline annual energy consumption SC**” (kWh/year) is the annual energy consumption calculated solely based on the characteristics of the device.

“**The Energy Efficiency Index (EEI)”** is the ratio of the annual energy consumption of a device and the annual reference energy consumption SC; both being in kWh/year.

The “**climate class**” refers to the ambient temperature range within which the refrigerating appliance must be able to maintain the required storage temperatures in the different compartments simultaneously. It is symbolized by a letter, inscribed on the device's nameplate. Climatic classes guarantee normal use of the appliance, which includes the environment in which the refrigeration appliance is located, since normal cooling capacity changes as temperatures change.

(i) ST - Subtropical from +16°C to +38°C
(ii) T - Tropical +16°C to +43°C

Energy efficiency calculation (UE method)

The energy efficiency index (IEE) is defined according to the following formula:

$$IEE = \frac{AEC}{SAEC} * 100$$

AEC = the annual energy consumption of the equipment, in kWh/year, calculated as the energy consumption of the household refrigeration appliance in kWh/24h and rounded to two decimal places (calculated in accordance with standard IEC 62552-3: 2015) x 365

SAEC = the standard annual energy consumption of the equipment, in kWh/year

« SAEC » is calculated according to the following formula:

$$SAEC = M * \sum_{compartments} \left(Vc * \frac{25 - Tc}{20} * FF * CC * BI \right) + N + CH$$

Or:

"Vc" means the net volume (in liters) of the compartment (in accordance with standard IEC 60335-2-24:2012);

"Tc" designates the temperature (in °C) of the compartment;

The M and N values are specified in Table 1;

The FF, CC, BI and CH values are specified in Table 2.

Table 1: Values of M and N by category of equipment required to calculate the annual energy consumption of the device

Equipment category	M	N
1. Refrigerator with one or more fresh produce storage compartments	0,233	245
2. Refrigerated wine cabinet, cellar and wine storage appliances	0,233	245
3. Refrigerator-cooler or refrigerator with 0 star compartment	0,233	245
4. Refrigerator with 1 star compartment	0,643	191
5. Fridge with 2 star compartment	0,450	245
6. Refrigerator with 3 star compartment	0,777	303
7. Fridge-freezer	0,777	303
8. Upright freezer	0,539	315
9. Chest freezer	0,472	286
10. Multipurpose refrigeration and other appliances	(*)	(*)

(*): For these appliances, the values of the cooling temperature and the star of the compartment with the lowest temperature will determine the value of M and N. Appliances with four-star compartments at -18°C should be considered refrigerators - freezers.

Table 2: Correction factors for different conditions

Correction factors	**Value**	**Conditions**
FF (frost free)	1.2	For frost-free (ventilated) compartments containing frozen food
	1	Others
CC (climate class)	1.2	For climate class T (tropical) equipment
	1.1	For equipment in climatic class ST (subtropical)
BI (built-in)*	1.2	For built-in equipment less than 58 cm wide
	1	Others
CH (chill compartment)	50 kWh/year	For equipment with refrigerated compartment of at least 15 liters
	0	Others

(*): an appliance is "built-in" only if it is designed exclusively for installation in a kitchen cavity requiring finishing of the furniture, and tested as such.

To compare the energy performance of such devices, it is important to compare devices with the same characteristics. In fact, large capacity refrigeration appliances will have to use more energy on an annual basis than small capacity ones, since they have to cool a larger volume. Nevertheless, they can be considered more efficient since they require less energy than for a similar volume. It is therefore necessary to take into account the type of refrigeration appliance. For example, a refrigerator with a freezer or a defrosting system will use more energy than a conventional refrigerator. Therefore, it is important to sort them precisely taking into account their characteristics. The different types correspond to the different services that the refrigeration appliance offers:

- Food storage;
- Storage of pre-frozen foods;
- Freezing and storing food;
- Ice production.

T and ST appliances have different average ambient temperature °C for correct use of the device. They are also tested at different temperatures, when power consumption is enabled.

Table 3: Climate class correction factor - refrigerators

Climate class	Temperature ambient average (°C) for correct use of the device	Ambient temperature (°C) when measuring AEC	Value of the CC correction factor, for the calculation of EEI
ST	+16 à +38	+25	1,10
T	+16 à +43	+32	1,20

Thanks to the Climate Class correction factor, the temperature difference when measuring AEC is mainly compensated; the requirements of EEI are therefore close to ST and T. But, if a device meets the requirements of both ST and T conditions, it will perform “better” in ST conditions than in T.

Source: EC 643/2009 – for the implementation of European Directive 2005/32/EC for climatic requirements for domestic refrigerating appliances.

3.2 Results of the survey regarding MEPS

A survey has been undertaken to determine the best practices worldwide. Attention has been paid to MEPS existing in the EU, at regional level (Ghana, Nigeria, Benin, Kenya, South Africa, etc), Australia, Canada as well as in lusophone countries (e.g. Portugal, Cape Verde, Brazil).

