Refrigerants, Naturally! for LIFE

SUSTAINABLE COOLING FOR EUROPE'S SMALL FOOD RETAIL STORES

TECHNOLOGY GUIDE

GUIDANCE DOCUMENT

Refrigerants, Naturally! for LIFE

CONTENT

INDIRECT EMISSIONS

Energy efficiency improves your store's economics while reducing your carbon emissions.

DIRECT EMISSIONS

Natural refrigerants are environmentally friendly and are one of the most effective ways to reduce your carbon emissions.

OPTIMAL CHOICES

Reduce your refrigeration costs with smart and efficient choices.

MARKET DEVELOPMENT

Have a look at the demand trend and how the markets response is.

SUSTAINABILITY IN YOUR STORE

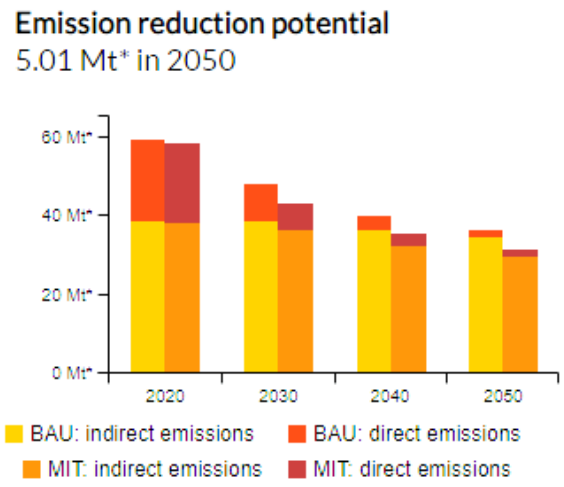
COOLING EQUIPMENT HAS GREAT OPPORTUNITIES TO INCREASE SUSTAINABILITY

Sustainability in your store can be greatly improved by choosing refrigeration, air-conditioning and heat-pump (RACHP) appliances that use natural refrigerants and choosing the most energy-efficient option suitable to your needs. In this guide, you will find useful and easy-to-access information that will guide you through this process.

Over the life of appliances, your operating costs will be reduced as efficient appliances use less power than less efficient options. Often, the lower electricity consumption will result in lower life-cycle costs, even if the efficient appliances are more expensive to purchase.

This guide provides general information on energy efficiency and refrigerant options available in RACHP appliances to increase your awareness of the options and point you in the right direction when you need to invest in this part of your business. This will help you make choices of equipment and systems as well as where and how to get support when you need it.

ENERGY EFFICIENCY



REDUCE YOUR COSTS AND GREENHOUSE GAS (GHG) EMISSIONS

Efficiency describes the relationship between a useful output and the related input. The higher the output per unit of input, the more efficient the system or process. The best way to better energy efficiency is reducing energy consumption. That can be done by reducing thermal losses (e.g. doors on cooled cabinets, better thermal insulation) and by changing the set temperatures for air conditioners and heat pumps. The next step to better energy efficiency is switching to highly efficient processes or products that help to minimise the use of the already reduced energy need.

Using highly efficient processes or products helps to minimise the use of primary energy as an input. Figure 1 shows the potential to reduce indirect (energy) emissions from now to 2050 with energy efficiency and renewable energy in Germany.

FIGURE 1 EMISSIONS REDUCTION POTENTIAL IN THE RACHP IN GERMANY. TWO SCENARIOS SHOWN: A BUSINESS-AS-USUAL SCENARIO (BAU) AND A MITIGATION SCENARIO (MIT) (SOURCE: GREEN COOLING INITIATIVE).

MEPS & LABELING

HOW TO IDENTIFY BEST PERFORMING APPLIANCES

MEPS (Minimum Energy Performance Standards) define minimum values of energy efficiency for certain products. Products that do not meet these minimum requirements will be banned from the market to ensure that outdated and low performing appliances do not enter the market. MEPS are usually combined with a labelling programme where appliances are presented with a label (Figure 2) that provides information on the energy efficiency of the appliance to enable you, the consumer, to distinguish between efficient and less efficient products.

