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SUSTAINABLE PUBLIC PROCUREMENT


# GREEN PUBLIC PROCUREMENT TECHNICAL GUIDELINES AND SPECIFICATIONS FOR ENERGY-EFFICIENT REFRIGERATION APPLIANCES

One planet procure with care

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United Nations Environment Programme – Global Environmental Facility – Department for Environment, Food and Rural Affairs | United for Efficiency (U4E)

# TECHNICAL GUIDELINES FOR ENERGY-EFFICIENT REFRIGERATION APPLIANCES

DOMESTIC REFRIGERATORS AND FREEZERS, COMMERCIAL/ PROFESSIONAL REFRIGERATION APPLIANCES, VENDING MACHINES, LABORATORY GRADE REFRIGERATORS

## ACKNOWLEDGEMENTS

**Editing:** Paul Kellett and Soledad Garcia, United Nations Environment Programme United for Efficiency initiative

**Compiled by:** Miquel Pitach Mocholi, United Nations Environment Programme United for Efficiency initiative

**Design:** Fabrice Belaire

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# ACRONYMS AND ABBREVIATIONS

**AE** Annual Energy Consumption

**CFC** Chlorofluorocarbons

**$CO_2$** Carbon Dioxide

**EC** Energy Cost

**EE** Energy Efficiency

**EOF** End of Life

**ESM** Environmental Sound Management

**EU** European Union

**GDP** Gross Domestic Product

**GEF** Global Environment Facility

**GHG** Greenhouse Gases

**GP** General Purpose

**GWP** Global Warming Potential

**HC** Hydrocarbons

**HCFC** Hydrochlorofluorocarbons

**HCS** Horizontal Closed Cabinet Solid door

**HCT** Horizontal Closed Cabinet Transparent Door

**HFC** Hydrofluorocarbons

**HP** High Performance

**IEC** International Electrotechnical Commission

**LCC** Life Cycle Cost

**MC** Maintenance Cost

**MEPS** Minimum Energy Performance Standard

**ODP** Ozone Depletion Potential

**OECD** Organization for Economic Co-operation and Development

**PCB** Printed Circuit Board

**SDG** Sustainable Development Goals

**SPP** Sustainable Public Procurement

**TD** Transmission and Distribution Losses

**ULT** Ultra-low Temperature

**UNEP** United Nations Environment Programme

**U4E** United for Efficiency

**VCS** Vertical Closed Cabinet Solid Door

**VCT** Vertical Closed Cabinet Transparent Door

**WEEE** Waste Electrical and Electronic Equipment

# 1. FOREWORD

The Public Sector stands out in its capacity to exert enormous purchasing power, representing 12% of GDP in OECD countries and up to 30% in developing countries. This demonstrates the considerable potential for public procurement to be leveraged as a means to drive a Nation's economy to a greener and more sustainable one.

Public procurement refers to the purchase made by governments, state and semi-state-owned enterprises for goods, services and works. As public procurement accounts for a substantial portion of the taxpayers' money, governments are expected to carry it out efficiently and with high standards of conduct in order to ensure high quality service delivery and to safeguard the public interest.[1] Furthermore, it allows governments to serve as an exemplary model and send strong market signals so as to achieve multiple benefits such as the reduction of greenhouse gas (GHG) emissions, improved energy security and economic competitiveness, resource efficiency or circularity.

Sustainable Public Procurement (SPP), or Green Public Procurement as it is often also called, practices have the ability to transform markets by leveraging the power of public purchases to drive markets towards sustainability, reducing governments' environmental footprint and contributing significantly therefore to the achievement of considerable GHG emissions reduction while at the same leading to significant financial savings for state and semi-state entities due to much lower energy consumption. Stimulating SPP can help gear government spending towards sustainability but also can foster private sector and consumer behavior change, enabling the overall transition to a green, sustainable economy. By sustainably procuring energy efficient products and services, governments and public authorities in general can also impact their countries´ Nationally Determined Contributions (NDC´s) in different ways and intensity, as well as contributing towards achieving the following SDGs: n° 7 "Affordable and Clean Energy", n° 12 "Responsible Consumption and Production" and n°13 "Climate action".

Therefore, as a side effect of SPP, markets can be ready to implement more stringent MEPS (Minimum Energy Performance Standards) and eco-design requirements for all appliances entering the market, leading to more energy savings and reducing the environmental impact. Figure 1 shows the energy consumption and potential energy saving across 156 nations for domestic refrigerators considering minimum and higher ambition scenarios for MEPs. Considering only domestic refrigerators, if high ambition MEPS are implemented in 2021, the expected annual energy savings for 2040 are 369 TWh compared to the base case scenario, and equivalent to 168 power plants of 500 MW each.

Currently, SPP is not sufficiently embedded in sectoral policies and overarching sustainable development strategies, resulting in a lack of market readiness and response capacity from governments to purchase sustainable and green products and service alternatives. The relatively poor performance of SPP leads in turn to insufficient leveraging of public procurement which results in:

- Limited market transformation,
- High environmental and social footprints of state actors, and
- Insufficient mitigation of climate change and limited impact on other sustainability objectives.

Against this background, the United Nations Environment Programme (UNEP) United for Efficiency (U4E) initiative, has developed a series

1 https://www.oecd.org/gov/public-procurement/

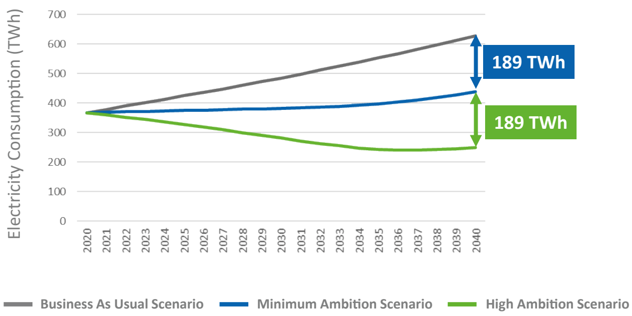
**Figure 1**

Energy consumption and potential energy saving across 156 nations for domestic refrigerators considering minimum and higher ambition scenarios for minimum energy performance standards

Source: U4E´s Country Savings Assessment

## 156 Country Savings Assessments

### Savings Potential of Residential Refrigerators by 2040*




| Annual Savings in 2040** | |
|---|---|
| Electricity savings (TWh) | 189 |
| *Equivalent to:* | |
| Power stations [500 MW] | 86 |
| Millions of $CO_2$ | 153 |
| Billions of USD in electricity bills | 18 |

| Electricity consumption growth by 2040 | |
|---|---|
| Business As Usual Scenario (BAU) | 71% |
| With Minimum Ambition Scenario (MEPS) | 20% |
| With High Ambition Scenario (HEPS) | (32%) |

* Savings refer to the 156 developing countries and emerging economies that had been assessed for the U4E Country Saving Assessments

** Minimum Ambition Scenario

of Sustainable Procurement Guidelines to provide a set of technical specifications for countries to develop their requirements for procuring higher energy efficiency products and thus, complement and strengthen their market transformation processes to more energy efficient lighting, appliances and equipment. If countries focus on the main electrical products, which are usually procured in large numbers by state and semi-state entities, they can instigate and accelerate the market penetration of high performance, positive impact electrical products such as lighting, appliances (refrigerators and room air conditioners) and equipment (electric motors and power distribution transformers), products that together represent more than one third of global energy consumption.

This guide includes a step-by-step approach on how to apply sustainability and current best technical criteria for the selected products in accordance with best international regulatory, social and environmental practices and introduces the rationale to be adopted by procurement practitioners when selecting among a set of products.

U4E Sustainable Procurement Guidelines are a key strategic instrument intended for public procurers, technical personnel and related officers in the expectation that these recommendations are integrated in their day to day procurement activities. They are also intended to address policymaker decisions related to Public Procurement Policy development to support their SPP implementation in the many relevant public institutions, as well as address those interested in raising awareness of the significant opportunities with climate-friendly and energy-efficient purchases.

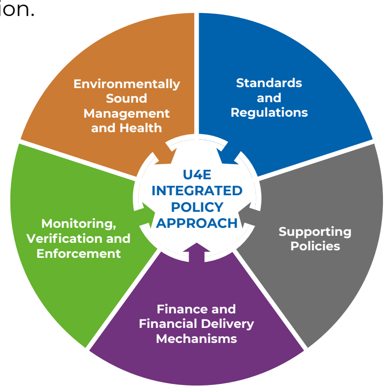
These Sustainable Public Procurement Guidelines are a supplement to the U4E Model Regulation Guideline and other already available international tools, standards guidelines and reports from the U4E portfolio.

# ABOUT UNITED FOR EFFICIENCY

U4E (*united4efficiency.org/*) is a global initiative led by UNEP, supported by leading companies and organizations with a shared interest in transforming markets for lighting, appliances and equipment, by encouraging countries to implement an integrated policy approach to energy-efficient products so as to bring about a lasting, sustainable and cost-effective market transformation.

The approach focuses on the end-user market and targets the five main components of the value chain for an energy efficient market:

1. **Standards and Regulations,**
2. **Supporting Policies including Education/Information/Training,**
3. **Market Monitoring, Verification and Enforcement,**
4. **Finance and Financial Delivery Mechanisms including Incentives and Public Procurement, and**
5. **Environmentally Sound Management and Health.**




U4E provides countries with tailored technical support through their in-house international experts and specialised partners, to get the most out of countries´ electricity by accelerating the widespread adoption of energy-efficient products, allowing monetary savings on consumer electricity bills, helping businesses to thrive through greater productivity, enabling power utilities to meet growing demands for electricity and assisting governments in reaching their economic and environmental ambitions. Currently the initiative is present in more than 30 countries worldwide. Based on each country's circumstances, U4E works with any of the following products: Lighting, Refrigerators, Room Air Conditioners, Electric Motors and Distribution Power Transformers – the five products that together consume over half of the world's electricity. Such support is available at three levels: Global, Regional and National; providing tools and resources and supporting multiple stakeholders on international best practices, regional policy roadmaps and harmonization process recommendations through guidelines and publications, such as energy efficiency Policy Guides, Global Model Regulations Guidelines, Model Public Procurement Specifications and Financing Guidelines. In addition, the initiative provides capacity building and education, policy tools and technical resources which include Country Savings Assessments completed for 156 countries showing the significant available financial, environmental, energy, and societal benefits that are possible with a full transition to more energy-efficient electrical products. This growing suite of tools and resources equips policymakers to understand the significant opportunities and the steps needed to start transforming their markets to higher performance, efficient appliances and equipment.

+33 (0)1 44 37 14 50

unep-u4e@un.org

UN ENVIRONMENT PROGRAMME
**United for Efficiency**
ECONOMY DIVISION,
Energy and Climate Branch
1 Rue Miollis, Building VII, 75015, Paris, FRANCE

For more information about UNITED FOR EFFICIENCY

PLEASE VISIT **united4efficiency.org**

# 2. SCOPE OF THESE GUIDELINES

These guidelines apply to vapour compression type, self-contained and closed refrigeration cabinets powered by electric mains. The requirements have been divided into four different sectors[2], covering the domestic refrigeration and commercial/professional refrigeration (self-contained and closed) sectors, vending machines and laboratory-grade refrigerating appliances (See Figure 2).

**THESE GUIDELINES DO NOT APPLY TO:**

- **A.** Wine storage appliances
- **B.** Mobile refrigerating appliances
- **C.** Remote refrigeration system (non-self-contained), such as the condensing unit, remote cabinets, compressors, process chillers, etc
- **D.** Open cabinets
- **E.** Blast cabinets
- **F.** Serve-over counters
- **G.** Walk-in coolers
- **H.** Other refrigerating appliances different than the vapor compression type

**THE MAIN ENVIRONMENTAL, ECONOMIC AND SOCIAL PROCUREMENT CRITERIA INCLUDED FOR THE APPLIANCES IN THE SCOPE ARE:**

1. Energy consumption
2. Refrigerant and foam blowing agent
3. Food preservation
4. Product durability (reparability)
5. Environmentally sound management
6. Social criteria

In some cases, the U4E Model Regulation Guidelines[3], or other regulations and programmes such as the Energy Star programme in the US or the European eco-design regulations, are used as reference to set recommendations on SPP criteria. Nevertheless, due to the diversity of situations, such as test standards, energy efficiency regulations, market conditions, etc., each country will need to adapt the guideline criteria to its own needs. Furthermore, while some parameters might be used as a minimum requirement, others can be applied as award parameters that will influence the acquisition decision.

2 *These sectors might differ slightly depending on the local regulations, which should be considered when adapting this guideline.*

3 *U4E's Model Regulation Guidelines for Refrigerators, published in September 2019. https://united4efficiency.org/resources/model-regulation-guidelines-for-energy-efficient-and-climate-friendly-refrigerating-appliances/*

The guidelines give recommendations on the technical requirements to be considered during the SPP process and present a methodology to calculate the life cycle costs and equivalent $CO_2$ emissions (Annex 5). They are accompanied by an Excel spreadsheet tool to help tenderers to make more informed decisions when comparing between different bids.


**Figure 2**

Refrigeration appliance examples for the four market sectors covered

# 3. TERMS AND DEFINITIONS

**A. AFFIDAVIT:** A written statement, in this case from the manufacturer or supplier of the refrigeration appliance, declaring that the product being offered meets a specific (or all) requirement(s) in the tender.

**B. BID:** An offer or proposal for goods and/or services submitted in response to the (sustainable) procurement request from the relevant government entity.

**C. COMPARTMENT:** Their classification depends on the target temperature (see Table 2) or other characteristics. It also refers to sub-compartments if they are inside a bigger compartment.

**D. COST:**

***End of life cost:*** Refers to the cost of the correct management of the product when it reaches its end of life, in accordance with legal requirements. For products falling into an extended producer responsibility policy, the producer[4] is responsible for the mentioned management and this cost can include requirements related to its recycling and/or preparation for reuse. Usually, the producer charges this cost to its client in the initial price of the product.

***External cost:*** Refers to the indirect cost related to GHG emissions, i.e. the effects of climate change. For example, increased flooding and storms; the spread of disease; sea level rise; increased food insecurity, etc. This value is usually expressed in USD per tonne of equivalent carbon dioxide pollution released into the atmosphere. Even though the GHG emitted by one country has an affect globally, there is no consensus yet for this value or range (see the Life Cycle Costs and Emissions Annex 5 for more information).

***Initial cost:*** Refers to the price of the product at the moment of acquisition. In some cases, parts of other types of cost might be included in the initial price, e.g. the end of life cost.

***Maintenance cost:*** Refers to the cost of repair and maintenance of the appliances. In some cases, it can be contracted with the supplier of the technology on a monthly basis.

***Operational cost:*** Refers to the cost of operation, mainly the cost of electricity used by the appliances.

**E. EMISSIONS:**

***Direct emissions:*** Emissions caused by the refrigerants when they are released into the atmosphere.

***Indirect emissions:*** Emissions caused in the power plants to produce the electricity that is used to run the refrigerating appliances.

