E360 Outlook | MARCH 2021

EMERSON

Pathway to Lower-GWP Refrigeration

Exploring available supermarket retrofit and remodel options

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When it comes to refrigeration retrofits and/or remodels, supermarket operators have an ever-increasing variety of options from which to choose. One of the primary considerations impacting this decision is the choice of refrigerant — which often dictates the type of architecture and servicing requirements while impacting the cost of system ownership.

Refrigerant selection is also critical to the extent that it must align with an operator's sustainability goals or help them to meet regulatory mandates. A refrigerant's environmental sustainability is determined largely by its greenhouse gas emissions, which are measured by their ozone depletion potential (ODP) and global warming potential (GWP). Today, operators have an expanding variety of emerging lower-GWP refrigerant alternatives to help them achieve a full spectrum of sustainability goals.

System selection criteria

The decision to retrofit or remodel a refrigeration system must be made with a long-term perspective. Many supermarkets benefit from 20 to 30 years of service from their refrigeration systems, and operators expect an extended lifespan from their upgrade investment. But today's market is much more dynamic than it was when these systems may have originally been installed, so planning for the next two decades of operation is more difficult.

Global, federal and state regulations are phasing down the use of high-GWP refrigerants and nearly phasing out those with ozone depletion potential. At the same time, aggressive corporate sustainability objectives are driving more companies to re-evaluate the viability of their refrigeration systems. Regardless of where you sit along the sustainability continuum, system and refrigerant selection should be guided by the *Six S's* of evaluation criteria:

- **Simple —** to own and operate
- **Serviceable —** aligns with maintenance and operations capabilities
- **Secure —** provides safe operation and data security
- **Stable —** delivers reliable, dependable performance
- **Smart —** is equipped with electronic controls and connectivity to provide operational data and insights
- **Sustainable —** from financial, technical and environmental perspectives

Available lower-GWP refrigerants

Over the past decade, alternative refrigerants have emerged that offer varying degrees of GWP reduction. But among those readily available options that are considered both safe and approved for use, several have emerged which represent distinct approaches to sustainability: low-, lower- and lowest-GWP.

Note: GWP ratings reported herein are from the Fourth Assessment Report (AR4) of the United Nations Intergovernmental Panel on Climate Change (IPCC).

R-448/449A (low-GWP option) — Designed as a substitute for R-404A, R-448A offers a 65% reduction in GWP (1,387 GWP compared to 3,922 GWP). Classified as an A1, R-448A is suitable for centralized direct expansion (DX) retrofits and new distributed systems but is not to be used as a drop-in replacement.

R-513A (lower-GWP option) — R-513A delivers a 56% reduction in GWP (631 GWP vs. 1,430 GWP). This proven low-pressure A1, zero-glide refrigerant was designed as a substitute for R-134a and is today being leveraged more frequently in new distributed systems such as scroll booster (see below). It is also not intended to be a drop-in replacement for R-134a.

A2L and A3 (lower- to lowest-GWP) — mildly flammable A2L and flammable A3 (aka R-290 or propane) refrigerants are primarily used in self-contained systems and offer lower- to lowest-GWP reductions, respectively. In the U.S., the creation of safety codes and standards governing their use in commercial refrigeration is currently underway. Until those standards take effect, using A2Ls and A3s may require the approval of local authorities having jurisdiction (AHJ). Today, R-290 is primarily only used in factory-sealed, self-contained systems with very small refrigerant charges of 150g or less.

While A2Ls are currently not allowed in commercial refrigeration applications, Emerson is already qualifying equipment for the use of A2Ls to achieve future regulatory readiness. In some cases, this will allow for end users to install R-448A based equipment today and then transition to an A2L when needed to comply with future regulations.

CO_2 aka R-744 (lowest-GWP option) — Used only in systems designed to handle its unique properties, R-744 is a natural refrigerant with a GWP of 1. Its high-pressure, low critical point (87.8 °F) and high triple point (-69.8 °F) introduce system complexities that require operators to have access to trained CO_2 technicians. For these reasons, CO_2 refrigeration can have a higher total cost of ownership (TCO) than other alternatives. Even so, systems such as CO_2 transcritical boosters have seen increased global adoption over the past two decades.

