OCTOBER 2018

ACCELERATE AMERICA

ADVANCING HVAC&R NATURALLY

Taking on Transcritical in Cold Storage

No Time to Lose

— by Michael Garry

The latest attempt to spark a sense of urgency about global warming came on October 8th when the Intergovernmental Panel on Climate Change (IPCC), the United Nation's climate-change advisory group, issued "The Special Report on Global Warming of 1.5°C."

The report, based on an analysis of more than 6,000 peer-reviewed scientific studies, makes the case that 1.5°C (2.7˚F), not 2°C (3.6˚F) should represent a hard stop on the amount of temperature rise above pre-industrial levels. We are now at 1°C, and anything above 1.5°C would lead to intolerable environmental impacts, and, of course, they get worse with temperature increases above 2°C.

Most alarmingly, the report says that limiting global warming to 1.5°C requires cutting carbon-equivalent emissions by 45% compared to 2010 levels by 2030, only 11+ years away, and going to net-zero by 2050. Doing this, of course, "would require rapid, far-reaching and unprecedented changes in all aspects of society," said the IPCC press release announcing the report.

While cutting fossil fuel emissions remains the largest task related to global warming, the IPCC report also notes the important role that reducing "non-CO_2 emissions" plays. Non-CO_2 sources, like HFCs and other short-lived climate pollutants (SLCPs) "contribute to peak warming and thus affect the remaining carbon budget," the report says.

There's a global remedy for HFC emissions known as the Kigali Amendment to the Montreal Protocol. Following the Kigali plan would avoid 0.5°C (0.9˚F) of global temperature rise by 2100 – the very difference between 1.5°C and 2.0°C upon which the IPCC report focused its warning. Given the significance of every fraction of a degree in temperature, Kigali has grown in importance as a partial answer to climate change.

While 56 parties (55 countries and the EU) out of 197 have so far ratified the Kigali Amendment (Page 14), the U.S. is not one of them, and there are no indications that the Trump administration will turn it over to the Senate for ratification before the Amendment takes effect in ratified countries on January 1, 2019. Meanwhile, the Supreme Court recently announced it won't hear the Appeals Court decision (written by Brett Kavanaugh, now on the Supreme Court) restricting the Environmental Protection Agency's ability to regulate HFCs. (Page 35.)

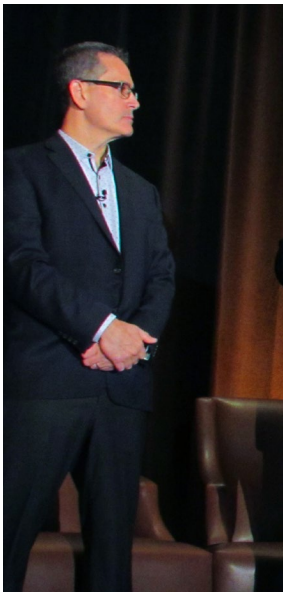
Nonetheless, as this and every issue of *Accelerate America* shows, there are still plenty of signs of progress on the HFC-reduction front and the adoption of HFC-replacing natural refrigerants.

For example, the HFC-reduction actions of four U.S. states (California, Connecticut, New York and Maryland) – with more on the way – are helping to counteract reversals on the federal level (page 34). And the use of CO_2 refrigerant, already a growing force in food retail, is now entering the industrial sphere, as we describe in the cover story on Henningsen Cold Storage (page 38). I also highly recommend reading the opinion piece by EIA's Avipsa Mahapatra, which delves further into the implications of the IPCC's report (page 16).

The HVAC&R industry has something concrete to contribute to avoiding global temperature rise and environmental hardships. There's no time to lose. MG

Michael Garry
Editor

In this issue



OCTOBER 2018

ACCELERATE
ADVANCING HVAC&R NATURALLY
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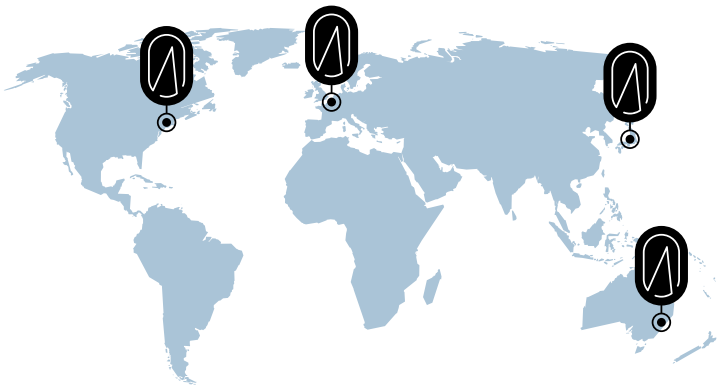

About *Accelerate America*

Brought to you by shecco, the worldwide experts in natural refrigerant news, *Accelerate America* is the first news magazine written for and about the most progressive business leaders working with natural refrigerant solutions in all HVAC&R sectors.

