Refrigerants, Naturally! for LIFE

TECHNICAL SOLUTIONS WITH NATURAL REFRIGERANTS FOR SMALL FOOD STORES

Plug-in (stand-alone) refrigerated display cabinets vs. a centralised CO_2-refrigerating system

Context

Energy efficient solutions for refrigeration and air conditioning are a must in the light of climate change in order to reduce greenhouse gas emissions in food retail. With around 50%, refrigeration systems account for the largest share of a store's energy consumption and are therefore in focus. Nevertheless, they should not be considered separately, but as part of an overall concept for refrigeration, air conditioning and heating at shop level or, if necessary, at building level. Depending on the situation, considerable saving potentials can be optimally exploited, e.g. through heat recovery, cold storage, or the integration of heat pumps and air conditioning systems. Energy savings of up to 20% through heat recovery are possible, the use of heat pumps for heating can save additional energy and costs. Find concrete examples of waterloop systems and centralised systems in small stores in our case studies.

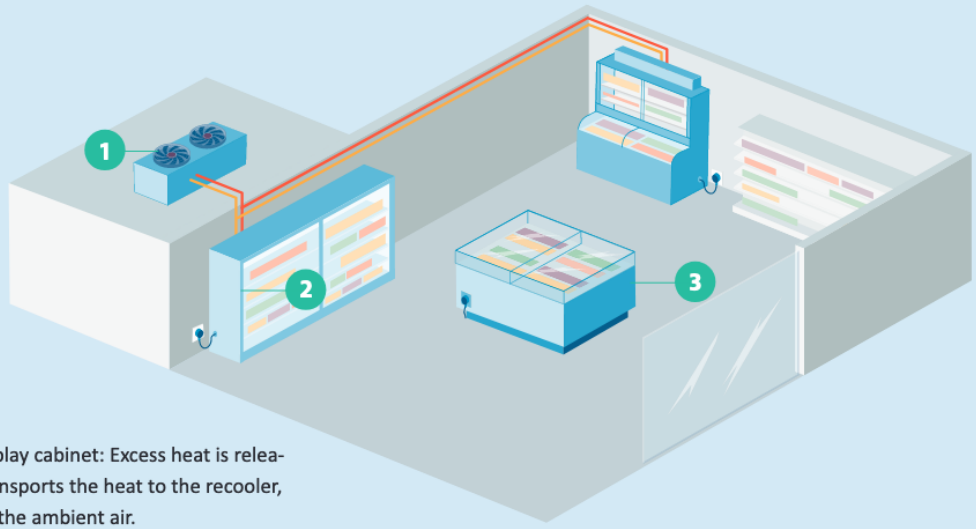
During operation, even small measures often have a considerable impact on the energy consumption of an appliance or system. Learn more in our technology guide and checklist for the optimal placement of the appliances in the store, product filling, cleaning and maintenance, covers, etc.

If your refrigeration equipment is due to be renewed or if a higher refrigeration capacity is required in the future due to an expansion of the store or a different product portfolio, it should be checked which system suits your needs and your store. For stores with small sales areas or limited demand for refrigeration capacity, the question arises whether a centralised system is feasible and represents an alternative to several plug-in refrigerated cabinets. Regardless of whether you opt for plug-in units or a centralised system, make sure to select units with natural refrigerants in any case, as they are envi-

ronmentally friendly, have a low global warming potential and are therefore future proof in terms of legal requirements. For plug-in appliances, pay attention to the highest energy efficiency class.

The following are key points of plug-in refrigerated cabinets compared to centralised systems to help you plan and make decisions. Your decision has implications for the next 10-15 years, because that's how long you expect to use your new refrigeration equipment. Therefore, be sure to take the time for an analysis of the technical possibilities and for appropriate professional advice.