Leading options for system retrofits and remodels

Based on this three-tiered approach to refrigerant sustainability, consider the following retrofit and remodel options to meet your specific sustainability goals.

Retrofit to R-448A/R-449A in existing centralized DX systems
Replacing R-404A with R-448A allows operators to achieve significant sustainability improvements while preserving their existing system investments. Due to R-448A's slightly higher discharge temperatures, this approach requires additional compressor cooling strategies, such as head cooling fans and/or demand cooling modules or the installation of a vapor-injected scroll compressor. For an additional reduction of indirect emissions, consider implementing energy optimization best practices while making these system modifications.

Emerson offers a range of R-448A/R-449A rated compressors to help with this transition, including: Copeland™ scroll compressors with enhanced vapor injection; Copeland semi-hermetic compressors; and Copeland Certified remanufactured semi-hermetic compressors. Copeland digital compressor models with variable-capacity modulation are also approved for R-448A/R-449A.

Copeland scroll compressor

Copeland semi-hermetic compressor

Copeland Certified remanufactured semi-hermetic compressor

Remote/outdoor condensing units (distributed)

Perfect for servicing a limited number of medium- or low-temperature refrigeration fixtures, remote condensing units offer installation flexibility and reliability while utilizing low-GWP R-448A. With options to mount on an external roof or wall, remote condensing units are ideal for small, urban store formats or large supermarkets deploying new refrigeration capabilities outside of their existing DX systems.

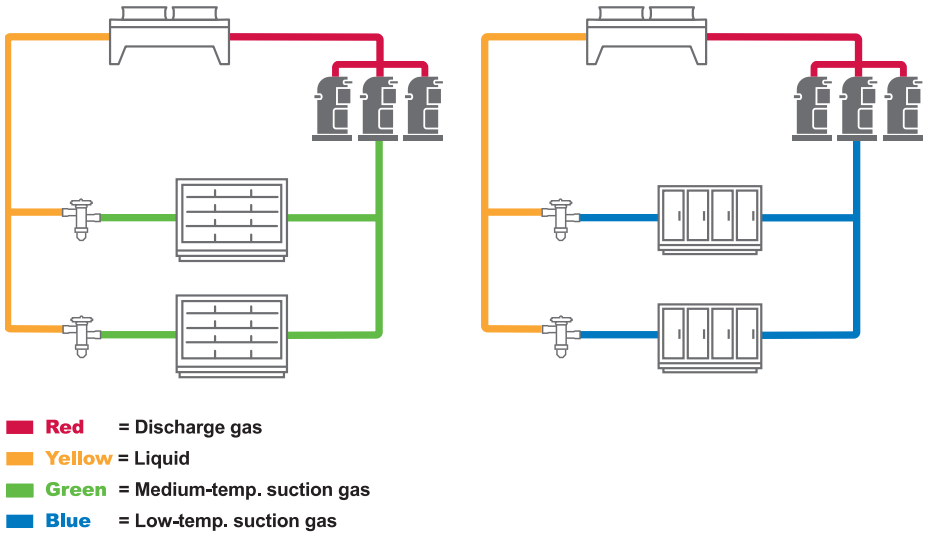
The Copeland digital outdoor condensing unit, X-Line Series, is ideal for these types of applications. Its digital capabilities enable variable-capacity modulation to deliver significant reductions in energy consumption and tighter control of case temperatures. In addition, its onboard electronic controls can communicate via modbus to an Emerson E2 facility management system or Site Supervisor HVACR facility control to maintain management of all refrigeration assets.

Copeland digital outdoor condensing unit, X-Line Series

Distributed systems

Another sustainable remodel option is to install multiple mini-racks or scroll packs in proximity to different refrigerated sections of a store. By utilizing R-448A in this architecture — which is essentially a scaled down, distributed version of a conventional rack system — operators can significantly reduce their overall refrigerant charge while benefiting from increased system reliability and energy efficiency.