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November 27, 2018

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Hydrocarbons in Refrigeration and AC
PUBLICATION DATE:
January 8
DISTRIBUTION:
AHR Expo (Atlanta, 1/14-16) and NAFEM (Orlando, 2/6-9)

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Low-Charge Ammonia (Central)
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February 14
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IIAR Natural Refrigeration & Expo (Phoenix, 3/3-6)

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March 14

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August 6

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Food Retail
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September 10
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FMI Energy & Store Development Conference

// ISSUE #49
October 2019

FOCUS:
CO_2 in Industrial Refrigeration
PUBLICATION DATE:
October 15

* Publisher reserves the right to modify the calendar.

LETTERS TO THE EDITOR

MODIFICATION TO SIX S'S

Based on feedback from attendees at the Food Marketing Institute (FMI) Energy & Store Development Conference, we have slightly modified the "Six S's" for clarity. (See "The Six S's of Refrigeration Selection," *Accelerate America*, September 2018.)

We will be emphasizing that "Sustainability" represents not only environmental but also financial, and we are replacing the word "Safety" with "Security" to also include IT security. So the terms are now defined as follows:

Sustainability — For those supermarket operators driven by corporate sustainability objectives or regional regulatory requirements, the push toward lower-GWP refrigeration strategies is continuing in earnest. Sustainability also speaks to the long-term economic viability of the refrigeration selection, as operators must factor in the total cost of ownership throughout the life cycle. Reducing energy consumption to minimize operating costs is a concern shared by all.

Security — Maintaining customer, employee and technician safety while preserving food quality and safety are always top priorities. With many operators now integrating IoT technologies for more effective facility and enterprise management, securing proprietary operational data is also critically important. Operators seek system architectures that can address these multi-faceted safety and security concerns.

André Patenaude
Director of Food Retail, Growth Strategy,
Emerson Commercial & Residential Solutions,
Branford, Ontario

Editor's Note: In the next letter, Joe Kokindo, president/CEO of Professional HVAC/R Services, responds to the modifications made to the "Six S's" in the previous letter and to André Patenaude's original article ("The Six S's of Refrigeration Selection," Accelerate America, September 2018).

LETTERS ARE WELCOMED!

Accelerate America invites readers to submit letters to the editor at michael.garry@shecco.com. They can be about a recent article; an industry issue that readers would like us to cover in greater detail; or the value of *Accelerate America* and ATMOsphere America in educating the industry about natural refrigerants, including what we can do better. Letters may be edited for clarity or length. Letters may be edited for clarity or length.

ANOTHER LOOK AT TCO

While energy conservation is indeed at the forefront of sustainability, we believe that the "buckets of money" considered by major retailers do not take into account other aspects of "total cost of ownership." How about the cost impact of maintenance, simpler and faster installation, and redundancy factors? These seem to not be a matter of discourse.

For example, more often than not many refuse to consider the ease of installing, and the simplicity of servicing, self-contained supermarket-grade fixtures that are everywhere except here in the USA (though starting to be used here).

Also, we believe that "building envelope conditions" affect all refrigerated fixtures regardless of their designs – more than ever with the energy-hogging architectures that are still out there, and. in fact, still being built.

In regard to the "Six S's," we should pay attention to the bullet points, and let's work together to use this data with EMOTION as we get into the market place.

Here is how the Six S's apply to self-contained fixtures:

- Serviceability with the easy-to-service self-contained supermarket-grade fixtures that we have in our test lab.
- Simplicity of the self-contained systems is what this is all about. We continue to tweak our test-lab components.
- Safety may be a major concern for all, but especially for the retailer. We share this concern.
- Stability of self-contained fixtures would minimize product loss should a failure occur.
- Smarts – improvements in controllers are being made.
- Sustainability – I hope the 500-g limit approval for propane/isobutane fixtures arrives soon.