The label gives information on energy consumption, noise, and other features of the appliance and provides a level of comparison with the market for you to make an informed choice. Remember, the greener the rank, the lower the running cost and the more your carbon emissions go down.

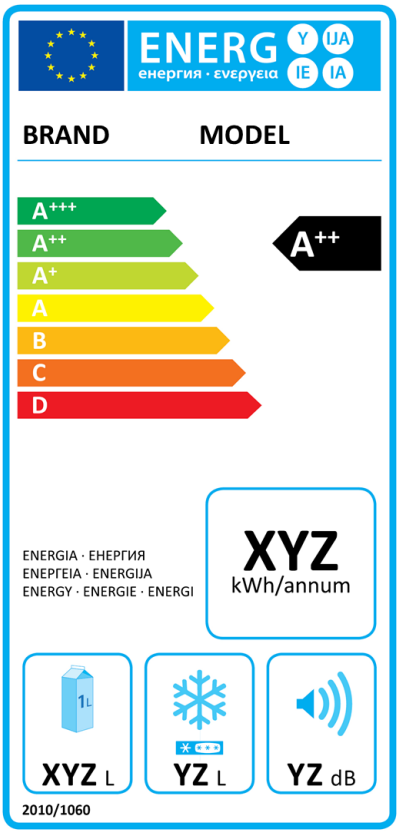


FIGURE 2 – SAMPLE FRIDGE ENERGY EFFICIENCY LABEL. INCLUDES MAKE AND MODEL, RANK, TOTAL ELECTRICITY CONSUMPTION, FRIDGE AND FREEZER SIZE, AND HUMIDITY.

EFFICIENCY IN BUILDINGS

BUILDINGS ALSO INFLUENCE ENERGY DEMAND

A significant proportion of your energy costs are on keeping warm or cool depending on the season. Air conditioning and heat pumps can be large energy consumers, so it is important to ensure that they are the right size and are energy efficient.
Similarly, the design and quality of the building can reduce energy demand through improved insulation. For example, wall insulation and double-glazed windows reduce thermal loses, and thus, energy demand. The European energy performance of buildings directive provides a framework for the improvement of buildings including providing a performance rating similar to the label of appliances. Again, better performing buildings will have lower heating and/or cooling costs.

FIGURE 3 – LOWER ENERGY CLASSES WITH LARGER ENERGY LOADS

DIRECTIVES & STANDARDS

IMPARTIAL MEASURING GUIDES

Standards are guides for developing products and services to meet strong quality and performance needs, often with regards to safety. These guides are usually developed with support from industry. It is important to note that standards are not laws or regulations and are usually not developed by the government.

Government directives and regulations often refer to standards when they want to enforce performance or behaviours making the requirements of a standard a legal obligation. Such legal obligation is for example the CE marking in the European market. Products sold in the European Economic Area need to comply with the related European safety, health, and environmental protection requirements but don´t necessarily need to have the CE mark (figure 4) on them.

CE

FIGURE 4 –CE MARK

Often, manufacturers adopt standards voluntarily to demonstrate a commitment to quality or the environment and will show this in their products through labels. An example here is the German Ecolabel, Blue Angel (figure 5).

FIGURE 5 – BLUE ANGEL, THE GERMAN ECOLABEL

NATURAL REFRIGERANTS

LOW-COST AND ENVIRONMENTALLY FRIENDLY

The refrigeration, air-conditioning and heat pump (RACHP) sector is facing changes as the use of many synthetic refrigerants is being restricted or banned under the Montreal Protocol[1] due to high ozone depletion potential (ODP) and global warming potential (GWP). GWP is the relative climate change impact of a substance compared to CO_2 which has a GWP of 1. So, a GWP of 1,430 from a common refrigerant (R134a), makes it 1,430 times worse than CO_2!!

