Refrigerants, Naturally! for LIFE

Executive summary of the public report

Towards sustainable cooling in the European organic and small food retail sector

Status, technology needs and expectations

Executive Summary of the Public Report

For the project RefNat4LIFE

Refrigerants, Naturally! for LIFE is an EU funded project to support the uptake of climate friendly cooling alternatives for food preservation, shop air conditioning and heating.

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December 2020

Glossary

Abbreviation	Description
AC	Air Conditioning
BAU	Business as usual
EE	Energy Efficiency
EEI	Energy Efficiency Index
GEF	Grid emission factor
GHG	Greenhouse gas
GWP	Global Warming Potential[1]
HC	Hydrocarbons
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbons
HFO	Hydrofluoroolefin
HP	Heat pump
LT	Low temperature
MEPS	Minimum Energy Efficiency Standards
MIT	Mitigation
MT	Medium temperature
MTOE	Million Tonnes of Oil Equivalent
MOOC	Massive open online course
OFR	Organic food retail
RAC(HP)	Refrigeration, Air conditioning (and Heat Pumps)
RefNat4LIFE Project	Refrigerants, Naturally! For LIFE project

[1] The following report adopts the GWP values provided in the IPCC Fifth Assessment Report (AR5). The term "low-GWP" is used for substances with a GWP <10. Wherever the term "low-GWP" is used throughout this report, for reasons of simplicity it also includes "zero-GWP" substances with a GWP = 0 (like ammonia R717, water R718, or air R729 as a refrigerant).

Executive Summary

Greenhouse gas emissions from refrigeration, air conditioning and heat pump (RACHP) systems in food retail demonstrate great mitigation potential. However, this potential is not fully exploited by the small food retail sector[2] which is ill-prepared for a change to a more sustainable technology and refrigerant choice.

As countries are trying to meet their Paris Agreement obligations by targeting net zero emissions by 2050 across all sectors, small food retailers increasingly aim to transit to zero greenhouse gas emissions associated with their cooling and heating appliances. Typical energy intensities in food retail are in a range of 500 to 1000 kWh/m² per year for total electricity consumption and an additional 80 to 250 kWh/m² per year for heating including domestic hot water. Typically, refrigeration equipment is responsible for about half of the total electricity consumption and air-conditioning for another 5 to 10 %. This demands appliances to be continuously upgraded for being as energy efficient as possible, as well as the deployment of near zero-emission refrigerants. In order to reduce the use of high Global Warming Potential (GWP) refrigerants, and to implement the F-Gas Regulation at EU-level, natural refrigerants have become an obvious choice in replacing synthetic substances like hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs). With their very low or zero GWP, and no ozone depletion potential, hydrocarbons (HC), carbon dioxide (CO_2), ammonia (NH_3) and water (H_2O) are energy-efficient and cost-effective options for a wide range of applications. Natural refrigerants are proven to be environmentally benign, where fluorinated refrigerants (e.g. hydrofluoroolefins, HFOs) are suspect for potentially negative environmental impact on the short and long term (e.g. combustion by-products and formation of trifluoroacetic acid for which there is no known degradation mechanism)[3]. Around 200 manufacturers already offer natural refrigerant-based solutions in Europe (shecco, 2016), addressing a constantly increasing demand. The market is moving as policy pressure to reduce refrigerant emissions and energy consumption from RACHP in the European Union is gaining force.

When looking at European small food retail stores, the use of energy-efficient, natural refrigerant-based RACHP systems has remained relatively low for most store types due to various reasons. Small retailers often deprioritise an investment in new RACHP systems due to a lack of cashflow or financial support schemes. Even while from a lifecycle perspective energy-efficient equipment would make financial sense, they tend to opt for the extended maintenance of existing systems and often purchase second-hand equipment to compete with larger food retail chains that seize financial savings from blueprinting across their chain of stores. Moreover, there's a lack of expert knowledge on the technical, environmental and commercial effects of inefficient RACHP systems and a lack of awareness in transiting to almost-zero-GHG solutions, making many small store owners reliant on the recommendations from local RACHP contractors and service companies. Contractors, servicing companies and their installers often lack the required know-how regarding the necessity of turning towards almost-zero-GHG solutions or are economically drawn to conventional solutions because they have to invest little time and money in these solutions. In other cases, they lack the technical knowledge in how to select and install appropriate zero-emission technical solutions. This results in stores running either old, inefficient and pre-owned RACHP systems or cheap new systems with refrigerants that will soon be banned from the EU due to their high GWP or low energy performance.