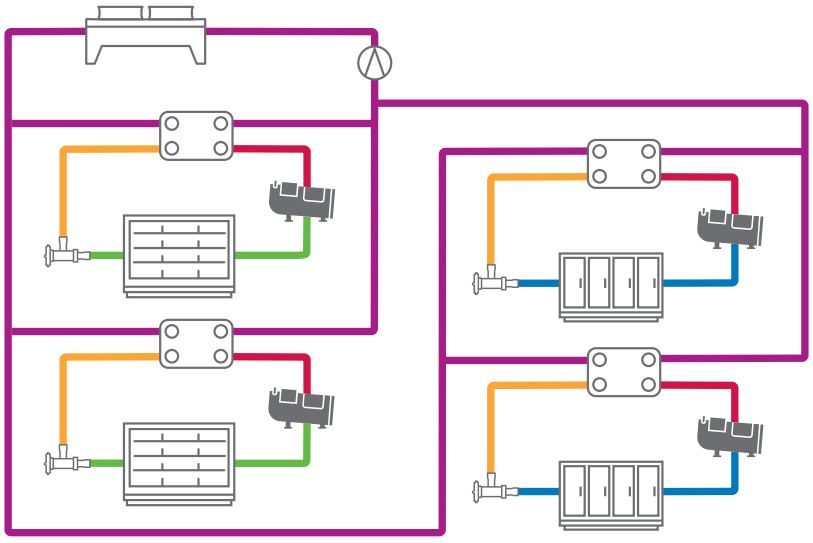
Distributed mini-rack systems feature Copeland scroll compressors and E2 or Site Supervisor refrigeration and facility management controls for reliable performance and optimized refrigeration system management.



Macro-distributed systems (self-contained)

For a simple, stand-alone retrofit or remodel option, many operators are exploring the use of large cases that integrate a single compressor, refrigeration circuit and electronic controls into the unit itself. This flexible approach can be scaled from one to multiple units, in which all cases can be connected to a shared water loop designed to remove heat from the store.

The Copeland indoor modular solution is ideal for these large integrated case applications. Featuring low-profile Copeland variable speed scroll compressors and onboard distributed controls for connectivity, this approach offers a reliable and low-GWP alternative to traditional centralized systems and outdoor condensing units. Approved for use with R-448A today, this solution also helps to ensure future regulatory readiness via compatibility with A2L refrigerants.

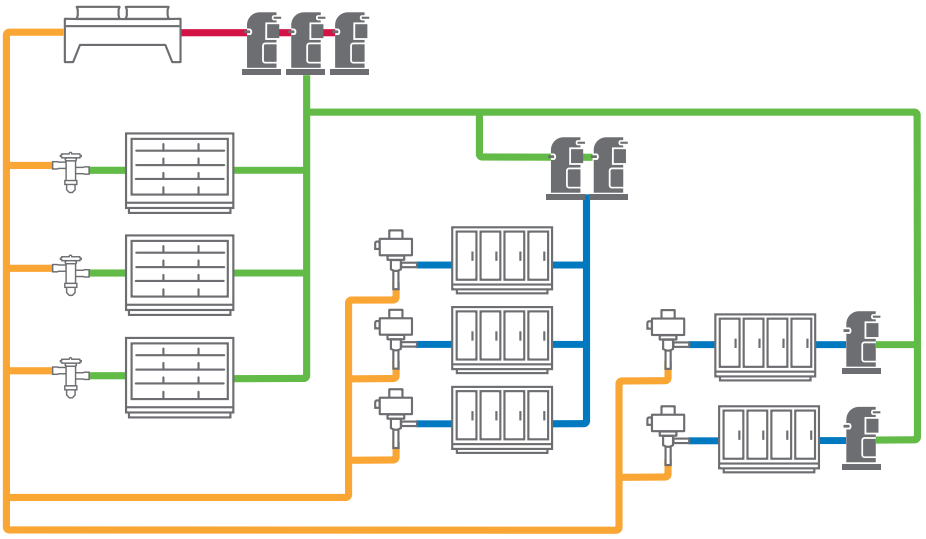


Red = Discharge gas
Yellow = Liquid
Green = Medium-temp. suction gas
Blue = Low-temp. suction gas
Purple = Water

Distributed scroll booster

This emerging distributed architecture utilizes low-pressure, lower-GWP R-513A for both low- and medium-temperature circuits. Designed to eliminate the high discharge temperatures and compression ratios typically found in low-temperature systems, a distributed scroll booster delivers improved energy efficiencies and high reliability in an operating footprint that doesn't introduce serviceability complexities.

