

# ACCELERATE

ADVANCING CLEAN COOLING

AMMONIA/CO<sub>2</sub> — INTEGRATED HVAC&R

# FOOD RETAIL BEST

# PRACTICES

HYDROCARBONS

TRANSCRITICAL CO<sub>2</sub>

NET-ZERO ENERGY

SERVITIZATION

Weis Markets • Seed to Table • Carrefour • My City Centre Masdar • Metro • Lawson • Al Salam  
• SPAR • Hannaford • Whole Foods Market • Wild Fork Foods • Colruyt • Joker • E.Leclerc •  
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# A New Approach for a New Time

— By Marc Chasserot



Marc Chasserot,  
CEO, shecco

**A**s we live through the unprecedented challenge of COVID-19, shecco has been reflecting on the value proposition of our *Accelerate* publication.

One change we introduced in the last issue (*Accelerate* #110) was a new tagline, Advancing Clean Cooling, along with a cover story on that topic. This means the publication's mission, while still covering natural refrigeration and sustainable HVAC&R, will go deeper and broader to address all aspects of Clean Cooling.

What is Clean Cooling? In partnership with Professor Toby Peters of the Centre for Sustainable Cooling, shecco has published a preliminary definition of Clean Cooling (available at <https://bit.ly/3j3U5Xe>); it's a multi-dimensional process that encompasses the transition to natural refrigerants, highly efficient equipment, demand mitigation, the utilization of waste energy and free resources like shading, among other elements, in an effort to support the Paris accord and deliver cooling to all who need it.

We see the next decade as a contest between Clean Cooling and dirty cooling, and we want *Accelerate* to represent and highlight the cutting edge of Clean Cooling implementation.

In addition to this broader approach, we have also decided that, in order to offer the best content on natural refrigerants and Clean

Cooling to our readers around the world, we will publish Special Issues that each take a deep dive into a particular topic of importance to the HVAC&R community. This is a departure from the traditional magazine format that addresses a variety of topics, which we feel are better covered in a timely way on our online websites, *Accelerate24*, *news*, *R744.com*, *Hydrocarbons21.com* and *Ammonia21.com*.

The best example of this new approach is the current issue focused on best practices for food retailers. We are able to cover many more end users and their experiences with natural refrigeration than we could ever do in a traditional magazine.

Over the next year, we will continue on a bi-monthly basis to devote these Special Issues to key single topics, which are listed in the editorial calendar on [page 9](#), and include a look ahead at 2021, industrial refrigeration best practices, natural refrigerants in air conditioning, and training best practices.

We are looking forward to leveraging our journalists and analysts from around the world to bring the latest and most in-depth news and intelligence on specific Clean Cooling topics in the pages of *Accelerate* over the coming months.

Let us know what you think of our new approach for a new time! ■ MC



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Transcritical CO<sub>2</sub>

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# Learning from the Best

— By Michael Garry



Michael Garry  
Editor in Chief

**S**omeone who knows the U.S. food retail industry recently told me that American supermarket operators looking at natural refrigeration systems are only interested in implementation examples in the U.S. Even though Europe has almost 30 times as many transcritical CO<sub>2</sub> installations as the U.S. and Canada combined ([see map on page 14](#)), American retailers, this person said, are not interested in those stores.

As an American, I am very familiar with the often-misguided notion of “American exceptionalism.” And I’m sure that there are U.S. retailers who take this narrow view of the world. But I also believe that many, if not most, companies here are curious about what is happening beyond our shores, aware of the ingenuity and innovation that exists in many other parts of the world. Except for regulatory factors that may inhibit the adoption of new technology – which are always subject to change – there is no reason why a breakthrough technology in Europe or Japan or in America, too, can’t be adopted anywhere in the world. For natural refrigeration is a global industry.

In this Special Issue of *Accelerate*, we offer retailers the opportunity to see the best examples of natural-refrigerant implementations in stores around the world, including North, Central and South America; Europe; the Middle East; Africa; Australia; Japan; and Southeast Asia. The companies profiled include some of the biggest brands as well as small independent operators.

The systems examined span the range of natural refrigerant equipment, from transcritical CO<sub>2</sub> to hydrocarbons to ammonia/CO<sub>2</sub>; they include the latest advances in these technologies, as well as examples of integrated HVAC&R systems, net-zero energy strategies, and even a leased transcritical CO<sub>2</sub> system.

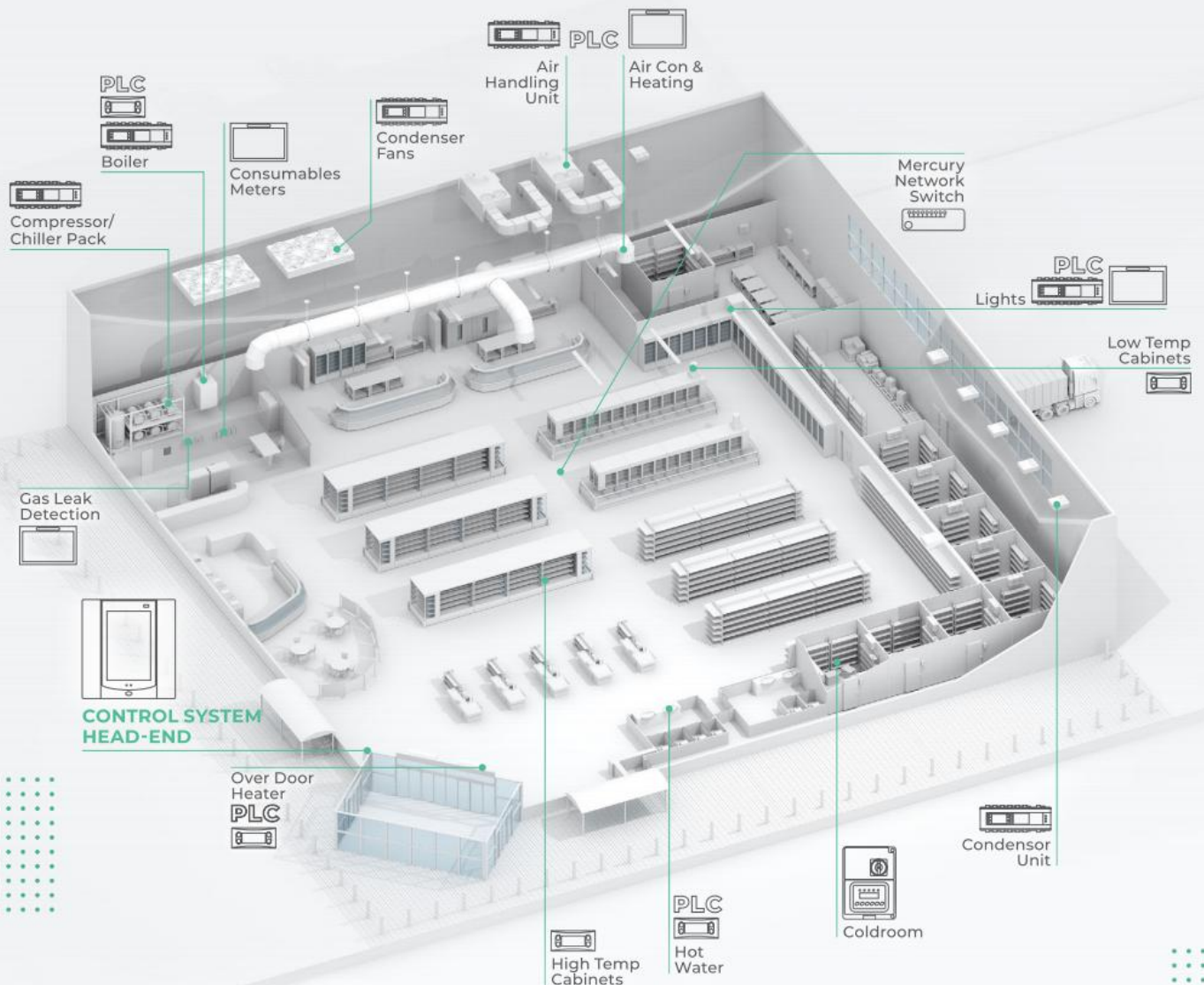
These case studies, based on implementations that have taken place over the past few years in new and retrofit stores, are all updated with the latest information on performance and reliability.

Speaking of performance, what is especially striking about these profiles is the energy-efficiency advantages associated with natural refrigerant systems. In the transcritical CO<sub>2</sub> section, we see that the technological advances made in recent years – from adiabatic gas coolers to parallel compression and ejectors – have made it possible for these systems to run more efficiently than halocarbon equipment in some of the warmest places on earth, including the Middle East and Ecuador. The intrinsic thermodynamic power of hydrocarbons and ammonia also make them energy savers for supermarkets, where tight profit margins cry out for cost cutting wherever possible.

And, of course, the combination of energy reduction and ultra-low GWPs make these natural refrigerant store systems essential contributors in the battle to slash greenhouse gas emissions and contain the climate crisis. Indeed, these systems are an integral part of overall store strategies being pursued by retailers in Canada, Europe and Australia to make their stores net-zero in carbon emissions, or close to it. And they are part of the broader mission to pursue Clean Cooling throughout the world.

We hope that this collection of best-practice case studies on natural refrigeration in retail stores will serve as a guide to what is possible and inspire more such implementations around the world. ■MG

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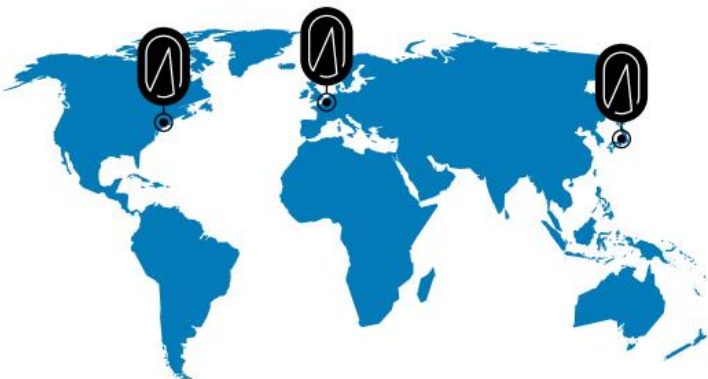
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# ACCELERATE

## ADVANCING CLEAN COOLING



shecco's network spans the globe with offices in Brussels, Tokyo and New York

### ABOUT ACCELERATE

Brought to you by the worldwide experts in clean cooling news, *Accelerate* is the first global publication written for and about the most progressive business leaders working with clean cooling solutions, including natural refrigerants and other sustainable technologies and resources, in all HVAC&R sectors. It builds on the legacies of *Accelerate Magazine* and six regional magazines: *Accelerate America*, *Accelerate Europe*, *Accelerate Australia/New Zealand*, *Accelerate Japan*, *Accelerate China* and *Accelerate Asia*.

### ABOUT ACCELERATE24.NEWS

Accelerate24.news is a 24-hour global website providing up-to-the-minute news on clean cooling solutions, including natural refrigerants and other sustainable technologies and resources, in all HVAC&R sectors. Leveraging the expertise of our journalists and analysts in North America, Europe and Japan, Accelerate24.news builds on the expertise and reach of R744.com, Hydrocarbons21.com and Ammonia21.com, the leading marketplace websites on CO<sub>2</sub>, hydrocarbons and ammonia over the past decade.

[Sign up here](#) to receive the Accelerate24.news newsletter highlighting the top stories, delivered every other Thursday.

[Sign up here](#) to receive a global newsletter every Tuesday highlighting the top stories of the week from R744.com, Ammonia21.com and Hydrocarbons21.com.

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# Editorial Calendar for Accelerate Special Issues, 2020-2021

Each Special Issue of *Accelerate*, published six times annually, addresses a specific topic aimed at advancing Clean Cooling 1– sustainable cooling for all – in commercial, industrial and residential HVAC&R markets around the world.

These Special Issues target end users and other key stakeholders, including manufacturers, contractors, policy makers, the financial community, academic experts and others.

Each Special Issue will take a deep dive into a particular topic, with a main story and secondary articles, guest writers, thought leader interviews, infographics, surveys and market research.

In addition to the topics listed at right, other potential topics include: technology innovations, mobile air conditioning (MAC), data center cooling, ice rink refrigeration, servitization of cooling, digitalization of cooling, alternative cooling technologies, renewable energy and HVAC&R, and regional HVAC&R markets.

The Special Issues are available online at <https://bit.ly/3841iCJ>; in addition print copies are distributed at major industry trade shows and conferences.

*Accelerate* Special Issues take full-page advertising as well as fractional ads

The editorial calendar is subject to change by the publisher.



## **SPECIAL ISSUE #111**

**October 2020**

Food Retailers Pursuing Clean Cooling Around the World

## **SPECIAL ISSUE #112**

**January 2021**

A Look Ahead at the Major Clean Cooling Trends for 2021

Ad Deadline: January 12

Publication Date: January 19

## **SPECIAL ISSUE #113**

**March 2021**

Industrial Refrigeration Operators Pursuing Clean Cooling Around the World

Ad Deadline: March 9

Publication Date: March 16

## **SPECIAL ISSUE #114**

**May 2021**

The Growing Use of Natural Refrigerants in Air Conditioning

Ad deadline: May 11

Publication Date: May 18

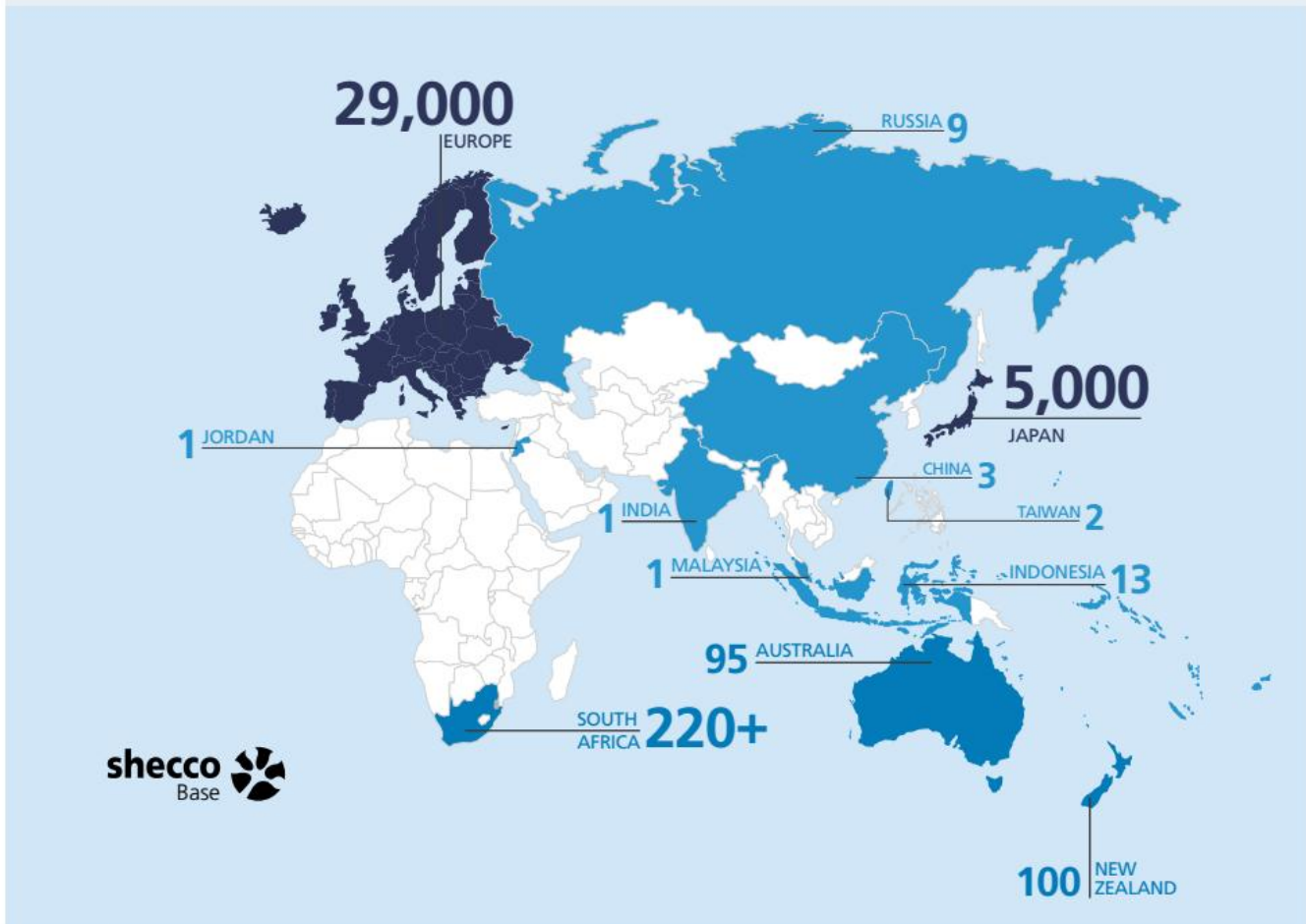
## **SPECIAL ISSUE #115**

**July 2021**

Training Best Practices Around the World

Ad deadline: July 13

Publication Date: July 20





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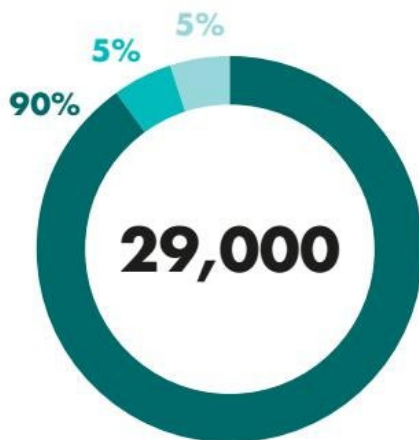


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# Transcritical CO<sub>2</sub> Installations, By Region and Sector

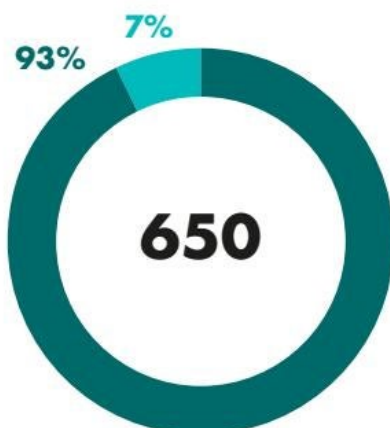
## Europe



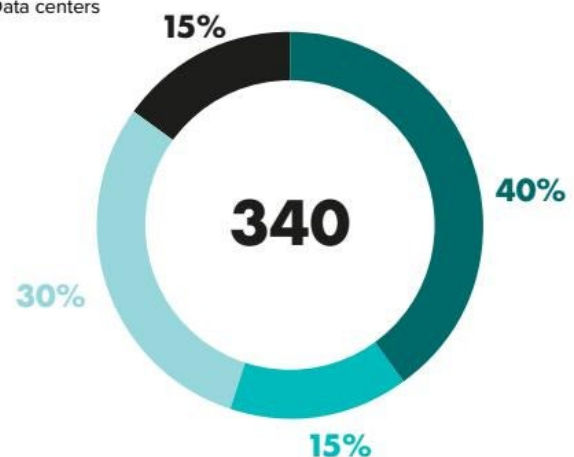
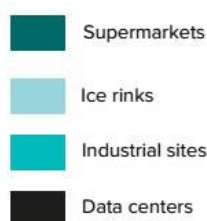
## Japan



## U.S.



## Canada





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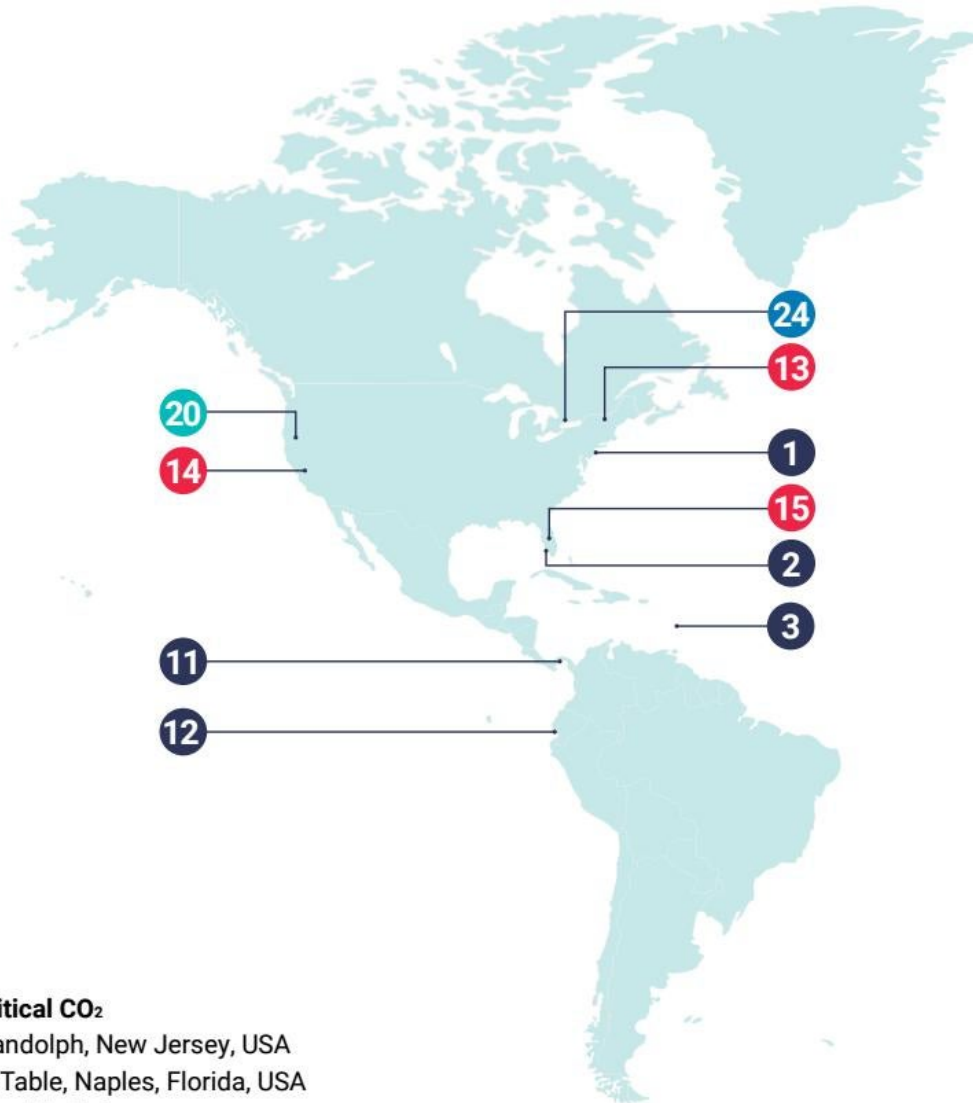
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# Natural Refrigerant Stores Around the World