Natural refrigerants are a climate-friendly solution to the high GWP of synthetic refrigerants as they have very low or zero GWP and zero ODP. They are naturally occurring substances and part of the natural earth cycles and do not create long-lasting waste in the atmosphere. The more commonly used natural refrigerants are CO_2, ammonia, water, air, and hydrocarbons such as propane (R290) and isobutene (R600a). These are already widely used in various applications such as isobutane in refrigerators, CO_2 in retail, and ammonia in large cooling processes.

However, the use of natural refrigerants often requires extra care due to potential flammability and toxicity depending on the refrigerant. Simple measures such as the use of appropriate materials, safe components and technician training can offset these seemingly challenging characteristics.

Refrigerant class	*Ozone Impact*	*Global Warming Potential (GWP)*	*Examples*
CFCs	High	Very high	High
HCFCs	Very low	Very high	R22
HFCs	Zero	Mostly high	R134a
HFOs	Zero	Low	R1234yf
HCs	Zero	Negligible	R290, R1270, R600a
CO_2	Zero	Negligible	R744
NH_3	Zero	Zero	R717
H_2O	Zero	Zero	R718
O_2	Zero	Zero	

TABLE 1 – MOST COMMON REFRIGERANT CLASSES AND THEIR IMPACT ON OZONE AND GLOBAL WARMING (CFC = CHLOROFLUOROCARBON, HCFC = HYDROCHLOROFLUOROCARBON, HFC = HYDROFLUOROCARBON HC=HYDROCARBONS, CO2=CARBON DIOXIDE).

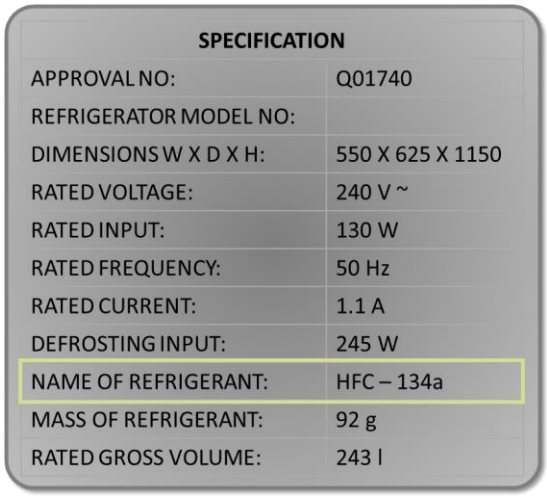


FIGURE 6 – REFRIGERATOR TECHNICAL SPECIFICATIONS LABEL WITH REFRIGERANT HIGHLIGHTED

[1] More information about the Montreal Protocol to be found in the Policy Guide, available for download at www.refnat4life.eu

HYDROCARBONS IN THE RACHP SECTOR

PROPANE AND ISOBUTANE ARE ALREADY WIDELY USED IN REFRIGERATION, AIR CONDITIONING AND HEAT PUMP EQUIPMENT

Hydrocarbons (HCs) are effective refrigerants as their physical properties are well suited for this task. R600a (isobutane) and R290 (propane) are the most prevalent hydrocarbon refrigerants in stand-alone refrigeration appliances in Europe. Hydrocarbon refrigerants can be more energy-efficient and the required refrigerant charge per appliance tends to be much lower (a half or less) than with fluorinated refrigerants (GIZ, 2020. QCR Module 5).

R600a is one of the most commonly used natural refrigerants with more than a billion household refrigerators and stand-alone cooling units in operation today (GIZ, 2020. QCR Module 5). This also demonstrates refrigerators can be safely operated with hydrocarbons. Similarly, modern refrigerators are more efficient than ever and are quiet in operation, partly supported by the suitable properties of R600a.
R290 presents similar advantages for air-conditioning and heating applications. Since 2000, well-known manufacturers have offered AC equipment charged with R290, often offering energy savings of between 10 - 30%. Industries that are used to handling flammable substances have used hydrocarbons as refrigerants in the past, but recently an increasing number of manufacturers are offering R290 as a refrigerant in commercial systems, stand-alone units as well as heat pumps and air-conditioners.