Emerson is pioneering the use of this architecture through its distributed scroll booster platform and partnerships with leading commercial refrigeration original equipment manufacturers. Configurations can scale from small, low-charge condensing units to larger systems of distributed scroll packs charged with several hundred pounds of refrigerant.



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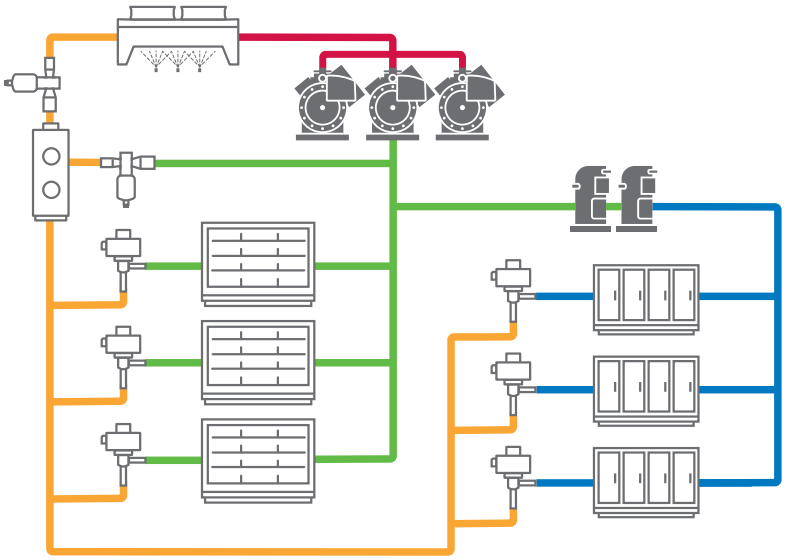
CO_2 transcritical booster

A CO_2 transcritical booster system is an environmentally friendly alternative to high-GWP, centralized DX systems. While this architecture utilizes the refrigerant CO_2 (R-744) for both low- and medium-temperature loads, its unique performance characteristics increase both system complexities and the total cost of ownership.

Emerson provides a full suite of CO_2 compression technologies, high-pressure and bypass-pressure valves and controls, variable frequency drives and distributed case controls for transcritical booster systems. To improve system efficiencies in warmer climates, we also offer parallel compression and adiabatic gas cooler controls. We recommend E2 and Site Supervisor facility management and refrigeration controls for ongoing CO_2 refrigeration system monitoring and optimization. Our comprehensive CO_2 solutions also include sub-critical compressors and a full suite of controls and components for CO_2 secondary and cascade systems.



Red = Discharge gas
Yellow = Liquid (for CO_2 booster system; can also represent saturated vapor from flash tank/receiver)
Green = Medium-temp. suction gas
Blue = Low-temp. suction gas

Making the case for distributed case controls

Regardless whether you are using a centralized or distributed refrigeration architecture, both approaches can benefit from implementing a distributed controls architecture during the remodel and/or retrofit process.

Characteristics of a distributed controls strategy include:

- Individual controls in each case
- Plug-and-play cases with factory wiring (OEM installation)
- Units connected via daisy chain of cables
- Multiple case sensors for a data-rich environment

Distributed controls architecture benefits include:

- Precise, individual case controls
- Simplified, shorter installation times with consistent wiring
- Elimination of cables routed to each case from a central point
- Individual asset troubleshooting and reporting

Transforming data into sustainability

Among all the architectures explored in this article, the collective use of facility management, refrigeration system and case-level controls is a common denominator for ensuring optimum refrigeration performance. In the case of CO_2 transcritical boosters, it is essential for system operation. Together, these controls can enable remote, real-time monitoring and system management capable of alerting operators of any potential issues that could impact critical refrigeration assets.

But for many operators, these electronic controls are also the foundation of a data-rich environment that can provide much deeper historic and real-time analyses of refrigeration and other key facility systems — all of which can contribute to their sustainability objectives.

Transforming this data into insights requires both domain expertise and a robust analytics platform. Emerson's ProAct™ Connect+ enterprise management software was designed to give retailers the tools they need to achieve an effective data management strategy. Connect+ provides near real-time access to critical information to help retailers immediately track, triage and quickly respond to issues across their multi-site network. Combined with our full suite of refrigeration components and controls, Connect+ can play a key role in helping retailers to achieve their sustainability and energy management goals.