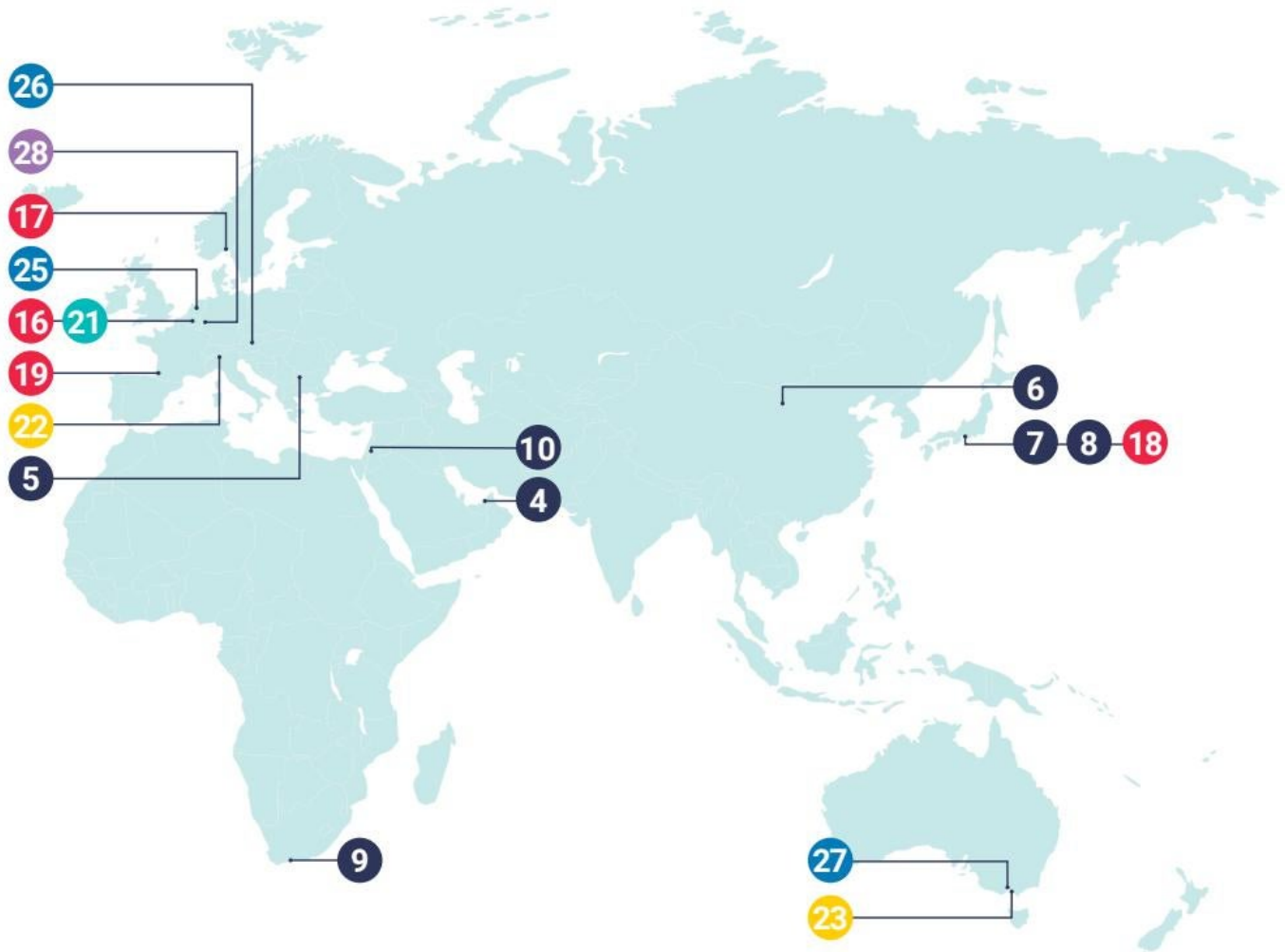


## Transcritical CO<sub>2</sub>

- 1 Weis, Randolph, New Jersey, USA
- 2 Seed to Table, Naples, Florida, USA
- 3 Carrefour, Martinique
- 4 My City Centre Masdar, United Arab Emirates
- 5 Metro, Sofia Bulgaria
- 6 Metro, Beijing, China
- 7 Lawson, Tokyo, Japan
- 8 Tokyu, Tokyo, Japan
- 9 SPAR, South Africa
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- 11 Riba Smith, Panama City, Panama
- 12 Mi Comisariato, Guayaquil, Ecuador

## Hydrocarbons

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- 14 Whole Foods Market, Santa Clara, California, USA
- 15 Wild Fork Foods, South Florida, USA
- 16 Colruyt, Brussels, Belgium
- 17 Joker, Oslo, Norway
- 18 Metro, Japan
- 19 E.Leclerc, Biarritz, France



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- 21 Delhaize, Wallonia, Belgium

### Integrated HVAC&R

- 22 Migros, Riazzino, Switzerland
- 23 Michael's SUPA IGA, Keysborough, Australia

### Net-Zero Energy

- 24 Longo's, Toronto, Canada
- 25 Lidl, Woerden, The Netherlands
- 26 Metro, St. Polten, Austria
- 27 Woolworths, Melbourne, Australia

### Servitization

- 28 Real, Krefeld, Germany



# FOOD RETAIL BEST PRACTICES



In 26 case studies encompassing 46 stores, we demonstrate how food retailers around the world are leveraging future-proof natural refrigerant solutions.

— By Michael Garry

**In** 2001, Sergio Girotto, who later founded the OEM Enex, installed at a Bingo store in Cornuda, Italy, what is thought to be the world's first transcritical CO<sub>2</sub> multi-compressor refrigeration system used by a supermarket.

As we approach the 20th anniversary of that inaugural deployment, there are now more than 36,618 global installations of transcritical CO<sub>2</sub> systems, including 29,000 in Europe ([see map, page 10](#)). Most of them are in supermarkets and other retail stores, with the remainder in cold storage or food processing warehouses, data centers and ice rinks.

In this Special Issue of *Accelerate*, we present recent examples of stores using transcritical CO<sub>2</sub> systems of various configurations from around the world. We also show how other natural refrigerants – hydrocarbons and ammonia – are being put to work by food retailers.

In its totality, this Special Issue's 26 case studies, which cover 46 stores as well as refrigerated lockers used by four chains, represent a best-practices guide to sustainable, natural refrigerant-based store solutions.

Most of the transcritical CO<sub>2</sub> systems in supermarket are multi-compressor rack-based central systems. But others, especially those serving Japanese convenience stores, consist of CO<sub>2</sub> condensing units.

Whatever its form, transcritical CO<sub>2</sub> technology has evolved into a solution that can be employed efficiently in any geography, even hot climates like the Middle East and Australia.

Some of the retailers profiled here have taken transcritical CO<sub>2</sub> to the next level of sustainability by incorporating them in integrated systems that also include heating and air conditioning. Other stores have made transcritical CO<sub>2</sub> part of a strategy to reach net-zero carbon emissions. And one store shows how a transcritical CO<sub>2</sub> system can be leased instead of bought.

While transcritical CO<sub>2</sub> has been the dominant natural refrigerant selected by supermarkets, hydrocarbons, especially propane (R290), have been gaining in popularity over the past five years in self-contained display cases. Initially serving as air-cooled spot merchandisers, R290 cases are increasingly being used around the world to handle all refrigeration loads in a store, particularly in conjunction with water loops that remove condensation heat; several examples are in this issue.

The use of hydrocarbon refrigeration is bound to grow stronger now that a new global charge standard is leading countries to allow more than 150g of hydrocarbons per circuit.

The latest natural refrigerant to make its presence felt in supermarkets is ammonia, in concert with CO<sub>2</sub>. We present here a U.S. store that recently installed its first ammonia/CO<sub>2</sub> system, and a Belgium store with an ammonia/CO<sub>2</sub>/glycol system. While small in number, the stores pioneering this technology are paving the way for others by showing that ammonia can be used safely in supermarkets.

We hope this Special Issue on best practices provides food retailers around the world with all the evidence they need that natural refrigerants are the future-proof answer to commercial refrigeration in the 21st century. ■ MG





# Buoyed by Initial Success, Weis to Install Two More Transcritical CO<sub>2</sub> Systems

**B**ased on the energy savings and overall performance of its initial transcritical CO<sub>2</sub> system at a store in Randolph, New Jersey (U.S.), Weis Markets has decided to install the refrigeration technology in two new stores next year.

Based in Sunbury, Pennsylvania (U.S.), Weis Markets is a 108-year-old Mid-Atlantic food retail chain of nearly 200 stores.

Its 54,000ft<sup>2</sup> (5,017m<sup>2</sup>) store in Randolph opened in July 2018, with an Advansor transcritical CO<sub>2</sub> rack from Hillphoenix, and two adiabatic gas coolers from Baltimore Aircoil (BAC). (See [“Weis Markets’ Journey to CO<sub>2</sub>,” Accelerate America](#), September 2018.) The two new stores will use transcritical racks from Zero Zone equipment, and BAC adiabatic gas coolers, noted Paul Burd, Manager, Refrigeration Engineering for Weis.

While the cost of transcritical CO<sub>2</sub> equipment remains higher than that of traditional systems, Burd noted that he is seeing the installed cost of transcritical CO<sub>2</sub> equipment “coming down” with all manufacturers. Last year, he said that Weis has found that the cost of transcritical technology was “getting closer to where it needed to be for the ROI.”

Weis is also installing another natural refrigerant – propane (R290) – in stand-alone point-of-purchase beverages cases throughout the chain.

The Randolph store’s transcritical rack employs three low-temperature and five medium temperature compressors, with a CO<sub>2</sub> charge of 1,100lbs (499kg). It supplies a low-temperature capacity of 343.2kBTU/hr

at -24°F (-31°C), and a medium-temperature capacity of 1,137.3kBTU/hr at 19°F (-7°C).

Last year, Burd reported on the energy advantages observed in the Randolph store’s transcritical CO<sub>2</sub> system, compared with different systems at three other stores of similar size and refrigeration load. He provided data on the systems at the ATMosphere America conference (see [“Weis Markets Reports Dramatic Energy Savings with Transcritical CO<sub>2</sub>,” Accelerate Magazine](#), July-August 2019) and at the Food Marketing Institute’s Energy & Store Development Conference (see [“Weis Markets’ CO<sub>2</sub> System Avoids Transcritical Mode in First Year,” Accelerate Magazine](#), October 2019). ATMosphere America is organized by shecco, publisher of *Accelerate*.

The other stores employed systems based on HFC or HFO blend refrigerants.

The U.S. chain’s first transcritical system in a New Jersey store continues to outperform legacy systems.

— By Michael Garry



Weis Markets operates nearly 200 stores.



### A few minor leaks

This year, the Randolph store “has operated very well,” said Burd. “We have had a few minor refrigerant leaks, mostly at access fittings, and also have had two ball valve failures/leaks.”

In the event of a power failure, the store has a 2HP condensing unit to prevent pressure build-up in the surge tank that could lead to large CO<sub>2</sub> losses.

With the help of its two adiabatic gas coolers, the transcritical system did not once enter less-efficient transcritical mode over the first year of operation, including during summer months when ambient temperatures exceeded 100°F (38°C). This year, it did experience transcritical mode “multiple days in July and early August,” said Burd.

He attributes that to a failed water pump in one of the adiabatic gas coolers. Since the pump was replaced, the system has not gone into transcritical mode. Weis has also installed software developed by BAC “that will send an alarm to our EMS system if a pump fails,” said Burd.

Burd acknowledged that the system consumed more energy than usual when it entered transcritical mode. Even so, he

added, “this store is still better than any of our legacy stores” with regard to energy consumption of the refrigeration system.

Weis has continued to monitor the energy performance of the transcritical system in 2020, along with that of five other legacy stores, which use a medium-temperature glycol secondary loop/low-temperature DX system (with adiabatic condensing) or a DX-only system.

Through July 14, the transcritical system consumed 250,000kWh. By contrast, the other stores consumed 340,000kWh, 380,000kWh, 400,000kWh, 410,000kWh and 450,000kWh.

When Weis decided to install a transcritical CO<sub>2</sub> system in 2018, the appeal of CO<sub>2</sub> as a future-proof refrigerant factored into its decision. “We’ve gone through refrigerant conversions,” said R. Kevin Small, Vice President, Construction and Development for Weis. “Now there’s a conversion from R404A. Are we going to be required to convert from R448A? We’re looking for a place where we aren’t looking at another conversion down the line. So it would be nice to get to a natural refrigerant.” ■ MG

### System Specs

Weis Markets’ new store in Randolph, N.J., uses a transcritical CO<sub>2</sub> system with the following specifications:

- ▶ Rack: Hillphoenix
- ▶ Two adiabatic condensers: Baltimore Aircoil
- ▶ Compressors (5 medium-temperature, 3 low-temperature): Bitzer
- ▶ Controllers: Danfoss
- ▶ Low-temperature capacity: 343.2 kBTU/hr at -24°F (-31°C)
- ▶ Medium-temperature capacity: 1,137.3 kBTU/hr at 19°F (-7°C)
- ▶ Low temperature required in cases: 260.8 kBTU/hr required at -22°F (-30°C)
- ▶ Medium temperature required in cases: 632.8 kBTU/hr required at 20°F (-6.7°C)
- ▶ CO<sub>2</sub> charge: 1,100lbs (499kg)
- ▶ Defrost: Electric (LT)/ Off-Time (MT)
- ▶ Heat Reclaim: For HVAC and water



Two adiabatic gas coolers for transcritical CO<sub>2</sub> system at Weis store





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# Transcritical CO<sub>2</sub> in Warm, Muggy Florida

Seed to Table's refrigeration system helps the store deal with the substantial humidity of the Sunshine State while operating in high ambient temperatures.

— By Michael Garry

**T**he first U.S. supermarket to install a transcritical CO<sub>2</sub> was a Hannaford store in Turner, Maine (U.S.), which opened in July 2013. As the most northeastern state in the U.S., Maine was considered a good location and climate for a transcritical system, which at that time worked less efficiently in warmer ambient temperatures.

But since then, technology – notably adiabatic gas coolers, parallel compression, ejectors, subcoolers, and more – has evolved to support the operation of transcritical CO<sub>2</sub> systems in warm climates. Now stores well below the “CO<sub>2</sub> equator” are opening with transcritical CO<sub>2</sub> as their refrigeration system.

A recent example is a 75,000ft<sup>2</sup> (6,968m<sup>2</sup>) Seed to Table Market, a refurbished Albertsons store that opened in December 2019 in North Naples, Florida, the most southeastern state in the U.S. The system, provided by OEM Hillphoenix, Conyers, Georgia (U.S.), includes three rooftop adiabatic gas coolers from Baltimore Aircoil (BAC), which helps the system function efficiently in the balm climates of southwest Florida.

The energy usage of the transcritical system has yet to be assessed. But, despite the high ambient temperatures of North Naples, the energy consumption of the system as compared to that of a traditional DX system is expected to be at “parity, probably using a little more,” said Glenn Williams, sales manager, Supermarket Source, a Hialeah, Florida (U.S.)-based distributor of supermarket equipment, which arranged the purchase of the transcritical system for Seed to Table. The company services independent stores in Florida, with a division that supplies stores in New York City.

Seed to Table is Williams’ and Supermarket Source’s first transcritical CO<sub>2</sub> project, though the company has handled subcritical CO<sub>2</sub> systems for several stores. Williams, who previously worked for Hillphoenix in the southern U.S., suggested to Seed to Table’s owner, Alfie Oakes, that he should use CO<sub>2</sub> refrigeration if he “wanted to go all natural,” though it would cost more up front. “But he was happy that CO<sub>2</sub> was only 10% the cost of R448A refrigerant,” Williams said.

Williams described the owner as “sophisticated” about refrigeration, which he uses for his farms and warehouses.

“When we explained it, he got it immediately,” he said.

Seed to Table’s corporate owner, Oakes Farms, is an independent agribusiness operation based in Collier County, which encompasses Naples in southwest Florida. Its businesses include farming, packing, shipping, retail stores, and food service and seafood distribution. In addition to Seed to Table, Oakes Farms runs an Oakes Farms Market and a Food & Thought Organic General Store in Naples, and two stores in Delaware (U.S.).

Oakes Farms says on its website ([www.oakesfarms.com](http://www.oakesfarms.com)) that it operates its farming divisions “in a manner that respects the long-term health and wellbeing of the environment, the land, our partners and the community.”

The Seed to Table store, which Williams calls a “destination” as well as a grocery store, features produce from the company farms, a large all-organic section, two-story wine section, ice cream shop, a fresh bakery and many other culinary favorites. Given its organic and environmental ethos, Oakes Farms was a good candidate for a natural refrigerant, in this case CO<sub>2</sub>.

## Dealing with humidity

The challenge posed by the weather in coastal South Florida is not just warm temperatures, but high humidity. So Seed to Table’s HVAC&R systems had to be designed to minimize the latter. SESCO, a North Carolina-based engineering and equipment supply company, designed a complete store AC system using R410A to accomplish this. “The AC has performed phenomenally well,” said Williams.





## System Specs

The transcritical CO<sub>2</sub> system at the Seed to Table store in North Naples, Fla., includes the following:

- ▶ Rack: Hillphoenix
- ▶ Glycol, water heat exchangers: Swep
- ▶ AC air heat exchanger: Super Radiator Coil
- ▶ Adiabatic Gas Cooler: Baltimore Aircoil (BAC)
- ▶ Medium-temperature capacity: 1,300 MBH at 11°F (-11.7°C) SST
- ▶ Low-temperature capacity: 100 MBH at -15°F (-26.1°C) SST
- ▶ Total heat rejected: 2,150 MBH when water and air heat reclaim are not used.

The Seed to Table store presented a particular challenge. Because the store does a lot of cooking, it has more than 100ft (30.5m) of exhaust hoods that are configured to utilize at least 80% of their supply air to help to lower outside air requirements. However, it is still necessary to pressurize the store by introducing outside air, and treating it as well as the inside air to maintain a 75°F (24°C) dry-bulb temperature and 55% relative humidity (ASHRAE conditions that cases are designed for).

But in subcooling the air to remove humidity, the temperature may drop below 75°F; in that case, hot discharged CO<sub>2</sub> is channeled to a heat exchanger coil in the AC system to warm the air, also helping to keep the refrigeration system in a more efficient, subcritical operational mode, said Williams. "The CO<sub>2</sub>-to-air heat exchanger took a little time to get adjusted properly, but everything has worked very well," said Williams.

In the event of cool outside temperatures where heat is needed, the heat reclaim can also be used to warm up the store. (Gas heat is also available). CPC

(Emerson) controls manage cooling, heating and dehumidification as well as refrigeration.

De-stratification fans are also used to "keep the aisles from getting too cold from open case spillage," he said. "We move a lot of air around to make the store more comfortable, and to have a smoother more efficient operation of the AC system."

The transcritical system also provides the heat by which the store preheats potable water that is further heated by a gas water heater (though sometimes the preheated water is sufficient). The two-step preheating takes place by means of two Swep heat exchangers; one is a blazed plate unit that employs glycol to grab heat from discharged CO<sub>2</sub>; the other uses the warm glycol to preheat potable water. "The water tank that we use can't handle the CO<sub>2</sub> pressure, so we needed another heat exchanger to heat the water and circulate it through the tank," said Williams.

Meanwhile, at the display cases, up to four case controllers – tied to the rack

controller – are used to manage the evaporators and electronic expansion valves.

A company called Cogent Enterprises monitors the cases remotely and contacts the store in the event of an issue. "They also use analytics to ensure proper operation and maximize energy saving where possible," said Williams.

The transcritical refrigeration system "has done much better than they expected," said Williams. "The system is working beautifully."

Williams acknowledged that the system has experienced "a few issues," but "that is to be expected with a store they had so many firsts for them and the contractor who installed it. This included "some minor leaks," though the system has never lost its original CO<sub>2</sub> charge.

Seed to Table may be Supermarket Source's first transcritical project, but it likely won't be its last. Many stores in its distribution network are still using HFC DX systems with HFCs (some even with R22), noted Williams. He hears discussion about needing to "start talking to them about natural refrigerants – we want people to be more prepared." ■ MG



# Bringing the CO<sub>2</sub> ‘Equator’ to the Real Equator

With retailers like Mi Comisariato in Ecuador, and Carrefour in Martinique, Arneg Central America is showing that transcritical CO<sub>2</sub> can be used in countries near, and at, the hot latitudinal center of the world.

— By Michael Garry

**A**rneg Central America, based in Panama City, Panama, has found a way to market transcritical CO<sub>2</sub> refrigeration in warm climates like Central America and the Caribbean, as well as Ecuador in South America, which the earth’s Equator cuts through.

The secret is that its transcritical CO<sub>2</sub> systems typically include parallel compression and often ejectors as well. These technologies, which the company started offering in December 2019, help prevent the systems from entering less-efficient transcritical mode at ambient temperatures above 31°C (88°F).

To find out more about Arneg Central America’s approach to transcritical CO<sub>2</sub>, *Accelerate* queried Rolando Bissot, its engineering and maintenance manager.

## What are some of your recent transcritical CO<sub>2</sub> installations?

**Rolando Bissot:** Our recent transcritical CO<sub>2</sub> installations include: a new Riba Smith store in Panama City, Panama, with parallel compression; a refurbished Carrefour Market in Le François, Martinique, with Carel ejectors and parallel compression; two Mi Comisariato stores in Guayaquil, Ecuador, with parallel compression; three new Marche Service stores in Guadeloupe with parallel compression; and a refurbished Leclerc Place D’Armes in Le Lamentin, Martinique, with Danfoss multiejector–vapor, and parallel compression.

## Do you see more interest in these systems in your region?

**Rolando Bissot:** In Ecuador, the largest chains only do new supermarkets with CO<sub>2</sub> technology. They have experienced the energy savings and do not want to turn back.

In Central America, we have had some hesitation from clients about the technology because they view it as brand new and their technicians do not have the experience. But with our experience

over the past couple of years in Panama, we have proved that qualified refrigeration technicians can be trained to manage these new systems.

In the Caribbean, we have positioned ourselves as a market leader for CO<sub>2</sub> technologies with several systems installed in Curacao, St. Maarten, Guadeloupe and Martinique. We hope to expand to St Lucia, Aruba, Trinidad and Tobago, and the Dominican Republic in the coming months. Electricity costs are a lot higher on the islands of the Caribbean than in Central America; therefore, energy savings drive the change.

## How does the capital and installation cost of these systems compare to that of traditional systems? Is cost a challenge in selling these systems in this part of the world?