Furthermore, the consultants have considered well established norms such as IEC (International Electrotechnical Commission), ANSI (American National Standards Institute), CIE (Commission Internationale de l'Eclairage) while also consulting institutes such as IGQPI (Institute for Quality Management and Intellectual Property), CISPR (Comité International Spécial des Perturbations Radioélectriques), IES (Illuminating Engineering Society), ARSO (African Standards), etc.

3.2.1 Air conditioners: examples of MEPS in other countries

Example 1: European Union

The EU MEPS for air conditioners are being updated, in order to facilitate the rescale of the A/C energy label, when the EU regulations come into force at the start of 2022. The deadline for the adoption of new regulations by the Commission has two additional stages, one on the basis of the framework regulation (Regulation (EU) 2017/1369), in which the Commission will adopt the new regulations until 2 August 2023 (Article 11.4) and one on the basis of the derogations granted for products covered by Regulations 811/2013, 812/2013 and 2015/1187, as set out in the framework regulation, in Article 11.5(a)".

Table 4: A/C MEPS – Energy Classes – EU

Energy efficiency class	*Seasonal Energy Efficiency Ratio*
A+++	SEER ≥ 8,50
A++	6,10 ≤ SEER < 8,50
A+	5,60 ≤ SEER < 6,10
A	5,10 ≤ SEER < 5,60
B	4,60 ≤ SEER < 5,10
C	4,10 ≤ SEER < 4,60
D	3,60 ≤ SEER < 4,10
E	3,10 ≤ SEER < 3,60
F	2,60 ≤ SEER < 3,10
G	SEER < 2,60

Example 2: Cabo Verde

Decree-Law No. 25 / 2019, of June 13, adopted by the Council of Ministers of Cape Verde, creates the national labeling system and energy performance requirements for electrical equipment, establishes the measures and information obligations to be provided to the end user through labeling and other indications on energy consumption, minimum requirements in terms of energy efficiency applicable to importation and marketing. This law creates a seal of guarantee of Cape Verde, which can only be affixed to equipment with higher levels of efficiency, thus favoring the most efficient and so-called "environmentally friendly" equipment. The government hereby seeks to raise awareness among citizens and leads them to make efficient and environmentally friendly choices, as the use of energy efficient equipment does not only reduce the energy consumption, which in turn allows significant cost savings, but also reduces greenhouse gas emissions, which leads to an important means of combating climate change.

Table 5: A/C MEPS - Cabo Verde

Electrical equipment	*Minimum requirements for import and marketing*	*Minimum Requirements for Obtaining a Warranty Seal*
Air conditioners	SEER ≥4,10	SEER ≥ 5,10
	Classe C	Classe A

Only equipment with minimum levels of energy efficiency corresponding to class C or higher may be imported and marketed (SEER ≥ 4,10).

Air conditioners are classified according to their Seasonal Energy Efficiency Ratio as shown in the following table:

Table 6: A/C MEPS – Energy Classes – Cabo Verde

Energy efficiency class	*Seasonal Energy Efficiency Ratio*
A+++	SEER ≥ 8,50
A++	6,10 ≤ SEER < 8,50
A+	5,60 ≤ SEER < 6,10
A	5,10 ≤ SEER < 5,60
B	4,60 ≤ SEER < 5,10
C	4,10 ≤ SEER < 4,60
D	3,60 ≤ SEER < 4,10
E	3,10 ≤ SEER < 3,60
F	2,60 ≤ SEER < 3,10
G	SEER < 2,60

Example 3: Benin

In Benin, two decrees govern the energy performance standards and the energy labeling of the equipment concerned by the current project at STP:
- a decree setting the energy performance standards and the energy labeling of lamps and individual air conditioners,
- a decree setting the energy performance standards and the labeling of refrigerators.

All air conditioners must meet the following specifications (required energy efficiency ratio):

Table 7: A/C MEPS – Benin

Type of air conditioner	*EER*
All Mobile Air Conditioners, Integrated Systems (Monobloc) and Split systems of power less than or equal to 20 kW	EER ≥ 2,8

These are respective requirements of ECOWAS performance requirements (ECOSTAND O71-2: 2017, Minimum energy performance standard (NPEM) – Part 2 – air conditioners).

Example 4: Djibouti

The minimum energy performance standards for air conditioners, lamps and refrigerators are described in Decree No. …/MERN/MHUE/MDC/PR/2017. This decree aims to define the methods of labeling and displaying the characteristics of equipment manufactured, imported or sold in Djibouti.

All air conditioning products must meet the following specifications:

Table 8: A/C MEPS – Djibouti

Type of air conditioner	*GRP - Global Warming Potential*	*MEPS value – minimum energy performance standard*
Portable air conditioner	Not indicated	EER ≥ 2,8
Other air conditioners and air conditioning products	< 150	EER ≥ 2,8
	> 150	EER > 3,1

All air conditioning systems must meet the following specifications for off and standby modes (off and standby powers are given by the manufacturers):

- Maximum power at standstill ≤ 0.5 W
- Maximum standby power ≤ 0.5W (for wake-up function only)
- Maximum standby power ≤ 1 W (for a wake-up function and only an indication that the wake-up function is activated, and/or the display of information or status)

Example 5: Ghana

The minimum energy efficiency standard for air conditioners to be acceptable in Ghana is an Energy Efficiency Ratio (EER) of 2.8 watts of cooling per watt of electricity input. This is equivalent to 9.55BTU/Watt. (The imperial unit measure of energy efficiency used in the United States and Canada). Air Conditioners with EER of 3.5 and above are available on the market.