The first-ever stock model on the use of RACHP equipment in small food retail in five selected European countries indicates that if energy-efficient and climate-friendly RACHP equipment is adopted, about 11 % of GHG emissions can be avoided (emission mitigation,

[2] All food stores with a sales area below 1000 m² are considered small food retail
[3] Norwegian Environment Agency. 2017

MIT scenario). This adds to the expected decrease of around 30 % of RACHP-related emissions from 2020 to 2025 resulting from the implementation of the F-Gas Regulation and moderate improvements of energy efficiency (business-as-usual, BAU scenario). Scenarios for the selected five countries are based on a data set of 197,000 small food stores[4].

RefNat4LIFE closes gaps on RACHP awareness, training, communication, data collection and GHG emissions projections for Europe's small food retail stores

The EU-funded Refrigerants, Naturally! for LIFE (RefNat4LIFE) project specifically helps small food store owners to better understand their current challenges and support them in the uptake of more sustainable RACHP technologies and best practices. The project's main actions address the small food retail sector, with a focus on the organic food sector and the RACHP contracting and servicing sector. It thus reflects the expertise of the project consortium. The main actions are:

1. Create a Refrigerants, Naturally! sustainability platform for capacity-building, training, technology selection and outreach
2. Develop a strategy to measure, report and communicate RACHP sustainability efforts;
3. Establish online training courses and guidance documents for end-users and the supply chain on how to select and maintain environmentally-friendly RACHP equipment.

It is clear that RefNat4LIFE actions will only be effective if based on solid data about current and future RACHP use in the European small food retail sector. As such data had largely been missing, a market study was implemented to gather insights into a sector often disregarded in European and national statistics. This is essential to get a better understanding of i) the number of stores in the sector, ii) the structure of the small food retail sector, iii) its economic position and challenges, and iv) the potential for GHG emissions savings in this sector.

The result of the project's efforts to create such a solid data base is the present report. It brings together expertise from eight partners from Belgium, Germany, the Netherlands, Portugal and Spain representing organic food retail, the RACHP contracting and servicing sector, and the natural refrigerants industry perspective. Its findings are based on extensive research, online surveys carried out among end-users and RACHP contractors and qualitative interviews from October 2019 to April 2020. The collected information was fed into a comprehensive modelling exercise covering European food stores with up to 1,000 m^2 and their business-as-usual (BAU) and a mitigation (MIT) scenario of GHG emissions projected up until 2025. Despite its uncertainty (numbers of stores estimated at an accuracy margin of +/-30 %, and additional uncertainty on the future projection, which relies on data and indicators defined prior to the Covid-19 pandemic), the resulting data is unique, as it is the first-ever approximation on RACHP-related emissions from small food retail stores in Europe.

[4] Considered store categories: conventional supermarkets < 1000 m², conventional superettes ("mini supermarkets"), bakeries, butcher stores and other specialised food stores (e.g. cheese, deli, farm, fish, poultry shops). The number of bakeries and butcher stores in Portugal and Spain were estimated based on market indicators. Other specialised food stores were not included for Portugal and Spain and in Germany this category was filled with farm shops only.

Europe's small (organic) food retail: A sector with diverse growth prospects

Europe's food retail sector generated 1,128 billion EUR in sales in 2015 and is expected to grow to 2,289 billion EUR by 2022 (IGD, 2018)[5]. When looking specifically at the future of small food stores in Europe, however, the growth outlook is divided: On the one hand, convenience stores are among those types expected to thrive in urban settings. On the other hand, the existence of small traditional retail stores will be threatened by competition from retail chains expected to further a consolidation of the European food retail market. In summary, one can expect a move towards fewer small stores run by single owners and more local chains with a larger average sales area per store, co-existing next to convenience stores run by large food retail chains. Also, these large food retail chains tend to increase their share of organic food sales in several countries, particularly in the Netherlands, where few specialised organic food stores exist in comparison to the number of supermarkets. In 2015, it was estimated that 85 % of European[6] supermarket stores[7] had a maximum sales area of less than 1,000 m^2 and are hence covered under the RefNat4LIFE project, approximately 64 % of them being smaller than 400 m^2 (own estimate based on Nielsen, 2014 and market assumptions).

The share of the small food retail market in the overall food retail sector varies within European countries. In 2015, the Netherlands had the lowest share of small food retail stores in all supermarket stores including superettes with 67 %, followed by France and Germany in the range of 75 %. In contrast, Poland stood out with by far largest share with 99 %, followed by Austria, Czech Republic and Italy which all exceeded 90 %. Within the project partner countries, Spain, followed by Belgium and Portugal, had the greatest share in the range of 80 %.