Joseph Kokinda
President/CEO
Professional HVAC/R Services, Inc.
Avon Lake, Ohio

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(VOLUME SERVED)

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Refrigerated Transport

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Refrigeration Systems

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600 MILLION

Air-Cooled Systems

Air Conditioners

2.8 MILLION

Water Chillers

Air Conditioners

700 MILLION

Air-Conditioned Vehicles
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Mobile Air-Conditioning Systems

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Heat Pumps
(residential, commercial and industrial equipment, including reversible air-to-air air conditioners)

Heat Pumps

3 BILLION

Refrigeration, Air Conditioning and Heat Pumps Units, Worldwide

Source: International Institute of Refrigeration, "The Role of Refrigeration in the Global Economy," November 2015

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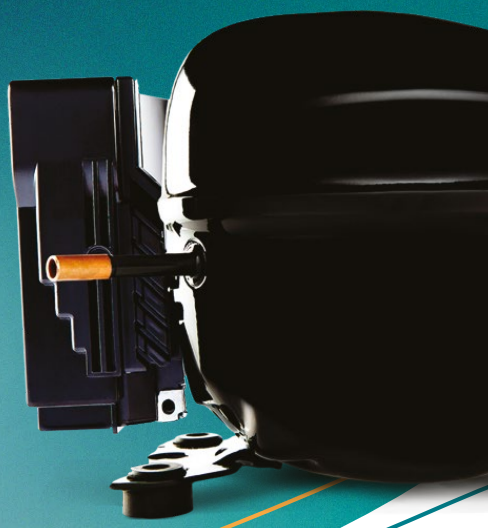
LEADING NATURAL REFRIGERATION



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OCT

16, 2 PM EDT

GreenChill Webinar: GreenChill Store Cerition Program
Online
Environmental Protection Agency, ICF and Publix present on GreenChill's store certification program, including how to apply for certifications. (Will be archived at www.epa.gov/greenchill.com.)

https://bit.ly/2P8vliKl

@EPAgreenchill

19-20

Produce Marketing Association (PMA) Fresh Summit
Orlando, Fla.
Event is designed for the produce and floral industry, including retail buyers, food safety experts and importers/exporters. Exhibitors include suppliers and manufacturers of packaging and equipment.

https://bit.ly/2yFEZ7J

@FreshSummit

20-23

NFRA Convention
San Diego, Calif.
The National Frozen & Refrigerated Foods Convention emphasizes one-on-one business meetings among retailers, manufacturers, sales agents and logistics providers. NFRA provides retailer members with complimentary meeting rooms.

https://nfraconvention.org

@EasyHomeMeals

24

CARB Workshop on Upcoming HFC Emission Reduction Measures
Sacramento, Calif.
The California Air Resources Board will hold this public workshop to discuss a proposal for reducing high-GWP HFC refrigerant emissions from stationary refrigeration and air conditioning equipment.

https://bit.ly/2DXnlj5

@AirResources

25

Emerson 360 Forum
Houston, Texas
This event will evaluate trends and discuss ways to address commercial refrigeration and air conditioning challenges.

https://bit.ly/2n3S2rq

@EmersonComRes

NOV

6-9

2018 RETA National Conference
Dallas, Texas

Refrigerating Engineers & Technicians Association (RETA) event is designed for those "working on the ground" in the industrial refrigeration industry in operations, engineering, management and compliance. It includes exhibits, sessions and certification opportunities.

https://bit.ly/2Nlbwme

@EPAgreenchill

07-09

MCAA Field Leaders Conferennce
San Francisco, Calif.

Mechanical Contactors Association of America event will provide foremen and other supervisory-level field personnel an opportunity to exchange ideas and gain an understanding of what their employers expect and what they should be doing as leaders.

https://bit.ly/2RnJrOo

@MCAANews

11-13

AHRI 2018 Leadership Forum
Tucson, Ariz.

This new event from the Air Conditioning, Heating & Refrigeration Institute is designed for company executives, product engineers, and sales and marketing professionals. Sessions will cover regulatory and technology trends that will impact national and global marketing plans, among other topics.

https://bit.ly/2BYR7CW

@AHRIEngage

14-15

ATX Montreal
Montreal, Quebec

This is an international automation technology expo featuring technological advances in custom automation and assembly, robotics, control software, motors, drives, motion control, and more. Attendees include manufacturing managers, packaging and process engineers, project managers, design engineers, purchasing staff, and general corporate managers.

https://bit.ly/2QsHNtt

14-16

Greenbuild International Conference & Expo
Chicago, Ill.

This event on sustainability in the built environment is designed for professionals in architecture, construction, engineering, planning, and interior design.

https://bit.ly/2uNwfau

@Greenbuild

AMERICA IN BRIEF

Emerson to Offer CO_2 Training in U.S.

U.S. component supplier Emerson announced it will run two-day CO_2 refrigeration training courses in four U.S. states – Georgia, California, New York and Wisconsin – during the first quarter of 2019.

The courses will cover both transcritical and subcritical applications, while providing an introduction to CO_2 as a refrigerant, according to Emerson. Safe handling, maintenance, charging a CO_2 system, oil management, gas-cooler control and start-up/shut-down procedures will also be explored.

The two-day training will take place:

- January 16 and 17 in Atlanta, Ga.
- February 13 and 14 in Rancho Cordova, Calif.
- February 27 and 28 in Elmsford, N.Y.
- March 20 and 21 in Cudahy, Wis.