**F. FOOD WASTE:** Is food that is lost (not eaten). There might be many reasons causing the waste of food, e.g. storage at temperatures that are not the optimum to increase the life of the product.

**G. MINIMUM ENERGY PERFORMANCE STANDARD (MEPS):** Refers to the minimum energy efficiency required to enter a product into the market. These standards refer to all products entering into the market, hence, the requirements for SPP should be more stringent than MEPS.

**H. MODEL REGULATION GUIDELINES:** Refers to the U4E guidelines used to support economies in the implementation or updating of MEPS.

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4 *Producer means any person who, irrespective of the selling technique used, puts on the market the product (manufacturer, retaileror importer).*

**I. SMART CONTROLS:** Automatic controls in the appliance that reduce the energy consumption, e.g. switching off the lights of the vending machine in periods of inactivity.

**J. SUSTAINABLE PUBLIC PROCUREMENT (SPP):** A process whereby public sector organisations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole life basis in terms of generating benefits not only to the organisation, but also to society and the economy, whilst minimizing, and if possible, avoiding, damage to the environment.

The term Green Public Procurement (GPP) is sometimes utilized interchangeably with SPP, however it should be noted that SPP more explicitly includes the social considerations of sustainable development.

**K. TENDER:** Document issued by the government requesting offers for goods or services. This document contains the specifications and minimum requirements to be met, for example the sustainability requirements suggested in these guidelines.

**L. TYPE OF REFRIGERATOR ACCORDING TO MARKET SECTOR:**

***Commercial/Professional:*** Refrigeration appliance that will be used under commercial or professional environments, e.g. bottled coolers, or professional kitchen refrigerators. They might have solid or transparent doors. They might be only refrigerator, only freezer, or a combination of compartments.

***Domestic refrigerator:*** Refrigeration appliance that will be used under domestic environments. They might be only refrigerator, only freezer, or a combination of compartments.

***Laboratory-grade refrigerator:*** Appliance used specifically for storing non-volatile reagents and biological specimens in laboratory settings at stable, low temperatures. The target temperature depends on the application, it can go from 12°C to as low as –80°C.

***Vending machine:*** Appliance designed to accept consumer payments and dispense beverages and other products at appropriate temperatures without on-site labour intervention.

**M. TYPE OF REFRIGERATOR ACCORDING TO CONSTRUCTION:**

***Built-in:*** Appliance designed, tested and marketed exclusively to be installed in cabinetry or encased (top, bottom and sides) by panels, and to be securely fastened to the sides, top or floor of the cabinetry or panels, and to be equipped with an integral factory-finished face to be fitted with a custom front panel.

***Closed refrigerator:*** Appliance that is closed on all sides, i.e. a door needs to be opened to provide access to the inside.

***Free-standing:*** Appliance that is not installed in cabinetry or encased (top, bottom and sides) by panels, i.e. they can be installed easily in any location. They are the most common models in the market.

***Self-contained:*** Appliance that contains all of its components inside the unit itself in order to work autonomously, such as the compressor, condenser and evaporator.

# 4. DOMESTIC REFRIGERATORS AND FREEZERS PROCUREMENT CRITERIA

Domestic refrigerators refer to those appliances that are supposed to be used under residential conditions (even if they are not used in residential buildings). They should be in accordance with the local regulation definitions.

The three main categories in which domestic refrigerators are usually divided are:

a. Refrigerator

b. Refrigerator-freezer

c. Freezer

This chapter describes the main parameters that should be considered during the SPP of domestic refrigerators. Apart from the considerations included in these guidelines, the products should comply with all other product specific requirements and certifications in place, such as MEPS, energy efficiency labels, safety standards, hazardous substance and heavy metal restrictions, etc.

## 4.1 ENERGY CONSUMPTION

The lower the energy consumption, the lower the operational cost and lower indirect emissions. Manufacturers declare the appliance energy consumption under the test method applied locally. Therefore, all the products submitted to the tender should be tested with the test standard applying in each country.

The following sub-sections discuss the parameters that influence the energy consumption and that should be considered when preparing the tender for domestic refrigerators:

- Energy efficiency
- Volume
- Free-standing vs. built-in appliances
- Functional requirements

The information needed to verify these requirements can be found in the energy label, which usually includes the energy consumption, the volume and energy efficiency. The other parameters, such as built-in and functional requirements can be obtained from the refrigerator technical information (manuals) and from a manufacturer/supplier affidavit.

### 4.1.1 Energy Efficiency

It is recommended to frequently update the energy efficiency requirements, so only the highly efficient refrigerators are targeted during the sustainable public procurement process. SPP energy requirements should target products that are above the average efficiency in the market if they want to incentivise the industry to accelerate the transition to more sustainable technologies. It is recommended that tenders set the energy limits to target around the 20% most[6] efficient refrigerators in the market.

*5 The number of categories might be different depending on the local regulation. For instance, the Mexican regulations for Domestic Refrigerators have 42 different MEPS depending on the characteristics of the refrigerator. In these cases, the number of categories should be reduced as much as possible in order to simplify the procurement process.*

More efficient products can also be targeted and justified with the life cycle cost (LCC) analysis method, which will account for the initial costs, operational costs and external costs due to $CO_2$ emissions, hence, the higher the energy consumption, the higher the operational costs and emissions (see the Life Cycle Costs and Emissions Annex 5 for more information).

Depending on local characteristics, the energy efficiency requirements can be set using the following different options.

## Option 1 – Setting the efficiency requirements based on the energy efficiency labels and supported by local market data

The simplest way to set the efficiency requirement is to use the energy efficiency label by targeting the energy efficiency classes with the most efficient products.

For example, Figure 3 shows the evolution of the energy efficiency classes distribution in Europe with the actual label and with the new label projected from 2021 until 2030. In this case, for the new label, the efficiency class D or higher are expected to share around 30% of the market in 2021, while C or higher will share around 5% of the market. Therefore, targeting the D efficiency class or higher (A, B and C) would be the SPP requirement for 2021. Taking a minimum efficiency class of C or higher as a mandatory requirement could be too ambitious, leaving the tender without any bid, or with higher life cycle cost (see Annex 5).

Nevertheless, the number of energy efficient models is expected to increase in the future. For example, the models in the classes A to C are expected to represent around 30% of the market in 2023. Therefore, the requirement could be increased to class C or higher in 2023. Then, the requirement can be updated again to class B or higher in 2025 and to class A in 2028.

Therefore, the energy efficiency requirements for SPP should be updated periodically. This must be considered when setting the legal basis to avoid administrative barriers when updating the minimum efficiency requirements in the future. Otherwise, the requirements might become obsolete in a few years.

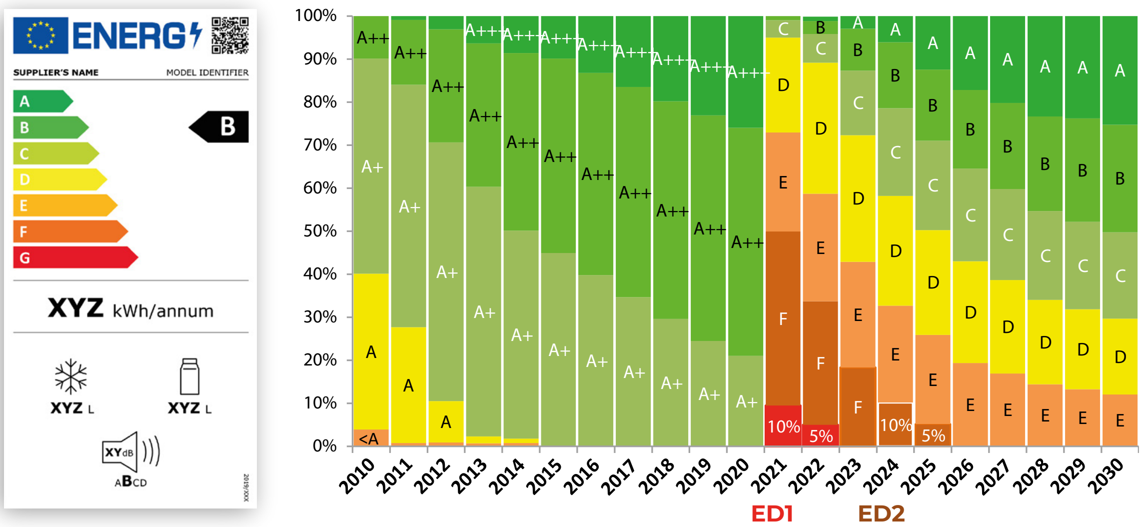



**Figure 3**

Energy efficiency label in Europe (from 2021) and market distribution projected until 2030

Source: Draft new labeling EU regulation [13]

6 *Around 20% of the Frost-Free Refrigerator-Freezer in India will pass the high energy efficiency level in the U4E model regulation [1]*

The same logic used in the previous example to set the SPP efficiency requirement on the European label (A to G) can be applied with any other type of comparative label. For instance, the 5-star label in India, or the % of savings label in Mexico. The most important aspect is to know the energy efficiency level in the market so as to set an ambitious, but realistic target for sustainable public procurement.

Some countries use specific energy performance endorsement labels [independent certification labels], which can only be used by the most efficient products in the market, e.g. Energy Star in USA, or PROCEL in Brazil. Independent endorsement labels or certification are also an easy way to identify the efficient products in the market. Nevertheless, it is recommended to check if the requirements of the endorsement label/certification are not obsolete and that they target the most efficient products in the market (around 20%). Otherwise, it needs to be updated before it could be used in the SPP process.

## Option 2 – Setting the efficiency requirements based on the energy efficiency labels and supported by international benchmark

This is similar to Option 1, where local labels are used to identify the most efficient products in the market, but the choice of the energy efficiency level for the SPP criteria is based on international benchmark for higher efficiency products.

In this case, high efficiency levels from other economies can be used as a benchmark to set the SPP requirements. The U4E Model Regulation Guidelines are based on the best international practice around the globe [1]. These guidelines give three levels of energy efficiency: low, intermediate, and high efficiency. Therefore, these levels can be compared with the local label to set the requirements for SPP.

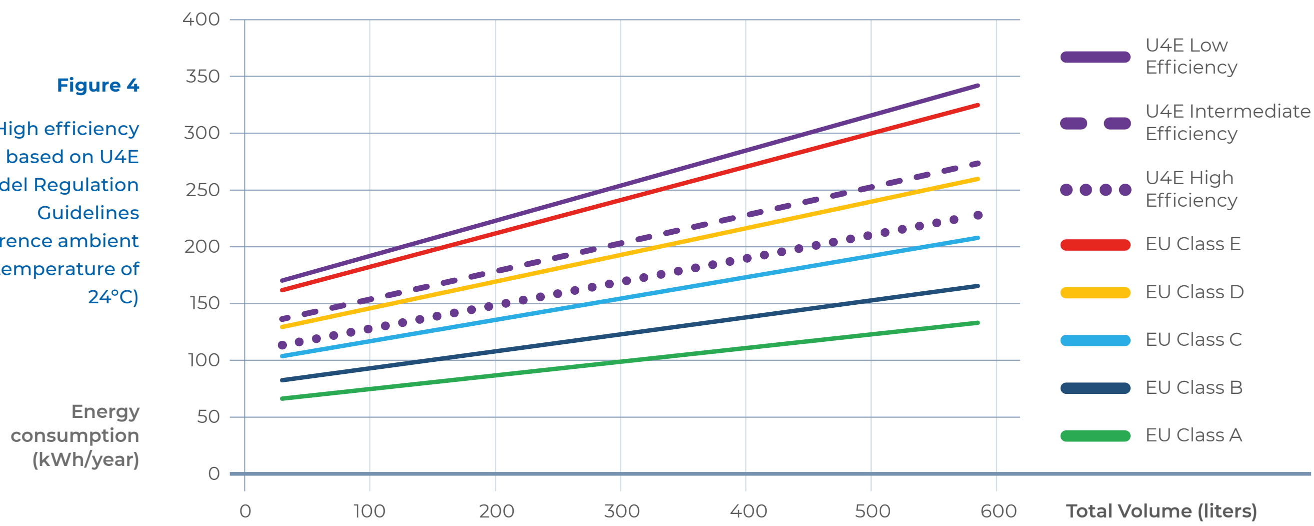
Figure 4 shows the example of the new EU label compared with the U4E Model Regulation Guidelines (energy consumption limits as a function of volume). The U4E high efficiency level is falling into class D (between C and D limits). Therefore, considering that the U4E Model Regulation Guidelines were aimed to be implemented around 2023, class C would be set as the minimum SPP requirement from 2023 and class D would be set as the requirement before 2023. This conclusion agrees with the requirements that were set considering the energy class distribution based on the European market assessment (see Figure 3).

One should notice that, in a lower energy efficiency market (or with higher initial cost for EE equipment), taking the U4E high efficiency level as a minimum requirement might be too ambitious. Therefore, the benchmark shall be supported with data gathered directly from the market for the target product, so the requirements are set with an ambitious but realistic limit.

In order to fairly compare between the U4E levels and the local label, both should be expressed for the same reference ambient temperature, type of appliance and test method (or adjusted for discrepancies).

**Figure 4**

High efficiency level based on U4E Model Regulation Guidelines (Reference ambient temperature of 24°C)



## Option 3 – No label available

In some countries, the energy efficiency label is not available, or it is not working effectively (top efficiency class with more than 30% of products), making it difficult to use it as a reference to distinguish the most efficient refrigerators in the market. In this case, the requirements can be set with the help of market data and/or with international best practices efficiency levels (benchmark). The difference with the other options is that the local label cannot be used as a reference for SPP.

In order to clearly show which is the maximum energy consumption requirement for SPP, tables can be used to show the maximum energy consumption as a function of volume and type of appliance. Table 1 shows an example with the maximum annual energy consumption for the three categories and different volumes (±15 liters). These limits are based on the high efficiency level in the U4E Model Regulation Guidelines[7] for an ambient reference temperature of 24°C [1]. See Annex 6 for an example of how to use a table with maximum energy consumption requirements for SPP.