Among the small store types included in the market analysis and stock model for selected countries[8] are small supermarkets, superettes (including traditional food retail shops), bakers, butcher stores, and other specialised food stores such as fish shops, poultry stores and farm shops, the first two of which were accounted separately for conventional formats and those specialised on organic food. Due to a lack of data clarity in distinguishing these store types from other formats such as small supermarkets, discount markets or convenience stores, the latter were included in the stock model when the sales area was below 1,000 m^2.

The organic food sector in particular is set to continue on a positive trajectory with more than one-third of the world's organic food sales occurring in the EU. Together, the five project countries make up over 40 % of all organic food sales in the EU (FiBL, 2020; AMI 2018). The picture becomes more blurred when looking at the store types selling organic food: while some countries such as Germany, Belgium or the Netherlands have a diverse mix of sales channels made up of conventional food retailers (52 to 58 %) and specialised organic food retail (OFR) channels (22 to 30 %); other countries like Spain and Portugal still

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[5] Please note that for the entire report, all data analysed and used for stock modelling was available before January 2020. It can be expected that due to the Covid-19 pandemic affecting all countries in the world, the economic outlook especially for the small food retail sector, including the organic food retail sector, might significantly differ from original projections. This was not considered in this report as implications on national economies or individual market segments are still unknown. Forecasts of market growth rates for the entire food retail sector and its sub-categories need to therefore be handled with particular care.

[6] Included countries ("EU16+3"): Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Spain, Sweden; Norway, Switzerland, United Kingdom

[7] Considered store categories: hypermarkets (> 2500 m², large supermarkets (1000-2500 m²), small supermarkets (400-999 m²) and superettes (< 400 m², store numbers estimated from food retail market indicators).

[8] Selected countries: Belgium, Germany, Netherlands, Portugal, Spain

feature a dominance of the specialised OFR sector (44 to 53 %) (Agence BIO, 2017). A third country group including Austria, Denmark or Sweden is dominated by large food retail groups selling mostly organic food. Essentially, in those countries where organic products are well-established on the market with high per capita consumption, large shares are typically commercialised through conventional food retail. As visible in the stock model, market shares by store type vary largely from one country to another. By number, stores with a sales area < 400 m² are dominant in the OFR sector in Germany, Belgium and especially the Netherlands, Portugal and Spain. In terms of sales, large OFR stores (i.e. sales area 400 to 999 m²) dominate the German OFR market and continue to gain market shares.

Energy performance & GHG emissions: The small (organic) food retail sector lacks capacity to assess RACHP technology and shift to sustainable options

Key results from two online surveys and complementary personal interviews with small food retail end-users representing 1,061 stores in Europe showed the following: Whilst the energy efficiency performance of the appliance is a selection criteria when purchasing a new RACHP system, the application of wider system energy conservation features including doors on cooling cabinets, heat recovery or thermal insulation in existing small stores is rather low. Only very few small food store owners have assessed the energy performance of their installed RACHP equipment, suggesting that the data basis for replacing existing systems is lacking. Europe's traditional small food retail sector, including specialised organic food retailers, mostly does not have the financial capacity and expertise to opt for more energy-efficient, natural refrigerant-based RACHP equipment. Relying on mostly local contractors, shop owners usually do not apply a lifecycle perspective when selecting a new RACHP system, despite the fact that energy costs for running the equipment can take a share of up to 90 % from the total cost of (inefficient) models (Steinmaßl, 2014). The decision on an initial investment is often also tied to uncertain commercial prospects and the renewal of lease agreements for the shops. This often leads to an extension of the lifetime of RACHP systems to above the recommended periods or to a purchase of second-hand equipment with lower energy efficiency and possibly more harmful refrigerants. Particularly in the small food retail sector, the use of high GWP f-gases is still widespread and not in line with quickly increasing pressure from the EU F-gas Regulation demanding a ban of certain substances in a growing range of applications. In contrast, most food stores organised in larger chains, a format which is less present in the small food retail sector, are advanced in the technology uptake of low-GWP technology with higher energy efficiency, largely due to their robust solvency, more and better internal RACHP expertise, and better access to information.

Results also confirm that for the smallest food stores with < 400 m² sales area, the most popular RACHP systems are of a plug-in type (stand-alone systems), whereas stores between 400 and 1,000 m² sales area are more prone to using centralised refrigeration systems. The assumed average use of such centralised systems in OFR is an installed cooling capacity of around 25 kW per store with a sales area of 400 to 999 m², and 6 to 7 kW per store with sales areas below 400 m² among all store types. However, most small food retailers have limited knowledge about the key technical specifications of their RACHP systems, such as the refrigerants used, their energy consumption and running costs. They therefore lack an understanding of its cost and environmental impact.