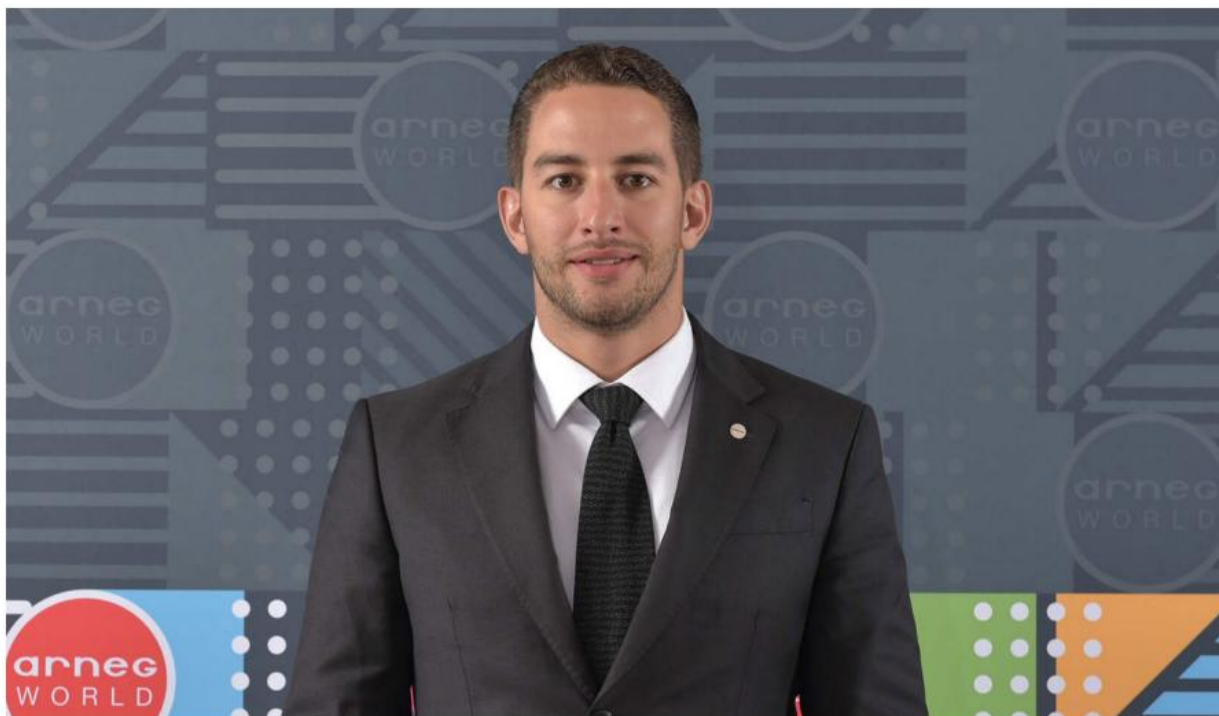
**Rolando Bissot:** When we first started with CO<sub>2</sub> technology, component costs were elevated when compared with traditional HFC systems, but year after year we have seen the prices go down and level out between the two. We always run ROI scenarios with potential clients, and when we include the energy savings of a transcritical system and the initial refrigerant charge, the transcritical option is very desirable. Refrigerant prices will continue to rise and this will in a way force the clients’ hand to make the switch to CO<sub>2</sub>, mainly transcritical.

## How does the energy efficiency of these systems compare with that of traditional systems?

**Rolando Bissot:** For our first transcritical installation in the Caribbean we expected a 14% energy savings compared to the R404A system we were offering. Following the installation and first year of operation, we have recorded energy savings of 21%.

The largest first-cost savings is the initial refrigerant charge and it must always be considered in the comparison. Depending on the region it can represent a 40-fold reduction (US\$80,000 to \$US2,000)





Rolando Bissot, Arneg Central America

#### How do you train technicians?

**Rolando Bissot:** The training we offer our technicians and clients starts with the basic concepts of transcritical refrigeration when we start discussing the types of systems we offer.

We then set up a more in-depth training session with the maintenance and engineering departments of the client so that they can feel confident they understand the technology before making a decision to switch to transcritical refrigeration. We do the same training sessions with the technicians of our partners that will carry out the installations and maintenance.

We also rely on training sessions offered by our suppliers and partners for more in-depth training on specific system components (compressors, valves, controls, supervision, etc.).

For some clients, the change to CO<sub>2</sub> is not just a change in the system's refrigerant gas, but a change from mechanical controls to electronic case controllers, electronic rack controllers, and electronic expansion valves.

#### Tell us about your training facility in Panama City

**Rolando Bissot:** We have created a training laboratory/showroom in our new offices in Panama City, Panama, but due to the COVID-19 travel restrictions we have not been able to use it yet; we expect it to be ready by January 2021. The idea is to bring technicians and clients to the laboratory setting so they can see the transcritical system working, manipulate the system parameters, and simulate common maintenance tasks.

The facility has a transcritical CO<sub>2</sub> system with a parallel compressor, ejectors and integrated air conditioning via a chilled water supply. We expect a couple of new stores before the end of 2020 will include an integrated transcritical air-conditioning system.

#### What is the biggest obstacle to selling transcritical CO<sub>2</sub> in Latin America?

**Rolando Bissot:** By far the biggest challenge is the fear of the unknown. I am referring to the irrational fear of new technologies. It's always the same claims you hear about transcritical refrigeration, such as: too high working pressure, only works in cold climates, only works in Europe, etc. This can be expressed as a fear of CO<sub>2</sub> technology or as a fear of new electronic components. But with our training, remote monitoring, and site visits, we can show technicians and clients that we brought the CO<sub>2</sub> equator all the way down to the Equator, with considerable energy savings.

With many installed projects, and several success stories and ROI validations in our portfolio, it has become easier to show prospective clients that transcritical technology is already in Latin America and it's here to stay. We have not experienced any client that has jumped backwards to HFCs after seeing the benefits of CO<sub>2</sub> and specifically transcritical benefits. Once they install transcritical systems, they start looking for more transcritical variations such as mechanical subcoolers, adiabatic subcoolers, heat reclaims, integrated A/C, ejector variations, among other options. ■ MG

# Metro AG Cuts Electricity and Heating Costs with Two CO<sub>2</sub> Ejector Retrofits in Bulgaria

Transcritical systems cut electricity use 24% and 26% compared to previously used HFC systems.

— By Tine Stausholm

**M**etro AG, a German wholesale retailer, has reaped considerable savings in electricity and heating from its first transcritical CO<sub>2</sub> installations in two retrofit stores in Bulgaria.

The two installations, in Sofia and Ruse, each include a booster system with ejector technology, and heat recovery to produce heating and hot water for the stores. The Sofia store was refurbished in 2018, and the store in Ruse followed in 2019.

The Sofia store is 8,386m<sup>2</sup> (90,266ft<sup>2</sup>) with a total medium-temperature capacity of 556kW (158.1TR), and low-temperature capacity of 130kW (37TR). The Ruse store is a bit smaller, at 6,199m<sup>2</sup> (66,725ft<sup>2</sup>), with 484kW (137.6TR) medium-temperature capacity and 116kW (33TR) low-temperature capacity.

The CO<sub>2</sub> systems are much more efficient than the previously used HFC equipment. In its first full year of operation, the Sofia store achieved a 400,000+ kWh savings, equaling 26.45% reduction, and store heating and hot water savings (via heat recovery) of 75.56%, equating to €36,901 (US\$40,718), according to Metro.

The Ruse system has seen a 24.22% electricity savings between September 1, 2019, and July 31, 2020, Metro said. It also experienced a heat recovery savings of 58.32% from November 2019 to July 31, 2020; the store saved €11,622 (US\$12,824) in heating costs in the four-month period from October 2019 to January 2020.

Additional energy saving features include doors on all medium-temperature cabinets and LED lighting.



Outdoor CO<sub>2</sub> rack station

## RACKS OUTSIDE

The CO<sub>2</sub> racks are located in containers outside the building. This was necessary because the existing machine rooms didn't have room to install the new systems with the old ones still in place. The vacated machine rooms now house the heat recovery features for the new systems.

Without incurring any downtime, installing the new systems with the old ones still operating was a challenging task. The Sofia store is open 24/7 while the Ruse store is open from 6am to 9pm every day, meaning that the installation teams worked mostly night shifts to minimize any disruption.

Metro also used temporary plug-in cabinets during the exchange of the old cabinets, to minimize any disruption to the customers.

The project was carried out in collaboration with the Swiss consultancy Frigo-Consulting. Frigo did the system specifications, commissioning and quality inspections of the installed solutions. Carrier was chosen to deliver the systems – Carrier's CO<sub>2</sub>OLtec solution – after a tender procedure. ■ TS





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Amman, Jordan

# Middle East's First Transcritical System Is an Energy Saver

Amman, Jordan store is saving 40,000kWh per year in a high-temperature climate after leap-frogging from R22 to CO<sub>2</sub>, bypassing HFCs.

— By Charlotte McLaughlin and Michael Garry

**In** January 2018, a 2000m<sup>2</sup> (21,528ft<sup>2</sup>) Al-Salam military supermarket in Amman, Jordan, became the first food retail store in the Middle East to install a transcritical CO<sub>2</sub> refrigeration system, replacing a system that used ozone-depleting R22.

The transcritical system has overcome the challenge of operating efficiently in a climate that typically reaches up to 36°C (97°F), and this year hit 44°C (111°F) for 10 days, said Firas Abdin of Abdin Industrial, a local contractor, which is responsible for the store's maintenance. During that period, "the system worked efficiently and we didn't receive any complaints from the customer," said Abdin.

The system was found to save 40,000kWh per year in its first year of operation compared to the legacy R22 system, said

Armin Hafner, Professor in Refrigeration in the Department of Energy and Process Engineering at the Norwegian University of Science and Technology (NTNU), and a technical adviser on the Al-Salam project.

In addition, the system's efficiency reduces CO<sub>2</sub>e emissions by 32 metric tons annually, and its removal of R22 avoids direct emissions of 35.2 metric tons of CO<sub>2</sub>e.

"We are still saving around 40,000kWh per year," noted Abdin.

Abdin Industrial also found that the transcritical system saved 20%-30% in energy consumption over one year compared to an HFC system in a similar supermarket in the same area.

How does the transcritical system manage to operate efficiently in such





Al-Salam's transcritical CO<sub>2</sub> system

a torrid climate? The answer is that the system uses parallel compression and multi-ejector technologies, which are designed to keep the system from entering the less-efficient transcritical mode in temperatures above CO<sub>2</sub> critical point (31°C/88°F).

### Cooperation breeds success

The CO<sub>2</sub> booster system is from Italian manufacturer Enx, and uses Dorin compressors and Danfoss's multi-ejectors. Abdin Industrial, designed, manufactured and installed the display cabinets.

"The fruitful cooperation of Abdin and Enx shows that local manufacturers and suppliers of commercial refrigeration equipment are able to leapfrog towards the latest CO<sub>2</sub> refrigeration technology," said Hafner.

The system also features non-superheated evaporator technology for both chilled and frozen food cabinets and

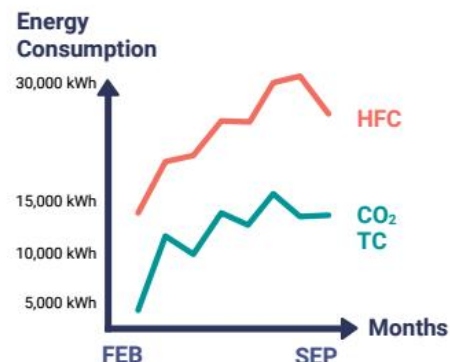
storage rooms. The waste heat from the system is recovered for the hot sanitary water supply, which further increases the efficiency of this system.

The transcritical refrigeration system is able to maintain chilled food at an evaporation temperature of -2°C (28.4°F), and frozen food at -25°C (-13°F), said Hafner.

Alfa Laval, LU-VE and Temprite also supplied components for this project.

Abdin testifies to the system's reliability. Since its installation, there has been "no single maintenance call," he said. "We do only a regular maintenance visit every three months to clean the gas cooler from dust."

Abdin added that he has a statement from Al-Salam saying that, while using the transcritical system, the store has not experienced food loss and has maintained temperature set points.



Source: Abdin Industrial

### A UNIDO project

The transcritical retrofit project received support from the Jordan Ministry of Environment and was funded by the Climate and Clean Air Coalition (CCAC). It was implemented by the United Nations Industrial Development Organization (UNIDO).

"The project implements the first transcritical CO<sub>2</sub> refrigeration system in the entire region in a supermarket and is truly state-of-the-art technology," said Sulafa Mdanat, UNIDO's country representative in Jordan. "The technology is spreading very fast in the world as it is considered one of the most energy efficient and climate-friendly refrigeration technologies for the retail sector."

"We are proud to confirm that Jordan is a global pioneer in [...] refrigeration technologies and we commend the efforts from the local companies in moving ahead towards more efficient refrigeration technologies," said Dina Kisbi, director of Climate Change Directorate, Ministry of Environment, Jordan. ■ CM & MG

# Transcritical System in Super-Warm Abu Dhabi Exceeds Energy Expectations

Epta's FTE system consumes 40%-50% less energy than an R404A system in a first-of-its-kind supermarket installation.

— By Tine Stausholm and Pilar Aleu



Arabian desert near Riyadh, Saudi Arabia

**T**ranscritical CO<sub>2</sub> refrigeration systems have traditionally not been considered a good choice for a desert country like the United Arab Emirates (U.A.E), where ambient temperatures can reach up to 51°C (123.8°F).

After all, at such high temperatures, the transcritical system would be expected to enter less-efficient transcritical mode.

Yet, on April 24, 2019, Italian manufacturer Epta installed a transcritical CO<sub>2</sub> refrigeration system incorporating its Full Transcritical Efficiency (FTE) technology at a 7,000m<sup>2</sup> (75,347ft<sup>2</sup>) supermarket in the brand new My City Centre Masdar shopping mall in Masdar City, Abu Dhabi, the capital of the U.A.E.

This is considered the first installation of transcritical CO<sub>2</sub> in an Arabian (Persian) Gulf country, according to Epta.

How has the system fared, energy-wise? Better than expected, said Andrea Cavalet, Contracting & After Sales Director, Epta U.A.E.

The reason for this is the FTE system. Launched at the EuroShop trade show in Dusseldorf, Germany, in March 2017, the system helps to improve the efficiency of CO<sub>2</sub> refrigeration systems and overcome the challenge of an installation in a desert climate.

Based on simulations, Epta expected the FTE technology to enable energy savings of up to 25% in the transcritical system compared to a standard R404A system in the Abu Dhabi area. But the energy savings turned out to be 40%-50% better in an analysis of electrical consumption data conducted from May to September in 2019, said Cavalet.

Despite operating at "extreme temperatures," the store "has performed exceptionally well, in line with the reliability of the FTE system installed worldwide," Cavalet noted. The system has been supported by preventive maintenance performed on site by "trained Epta engineers," he added.

The customer, My City Centre Masdar, "is totally satisfied [with] the reliability of the system and the energy efficiency showed," said Cavalet.

## SIMPLE DESIGN

The FTE technology, according to Epta, is based on a very simple design, whereby a low-pressure liquid receiver is used to flood medium-temperature cabinets with liquid CO<sub>2</sub>, eliminating superheat and allowing the evaporation temperature of the cabinets – and, ultimately, the efficiency of the system – to increase.

Over the past three years, FTE systems have been widely installed in Europe and the rest of the world, and were brought to North America following Epta's acquisition of Kysor Warren last year.

In February of 2020, at the most recent EuroShop, Epta unveiled an updated version of FTE called FTE 2.0; it also introduced an entirely new technology called the Extreme Temperature Efficiency (ETE) system, which further supports transcritical operations at ambient temperatures higher than 40°C (104°F). (See "[Transcritical CO<sub>2</sub> in Climates Above 40°C? No Problem, Says Epta](#)," *Accelerate* Special Issue #110.)

Epta has not installed other transcritical CO<sub>2</sub> systems yet in the Arabian Gulf, though "different customers showed interest and studies are ongoing," said Cavalet. ■ TS & PA



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# Energy Savings On Target at Metro Wumart China's 3 Transcritical Stores

Two systems installed in existing stores were forecast to save 25% in energy consumption compared to previous R22 systems.

— By Devin Yoshimoto

**In** the three stores where Metro Wumart China is running a transcritical CO<sub>2</sub> system, the energy performance of the systems is "on target," with one "far better than others," said Alan Lin, the retailer's Head of Facility Management, adding, "The operation is smooth and safe."

However, Metro Wumart – which has since October 2019 been 20% owned by German retailer Metro AG and 80% owned by Chinese retailer Wumart – has no plans currently to install transcritical systems at other stores," Lin said.

Original owner Metro AG installed the first transcritical system at a new store in Beijing in January 2018, and then two others at existing stores in Beijing and Chongqing in June 2019. The two Beijing transcritical systems employ parallel compression while the Chongqing system uses an ejector; both the parallel compression and ejector technologies are thought to be firsts for China.

Metro Wumart's Chongqing store is located in the Nan'an district and originally opened in 2001. The store's sales area is 8,597m<sup>2</sup> (92,537ft<sup>2</sup>). The store's transcritical CO<sub>2</sub> system, provided by Carrier, replaced an existing R22 system. "Due to the high temperature of Chongqing in the summer, we chose to use the ejector system as a solution for this store," said Metro AG in 2019. Energy savings compared to the previous system were estimated to be 25%. Emissions were expected to be reduced by around 917 metric tons of CO<sub>2</sub>e per year.

The Chongqing store's system has a low-temperature cooling capacity of around 140kW (39.8TR) and a medium-temperature cooling capacity of around 350kW (99.5TR). The CO<sub>2</sub> gas coolers and evaporators are from Güntner, the controls from Danfoss and the refrigerated cabinets from Haier Carrier, which also handled installation. In addition, the CO<sub>2</sub> system employs heat reclaim to provide hot water.

## Second parallel compression store

Metro Wumart's second Beijing store with transcritical CO<sub>2</sub> refrigeration, called the Beijing Shilihe store, opened in 2006. The two-story building has a sales area of 6,587m<sup>2</sup> (70,902ft<sup>2</sup>). The store's transcritical CO<sub>2</sub> system, provided by Italian refrigeration supplier Crea, also replaced an existing R22 system.

The system, which employs parallel compression, was estimated to save 25% in energy consumption. Emissions were expected to be reduced by 830 metric tons of CO<sub>2</sub>e per year.

The system has a total low-temperature cooling capacity of around 100kW (28.4TR) and a medium-temperature cooling capacity of around 130kW (37TR). In addition, the system provides around 220kW (62.6TR) of high temperature cooling for a prep room and sales area.

The CO<sub>2</sub> gas coolers are from Modine, evaporators from Güntner, controls from Carel, and refrigerated cabinets from Panasonic. Shanghai-based installation contractor Shanghai Qingneng Cool Chain Equipment & Engineering, which partners with Crea, handled installation.

SCM Frigo installed the transcritical CO<sub>2</sub> system in Metro Wumart's first transcritical store in Beijing, also a first for SCM Frigo in China. The system comprises two indoor racks, both with parallel compression and two remote air-cooled gas coolers. Refrigerating capacities are approximately 275kW (78.2TR) for medium temperature and 93kW (26.4TR) for low temperature.

■ DY



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# LAWSON C-STORE CHAIN SEES ENERGY SAVINGS IN 100% NATREFS STORE

The freon-free store is the Japanese retailer's first to use hydrocarbon plug-in equipment, along with CO<sub>2</sub> cases.

— By Devin Yoshimoto

**LAWSON CONFIRMED THAT THE HYDROCARBON PLUG-IN UNITS OFFER A 20% TO 30% ENERGY SAVINGS COMPARED TO FREON-BASED EQUIPMENT.**

**J**apanese convenience store chain Lawson is realizing energy savings at its first freon-free store, which employs only natural refrigerant-based equipment.

Lawson, which operates more than 14,000 outlets, is one of Japan's top three convenience store chains, together with 7-Eleven and Family Mart.

The store, which opened in September 2019, was billed as an "environmentally friendly model store" that employs CO<sub>2</sub> and hydrocarbon refrigeration equipment. It is located on the Shonan Fujisawa Campus of Keio University, in Kanagawa Prefecture — about one and a half hours southwest of Tokyo by train.

At the Keio University store, Lawson employs CO<sub>2</sub> in its typical configuration for large applications, which include in-store refrigerated and frozen display cases linked to outdoor condensing units. In addition, the store is Lawson's first to use hydrocarbons for its smaller plug-in upright and under-counter refrigerators as well as its ice makers.

Japanese OEM Hoshizaki supplied the hydrocarbon plug-in equipment while Panasonic provided the CO<sub>2</sub> equipment.

According to a representative from the construction department of Lawson's development division, the CO<sub>2</sub> condensing

units have demonstrated the same energy performance as the ones installed in previous Lawson stores. Those exhibit a 20% improvement compared to R410A systems, according to lab test data Lawson presented at the ATMosphere Japan conference in 2019 (organized by shecco, publisher of *Accelerate*).

Lawson also confirmed that the hydrocarbon plug-in units offer a 20% to 30% energy savings compared to freon-based equipment.

Lawson has long been one of the world's leading end users of CO<sub>2</sub> systems, opening its first CO<sub>2</sub> store in 2010 and expecting to reach 4,100 CO<sub>2</sub> stores in 2020. Its Panasonic systems feature 10HP outdoor condensing units for open cases and 2HP outdoor condensing units for glass-door freezers and walk-ins.

While Japan has taken a very strict stance towards the use of hydrocarbon-based commercial refrigeration equipment, the opening of this Lawson store is one of several important hydrocarbon developments happening in the country.

The Japan Refrigeration and Air Conditioning Industry Association (JRAIA) is expected to issue its official guideline on the safe use of hydrocarbons in 2020, while continuing to proceed with its risk assessment for A2L and A3 refrigerants. ■ MG



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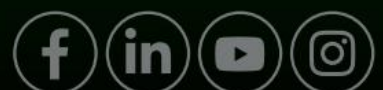
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# Running CO<sub>2</sub> Showcases in the Basement of a High-Rise

Tokyu Department Store installed a water-loop system in its food-shopping area rather than condensing units.

— By Devin Yoshimoto



Tokyo's Shibuya Scramble Crossing

**In** November 2019, Tokyu Department Store Co. Ltd., a major Japanese chain, opened "Tokyu Foodshow Edge" – a deli and sweets shopping area – in a new 47-story high-rise commercial complex called Shibuya Scramble Square, just a few blocks from Tokyo's well-known "Shibuya Scramble Crossing" intersection.

The company installed several CO<sub>2</sub> plug-in display cases combined with a water-loop system in the complex's second-floor basement food-shopping area. (It also occupies the first basement floor.) The combination of CO<sub>2</sub> plug-in equipment with a water-loop system in a retail store is relatively new in Japan, where CO<sub>2</sub> outdoor condensing units in convenience stores are dominant.

The innovation also represents a new opportunity for retailers to employ natural refrigerant systems in space-restricted high-rise commercial buildings, such as those found in densely populated Tokyo.

In the second-floor basement of the Shibuya Scramble Square high-rise tower, two food suppliers, Head Line (a rotating showcase of various food makers) and Sanwein (a vendor specializing in

Taiwanese delicacies), use seven pieces of the specially designed CO<sub>2</sub> water-cooled plug-in showcases.

To date, the operation of the CO<sub>2</sub> units is "quite comparable to even normal freon-based equipment, and they have been running without any issue," said Tatsuya Tamura, Section Chief, Facility Planning, Tokyu Department Store.

## THIRTEENTH-FLOOR COOLING TOWER

Tokyu Department Store worked with Japanese OEM Panasonic and Japanese refrigeration installer Hama Refrigeration Industries to design and install CO<sub>2</sub> plug-in showcases that would be cooled by a water loop. The cooling tower is located outside on the 13<sup>th</sup> floor.