Furthermore, independently of the option followed to apply the minimum energy efficiency requirements for the SPP, the use of specific tools is also helpful. This SPP guideline includes an Excel spreadsheet tool[8] that can be used for this purpose. Furthermore, it calculates the life cycle cost and $CO_2$ equivalent emissions for the different acquisition options (see Annex 5).

| Maximum Energy Consumption for SPP (kWh/year) | | | |
|---|---|---|---|
| Target total volume (±15 liters) | Refrigerator | Refrigerator (70%) – Freezer (30%) – Frost Free | Freezer (Manual Defrost) |
| 50 | 73 | 118 | 141 |
| 80 | 77 | 124 | 150 |
| 110 | 80 | 130 | 158 |
| 140 | 83 | 136 | 167 |
| 170 | 86 | 142 | 176 |
| 200 | 90 | 149 | 184 |
| 230 | 93 | 155 | 193 |
| 260 | 96 | 161 | 202 |
| 290 | 100 | 167 | 210 |
| 320 | 103 | 173 | 219 |
| 350 | 106 | 179 | 228 |
| 380 | 109 | 186 | 236 |
| 410 | 113 | 192 | 245 |
| 440 | 116 | 198 | 254 |
| 470 | 119 | 204 | 262 |
| 500 | 122 | 210 | 271 |
| 530 | 126 | 217 | 280 |
| 560 | 129 | 223 | 288 |
| 590 | 132 | 229 | 297 |
| 620 | 135 | 235 | 305 |
| 650 | 139 | 241 | 314 |
| 680 | 142 | 248 | 323 |
| 710 | 145 | 254 | 331 |

**Table 1**

High efficiency level according to U4E Model Regulation Guidelines for refrigerator only, refrigerator-freezer (70%–30% volumes share) and freezers (Reference ambient temperature of 24°C and test method IEC 62552:2015)

7 *The Model Regulation guideline can be downloaded here: https://united4efficiency.org/resources/model-regulation-guidelines-for-energy-efficient-and-climate-friendly-refrigerating-appliances/*

8 *The U4E SPP tool for Refrigerating Appliances can be download here: https://united4efficiency.org/resources/tools/*

### 4.1.2 Volume

The energy consumption will depend on the volume of the compartments. For the same energy efficiency, a refrigerator with bigger compartments will consume more energy. Therefore, the target volume of each compartment must meet the real needs and not be oversized. Refrigerators might be a combination of compartments at different temperatures depending on the application (see Section 4.3.1).

Furthermore, the total number of refrigerators should be rationalized. More refrigerators than needed will lead to higher overall energy consumption.

### 4.1.3 Free-standing and built-in appliances

There are some appliances that are designed especially for the built-in configuration, and the manufacturer declares the energy consumption considering the final installation in the conditions that the build-in refrigerator will work. For a given refrigerators, the built-in configuration will tend to consume slightly more energy given the confinement configuration. Depending the local energy efficiency regulations, this extra consumption might be compensated in the energy efficiency calculation so that the energy efficiency of the product is not affected by the configuration, and therefore the extra consumption is not reflected in the label. Therefore, generally, the free-standing installation is preferred in terms of energy consumption.

Nevertheless, if the installation is required to be built-in, it is recommended to purchase a refrigerator specially designed for this purpose. If a free-standing refrigerator is installed as built-in, the consumption will be higher than that declared by the manufacturer.

### 4.1.4 Functional requirements

There are some functions (e.g. fast freeze facility and winter settings) that might influence the energy consumption of the appliance, but they are not considered during the laboratory test, thus they are not reflected in the declared energy consumption by the manufacturer. Therefore, in order to minimize the effect of these functions on the real energy consumption, the following requirements[9] should apply:

- Any fast freeze facility, or any similar function achieved through modification of the temperature settings in the freezer compartments, shall, once activated by the end-user, automatically revert to the previous normal storage conditions after no more than 72 hours.
- Refrigerators with winter settings to keep all compartments below target temperatures shall be automatically activated or de-activated according to the need to maintain the frozen compartment at the target temperature.

## 4.2 REFRIGERANTS

The requirements for the refrigerant and foam blowing agent in all types of refrigerators can be given in terms of maximum ODP (Ozone Depleting Potential) and GWP (Global Warming Potential). The upper limit should be:

**MAXIMUM ODP = 0**  **MAXIMUM GWP = 20**

Natural refrigerants with zero ODP and low GWP, such as isobutane (R600a) and cyclopentane for the refrigeration cycle and foam blowing agent respectively, are widely used in domestic refrigerators and have been demonstrated to work efficiently. Therefore, there is no need to allow refrigerants with higher GWP.

9 *Europe has implemented these requirements in their Eco-design regulations to all refrigerators being introduced in the market.*

The new synthetic unsaturated HFCs, known as HFOs, also have zero ODP and low GWP. Nevertheless, they still have an unknown degradation pathway, they are also flammable and/or have toxicity implications and yield dangerous decomposition products when they burn. Therefore, for domestic refrigeration, where technology is efficient and widely available, natural refrigerants are preferred even if synthetic refrigerants have similar OPD and GWP.

The information needed to verify these requirements can be found in refrigerator technical information, manuals, identification plate and manufacturer/supplier affidavit.

## 4.3 FOOD PRESERVATION

Food waste has an impact on climate, water, land, and biodiversity. According to Freija van Holsteijn and René Kemna (2018) [2], in Europe, 11% of end-use food ends up as avoidable waste. Overall GHG emissions related to the entire food supply chain are around 27 times higher than overall GHG emissions related to domestic refrigerators, hence, avoiding waste food also has a high impact on reducing GHG emissions. Energy related GHG emissions from fossil fuels accounted for more than half of the total food supply chain emissions in Europe [2].

Food waste could be reduced with:

- Refrigerators that have compartments at different temperatures (See Section 4.3.1)
- Refrigerators that can maintain the target temperature at the local ambient temperature range in the household (See Section 4.3.2)

See Annex 5 for the economic and GHG impacts for food waste.

These features can be verified by the energy label, refrigerator technical information, manuals, compartment marks and manufacturer/supplier affidavit.

### 4.3.1 Compartment temperature

The typical compartment for fresh food has a target temperature of 4°C. Nevertheless, the optimal storage temperature might differ depending on the type of product.

Table 2 shows the recommended temperatures for storing some fresh products that will extend their life. Furthermore, some refrigerators can also control the humidity. In this way, the same compartment (or sub-compartment) can be used to store meat and fish (low humidity requirements) and vegetables (higher humidity requirements) depending on the settings of the compartment or sub-compartment[10].

The optimization of volume and compartment temperatures according to the storage needs of the user can reduce the level of food waste. In this sense, it makes sense to procure a refrigerator with several types of compartments depending on the products that will be stored. Nevertheless, is not recommended to procure refrigerators with compartments that will not be used. For instance, the chill compartment to store meat and fish might reduce food waste, but it also has lower temperatures, so it might consume more energy (for similar products). In this sense, the extra energy consumption might be worth it only if the compartment will be used to store these types of products.

Regarding the frozen compartment (1 to 4 stars), only the 4-star compartment is intended to freeze products. The other frozen compartments must be used only to maintain products that are already frozen.

10 *A sub-compartment is inside a bigger compartment, but with a different target temperature*

Table 2

Recommended temperatures for fresh food

Source: Freija van Holsteijn and René Kemna, 2018 [2]

| Compartment type/ Typical temperature | Meat chiller | Salad chiller | Fresh food | Cellar | Pantry |
|---|---|---|---|---|---|
| Product | 0°C | 2°C | 4°C | 12–14°C | 17°C |
| Meat, fish & shellfish | | | | | |
| Broccoli, cauliflower, carrots, cabbage, lettuce, mushrooms... | | When ripe | | | |
| Apples, pears, kiwi, peaches... | | Maximum storage | | | Ripening |
| Milk, Yogurt, butter, beans... | | | | | |
| Citrus fruits, avocado, eggplant, bell pepper, cucumber, onion... | | | | | |
| Banana, pineapple, mango, melon, tomatoes... | | | | | Ripening |

## 4.3.2 Climatic zone

Refrigerators are categorized depending on the ability to maintain the target temperatures in different climatic conditions (see Table 3). For instance, “Temperate” refrigerators might be able to maintain the target temperatures of their compartments for a range of ambient temperatures between 16°C to 32°C.

Therefore, the refrigerator should be selected according to the ambient temperature where it will be installed (not the outdoor temperature) to minimize food waste when working at extreme temperatures.

Tropical refrigerators have oversized compressors that allow them to maintain the target temperatures even when the ambient temperature reaches 43°C [3]. Oversized compressors might lead to higher energy consumption, especially for fixed speed compressors. Therefore, tropical refrigerators should be preferred only when the ambient temperature where the refrigerator will be installed is expected to reach high temperatures.

Table 3

Refrigerator climatic zones

Source: IEC 62552:2015 [4]

| Description | Class* | Ambient temperature range |
|---|---|---|
| Extended temperature | SN | 10°C to 32°C |
| Temperate | N | 16°C to 32°C |
| Subtropical | ST | 16°C to 38°C |
| Tropical | T | 16°C to 43°C |

* N=Normal ; SN=Subnormal

## 4.4 PRODUCT DURABILITY (REPARABILITY)

The typical lifespan of a domestic refrigerator is around 16 years. This is adequate in most situations considering the overall environmental impact: manufacturing, transport, energy use, recycling, etc. [3]. To ensure that a refrigerator can work efficiently during its lifespan, the manufacturer/supplier needs to meet several reparability requirements, such as providing availability of spare parts (see Section 4.4.1) and access to repair and maintenance information (see Section 4.4.2).

The reparability requirements presented in this section are based on the new European eco-design regulation for 2021, (EU) 2019/2019 [5], which will be mandatory for all refrigerators entering into the European market. Therefore, if this is not a requirement yet for all refrigerators in the application country, it might be included as a requirement for SPP.

These requirements can be verified by the manuals and manufacturer/supplier affidavit.

### 4.4.1 Availability of spare parts

The manufacturer/supplier should guarantee the supply of essential spare parts. At least the following:

- For professional repairers:
  - Thermostat
  - Temperature sensors
  - Printed circuit boards
  - Light sources
- For professional repairers and end-users:
  - Door handles and door hinges
  - Trays and baskets
  - Door gaskets

The spare parts shall be delivered in a reasonable period of time from the date of order (e.g. maximum 15 working days) and they shall be offered even when the model is no longer in the market, ideally during the lifespan of the product (at least 10 years for the door gasket, and 7 years for other spare parts).

Furthermore, the manufacturer/supplier shall ensure that these spare parts can be replaced with the use of commonly available tools and without permanent damage to the appliance.

### 4.4.2 Access to repair and maintenance information

Apart from making available the spare parts listed above, if requested[11] by qualified[12] professional repairers, the manufacturer/supplier shall provide access to the following appliance repair and maintenance information:

- Qualification requirements of maintenance personnel.
- The unequivocal appliance identification.
- A disassembly map or exploded view.
- List of necessary repair and test equipment.
- Component and diagnosis information (such as minimum and maximum theoretical values for measurements).
- Wiring and connection diagrams.
- Diagnostic fault and error codes (including manufacturer-specific codes, where applicable).
- Data records of reported failure incidents stored on the refrigerating appliance (where applicable).
- Access to professional repair, such as internet webpages, addresses, contact details.
- Relevant information for ordering spare parts.
- The minimum period during which spare parts, necessary for the repair of the appliance, are available.

11 *Manufacturers, importers or authorized representatives may charge reasonable and proportionate fees for access to the repair and maintenance information or for receiving regular updates. A fee is reasonable if it does not discourage access by failing to take into account the extent to which the professional repairer uses the information.*

12 *In order to give access to repair and maintenance information, the professional must have the technical competence to repair refrigerating appliances and comply with the applicable regulations for repairers of electrical equipment in the country of application.*

Furthermore, the manufacturer/supplier shall give all necessary information to all users in order to minimize the environmental impact due to the use of the refrigerating appliance. Instruction manuals for installers and end-users shall include the following information:

- Combination of drawers, baskets and shelves that result in the most efficient use of energy.
- Clear guidance about where and how to store foodstuffs in the refrigerating appliance for best preservation, to avoid food waste.
- Recommended setting of temperatures in each compartment for optimum food preservation.
- Instructions for the correct installation and end-user maintenance, including cleaning of the appliance and circuit components. For instance, the frequency to clean the condenser (times per year) to maintain good energy efficiency.

### 4.4.3 Warranty

A minimum warranty period for the refrigerator of one year after the date of purchase. Other parts of the equipment might be guaranteed with at least 3 years (compressor, heat exchanger, control board, cabinet, door, thermostat, filter, capillary tube fan motor, defrost heating wire, ice maker, timer).

## 4.5 ENVIRONMENTALLY SOUND MANAGEMENT

The SPP acquisitions should minimize the adverse effects that may result from end of life of the product, i.e. waste, with a strong emphasis on reduction, reuse, and recycling.

Some countries already have a take-back programme that ensures the correct environmental disposal of the refrigerator at the end of life, for instance through extended producer responsibility policies. In any case, the manufacturer/supplier should be responsible for the sustainable management of waste at the end of the useful life of the equipment (Waste Electrical and Electronic Equipment – WEEE).

The European eco-design regulation requires that all refrigerating appliances are designed in such a way that the maximum portion of materials can be removed with the use of commonly available tools in order to facilitate material recovery (for re-use) and recycling while avoiding pollution. Therefore, if this is not a requirement yet for all refrigerators, it might be included as a requirement for SPP.

To reduce the solid waste generated by packaging, the packaging shall be the minimum possible to facilitate handling the equipment and it should be recyclable or reusable. Purchasers are also encouraged to prefer packaging with at least one of the following characteristics:

- Does not contain styrene (eg, styrofoam, EPS (expanded polystyrene), polystyrene).
- Maximizes post-consumer recycled content.
- Minimizes the contents of lead, cadmium, mercury and hexavalent chromium, with a goal of less than 100 ppm (0.01%) in total content.
- Packaging remains the property of the supplier and not the recipient.

These can be difficult requirements to verify, a manufacturer/supplier affidavit can be used for this purpose as further described below.

The generation of waste arises when purchasing new refrigerators and freezer units in order to replace old ones. This must be taken into account during any procurement process. This includes:

- The old devices that are replaced.
- The new refrigerators and/or freezers, which will become waste at the end of their useful life.
- The shipment containers and packaging in which the new appliances are sent.

Old refrigerators and freezers must be managed correctly and if there is a suitable local recycling plant available, it should be the first preferred management option. During the development of the procurement documentation, current relevant environmental legislation should be the main factor to be considered.

The entity responsible for the management of the old devices varies depending on the legislation. If the current applicable legislation provides for an extended producer responsibility regime that includes the relevant refrigerators and freezers, the buyer entity should require that the seller/supplier be part of an appropriate environmentally sound management (ESM) system and that this system guarantees the correct management of the replaced devices. If the relevant refrigerators and freezers are not included in any extended producer responsibility scheme, the buyer can request that the tender criteria include that the selling/supplying company is responsible for the collection and environmentally sound management of the replaced units. In all other cases, the buyer must take care of the refrigerator and freezer end of service life management themselves.

If the buyer chooses to pass on the responsibility of the management of the used refrigerators/freezers to the seller/supplier (as an additional condition of the contract), some aspects must be included in the request for a proposal to the selling/suppling companies, mainly:

- The minimum requirements for the withdrawal of the relevant used products and their subsequent management.
- The obligation to show verifiable/proven documentation from the seller that proves that the removed devices are being managed correctly, including the gases the refrigerators/freezers contained, and that the company in charge of the used/waste product management is an authorized operator.