RACHP-related greenhouse gas emissions from Europe's small food retail sector

The assessment carried out as part of the report, based on the stock model, underlines the relevance of the small food retail sector and its RACHP-related GHG emissions. According to these estimations, small supermarkets (400 to 999 m² sales area) contributed 40 % and superettes (<400 m² sales area) approximately 27 % to total RACHP emissions which exceeded 18 Mt CO_2eq in 2015 (accuracy margin +/- 30 %) for supermarkets of all sizes in

an aggregated scenario for selected EU (16) and other (3) European countries[9]. Especially superettes offer a significant unexploited emission mitigation potential, due to the relatively delayed technological transformation and a lower level of organisation in this store type. Based on sales area specific assessments of GHG emissions in small food retail within the five project countries, RACHP-related carbon footprints of conventional supermarket stores were found typically in the range of 150 to 200 kg CO_2eq/m² per year for superettes and 80 to 150 kg CO_2eq/m² per year for small supermarkets. OFR and other small food retail stores (bakeries, butcher stores, other specialised stores) commonly showed RACHP carbon footprints in a range from 20 to 90 kg CO_2eq/m² per year, largely due to lower densities of installed RACHP equipment, and effectively less cooling demand, compared to conventional supermarket stores. In most OFR stores, reduction potentials of RACHP-related carbon footprints were projected in a range of 15 kg CO_2eq/m² per year by 2025. Projections did not consider the use of certified green electricity as data availability was limited across the project countries. As a result, indirect, energy-related emissions and related saving potentials might be lower for certain store categories, e.g. in the German OFR sector.

For all food store types considered in the five project countries, best practice energy efficiency improvements and an accelerated conversion of RACHP appliances to low-GWP, natural refrigerants, with special relevance to small store categories below 400 m² sales area, are expected to achieve additional emission reductions in the range of 0.4 Mt CO_2eq in 2025 compared to the baseline (BAU) scenario[10]. Cumulative RACHP-related emissions savings from 2021 to 2025 are projected to amount to 1.1 Mt CO_2eq. More than half of the total projected RACHP emission mitigation potential for the five project countries in 2025 is attributed to German small food retailers, followed by Spain.

Energy consumption and findings for different store categories

The survey in the five project countries showed that area-specific RACHP-related energy intensities in 2018 were typically between 150 to 200 kWh/m² per year both for conventional small supermarkets (sales area 400 to 999 m²) as well as for small OFR stores (sales area < 400 m²)[11]. Conventional superettes (sales area < 400 m²) stand out for the largest range of RACHP energy intensities in 2018, reaching from 150 to 400 kWh/m² per year. This is closely related to significant differences in the typical shop format in each country, coming along with great variations in the organisation level (large and financially strong chains vs. individual shop owners), variations of sales areas, installed RACHP equipment as well as the quality level and resulting energy performance of such appliances. RACHP energy intensities in 2018 in other small retail stores as e.g. bakeries, butcher stores, and also large OFR stores were estimated lower than 150 kWh/m² per year. Beside the installed cooled display area (refrigerated area) relative to total sales area, another important driver of high energy intensity is the widespread use of inefficient equipment and neglection of proper maintenance which is most relevant for the smallest store size categories (all considered small food retail stores except small supermarkets and large OFR stores). For those reasons, the greatest mitigation potentials are attributed to the smallest food retail stores.

[9] 16 EU member states according to **Fehler! Verweisquelle konnte nicht gefunden werden.**, plus Norway, Switzerland and United Kingdom (UK). Estimations are based on extrapolations from small food retail in the project countries Belgium, Germany, the Netherlands, Portugal and Spain.

[10] In the business-as-usual (BAU) scenario, moderate energy efficiency improvements and transformation of RACHP appliances towards the use of low-GWP refrigerants are assumed.

[11] An exception were conventional small supermarkets in the Netherlands with approximately 100 kWh/m² per year due to low relevance of centralised AC and of heat pumps.

Survey results also indicate that a number of stores operate centralised refrigeration systems without employing heat recovery. An optimisation of system configurations is expected to offer a significant energy saving potential for smaller food retail stores.