While Tokyu Department Store aimed to use natural refrigerant equipment, the space restrictions and the underground location of the food sales area meant that a conventional CO<sub>2</sub> air-cooled condensing unit was not seen as a viable option.

And due to a tight construction and delivery schedule, Tokyu Department Store chose to forego using subsidies

for this project. Because of that, the company is not currently measuring the energy consumption of individual CO<sub>2</sub> units, said Tamura.

Tokuo Sato, Director of Hama Refrigeration Industries, said that in addition to preventing waste heat from being released on the sales floor, water-cooled systems are a good option for commercial facilities with limited space, and will help businesses transition away from synthetic refrigerants.

"Several major department stores have called for water-cooled CO<sub>2</sub> showcases," said Sato. "Looking ahead, it is better to transition away from fluorocarbons now rather than half-way through with low-GWP refrigerants such as mixed fluorocarbons."

In its renewal plans, Tokyu Department Store is looking at using freon-free equipment as much as possible, said Tamura. The focus is still on CO<sub>2</sub> refrigeration, though "we are considering other effective freon-free equipment." However, propane (R290), as a flammable refrigerant, is not an option because "considering the safety management of department stores, the hurdle is a little high," he added. ■ DY



# SPAR's First Transcritical CO<sub>2</sub> System in South Africa Overcoming Climate Challenge

Two additional CO<sub>2</sub> systems have been installed, with more expected.

— By Ilana Koegelenberg and Michael Garry

**S**PAR South Africa, a division of Dutch retail giant SPAR, had its eye on transcritical CO<sub>2</sub> systems, but hesitated to install them because “the South African climate had a significant impact on the efficiencies of these systems,” said Wayne Dedekind, Group Development Manager for SPAR Group South Africa.

But with advances in transcritical systems, SuperSPAR Wonderpark in Middelburg became the first SPAR South Africa independent retailer to install one, replacing its existing R22/R404A refrigeration system in September 2019 with a transcritical CO<sub>2</sub> system built by Sphere's Matador Refrigeration contracting division.

The 3,700m<sup>2</sup> (39,827ft<sup>2</sup>) store belongs to the Patricio Group, which owns five SPAR stores across the Limpopo and Mpumalanga provinces in South Africa.

“We were aware of the fast-growing increase in the price of synthetic refrigerants,” explained Firmino Patricio, Owner of SuperSPAR Wonderpark. “And by installing a CO<sub>2</sub> system, it would help us negate this future problem.”

“Mr. Patricio was the first of our independent retailers to acknowledge the inevitable future of refrigeration for the SPAR Group South Africa,” said Dedekind.

Two other SPAR stores in South Africa subsequently installed transcritical CO<sub>2</sub> systems, and another nine were planned for 2020, but have been put on hold or cancelled by the COVID-19 pandemic. “We will be revisiting these projects again in the near future,” said Dedekind.

## PARALLEL COMPRESSION USED

To address the warm South African climate, Matador supplied and installed a CO<sub>2</sub> booster system with parallel compression, designed to operate at 36°C (96.8°F) ambient conditions, 1,371m (4,498ft) above sea level.

An adiabatic gas cooler was also installed to maintain a 28°C (82.4°F) gas cooler outlet temperature for maximum energy savings. All cabinets are fitted with acrylic doors to further improve energy efficiency.

The system's capacity is 265kW (75.35TR) at -6.5°C (20.3°F) on the medium-temperature side with low-temperature capacity at 23kW (6.54TR) at -35°C (9°F).

The system was also designed with hot water reclaim, heating 500L (132gal) of water from 20°C to 55°C (68°F to 131°F).

In its first year of operation, the system has been running “very well, and has had no issues with reliability,” said Dedekind. “The retailer is very happy with their choice to go with a CO<sub>2</sub> plant.”

With regard to the critical question of transcritical system's electricity usage, Dedekind said that consumption is roughly 22% better than at “comparative-sized stores running on previous-generation multiplex plants.”

However, in a direct comparison to advanced 404A systems installed over the previous year, the energy consumption of the transcritical system was “marginally better,” and during periods where the temperature requires transcritical cooling, the modern R404A system's consumption was marginally better, Dedekind said.

“The retailer is, however, keen to point out that the main objective was not to make large energy savings but rather to make a responsible choice for his store's refrigeration,” he added. ■ IK & MG





# Hannaford's Hybrid R290-CO<sub>2</sub> Store

In South Burlington, Vermont, the chain has installed a lineup of R290 low-temperature cases along with a CO<sub>2</sub>/glycol chiller to cool medium-temperature cases

— By Michael Garry

**H**annaford, a Scarborough, Maine (U.S.)-based chain of 181 stores in five states, is recognized for installing the first transcritical CO<sub>2</sub> system in a U.S. supermarket, at a store in Turner, Maine, in 2013.

Since then the New England food retailer – now a part of the Ahold-Delhaize – has installed transcritical refrigeration in another new store, as well in an existing store.

But Hannaford, like many other U.S. food retailers including Target, ALDI US and Whole Foods Market, has also been deploying another natural refrigerant – propane (R290) – in self-contained display cases as spot add-on or replacement merchandisers in stores mainly served by central rack systems.

In the last two years, Hannaford has begun taking R290 to the next level – in a full lineup of low-temperature cases condensed by a water (with glycol)-loop. And in one store in South Burlington, Vermont (U.S.), the retailer is combining that low-temperature R290 lineup with medium-temperature cases cooled by glycol coming from a transcritical CO<sub>2</sub> chiller.



Transcritical CO<sub>2</sub>/glycol chiller for medium-temperature loads

## System Specs

Hannaford's South Burlington, Vermont (U.S.) store features the following refrigeration systems

- ▶ Hussmann R290 low-temperature cases with water loop
- ▶ Ambient fluid cooler with misting system
- ▶ Zero Zone CO<sub>2</sub>/glycol medium-temperature chiller; capacity: 1,100,000 BTUH (91.6TR/322.3kW)
- ▶ Baltimore Aircoil adiabatic condenser





Ambient fluid cooler for heat of rejection from low-temperature R290 cases

Hannaford first tried the a low-temperature lineup of R290 low-temperature cases at a 20,000ft<sup>2</sup> (1,858m<sup>2</sup>) store in Mechanic Falls, Maine, which opened in July 2018. (See [“R290: The Future of Retail Refrigeration? Accelerate America, January 2019.”](#)) The excess heat in the cases is removed by water that’s chilled to 50°F (10°C) by an R407A rack/chiller. Hussmann, which supplied the R290 cases, allows technicians to monitor them via a cell phone.

Joshua Smith, Manager of refrigeration / HVAC services, Retail Business Services, a subsidiary of Ahold Delhaize that handles refrigeration, recently called this R290 lineup “a good performer, with no significant maintenance.”

As its next step, in 2019 Hannaford deployed the R290 Hussmann cases at a new 39,000ft<sup>2</sup> (3,623m<sup>2</sup>) store in Ballston, N.Y., that opened in early 2020.

Unlike the Mechanic Falls store, the Ballston store uses an adiabatic fluid cooler to remove heat from the water loop, which is also used for heat reclaim. This store’s refrigeration system has had “no service calls outside of preventive maintenance,” said Smith.

Smith added that, while it is too early to obtain “real numbers” on the energy performance of the R290 lineup at the Ballston store, “so far it’s looking good.”

Though the R290 low-temperature lineups have been in smaller stores. “I feel this is a viable solution for any size stores that we operate,” said Smith. “They are very easy to install and if something happens you can replace five doors instead of an entire lineup.”

In fact, a more typical 60,000ft<sup>2</sup> (5,574m<sup>2</sup>) store that Hannaford opened last summer in Rome, New York, also employs the R290 low-temperature lineup.

On the medium-temperature side of the R290 stores, Hannaford is employing an R448A rack/chiller to cool glycol to 20°F (-6.7°C), and deliver it to the medium-temperature cases and walk-in coolers as a secondary cooling agent.

Harrison Horning, Director of Maintenance for Retail Business Services, who has overseen all of Hannaford’s natural refrigerant projects, believes Hannaford has overcome the energy penalty traditionally associated with pumping secondary glycol through a store as a cooling agent.

“We’re using copper piping that is sized a little bigger than normal so the pressure drop is less and the pump energy is less,” Horning explained.

In addition, Hannaford saves “a ton” of energy through the adroit adjustment of compressor head pressure during the cold New England winter.

### A novel approach

In the 60,000ft<sup>2</sup> South Burlington store, which opened in March, the Hussmann low-temperature R290 lineup’s glycol loop has its heat removed by an ambient fluid cooler with a misting system; the fluid cooler provides “adequate heat rejection” during the summer, said Horning.

In this store, Hannaford is using CO<sub>2</sub> instead of R448A for the glycol medium-temperature chiller, which is provided by Zero Zone. (R448A is used for condensing units supporting a walk-in freezer and a few open low-temperature coffin cases.) Horning describes the CO<sub>2</sub> chiller as “a large industrial-type system, not like a commercial packaged chiller.” It features on-board evaporators and a remote pump station. Its capacity is 1,100,000 BTUH (91.6TR/322.3kW), with a saturated suction temperature of 10°F (-12.2°C).



A rooftop adiabatic gas cooler from Baltimore Aircoil (BAC) is employed to reject heat from the CO<sub>2</sub> chiller; this is the first time Hannaford is using an adiabatic gas cooler with a transcritical system.

While the idea in using a glycol chiller with R448A was to reduce the refrigerant charge compared to a conventional DX system, the move to replacing R448A with CO<sub>2</sub> was to have an "entirely natural refrigerant store" (with the exception of the R448A condensing units), said Smith. Horning said he had originally expected to install a transcritical CO<sub>2</sub> system, but his merchandisers preferred cases not designed for CO<sub>2</sub>.

The South Burlington store's refrigeration – water-loop for low temperature self-contained R290 cases, combined with a CO<sub>2</sub>/glycol chiller for medium-temperature cases – is a fairly novel approach, noted Smith. "I'm not aware of anybody else doing it."

While Smith could not offer energy consumption numbers on the transcritical CO<sub>2</sub> chiller, he observed that during one day during the summer at 97°F (36°C) with 41% relative humidity, the adiabatic gas cooler operated at 95% capacity and the rack ran in subcritical, not transcritical, mode, with a condensed liquid temperature of 84°F (28.9°C). "The racks run pretty efficiently in subcritical mode," he said. "The adiabatic feature is definitely an energy saver."

The system did enter transcritical mode "a few times" when relative humidity was high, Smith said. Overall he expects lower energy usage with the combined R290-CO<sub>2</sub> systems than with HFC systems, based on the use of the adiabatic gas cooler.

Smith added that the adiabatic gas coolers require thorough maintenance, as their pads can get clogged with debris like dust and pollen. "If you keep the pads clean, the adiabatic gas coolers are great performers," said Smith.

Smith acknowledged that the South Burlington store's equipment came with a 10% incremental cost, not including the cost premium of the adiabatic gas cooler. Offsetting that was a \$100,000 energy incentive from Efficiency Vermont, a utility that supports natural refrigeration projects. And the cost of CO<sub>2</sub> systems "is coming down as the systems gain popularity," he said.

If first cost were no object, Smith would select the South Burlington's refrigeration for other stores. "I

like the performance," he said. The CO<sub>2</sub> system is in subcritical mode mostly, so you're saving energy with a natural refrigerant. And the R290 cases are plug and play."

Smith also pointed out the "flat-line" case temperatures produced by the CO<sub>2</sub>/glycol chiller. "The temperatures are within a degree [of setpoint]," he said. "From a product quality standpoint, that's an advantage." The low-temperature cases keep ice cream cold, down to -10°F (-23°C), he added.

On the maintenance side, the South Burlington store has not lost any R290 to leaks and has some losses of CO<sub>2</sub> during power outages – "nothing out of the ordinary," said Smith.

### Other R290 cases

In addition to the water-loop R290 cases, Hannaford is using more air-cooled R290 cases "than ever" for promotions, floral, wine and beverages. Smith said. Air-cooled cases for frozen foods could be an option if manufacturers make the compressors for those units quieter.

Hannaford would also consider R290 for a medium-temperature lineup when the charge limit in the U.S. for open meat and deli merchandisers rises to 500g from 150g, Smith said. (UL is looking into making that change.)

Having gained experience with water-cooled R290 low-temperature lineups in new stores, Hannaford is considering installing them in existing stores in a retrofit. "We have a couple of existing stores we're looking at for next year," Smith said. The roof of these stores would have to support a fluid cooler, he noted.

Meanwhile, the combination of R290 frozen-food cases and secondary glycol medium-temperature cases represents "a significant improvement over what we have, and moves us toward the end game," said Horning.

Horning acknowledges a particular fondness for the "plug-and-play" capability of R290 cases. "By the time I get to the end of my career, I'd love to know that when you are replacing cases in the middle of the night, it can be as easy as wheeling them in and plugging them in," he said. ■ MG





Whole Foods Market, Santa Clara, California (U.S.)

# 'I WOULD DO IT AGAIN'

Whole Foods Market would install a second R290/CO<sub>2</sub> cascade system, after finding its initial performance promising, and overcoming permitting challenges.

— By Michael Garry

**T**hough small-charge propane (R290) self-contained cases have proliferated, in July 2016 Whole Foods Market became the first food retailer in North America to install a propane/CO<sub>2</sub> cascade refrigeration system. (See "[Whole Foods Pushes the Propane Envelope](#)," *Accelerate America*, October 2016.)

Four years later, its 49,000ft<sup>2</sup> Santa Clara, Calif., Whole Foods outlet remains the only store in North America known to use a propane/CO<sub>2</sub> system. Last year, this made it the object of considerable interest at the 2019 IIAR Natural Refrigeration Conference & Expo, held in Phoenix.

At the conference, Tristram Coffin, director of sustainability & facilities for Whole Foods Market (now President of Livingstone Consulting), shed light on the system's provenance and performance in a case-study presentation. (This is detailed in an IIAR Technical Paper: "Case Study: The First Commercial Propane/Carbon Dioxide Cascade Refrigeration System in North America," which can be purchased at <https://bit.ly/2WtvnIG>.)

The presentation was part of the commercial refrigeration track organized by the North American Sustainable Refrigeration Council (NASRC).

As he concluded, Coffin divulged the answer to the question many in the audience were undoubtedly entertaining: Would Whole Foods choose to use this technology in another new store?

His answer: "I would absolutely explore this again. The system architecture and operation are more than worthy of further deployment." But he added, with a smile, "I would encourage others to do it so I don't have to!"

For there were a number of hard lessons learned in deploying the first R290/CO<sub>2</sub> cascade system in North America (and a second deployment would offer lessons of its own, he said).



Perhaps the hardest lesson learned stemmed from Whole Foods' experience with the authority having jurisdiction (AHJ) in Santa Clara, responsible for providing permits for the store.

"We received a building permit in 2015 after the appropriate parties, including the fire department, reviewed the plans," recalled Coffin. "But, as we walked the building inspector [fire marshal] through the propane/CO<sub>2</sub> system weeks before the store opening, he said that was the first he had heard about it."

The discovery prompted some "pretty tough questions," which considerably delayed the final permit sign-off and resulted in a number of design changes for control, leak detection and response. This clearly showed the need for earlier and closer engagement with the AHJ.

"Let the AHJ know in no uncertain terms exactly what you are doing versus handing them the plans and expecting that they understand the concept," Coffin said.

Another step needed to deploy the R290/CO<sub>2</sub> cascade system called for the system supplier, Quebec-based Carnot Refrigeration, to apply for and receive test-market approval from the U.S. Environmental Protection Agency (EPA) under its SNAP (Significant New Alternatives Policy) program. Carnot did that, and was also able to get the system listed by the UL equivalent – CSA – in Canada.

## COST AND ENERGY COMPARISONS

The R290/CO<sub>2</sub> cascade system consists of three low-temperature rooftop chillers (each with 25 lbs/11.3kg of R290) and four medium-temperature rooftop chillers (each with 39 lbs/17.7kg of R290). A cascade CO<sub>2</sub> rack is used for the low-temperature cases, while liquid overfeed is used with medium-temperature cases. The CO<sub>2</sub> charge is 1,730 lbs.

Given the presence of flammable propane, "a lot of attention was paid to safety," said Tom Wolgamot, principal, DC Engineering, who presented with Coffin at the IIAR conference. The safety features include features to keep the amount of propane well below the 21,000 ppm LFL (lower flammability limit) in the event of a leak; for example, a notification is sent when a leak reaches 1,000 ppm; an email is sent at 2,500 ppm and power is cut off at 5,000 ppm.

As of Coffin's IIAR presentation, no propane had leaked, though "one of the systems did have a small leak earlier [in 2020], noted Mike Ellinger, Principal Program Manager - Engineering, Compliance & Sustainability. There was also a leak of 120 lbs of CO<sub>2</sub> into one of the propane chillers.

In studying the deployment of its R290/CO<sub>2</sub> cascade system, Whole Foods compared it to three other systems at Northern California stores: a baseline (distributed R407A with scroll compressors and hybrid condensers); transcritical CO<sub>2</sub> with an air-cooled gas cooler; and an ammonia/CO<sub>2</sub> cascade system with hybrid condensers.

Experimental systems like an R290/CO<sub>2</sub> cascade system are known to be more expensive than traditional equipment, and in this case, it was 136% more costly than the baseline system.

Similarly, during 2018 the R290/CO<sub>2</sub> system was found to consume a little more energy than the baseline system, a highly efficient unit that has an inherent advantage in not using a cascade heat exchanger.

Normalized to weather and refrigeration load, the R290/CO<sub>2</sub> system consumed about 1.3 KWH/°F-MBH at 40°F, compared to 0.9 for baseline, a difference of 0.4. However the difference shrinks to 0.2 at 70°F and then to zero at 95°F.

The R290/CO<sub>2</sub> system generally performed better than the other natural refrigerant systems. The transcritical system outperformed it between 40°F and 55°F; thereafter R290/CO<sub>2</sub> consumed less energy, and by 80°F it consumed 0.5 KWH/°F-MBH less. R290/CO<sub>2</sub> consumed less than ammonia/CO<sub>2</sub> over the entire temperature range; at 60°F the difference was 0.5.

Coffin was pleased with the overall energy performance of the R290/CO<sub>2</sub> system. "We were told the energy penalty would be 50%-60% higher than baseline," he said. "Getting so close to the HFC DX baseline in my mind is a success. If we did 100 more, we'd start to be neutral or better."

In terms of TEWI (total equivalent warming impact), which combines direct refrigerant emissions and indirect electricity-driven emissions, all of the natural refrigerant systems far outperform the baseline system, which uses a high-GWP refrigerant (R407 with a GWP of 2,107) and generates more than 400 metric tons of CO<sub>2</sub>e. The R290/CO<sub>2</sub> system's TEWI is about 160 metric tons of CO<sub>2</sub>e.

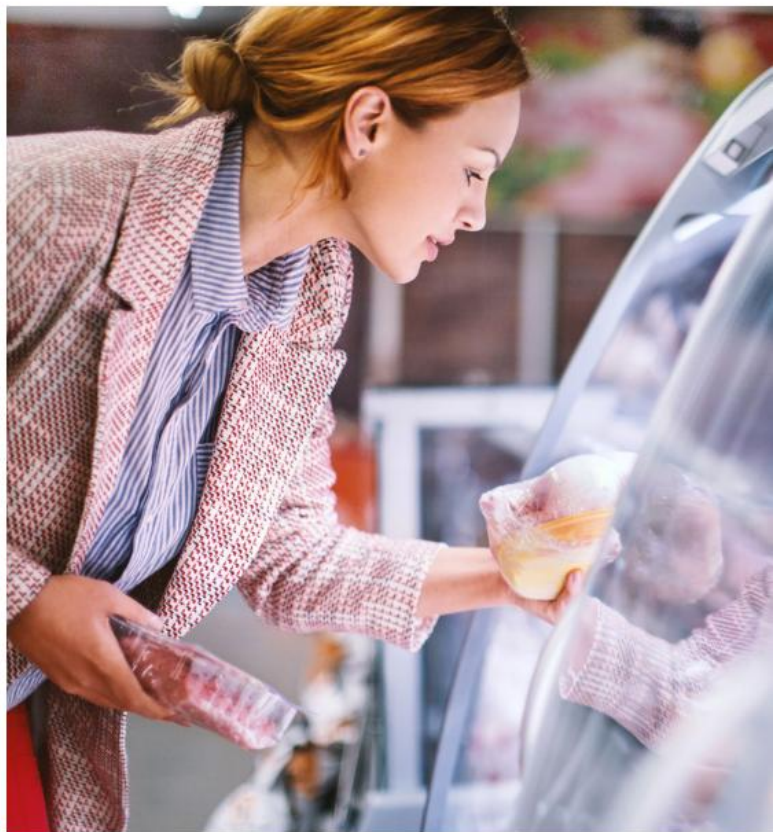
"With regulatory implications and corporate sustainability goals, it's important to look at TEWI versus just indirect emissions from energy use," said Coffin. In California, regulations are heading toward a 150 GWP cap in new commercial systems in 2022, offering further incentive to use R290 (GWP 3) and CO<sub>2</sub> (GWP 1). ■ MG



# More U.S. Stores Pursue Full-Store R290 Layouts

Wild Fork Foods has installed air-cooled cases from AHT in nine stores, while Grocery Outlet is beginning to use AHT's water-cooled cases.

— By Michael Garry



**O**ver the past two years, AHT Cooling Systems USA, Ladson, S.C. (a division of AHT Group, acquired in 2018 by Daikin), has been highly proactive in installing self-contained propane (R290) display cases that are air-cooled or water (mixed with glycol)-cooled in full-store configurations in the U.S.

This is a follow-up to supplying R290 cases in partial-store layouts, or in spot merchandising situations.

Globally, AHT supplies self-contained propane cases in full-store layouts to more than 7,000 stores (many in Europe). In the U.S., AHT has supplied more than 90 stores where more than half of refrigerated load uses propane cases, said Drew Tombs, president of AHT Cooling Systems USA. "We see more [U.S.] retailers engaging in design discussion about R290 water-cooled and air-cooled projects to better understand the advantages first hand."

AHT USA customer Wild Fork Foods, which offers only frozen foods, particularly meat, poultry and fish, opened three roughly 5,000ft<sup>2</sup> (464.5m<sup>2</sup>) stores in South Florida in

December 2018, and equipped them each with 40-50 air-cooled plug-in AHT R290 frozen-food cases in a full-store layout. The chain has since installed the R290 cases in six other new stores.

"As each store is unique, the layouts change slightly," said Tombs. "But, in general, the decision for 100% [air-cooled] self-contained is their only direction forward for their next wave of stores planned for 2021."

The Wild Fork Foods equipment includes both horizontal chest units throughout the store and vertical reach-ins that are built into the perimeter wall, overhanging the retail space.

The single-circuit cases all have doors or lids, and do not require floor drains for condensation removal. The stores use an R448A split system in the cold room.

AHT USA, in cooperation with sister company Zanotti, has since developed both air-cooled and water-cooled R290 low-temperature and medium-temperature "Monoblocks" for cold rooms; these

packaged units are already installed and planned for several upcoming installations, said Tombs.