The minimum proven documents that should be requested, so as to assess the tracking of the discarded devices, are the certificates of the recycling plants that have received the electrical and electronic equipment waste and the certificate of the plant in charge of the gases management. It is recommended that the disbursement of the final contract payment should depend upon receiving all of the necessary environmentally sound management documentation. The collection and management of refrigerators/freezers can be expensive, mainly if the treatment includes the management of gases inside the insulating foams.

Alternatively, the buyer can choose to manage it through a waste manager that is legally authorized and who has the capacity to manage cooling appliances correctly, and guarantee the adequate removal and treatment of the gases and the oil contained in the appliance. Once the gases and oil are extracted, they can be recycled or destroyed, depending of the type of gas. The rest of the materials that make up the equipment (mainly metals, plastics and glass) should also be recycled.

If the buyer decides to compel the seller to manage the old appliances, this should be included in the tender conditions. At a minimum the following aspects should be considered:

- Explaining the minimum requirements for the withdrawal of the spent products from service/storage and their subsequent management.
- Present verifiable/proven documentation from the seller that proves that the removed refrigerators/freezers are being managed correctly, as well as the gases they contain, and that the company in charge of the used/waste product management is an authorized operator.
- If an extended producer responsibility scheme exists, the seller should present a certificate which proves that the seller or the legal manufacturer of the refrigerator/freezer has joined a collection and recycling system organization.
- Issue a document that certifies that the collection of the refrigerators/freezers has been completed by an authorized waste manager.
- Issue a certificate proving that the refrigerators/freezers have been delivered to the treatment plant and the authorization certificate of the plant to treat refrigeration appliances.
- Issue a certificate proving the adequate destruction of the gases in the refrigerators/freezers.

In particular, the gas destruction certificate may take a few weeks to be received, as gases are not usually destroyed in the treatment plant, but by a specialized third party. **It is recommended that the disbursement of the final contract payment be dependent upon receiving all of the necessary environmentally sound management documentation.**

Refrigerators contain gases in the refrigeration circuit, mixed with oil, and in the insulating foams. In the past, both kinds of gases used to be a group of synthetic gases called chlorofluorocarbons (CFCs), but the use of CFCs was progressively banned by the Montreal Protocol (1987), as they destroy the protective ozone layer. CFC's were soon replaced by other synthetic gases, first by hydrochlorofluorocarbons (HCFCs) less harmful for the ozone layer; and later by hydrofluorocarbons (HFCs), that have little impact on the ozone layer.

The evolution of the replacement of refrigerant gases has been uneven over the world, and different approaches have been taken by European and American industries for example. In any case, the most important points to take into account are:

- Gases used in the refrigeration circuit of refrigerators can be different depending on the age of the appliance and the place where it was built. The reality is that the vast majority of the refrigerators that become waste today across the world, have gases that damage the ozone layer and have an important GWP.
- Improper management of refrigerators can break the cooling circuit and thus the gases can be released into the atmosphere and the oil can contaminate the soil.
- Gases in the insulation foam are released slowly, but their negative environmental impacts can be similar to those produced by some of the refrigeration gases unless they are environmentally sound. In fact, there can be more harmful gases in the foam than in the refrigeration circuit, depending on the manufacturing processes used for the insulation materials.

For these reasons it is important to guarantee the correct treatment of refrigerators and freezers.

Another point to consider is that older refrigerators can include components classified as hazardous waste, like capacitors with PCB or mercury containing switches. This aspect should also receive adequate recycling treatment. Once properly treated, refrigerators and freezers contain metals and plastics that can be sold, but the value of these recovered materials will not be sufficient to pay for the full end of life treatment costs.

Regarding the packaging of the new refrigerators and freezers, this must be separated and sent to a recycler. If an extended producer responsibility system is established for these packaging materials, then it should be managed by the entity supplying the appliances. If it is not, the best option is to deliver the packaging waste directly to the local waste management facility or paper/ cardboard recycler.

### Summary of the ESM considerations to take into account

1. The entity that acquires the refrigerators/freezers must know, before calling the tender, if the relevant waste management legislation incorporates an extended producer responsibility scheme for the type of waste generated at the time of the acquisition of the new appliances, specifically:
   - If the seller/supplier of the refrigeration appliance has an obligation to take responsibility for the management and recycling of the old devices;
   - The same for the packaging generated.

   If there is an obligation, it will be the management system to which the seller/supplier is attached for the aforementioned products that will be responsible for their collection and recycling/treatment. However, the buyer must verify that there are no exceptions in relation to equipment installed before the entry into force of the legislation.
2. If an extended producer responsibility scheme has not been locally implemented, or does not affect the relevant refrigerators/freezers, the responsibility for the collection and recycling/management of said products lies with the buyer of the new refrigerators/freezers, as the final holder of the waste. However, the buyer can request appropriate agreement(s) with the manufacturer/seller/supplier for the management of the waste, but the conditions of this agreement must be included in the bidding rules for the acquisition of the new cooling products.
3. It should be noted that the environmentally appropriate treatment of used refrigerators/freezers can be expensive and the procurer must take this into account in considering their disposal cost in the offers.
4. During the tendering process, inclusion of provision for the submission and verification of bidder certificates on appropriate extended producer responsibility scheme membership and separate additional certification stating the destination of the gases in order to guarantee their correct disposal is recommended.

## 4.6 SOCIAL CRITERIA

Social criteria can be included in the SPP tender. The bidding entity must provide evidence that it complies with national and international decent work standards, if possible, throughout the production and service chain.

Possible ways of verification are a manufacturer/supplier affidavit or with certification to local and international standards on labour laws.

# 5. COMMERCIAL AND PROFESSIONAL REFRIGERATION APPLIANCES PROCUREMENT CRITERIA

There is a large variety of commercial and professional refrigeration appliances, both in design and size. These guidelines give recommendations only for the self-contained (plug-in), where the cabinet contains all the required components to work. Furthermore, all appliances are considered closed, not having any open sides. The different types of appliances considered here can be divided into:

- Solid door type
- Transparent door type

This chapter describes the main parameters that should be considered during SPP for commercial/ professional refrigerators. Apart from these considerations, the products should comply with all other relevant product specific requirements and certifications in place, such as minimum energy performance standards (MEPS), energy efficiency labels, safety standards, hazardous substances, heavy metals, etc.

## 5.1 ENERGY CONSUMPTION

The choice between the solid and transparent door type will depend on the application. Nevertheless, in terms of energy efficiency it is usually recommended to buy refrigerators with solid doors because they usually consume less energy, simply because glass doors have a higher heat transfer coefficient.

The following sub-sections discuss the parameters that influence the energy consumption level and that should be considered when preparing the tender for commercial and professional refrigerating appliances:

- Energy efficiency
- Volume
- Smart controls and lighting

The parameters that influence the energy consumption level can be verified by the energy label (comparison or endorsement), declared energy consumption, declared volumes, refrigerator technical information and manufacturer/supplier affidavit.

### 5.1.1 Energy efficiency

The idea is to frequently update the energy efficiency requirements, so only the highly efficient refrigerators are targeted during the SPP process. SPP energy requirements should target products that are above the average efficiency in the market if they want to incentivise the industry to accelerate the transition to more sustainable technologies. It is recommended that tenders set the energy limits to target around the 20% most efficient refrigerators in the market.

More efficient products can also be targeted and justified with the life cycle cost (LCC) analysis method, which will account for the initial costs, operational costs and external costs due to $CO_2$ emissions, hence, the higher the energy consumption, the higher the operational costs and emissions (see Annex 5).

Depending on local characteristics, the energy efficiency requirements can be set using the following different options.

### Option 1 – Setting the efficiency requirements based on the energy efficiency labels and local market data

If there is a comparative or endorsement label system in the market which is working effectively, i.e. the top efficiency classes are not overcrowded, it is recommended to use this label as a reference to target the most efficient products in the market. The idea is to set the energy limits to target the 20% most efficient refrigerators in the market. See Section 4.1.1 for an example on how to use market information to set the SPP requirements based on the local label.

### Option 2 – Setting the efficiency requirements based on the energy efficiency labels and supported by international benchmark

This is similar to Option 1, where local labels are used to identify the most efficient products in the market, but the choice of the energy efficiency level for the SPP criteria is based on international benchmarks for highly efficient products.

See Option 2 in Section 4.1.1 for an example with domestic refrigerators.

### Option 3 – No label available

In some countries, the energy efficiency label is not available, or it is not working effectively (top efficiency class with more than 30% of products), making it difficult to use as a reference to distinguish the most efficient refrigerators in the market. In this case, the requirements can be set with the help of market data and/or with international best practice efficiency levels (benchmark). The difference with the other options is that the local label cannot be used as a reference for SPP.

In order to clearly show which is the maximum energy consumption requirement for SPP, tables can be used to show the maximum energy consumption as a function of volume and type of appliance.

Table 4 and Table 5 show an example with the maximum daily energy consumption for different types of product categories and different volumes (±30 liters). The types of product are:

- **Table 4: All with solid door;** vertical and horizontal (VCS and HCS) and medium or low temperature (M → 3.3°C; L → –17.8°C)
- **Table 5: All with transparent door;** vertical and horizontal (VCT and HCT) and medium or low temperature (M → 3.3°C; L → –17.8°C)

Furthermore, each table includes two tiers. The tiers aim to serve as a reference value to implement SPP requirements depending on the readiness of the country:

- Tier 1[13]: This level can be used as a reference level for SPP in those countries with low energy efficiency levels, so availability of products is guaranteed.
- Tier 2[14]: This level can be used as a reference for SPP in those countries with a higher energy efficiency product level.

13 *Based on US MEPS in place from 2017. Europe has implemented MEPS and labels recently. Nevertheless, US has greater recent experience on MEPS for Commercial appliances, leading to more stringent MEPS than apply in Europe. Therefore, these values can be taken as a reasonable reference for SPP in those countries that are not ready to implement Tier 2. The test methods and the US MEPS levels for commercial refrigeration can be found in the US Electronic Code of Federal Regulations, available at: https://www.ecfr.gov/cgi-bin/text-idx?SID=834d4f3ec6499b40a3bb7f2587ba0576&mc=true&node=pt10.3.431&rgn=div5#sg10.3.431_162.sg4 (last accessed June 2020)*

14 *Based on the US Energy Star levels in place since 2017. The US Energy Star levels for the commercial refrigeration available at: https://www.energystar.gov/products/commercial_food_service_equipment/commercial_refrigerators_freezers/key_product_criteria (last accessed June 2020)*

Independently of the option followed to apply the minimum energy efficiency requirements for SPP, the use of specific tools is also helpful. This SPP guideline includes an Excel spreadsheet tool[15] that can be used for this purpose. Furthermore, it calculates the life cycle cost and $CO_2$ equivalent emissions for the different acquisition options (see Annex 5) and provides an example of how to use a table with maximum energy consumption requirements for SPP (see Annex 6).

It should be noted that, due to the lack of harmonized[16] standards around the world, it is difficult to compare the declared energy consumption with MEPS levels in different regions of the world. Therefore, the energy requirements presented here must be checked with the local standards and adjusted if necessary.

**Table 4**

Two tier maximum energy consumption recommendations for SPP for self-contained (SC), vertical and horizontal closed cabinets with solid doors (VCS and HCS), and for medium and low temperature[17] (M and L)

| Target volume (± 30 L) | Maximum Energy Consumption for SPP (kWh/day) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Tier 1 | | | | Tier 2 | | | |
| | VCS.SC.M | VCS.SC.L | HCS.SC.M | HCS.SC.L | VCS.SC.M | VCS.SC.L | HCS.SC.M | HCS.SC.L |
| 250 | 1.74 | 5.51 | 0.90 | 1.94 | 1.28 | 4.41 | 0.72 | 1.05 |
| 310 | 1.95 | 6.12 | 1.03 | 2.11 | 1.48 | 4.90 | 0.83 | 1.17 |
| 370 | 2.17 | 6.74 | 1.15 | 2.28 | 1.69 | 5.39 | 0.93 | 1.29 |
| 430 | 2.38 | 7.35 | 1.28 | 2.44 | 1.89 | 5.88 | 1.04 | 1.42 |
| 490 | 2.59 | 7.97 | 1.41 | 2.61 | 1.99 | 6.37 | 1.15 | 1.54 |
| 550 | 2.80 | 8.58 | 1.54 | 2.78 | 2.09 | 6.87 | 1.25 | 1.66 |
| 610 | 3.01 | 9.20 | 1.66 | 2.95 | 2.20 | 7.36 | 1.36 | 1.78 |
| 670 | 3.23 | 9.81 | 1.79 | 3.12 | 2.30 | 7.85 | 1.46 | 1.90 |
| 730 | 3.44 | 10.43 | 1.92 | 3.29 | 2.41 | 8.34 | 1.57 | 2.02 |
| 790 | 3.65 | 11.04 | 2.04 | 3.46 | 2.51 | 8.83 | 1.67 | 2.14 |
| 850 | 3.86 | 11.65 | 2.17 | 3.63 | 2.62 | 9.32 | 1.78 | 2.26 |
| 910 | 4.07 | 12.27 | 2.30 | 3.80 | 2.78 | 9.81 | 1.89 | 2.38 |
| 970 | 4.29 | 12.88 | 2.43 | 3.97 | 2.94 | 10.31 | 1.99 | 2.50 |
| 1030 | 4.50 | 13.50 | 2.55 | 4.14 | 3.10 | 10.80 | 2.10 | 2.62 |
| 1090 | 4.71 | 14.11 | 2.68 | 4.31 | 3.27 | 11.29 | 2.20 | 2.74 |
| 1150 | 4.92 | 14.73 | 2.81 | 4.48 | 3.43 | 11.78 | 2.31 | 2.86 |
| 1210 | 5.13 | 15.34 | 2.93 | 4.65 | 3.59 | 12.27 | 2.42 | 2.99 |
| 1270 | 5.34 | 15.95 | 3.06 | 4.82 | 3.75 | 12.76 | 2.52 | 3.11 |
| 1330 | 5.56 | 16.57 | 3.19 | 4.99 | 3.91 | 13.26 | 2.63 | 3.23 |
| 1390 | 5.77 | 17.18 | 3.31 | 5.16 | 4.07 | 13.75 | 2.73 | 3.35 |
| 1450 | 5.98 | 17.80 | 3.44 | 5.33 | 4.26 | 14.24 | 2.84 | 3.47 |
| 1510 | 6.19 | 18.41 | 3.57 | 5.50 | 4.49 | 14.73 | 2.95 | 3.59 |
| 1570 | 6.40 | 19.03 | 3.70 | 5.66 | 4.71 | 15.22 | 3.05 | 3.71 |
| 1630 | 6.62 | 19.64 | 3.82 | 5.83 | 4.93 | 15.71 | 3.16 | 3.83 |

15 *The U4E SPP tool for Refrigerating Appliances can be download here: https://united4efficiency.org/resources/tools/*