Table 9: A/C MEPS – Energy Classes – Ghana

Energy Efficiency Star Rating	Non-ducted air-cooled air conditioners
5 – star	4.00 < EER
4 – star	4.00 ≥ EER > 3.75
3 – star	3.75 ≥ EER > 3.45
2 – star	3.45 ≥ EER > 3.15
1 – star	3.15 ≥ EER > 2.80

Example 6: Brazil

In Brazil energy efficiency standards policy formally begins with the ‘‘Energy Efficient Act’’ enacted in 2001. The specified set of MEPS for air conditioning devices was adopted only 6 years after the Law (MME—Ministry of Mines and Energy, 2007).

In the past year Brazil has speed up revisions on MEPS of already regulated A/Cs. A regulatory impact analysis for refrigerators was programmed for 2021.

At present, each AC unit sold in Brazil must include a label classifying its energy efficiency. It is widely known that ‘A’ grade equipment is more efficient, but the current threshold for top-rated products is particularly unambitious, meaning that most of the ACs currently sold in the country have an ‘A’ grade.

The new regulation determines that:

- from December 2022 (Phase 1), ‘A’ labeled ACs must be at least 52% more efficient than current ‘A’ rated models; and

- from December 2025 (Phase 2), ‘A’ labeled ACs must be at least 108% more efficient than current ‘A’ rated models.

The early adoption of Phase 1 is optional, but many of Brazil’s major manufacturers have already expressed their intention to adopt the Phase 1 level immediately.

3.2.2 Lighting: examples of MEPS in other countries

Example 1: European Union

The EU MEPS for lighting fixtures have recently been updated, in order to facilitate the new energy label. The introduction of the new labels was organized in a phased manner according to specific EU legislation. In 2021, new labels were rolled out in physical and online stores for lighting products.

Table 10: Lighting MEPS – Energy Classes – EU

Energy efficiency class	*Total mains efficacy* η_{TM} *(lm/W)*
A	$210 \leq \eta_{TM}$
B	$185 \leq \eta_{TM} < 210$
C	$160 \leq \eta_{TM} < 185$
D	$135 \leq \eta_{TM} < 160$
E	$110 \leq \eta_{TM} < 135$
F	$85 \leq \eta_{TM} < 110$
G	$\eta_{TM} < 85$

The energy efficiency class of light sources is determined on the basis of the total mains efficacy η_{TM}, which is calculated by dividing the declared useful luminous flux $\mathbf{\Phi_{use}}$ (expressed in lm) by the declared on-mode power consumption $\mathbf{P_{on}}$ (expressed in W) and multiplying by the applicable factor F_{TM} of the following table:

Table 11: Lighting MEPS – F_{TM} Values – EU

Energy efficiency class	*Total mains efficacy* η_{TM} *(lm/W)*
Non-directional (NDLS) operating on mains (MLS)	1,000
Non-directional (NDLS) not operating on mains (NMLS)	0,926
Directional (DLS) operating on mains (MLS)	1,176
Directional (DLS) not operating on mains (NMLS)	1,089

The η_{TM} is calculated according to the following formula:

$$\eta_{TM} = \frac{\phi use}{Pon} \times F_{TM} \text{ (lm/W)}$$

Example 2: Cabo Verde

Table 12: Lighting MEPS – Cabo Verde

Electrical equipment		*Minimum requirements for import and marketing*	*Minimum requirements for obtaining a warranty seal*
Lamps	No directional	EER ≤ 0,60	EER ≤ 0,24
		Class C	Class A
	Directional	EER ≤ 1,20	EER ≤ 0,40
		Class C	Class A

Minimum import and marketing requirements: Only equipment with minimum levels of energy efficiency corresponding to class C or higher may be imported and marketed.

Lamps are classified according to their energy efficiency ratio (EER), as shown in the following table:

Table 13: Lighting MEPS – Energy Classes – Cabo Verde

Energy efficiency class	*Energy efficiency ratio (EER) of non-directional lamps*	*Energy efficiency ratio (EER) of the directional lamp*
A++	EER ≤ 0,11	EER ≤ 0,13
A+	0,11 < EER ≤ 0,17	0,13 < EER ≤ 0,18
A	0,17 < EER ≤ 0,24	0,18 < EER ≤ 0,40
B	0,24 < EER ≤ 0,60	0,40 < EER ≤ 0,95
C	0,60 < EER ≤ 0,80	0,95 < EER ≤ 1,20
D	0,80 < EER ≤ 0,95	1,20 < EER ≤ 1,75
E	EER > 0,95	EER > 1,75

Example 3: Benin

All network lighting lamps must meet the following requirements:

Lamp efficiency – lamps must have a minimum efficiency, measured in lumens per watt (lm/W) according to the values defined in the following table:

Table 14: Lighting MEPS – Energy Classes – Benin

Nominal power of a lamp P (W)	*Minimum efficiency (lm/W)*
P < 5	40
5 ≤ P < 9	45
9 ≤ P < 15	50
15 ≤ P < 25	55
P ≥ 25	60

These requirements are respectively ECOWAS performance requirements (ECOSTAND O53: 2016, technical specifications for networked lighting service lamps).