## Store flexibility

Wild Fork Foods installed the R290 cases to be "more environmental" and because "it was conducive to what we wanted to do," said Layli Sobhani, head of brand and marketing for the retailer, last year in regard to the first three stores. In particular, the cases "give us the flexibility to build out the stores consistently to fit all of our products." In addition, she expects the cases to save the stores additional energy because they all use doors.

Wild Fork does not provide energy consumption numbers, but AHT USA's R290 cases have been "performing and meeting [Wild Fork's] expectations" and providing flexibility to the chain "given the type of retail footprints they are targeting for store growth," said Tombs.

In addition to Wild Fork Foods, in 2020 AHT has implemented a complete-store R290 configuration for other U.S. chains,





including a Grocery Outlet location in California; four additional Grocery Outlet stores (two in California and two in Pennsylvania) are also getting a full-store R290 installation in 2020, said Tombs. These are all semi-plug-in cases with water-loop cooling.

ALDI US said it anticipates testing AHT USA's R290 semi-plug-in cases with water-loop cooling, as well as air-cooled R290 display cases and cold room packaged units.

AHT USA is also planning an installation at a Piggly Wiggly store in Georgia in which "our R290 water-loop [cases] were selected over traditional DX remote for a multi-use retail project," said Tombs.

#### Air- or water-cooled?

Whether a store would use air-cooled or water-loop cases depends on its products and layout, said Tombs. "For Wild Fork Foods, it was easier to do a true

[air-cooled] self-contained [lineup] with plugs and no drains," he said.

In general, stores using only propane cases tend to employ a water loop on the perimeter, with air-cooled cases in the center store, where they can be flexibly merchandised, Tombs said. Air-cooled units can also be used to add refrigeration capacity to an existing store without expanding the rack.

Globally, there are an estimated 1,900+ stores using hydrocarbon water-loop systems, including about 1,700+ in Europe and 100 in the U.S., according to sheccoBase, a division of Accelerate publisher shecco.

For water-loop R290 units, AHT leverages a dry fluid cooler to move water/glycol through the system and remove heat from the cases; the system maintains an average water temperature of 86°F (30°C), with a range of 62°F-113°F (17°C-45°C) based on ambient temperature.

■ MG

Leading manufacturer of R290 energy-efficient, medium and low-temperature plug in food merchandisers.

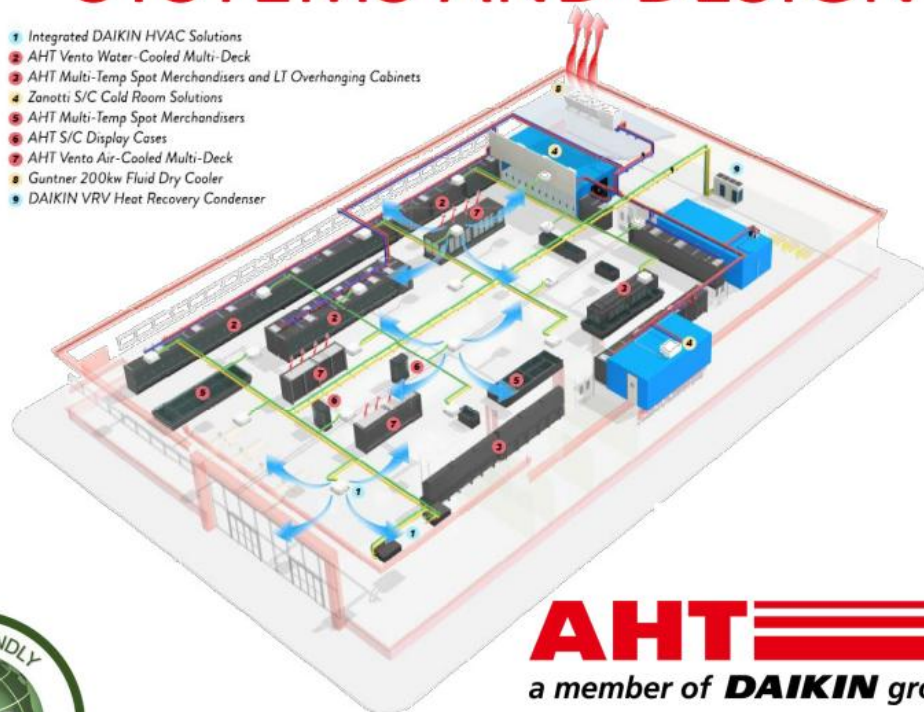
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## FULL STORE R-290 SYSTEMS AND DESIGN



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# To Avoid Fossil Fuels, Colruyt Group Arranges Import of R290 Heat Pumps into Belgium

The retailer has installed the heat pumps made by French manufacturer Auer in five new stores, supplementing heat reclaim from R290 refrigeration.

— By Tine Stausholm

A few years ago, Colruyt Group, Belgium's largest retailer, decided that, on top of its commitment to propane (R290) for refrigeration, it also wanted to avoid using fossil fuels for heating in new and existing stores.

However, the company couldn't find a heat pump suiting its needs in Belgium, so it had to look elsewhere.

Colruyt Group Project Engineer Collin Bootsvelde found the solution he wanted, an R290 heat pump from French manufacturer Auer, at an industry fair in the Netherlands. There was one problem — the Dutch importer ACR wasn't able to deliver to Belgium.

But Bootsvelde and his team did not give up. Colruyt Group's procurement officer, Jan Verdonck, along with Ian Vinck, Maintenance Manager, Industrial Refrigeration and Hydrogen Fueling Stations, managed to convince HVAC supplier Cairox Belgium (of which Colruyt Group is a regular customer), to add the Auer heat pump to its product catalogue. This made it available not only for Colruyt

Group, but for anyone in Belgium with a need for an environmentally friendly heat pump with a high coefficient of performance (COP) of up to 4.9, which is suitable for both domestic and commercial uses.

The main reasons he wanted this exact heat pump model were that Auer has "a suitable capacity range, so that we can match smaller and bigger heat demands; a good price level due to a basic design with heating only; and the ability to reach 70 degrees (158°F) with no electrical battery (to prevent legionnaires disease)," Bootsvelde said.

He also stressed that it was important to find an off-the-shelf product, as client-specific heat pumps "become too expensive to be economical."

The determination to find the right heat pump solution is part of Colruyt Group's efforts to create a "universal" heating and cooling system that can be reused, while also providing a concept for future stores.

"The task was to make a cooling system that could be reused," Bootsvelde

explained. "So if the shop gets refurbished, or maybe we change location, then we can take parts out and reuse them. So we don't have to throw away the cooling system."

Among large retailers, Colruyt Group is noted for its commitment to R290 for refrigeration and now for heating. Bootsvelde said this is not due to a certain ideology, but because the company genuinely believes that R290 is the best solution for their shops. (See ["Colruyt Charts Course for 100% Hydrocarbons in Stores," Accelerate Europe](#), September 2016)

The group's overall environmental goal is to reduce its CO<sub>2</sub>e emissions by 20% by December of this year compared to 2008 figures. To that end, electricity from solar panels and wind turbines power Colruyt Group's stores and distribution centers, with help from highly efficient CHP (combined heat and power) plants.



Auer HRC 70 heat pump, on the roof of a Colruyt store in the Etterbeek section of Brussels, Belgium.  
Photo by Tine Stausholm





### The Etterbeek store

Colruyt now has an Auer HRC 70 heat pump up and running in five new stores instead of gas-driven heaters, with three more installations planned this year. One of the first R290 heat pumps was installed in a large supermarket in the Etterbeek section of Brussels, which opened last December. In addition, Colruyt Group plans to replace gas heaters with the heat pump in future remodels of existing stores.

"It has been decided that we will try as much as reasonably possible to avoid gas connections in the future," said Bootsvelde. Auer has different, smaller models of the HRC70 heat pump so that "we can match the need with the right size of the heat pump," he noted.

The Etterbeek store has a "standard" refrigeration system for Colruyt shops, said Bootsvelde. This includes two or three "ventilated enclosure" compact R290/glycol chillers, depending on the size of the store, which serve large a cold room open to shoppers for produce, dairy and other medium-temperature products; they also support the butcher/deli in the main store area. (The Etterbeek store's chillers are from Futron.) Stand-alone

chest freezers employ isobutane (R600a) or propane as the refrigerant. The Etterbeek store also has heat recovery installed.

The large size of the Etterbeek store presented a problem, however. The heat recovery from the chillers wasn't expected to be sufficient in the winter months; hence the decision was made to install the heat pump to produce heating, and hot tap water for butchers.

The refrigeration system was designed to always prioritize the recovered heat over the heating produced by the additional heat pump, thus increasing efficiency, Bootsvelde explained.

Heat recovery is not unique to the Etterbeek store. It is quickly becoming standard for Colruyt and Bootsvelde expects to reach 63 stores with heat recovery by the end of 2020.

While many retailers have started utilizing heat recovery to improve efficiency, most Colruyt supermarkets stand out with their large cold rooms for fresh food, rather than traditional refrigerated cabinets. This solution is "three times more efficient," according to Bootsvelde.

Colruyt Group aims to eventually convert all of its stores to R290 refrigeration. Currently the number stands at 113 stores, out of 413 stores in total (most in Belgium). Bootsvelde expects this number to rise to 132 by the end of the year.

### The Auer HRC 70

Colruyt Group's preferred R290 heat pump, Auer's air-source HRC 70, is designed for both domestic, communal, tertiary industrial, and agricultural applications, according to Auer's website (<https://bit.ly/31DmzAj>).

The series, which is based on patented technology, comes in capacities from 11-35kW (3.1-10TR), and up to 140kW (39.8TR) when installed in cascade. One of its selling points is the fact that it can produce hot tap water up to 70°C (158°F), distinguishing it from most other propane heat pumps that are designed to produce up to 60°C (140°F) water, according to Bootsvelde.

Colruyt also uses CO<sub>2</sub> Ecocute heat pumps for hot tap water only, but not in the Etterbeek shop.

The HRC 70 is a highly efficient model, with a COP up to 4.9, and the whole range has been awarded the A++ European Union energy rating.

Other selling points, according to the Auer website, is that it's very quiet, due to a large-diameter low-speed fan, and it's a turnkey solution, enabling easy installation on existing heating circuits in, for example, homes.

Last, but certainly not least, it can achieve the promised 70°C hot water at ambient temperatures down to -20°C (-4°F). For this, it is equipped with two, differently sized compressors. The small compressor runs in mild weather, with the larger one taking over as it gets colder, and both compressors running concurrently at very low ambient temperatures, for increased efficiency. ■ TS

# Norwegian Retailer Remodels Store with Freor R290 Water-Loop System

The Joker c-store chain wanted a compact and energy-efficient solution for its small shop.

— By Nicholas Cooper

**F**or Joker, a Norwegian chain of more than 400 small convenience stores, saving space and energy is no joke.

Earlier this year, the company installed propane (R290)-based self-contained refrigeration cabinets cooled by a water (mixed with glycol)-loop system in a remodeled store in Oslo, Norway, seeking to maximize efficiency as well as store sales area.

This was the second Joker store in Oslo to use the Hydroloop Glycol R290 refrigeration system, designed by Freor, a Lithuanian commercial refrigeration equipment manufacturer.

Freor, which supplies retailers and supermarket chains throughout Western Europe and the Nordic regions, has seen strong sales growth for its R290 water-loop systems, the company says.

Joker specializes in small shops with a floor space of less than 100m<sup>2</sup> (1,076ft<sup>2</sup>). This limit is what allows the chain to legally open on Sundays, according to *Verdens Gang*, a Norwegian newspaper.

Hence, Joker needs compact and efficient refrigeration equipment, and this is what made it choose the Hydroloop refrigeration system in the first shop, in April 2019, according to Freor's website, and again for the second location.

As for energy consumption, "I know for sure the energy is lower than normal f-gas equipment because of the R290," said Bjørn Erik Korsnes, manager at NordDisk, a refrigeration and service and equipment provider that is the main supplier of Freor refrigeration technology in Norway, according to its website.

Also contributing to efficiency is the use of Carel expansions valves, energy-efficient fans in the dry cooler and evaporators, a frequency-regulated dry-cooler pump, LED lightning, and doors on all equipment, noted Korsnes.

## Wall-mounted pump station

The Hydroloop refrigeration system works by removing excess condensation heat from the cabinets to the exterior of the shop in water-and-glycol-filled pipes.

The liquid circulation in the closed system is "supported by a pump station mounted on the wall, thus freeing up more sales area," Freor said. Excess heat can be used for store needs, such as to heat water.

Korsnes has observed no problems with the system. "Freor has done these hydroloop systems for a long time and has taken care of all the problems before we started to use it," he said.

As well as using the Hydroloop refrigeration system, the Joker store switched to the ERIDA SLIM freezer cabinet, also made by Freor. The unit optimizes freezer capacity without compromising on a compact design, said Freor. The Joker store also installed Freor's JUPITER multideck lines, featuring glass doors. Freor noted the model is "safe for customers, as it uses only 150g of R290 refrigerant" per cooling cycle. ■ NC



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BY HUSSMANN

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# PANDEMIC DRIVES USE OF 'CLICK AND COLLECT' R290 REFRIGERATED LOCKERS



#EPTABricks R290 refrigerated lockers

**D**uring this year of the COVID-19 pandemic, online food shopping has skyrocketed in popularity as many shoppers seek an alternative to shopping at stores.

While in most cases this means having orders delivered to shoppers' homes, another option is "click and collect," whereby shoppers pick up their online orders at a store or other location.

One click and collect option that has taken root in France and elsewhere in Europe is #EPTABricks, which are refrigerated lockers located inside buildings or outside. Manufactured by Italian OEM Epta, #EPTABricks use propane (R290) refrigerant for both fresh food (#EPTAfreshBricks) and frozen food (#EPTAfrozenBricks).

Epta calls its click and collect solution a "smart, safe and easy-to-use shopping solution, minimizing waiting times, [with] all key elements for respecting the restriction obligations imposed by the current situation." #EPTABricks can be located in residential districts along the "home-work route," inside or close to large companies, and close to stores or to petrol stations.

In France, #EPTABricks have been adopted by several major retailers, such as E.Leclerc, Intermarché, Casino, Carrefour and SuperU. Driven by the growth in online sales, #EPTABricks French orders jumped by 300% during one week on April 2020, compared to the same period in 2019, according to Epta. In one week in March, click and collect accounted for 7% of total online sales in France.

In France, #EPTABricks online grocery orders jumped by 300% during one week in April 2020, compared to the same period in 2019.

— By Michael Garry and  
Charlotte McLaughlin

## 77 REFRIGERATED LOCKERS

In 2018, EPTA France installed 77 EPTABricks refrigerated lockers for E.Leclerc outside of one location in Anglet (near Biarritz) in the Nouvelle-Aquitaine region (southwestern France).

The lockers were installed adjacent to a Leclerc Express and in front of the main tram line in the center of Anglet.

"These [lockers] can be used to retrieve, even outside the store opening hours, 24/7, purchases of fresh, frozen and dry products ordered online during the day," said Epta.

E.Leclerc is a significant player in the French market with 569+ locations in France and 114+ stores outside of the country ■ MG & CM



# METRO JAPAN CUTS ENERGY USE WITH R290 REPLACEMENT CASES

Two hundred R290 cases replaced HFC units at three stores.

— By Devin Yoshimoto and Tomoro Sato

**M**etro Cash and Carry Japan, a division of German retailer Metro AG, reduced its electricity use by replacing 200 HFC display cases at three locations with propane (R290) plug-in units, said Kenji Funamori, Construction and Fitting Manager in Metro Cash and Carry Japan's Asset Management Department.

The R290 cases were installed in November 2019.

"It is the first such case of such a large-scale retrofit for us in Japan," said Funamori, speaking during the end user panel discussion at ATMosphere Japan 2020, held in Tokyo in February. "Our electricity demand has been greatly reduced and we have also reduced our maintenance and repair costs."

At that time, he reported energy savings of 60% in all three stores. At one of these stores, electricity use has been reduced by 40% over an eight-month period, according to Funamori. Although the eight-month results are lower, Funamori said he is satisfied because electricity costs have risen recently.

The cabinets were supplied by Austrian OEM AHT through its distribution partnership with Japan-based company Nihon Netsugen Systems.



Kenji Funamori, Metro Cash & Carry Japan

## NON-STOP STORE OPERATIONS

In addition to energy and maintenance cost reductions, one of the biggest reasons the large-scale retrofit project was successful, Funamori said, was because all cabinets were installed without stopping store operations.

Funamori said the installation of electric cables was completed prior to bringing in the cabinets. An advantage of going with the plug-in systems, he added, was that there was no gas piping or drainage work.

The installation of the cabinets was done at night over a period of five days with work starting after 6pm and finishing before the store opened at 6am.

"In addition," Funamori said, "future layout flexibility of the cabinets is possible and because it is not a remote system, if one cabinet fails, it can easily be replaced without interrupting the operation of the other cabinets."

One-third of the total cost of the initial investment, Funamori said, was covered by the Japanese Government's Ministry of Environment natural refrigerant subsidy.

One of the project's challenges, Funamori said, was that there is only a limited lineup of R290 cabinet types available, citing a lack of "chilled type, vertical type and cold room type cabinets." ■ DY & TS

Peter Michael Hansen, Head of  
Global Application and MD for  
Secop Germany



# Secop: 'Hydrocarbons Are Where We Should Be'

The German compressor manufacturer is increasing emphasis on R290 and R600a refrigerants for its commercial compressors, with growing attention to variable-speed units, says executive Peter Michael Hansen

— By Michael Garry

**G**erman compressor manufacturer Secop came into being a decade ago when the German holding company Aurelius AG acquired Danfoss Household Compressors from Denmark's Danfoss Group. After the takeover, the Danfoss Household Compressors' name was changed to Secop GmbH.

On August 1, 2017, Japanese manufacturer Nidec acquired Secop. However, due to its subsequent acquisition of Embraco, Nidec was required to divest the Secop business. ESSVP IV, a fund managed by private equity firm Orlando Management AG, completed its acquisition of Secop from Nidec in September 2019.

Today, Secop is continuing its original mission to promote the use of natural refrigerants and energy-efficient, sustainable refrigeration systems. In commercial refrigeration, its primary focus is on hydrocarbon compressors, including variable-speed units, and on mobile cooling solutions.

The company, based in Flensburg, Germany, has two manufacturing facilities, in Slovakia and China, as well as R&D hubs in Germany, Austria, Slovakia, China and the U.S. It employs over 1,350 people.

To gain a better understanding of Secop's commercial refrigeration business, *Accelerate* recently interviewed Peter Michael Hansen, Head of Global Application and MD for Secop Germany.

## **How important are hydrocarbon compressors to your commercial refrigeration business?**

**Peter Michael Hansen:** Hydrocarbon compressors make up 43% – and the percentage is growing – of Secop's commercial refrigeration business, with 30% of sales for propane (R290) units and 13% for isobutane (R600a) units. R290 is for higher capacity systems (300W-3kW/0.09-0.9TR) and R600a for smaller capacities (below 400W/0.1TR). We have had strong growth in the hydrocarbon business over the last year, and we anticipate hydrocarbons crossing 50% of sales this year. Hydrocarbons are where we feel we should be. ▶



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“

*Hydrocarbon compressors make up 43% – and the percentage is growing – of Secop's commercial refrigeration business.*

– Peter Michael Hansen, Secop

”



**Where are most of your hydrocarbon sales for commercial systems?**

**Peter Michael Hansen:** About 70% of our hydrocarbon sales are in Europe, 13% in China and 12% in the U.S. In 2020, China will cross to 20% of sales, the U.S. will remain the same, and Europe will be lower percentage-wise.

**What are the most popular commercial applications for your hydrocarbon compressors?**

**Peter Michael Hansen:** Our main volume is for bottle coolers – glass-door merchandisers. In Europe it had previously been large commercial freezers for supermarkets but the change in policy by the large bottlers like Coca-Cola and Pepsi caused bottle coolers to be by far the largest sector. But we still have a large, stable volume in horizontal display cabinets, and there is big growth in glass-door merchandisers, both single- and double-door. Next will be larger commercial freezers with glass doors.

**How has the IEC's new charge standard for hydrocarbons in commercial cases impacted your business?**

**Peter Michael Hansen:** The trend is for larger capacity systems so this is a very good move. We need to move to larger charges to realize their full potential. We are in the process of launching a larger variable-speed platform for R290, which will be coming to the market in October. In Europe, we are waiting for CENELEC to get down to the details of what the systems needs to look like, safety-wise, system-wise. But it's a great opportunity for us.

**What can you tell us about Secop's variable-speed hydrocarbon compressors?**

**Peter Michael Hansen:** Our DLV line serves smaller applications like glass-door merchandisers, and the NLV line serves medium-size commercial applications. The SLV line, for larger platforms and charge sizes, is the new one, launching in October.

We launched the DLV line for R290 three to four years ago in the U.S. and Mexico, targeting bottle coolers. We recently released it for Europe and the global market; the Middle East, for example, is starting to pick up on hydrocarbons.

Variable speed makes up 6-7% of our commercial compressor sales, but it's growing, driven mainly by energy efficiency regulation. In Europe, there will be new regulations in March 2021. Variable speed increases efficiency from 20% to 40% compared to a fixed-speed baseline for any given cabinet that has been optimized with efficient lighting and fans. The technology will be a strong enabler of reducing the strain from the coming energy regulations.

There is a cost premium for variable-speed compressors – about double the cost of fixed speed. But there is a quick ROI for the end user, about six months to a year for DLV, and three to six months for NLV; it will be under three months for SLV.

**What is the Tool4Cool software tool?**

**Peter Michael Hansen:** It enables the end user to optimize parameters like hot-gas defrost, faster pull-downs, and fan control. You can go in and adjust the controller to fit your needs.

**How has the recent spinoff from Nidec affected Secop?**

**Peter Michael Hansen:** Nidec had a commitment to household appliances, while Secop has a strong focus on commercial refrigeration and mobile cooling solutions. After the acquisition from ESSVP IV, we are back on track, focusing our development efforts on energy optimization, hydrocarbons and green sustainable solutions for our core businesses: stationary cooling (commercial refrigeration) and mobile cooling (battery-driven solutions). In parallel, we discontinued our focus on domestic refrigeration, which is not part of our core business anymore.