The fee for the course is $700 per person (including course materials, breakfast and lunch).

Online registration opens on November 1 at https://education.emerson.com/learn. ■ CM

ARF Supports Job Training Bill

The Ammonia Refrigeration Foundation (ARF) is supporting the passage of U.S. legislation that would provide tax credits for donations to worker training, development and apprenticeship programs.

Introduced in March by U.S. Representative Lloyd Smucker (R-PA-16), the legislation – called the USA Workforce Tax Credit Act (H.R. 5153) – seeks to help "address the nation's skills gap" in manufacturing, according to USA Workforce, a coalition that was founded to advocate for job training policies.

"This is a super-important bill that can affect our small business owners/manufacturers and our industry, as well as others," said Lois Stirewalt O'Connor, executive director, Alexandria, Va.-based ARF, an affiliate of the International Institute of Ammonia Refrigeration (IIAR).

The bill would allow a maximum credit of $250,000 for individuals or corporations, capped at no more than 25% of a taxpayer's overall tax bill. ■ MG

Molina, McKenna Win CCAC Awards

At a ceremony in San Francisco, Calif., last month, the Climate & Clean Air Coalition (CCAC) presented Nobel Prize-winning chemist Mario Molina and Canadian environmental minister Catherina McKenna with Climate and Clean Air Awards in the individual prize category, praising their efforts in combating HFCs.

They were among the individuals honored at the ceremony for actions taken to reduce short-lived climate pollutants (SLCPs) – which include HFCs – and protect the climate. The event took place on September 12 during the Global Climate Action Summit.

A Mexican-born chemist, Mario Molina won the 1995 Nobel Prize in Chemistry for his pivotal role on the discovery of the harmful effect of CFCs on the atmospheric ozone layer. His studies paved new way for research into environmentally friendly alternatives to synthetic refrigerants.

Catherine McKenna, Canada's Minister for Environment and Climate Change since 2015, has been at the forefront of reducing the country's climate impact. A major result was achieved on April 16, when the government of Canada launched an HFC phase-down plan; in line with the Kigali Amendment to the Montreal Protocol, it aims to limit the consumption of HFC by 85% by 2036.

Besides Molina and McKenna, other award recipients in the individual category were: actor Leonardo DiCaprio (for raising awareness of climate change), scientist Veerabhadran Ramanathan (for his research on SLCPs) and environmentalist Hal Harvey (for his philanthropic investments in climate actions).

Other awards were given in the Policy and Innovation categories. (See http://www.ccacoalition.org/en/news/2018-climate-and-clean-air-awards). ■ DB

Kigali Reaches 56 Ratifications

As of October 15, 56 parties had ratified the Kigali Amendment to the Montreal Protocol on phasing down HFCs worldwide, including Mexico (September 25); the European Union, Czech Republic, and Estonia (September 27); Panama and Sri Lanka (September 28); and Greece (October 5).

The Kigali Amendment was adopted by 197 parties meeting in the Rwandan capital on October 15, 2016. The amendment requires developed countries to take the lead on phasing down HFCs, starting with a 10% reduction in 2019 and delivering an 85% cut in 2036 (compared to a 2011-2013 baseline).

The Kigali Amendment has already reached the threshold to enter into force, having been ratified by 20 parties at the end of 2017.

In the U.S., President Trump has yet to deliver the Kigali Amendment to the U.S. Senate for ratification.

"We encourage all Parties to the Montreal Protocol to take action on HFCs as soon as possible," said Miguel Arias Cañete, the EU commissioner for climate action and energy.

So far, out of the European Union's 28 member states, 18 countries have ratified Kigali. More EU countries are expected to ratify, separately from the EU ratification, in the coming months.

Though it has ratified Kigali, Mexico has yet to put in place regulation on phasing down HFCs. But Environment and Natural Resources (Semarnat) Minister Rafael Pacchiano Alamán is confident the country will phase down its annual consumption of 30,000 tons of HFCs, mainly found in its refrigeration and air conditioning systems.

These 30,000 tons translate into 49.6 megatons of CO_2e, according to Pacchiano Alamán. ■ CM

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States Offer Hope for Climate Action

In the absence of federal leadership, four states – with more to come – have committed to curbing HFCs, providing opportunities for industry

By Avipsa Mahapatra

What a month it has been! The International Panel on Climate Change (IPCC), a UN body of climate experts from around the world, recently released "The Special Report on Global Warming of 1.5˚C." IPCC's special report unequivocally pointed out that the global average temperature rise has already reached 1˚C (1.8˚F) ; and the additional rise of half a degree is merely about 12 years away, within most of our lifetimes, even with a 45% reduction in CO_2e emissions compared to 2010 levels.