16 *The energy requirements presented here are based on the test standard ANSI/AHRI Standard 1200 [6]. If a different test protocol is used, the limits for the high efficiency level shall be adjusted accordingly. In Europe there are different test standards depending on if the refrigerated cabinet is considered for professional use, or for direct sales (commercial). The professional refrigerated cabinets are measured according to the test standard "EN 16825" [7], while the direct sale refrigerated cabinet is measured according to the test standard "EN ISO 23953-2" [8]. Furthermore, there is a new international test standard for professional refrigerated storage ISO 22041:2019 [9]*

17 *If the appliance is a combination of M and L compartments, a weighted maximum energy consumption can be used*

| Target volume (± 30 L) | Maximum Energy Consumption for SPP (kWh/day) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Tier 1 | | | | Tier 2 | | | |
| | VCT.SC.M | VCT.SC.L | HCT.SC.M | HCT.SC.L | VCT.SC.M | VCT.SC.L | HCT.SC.M | HCT.SC.L |
| 250 | 1.74 | 5.51 | 0.90 | 1.94 | 1.28 | 4.41 | 0.72 | 1.05 |
| 310 | 1.95 | 6.12 | 1.03 | 2.11 | 1.48 | 4.90 | 0.83 | 1.17 |
| 370 | 2.17 | 6.74 | 1.15 | 2.28 | 1.69 | 5.39 | 0.93 | 1.29 |
| 430 | 2.38 | 7.35 | 1.28 | 2.44 | 1.89 | 5.88 | 1.04 | 1.42 |
| 490 | 2.59 | 7.97 | 1.41 | 2.61 | 1.99 | 6.37 | 1.15 | 1.54 |
| 550 | 2.80 | 8.58 | 1.54 | 2.78 | 2.09 | 6.87 | 1.25 | 1.66 |
| 610 | 3.01 | 9.20 | 1.66 | 2.95 | 2.20 | 7.36 | 1.36 | 1.78 |
| 670 | 3.23 | 9.81 | 1.79 | 3.12 | 2.30 | 7.85 | 1.46 | 1.90 |
| 730 | 3.44 | 10.43 | 1.92 | 3.29 | 2.41 | 8.34 | 1.57 | 2.02 |
| 790 | 3.65 | 11.04 | 2.04 | 3.46 | 2.51 | 8.83 | 1.67 | 2.14 |
| 850 | 3.86 | 11.65 | 2.17 | 3.63 | 2.62 | 9.32 | 1.78 | 2.26 |
| 910 | 4.07 | 12.27 | 2.30 | 3.80 | 2.78 | 9.81 | 1.89 | 2.38 |
| 970 | 4.29 | 12.88 | 2.43 | 3.97 | 2.94 | 10.31 | 1.99 | 2.50 |
| 1030 | 4.50 | 13.50 | 2.55 | 4.14 | 3.10 | 10.80 | 2.10 | 2.62 |
| 1090 | 4.71 | 14.11 | 2.68 | 4.31 | 3.27 | 11.29 | 2.20 | 2.74 |
| 1150 | 4.92 | 14.73 | 2.81 | 4.48 | 3.43 | 11.78 | 2.31 | 2.86 |
| 1210 | 5.13 | 15.34 | 2.93 | 4.65 | 3.59 | 12.27 | 2.42 | 2.99 |
| 1270 | 5.34 | 15.95 | 3.06 | 4.82 | 3.75 | 12.76 | 2.52 | 3.11 |
| 1330 | 5.56 | 16.57 | 3.19 | 4.99 | 3.91 | 13.26 | 2.63 | 3.23 |
| 1390 | 5.77 | 17.18 | 3.31 | 5.16 | 4.07 | 13.75 | 2.73 | 3.35 |
| 1450 | 5.98 | 17.80 | 3.44 | 5.33 | 4.26 | 14.24 | 2.84 | 3.47 |
| 1510 | 6.19 | 18.41 | 3.57 | 5.50 | 4.49 | 14.73 | 2.95 | 3.59 |
| 1570 | 6.40 | 19.03 | 3.70 | 5.66 | 4.71 | 15.22 | 3.05 | 3.71 |
| 1630 | 6.62 | 19.64 | 3.82 | 5.83 | 4.93 | 15.71 | 3.16 | 3.83 |

**Table 5**

Two tier maximum energy consumption recommendations for SPP for self-contained (SC), vertical and horizontal closed cabinets with transparent doors (VCT and HCT), and for medium and low temperature (M and L)

### 5.1.2 Volume

For the same energy efficiency, the higher the volume, the higher the energy consumption. Therefore, the target volume of each compartment must meet the real needs of the application and not be oversized.

Furthermore, the total number of refrigerators should be rationalised. More refrigerators than needed will lead to higher overall energy consumption.

### 5.1.3 Smart controls and lighting

The energy consumption level due to lighting might be much higher than in the domestic refrigerator's category, especially for transparent door appliances where the light is ON even with the door closed, so consumers or users can see what is inside the cabinet. Therefore, the tender should include requirements to reduce the impact of lighting. For instance, using LED technology and using smart controls to automatically switch off after a period of inactivity or during the off-hours.

## 5.2 REFRIGERANTS

Natural refrigerants in the commercial and professional refrigeration sector, such as R290, R600a, or R744 ($CO_2$), can be used efficiently in the majority of light commercial applications and self-contained units. Therefore, the requirements for the refrigerant and foam blowing agent can be given in terms of maximum ODP and GWP as:

**MAXIMUM ODP = 0**

**MAXIMUM GWP = 20**

Nevertheless, the GWP requirement might not be possible to meet in some countries, either because these technologies are not yet widely available in the country, or because the local safety standards limit the amount of some refrigerants. Therefore, even though the above-mentioned limit is highly recommended, it should be assessed locally if they are applicable in the country of SPP implementation.

The information needed to verify these requirements can be found in refrigerator technical information, manuals, identification plate and manufacturer/supplier affidavit.

## 5.3 FOOD PRESERVATION

Commercial and professional refrigerators might be exposed to different working conditions compared to domestic refrigerators. For instance, the professional kitchen of a restaurant might experience higher ambient temperatures and humidity.

Therefore, commercial/professional refrigerators need to be able to maintain the products at the target temperatures for the ambient temperature and relative humidity of the application.

There are also dedicated refrigerators for specific types of food, or with variable temperature, so they can be adjusted depending on the food items that will be stored. To avoid waste food, select a refrigerator with a temperature range according to the type of food that will be stored.

These features might be verified by the energy label, refrigerator technical information, manuals, compartment marks and manufacturer/supplier affidavit.

# 5.4 PRODUCT DURABILITY (REPARABILITY)

To ensure that a refrigerator can work efficiently during its lifespan, the manufacturer/supplier needs to meet several reparability requirements, such as providing availability of spare parts (Section 5.4.1) and access to repair and maintenance information (see Section 5.4.2).

The reparability requirements presented in this section are based on the new European eco-design regulation for commercial refrigerating appliances, (EU) 2019/2024 [10], which will be mandatory for all appliances entering into the European market. Therefore, if this is not a requirement yet for all refrigerators in the application country, it might be included as a requirement for SPP.

If the maintenance is contracted together with the acquisition of the appliances, the tender specification should ensure that each unit is required to work efficiently during the whole of the contract lifespan.

These requirements can be verified via the manuals and manufacturer/supplier affidavit.

## 5.4.1 Availability of spare parts

The manufacturer/supplier should guarantee the supply of essential spare parts. At least the following:

- For professional repairers:
  - Thermostat
  - Temperature sensors
  - Printed circuit boards
  - Light sources
  - No-frost heating resistors
  - Starting relays
- For professional repairers and end-users:
  - Door handles and door hinges
  - Trays and baskets
  - Door gaskets
  - Knobs, dials and buttons

The spare parts shall be delivered in a reasonable period of time from the date of order (e.g. maximum 15 working days) and they shall be offered even when the model is no longer in the market, ideally during the lifespan of the product (at least 8 years).

Furthermore, the manufacturer/supplier shall ensure that these spare parts can be replaced with the use of commonly available tools and without permanent damage to the appliance.

### 5.4.2 Access to repair and maintenance information

Apart from making available the spare parts listed above, if requested[18] by qualified[19] professional repairers, the manufacturer/supplier shall provide access to the following appliance repair and maintenance information:

- Qualification requirements of maintenance personnel.
- The unequivocal appliance identification.
- A disassembly map or exploded view.
- List of necessary repair and test equipment.
- Component and diagnosis information (such as minimum and maximum theoretical values for measurements).
- Wiring and connection diagrams.
- Diagnostic fault and error codes (including manufacturer-specific codes, where applicable).
- Data records of reported failure incidents stored on the refrigerating appliance (where applicable).
- Access to professional repair, such as internet webpages, addresses, contact details.
- Relevant information for ordering spare parts.
- The minimum period during which spare parts, necessary for the repair of the appliance, are available.

Furthermore, the manufacturer/supplier shall give all necessary information in order to minimize the environmental impact due to the use of the refrigerating appliance. Therefore, instruction manuals for installers and end-users shall include the following information:

- Combination of drawers, baskets and shelves that result in the most efficient use of energy.
- Clear guidance about where and how to store foodstuffs in the refrigerating appliance for best preservation, to avoid food waste.
- Recommended setting of temperatures in each compartment for optimum food preservation.
- Instructions for the correct installation and end-user maintenance, including cleaning of the appliance and circuit components. For instance, the frequency to clean the condenser (times per year) to maintain good energy efficiency.

### 5.4.3 Warranty

The minimum warranty period for the refrigerator shall be of one year after the date of purchase. Other parts of the equipment shall be guaranteed for at least 3 years (compressor, heat exchanger, control board, cabinet, door, thermostat, filter, capillary tube fan motor, defrost heating wire, ice maker, timer).

18 *Manufacturers, importers or authorized representatives may charge reasonable and proportionate fees for access to the repair and maintenance information or for receiving regular updates. A fee is reasonable if it does not discourage access by failing to take into account the extent to which the professional repairer uses the information.*

19 *In order to give access to repair and maintenance information, the professional must have the technical competence to repair refrigerating appliances and comply with the applicable regulations for repairers of electrical equipment in the country of application.*

## 5.5 ENVIRONMENTALLY SOUND MANAGEMENT

The SPP acquisitions should minimize the adverse effects that may result from end of life of the product, i.e. waste, with a strong emphasis on reduction, reuse, and recycling.

Some countries already have a take-back programme that ensures the correct environmental disposal of the refrigerator at the end of life, for instance through extended producer responsibility policies. In any case, the manufacturer/supplier should be responsible for the sustainable management of waste at the end of the useful life of the equipment (Waste Electrical and Electronic Equipment – WEEE).

The European eco-design regulation requires that all refrigerating appliances are designed in such a way that the maximum portion of materials can be removed with the use of commonly available tools in order to facilitate material recovery (for re-use) and recycling while avoiding pollution. Therefore, if this is not a requirement yet for all refrigerators, it might be included as a requirement for SPP.

To reduce the solid waste generated by packaging, the packaging shall be the minimum possible to facilitate handling the equipment and it should be recyclable or reusable. Purchasers are also encouraged to prefer packaging with at least one of the following characteristics:

- Does not contain styrene (eg, styrofoam, EPS (expanded polystyrene), polystyrene).
- Maximizes post-consumer recycled content.
- Minimizes the contents of lead, cadmium, mercury and hexavalent chromium, with a goal of less than 100 ppm (0.01%) in total content.
- Packaging remains the property of the supplier and not the recipient.

These can be difficult requirements to verify, a manufacturer/supplier affidavit can be used for this purpose as further described below.

The generation of waste arises when purchasing new refrigerators and freezer units in order to replace old ones. This must be taken into account during any procurement process. Section 4.5 above has additional information on environmentally sound management.

**It is recommended that the disbursement of the final contract payment be dependent upon receiving all the necessary environmentally sound management documentation.**

### Summary of the ESM considerations to take into account

1. The entity that acquires the refrigerators/freezers must know, before calling the tender, if the relevant waste management legislation incorporates an extended producer responsibility scheme for the type of waste generated at the time of the acquisition of the new appliances, specifically:
   - If the seller/supplier of the refrigeration appliance has the obligation to take responsibility for the management and recycling of the old devices;
   - The same for the packaging generated.

   If there is an obligation, it will be the management system to which the seller/supplier is attached for the aforementioned products that will be responsible for their collection and recycling/treatment. However, the buyer must verify that there are no exceptions in relation to equipment installed before the entry into force of the legislation.
2. If an extended producer responsibility scheme has not been locally implemented, or does not affect commercial/professional refrigerators/freezers, the responsibility for the collection and recycling/management of said products lies with the buyer of the new refrigerators/freezers, as the final holder of the waste. However, the buyer can request appropriate agreement(s) with the manufacturer/seller/supplier for the management of the waste, but the conditions of this agreement must be included in the bidding rules for the acquisition of the new cooling products.
3. It should be noted that the environmentally appropriate treatment of used refrigerators/freezers can be expensive and the procurer must take this into account in considering their disposal cost in the offers.
4. During the tendering process, inclusion of provision for the submission and verification of bidder certificates on appropriate extended producer responsibility scheme membership and separate additional certification stating the destination of the gases in order to guarantee their correct disposal is recommended.

## 5.6 SOCIAL CRITERIA

Social criteria can be included in the SPP tender. The bidder must provide evidence that it complies with national and international decent work standards, if possible, throughout the production and service chain.

Possible ways of verification are a manufacturer/supplier affidavit or with certification to local and international standards on labour laws.

# 6. VENDING MACHINES PROCUREMENT CRITERIA

A vending machine is a self-contained system designed to accept consumer payments and dispense beverages and other products at appropriate temperatures without on-site labour intervention.

They are widely used in public buildings, such as universities, hospitals, etc. They can be classified depending on the:

- Opaque or transparent front: For instance, the typical spiral vending machine with transparent door and the opaque front machine with bottles/cans inside.
- Target temperature: Cans and bottle coolers (beverages) have a target temperature of around 3°C, sandwiches around 5°C, and snacks >10°C.

This chapter describes the main parameters that should be considered during the SPP process for vending machines. Apart from these considerations, the products should comply with all other product specific requirements and certifications in place, such as MEPS, energy efficiency labels, safety standards, hazardous substance, heavy metals, etc.

## 6.1 ENERGY CONSUMPTION

The following sub-sections discuss the parameters that influence the energy consumption level and that should be considered when preparing the tender for vending machines:

- Energy efficiency
- Volume
- Smart controls and lighting

The parameters that influence energy consumption levels can be verified in the energy label (comparison or endorsement), declared energy consumption, declared volumes, refrigerator technical information and manufacturer/supplier affidavit.

### 6.1.1 Energy efficiency

The idea is to frequently update the energy efficiency requirements, so only highly efficient refrigerators are targeted during the SPP process. SPP energy requirements should target products that are above the average efficiency in the market if they want to incentivise the industry to accelerate the transition to more sustainable technologies. It is recommended that tenders set the energy limits to target around the 20% most efficient refrigerators in the market.