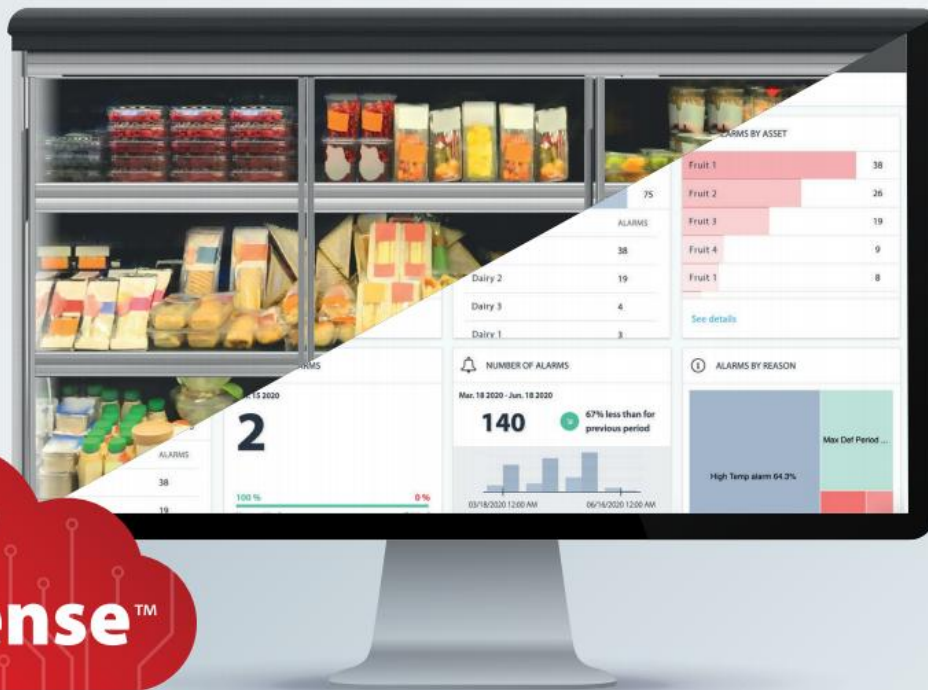
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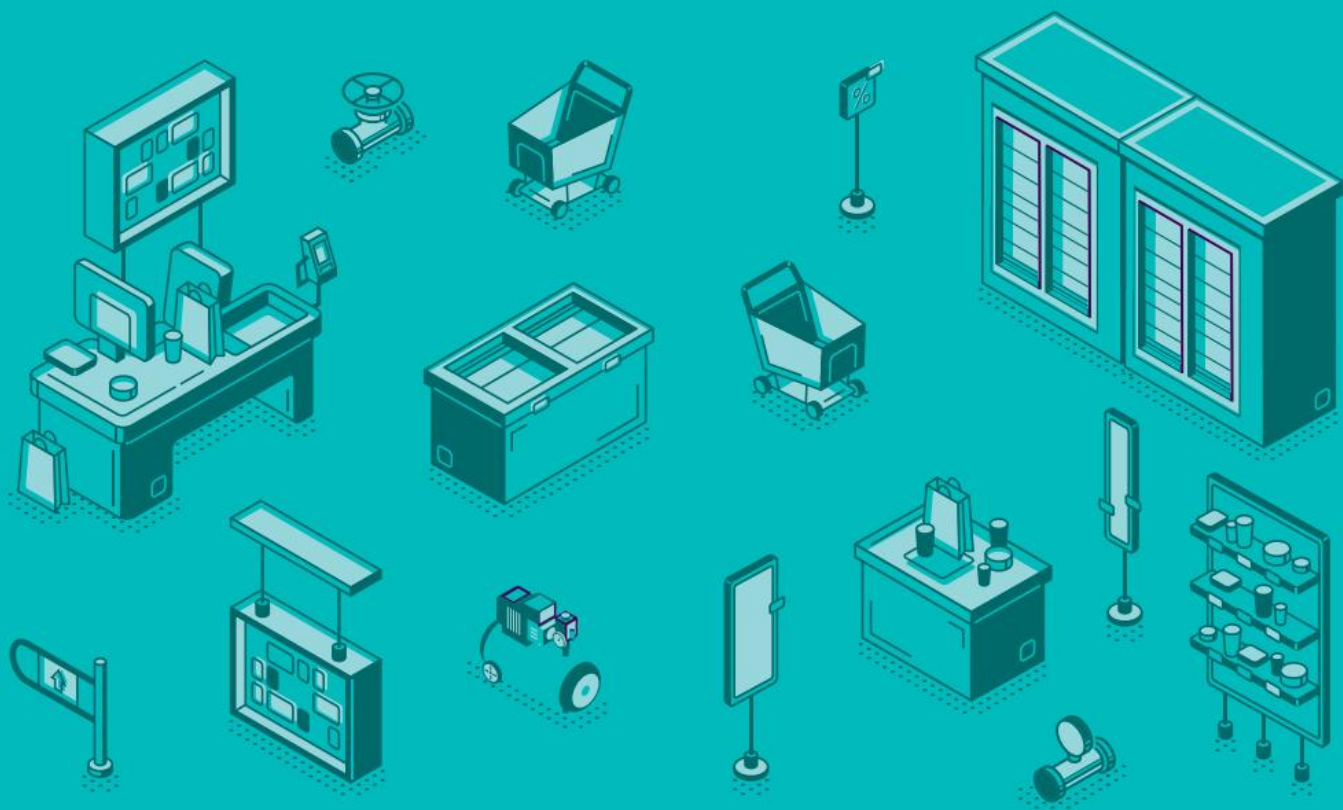
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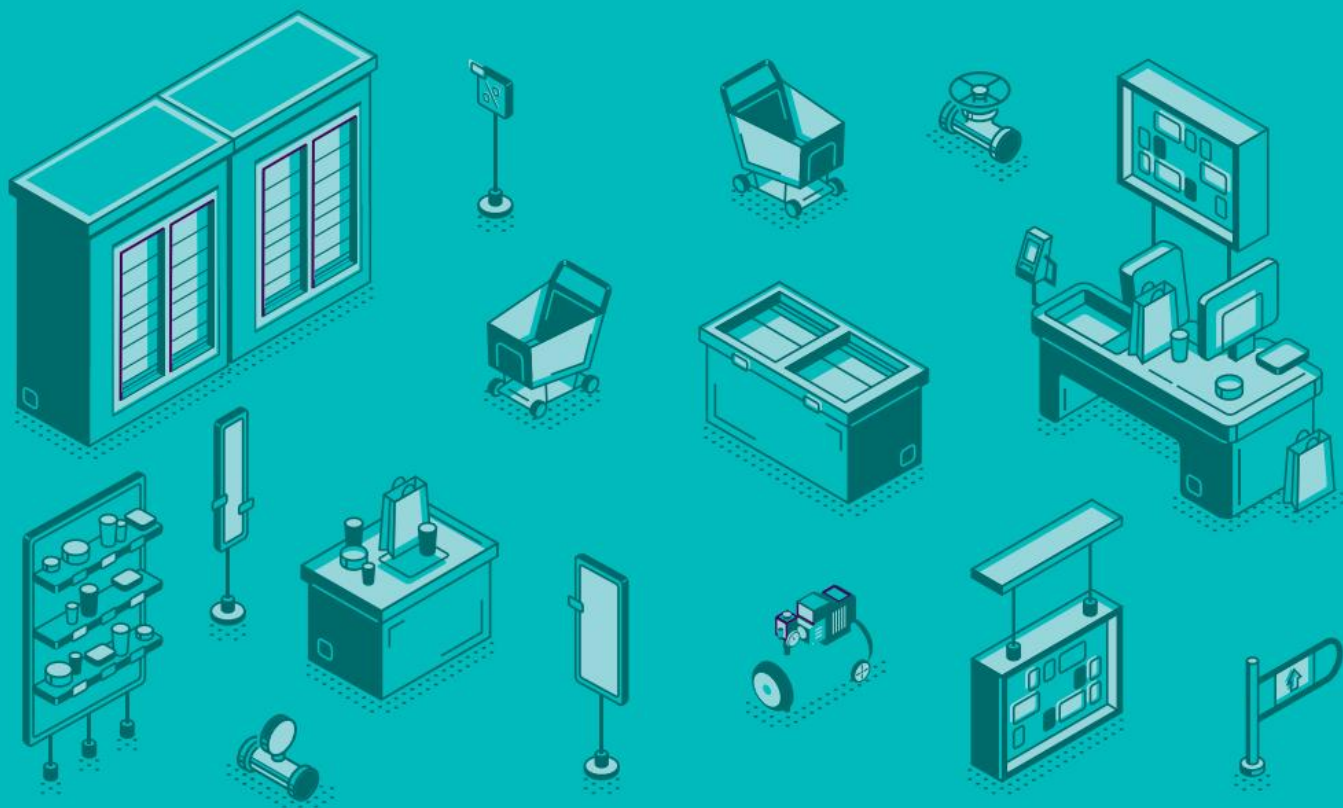
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# Ammonia/CO<sub>2</sub>





# Raley's Unorthodox Ammonia/CO<sub>2</sub> System

Installed at its first Raley's supermarket, the system is the California chain's answer to impending state regulations capping the GWP of refrigerant at 150.

— By Michael Garry



Ed Estberg, Raley's

**O**n April 15, Raley's, an 85-year-old California (U.S.) food retailer, opened a 55,000ft<sup>2</sup> (5,109.7m<sup>2</sup>) store in a Sacramento shopping center featuring the chain's first ammonia (NH<sub>3</sub>)/CO<sub>2</sub> refrigeration system. The store became only the fifth supermarket in the U.S. to employ such a system.

For the most part, supermarkets in the U.S. and around the world have avoided using ammonia, despite its zero GWP and high thermodynamic efficiency. That's because of its potential for toxicity and its pungent odor, as well as the high cost of ammonia systems relative to conventional supermarket refrigeration.

But supermarkets in California face a challenge that other U.S. states don't: the expectation that the California Air Resources Board (CARB) will, by 2022, begin mandating a 150-GWP cap in new stationary refrigeration systems with more than 50lbs of refrigerant. As a result, many retailers in California have installed natural refrigerant systems, including trans-critical CO<sub>2</sub> and ammonia/CO<sub>2</sub>.

Three of the five U.S. ammonia/CO<sub>2</sub> stores are in California: Raley's in Sacramento, a Whole Foods Market outlet in Dublin, and an Albertsons store in Carpinteria. (The other two are a Piggly Wiggly store in Columbus, Georgia; and a U.S. Defense Commissary Agency outlet in San Antonio, Texas.)

Ed Estberg, a refrigeration consultant to Raley's who was previously the 130-store chain's longtime senior director of facilities, persuaded the chain's ownership

that, given the impending 150-GWP cap, Raley's "really [doesn't] have a choice" but to invest in natural refrigerant-based technology for future stores, he explained last year at the IIR Natural Refrigeration Conference and Expo. (See "[Should Grocers Fear Ammonia](#)," *Accelerate America*, April-May 2019.)

The ammonia/CO<sub>2</sub> system that Raley's selected for its initial installation is different from those used by the other four U.S. stores in several respects. One is the way CO<sub>2</sub> is employed. While the other stores use a cascade system that includes CO<sub>2</sub> compressors for low-temperature cases, Raley's has opted for a CO<sub>2</sub> compressor-free, pumped liquid-overfeed system. (Raley's and the other systems all use pumped overfeed for medium-temperature cases.)

One reason for that choice is that liquid overfeed is "more efficient" than cascade, said Estberg. Another is that Raley's technicians and service companies are already familiar with the open-drive Carlyle compressors and two-stage system used on the ammonia side, but not with CO<sub>2</sub> compressors. So eliminating the latter from the equation made their life simpler.

Raley's ammonia/CO<sub>2</sub> system is also different in that it delivers cooling for air conditioning as well as refrigeration, and leverages heat reclaim for space heating and domestic hot water in the store. The total load of the system is 1.8 million BTUH (150TR/527.5kW), including 190k BTUH for low-temperature cases, 1.1million BTUH for medium-temperature cases, and 480k BTUH for air conditioning. Suction temperatures are -20°F/-28.9°C (low temperature) and 20°F/-6.7°C (medium temperature and air conditioning).

## DEALING WITH COST AND SAFETY

How does Raley's deal with the twin impediments to ammonia/CO<sub>2</sub> systems: cost and ammonia safety?

Ammonia/CO<sub>2</sub> systems typically cost 150% more than conventional DX supermarket systems, said former refrigerant consultant Keilly Witman last year at the IAR Natural Refrigeration Conference & Expo. (She is now Director of Refrigerant Management and Sustainability for Texas food retailer H-E-B.)

But Raley's estimated that the ammonia/CO<sub>2</sub> system would have a cost premium of about \$300,000, or 15%, more than the baseline system. He now believes this estimate is close to the actual cost premium, though he does not have access to the final numbers.

Raley's cost for its first ammonia/CO<sub>2</sub> system was reduced by a \$250,000 incentive it received from the Sacramento Municipal Utility District (SMUD) for both energy efficiency and the use of natural refrigerants. "It was just for the first store," said Estberg. "We really have to make it cost competitive and efficient" for future stores. (See, "[Game Changer](#)," *Accelerate America*, May 2017.)

Raley's is already designing its next ammonia/CO<sub>2</sub> system for a new store in Roseville, California. The system could be installed in an existing store but "it would have to be a very major remodel," Estberg said. While ammonia/CO<sub>2</sub> is Raley's preferred natural refrigerant system, the chain would consider using a transcritical CO<sub>2</sub> system in a store with a cooling load of under 800,000BTUs/hr (66.7TR/234.6kW), he added.

With regard to safety, the ammonia/CO<sub>2</sub> system adheres to California's mechanical and fire codes, and drew no challenges from Sacramento fire marshals, noted Estberg.

The safety of the system is a function of its very low ammonia charge (135lbs/61.2kgs) and its confinement to the machine room. (The CO<sub>2</sub> charge consists of 1,000lbs/453.6kgs on the low-temperature side and 2,600lbs/1,179.3kgs on the medium-temperature side.)

Ammonia compressors







The machine room, located on the top (third) floor of the building, is exposed to the outside and connected by a stairwell to the inside. "You have to go through a boiler room, an electrical room and four doors before you get to the inside," explained Estberg.

To date, there have been no ammonia leaks, but in the event of a leak, an exhaust system in the machine room removes the gas to the outside. Estberg's biggest concern about safety is having enough trained technicians who know how to deal with it. Raley's third-party maintenance company, PMC Southwest (a division of the Arcticom Group), which also built the system, "has done a good job," he said, but only one or two technicians are fully trained on the system.

The CO<sub>2</sub> side of the system requires technician training as well. In fact, it has presented far greater challenges than the ammonia side, noted Estberg. The store experienced a failed CO<sub>2</sub> pressure relief valve, which "dumped the medium-temperature CO<sub>2</sub> charge," he said. PMC Southwest technicians had to replace the valve and recharge the system overnight; there was "some loss" of product.

## HOW IT WORKS

Raley's machine room contains the ammonia/CO<sub>2</sub> system's Carlyle open-drive ammonia compressors as well as two CO<sub>2</sub> "overfeed racks" supplied by Zero Zone. These racks condense CO<sub>2</sub> gas coming (with some liquid) from the low-temperature and medium-temperature display cases in the store, and pumps liquid CO<sub>2</sub> back to the cases.

The overfeed rack includes: a horizontal tank holding liquid and gaseous CO<sub>2</sub>; pumps that convey the liquid CO<sub>2</sub> to the display cases; and a thermosyphon condenser (a plate heat exchanger) located above the tank.

The thermosyphon condenser sucks up the CO<sub>2</sub> gas from the holding tank; at the same time, liquid ammonia from the ammonia circuit cools the condenser plates, condensing the CO<sub>2</sub> gas to liquid, which drops into the tank for delivery to the cases.

The design of this overfeed rack is unusual for the supermarket industry, Estberg noted.

On the ammonia side, the hot discharged NH<sub>3</sub> gas is condensed in a plate heat exchanger, using water circulating in a BAC water tower and a Heatcraft air fluid cooler. Depending on ambient conditions, fans either run on the tower or the fluid cooler. Estberg calls this arrangement a "dual-medium condensing system" (DMCS), which uses either water evaporation or air to reject heat from the ammonia gas to the atmosphere. "We only evaporate water when we have to," said Estberg. "That saves us 5,000 gallons per day compared to an evaporative condenser."

Over its first four months of operation, the ammonia/CO<sub>2</sub> system is "doing fine," said Estberg. "All of our theories work – it does what it's supposed to do."

He has identified three issues that are being addressed and will be "engineered out of the next one":

- ▶ The lines in the water tower are being expanded.
- ▶ Oil return from the thermosyphon condenser is being adjusted.
- ▶ Connections for noncondensables (such as air) in the ammonia circuit are being added.

## EFFICIENCY COMPARISON

Raley's has not yet compared the efficiency of the ammonia/CO<sub>2</sub> system to that of its baseline direct-drive system, which uses R449A. (About a dozen Raley's stores use this system.) Estberg estimates that, despite the inherent efficiency of ammonia, the ammonia/CO<sub>2</sub> system will be "a little less efficient" than the baseline. He attributes that to the extra horsepower required to pump the liquid CO<sub>2</sub> to and from store cases, and to the additional heat exchange between the CO<sub>2</sub> and the ammonia.

To measure the efficiency of Raley's refrigeration systems, Estberg has developed an EER (energy efficiency ratio) methodology. (See ["How to Determine the Efficiency of Your Refrigeration System," Accelerate America](#), June-July 2018.)

Estberg has been "fine-tuning" the EER scheme at the new stores that employ the baseline system. Over





Water tower/air fluid cooler

CO<sub>2</sub> overfeed rack

### SYSTEM SPECS:

The ammonia/CO<sub>2</sub> system at Raley's Sacramento, California, store has the following specifications:

- ▶ Capacity: 190k BTUH for low-temperature cases, 1.1 million BTUH for medium-temperature cases, and 480k BTUH for air conditioning
- ▶ Suction temperatures: -20°F/-28.9°C (low temperature) and 20°F/-6.7°C (medium temperature and air conditioning).
- ▶ Ammonia charge: 135lbs (61.2kgs)
- ▶ CO<sub>2</sub> charge: 1,000lbs (453.6kgs) for low temperature; 2,600lbs (1,179.3kgs) for medium temperature
- ▶ Carlyle open-drive compressors (four high-stage, two low-stage)
- ▶ Zero Zone CO<sub>2</sub> overfeed racks (two)
- ▶ BAC water tower
- ▶ Heatcraft air fluid cooler
- ▶ Emerson/CPC controls
- ▶ Hussmann cases
- ▶ Howe recirculated CO<sub>2</sub> ice machine, 1,000lbs of ice/day

the next six month, he will compare the EER of the ammonia/CO<sub>2</sub> system to that of the baseline system in those stores.

When Raley's assesses the efficiency of refrigeration, it looks at not only energy consumption, but also water and natural gas consumption. "When people say 'efficiency,' they talk about just electricity; we don't do that," said Estberg. "We talk in terms of utilities."

The heat reclaim from the ammonia discharge gas is expected to substantially lower gas costs to heat the store, and "may offset some of the inefficiency on the electricity side," noted Estberg, adding that the DMCS system will save water compared to stores that don't use it.

Raley's plans to study heat reclaim at the store as the chain prepares for California's ban on the use of natural gas by 2025. One scenario would be to run the air handler 24 hours per day so that "the heat from the refrigeration system will completely heat the store," Estberg said.

Estberg estimates the savings from all three utilities, compared to the baseline system, will be \$35,000 per year, adding, "That's my goal." (Annual maintenance costs are yet to be determined.) If the store achieves a utilities saving of \$35,000 per year, the payback period (ROI) on the estimated \$300,000 cost premium would be 8.6 years on a system expected to last 15 to 20 years.

■ MG





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# Ammonia/CO<sub>2</sub>/Glycol System Saves Belgian Store Up To 42% on Energy Bill

A family-owned Delhaize supermarket chooses unusual natural refrigeration system rather than CO<sub>2</sub>.

By Zita Laumen

“

*It is user friendly and economical in terms of [energy] consumption.*

– Luc Bormans, Delhaize

”

**D**elhaize store owner Luc Bormans in 2018 joined a select group of food retailers by installing an ammonia(NH<sub>3</sub>)/CO<sub>2</sub>/glycol system at a new store in Rhisnes, Wallonia (Belgium), rather than a far more commonly used transcritical CO<sub>2</sub> system.

In its first year, the ammonia/CO<sub>2</sub>/glycol system saved Bormans a considerable amount of money in energy consumption. At his 800m<sup>2</sup> (8,611ft<sup>2</sup>) Rhisnes store Bormans was able to reduce his overall annual electrical energy consumption from 500-600kWh/m<sup>2</sup> (46-56kWh/ft<sup>2</sup>), which is typical for similar stores using f-gases, to a maximum of 350kWh/m<sup>2</sup> (32kWh/ft<sup>2</sup>), a savings of up to 42%. This was largely thanks to the natural refrigeration system, insulating the building and pipes, and installing LED lighting, as well as rotating doors and efficient isothermal rooms.

The significant energy savings means that he will be able to recoup the premium paid for the complete ammonia system (including various refurbishment work) compared to a transcritical CO<sub>2</sub> system in four years – and just 2.5 years for the central refrigeration equipment.

Last month, Bormans reported that he continues to be happy with the system. “It is user friendly and economical in terms of [energy] consumption,” he said. He is currently undertaking a comparative study with other CO<sub>2</sub> systems “to work out the real positive impact on energy consumption.” He expected the study to be completed at the end of October.

Because it uses ammonia (though not inside the store), ammonia/CO<sub>2</sub>/glycol or ammonia/CO<sub>2</sub> systems are rarely used around the world, despite their considerable energy savings and excellent safety and performance record.

The Bormans family has an “affiliated” status with Delhaize (part of the Ahold Delhaize Group) but is otherwise entirely independent. As such, they could select an ammonia/CO<sub>2</sub>/glycol system for their new store. Bormans’ two other Delhaize stores rely on f-gas refrigerants.

According to Bormans, his motivation for opting for this system was based on three key factors: “Firstly, we wanted a refrigerant that was neutral in terms of CO<sub>2</sub> emissions,” he explained. “Then came the safety aspect and the energy savings.”

## Multiple suppliers

Each segment of the ammonia/CO<sub>2</sub>/glycol system had a different supplier. French manufacturer Engie Axima built the ammonia circuit (and installed the entire refrigeration system). Profroid (a division of Carrier) manufactured the CO<sub>2</sub> circuit, while Georg Fischer supplied the glycol equipment.

Ammonia is the high-side refrigerant, confined to the plant room. Glycol is used to cool medium-temperature cases, while CO<sub>2</sub> serves low-temperature cases. Heat is recovered from the condensers.





Part of the ammonia refrigeration rack used by the ammonia/CO<sub>2</sub>/glycol system in a Delhaize store in Belgium

A total of 40kg (88.2lbs) of ammonia is used to achieve a total cooling capacity of 110kW (31.3TR), yielding a specific ammonia charge of 364g/kW (2.9lbs/TR).

The pressure in the plant room is limited to 8-10 bar and the store itself to 1-1.5 bar. The CO<sub>2</sub> system works in subcritical mode with a maximum pressure of 30 bar.

Bormans considers the system to be safe because the ammonia is confined to the machine room and any leakage would result in an odor, making it easy to detect. Additionally, the installer Engie Axima gave him a 10-year guarantee that the system will remain leak-free.

Engie Axima is responsible for the project's overall maintenance, with a focus on ammonia safety. The company offers both internal and external training on the safe handling of ammonia.

It regularly does safety trainings with the Antwerp, Belgium fire brigade.

Nonetheless, "there are no additional labor costs for the maintenance of ammonia compared to other HFC installations," said Dominique Kötting, Manager Division Smart Solutions at Engie Axima.

■ MG

## Ammonia/CO<sub>2</sub> in Retail

Ammonia/CO<sub>2</sub> refrigeration systems (with or without glycol) are rare in the food retail industry, with only a handful installed in stores around the world.