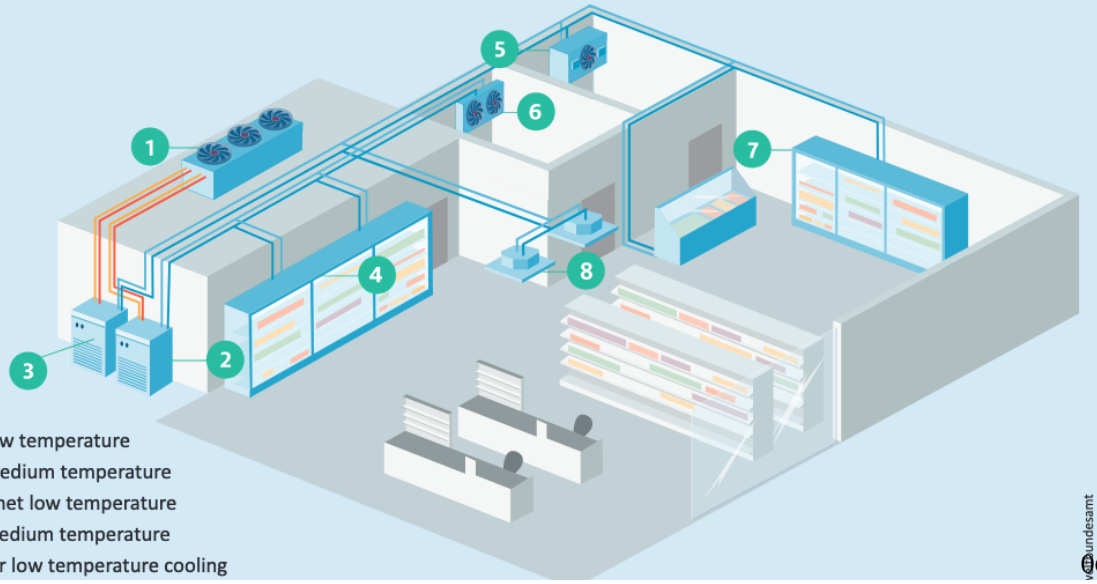
Typical small food store < 400 m² using plug-in appliances



1) Dry cooler
2) Plug-in refrigerated display cabinet: Excess heat is released to water, which transports the heat to the recooler, where it is released to the ambient air.
3) Plug-in refrigerated display cabinet (air-cooled): Excess heat is released into the ambient air.

Source: Umweltbundesamt

Typical supermarket



1) Dry cooler
2) Chiller for low temperature
3) Chiller for medium temperature
4) Display cabinet low temperature
5) Air cooler medium temperature
6) Air cooler for low temperature cooling

Source: Umweltbundesamt

7) Refrigerated display cabinet
8) A/C convectors

Source: Umw

Comparison: Plug-in refrigerated display cabinets and a centralised refrigerating system

Plug-in refrigerated cabinets with propane refrigerant	Centralised refrigerating system with CO_2 refrigerant
• Can be used flexibly, as required	• Adapts well and with low losses to required capacity variations • In most cases, lower total energy need, compared to many individual small plug-in appliances • Larger refrigeration capacities can be provided by several smaller compressors in series (hermetic or semi-hermetic).
• Decentralized system structure requires a minimum total refrigerant quantity.	• Refrigerant warning system or level monitoring is required, since a larger refrigerant charge quantity in the event of an accident means greater refrigerant emissions.
• No machinery room required	• Machinery room needed, or space for outdoor installation
• In case of failures, quick repair/replacement and/or alternative product storage is possible.	• High operational safety, because several parallel compressors are in use, whose simultaneous failure is unlikely • Maintaining emergency operation in the event of compressor failure • But, if the complete system fails, the refrigeration for all appliances fails (short troubleshooting times required)
• With their heat of condensation, appliances contribute to the heating of the sales area in the store and may therefore require store air conditioning, especially in summer. • To counteract this, so-called „waterloop“ or hybrid or semi-plug-in systems can be used. The heat generated by the condensers of the decentralised appliances (e.g. refrigerated cabinets) is dissipated via a central water cooling circuit. The heat can also be used for store heating.	• Common high pressure line simplifies heat recovery (use of waste heat from the refrigerating system for store heating) • In addition, an integrated heat pump is possible. • The integrated concept for refrigeration and air conditioning can be easily expanded.
• Sometimes considerable noise development in the store sales area	• Noise level for outdoor equipment must be taken into account.
• Easy installation and operation	• Sophisticated control system is required. • Clean working is required during installation, as the entire refrigerant circuit is sensitive for contamination. • Involvement of a refrigeration company with appropriate knowledge and experience is indispensable: execution by non-experts can lead to system failures due to wrong oil management and consequently compressor damage.
• Possibly high electrical grid load	• Lower electrical grid load during start-up with time-delayed sequencing of the compressors
• Overall, higher total installed capacity with several individual appliances	• Smaller installed machine capacity due to simultaneity factor (0.85...0.7 depending on the number of refrigerated appliances)
• Expansion for increasing cooling demand possible with additional refrigerated cabinets	• In case of increasing refrigeration demand, expansion by an additional compressor unit possible

The decision whether a centralised system makes sense for your store depends on several factors over the lifetime of the equipment, such as investment costs, energy consumption/ costs, service costs. In addition, requirements for reliability, refrigeration/heating requirements and the specific conditions of the site must be observed. The question of the store size above which a centralised system is preferable above a solu-

When using several plug-in appliances, waterloop systems offer an alternative to centralised systems. Heat generated by the decentralised appliances (e.g. refrigerated cabinets) is dissipated via a relatively easy-to-install water or glycol cooling circuit. Heat recovery- systems and various heating systems can be integrated, reducing overall costs.

tion with plug-in appliances cannot be answered in general since various aspects such as cost-effectiveness and sustainability come into play here.