Example 4: Djibouti

The lamps must have a minimum efficiency, measured in lm/W (lumen per watt):

Table 15: Lighting MEPS – Energy Classes – Djibouti

Nominal power P (W)	*Minimum efficiency (lm/W)*
P < 5	40
5 ≤ P < 9	45
9 ≤ P < 15	50
15 ≤ P < 25	55
P ≥ 25	60

Example 5: Ivory Coast

Ivory Coast is currently undergoing the final implementation phase of the national MEPS for general service lamps. The following requirements are included in the national MEPS for general service lamps in Ivory Coast.

Table 16: Lighting MEPS – Ivory Coast

Technology Scope	Neutral
MEPS range (lm/W)	LED 60 to 80 CFL 50 to 60
Corrections	Directional Colour Tuneable Connected
Energy labelling levels	None
Colour Rendering Index – CRI (Ra)	≥80
Correlated Colour Temperature – CCT (K)	Not dependent
Flicker Pst/SVM	None
Lifetime (h) / early failures	LED 15000 minimum CFL 6000 minimum Failures at 1000 hours ≤5%
Dimming requirement	None

Example 6: Brazil

In Brazil, INMETRO is a governmental agency that develops standards called “Technical Regulation”, which are normative acts of mandatory character. A lot of low quality LED lamps were imported to Brazil, and INMETRO needed to create standards to be met by importers and manufacturers. Such standards were created in 2014, entitled “**Technical Quality Regulation (RTQ)**”, which focuses on energy efficiency and safety, and “**Conformity Assessment Requirement (RAC)**”, which focuses on performance, electrical safety and electromagnetic compatibility.

RTQ states that LED Lamps with Base or Body Integrated Control Device constitute a single, non-detachable part intended for operation at 60 Hz AC for rated voltages of 127 V and/or 220 V, voltage ranges that cover them, with direct current, overvoltage protection, supply voltage up to 250 V, intended for domestic use and rated up to 60 W. The energy consumed by the LED lamp shall not exceed the

stated rated power of more than 10%. For LED lamps with a declared rated power of 5 to 25 W, the power factor (FP or PF) must be greater than or equal to 0.70, and harmonic current limits are not set. The Correlated Color Temperature (CCT) of a LED lamp is calculated from spectral distribution measurements or non-season chromaticity coordinates according to IES LM-79-08. The CCT values obtained are classified as shown in Table 1 according to ANSI C78.377. The CCT value obtained from a LED lamp may not exceed the category tolerance indicated by the supplier responsible. The measured initial luminous flux of a LED lamp shall not be less than 90% of the declared nominal luminous flux and shall maintain the manufacturer's declared luminous value for at least 70% of its lifetime and the minimum luminous flux value is not defined for omnidirectional lamps with a power output of less than 20 W. The initial measured luminous efficacy shall be a minimum of 55 lm/W for lamps of less than 15 W and a minimum value of 60 lm/W for lamps of 15 W or greater.

The RAC applies to single-piece, non-detachable LED lamps with a built-in fixture or body and are intended for operation in a 60 Hz, AC distribution network for rated voltages of 127 V and/or 220 V, or in direct current in any voltage range. The RAC defines the information to be provided in the technical information such as product code, rated power (W), luminous flux (lm), correlated colour temperature (K), power factor, operating voltage (V), colour reproduction index, external and internal photos of the object (body, LED and the control device), as well as the packaging, already with the ENCE prototype provided, IES LM80 test report of the LEDs used in the lamps, capacitor specification (electrolytic capacitor) used, datasheet/part number of all LED lamp electronics, and Electrolytic Capacitor Temperature Life Time Curve, if applicable. The RAC also makes available the conformity identification seal templates, technical specification worksheet, lists the types of tests to be performed, the number of samples to be made available by the manufacturer, the number of samples required for each type of test, criteria for maintenance of luminous flux.

The following table shows the limits of luminous and power quality parameters established by the RTQ and RAC ordinances, which apply to samples of lamps used in this work, with a power of less than 20 W.