You can find out the type of refrigerant of appliances as they all have a tag (Figure 2) with technical specifications, including the type of refrigerant. Information is also usually available on the shopping websites where they list the technical specifications of the appliance.

CO_2 AS A REFRIGERANT

EXPANDING AVAILABLE OPTIONS

Carbon dioxide or CO_2 (R744) is another effective natural refrigerant that is not flammable and is non-toxic. It is being increasingly used and by 2020, around 27,500 stores used CO_2 refrigeration systems in Europe (SheccoBase,2020). Also, the availability of CO_2-based remote systems is constantly increasing and today a strong market with multiple competitors has emerged in Europe.

Some hazards remain, and it is important to have qualified technicians to install and maintain the plant. This is an area of current development and is increasing. Ask your service provider if they can deliver and maintain CO_2 units as another environmentally friendly cooling option.

FIGURE 7 – NATURAL REFRIGERANT OPTIONS FOR APPLICATIONS

LIFE CYCLE COST

A KEY FACTOR WHEN MAKING CHOICES ON NEW APPLIANCES

Life Cycle Cost (LCC) is a measure of the cost of an appliance over its life cycle and it is used to compare the economic efficiency of products by accounting for all relevant costs. Often, environmentally friendly products are the most economic despite a higher purchase cost. The most inexpensive products are often not the most economic ones as they may have higher running costs than more expensive alternatives. Such higher costs arise from higher energy consumption, maintenance costs (including the costs of refrigerants), and repair costs. Sometimes, the costs at the end of the useful life such as removal, disposal, and recycling are also likely to be higher.

Life Cycle Costing includes these factors in a calculation of the actual costs for a product, and it is recommended that you consider this in your next purchase.

EQUIPMENT CHOICE & USAGE

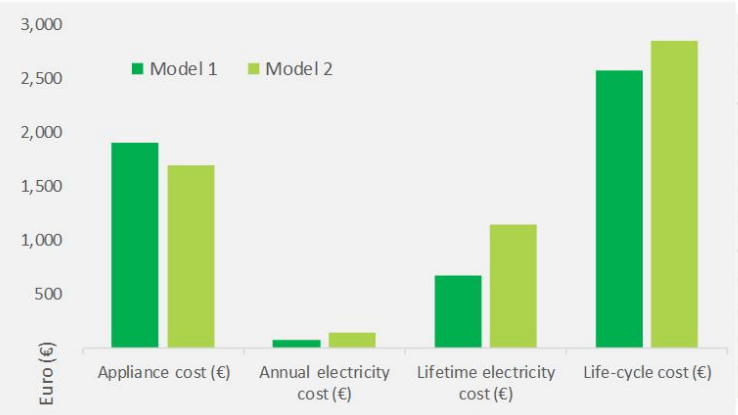
MAKING THE MOST COST-EFFECTIVE AND SUSTAINABLE CHOICE FOR YOUR STORE

When it´s time to replace existing RACHP appliances or you are planning to update your store, it is important to choose the right equipment. Not only do you need to ensure that the needs of your store are met, but choosing the right quality, energy performance, and refrigerant could end up saving you significant amounts of money and improving your sustainability. So, what should you consider?

- Get the right type and size equipment for your needs. If the system is too large, it will result in wasted space or energy (whether it is an AC or a refrigerator). If the system is too small, it won't serve your needs or it will be overloaded, affecting its efficiency.
- Look for the energy efficiency label and choose the more efficient appliances. From the example below, comparing refrigerated cabinets of similar size demonstrates that the cost of the cabinets is lower than the cost of the total energy used by the cabinet. A difference in performance more than warrants the extra expense on better performance appliances.
- Choose appliances that use natural refrigerants. All appliances have a tag with this information, or even online sellers list this information in the technical specifications of the appliance. Commonly used natural refrigerants are R600a (isobutane), R290 (propane) and CO_2.