More efficient products can also be targeted and justified with the life cycle cost (LCC) analysis method, which will account for the initial costs, operational costs and external costs due to $CO_2$ emissions, hence, the higher the energy consumption, the higher the operational costs and emissions (see Annex 5).

Depending on local characteristics, the energy efficiency requirements can be set using the following different options.

### Option 1 – Setting the efficiency requirements based on the energy efficiency labels and local market data

If there is a comparative or endorsement label system in the market which is working effectively, i.e. the top efficiency classes are not overcrowded, it is recommended to use this label as a reference to target the most efficient products in the market. The idea is to set the energy limits to target the 20% most efficient refrigerators in the market. See Section 4.1.1 for an example on how to use market information to set the SPP requirements based on the local label.

### Option 2 – Setting the efficiency requirements based on the energy efficiency labels and supported by international benchmark

This is similar to Option 1, where local labels are used to identify the most efficient products in the market, but the choice of the energy efficiency level for the SPP criteria is based on international benchmark for high efficient products.

See Option 2 in Section 4.1.1 for an example with domestic refrigerators.

### Option 3 – No label available

In some countries, the energy efficiency label is not available, or it is not working effectively (top efficiency class with more than 30% of products), making it difficult to use as a reference to distinguish the most efficient refrigerators in the market. In this case, the requirements can be set with the help of market data and/or with international best practice efficiency levels (benchmark). The difference with the other options is that the local label cannot be used as a reference for SPP.

In order to clearly show which is the maximum energy consumption requirement for SPP, tables can be used to show the maximum energy consumption as a function of volume and type of appliance.

Table 6 shows the maximum daily consumption for opaque and transparent vending machines as a function of volume (±30 liters). There are two tiers:

- Tier 1[20]: This level can be used as a reference for SPP in those countries with lower energy efficiency levels.
- Tier 2[21]: This level can be used as a reference for SPP in those countries with a higher energy efficient product level.

Independently of the option followed to apply the minimum energy efficiency requirements for SPP, the use of specific tools is also helpful. This SPP guideline includes an Excel spreadsheet tool[22] that can be used for this purpose. Furthermore, it calculates the life cycle cost and $CO_2$ equivalent emissions for the different acquisition options (see Annex 5) and provides an example of how to use the table with maximum energy consumption requirements for SPP (see Annex 6).

*20 Based on US MEPS (2019). Europe has implemented MEPS and labels recently. Nevertheless, the US has greater recent experience on MEPS for Vending Machines, leading to more stringent MEPS than apply currently in Europe. Therefore, these values can be taken as a reference for SPP in those countries that are not ready to implement Tier 2. In this case, the US regulations only consider beverage cans and bottles at a target temperature of 2.2ºC. Nevertheless, these values (or more stringent) can also be used for vending machines with higher target temperatures. The test methods and US MEPS can be found in the Electronic Code of Federal Regulations: https://www.ecfr.gov/cgi-bin/text-idx?SID=3e9fa89f521ed5adoaco6f916c524935&mc=true&node=pt10.3.431&rgn=div5#sp10.3.431.q (last accessed June 2020)*

*21 At the date on which this guide was written (June 2020), the energy requirements for the Energy Star rating where not updated according to the newest MEPS, hence a 10% improvement with respect to latest MEPS is taken as a more stringent limit for SPP.*

*22 The U4E SPP tool for Refrigerating Appliances can be download here: https://united4efficiency.org/resources/publications/*

It should be noted that, due to the lack of harmonized[23] standards around the world, it is difficult to compare the declared energy consumption with MEPS levels in different regions of the world. Therefore, the energy requirements presented here must be checked with the local standards and adjusted if necessary.

| Target volume (± 30 L) | Maximum Energy Consumption for SPP (kWh/day) | | | |
|---|---|---|---|---|
| | Tier 1 | | Tier 2 | |
| | Transparent | Opaque | Transparent | Opaque |
| 250 | 2.89 | 2.66 | 2.60 | 2.39 |
| 310 | 3.00 | 2.77 | 2.70 | 2.49 |
| 370 | 3.11 | 2.88 | 2.80 | 2.59 |
| 430 | 3.22 | 2.99 | 2.90 | 2.69 |
| 490 | 3.33 | 3.10 | 3.00 | 2.79 |
| 550 | 3.44 | 3.21 | 3.10 | 2.89 |
| 610 | 3.55 | 3.32 | 3.20 | 2.99 |
| 670 | 3.66 | 3.43 | 3.29 | 3.09 |
| 730 | 3.77 | 3.54 | 3.39 | 3.19 |
| 790 | 3.88 | 3.65 | 3.49 | 3.29 |
| 850 | 3.99 | 3.76 | 3.59 | 3.38 |
| 910 | 4.10 | 3.87 | 3.69 | 3.48 |
| 970 | 4.21 | 3.98 | 3.79 | 3.58 |
| 1030 | 4.32 | 4.09 | 3.89 | 3.68 |
| 1090 | 4.43 | 4.20 | 3.99 | 3.78 |
| 1150 | 4.54 | 4.31 | 4.09 | 3.88 |
| 1210 | 4.65 | 4.42 | 4.19 | 3.98 |
| 1270 | 4.76 | 4.53 | 4.29 | 4.08 |
| 1330 | 4.87 | 4.64 | 4.38 | 4.18 |
| 1390 | 4.98 | 4.75 | 4.48 | 4.28 |
| 1450 | 5.09 | 4.86 | 4.58 | 4.38 |
| 1510 | 5.20 | 4.97 | 4.68 | 4.48 |
| 1570 | 5.31 | 5.08 | 4.78 | 4.57 |

**Table 6**

Two tier maximum energy consumption recommendations for SPP based on US MEPS (Tier 1) and Energy Star (Tier 2) for vending machines (transparent and opaque doors)

23 *The energy requirements presented here are based on the test standard ANSI/AHRI Standard 32.1 [11]. If a different test protocol is used, the limits for the high efficiency level shall be adjusted accordingly. In Europe, the test standard "EN 16901:2016" [12] is used for vending machines.*

### 6.1.2 Volume

For the same energy efficiency, the higher the volume, the higher the energy consumption. Therefore, the target volume of each compartment must meet the real needs of the application and not be oversized.

Furthermore, the total number of refrigerators should be rationalized. More refrigerators than needed will lead to higher overall energy consumption.

### 6.1.3 Smart controls and lighting

The energy consumption level due to lighting might be much higher than in the domestic refrigerator's category, especially for transparent front appliances where the light is on, so consumers or users can see what is inside the cabinet.

Therefore, the tender should include requirements to reduce the impact of lighting. For instance, using LED technology and using smart controls to automatically switch off after a period of inactivity or during the off-hours.

Furthermore, it is recommended that vending machines are equipped with integrated smart controls, which are programmed to reduce the energy consumption when the machine is rarely used. For example, if the vending machine temperature is between 0°C to 7°C during the peak hours, the unit raises the temperature to 7°C–14°C when the machine is rarely used (only for non-perishable foods).

## 6.2 REFRIGERANTS

Whenever possible, the refrigerant and foam blowing agent shall be limited to a maximum ODP and GWP of:

**MAXIMUM ODP = 0**

**MAXIMUM GWP = 20**

Nevertheless, the GWP requirement might not be possible to meet in some countries, either because these technologies are not yet widely available in the country, or because the local safety standards limit the amount of some refrigerants. Therefore, even though the above-mentioned limit is highly recommended, it should be assessed locally if these levels are applicable in the country for SPP implementation.

These requirements can be verified via refrigerator technical information, manuals, identification plate and manufacturer/supplier affidavit.

## 6.3 FOOD PRESERVATION

The vending machine shall be able to maintain the products at the target temperature for the ambient temperature where the unit will be installed, especially for perishable products.

These features might be verified by the energy label, refrigerator technical information, manuals, compartment marks and manufacturer/supplier affidavit.

## 6.4 PRODUCT DURABILITY (REPARABILITY)

In the case of vending machines, the maintenance is usually contracted together with the acquisition of the appliances. Therefore, the contract should ensure that the unit will work efficiently during the lifespan of the product.

If maintenance is not guaranteed in the contract, other reparability requirements can be asked to ensure that an appliance can work efficiently during its lifespan. See the reparability requirements for commercial/professional refrigerators on availability of spare parts (Section 5.4.1) and access to repair and maintenance information (Section 5.4.2).

## 6.5 ENVIRONMENTALLY SOUND MANAGEMENT

The SPP acquisitions should minimize the adverse effects that may result from end of life of the product, i.e. waste, with a strong emphasis on reduction, reuse, and recycling.

Some countries already have a take-back programme that ensures the correct environmental disposal of the refrigerator at the end of life, for instance through extended producer responsibility policies. In any case, the manufacturer/supplier should be responsible for the sustainable management of waste at the end of the useful life of the equipment (Waste Electrical and Electronic Equipment – WEEE).

The European eco-design regulation requires that all refrigerating appliances are designed in such a way that the maximum portion of materials can be removed with the use of commonly available tools in order to facilitate material recovery (for re-use) and recycling while avoiding pollution. Therefore, if this is not a requirement yet for all refrigerators, it might be included as a requirement for SPP.

To reduce the solid waste generated by packaging, the packaging shall be the minimum possible to facilitate handling the equipment and it should be recyclable or reusable. Purchasers are also encouraged to prefer packaging with at least one of the following characteristics:

- Does not contain styrene (eg, styrofoam, EPS (expanded polystyrene), polystyrene).
- Maximizes post-consumer recycled content.
- Minimizes the contents of lead, cadmium, mercury and hexavalent chromium, with a goal of less than 100 ppm (0.01%) in total content.
- Packaging remains the property of the supplier and not the recipient.

In order to reduce waste during the use phase of the vending machine, it is recommended to enable the use of reusable cups instead of disposable cups where relevant.

These can be difficult requirements to verify, a manufacturer/supplier affidavit can be used for this purpose as further described below.

The generation of waste arises when purchasing new refrigerators and freezer vending units in order to replace old ones. This must be taken into account during any procurement process. Section 4.5 above has additional information on environmentally sound management.

**It is recommended that the disbursement of the final contract payment be dependent upon receiving all the necessary environmentally sound management documentation.**

### Summary of the ESM considerations to take into account

1. The entity that acquires the refrigerator/freezer vending machines must know, before calling the tender, if the relevant waste management legislation incorporates an extended producer responsibility scheme for the type of waste generated at the time of the acquisition of the new appliances, specifically:
   - If the seller/supplier of the refrigeration appliance has the obligation to take responsibility for the management and recycling of the old devices;
   - The same for the packaging generated.

If there is an obligation, it will be the management system to which the seller/supplier is attached for the aforementioned products that will be responsible for their collection and recycling/treatment. However, the buyer must verify that there are no exceptions in relation to equipment installed before the entry into force of the legislation.

2. If an extended producer responsibility scheme has not been locally implemented, or does not affect refrigerator/freezer vending machines, the responsibility for the collection and recycling/management of said products lies with the buyer of the new refrigerators/freezers, as the final holder of the waste. However, the buyer can request appropriate agreement(s) with the manufacturer/seller/supplier for the management of the waste, but the conditions of this agreement must be included in the bidding rules for the acquisition of the new cooling products.
3. It should be noted that the environmentally appropriate treatment of used refrigerators/freezers can be expensive and the procurer must take this into account in considering their disposal cost in the offers.
4. During the tendering process, inclusion of provision for the submission and verification of bidder certificates on appropriate extended producer responsibility scheme membership and separate additional certification stating the destination of the gases in order to guarantee their correct disposal is recommended.

## 6.6 SOCIAL CRITERIA

Vending machines also provide a service to society to supply food. Therefore, the tender should consider several aspects regarding social criteria:

- **Production:** The bidder shall provide evidence that it complies with national and international decent work standards, if possible, throughout the production and service chain.
- **Food supply:** The bidder shall provide evidence that the list of food and drink items has been produced and traded in accordance with the requirements of a fair and ethical trade certification scheme.
- **Health:** The contract might specify a minimum list of healthy products. Furthermore, it is recommended to target products from organic sources.

Sometimes it is difficult to provide evidence for all products. Therefore, special award points can be given to those bids that offer more products that meet the social criteria.

Possible ways of verification are a manufacturer/supplier affidavit, certification to local and international standards, identifying suppliers for the different products, etc.

# 7. LABORATORY GRADE REFRIGERATORS PROCUREMENT CRITERIA

Laboratory grade refrigerators and freezers are products used specifically for storing non-volatile reagents and biological specimens in laboratory settings at stable, low temperatures. It includes hospitals, clinics, universities and government research laboratories as well as pharmaceutical manufacturing plants.

Laboratory refrigeration cabinets can be categorized depending on:

- Temperature of the compartment:
  - Refrigerators: temperatures between 0°C and 12°C
  - Freezers: temperatures from –40°C to 0°C, depending on the application
  - Ultra-low temperature freezers (ULT): temperatures between –80°C and –70°C
- Temperature stability inside the refrigerated compartments:
  - General purpose (GP)
  - High performance (HP)

In this case, high performance does not mean higher energy efficiency or lower energy consumption, it means that it is able to maintain the internal temperature of the appliance closer to the target value, which might be a requirement for certain applications.

There is a lack of knowledge about the energy efficiency of this type of product in the market. Energy Star in the US is one of the few attempts to label this kind of refrigerating appliance.

Therefore, this guideline presents the Energy Star[25] requirements as a reference value (Table 7). Nevertheless, since more studies on this appliance are needed, it is recommended to base the selection of laboratory grade refrigerators on comparisons between different products (e.g. with life cycle cost, $CO_2$ emissions and requirements from the application) instead of on minimum energy efficiency requirements.

More studies on this type of product are needed to assess the appropriate inclusion of more specific energy efficiency and other requirements in future editions of this guideline.