In terms of cost-effectiveness, however, it can be said that the market is currently undergoing major change, especially in the area of smaller centralised systems, and that the prices for such systems (e.g. with larger production quantities in the future) can change considerably. The following estimates are therefore only valid at the current time (as of 2022) and require constant updating. The advice of a competent specialist company is strongly recommended in any case.

>> Currently, centralised systems with CO_2 refrigerant are generally available on the market from a refrigerating capacity of 3-12 kW cooling and about 1.5-3 kW freezing. Compact systems for small capacities, combining AC and heating, are also already on the market.

>> In stores up to approx. 150m² sales area, practically only plug-in refrigerated cabinets are currently used. For larger sales areas, centralised refrigerating systems with CO_2 or R290 refrigerant or plug-in appliances combined with a waterloop system are used.

Due to the constantly advancing developments by designers and manufacturers, the market will develop very dynamically in the coming years and increasingly offer integrated solutions for small refrigeration capacities. Therefore, keep yourself informed.

Glossary

Refrigerated display cabinet
Cabinet cooled by a refrigerating system which enables chilled and frozen produce placed therein for display to be maintained within prescribed temperature limits.
They can be classified according to various criteria, e.g.

- type: "open" or "closed",
- temperature range: "chilling" (for fresh meat, fruit and vegetables, dairy products and beverages) or „freezing" (frozen food, ice cream),
- refrigeration type: silent cooling without fan, circulating air cooling with fan, circulating air cooling with fan and air curtain,
- Shape: horizontal cabinets, e.g. display islands, chest freezers, or vertical, e.g. refrigerated glass door cabinets.

Refrigerated display cabinets are usually connected to centralised refrigerating systems (see below) in the larger stores, but there are also plug-in (stand-alone) cabinets, containing their own refrigerating unit system.

Waterloop system
Further development of plug-in cabinets for small and medium-sized stores, in which the condensing heat of the individual cabinets is not directly transferred into the store air, but transferred to a common water or glycol circuit throughout the store. The water/glycol releases the absorbed heat outside the store into the ambient air via a dry cooler. This reduces the heat load to the store in summer and thus relieves the air conditioning system. In winter, this heat from the water loop can be easily used for the heating system of the store.

Refrigerating system or heat pump
Combination of interconnected refrigerant-containing parts constituting one closed circuit in which the refrigerant is circulated for the purpose of extracting and delivering heat (i.e. cooling and heating).

Self-contained system
Complete factory-made refrigerating system in a suitable frame and/or enclosure, that is fabricated and transported complete, or in two or more sections and in which no refrigerant-containing parts are connected on site other than by isolation valves, such as companion valves.

Unit system
Self-contained system that has been assembled, filled ready for use and tested prior to its installation and is installed without the need for connecting any refrigerant-containing parts. A unit system can include factory assembled companion valves.

Condensing unit
A combination of one or more compressors, condensers, receivers (when required) and the associated components. Compared to a refrigerating system, the evaporator, the expansion device and the system controls are not included. A condensing unit is connected via piping to display cabinets or cold rooms. A condensing unit is normally pre-assembled, i.e. factory-assembled on a frame and piped.

Parallel compressors
Any of these systems or units can operate with one compressor. In cases where several display cabinets or rooms are connected to one system, typically in a supermarket, this results in significant refrigeration load variations. Then it is preferable to apply two or more parallel compressors, improving the overall part-load efficiency.

Centralised system
A centralised system is normally used in larger supermarkets (sales area typically greater than 400 square meters). They operate with a refrigerating system located in a separate machinery room or outside. Air-cooled condensers are always located outside the building. The mostly custom-made system is assembled on site or partly preassembled. Secondary loop circuits in which a secondary fluid circulates (e.g. water, glycol, brine, CO_2) are often used as heat transfer medium to the individual equipment (for freezing, cooling or heating) throughout the store and building. The secondary loop is connected with the evaporators in the refrigerating system.

Definition of terms by: EN 378 part 1, chapter 3: Terms and definitions; ISO 23953-1, chapter 3: Terms and definitions, Cabinet families and types.

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