Table 17: Lighting MEPS – Energy Classes – Brazil

Power (W)	Must not exceed rated power by 10%
PF Harmonic current (mA)	≥0.7 No limit set for lamps with power less than 25W
Luminous flux (lm)	No limit set for omnidirectional lamps with power less than 20W
LE – Luminous efficacy (lm/W)	If power < 15 W, LE > 55 lm/W If power ≥ 15 W, LE > 60 lm/W
CRI (K)	> 80
THD	No limit set for lamps with power less than 25 W

3.2.3 Refrigerators: examples of MEPS in other countries

Example 1: European Union

The energy efficiency class of refrigerating appliances is determined on the basis of the energy efficiency index (EEI) as set out in the following table. The EEI is calculated according to the following formula:

$$EEI = \frac{Standard\ Energy\ Consumption\ \left(\frac{kWh}{year}\right) *}{Measured\ Energy\ Consumption\ of\ model\ \left(\frac{kWh}{year}\right)}$$

* The Standard Energy Consumption (SAEc) is defined by the technical difficulty of a product to reach a specific efficiency.

Table 18: Refrigerator MEPS – Energy Classes – EU

Energy efficiency class	*Energy Efficiency Index*
A	EEI ≤ 41
B	42 < EEI ≤ 51
C	51 < EEI ≤ 64
D	64 < EEI ≤ 80
E	80 < EEI ≤ 100
F	100 < EEI ≤ 125
G	EEI >125

Example 2: Cabo Verde

Table 19: Refrigerator MEPS – Cabo Verde

Electrical equipment	*Minimum requirements for import and marketing*	*Minimum Requirements for Obtaining a Warranty Seal*
Refrigerators	EER < 75	EER < 55
	Class B	Class A

Minimum import and marketing requirements: Only equipment with minimum levels of energy efficiency corresponding to class B or higher can be imported and marketed (EER ≤55).

Refrigeration equipment for domestic use is classified according to its Energy Efficiency Ratio (EER), as shown below:

Table 20: Refrigerator MEPS – Energy Classes – Cabo Verde

Energy efficiency class	*Energy Efficiency Index*
A+++	EER < 22

A++	22 ≤ EER < 33
A+	33 ≤ EER < 42
A	42 ≤ EER < 55
B	55 ≤ EER < 75
C	75 ≤ EER < 95
D	95 ≤ EER < 110
E	110 ≤ EER < 125
F	125 ≤ EER < 150
G	150 ≤ EER

Example 3: Benin

The manufacture, import, marketing or distribution, for a fee or free of charge, throughout the national territory, of refrigerators that do not have the characteristics specified in the ECOWAS standards are prohibited: ECOSTAND 071-1:2017 (F): “Minimum energy performance standards (MEPS) – Part 1 – refrigerating appliances”.

The refrigerators, which correspond to the field of application detailed in the decree, will have to satisfy the requirements as they are indicated in the table below. The minimum energy performance of the refrigerating appliance is indicated by the Energy Efficiency Ratio (EER) specified below across the two climatic classes.

Table 21: Refrigerator MEPS – Climate Classes – Benin

Climate class	*Ambient temperature (°C)*	*Energy Efficiency Ratio (EER)*
Sub-Tropical (ST)	+16 to +38	EER ≤70
Tropical (T)	+16 to +43	EER ≤80

Source: ECOSTAND 071-1:2017 (E) : « Minimum energy performance standards (MEPS) – Part 1 – refrigerating appliances »

The energy efficiency class of refrigerators is determined on the basis of their energy efficiency ratio (EER), as shown in the table below.

Table 22: Refrigerator MEPS – Energy Classes – Benin

energy efficiency ratio (EER)		*energy efficiency class*
Fridge-freezer (Type 5)	*Type 1, 2, 3, 4 Refrigerators*	
EER ≤ 50 %	EER ≤ 60 %	03 star
50 % < EER ≤ 70 %	60 % < EER ≤ 70 %	02 star
70 % < EER	70 % < EER	01 star

Example 4: Djibouti

All refrigeration appliances must meet the following characteristics:

- Climatic class: T (tropical) or ST (sub-tropical)
- Sub-tropical class: IEE < 42
- Tropical class: IEE < 55 IEE: Energy Efficiency Index

Example 5: Ghana

According to article 56 of the law 541, 3 energy efficiency acts have been elaborated and adopted by the Parliament of Ghana, to ensure that only lighting, refrigerating or AC appliances that respect the MEPS can enter the Ghana market. The acts are:

- Norms and energy efficiency label of AC and fluorescent lamps, 2005's regulation (law n°1815)

- Norms and energy efficiency label for refrigerating appliances, 2009's regulation (law n°1958)

- Energy efficiency: prohibition of manufacturing, sale or import of incandescent lamps as well as second hand refrigerator and AC, 2008's regulation (law n°1932).

Any refrigeration appliance should be marked as 1, 2, 3, 4 or 5 star according the energy efficiency index, defined in the table below.