The report also notes the critical role of highly potent short-lived climate pollutants (SLCPs), such as hydrofluorocarbons (HFCs) and methane. While it is important to reduce CO_2 emissions from a long-term warming perspective, reduction of these other pollutants can contribute to limiting the temperature increase to 1.5˚C (2.7˚F) in the short term, with substantial co-benefits, such as reducing air pollution.

While the IPCC report leaves no doubt about the need for urgent climate action, including on HFCs, in the the U.S. the Supreme Court decided not to review a lower court decision by then-Judge Brett Kavanaugh that restricts the U.S. Environmental Protection Agenct (EPA) in regulating HFCs. (See page 35.) And it is still unclear if the Trump administration will submit the Kigali Amendment to the Montreal Protocol, the international HFC phase-down agreement, to the Senate for ratification, even though it has broad support by industry, environmentalists, and senators on both sides of the aisle.

While one might infer from these statements and actions by the president and the EPA, as well as the Supreme Court, that one of the largest climate polluters in the world is not going to do anything despite the undebatable need for urgennt climate action, there is a new ray of hope.

STATE ACTION ON HFCS

At the Global Climate Action Summit last month in San Francisco, leaders from states and regions, cities, businesses and civil society announced efforts to drive action forward on climate while calling on countries to "step up ambition" and commit to strengthening their national climate plans.

Four states — California, New York, Maryland, and Connecticut —committed to pursuing regulations aimed at curbing HFCs, and others are expected to follow. (See page 34.) This will help shore up current emission reductions and provide certainty that previous federal bans on many of the most climate damaging HFCs will stick, at least for new cooling equipment used in these states. The question now is not *if* but *how many* states in the US Climate Alliance will join this group in the coming months.

California set a specific target to reduce HFC emissions 40% by 2030, bypassing in its level of ambition all previous federal policies enacted during the Obama Administration under the Significant New Alternatives Policy, or SNAP (which are now being scaled back). California Governor Jerry Brown also signed a new bill into law, The California Cooling Act (SB 1013).

The Cooling Act completely backstops the federal EPA SNAP Rules and calls for an innovative incentive program that can help end users of large refrigeration systems like supermarkets to be early adopters of the most climate-friendly refrigerant technologies to replace HFCs, while also achieving energy efficiency improvements. Meanwhile California's state agency, the Air Resources Board, will begin looking at adopting additional measures by next year to meet the more ambitious 2030 target.

A recent report by America's Pledge lists the potential contributions from states and business on HFC reduction as one of 10 fast-action opportunities for mitigating emissions. This report concludes conservatively that with a

significant number of states adopting SNAP rules and more supermarkets reducing their refrigerant leakage, these efforts could cut 5 million metric tons of CO_2e by 2025. In a more ambitious "enhanced action" scenario, the report found that if all states follow the lead of California in targeting a 40% reduction in emissions, the U.S. could conservatively reduce HFC emissions by an additional 15 million metric tons of CO_2e beyond current measures by 2025.

So if states look to set more ambitious targets in line with California, and also implement programs to incentivize businesses like supermarkets to more rapidly adopt new alternatives and better manage the HFCs used in their existing systems, this can significantly reduce emissions by 2025.

NO FUTURE FOR HFCS

What does this all mean for the HVAC&R industry? First, despite the uncertainty at the U.S. federal level, the writing on the wall is clear: There is no future for HFCs. Second, there are now opportunities for end users to be incentivized to adopt new systems using better refrigerants more quickly. As such the industry can make sure its challenges are known and heard by a growing number of states.

Additionally, a huge chunk of additional emissions from HFCs in current cooling systems can be avoided through leak prevention, recovery and destruction of refrigerants. As Project Drawdown recently found, this approach of managing and properly disposing of refrigerants in existing systems is the No. 1 climate solution available today. So companies and states looking to truly be leaders on reducing HFC refrigerant emissions should continue to innovate with new incentive programs and regulations that target existing HFCs as well as those in new systems.

While all countries committed under the Paris Agreement to limit global temperature rise to 1.5˚C-2˚C, the key unanswered question remains: How can the world achieve this temperature goal? The IPCC report makes it clear that the world now has the scientific understanding, the technological capacity and the financial means to tackle climate change – and therefore no excuses not to. But transformation on this scale can only be achieved with true collaboration between industry, governments and non-governmental organizations. There is a need for leaders and policy-makers to not only provide clear regulatory signals but also create an environment that fosters healthy competition, incentives for innovation, and sustained investment to increased market penetration.