MAKING OPTIMAL COOLING CHOICES

	Model 1	Model 2	Difference
Appliance cost (€)	1,904	1,698	206
Annual energy use (kWh/Jahr)	336	576	240
Cost of electricity per unit (€/kWh)	0.25	0.25	-
Annual electricity cost (€)	84	144	60
Appliance life time (years)	8	8	-
Lifetime electricity cost (€)	672	1,152	480
Life-cycle cost (€)	**2,576**	**2,850**	**274**



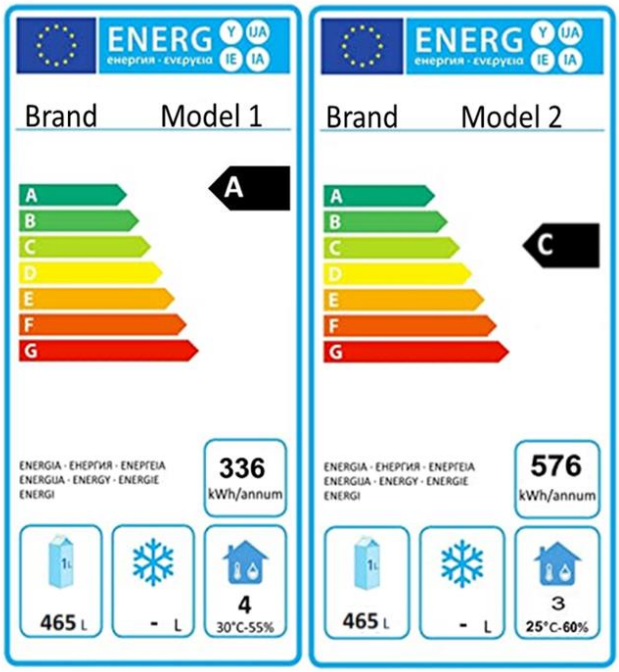


FIGURE 8 – ENERGY LABELS FOR COMPARABLE DISPLAY CABINETS AND LIFE CYCLE COST COMPARISON, EXCLUDE DISPOSAL AND MAINTENANCE COSTS.

EFFICIENT USE OF APPLIANCES

As well as choosing an efficient appliance, it also important to consider how to use it effectively and efficiently. With some simple considerations you can improve the energy performance of your appliances. Key considerations include:

- **Shading** – keep your appliance away from direct sunlight as much as possible to minimize direct heat gains. This will reduce the load on the appliance and save energy.
- **Location** – some appliances discharge warm air into the room and it´s important to place them in locations where the hot air won't pool or affect the performance of other appliances.
- **Maintenance** - appropriate maintenance of different parts ensures optimum performance. For example, magnetic seals can wear off and develop leaks allowing the cool air to escape increasing the load significantly.

RACHP DEMAND

RISING DEMAND FOR RACHP IN EUROPE.

Rising temperatures and economic development continues to fuel increasing demand for RACHP services in the residential and commercial applications across the world, and Europe is no different. In 2015, the market for ACs increased by 6% in Europe to 5 million AC units.
Figure 9 shows the increasing trend of installed RACHP appliances in the world. While the trends differ by country, all European countries are estimated to continue increasing until 2030 before slowing down.
Similarly, the supermarket industry continues to grow, driving demand for the refrigeration appliances and space cooling and heating. The European food retail market is expected to grow between 2% and 3% per year between 2017 and 2022 (RefNat4LIFE, 2020) depending on the country.

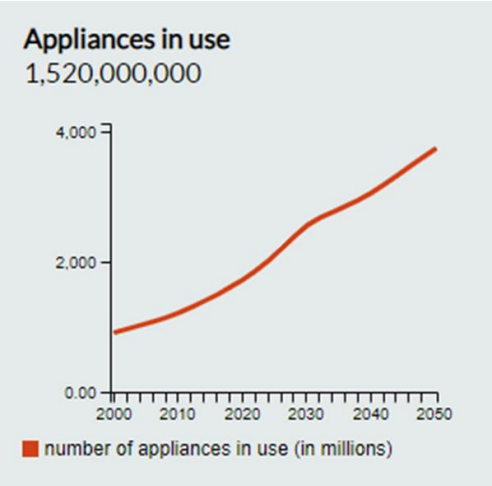


FIGURE 9 – ESTIMATED NUMBER OF INSTALLED RACHP APPLIANCES AROUD THE WORLD 2000 – 2050 (SOURCE: GREEN COOLING INITIATIVE)