Table 23: Refrigerator MEPS – Energy Classes – Ghana

Energy efficiency class	*energy efficiency ratio (EER)*	
	Climate class (ST)	*Climate class (T)*
5 stars	EER < 30	EER < 42
4 stars	30 < EER ≤ 42	42 < EER ≤ 55
3 stars	42 < EER ≤ 55	55 < EER ≤ 75
2 stars	55 < EER ≤ 75	75 < EER ≤ 90
1 star	75 < EER ≤ 90	90 < EER ≤ 100

Example 6: Brazil

In Brazil energy efficiency standards policy formally begins with the ''Energy Efficient Act'' enacted in 2001. The specified set of MEPS for refrigerators, freezers and fridge freezers was adopted only 6 years after the Law (MME—Ministry of Mines and Energy, 2007). Criteria to specify the first MEPS for residential refrigerators were based on the experience of the Brazilian Labeling Program (PBE). Through the PBE, Brazilian manufacturers, CEPEL and INMETRO decided to eliminate the last label classes on a voluntary basis. The standard prohibits manufacturers and importers from placing F and G rated appliances on the Brazilian market. The following table shows the equations used for estimating the MEPS for the existing refrigerator models in the country in 2007. AV is the adjusted volume, and R141B and cyclopentane are the refrigerants.

Table 24: Refrigerator MEPS – Brazil

Categories	Equations for maximum consumption levels (MCL—kWh/month)	
	R141B	Cyclopentane
Refrigerator	MCL=0.0422 x AV+23.3227	NMC=0.0416 x AV+22.9786

Combined refrigerator / freezer	MCL=0.1118 x AV+20.8413	NMC=0.1101 x AV+20.5338
Combined refrigerator / freezer frost free	MCL=0.1292 x AV+9.1322	NMC=0.1258 x AV+8.8936
Vertical freezers	MCL=0.0257 x AV+47.8582	NMC=0.0254 x AV+47.1521
Vertical freezers frost free	MCL=0.0217 x AV+71.6286	NMC=0.0214 x AV+70.5718
Horizontal freezers	MCL=0.0925 x AV+15.9759	NMC=0.0911 x AV+15.7402

In the past year Brazil has speed up revisions on MEPS of already regulated refrigerators. A regulatory impact analysis for refrigerators was programmed for 2021 but results are not available.

4 The three (3) harmonized MEPS proposed

In this chapter, the MEPS for lighting, air conditioners and refrigerators to be adopted in STP are detailed.

Several points of vigilance were considered during the validation of these standards:

- Consultants ensured that harmonized MEPS are proposed;
- Consultants worked with the main stakeholders to validate this MEPS and labeling program while considering regional and international standards (ECCAS, ECOWAS approaches) and the experiences successfully carried out in other countries;
- Consultants take note of the existing similar programs in the countries of the sub-region and at the regional level in order to take them into account in the STP program.

Evaluating the impacts of MEPS along with a labeling program, is important to show how standards are efficient tools for energy efficiency, thereby reducing the demand, the peak and bills for electricity as well as decreasing greenhouse gases emissions. Such an assessment is a powerful tool to gain support from governments and the general public, showing the good use of public money and paving the way for the development of new MEPS and labeling programs. This evaluation is described in the baseline assessment report.

The technical details necessary to support the implementation of the MEPS are described in the implementation and compliance reports.

4.1 The results of the validation workshops

The consultant supported UNIDO to organize the workshops for validation and harmonization of MEPS and labels (while also participating in the aforementioned workshops).

Two validation (2) workshops were organized and the report was created and shared with UNIDO along with this document. The workshops covered the MEPS and labeling schemes jointly. The used raw data and spreadsheets will be provided to UNIDO and MOPIRNA.

During the first workshop, the consultant presented the elements of the current phase. The mechanism for MEPS and labels was explained, along with information on testing procedures and the plan for implementing and comply to the above. The consultant's recommendations were also shared with the group, and after the presentation the participants were asked to share their questions with the consultants.

During the second workshop, the participants were divided into workgroups, and were asked to fill out a questionnaire for the purpose of validating the consultant's proposal, and voice their opinions on the matter.

On the matter of MEPS, all of the groups agree that EU MEPS should be adopted, for the reasons that they are well proved and well established in an advanced market, there is available documentation on the standards and the appliances that the MEPS are developed for have been tested in accredited laboratories.

- Group 1 & 2: EU MEPS because the majority of imported products come from the EU. This means that equipment from Portugal has already been tested by accredited laboratories.
- Group 3: STP must opt for EU values because the documentation available on these standards is well advanced.
- Group 4 & 5: European standards because the imported products are products from Europe and therefore have proven themselves on the market (no more guarantee).

4.2 MEPS proposed for STP

In chapter 3, various MEPS practices from around the world are presented. It is apparent that the way to define MEPS is depending on the type of label being used. For example, regarding MEPS for lighting, Cabo Verde has adopted the EU MEPS model, which is consisted of 7 categories (energy class A+++ to E), according to lamp efficacy (lm/W). Those classes have been established according to worldwide technology progress.

On the other hand, Benin has adopted the ECOWAS MEPS model, which is consisted of 5 categories (energy class – 5-star to 1-star), according to nominal power (W) and minimum lamp efficacy (lm/W).