Energy-efficient HFC-free cooling can become cost-effective for individual owners with scale. But U.S. industry must play its part in identifying new approaches to increasing energy efficiency and reducing the climate footprint of cooling –not only for U.S. jobs and economic growth but also for the survival of our planet. ■ AM

Based in Washington, D.C., **Avipsa Mahapatra** is the climate campaign lead for the Environmental Investigation Agency, an NGO focused on solving global environmental problems.

LIDL US STORE WITH HC CASES: 'BEST OF THE BEST'

In the EPA GreenChill awards ceremony, a Kinston, N.C., Lidl store is the best among all stores certified by the EPA program – and the first to be certified for using mostly self-contained propane cases

— By Michael Garry

A Lidl US store in Kinston, N.C., was named the "Best of the Best" GreenChill certified store in a breakfast ceremony at the Food Marketing Institute's Energy & Store Development Conference in Atlanta last month.

The majority of the cases in the store, both medium- and low-temperature, are self-contained units that use a hydrocarbon refrigerant, with a glycol water-loop system employed to remove heat from cases, said Matt Finnell, national energy manager for Arlington, Va.-based Lidl US (a division of Neckarsulm, Germany-based Lidl), who accepted the award.

Finnell did not confirm that the hydrocarbon is propane, though it is widely understood in the U.S. HVAC&R industry that propane (R290) is the refrigerant used.

The GreenChill Advanced Refrigeration Partnership is a decade-old voluntary program run by the U.S. Environmental Protection Agency (EPA). The program supports leak and charge reduction and the use of advanced refrigeration technology; it also certifies stores that meet certain leak, charge and technology criteria (at Silver, Gold and Platinum levels) over a 12-month period running from July 1-June 30. About 11,000 U.S. supermarkets from all 50 states are in the program, representing about 29% of U.S. stores.

Lidl's Kinston store is the first to receive GreenChill certification for using self-contained cases as its primary refrigeration system. It is also the first of "more than 10" Lidl US stores that have been recognized by GreenChill with Platinum certification. Platinum is the highest certification that the GreenChill Partnership grants a supermarket, based on either extremely low charge and leak rates for HFC refrigeration systems or the use of refrigerants with a GWP under 150.

The Best of the Best recognition goes to the certified store regarded as the "best" of all stores certified during the most recent 12-month period. Since 2012, the award has been given to stores using natural refrigerant systems such as transcritical CO_2 or ammonia/CO_2 cascade. (See chart, page 19.)

"This award allows us to recognize a lot of innovation in the industry," said Tom Land, manager of GreenChill, who presided at the awards ceremony. He noted that the Lidl store's self-contained architecture is "an emerging technology in U.S. food retailing."

Allows quick reaction

A self-contained display-case architecture that covers most or all of a store's refrigerated and frozen products is used by Lidl and other retailers in Europe. In the U.S. market. retailers generally employ self-contained air-cooled propane cases on a spot basis.

The self-contained layout "allows us quick reaction" when setting up a new store, said Finnell. He declined to comment on how much hydrocarbon refrigerant is used in each refrigeration circuit (150 g is the most allowed by law) or whether multiple circuits are used in any of the cases.

Some large self-contained cases, such as multi-decks, are known to use multiple propane circuits (each still under 150 g). The International Electrotechnical Commission (IEC) is working on raising its propane charge limit standard to 500 g.

In Europe, Lidl said in 2016 that it has committed to using propane for all new plug-in, self-contained refrigerated units throughout its German stores, and plans to roll out R290 for all future installations across Europe. In some instances, Lidl is employing propane chillers with a secondary glycol loop to remove heat from the cases.

Finnell acknowledged that Lidl US follows the lead of its German parent company with respect to store design and sales approach (focusing on low-price private-label products). Each Lidl outlet contains six aisles, with water-cooled refrigerated and frozen foods running along the left side and back perimeter of the store, as well as air-cooled produce cases, semi-vertical meat-and-poultry cases, and multi-temperature chest units.

The Kinston location was one of the first 10 Lidl US stores to open in the U.S. on June 15, 2017. Lidl US now operates 57 U.S. stores across seven Mid-Atlantic and South-Atlantic states.

Lidl stores occupy 21,000 sq ft of selling space, out of a total of 36,000 sq ft.

THE BEST OF THE BEST: NATURAL REFRIGERANTS

Since 2012, every supermarket named by the EPA GreenChill program as the best certified store uses only natural refrigerants for refrigeration.