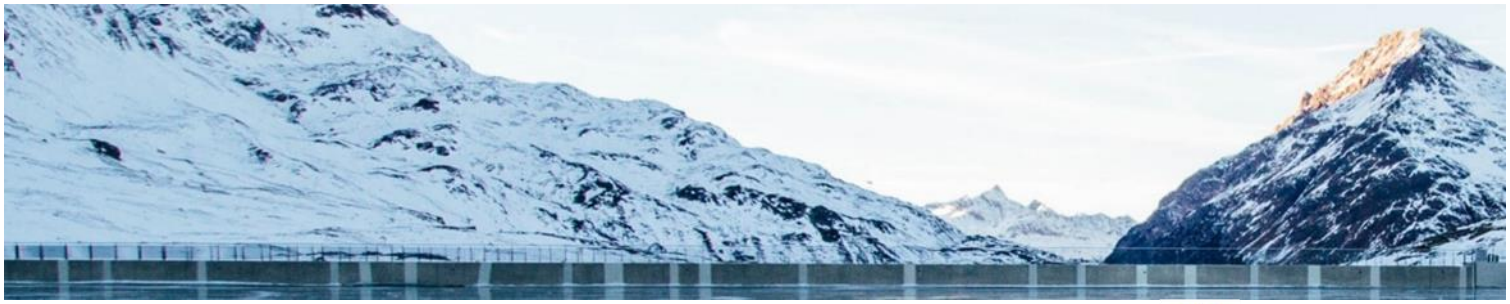
NATURAL REFRIGERANT USE IN EUROPE

WIDE VARIETY OF MODELS ALREADY AVAILABLE FOR DIFFERENT APPLICATIONS

Today, already approx. 200 manufacturers use natural refrigerants in residential and (light)-commercial refrigeration and air conditioning units in Europe (Shecco, 2016). Hence, a growing supply base exists for a more accelerated uptake of equipment using non-fluorinated gases. In fact, the use of such refrigerants in the European food retail sector is increasing, as a result from early investment of large food retail chains. By 2020, around 27,500 stores used CO2 transcritical RAC systems in Europe.
Worldwide, 2.5 to 3 million hydrocarbon-based commercial refrigeration units (excl. bottle coolers, vending machines) are used. A growing number of large food retail chains have adopted natural refrigerants and energy efficiency measures as a blueprint for future stores. However, looking at smaller food retailers the situation was assumed to be significantly different: Small store owners, often independent, family-run businesses or local chains, many times struggle with the selection and maintenance of best-available RACHP equipment.
Available models at the leading tradeshow for the food retail sector EuroShop in February 2020, show that most RACHP suppliers today offer plug-in (stand-alone) refrigeration units with R290 (propane), and those that do not, have plans to introduce them in the near future. Also, the availability of CO_2-based remote systems is increasing and today a strong market with multiple competitors has emerged in Europe.
A 2019 survey found that over 32% of organic food retail (OFR) stores had appliances running on R290 and 16% had appliances with R600a. These are the leading hydrocarbon refrigerants. The survey also found that a further 11% of respondents had R744 (carbon dioxide) systems. It is of note that the majority of this use is on stand-alone (plug-in) units, while centralised cooling systems still largely rely on fluorinated refrigerants.

WHERE YOU CAN GET SUPPORT

Name of Organization	*Type of Organization*	*Link*
REFNAT	NGO	Link
REFNAT4LIFE Online Course on sustainable cooling	Training course	Coming soon!!
Environmental Protection Agency	Central Government Department	Link
Refrigerants, Naturally! For Life.	EU-funded project	Link
EU Heating and Cooling info page	European Commission	Link
EU Climate friendly alternatives to HFCs	European Commission	Link



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