To understand which direction is optimal for STP, regarding the establishment of MEPS, it is important to understand how other countries chose their MEPS model. Benin chose to adopt the regional MEPS, as it is a member of ECOWAS. Cabo Verde, though it is not part of the European Union, chose to adopt the EU MEPS model, for the reason that most of the imported appliances come from the EU, and therefore it is easier to align with EU policies.

According to customs data, the imported equipment (lighting, refrigerators, A/Cs) in STP from 2019 to 2021 is mainly from Portugal, while appliances are also imported from China (Cf. Baseline assessment report).

By adopting the EU MEPS, STP will be able to align with the EU Standards, since the imported appliances are already coming from Europe.

It is also important that STP can quickly establish a mechanism for regulating imports, and forbid inefficient appliances from entering the STP market. If EU MEPS are adopted, then STP can easily check if the imported appliances, which are mainly coming from EU and therefore already tested according to EU standards, are meeting the national criteria for entering the country.

In order to adapt the MEPS to the context of STP, there is another mechanism in place, the Energy Class Thresholds, which are presented and studied in chapter 5 of this report.

5 ENERGY CLASS THRESHOLDS

Energy class thresholds is a mechanism that is used to determine which energy class is the lowest acceptable. This mechanism can act as a safety measure, in order to further protect the market.

In EU, the energy class threshold is set by the lowest class that appears on the label. The newly designed label has been developed so that class G is the least efficient that is available in the European market.

Cabo Verde has adopted MEPS and labels and the values that define them from the EU label. Those values however are based on the old label, and so in order to regulate the influx of imported appliances, Cabo Verde has instituted the use of the energy class threshold, which means that, for example, class D which appears on the old EU label, is no longer acceptable in the country. That means that after the implementation of the threshold, class C is the lowest acceptable energy class for ACs in Cabo Verde.

Threshold as a mechanism is very flexible, and can be updated periodically according to the needs of the country that applies it.

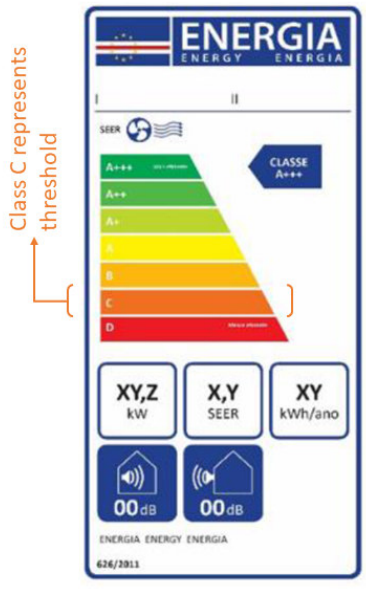
As an extension of the work of MEPS, energy classes will be defined. Energy classes start from the lowest acceptable value of energy efficiency and end at the highest expected within a reasonable amount of time (e.g. a decade).

5.1 Example: Cabo Verde

5.1.1 AC thresholds

Cabo Verde

In Cabo Verde, air conditioners are classified according to their Seasonal Energy Efficiency Ratio in categories, from A+++ (highest) to G (lowest). On the label, category D is the lowest, but the energy class threshold set by the country is category C. This means that air conditioners of energy class lower than C, or with SEER lower than 4.10, cannot be imported or sold in the country. In that case, classes D, E, F, G are ineligible for importation in Cabo Verde.



Energy efficiency class	*Seasonal Energy Efficiency Ratio*
A+++	SEER ≥ 8,50
A++	6,10 ≤ SEER < 8,50
A+	5,60 ≤ SEER < 6,10
A	5,10 ≤ SEER < 5,60
B	4,60 ≤ SEER < 5,10
C	4,10 ≤ SEER < 4,60
D	3,60 ≤ SEER < 4,10
E	3,10 ≤ SEER < 3,60
F	2,60 ≤ SEER < 3,10
G	SEER < 2,60

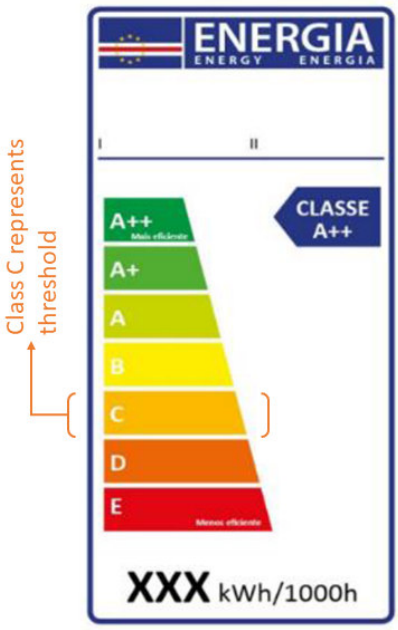
Figure 1: AC Thresholds - Cabo Verde

5.1.2 Lighting thresholds

Cabo Verde

Cabo Verde sets two thresholds, one for directional and one for non-directional lamps.