2012	**Store:** Albertsons, Carpinteria, Calif. **System:** NH_3/CO_2 Cascade
2013	**Store:** Hannaford, Turner, Maine **System:** Transcritical CO_2
2014	**Store:** Whole Foods, Brooklyn, N.Y. **System:** Transcritical CO_2
2015	**Store:** Sprouts, Dunwoody, Ga. **System:** Transcritical CO_2
2016	**Stores:** Piggly Wiggly, Columbus, Ga.; Whole Foods, Dublin, Calif. **System:** NH_3/CO_2 Cascade
2017	**Stores:** ALDI US (all certified stores) **System:** Transcritical CO_2
2018	**Store:** Lidl, Kinston, N.C. **System:** Self-Contained Propane

Whole Foods: Distinguished Partner

A number of other food retailers received 2018 GreenChill Recognition awards at the ceremony.

Whole Foods Market received the "Distinguished Partner" award. This award is given to an individual or organization "demonstrating extraordinary leadership and initiative in achieving GreenChill's mission in the past year."

Whole Foods is one of the leading users of transcritical CO_2 systems in the U.S., and has also tested cascade systems that use ammonia or propane on the high side and CO_2 as a secondary refrigerant. Land praised Whole Foods' willingness to share "detailed information about many systems" with the industry in GreenChill webinars.

The "Best Emissions Rate" award for the lowest corporate annual refrigerant emissions rate in calendar year 2017 went to Harris Teeter (chain category) and City Market Onion River Co-op (small independent category). The winners' emission rates, which cover emissions from refrigeration (including under-50-lb systems) and air conditioning, were not disclosed.

Other awards included:

- Store Certification Excellence (supermarket category) for the retailer with the most certified stores in the past year: Sprouts Farmers Market (81 stores).
- Store Certification Excellence (non-supermarket category) for the OEM with the most system installations in certified stores in the past year: Hillphoenix (204 stores).
- Store Re-Certification Excellence for each supermarket that has renewed its certification for five consecutive years: Hannaford, Turner, Maine; Whole Foods Market, Brooklyn, N.Y.; Sprouts Farmers Market, Fresno, Calif.; Stater Bros., Redlands, Calif.; and Weis Markets. Hillsborough, N.J.
- Most improved emissions rate: Harris Teeter (year-to-year) and Hanover Co-op Food Stores (since initial baseline year).
- Superior Goal Achievement for each retailer that achieves its annual GreenChill refrigerant emissions-reduction goal: Coborn's, Food Lion, Harris Teeter and Hy-Vee.
- Exceptional Goal Achievement for each retailer that achieves its "stretch" refrigerant emissions goal, which aims for a greater emissions reduction than the regular goal: Hy-Vee. ■ MG

TARGET AND WEIS MARKETS TALK ABOUT SYSTEM SELECTION

At FMI Energy, the two food retailers explain how they apply Emerson's 'Six S's' in navigating the current regulatory climate and choosing natural refrigerant systems

— By Charlotte McLaughlin and Michael Garry

What's the best way to select a new refrigeration system?

That was the $64,000 question under consideration at the Refrigeration Trends panel discussion held last month at the Food Marketing Institute's Energy & Store Development Conference in Atlanta, Ga.

One approach to system selection, outlined at the session by André Patenaude, director of food retail, growth strategy, marketing/business development, for Emerson Commercial and Residential Solutions, is to apply what he called the "Six S's": Safety, Simplicity, Serviceability, Stability, Sustainability and Smarts. (See "The Six S's of Refrigeration Selection," Accelerate America, September 2018.)

Following Patenaude, Andres Lacassie, VP, core & distributed cases, Hussmann, moderated a three-person retail panel on their approach to refrigeration selection in light of the Six S's, among other issues. The panel consisted of Kelly Noel, senior director of engineering, Target; Cara Bastoni, director of engineering, Target; and Dustin Herner, energy manager for Weis Markets.

The following contains highlights from the discussion.

Andres Lacassie: Tell us about your general approach to refrigeration?

Dustin Herner: We have a pretty good program in place with our existing designs and in-house service technicians. But one area I think we can look for manufacturers to improve is to make things sustainable, both from an environmental and business perspective. That touches on the rest of the six S's. We need to make sure things are safe and smart so we can continue our business model in the future as we see outside competitors and disruptors come into play.

Kelly Noel: My big thing is teamwork. So I think that all six S's have to work together very well. You can't have one without the other and there's no clear winner in my mind. I've been at Target for three months, and the only reason I'm up here and able to answer these questions is because the Target team helped me. Thanks guys.

Simplicity is an area where I think there is an opportunity for more development. We like to use several OEMs together to create one system, and it's in our best interest that those OEMs can play in the sand box really well together and give us an overall system that works very well and very simply. That leans into serviceability and refrigeration technician questions. Its helps if our technicians are already trained to use those simple systems.

AL: Is your organization getting ready to address natural refrigerants?