24 *The US Energy Star levels and test standards for laboratory grade refrigerators and freezers is available at: https://www.energystar.gov/products/other/laboratory_grade_refrigerators_and_freezers (last access May 2020)*

**Table 7**

Maximum energy consumption recommendations for SPP based on Energy Star for laboratory grade refrigerators and freezers

(GP = General purpose; HP = High performance; ULT = Ultra-low temperature)

| Target volume (± 30 L) | Maximum Energy Consumption for SPP (kWh/day) | | | |
|---|---|---|---|---|
| | Refrigerator GP | Refrigerator HP | Freezer HP | ULT Freezer |
| 250 | 3.09 | 5.12 | 10.79 | 4.86 |
| 310 | 3.36 | 5.51 | 10.99 | 6.02 |
| 370 | 3.62 | 5.90 | 11.18 | 7.19 |
| 430 | 3.88 | 6.29 | 11.37 | 8.35 |
| 490 | 4.15 | 6.68 | 11.56 | 9.52 |
| 550 | 4.41 | 7.07 | 11.75 | 10.68 |
| 610 | 4.67 | 7.46 | 11.94 | 11.85 |
| 670 | 4.93 | 7.85 | 12.71 | 13.01 |
| 730 | 5.20 | 8.24 | 13.61 | 14.18 |
| 790 | 5.45 | 8.55 | 14.51 | 15.34 |
| 850 | 5.70 | 8.87 | 15.42 | 16.51 |
| 910 | 5.96 | 9.20 | 16.32 | 17.67 |
| 970 | 6.21 | 9.52 | 17.22 | 18.84 |
| 1030 | 6.47 | 9.84 | 18.12 | 20.00 |
| 1090 | 6.73 | 10.17 | 19.03 | 21.17 |
| 1150 | 6.98 | 10.49 | 19.93 | 22.33 |
| 1210 | 7.24 | 10.82 | 20.83 | 23.50 |
| 1270 | 7.50 | 11.11 | 21.73 | 24.66 |
| 1330 | 7.75 | 11.37 | 22.64 | 25.83 |
| 1390 | 8.01 | 11.64 | 23.54 | 26.99 |
| 1450 | 8.27 | 11.90 | 24.44 | 28.16 |
| 1510 | 8.52 | 12.16 | 25.34 | 29.32 |
| 1570 | 8.78 | 12.43 | 26.25 | 30.49 |
| 1630 | 9.03 | 12.69 | 27.15 | 31.66 |

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[8] EN ISO 23953-2:2016. Refrigerated display cabinets – Part 2: Classification, requirements and test conditions

[9] ISO 22041:2019. Refrigerated storage cabinets and counters for professional use — Performance and energy consumption

[10] Commission Regulation (EU) 2019/2024 October 2019 laying down ecodesign requirements for refrigerating appliances with a direct sales function pursuant to Directive 2009/125/EC of the European Parliament and of the Council (https://eur-lex.europa.eu/eli/reg/2019/2024/oj, last access September 2020)

[11] ANSI/AHRI Standard 32.1-2017. Methods of Testing for Rating Vending Machines for Sealed Beverages.

[12] EN 50597. Energy consumption of vending machines.

[13] Draft new EU regulation: COMMISSION DELEGATED REGULATION supplementing Regulation (EU) 2017/1369 of the European Parliament and of the Council with regard to energy labelling of refrigerating appliances and repealing Commission Delegated Regulation (EU) No 1060/2010

[14] Muller Nicholas Z., Robert Mendelsohn, and William Nordhaus, (2011). "Environmental Accounting for Pollution in the United States Economy". American Economic Review, 101 (5): 1649-75.

[15] ISSO 26000:2010, Guidance on social responsibility (https://www.iso.org/obp/ui#iso:std:iso:26000:ed-1:v1:en)

[16] EN 16902:2016. Commercial beverage coolers – Classification, requirements and test conditions.

## ANNEX 1

# SUMMARY – CRITERIA FOR DOMESTIC REFRIGERATORS

| Criteria | Parameter | Recommendation for SPP | Section |
|---|---|---|---|
| **Energy consumption** | Energy efficiency | Target the efficiency class in the energy label corresponding to around the 20% most energy efficient models in the market. | 4.1.1 |
| | Volume | Optimize volume depending on needs, do not oversize. Rationalise the total number of refrigerators. | 4.1.2 |
| | Installation | Prioritize free-standing installation. | 4.1.3 |
| | Functions | Functions that require more energy consumption should come back to normal operation after use. | 4.1.4 |
| **Refrigerants** | ODP | ODP=0 | 4.2 |
| | GWP | GWP≤20 and prioritise natural refrigerants. | |
| **Food preservation** | Type of compartment | Select the right compartment combination (target temperature), depending on the need. | 4.3.1 |
| | Climatic zone | Chose the right climatic zone depending on the ambient temp. where the refrigerator will be installed. | 4.3.2 |
| **Product durability** | Spare parts | The manufacturer/supplier should ensure availability of spare parts, even when the model is no longer in the market. | 4.4.1 |
| | Information | The manufacturer/supplier should make available the repair and maintenance information. | 4.4.2 |
| **Environmentally sound management** | Dismantling | Facilitate material recovery (for re-use) and recycling while avoiding pollution. | 4.5 |
| | Take-back requirements | Manufacturer/supplier should ensure the correct environmental disposal of the refrigerator at the end of life. | 4.5 |
| | Packing | Minimum possible to facilitate handling the equipment and it should be recyclable. | 4.5 |
| **Social criteria** | Decent work | Complies with national and international decent work standards. | 4.6 |

## ANNEX 2

# SUMMARY – CRITERIA FOR COMMERCIAL/PROFESSIONAL REFRIGERATORS

| Criteria | Parameter | Recommendation for SPP | Section |
|---|---|---|---|
| **Energy consumption** | Energy efficiency | Target the efficiency class in the energy label corresponding to around the 20% most energy efficient models in the market. (Prioritize solid doors instead of transparent). | 5.1.1 |
| | Volume | Optimize volume depending on needs, do not oversize. And rationalised the total number of refrigerators. | 5.1.2 |
| | Light | LED light and smart control. | 5.1.3 |
| **Refrigerants** | ODP | ODP=0 | 5.2 |
| | GWP | Prioritize GWP≤20 (natural refrigerants). | |
| **Food preservation** | Ambient temperature | Chose the right climatic zone or ambient temperature and humidity depending on the application. | 5.3 |
| **Product durability** | Spare parts | The manufacturer/supplier should ensure availability of spare parts, even when the model is no longer in the market. | 5.4.1 |
| | Information | The manufacturer/supplier should make available the repair and maintenance information. | 5.4.2 |
| **Environmentally sound management** | Dismantling | Facilitate material recovery (for re-use) and recycling while avoiding pollution. | 5.5 |
| | Take-back requirements | Manufacturer/supplier should ensure the correct environmental disposal of the refrigerator at the end of life. | 5.5 |
| | Packing | Minimum possible to facilitate handling the equipment and it should be recyclable. | 5.5 |
| **Social criteria** | Decent work | Complies with national and international decent work standards. | 5.6 |

# ANNEX 3
# SUMMARY – CRITERIA FOR VENDING MACHINES

| Criteria | Parameter | Recommendation for SPP | Section |
|---|---|---|---|
| **Energy consumption** | Energy efficiency | Target the efficiency class in the energy label corresponding to around the 20% most energy efficient models in the market. | 6.1.1 |
| | Volume | Rationalise the total number of units (optimize location). | 6.1.2 |
| | Light | LED light and smart control. | 6.1.3 |
| **Refrigerants** | ODP | ODP=0 | 6.2 |
| | GWP | Prioritize GWP≤20 (natural refrigerants). | |
| **Food preservation** | Ambient temperature | Chose the right climatic zone or ambient temperature and humidity. | 6.3 |
| **Product durability** | Contract | The contract should include best maintenance practices to ensure that the unit will work efficiently during the whole lifespan. | 6.4 |
| **Environmentally sound management** | Dismantling | Facilitate material recovery (for re-use) and recycling while avoiding pollution. | 6.5 |
| | Take-back requirements | Manufacturer/supplier should ensure the correct environmental disposal of the refrigerator at the end of life. | 6.5 |
| | Packing | Minimum possible to facilitate handling the equipment and it should be recyclable. | 6.5 |
| | Use phase | Enable the use of reusable cups instead of disposable cups. | 6.5 |
| **Social criteria** | Decent work | Complies with national and international decent work standards. | 6.6 |
| | Food and drink | Offer a list of health food and drink items, targeting products from organic sources and being produced and traded in accordance with the requirements of a fair and ethical trade certification scheme. | 6.6 |

## ANNEX 4

# SPP EXCEL SPREADSHEET TOOL

These SPP guidelines are accompanied by an Excel spreadsheet tool[25], which provides information about the maximum energy consumption requirements for the SPP process and calculates the impact of a given bid: cost and emissions.

Figure 5 shows the "Country Input" tab, where the user should input the characteristics of the region/project, such as energy price, real discount rate, emissions factor for the electricity generated, lifespan of products, etc. If the user does not input information for a certain parameter, a default value is automatically used. For those parameters that are expected to be constant, it is recommended to block the cell after the policy makers have introduced the correct value, so it cannot be changed by other users, e.g. for the reference ambient temperature for the domestic refrigerator.

**Figure 5**

Excel SPP spreadsheet tool: "Country Input" tab

Introduce the specific data for your country or project in the yellow cells. If no data is introduced, the default value will be used.
Yellow cells are expected to be filled by the user, while the blue ones are expected to be adjusted by the country and blocked, so a normal user cannot change it accidentally

| Parameter | Country | Default | Comments about the parameter | Values that will be used |
|---|---|---|---|---|
| Real electricity price [USD] | | 0,16 | The real electricity price refers to the real cost for the government for each kWh consumed. If the electricity is subsided, the real price should account for the cost in the electricity bill + the subsided part | 0,16 |
| Select Temperature-Hour distribution from the droplist. | | Group 1 | Group 1 climate is being used as default, please select the climate that corresponds to your country. The U4E requirements depends on the selected climate. More information about Temperature-bin hours can be find in Climate zones Tab. | Group 1 |
| Select the Efficiency level requirement from the droplist | | U4E | The default U4E refers to the High Energy Efficiency levels of the U4E model regulations. To use different values, the "user input" should be selected in the drop-list, and the legislator has to introduce the local SPP requirements in the Tab "MEPS&EE". | U4E |
| GWP requirement | | 750 | GWP refers to the Greenhouse Warming Potential of the refrigerant being used. A GWP<750 is the requirement used as a default value. This is the value recommended by the U4E model regulation for window and split air conditioners up to 16 kW. In some cases, more stringent values can be used. For portable AC, the recommended value is GWP<150. | 750 |
| Real Energy Escalation Rate [%] | | 4% | | 4% |
| Real Energy Escalation Rate [%] | | 4% | Accounts for future increase of electricity price. | 4% |
| Real Discount Rate for Energy [%] | 0% | 0% | The Real Discount Rate for Energy takes into consideration the Real Discount Rate and the Real Energy Escalation Rate: Real Discount rate for Energy = Real discount rate -Real energy price escalation (all corrected with inflation) | 0% |
| Emissions per energy use [kg CO2/kWh] | | 0,5 | CO2-eq emissions of the national electricity mix. This might differ from country to country. Typical values are between 0.5 to 1 kg of equivalent CO2 per kWh produced | 0,5 |
| Energy transport and distribution losses [%] | | 8,25% | Used to calculate the total kWh produced in the power plant. Default value is the world average (source: world bank) | 8,25% |
| GHG cost [USD/Tonne of CO2] | | 27 | This accounts with the external cost due to the GHG emissions. The default value (27 USD) corresponds to the one used by Muller et al. (2011) for the US economy. Different values can applied in different countries. | 27 |
| Lifespan of the product | | 12 | It might differ from country to country and type of product. | 12 |
| Emissions for manufacturing and distribution [kg CO2] | | 500,00 | The default corresponds to the Preliminary Study to update the European Regulation 206/2012. This corresponds to a typical product with 7.1 kW of capacity. The value can be adjusted if the procured air conditioner is very different in size. | 500,00 |

25 *This is available on the U4E website at: https://united4efficiency.org/resources/tools/*

Figure 6 shows the calculation tab for the "Domestic Refrigerator" type. On the top of the window, the category of refrigerator and the energy efficiency ambition level can be selected (intermediate or high efficiency based on the U4E efficiency levels [1], this can be adjusted by an energy efficiency expert on the "General data" tab). The information of different models (for example, different bids) is introduced in the yellow cells: number of refrigerators, volumes, energy consumption, refrigerant type, initial price, and if the model contains specific compartments to reduce food waste.

The tool provides information about the maximum energy consumption requirement and if the model under analysis passes or not (also for the refrigerant and the blow foaming agent). For instance, both examples in Figure 6 pass the intermediate requirements. The refrigerator model of Bid 2 has lower energy consumption, which leads to a lower life cycle cost (around 5,000 USD less), even with a higher initial price (around 2,000 USD more). The life cycle cost includes the external cost due to the GHG emissions (see Annex 5). Bid 2 will reduce emissions due to energy consumption by 33 tonnes of $CO_2$ equivalent compared to Bid 1 during the lifetime of all appliances.

Bid 1 has specifically designed compartments to reduce food waste, which will lead to an estimated economic saving of around 165,000 USD and a reduction in emissions of around 135 tonnes of $CO_2$ equivalent during the lifetime of the appliances (for this example, the default value of 2% of avoided waste food was considered). In this sense, if the special compartments are going to be useful for the user, this element might be considered in the acquisition decision.

**Figure 6**

Excel SPP spreadsheet tool: "Domestic Refrigerator" calculation tab – impact of new appliances

| Select the category of domestic refrigerator from the drop-down list (see the pictures below for help) | Category | Level of efficiency |
|---|---|---|
| | Refrigerator-Freezer | Intermediate |
| | Refrigerator-Freezer<br>Freezer<br>Refrigerator | |

| Bid code | Number of units | Volume for fresh food compartment [liters] | Volume for Frozen compartment [liters] | Maximum energy consumption in kWh per year | Unitary energy Consumption in kWh per year | Meets Energy requirements? | GWP for refrigerant | GWP for gas blowing agent | Meets fluid requirements? | Total p… the bi… |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 100 | 230 | 100 | 210 | 205 | YES | 3 | 10 | YES | 54 |
| 2 | 100 | 210 | 91 | 203 | 180 | YES | 3 | 10 | YES | 56 |
| | | | | | | - | | | - | |
| | | | | | | - | | | - | |
| | | | | | | - | | | - | |
| | | | | | | - | | | - | |
| | | | | | | - | | | - | |
| | | | | | | - | | | - | |

| | | The costs and environmental impact are considered for procured amount of refrigerators and for their total lifespan | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| …ets fluid …irements? | Total price of the bid [USD] | Operational cost [USD] | External cost for CO2 emissions [USD] | Total Life Cycle Cost [USD] | Emissions during usage stage kg CO2eq | Emissions Usage + Refrigerants kg CO2eq | Compartments to better preserve food? | Waste Food Savings in USD | Waste Food GHG avoided in kg CO2eq |
| YES | 54,000 | 52,480 | 4,837 | 111,317 | 178,747 | 179,142 | YES | 165,565 | 135,000 |
| YES | 56,000 | 46,080 | 4,248 | 106,328 | 156,948 | 157,343 | NO | 0 | 0 |
| - | | | | | | | | | |
| - | | | | | | | | | |
| - | | | | | | | | | |
| - | | | | | | | | | |
| - | | | | | | | | | |
| - | | | | | | | | | |

It should be noted that the savings due to specifically designed compartments should be considered only if the user expects to use them correctly and reduce food waste, otherwise, they should not be considered even if they are present. Furthermore, since the final reduction of waste food is highly dependent on the user, the results related to waste food should be taken as indicative (they are not automatically considered in the life cycle cost).