In Europe, Luc Bormans' Delhaize ammonia/CO<sub>2</sub>/glycol installation in 2018 marked the third one of its kind for Engie Axima (all are medium-sized Delhaize stores). In Australia there was only one known NH<sub>3</sub>/CO<sub>2</sub> installation – a supermarket in Western Sydney that was later retrofitted with a transcritical CO<sub>2</sub> system. In South Africa, there are three stores known to use this technology.

In the U.S., five supermarkets employ an ammonia/CO<sub>2</sub> system: an Albertsons in Carpinteria, California; a Piggly Wiggly (owned by JTM Corp.) in Columbus, Georgia; a Whole Foods Market in Dublin, California; a Defense Commissary Agency (DeCA) unit in San Antonio, Texas at the Lackland Air Force Base; and a Raley's store in Sacramento, California. ([see page 57](#)).

At the 2019 International Institute of Ammonia Refrigeration (IIAR) Natural Refrigeration Conference and Expo, executives who have worked on four of the five U.S. installations of ammonia/CO<sub>2</sub> said that the relatively small amount of ammonia used in these systems should not pose a safety concern. However, the initial cost of the system remains high. (See "[Should Grocers Fear Ammonia?](#)" *Accelerate America*, April-May 2019.)







# Migros Ticino's First 'Total Energy' CO<sub>2</sub> System Meeting Expectations

Working with Biagini Frigoriferi, the Swiss retailer has deployed an integrated transcritical system that is using 25% less energy than similar CO<sub>2</sub> systems.

— By Tine Stausholm

**M**igros Ticino, a cooperative that is part of Swiss retail giant Migros, has been at the forefront of the CO<sub>2</sub> revolution in HVAC&R since 2009, when it installed its first transcritical CO<sub>2</sub> system.

Last year, the company, which operates 33 grocery stores among other businesses, took its commitment to natural refrigerants one step further and installed its first fully integrated CO<sub>2</sub> system at a store in Riazano, Switzerland, in the Italian-speaking section of the country.

Opened on February 28, 2019, the store is Migros Ticino's 21st to employ a transcritical CO<sub>2</sub> system; Migros Ticino is aiming to have all of its stores converted to CO<sub>2</sub> refrigeration by 2025. (Migros as a whole has 302 transcritical CO<sub>2</sub> stores; it operates about 700 stores, divided into 10 cooperatives.)

The system provides for the store's refrigeration, winter space heating and summer air-conditioning requirements. Migros Ticino has dubbed this a "total energy" system.

The system's transcritical CO<sub>2</sub> compressor rack has subcooling, heat pump and chiller sections, and works with two separate water tanks providing the secondary fluid for the HVAC requirements. In two other Migros stores, Biagini Frigoriferi has installed a compressor rack with a heat pump but not a chiller.

The integrated CO<sub>2</sub> system was conceived, designed and installed by Biagini Frigoriferi, a 92-year-old OEM based in Cadenazzo, Switzerland. Eliwell by Schneider Electronic supplied the electronics and management software for the system, and Dorin the CO<sub>2</sub> compressors.

"Our plant has to satisfy at the same time the refrigeration and the HVAC requirements of the store," said Luca Rossi, a project manager with Biagini Frigoriferi.

Asked last year about his overall impression of the system, Andrea Skory, technical manager, Migros Ticino, said that it was "optimal" and had "reliable operation."

Rossi recently reported that the system "is running properly and better than the first year, because we have optimized some parameters. It never breaks down."

Rossi said the system has been tested down to -5°C (23°F) in winter and up to 42°C (107.6°F) in late June, meeting the store's needs in all conditions, according to Rossi.

## Auxiliary compressors

The Riazino store has 1,200 m<sup>2</sup> (12,917ft<sup>2</sup>) of sales area with 50m (164ft) of 2°C/4°C (35.6°F/39.2°F) medium-temperature cabinets and 20m (66ft) of -22°C (-7.6°F) low-temperature cabinets. The location also has 500m<sup>2</sup> (5,382ft<sup>2</sup>) of warehouse space, offices and technical rooms, including three medium-temperature and one low-temperature cold rooms.

The system has the following capacities: 60kW (17.1TR) for medium-temperature cases, 15kW (4.3TR) for low-temperature cases, 55kW (15.6TR) for the heat pump, and 70kW (19.9TR) for the chiller.

Rossi noted that the heat pump and chillers use some of the same devices as the rack, such as a receiver and oil separator. Two auxiliary compressors are dedicated to the heat pump in the winter and the chiller in the summer, making the switch via a bypass system with automatic three-way valves. Two high-pressure CO<sub>2</sub> expansion valves (84 bar in the winter and 94 bar in the summer) are used with the heat pump's external air evaporator and the chiller's plate evaporator.

The heat pump's water temperature reaches 45°C (113°F) in the winter while the chiller's water is 10°C (50°F) in the summer. He added that the chiller can also offer heat recovery, thereby providing heating and cooling at the same time. "The store is heated and cooled by fan coils that use the water from the water tanks," said Rossi.

Floating evaporation, which can improve the efficiency of the heat pump and chiller "a lot," depends on the external air temperature and on the set points in the water tanks, he said.

An unusual feature of the system is that the heat pump's external evaporator is integrated into the frame holding the gas cooler in a configuration custom-built for Migros Ticino by LU-VE. The evaporator is thereby able to leverage the horizontal airflow warmed by the gas cooler for defrost, in what Rossi described as "a free defrosting cycle."



From left: Luca Rossi, Biaggini Frigoriferi; and Andrea Skory, Migros Ticino

## Free subcooling

The subcooling section of the rack, which optimizes the system in warm ambient temperatures, is capable of cooling down the outlet CO<sub>2</sub> mass flow from the gas cooler by more than 10°C, without any additional energy consumption. In late June, when the temperature out of the gas cooler was 40.2°C (104.4°F), the temperature out of subcooling was 27°C (80.6°F).

Migros and Biaggini Frigoriferi declined to expand on how exactly this "free" subcooling is achieved, but Rossi stated that it was made possible by combining "the chiller working with the booster." He recently said that the free cooling feature is working "maybe better than expectations."

Thanks to these subcooling capabilities, the system runs on only two compressors (out of four installed) for medium-temperature cases in the summer, Rossi said.

Migros Ticino uses the annual consumption per linear meter of refrigerators as its parameter to compare energy efficiency between shops and different systems. Last year, Skory expected that with the free subcooling, "the annual energy

consumption will be certainly lower than the other installations." Migros Ticino recently informed Rossi that the system had energy consumption, during its first 12 working months, 25% lower than that of similar CO<sub>2</sub> systems in the region.

As for the capital cost of the system, Rossi said it was lower than comparable refrigeration and HVAC systems.

Rossi observed that the integrated system is "the first kind" installed for Migros Ticino with "new advanced solutions," such as the high-pressure expansion valves for the auxiliary compressors and the subcooling section. He also acknowledged the "unusual" design of the gas cooler coupled with the external evaporator.

Pleased with the success of its initial total energy system, Migros Ticino plans to install it in projects planned for 2021, said Rossi, who added that the system has become the retailer's "new standard."

Biaggini Frigoriferi has also started installing for Migros Ticino a large CO<sub>2</sub> air-conditioning system, expected to be ready by March-April 2021. ■ TS





Migros Ticino store in Riazzino, Switzerland

### System Specs

The Migros Ticino store in Riazzino, Switzerland, uses a transcritical CO<sub>2</sub>/heat pump/chiller system with the following specifications:

**Medium-temperature capacity (four compressors):** 60 kW (17.1 TR)

**Low-temperature capacity (three compressors):** 15 kW (4.3 TR)

**Heat pump capacity:** 55 kW (15.6 TR)

**Chiller capacity:** 70 kW (19.9 TR)

**Medium temperature in cabinets and cold rooms:** 2°C/4°C (35.6°F/39.2°F)

**Low temperature (in cabinets and cold rooms):** -22°C (-7.6°F)

**Heat pump temperature:** 45°C (113°F)

**Chiller temperature:** 10°C (50°F)

**OEM:** Biagini Frigoriferi

**Compressors:** Dorin

**Electronics and management software:** Eliwell by Schneider Electric

**Gas cooler/external evaporator:** LU-VE



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# Italian Supermarket Increases Efficiency of Transcritical CO<sub>2</sub> System with Groundwater

The groundwater condenses CO<sub>2</sub>, allowing the integrated system to run subcritically during the summer, says OEM Crea.

— By Tine Stausholm

**An** Italian supermarket chain is using groundwater as a cooling fluid to condense the CO<sub>2</sub> in a transcritical system at a remodeled store in Milan, according to Italian OEM Crea, the system provider.

This allows the integrated system to run subcritically in the warm summer months, and reduces the electricity consumption of the compressors, said Crea.

The groundwater used as a cooling fluid in the system is 15-20°C (59-68°F) year round. This allowed Crea to set a 25°C (77°F) condensing temperature in the system, using a plate heat exchanger.

The use of groundwater, instead of air, to condense the CO<sub>2</sub>, allows the system to run in subcritical mode even during the hottest summer months when the ambient air temperature is 27-28°C (80.6-82.4°F) or more, Crea said.

The 400m<sup>2</sup> (4,306ft<sup>2</sup>) remodeled store was officially reopened in December 2019, after a two-month refurbishment period. Crea did not name the retailer.

Since the reopening, the system has not shown “any kind of issues and it’s working well,” said Emiliano Testa, technical engineer, Crea. “We and our retailer are very satisfied with this solution.”

## COP of 4.2

In the winter months the system is designed to run in transcritical mode to satisfy the supermarket’s need for hot water and space heating. To gain the needed heat, the system employs heat recovery, which can recover up to 42kW in the winter, equaling “total” heat recovery, and increasing the system’s COP to 4.2, according to Stefano Tortorici, Technical Engineer at Crea.

Crea experienced several challenges in designing the system, including limited space and local noise-level requirements. The store is located in a building in the historical center of Milan, near the Milan Cathedral, with a narrow technical room in the basement.

The narrow space issue was solved via integration of air conditioning in the main rack. The high-temperature compressor



The technical room in the Milan store

used for air conditioning also doubles as a parallel compressor, disposing of flash gas accumulated in the receiver.

The capacity of the Milan system is 30kW (8.5TR) for medium temperature, 6kW (1.7TR) for low temperature and 40kW (11.4TR) for high temperature (air conditioning). The system contains six Frascold compressors, three medium temperature, two low temperature and one high temperature. It has three Alfa Laval plate heat exchangers for the heat recovery, condenser and air conditioning. It also has a liquid receiver and Carel controls.

Crea declined to comment on the cost or ROI of the system compared to an HFC system, saying that the client for whom the project was designed has worked with natural refrigerants for several years, and that a HFC system was never considered for this store. ■ TS



# Australian Retailer Lauds Carbon Footprint of Integrated CO<sub>2</sub> System

Michael's SUPA IGA store's transcritical CO<sub>2</sub> HVAC&R system is seen as more efficient than R404A systems.

— By Ilana Koegelenberg and Michael Garry

**A** year-old remodeled Michael's SUPA IGA store in Keysborough, Victoria, Australia, with a fully integrated transcritical CO<sub>2</sub> HVAC&R system, is "certainly more efficient" than the retailer's other sites running conventional R404A systems.

So said Domenic D'Agostino, Operations Manager at Michaels/Fairleys Supa IGA Stores, a group of five independent supermarkets (and a liquor store) near Melbourne, in a recent update on the progress of the store.

The remodeling was completed in November 2019, and is the retailer's first transition from traditional refrigerants to CO<sub>2</sub> in an existing store.

The 3,500m<sup>2</sup> (37,673.7ft<sup>2</sup>) Keysborough store has been designed to maximize efficiency with all-LED lighting and all of its dairy and meat cases behind glass doors.

D'Agostino is waiting for a full year of operation, and for the HVAC part of the system to be optimized, before coming to any final conclusions and the HVAC&R system's performance. But he is certain about its beneficial environmental impact.

"The thing that is best is the carbon footprint, and how much better the CO<sub>2</sub> is for the environment," he said. "You cannot put a price on that aspect."

## 90 refrigeration points

The HVAC&R system consists of two CO<sub>2</sub> transcritical racks – manufactured by South African OEM Sphere – that feed 90 refrigeration points as well as a two-metric-ton ice flaker.

And in addition to refrigeration, the fully integrated system includes space heating, domestic hot water and air conditioning.

The capacities of the racks are as follows:

- Low temperature: 19.86kW (95.65TR) at -33°C (-27°F) and 20.68kW (5.89TR) at -26°C (-14.8°F)
- Medium temperature capacity: 85.39kW (24.28TR) at -8°C (18°F) and 78.48kW (22.32TR) at -6°C (21°F)

Work on the started in July of 2018 and was completed on November 22, 2019, according to Quintan Naude, Project Manager at MB Refrigeration (part of the

MB Group), which handled the design and installation of the refrigeration system.

The retailer specified natural refrigerants, according to Naude. "They invested in the future of the planet by promoting a lower carbon footprint."

The size of the store made it difficult to coordinate all the elements. "The most difficult obstacle was our piping route that clashed with mechanical ducting and underground services," Naude explained. "This was resolved by good communication skills with relevant parties on site by means of detailed drawings and landscape surveyors."

D'Agostino acknowledged dealing with "a few minor issues" – a faulty CO<sub>2</sub> sensor, some high temperature issues during the commissioning stage, and some freezing issues around the case coils. "Nothing too out of the ordinary in the scheme of things for a project of this size."

D'Agostino noted that for him, getting familiar with, and training others to use, the Carel controller "has probably been the biggest challenge," as he is accustomed to using a Danfoss system.

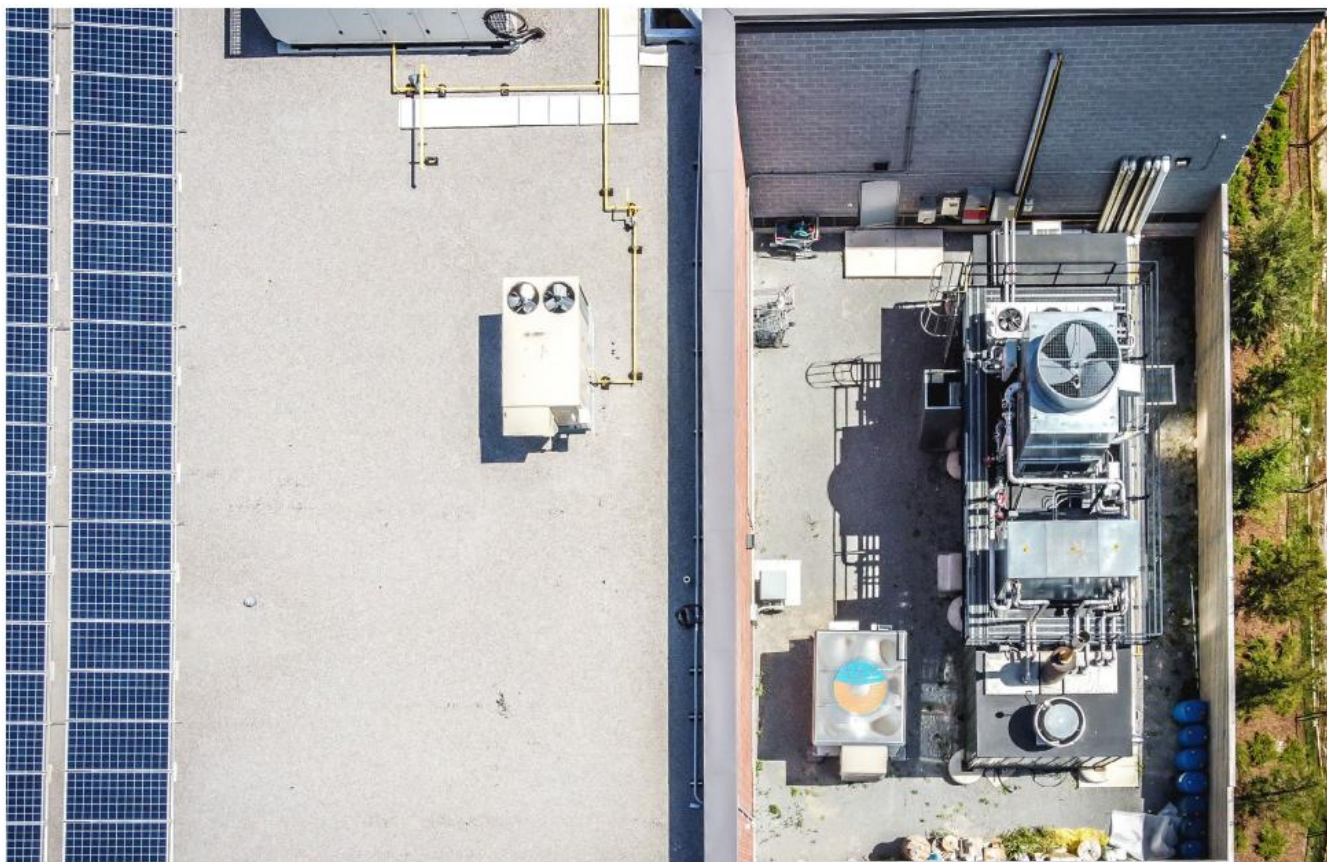
■ IK & MG



Transcritical CO<sub>2</sub> system at Michael's SUPA IGA store in Keysborough, Victoria.







# After Two Years, Longo's Store Heads Towards Net-Zero Energy

The Canadian supermarket, which uses transcritical CO<sub>2</sub> refrigeration and an absorption chiller, has cut its reliance on the grid by 70%.

— By Michael Garry

Longo's installed 235kW solar panels on the roof of its Stouffville, Ontario, store





**L**ongo Brothers Fruit Markets (aka Longo's), a 36-store food retailer serving the greater Toronto area in Ontario, Canada, has gained a reputation for its environmentally friendly practices; these include installing transcritical CO<sub>2</sub> refrigeration systems in 13 stores, being the first Canadian grocer to employ a solar energy and CCHP (combined cooling, heating and power) system tied to the hydropower grid, and offering electric vehicle charging stations

In November 2018, the chain went to the next level by opening what it called Canada's first "near net-zero energy supermarket" in Stouffville, Ontario. The 40,000ft<sup>2</sup> (3,716m<sup>2</sup>) store was designed to use 35% less energy than the average supermarket of that size, produce 65% of its own energy, and cut CO<sub>2</sub>e emissions by 1,500-2,000 metric tons per year (the equivalent of taking 274 to 366 cars off the road annually).

The Stouffville store is one of the few supermarkets in the world aspiring to be net-zero in energy production, which is especially challenging in Canada, given its climate and geography.

"This first-in-Canada project is a visible way for us to contribute to solving climate change," said Anthony Longo, President and CEO of Longo's, when the store opened in 2018. "It will also establish a new benchmark for the performance of future supermarkets in Canada and elsewhere."

"We set our goals high because the stakes are high and we must reduce our environmental impact," recently added Dave Mastroieni, Vice President, Procurement & Facilities for Longo's. "Our team is focused on creating a culture that supports sustainable practices throughout our company and in our stores."

To achieve near net-zero status, the Stouffville store has been equipped with leading-edge technologies. In addition to a transcritical CO<sub>2</sub> system with heat reclaim (which by itself cuts an estimated 1,333 metric tons of CO<sub>2</sub>e), the store employs a CCHP system (which includes an absorption chiller) and LED lighting. Longo's enhanced the thermal efficiency by incorporating window glazing and best-in-class insulation while avoiding thermal bridging.

The store has also installed 235kW solar panels on the roof, and additional 39kW on a carport and 12kW on the building façade. It is also in the process of hooking up a 100kW lithium-ion storage battery.

Air conditioning is supplied via an air handler and Lennox AC unit using R410A. The store supports four electric-vehicle charging stations.

To ensure that its opening months went smoothly, the Stouffville store gradually rolled out its energy-generation elements, starting with the solar panels in March 2019, followed by the CCHP system in May of that year. Battery storage was installed in March 2020, and its connection, delayed by the COVID-19 pandemic, is expected to be completed by the end of the year.

The total cost of the store is about 25% more than a typical location. However, given the store's complexities and unknowns as the first project its kind, Longo's expects future near-net-zero stores to cost less. Natural Resources Canada, Canada's environmental agency, helped finance this project with a CA\$1.995 million (US\$1.5 million) grant.

Neelands Group helped develop the net-zero strategy.  
LED lighting is used throughout the store







### Progress report

Almost two years after its opening, has the Stouffville store met expectations?

To find out, *Accelerate* recently spoke to Ady Vyas, Vice President of Energy and Digital Services for Neelands Group, the Burlington, Ontario-based contractor responsible for installing and maintaining the cooling, heating and control systems in the store. He joined Neelands in April, having previously worked for s2e Technologies, which, under his direction, partnered with Neelands Group on the net-zero development and supplied its solar photovoltaics.

"Longo's could not have done this without a partner like Neelands Group, who have a shared vision of a sustainable future, and have guided us from the spark of this idea to the development of the store, and continue to analyze and optimize our operations," said Mastroieni.

A "closet environmentalist who drives a Tesla," Vyas pointed out that grocery stores have some of the highest EUI (energy use intensity) values among commercial buildings, and hence generate higher levels of GHG emissions.

A large portion of those emissions come from the refrigeration system, which led Longo's to install the climate-friendly transcritical CO<sub>2</sub> refrigeration system. Manufactured by Hillphoenix, it employs two racks and delivers a cooling capacity of 123TR (432.9kW), with a low temperature of -25°F (-32°C) and a medium temperature of 19°F (-7.2°C). The waste heat from the system contributes to space heating and domestic hot water, along with heat from the CCHP system.

The CCHP system, via the absorption chiller, also delivers chilled glycol to the refrigeration system to assist in condensing CO<sub>2</sub> gas and preventing the CO<sub>2</sub> system from entering less-efficient transcritical mode during the summer. Heat from the CCHP system drives the absorption chiller. "With this integration, you are able to not run the CO<sub>2</sub> system in transcritical mode as long," said Vyas. "You should be able to deploy it anywhere."

Whereas a typical transcritical CO<sub>2</sub> system might enter transcritical mode about 15% of the time in a northern climate, resulting in higher energy consumption, the Stouffville store's CO<sub>2</sub> system enters transcritical mode far less. As a result it uses 65% less power in the summer months, said Tom Quaglia, Senior Construction Manager at Neelands Group.

The transcritical system's integrated, holistic design, utilizing free cooling from the absorption chiller, is what separates it from other transcritical CO<sub>2</sub> systems, Vyas said. "There are stores that have individually used solar, CCHP and transcritical CO<sub>2</sub>. What makes this unique is that it's the integration of all of those systems."

The store's use of solar, CCHP and waste heat has enabled it to reduce its energy consumption compared to a typical store. For example, natural gas is used in the CCHP system as well as to support prepared-food kitchens. However, with the application of waste heat from the refrigeration system and CCHP, the store has cut its gas usage by 50%, said Vyas.

In electricity usage, the store consumes about 1.9 million kWh per year, or 10% less than a typical store, while reducing reliance on the grid by 70%. Onsite power generation has helped cut demand charges at the Stouffville store by "at least 40%," said Vyas. He expects them to be reduced by another 10% when the battery is connected.