Harmonised data, information, and effective financial schemes are key to support Europe's small food retail sector in making more sustainable RACHP choices

Data collection and analysis performed under the RefNat4LIFE project took a deep dive into the current challenges which owners of small food stores face in Europe. The following central measures are recommended to support the uptake of more environmentally friendly RACHP equipment (see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** for the full recommendations):

Close identified data gaps and harmonise categorisation of small food retail

For a more reliable analysis and to ultimately better support small businesses, national statistical offices and other data collection bodies should work in unison to capture data on structure and developments in Europe's small food retail sector. A central European database with clear definitions, combined with national reporting obligations could be one possible tool to avoid data overlaps or omissions. As a relatively new sub-sector, especially Europe's OFR sector should create independent working groups inside umbrella food retail associations to collect more reliable data on store numbers, average sales area or sales channels, building on a standardised methodology to avoid the current variety of definitions. An easy-to-access online interface could complement data collection, allowing each individual store owner to enter data on a regular basis. Once having established such improved data collection and analysis, the uncertainties and inaccuracies in current study results could be reduced. However, this is not part of the current project.

Develop and disseminate basic information for smallest store formats

For stores with < 400 m^2 sales area, especially those run by independent shop owners or local chains, educational and communication campaigns should focus on the evaluation of installed RACHP units, the basics in choosing RACHP technology and the most important environmental, legal and economic impact associated with choosing the "wrong" system. The technology focus should be put on plug-in units. Non-technical information should focus on a comparison of capital cost vs. lifecycle cost, especially highlighting the relevance of energy efficiency as the decisive cost driver for any store owner regarding a piece of equipment's normal lifetime.

To effectively reach small shop owners with information and training materials developed under the RefNat4LIFE project, communication channels as specialised press, the respective OFR project partners and other associations and other actors as wholesalers in direct contact with the final client should be engaged.

If small business owners demand more energy-efficient, less harmful RACHP systems this would activate a pull strategy.

Contracting and servicing companies are key partners for best-practice maintenance, data collection, reporting and awareness-raising & chain stores enable fast replication of sustainable RACHP concepts and zero-carbon stores

As trusted partners of small store owners, RACHP contracting and servicing companies are best-placed to evaluate the energy performance and use of high-GWP refrigerants in existing RACHP equipment. Theoretically they could therefore play a key role in data collection for a central database to derive sector-specific and national data sets about the type and performance of installed RACHP units to monitor environmental impact from cooling and heating. However, such engagement would not only require regular access to

and maintenance of the technical equipment, which is particularly not the typical case for small stores, but also the existence of a centralised data collection body managing this data. As required documentation would add to already significant administrative burdens for these small companies, strong incentives would need to be established.

Contracting and servicing companies are also key to raise awareness and to push sustainable technical solutions with a better lifecycle-cost-performance-ratio towards store owners. RefNat4LIFE actions therefore involve training and information for this stakeholder group. Priority educational topics are technology and refrigerant options available for cooling or heating needs, the advantages and challenges of natural refrigerants, legislative requirements regarding energy efficiency and a phase-out of fluorinated gases, as well as best practice maintenance and disposal of RACHP systems. Possible formats include MOOC training courses, short guidance documents and checklists – elements developed under the RefNat4LIFE project.

Given the strong impact of convenience stores and small supermarkets on overall GHG emissions, a first focus to reduce RACHP-related emissions should be put on local, regional or national chains operating multiple (OFR) stores, bakeries or butcher stores, as well as conventional chain stores. The adoption of renewable energies, using doors and remote controls on equipment, the selection of stand-alone and centralised refrigeration systems with natural refrigerants, or the utilisation of heat recovery especially in larger stores or those with bordering facilities (as e.g. processing areas or catering areas), are among those topics that should be discussed first. Under the RefNat4LIFE project, best practice criteria for small stores are developed to provide orientation.

Promote and set-up adequate financial models to alleviate financial pressure on small business owners

RACHP system suppliers and contracting companies are best suited to support innovative financing models tailored to the financial capabilities of small business owners. Such models might include financial or operational leasing schemes or ‘’Cooling as a Service’’ (CaaS) to reduce the initial investment. Approaches that enable store owners to outsource their refrigeration needs to a third party would reduce their level of needed technical expertise and would also shift responsibility for efficiency and disposal of the appliances to the manufacturers. Special tax, credit schemes or loans for energy efficient RACHP do exist in some EU countries but should be reviewed in their effectiveness to support small food retailers.

In addition, RACHP system suppliers should demonstrate that an early investment in a more efficient system, even at a significant capital expenditure, offsets higher energy costs from a continued use of inefficient RACHP systems. This message should be emphasized by local contracting and servicing companies and energy auditors/advisors in direct contact with the final client (store owner) or operator.

The full report is available for download at www.refnat4life.eu. For more information visit us at www.refnat4life.eu

Refrigerants, Naturally! for LIFE

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The Refrigerants, Naturally! for LIFE project has received funding from the LIFE Programme of the European Union, project number: LIFE18 GIC/DE/001104