Lastly, if the new appliances will replace old, but still functional equipment (early replacement), the tool can be used to calculate the payback period from the economic and environmental perspective compared with the new appliances. Figure 7 shows the necessary input for the old appliances. Furthermore, with the expectancy of years left for the old equipment, the tool calculates the balance cost and emissions from the replacement, which might be positive or negative depending on the situation. In this example, the replacement of 100 old refrigerators (with average consumption of 450 kWh) with 100 new refrigerators (Bid 1 from Figure 6) will save 2,189 USD and avoid 40.9 tonnes of $CO_2$ equivalent (excluding consideration of food waste improvement savings, which may be significantly more than energy savings alone, where relevant).

**Figure 7**

Excel SPP spreadsheet tool: "Domestic Refrigerator" calculation tab – early replacement

Note: The table below can be used to calculate the Payback and balance cost and emissions due to an early replacement. It considers the emissions of production and distribution of new appliances.

| Compare with Bid code | Number of units | Unitary energy Consumption in kWh per year | GWP for refrigerant | GWP for gas blowing agent | Discounted Payback Period Cost (years) | Payback Period for CO2 emissions (years) | Expected years left for old appliance | Balance cost for early replacement [USD] | Balance emissions for early replacement [kg CO2 eq] |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 100 | 450 | 3 | 10 | 13.8 | 3.7 | 4 | -2,180 | -40,906 |
| | | | | | | | | The early replacement will safe money | The early replacement reduce emissions |

# ANNEX 5
# LIFE CYCLE COSTS AND EMISSIONS

This annex shows how life cycle costs and emissions can be calculated for refrigerating appliances. Life cycle costings are a good tool to quantify the impact of a given bid and help the tenderer to choose between different alternatives that exceed the minimum requirements (see the SPP Excel spreadsheet tool in Annex 4)

## A5.1 ECONOMIC IMPACT

### A5.1.1 Life cycle cost (LCC)

From the economic point of view, the entire cost during the life cycle of the product should be considered, and not only the acquisition cost. In this sense, the life cycle cost analysis can be calculated .as per Equation 1 (EQ.1).

$$LCC = PP + N \cdot \sum_{n=1}^{L} \frac{AE \cdot EC}{(1+r)^n} + MC + EOL + \alpha \cdot E_{app} \quad \textbf{EQ.1}$$

Where:

- PP is the initial cost of the SPP
- AE is the annual energy consumption declared by the manufacturer in kWh
- EC is the real cost of the energy in $/kWh
- MC is the maintenance cost
- EOL is the end-of-life cost (such as collection and recycling costs)
- L is the expected lifespan of the product (around 16 years for domestic refrigerators and 10 years for the rest)
- N is the number of appliances in the tender
- r is the difference between the real discount rate and the real escalation rate of energy price. If the discount rate and escalation rate of energy price are similar, r≈1

Since these guidelines are intended for public procurement, the real energy cost should be considered, i.e. the price of energy without governmental subsides. The maintenance cost might be included in the contract. The cost related to the product disposal at the end of life is usually included in the price of the product, especially in those countries with extended producer responsibility policies.

Some countries charge taxes to entities depending on their GHG emissions. Even without taxes, GHG emissions will affect other parts of the economy, involving costs for both public institutions and society. The external cost due to GHG emissions can be considered using the factor α ($/tonne of eq. $CO_2$) multiplied by the emissions due to energy consumption during the use phase and the type of refrigerants used (see *Eapp* in Section A.2). According to Muller et al. (2011) [14], the external environmental cost[26] due to the emission of 1 tonne of equivalent $CO_2$ is 27 USD (based on average value for the US).

26 *The external environmental cost might vary for different countries and the assumptions made to calculate the cost, e.g. if it considers or not the effect of emissions outside of the country.*

### A5.1.2 Food waste reduction (cost)

As discussed earlier in the guidelines, the optimization of volume and compartment temperatures according to the storage needs of the user can reduce the amount of food waste. According to Freija van Holsteijn and René Kemna (2018) [2], 11% of the end-use food is wasted and might be avoided. They estimate a 2% waste food reduction (from 11% to 9%) by optimizing the size and temperatures of different compartments in a household refrigerator (see Section 4.3).

Considering an average reduction of 2% in waste food for SPP for those refrigerators with specifically designed compartments at different target temperatures to better preserve food, the economical savings are estimated at around 92 USD per year (for an average domestic refrigerator around 280 litres).

### A5.1.3 Early replacement (cost)

A life cycle costing is useful in comparing the total cost between two alternatives. When an early replacement is considered, i.e. the replacement of existing equipment that has not yet reached the end of its life (still working properly), a cost balance can be used to calculate the worthiness of the replacement of the old inefficient unit by a new efficient appliance.

In this case, the savings will also depend on the consumption and the life expectancy of the old appliance, see Equation 2 (EQ.2).

$$balance\ cost = \left( \frac{PP \cdot L_{exp}}{L} + N \cdot \sum_{n=1}^{L_{exp}} \frac{AE \cdot EC}{(1+r)^n} \right) - \left( N_{old} \cdot \sum_{n=1}^{L_{exp}} \frac{AE_{old} \cdot EC}{(1+r)^n} \right) \quad \textbf{EQ.2}$$

The first term corresponds to the cost of the new appliance during the life expectation of the old equipment (*Lexp*), e.g if the equipment is 12 years old, considering a lifespan[27] of 16 years, *Lexp* = 4 years. In this case, the initial price is normalized with the life expectation of the old equipment and the lifespan of the new equipment considered for the early replacement. The operating cost of the new and old appliances are considered during the life expectation of the old equipment. *AEold* refers to the annual energy consumption of the old refrigerator in kWh.

The early replacement will lead to economical savings if the balance cost is negative.

27 *16 years is taken as a reference value, but depending on the conditions of the equipment, this number can be reduced or increased.*

## A5.2 GHG EMISSIONS

### A5.2.1 Emissions during use stage and refrigerants

Equation 3 (EQ.3) can be used to calculate the total emissions, the indirect emissions due to the energy use of the refrigerator during its lifetime and the direct emissions due to the use of refrigerant and foam blowing agent (*Eapp* in kg of equivalent $CO_2$).

$$E_{app} = N \cdot \left( \frac{AE}{1 - TD} \cdot \beta \cdot L + (GWP_{ref} \cdot m_{ref} \cdot R_{EoF,ref}) + (GWP_{fo} \cdot m_{fo} \cdot R_{EoF,fo}) \right) \quad \text{EQ.3}$$

Where:

- AE is the annual energy consumption in kWh
- TD is the transmission and distribution losses
- β is the indirect emission factor in equivalent $CO_2$ per kWh of consumed electricity, which will depend on the energy mix of the country or region
- L is the expected lifespan of the product
- N is the number of appliances in the tender

For the refrigerant (*ref*) and the foam blowing agent (*fo*):

- GWP is the global warming potential,
- m is the mass in kg (usually around 30% for *ref* and 70% for *fo*)
- $R_{EoF}$ is the ratio of the refrigerant that will end up in the atmosphere after the disposal of the unit, which might depend on the recycling practices of each country.

This calculation does not consider the emissions due to production and distribution. For the average refrigerator in 2016, the emissions due to energy consumption during the use phase accounts with around 80% of the total emissions, i.e. production and distribution account for around 20%. The share of emissions for production and distribution might increase in the high efficiency models (less energy during the use phase).

The emission of ozone depletion substances is not included because it is a requirement for all refrigerators to have an ODP=0.

### A5.2.2 Food waste reduction (emissions)

The equivalent GHG emissions during the full food supply life cycle are estimated to be around 27 times the overall GHG life cycle emissions of domestic refrigerating appliances. Energy related GHG emissions from fossil fuels accounted for more than half of total food supply chain emissions in Europe.

As mentioned earlier, the optimization of volume and compartment temperatures according to the storage needs of the user can reduce the level of food waste. According to Freija van Holsteijn and René Kemna (2018) [2], 11% of end-use food is wasted and might be avoided. They estimate a 2% waste food reduction (from 11% to 9%) by optimizing the size and temperatures of different compartments in a household refrigerator (see Section 4.3).

Considering an average reduction of 2% in waste food for SPP for those refrigerators with specifically designed compartments at different target temperatures, it is estimated a reduction of 1,300 kg of equivalent $CO_2$ emissions for an average domestic refrigerator (i.e. around 280 litres) during the whole lifespan (16 years).

### A5.2.3 Early replacement (emissions)

When early replacement is considered, i.e. the replacement of existing equipment that has not yet reached the end of its life (still working properly), a cost balance can be used to calculate the worthiness of the replacement of the old inefficient unit by a new efficient appliance (as considered in Section A.1.3).

In this case, the emissions reduction will also depend on the characteristics and the life expectancy of the old appliance, see Equation 4 (EQ.4).

$$balance\ emissions = \frac{L_{exp}}{L}\left(\lambda \cdot E_{app}^{new} - E_{app}^{old}\right) \quad \textbf{EQ.4}$$

Where $E_{app}^{new}$ and $E_{app}^{old}$ are the emissions during the use-phase of the new and old appliances[28] respectively (see EQ.3). is the production and distribution factor, which considers the extra emissions due to early replacement. For instance, considering that for an efficient domestic refrigerator, production and distribution accounts for 25% of the GHG emissions, = 1.33. The balance of emissions are weighted in accordance with the life expectation of the old equipment (*Lexp*), e.g. if the equipment is 12 years old, considering a lifespan L of 16 years → *Lexp* = 4 years.

The early replacement will lead to a reduction of emissions if the balance in EQ.4 is negative.

## A5.3 POWER LOAD

While reducing energy consumption will benefit the environment and reduce the operating costs for the owner, a more efficient product will also reduce the power demand, alleviating the capacity of power plants and reducing investments needed to increase this capacity in the future.

Even though there are some parts of the day where refrigerators use more energy (opening hours, process loads, higher ambient temperatures, etc.), since it works 24 hours a day, for simplicity, it can be considered as constant power consumption. Therefore, the estimated power demand of several appliances (N) can be calculated as per Equation 5 (EQ.5).

$$P = N \cdot \frac{AE}{24 \cdot 365} \quad \textbf{EQ.5}$$

One should note that the constant power demand approach cannot be applied to all types of appliances. For example, air conditioners do not run all day and their consumption is highly affected by the outside ambient temperature. In this case, the peak load should be considered.

28 *Consider that the number of new and old appliances might not be the same. For instance, the new tender has optimized the location of refrigerators, reducing total number of installed appliances.*

# ANNEX 6
# SELECTION EXAMPLE FROM TABLE

As discussed in earlier sections of these guidelines, whenever possible, the energy label (comparative and/or endorsement) should be used to set the criteria on energy efficiency requirements for SPP, so it is easy to target the most efficient products in the market. Nevertheless, in many cases, the appropriate labels are non-existent or out of date. One method to set the energy requirements is by using a table with the maximum energy consumption requirements as a function of the volume and type of refrigerator as described in previous sections of these guidelines with examples for each of the respective refrigerator types.

This annex shows an example of how to use a table with the maximum energy consumption requirements for SPP. For the sake of clarity, Table 1 has been repeated in this annex (now as Table 8).

## Selection Example

The refrigerator being procured should have the following specifications: Domestic refrigerator-freezer with a total volume of 350 liters, 250 liters for the fresh food compartment and around 100 liters for the freezer.

Three different bids arrive with the following offers:

- *Bid 1:* Refrigerator-freezer with a volume of 245 liters for fresh food and 110 liters for the freezer with an annual energy consumption of 205 kWh per year → the total volume is 355 liters. The closest value in Table 8 is 350 liters, which indicates a maximum energy consumption of 179 kWh.
- *Bid 2:* Refrigerator-freezer with a volume of 258 liters for fresh food and 105 liters for the freezer with an annual energy consumption of 178 kWh per year → the total volume is 363 liters. The closest value in Table 8 is 350 liters, which indicates a maximum energy consumption of 179 kWh.
- *Bid 3:* Refrigerator-freezer with a volume of 320 liters for fresh food and 120 liters for the freezer with an annual energy consumption of 190 kWh per year → the total volume is 440 liters. The closest value in Table 8 is 440 liters, which indicates a maximum energy consumption of 198 kWh.

Therefore, Bid 1 does not pass the energy consumption requirements. While Bid 2 and Bid 3 meet the energy consumption requirements, Bid 3 has a greater energy consumption. Since the compartment volumes of Bid 2 are closer to the equipment procurement specifications, from the energy consumption point of view, Bid 2 would be preferred.

The maximum energy consumption requirements suggested in Table 8 are based on the high efficiency levels of the U4E Model Regulation Guidelines [1], which point out the high efficiency refrigerator performance levels for those refrigerators that are commonly available around the world. Each country can adjust their energy efficiency requirements to its reality.

When there are no suitable labels in place (or where they are out of date), presenting the energy requirements with the table method is simple and easy to use. Nevertheless, to simplify the output, several assumptions are taken, e.g. using volume ranges and considering a constant share of fresh food and freezer volume in the refrigerator-freezer category (in Table 8 the share is 70% and 30% respectively).

**More accurate results can be obtained using a specific tool to make it easier for the user.** See Annex 4 for more information on the U4E Excel spreadsheet tool for the SPP of higher energy performance, low carbon, refrigerators. Furthermore, this tool can calculate the life cycle costs, $CO_2$ equivalent emissions and savings as well as for the early replacement of old refrigeration equipment.

| | Maximum Energy Consumption for SPP (kWh/year) | | |
|---|---|---|---|
| Target total volume (±15 liters) | Refrigerator | Refrigerator (70%) – Freezer (30%) – Frost Free | Freezer (Manual Defrost) |
| 50 | 73 | 118 | 141 |
| 80 | 77 | 124 | 150 |
| 110 | 80 | 130 | 158 |
| 140 | 83 | 136 | 167 |
| 170 | 86 | 142 | 176 |
| 200 | 90 | 149 | 184 |
| 230 | 93 | 155 | 193 |
| 260 | 96 | 161 | 202 |
| 290 | 100 | 167 | 210 |
| 320 | 103 | 173 | 219 |
| 350 | 106 | 179 | 228 |
| 380 | 109 | 186 | 236 |
| 410 | 113 | 192 | 245 |
| 440 | 116 | 198 | 254 |
| 470 | 119 | 204 | 262 |
| 500 | 122 | 210 | 271 |
| 530 | 126 | 217 | 280 |
| 560 | 129 | 223 | 288 |
| 590 | 132 | 229 | 297 |
| 620 | 135 | 235 | 305 |
| 650 | 139 | 241 | 314 |
| 680 | 142 | 248 | 323 |
| 710 | 145 | 254 | 331 |

**Table 8**

High efficiency level according to U4E Model Regulation Guidelines for refrigerator only, refrigerator-freezer (70%–30% volumes share) and freezers (Reference ambient temperature of 24°C and test method IEC 62552:2015)

UN environment programme

50 1972-2022

United Nations Environment Programme – Global Environmental Facility – Department for Environment, Food and Rural Affairs | United for Efficiency (U4E)