Combining electricity and gas, “we have seen a reduction in energy consumption by about 20%, resulting in a net cost savings of 40%, or more than \$100,000 annually, compared to an average grocery store, said Mastroieni. This could result in a return on investment on the store’s cost premium in a little over 6 years, noted Vyas.

Regulations in Ontario prevent the store from exporting excess solar energy to the grid when a natural gas-powered electricity source (in this case the CCHP) is also used, but that energy will be stored in the lithium-ion battery. The percentage of energy derived from solar could be up to 100% were it not for the grid regulation, Vyas said.

The Longo’s store employs software called Kalder – developed by Neelands – to monitor energy consumption and equipment performance. “It looks at the compressor to make sure it’s not running too hard,” explained Vyas. The system can also modulate temperature set point to take advantage of times when more energy is available than can be stored in the battery – what is, effectively, “free energy,” he said.

### Overcoming the status quo

Vyas contends that from a technology perspective, net-zero stores are possible, and future stores may include wind turbines on site, and geothermal energy if the location supports it.

The challenge comes from regulatory barriers as well as a change-averse retail mindset that prefers maintaining the status quo and eschews paying 20% more than usual for energy-saving systems. Most retailers insist that their business is “groceries, not energy,” he noted. “But everybody’s business is energy, so let me show you how to [save energy] and make more money.”

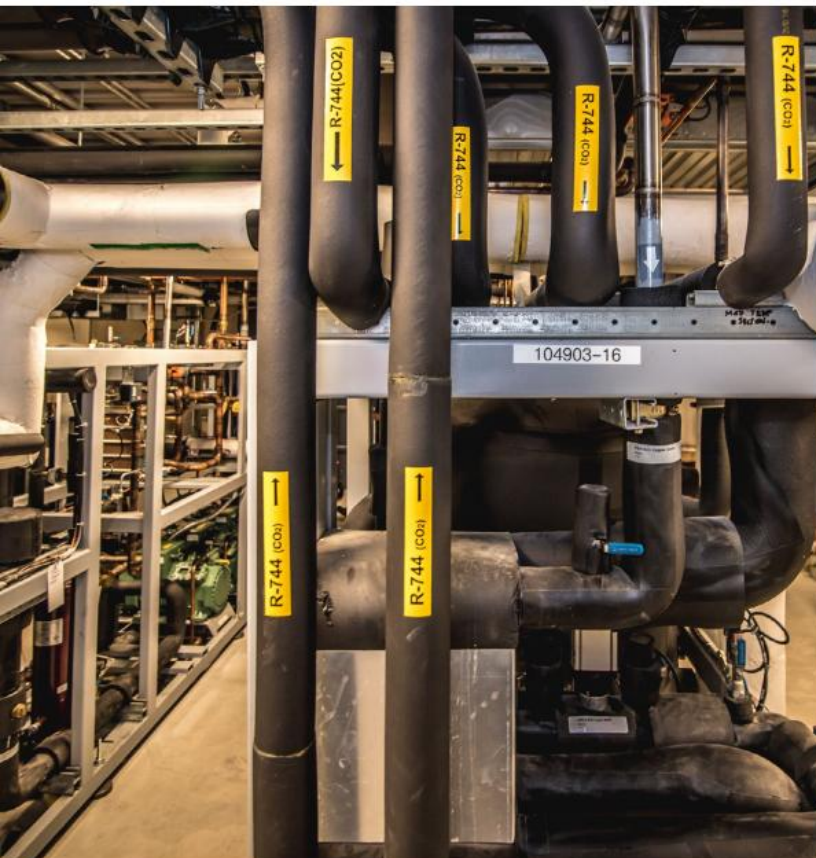
Some retailers may be open to energy-saving projects, but insist on an unrealistically short two-year payback period for the cost premium. “That kills more than half the projects,” Vyas said. “You need a longer-term horizon” – at least five years – “and then you’ll see that this pays off.”

Longo’s “is one of the few retailers with the forward thinking” needed to embrace the net-zero opportunity, Vyas noted. “We are very fortunate to find a partner like Longo’s that is willing to push the envelope with us in terms of sustainability.”

Neelands plans to pursue more net-zero projects, with Longo’s and other retail customers in Canada and the U.S., but only after collecting more data from the Stouffville project. Vyas put it this way: “In God we trust; everyone else brings data.”

Noel Neelands, President of Neelands Group stressed that he wants the Stouffville store to be an application model. “True success would be to replicate this more and more with different customers,” he said. ■ MG

The two transcritical CO<sub>2</sub> racks.



### System Specs

The 40,000ft<sup>2</sup> (3,716m<sup>2</sup>) near-net-store Longo’s store comprise the following equipment

- ▶ Two Hillphoenix transcritical CO<sub>2</sub> racks
- ▶ Cooling capacity: 123TR (432.9kW),
- ▶ Low temperature: -25°F (-32°C)
- ▶ Medium temperature: 19°F (-7.2°C).
- ▶ CCHP system (including absorption chiller)
- ▶ LED lighting store-wide
- ▶ Window glazing
- ▶ Solar panels on roof (235kW), carport (39kW) and building façade (12kW)
- ▶ 100kW lithium-ion storage battery
- ▶ Air conditioning is supplied via air handler and Lennox AC unit using R410A.
- ▶ Neelands Group’s Kalder software to monitor energy consumption and equipment performance





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# Lidl Net-Zero Store Uses CO<sub>2</sub> Ground-Source Heat Pump



The refrigerated cabinets in the store are cooled by a Teko CO<sub>2</sub> rack.

“ It is a very closed chain of electricity generation and waste streams from cold and heat, which are used immediately or stored immediately. ”

– Marcel Ganzeboom, Lidl Netherlands

The Dutch supermarket employs only green energy sources – solar panels and a thermal underground reservoir.

– By Tine Stausholm and Ilana Koegelenberg

**As** the global climate emergency becomes increasingly evident around the world, many businesses, organizations, and even countries have set a goal of reaching “net-zero” in their greenhouse gas emissions by improving efficiency and using renewable energy.

One of the latest supermarket chains to try its hand at net zero is German retailer Lidl, at a 2,057m<sup>2</sup> [22,141ft<sup>2</sup>] store/warehouse opened in September 2019 in Woerden, the Netherlands, on the site of an old demolished shop.

An important requirement from Lidl in the planning process for this store was to create an energy-neutral building, meaning that the power consumption of the whole building had to be fully self-sufficient and that no energy bills should be paid at any time during the year. All energy that is used in the store, such as for lighting, heating and cooling, the cashier tills and more, is therefore produced in the store itself from green energy sources, including 1,766 rooftop solar panels as well as thermal energy via a ground-source heat pump.



The Woerden store, like most of Lidl's new stores, cuts its energy demand with LED lighting and efficient HVAC&R systems, and includes other environmentally friendly features like rainwater filtration. The Woerden store is particularly innovative with HVAC&R technology, using two transcritical CO<sub>2</sub> systems – a refrigeration system, and the ground-source heat pump, which is also used as a chiller for air conditioning.

Lidl opened its first store in the Netherlands in 1997, and since 2014 all new stores in the country have been awarded the A+++ energy rating, the highest possible.

### Leveraging pre-cast concrete piles

One of the key energy-saving technologies at the Woerden net-zero store is the (50kW/14.2TR) transcritical CO<sub>2</sub> ground-source heat pump provided by Dutch installer Frimex.

The heat pump is connected to special pre-cast concrete piles in the ground underneath the store and the parking lot, which serve as a thermal reservoir. Glycol is circulated via hollow tubes inside these thermal precast piles to transport heat to and from the thermal reservoir, taking advantage of the natural ground temperature during the year to complement the cooling and heating cycle in the building.

The heat pump can be used to create a comfortable climate inside the store when the refrigeration system doesn't produce enough excess heat to heat the shop through heat recovery during the winter months. Conversely, the heat pump can also serve as an air-conditioning system during the summer by reversing its operation, using the cooler ground temperatures. Hot and chilled water tanks are used for climate control of the store.

A benefit of the system is that, as a result of pumping excess heat back into the thermal reservoir (via glycol), the refrigeration system's CO<sub>2</sub> refrigerant is cooled, increasing the efficiency of the system for the store/warehouse, and reducing the energy needs of the whole building.



Hot and chilled water tanks for climate control of the store.

Marcel Ganzeboom, Senior Manager in the Construction Department of Lidl Netherlands, and the initiator is of the net-zero project, confirmed the retailer's satisfaction with the technical solutions. "It is a very closed chain of electricity generation and waste streams from cold and heat, which are used immediately or stored immediately," he said. "Very genius to see how it works."

### The cooling power behind net-zero

The refrigerated cabinets in the new Woerden store are cooled by German manufacturer Teko's ROXSTAsmart CO<sub>2</sub> rack. The unit offers a medium-temperature capacity of 112kW (32TR) at -8°C (17.6°F) and a low-temperature capacity of 4kW (1.2TR) at -33°C (-27.4°F). This is needed to cool a total of 85m (279ft) of medium-temperature cabinets in the sales area, plus two cold rooms and one freezer room.

The ROXSTAsmart system was installed in a separate plant room above the warehouse, taking up minimal space. It

only measures 2.6m by 1.9m by 0.98m (8.6ft by 6.2ft by 3.2ft), including a sound enclosure, three medium-temperature compressors, and one low-temperature compressor.

In addition to aiming for net-zero emissions, Lidl required that no synthetic refrigerants be used, and Frimex opted for CO<sub>2</sub>. "By using CO<sub>2</sub>, even though it is a greenhouse gas as well, we designed a system with minimal impact on the environment," said Hendrine Kalkman, Head Engineer at Frimex.

While Lidl confirms that the investment costs for the net-zero store were higher than an average supermarket, the expected payback time will be around five to 10 years.

However, Lidl emphasizes that supermarket customers should not pay a premium for the sake of shopping in a sustainable store like this. "We do not charge sustainability to the customer; it is the other way around – it makes the shopping cheaper," said Ganzeboom.

■ TS & IK



# Austrian Metro Store Aims for Net-Zero Energy

Using solar energy, the store in St. Pölten is cutting demand with enhanced efficiencies, helping the food wholesale giant to reach its emissions goal.

— By Ilana Koegelenberg



The store intends to use only solar energy for electricity.

**G**erman food wholesale specialist Metro AG is one of the leading users of natural refrigerants, with 114 stores running transcritical CO<sub>2</sub> systems.

One of those transcritical CO<sub>2</sub> stores, located in St. Pölten, Lower Austria, has the further distinction of being Metro's first store to aim for net-zero energy consumption, with a goal of using only renewable energy created on site with a 6,000m<sup>2</sup> (64,583ft<sup>2</sup>) photovoltaic system on the roof.

Opened in 2017, the 12,700m<sup>2</sup> (136,702ft<sup>2</sup>) St. Pölten store is part of the company's ambitious plan to reduce its CO<sub>2</sub> emissions by 50% in 2030 as compared to 2011 levels. As the store's energy profile is refined, it will be used as a model for optimizing efficiency in new stores, especially in Europe.

"New [Metro] stores opening today have to be much more competitive in terms of energy demand to reach our 2030 targets," explained Olaf Schulze, Director Energy Management at Metro AG, during ATMOsphere Europe 2019 in Warsaw.

St. Pölten is designed to realize a 60% reduction in energy demand as compared to the Metro worldwide average. Because of the time needed to optimize systems and the extreme temperatures of the summers of 2018 and 2019, this figure hasn't been realized yet.

"The photovoltaic is producing stable [energy], but our demand is 10% (more or less) higher," Schulze said, adding that the store needs "further optimization of equipment and awareness." And because of the large amount of energy being consumed by 10 electric-vehicle chargers, this year, Metro decided to longer include them in its calculations, since "they have nothing to do with store operations," he said.

Still, the store has been recognized for its net-zero efforts. In 2018, it received the German EHI Energy Management Award for its dramatic energy reduction. It has also achieved "outstanding" certification from BREEAM, an evaluation system for the ecological and socio-cultural sustainability of buildings.

## Efficient transcritical system

The St. Pölten store is equipped with a transcritical CO<sub>2</sub> booster system supplied by German OEM Teko, with a number of features designed to boost efficiency. Andreas Meier, Managing Director for Teko, was also at ATMOsphere Europe 2019 to present alongside Schulze on the particulars of the refrigeration system his company supplied.

The refrigeration rack offers 290kW (82.5TR) on the medium-temperature side and 93kW (26.4TR) on the low-temperature side, as well as full heat recovery (160kW/45.5TR) used to heat domestic hot water in the building. It also includes an Evalift suction heat-exchanger system to improve system efficiency, as well as parallel compression.

Most of the building is cooled by natural ventilation, with 12kW (3.4TR) of air conditioning for the sales area also being supplied by the refrigeration rack.

Thanks to these features, the St. Pölten store's transcritical system is 20% more efficient than a standard transcritical CO<sub>2</sub> system, said Schulze. He expects the return on investment in the premium paid over a standard system to be less than five years.

■ IK



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# Meeting the 'Living Building Challenge'



Two transcritical CO<sub>2</sub> racks from Kirby at the Woolworths Burwood store.

A Woolworths store near Melbourne uses transcritical CO<sub>2</sub> refrigeration and doors on all display cases as part of an effort to become the first supermarket associated with the highly demanding performance standard.

— By Ilana Koegelenberg

**A** Woolworths Supermarket in Burwood, a suburb of Melbourne, Australia, that opened last December is the first supermarket in the world to become associated with certification from the stringent Living Building Challenge (LBC) performance standard, in part by employing two transcritical CO<sub>2</sub> refrigeration systems and doors on all meat and dairy cases.

The supermarket is located in the Burwood Brickworks shopping center, which is in the process of completing its certification, expected by early 2021.

The LBC is a green-building certification program and sustainable-design framework that visualizes an "ideal" built environment. It is marketed as "the world's most rigorous proven performance standard for buildings." Successful certification requires net positive energy and water usage, among many other criteria.

To support that goal, the Woolworths store will incorporate a range of sustainability initiatives that aim to reduce the environmental impact of the store's operations and help customers live more sustainably, too. The Burwood Brickworks development incorporates a large solar PV system and an embedded electricity network.

The Woolworths store "is the next step in our journey to create a neighborhood food store, with sustainability and the needs of local customers at the heart of its design," explained Claire Peters, Woolworths Supermarkets Managing Director, in a statement. "As Australia's largest retailer, we recognize our responsibility to minimize our environmental footprint and are committed to playing our part in creating a greener, more sustainable future."

## 100% renewable energy

The store uses 100% renewable energy, which is equivalent to taking 700 cars off the road each year. "From store lighting and air-conditioning to food refrigeration and preparation, we have looked at all angles to see how we can build and run this store more sustainably," said Peters.



Three transcritical CO<sub>2</sub> refrigeration racks are being used by Woolworths in the shopping center, two from Kirby for the supermarket's chillers and freezers, and one from SCM Frigo (Beijer Ref) for the Dan Murphy's liquor store (part of the Woolworths group) located in the shopping center. Both systems include parallel compression.

Doors have also been included on all meat and dairy cases, which will reduce the energy consumption by around 30%, by preventing cold air from spilling from the cases, noted Woolworths. CO<sub>2</sub> heat pumps are used to produce hot water.

The refrigeration design criteria "was aimed at achieving the required product performance temperatures in all cool rooms and showcases, at peak outdoor ambient conditions, in a manner which optimized energy consumption, minimized site installation complexity (for Woolworths in-house technicians) and operated without employing synthetic refrigerants," said Dario Ferlin, Refrigeration Engineer at Woolworths Food Group Australia.

Other refrigeration equipment includes display cases from Hussmann, LU-VE gas coolers from Kirby, and controls from Emerson, which Woolworths has optimized over the past year.

According to Ferlin, as of August 2020 the energy consumption of the Burwood store's refrigeration system is "more than 10% more efficient than comparable Woolworths transcritical CO<sub>2</sub> refrigeration systems." He added that the Burwood store has made "more than usual" use of doors on display cases at this site.

Ferlin noted that the operation of the transcritical systems has been "very smooth sailing" with the exception of some challenges during extreme-weather days that led to severe bush fires last summer. "But even then, the refrigeration system was quite resilient," he said.

LBC compliance included a "red list" of undesirable materials, such as PVC. This proved quite a challenge for Woolworths as the material is usually widespread throughout electrical insulation and drain piping, explained Ferlin. "Kirby contacted over 40 suppliers to obtain component composition details to ensure compliance. Through such measures and close consultation with the Woolworths engineers, we were able to achieve a significant reduction in PVC across both racks," explains Douglas Herkess, Segment Engineer, Kirby.

Another challenge was installing doors on virtually all showcases, including the low-height, semi-vertical ones – which is quite uncommon and required some bespoke design work.

“

*[The Woolworths Burwood Brickworks store] is the next step in our journey to create a neighborhood food store, with sustainability and the needs of local customers at the heart of its design.*

– Claire Peters, Woolworths

”

The shopping center was developed by Frasers Property Australia, whose first engagement with Woolworths dates back to January 2017, confirmed Ferlin. The refrigeration installations were undertaken by Woolworths installation team WRI, with work beginning around June 2019 and commissioning completed by late November 2019 – in time for the store opening on December 6, 2019.

### Refrigeration leads HVAC

According to Ferlin, the refrigeration sector in Australia is several steps ahead of the local HVAC industry when it comes to sustainability and natural refrigerant systems. This is in part because of build and lease agreements where the ownership of the HVAC assets generally sit with the landlord, unlike the refrigeration assets. At the Burwood Brickworks store, the AC system, which uses HFCs, is provided by the shopping center, which also provides space heating.

Ferlin sees great potential in using natural refrigerants in retail applications. "Wearing an engineering hat alone, it's fair to say the opportunities are enormous – particularly with propane self-contained systems (refrigeration and AC)," he explained. "However, a broader view requires other non-engineering challenges to be addressed, including governance of technicians suitably qualified to work on flammable and/or toxic refrigerant systems."

Meanwhile, in 2020, Woolworths now runs nine CO<sub>2</sub> stores with integrated space heating, four of which also have integrated space cooling. All told, Woolworths operate 19 transcritical CO<sub>2</sub> stores, and expects to add more this year, said Ferlin.

But the Woolworths Burwood Brickworks store remains "the culmination of all our efforts to date in one store," said Peters. "We will continue to try initiatives that help us reduce our environmental impact and look forward to the feedback from our teams and customers as we do." ■ IK





At a refurbished hypermarket, Real is saving up to 30% in electricity usage with its transcritical system, while avoiding upfront capital costs, in one of the first arrangements of its kind.

— By Tine Stausholm

**R**eal, a German hypermarket chain, is for the first time leasing, rather than purchasing, a transcritical CO<sub>2</sub> refrigeration system for a remodeled store in Krefeld, Germany, thereby avoiding a significant capital investment while cutting electricity costs.

The system is being leased from E.ON, an energy provider based in Essen, Germany. E.ON was responsible for buying and installing the refrigeration equipment; the refurbishment process took around eight months, and was completed in November 2019.

E.ON guarantees the operation and maintenance of the system for 10 years. Real pays a fixed monthly fee for the duration of the contract, after which the equipment becomes the retailer's property.

Real operates 271 stores in Germany, of which 22 use transcritical CO<sub>2</sub> systems purchased by the chain. Previously owned by transcritical CO<sub>2</sub> pioneer Metro AG, Real was sold in February to German-Russian consortium SCP Group and X+Bricks.

Real hypermarket, Ingelheim, Germany

# Why a German Retailer Chose to Lease, Not Buy, a CO<sub>2</sub> System



“It is not our core competency to refurbish the technical equipment in our stores, but it is the opposite for E.ON.”

—Antonio Tegas, Real

”

As for why Real opted for the first time to lease this refrigeration system, “We wanted to save cash, time and carbon,” said Antonio Tegas, Head of Real’s Technical Purchasing Department. “It is not our core competency to refurbish the technical equipment in our stores, but it is the opposite for E.ON. Therefore we wanted to use such competency and spirit and focus on our core business.”

By avoiding upfront capital expenses, Real also sees an opportunity to accelerate the installation of cooling, HVAC, lighting, and other devices, Tegas added. “E.ON will give us a guarantee about the planned and calculated savings – the business case can financially only be better, never worse.”

“We are saving money by cost, capex reduction and by time, and time is money in our business,” he said.

### Epta FTE CO<sub>2</sub> system

The existing refrigeration system in the Krefeld store had already been updated to a lower GWP fluid matching the EU F-Gas regulation’s requirements, but due to its age, the system was not “operating efficiently,” Tegas said.

Real and E.ON therefore agreed to install an FTE transcritical CO<sub>2</sub> system from Italian OEM Epta in the store, bringing in a 10% energy savings over a “standard” CO<sub>2</sub> system, according to Sascha Onucka, a Key Account Manager at E.ON. The leased transcritical system uses up to 30% less electricity than a previously used HFC system, she said. With doors on display cases and efficient fans, the store has reduced energy consumption by almost 50%.

The system has a total capacity of 200kW (56.9TR) for the 7,000m<sup>2</sup> (75,350ft<sup>2</sup>) store, and it includes heat recovery for hot tap water.

To further increase the store’s energy efficiency, solar photovoltaic panels have been installed on the roof, and lighting has been converted to LED in all areas.

With the efficient refrigeration system, heat recovery, and electricity produced by the PV panels, E.ON has calculated a 61% reduction in grid electricity purchases, in addition to a 35% reduction in gas consumption. These reductions result in a total of 51% CO<sub>2</sub>e emissions reduction.

### New for food retail

The leasing business model appears to be new to the food retail market. “So far as I am informed, [the Real store] is one of the first leasing partnerships for cooling as part of store performance contracting,” said Olaf Schulze, Director of Energy Management Investments & Technical Solutions at Metro AG.

However, the model isn’t entirely new to E.ON. The company operates around 10 similar ventures in the hospitality and food industry sectors, where the end user pays a fixed monthly fee. “The solutions we offer to our customers create a win-win situation,” said Onucka. “Our customer can focus on their core business, and we bring in our strength to operate complex technical systems in the most efficient way.”

“We are convinced that our other customers are very satisfied, and an indicator for us is that we are extending the leasing with some hotel chains in all EU locations,” she added.

The monthly fee paid by the customer is based on the capital investment and the calculated risks. For the Krefeld store, E.ON’s return of investment will be around eight years, according to Onucka, though the exact time frame depends on the developments in energy prices and maintenance costs. (Real’s monthly fee was not disclosed.)

The monthly customer fee does not include the electricity the store uses. “We buy the energy for all of our operations, but E.ON has to install the right technology – and operate and maintain it in the best way – to achieve the calculated energy savings of the total system, Tegas explained.

Real’s leasing arrangement contrasts with another servitization model, cooling as a service (CaaS), which was not sufficiently developed when Real began its Krefeld store refurbishment.

According to the Basel Agency for Sustainable Energy, under the CaaS model, the end user pays the product supplier for each unit of cooling used, and this includes the cost of electricity, water, maintenance and repair. However, the end user does not acquire the product after a period of time. ■ TS





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