For directional lamps, the threshold is set on energy class C, which means that lamps with EER higher than 1.20 cannot be imported and marketed in the country. For non-directional lamps, the threshold is set on energy class C, which means that lamps with EER higher than 0.60 cannot be imported and marketed in the country.



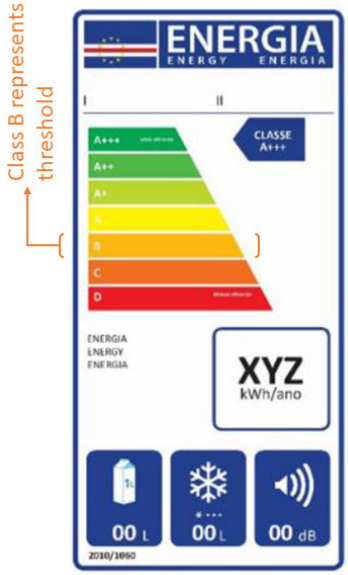
Energy efficiency class	*Energy efficiency ratio (EER) of non-directional lamps*	*Energy efficiency ratio (EER) of the directional lamp*
A++	EER ≤ 0,11	EER ≤ 0,13
A+	0,11 < EER ≤ 0,17	0,13 < EER ≤ 0,18
A	0,17 < EER ≤ 0,24	0,18 < EER ≤ 0,40
B	0,24 < EER ≤ 0,60	0,40 < EER ≤ 0,95
C	0,60 < EER ≤ 0,80	0,95 < EER ≤ 1,20
D	0,80 < EER ≤ 0,95	1,20 < EER ≤ 1,75
E	EER > 0,95	EER > 1,75

Figure 2: Lighting Threshold - Cabo Verde

5.1.3 Refrigerator thresholds

Cabo Verde

In Cabo Verde, refrigerators are classified according to their Energy Efficiency Ratio in categories, from A+++ (highest) to G (lowest). On the label, category D is the lowest, but the energy class threshold set by the country is category B. This means that air conditioners of energy class lower than B, or with EER higher than 74, cannot be imported or sold in the country. In that case, class C, D, E, F, G refrigerators are ineligible for importation in Cabo Verde.



Energy efficiency class	*Energy Efficiency Index*
A+++	EER < 22
A++	22 ≤ EER < 33
A+	33 ≤ EER < 42
A	42 ≤ EER < 55
B	55 ≤ EER < 75
C	75 ≤ EER < 95
D	95 ≤ EER < 110
E	110 ≤ EER < 125
F	125 ≤ EER < 150
G	150 ≤ EER

Figure 3: Refrigerator Threshold - Cabo Verde

5.2 Choosing Thresholds for STP

We suggest that STP follows the EU practices on MEPS & labels, and their respective thresholds.

For refrigerators and lighting fixtures, a new energy label has been developed, and energy classes have been redefined. Therefore, for those appliances, the lowest acceptable energy class is G.

Air conditioners are yet to be upgraded to the new energy label. New EU regulations to support the new label are being prepared. Until they are released, and the new energy label for ACs is available on appliances in stores, STP can adopt the threshold mechanism that Cabo Verde is using, which is described above. When EU has developed the new label, then the STP threshold can be updated, in order to follow the new EU guidelines.

6 Conclusion

This report contains the analysis of the Minimum Energy Performance Standards to be applied in STP, in order to support and regulate the labelling program.

For the MEPS mechanisms presented in this report are the basic elements that are used to define the standards for each appliance:

- Specific equipment that the standards describe
- Explanation of concepts and appliance-specific terms
- Tools that are used in order to tailor the mechanism according to the country's climate
- Calculation method of energy efficiency

Also included in this report are examples of MEPS mechanisms from countries around the world. In order to form MEPS that are suitable for STP, it is important to understand the MEPS that other countries have implemented. Therefore, MEPS from Europe, African and Lusophone countries are presented.

The proposed of the consultant is to adopt the MEPS from European Union. It was discovered during the assessment of the market that STP imports a lot of appliances from Portugal, which is a part of the EU. In that way, it makes sense for the country of STP to choose to adopt the EU model, for the following reasons:

- STP is already importing and using EU appliances
- EU market is a well-regulated market in general
- By adopting similar MEPS it facilitates the quick and easy organization of the STP imports by utilizing existing knowledge and expertise

Finally, described in this report is the thresholds mechanism, a supporting mechanism for MEPS & labels. The application of this mechanism for EU and Cabo Verde is described, and a suggestion is given for the country of STP. The thresholds mechanism is a flexible one, and can be revised periodically, according to the need of the country.

Next steps: During the mission 4, the consultant will assist the legal bodies involved and concerned to adopt the regulatory texts (decrees, orders, testing procedures) required to implement the standards while considering regional directives and the guidelines of international standards during the next phases of the project. In this sense, the consultant will:

- Write the draft of regulatory texts
- Train institutions during webinars and workshops
- Write an argument on the interest of standards and labels for people in charge of adopting regulatory texts.

Of course, for the success of the implementation of the standards, all the actions described in the implementation plan will have to be carried out.