From left: André Patenaude, Emerson; Andres Lacassie, Hussmann; Dustin Herner, Weis Markets; and Cara Bastoni and Kelly Noel, Target

Cara Bastoni: We have several stores where we're using CO_2 cascade or transcritical. We have come to this conference in the past and given updates on them in terms of energy and performance, but we are still evaluating the performance of those stores.

We are also using a lot of R290 self-contained cases in our stores and we've provided our energy data to the industry to show the benefits that we're seeing from that. (See "Target Exceeds 1,000 Propane Stores," *Accelerate America*, October 2017.) We use a lot of self-contained flexible merchandisers in our stores, working with our merchandising team. And we are building a lot of new stores with a unique and complex environment that that has given us a lot of opportunity to experiment with distributed systems.

We continue to see what's best based on what we find. Maybe we can comb through data more to come to some conclusion, but we're not quite there yet.

KN: Target does like to occasionally take a risk and be an industry leader and try out new technologies.

DH: We tried our first CO_2 store this year. It's been up and running for a couple of months. We're in the process right now of making it simple and sustainable. We train our own in-house techs and make sure they can handle the systems. We come to conferences like this and we get that 100-foot view of what a system is like; when we get it in the store, we really try to get down to that 5-foot level and understand how everything works to make it simple and sustainable.

AL: How does your company measure carbon-footprint reduction related to refrigeration?

CB: Target does have public greenhouse gas emission-reduction targets for scope 1 [direct emissions] and scope 2 [indirect/electricity emissions], and refrigeration is a big part of that. Our approach so far has been to test natural refrigerants and low-GWP refrigerants like other retailers. We work with many manufacturers to try new things. And we look at energy use and emissions, and make sure we're getting the performance that we're expecting over time.

DH: We've been tracking our Scope 1 and 2 emissions since 2008. We put out a public sustainability report where you can see all the information, and we have goals going forward. Also for 10 years we have been tracking our leak rates with [the U.S. Environmental Protection Agency] Greenchill program. We look to our manufacturers and in-house teams to make sure these are successful in terms of simple, serviceable and safe as we try new technology.

> *"It's in our best interest that those OEMs can play in the sand box really well together and give us an overall system that works very well and very simply."*

AL: Does the current uncertainty regarding refrigerant regulations at the federal and state level affect your choice of refrigeration architecture and refrigerants?

CB: Target's refrigerant strategy is forward-looking and we try to make it as future-proof as possible. We're still testing a wide range of refrigerants and finding different uses. Even in advance of regulation, we look at what makes sense for our business like upfront capital cost, maintenance cost, energy cost, and the amount of downtime, as well as the environmental footprint.

DH: The new technologies that we're trying out are closer to making business sense from a financial and sustainable aspect, which usually go hand-in- hand. And as we look at the future potential of regulation changes, we want to prove we will be able to act on them as they become realized in our territories. We tried our first CO_2 store this year, which is up and running, and we're learning from that what we can. And if we have to move that way in the future, then we want to be prepared to head down that path with the right tools and the information in hand to make it serviceable, and be able to continue operating in a simple, safe and successful way.

AL: What are you doing to address the shortage of technicians?

KN: It's a big deal, not just in the refrigeration technician realm; construction, trades, and specialists in general are facing a shortage. On the refrigeration side what we can do is just make engagement with technicians more efficient, maybe minimizing the opportunity for technicians to be on site. What we're looking at is how do we as the end user, who doesn't usually think about it, get involved in partnerships, maybe interning? How do we get into the pipeline of technicians and fuel that industry? We need to help establish a technician pool.

From left: Kelly Noel and Cara Bastoni, Target (photo courtesy of the Food Marketing Institute)

AL: How effectively are you leveraging the Internet of Things and cloud-based services to improve your facility or operations?

DH: We've got all these data streams coming in from our stores – what do we do with the data? It's data like the suction pressure or energy demand from a given rack or compressor or condenser, at that point in the day, week or year. My job is to decipher the data. We get assistance from vendors and software but it still takes a person to look at two stores with a very similar design, and yet one is using 50 kilowatts more at night. I can look at serviceability issues and operating set points.

KN: Target loves data. We like to use that data to keep improving our processes. What's important to us is the accuracy of data, and being able to respond in a remote way. Also important is OEM flexibility, and our ability to use the products they have in an integrated way with one another. ■ MG & CM

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CO_2 MAC'S WINDING ROAD

Though mobile air-conditioning (MAC) with CO_2 refrigerant has been favorably rated since the 1990s, only a few automakers have adopted it in small numbers, largely in Europe. Will electric vehicles help push CO_2 into the mainstream?

— By Charlotte McLaughlin

CO_2 transcritical mobile air-conditioning (MAC) has a long history in the AC and passenger-vehicle worlds.

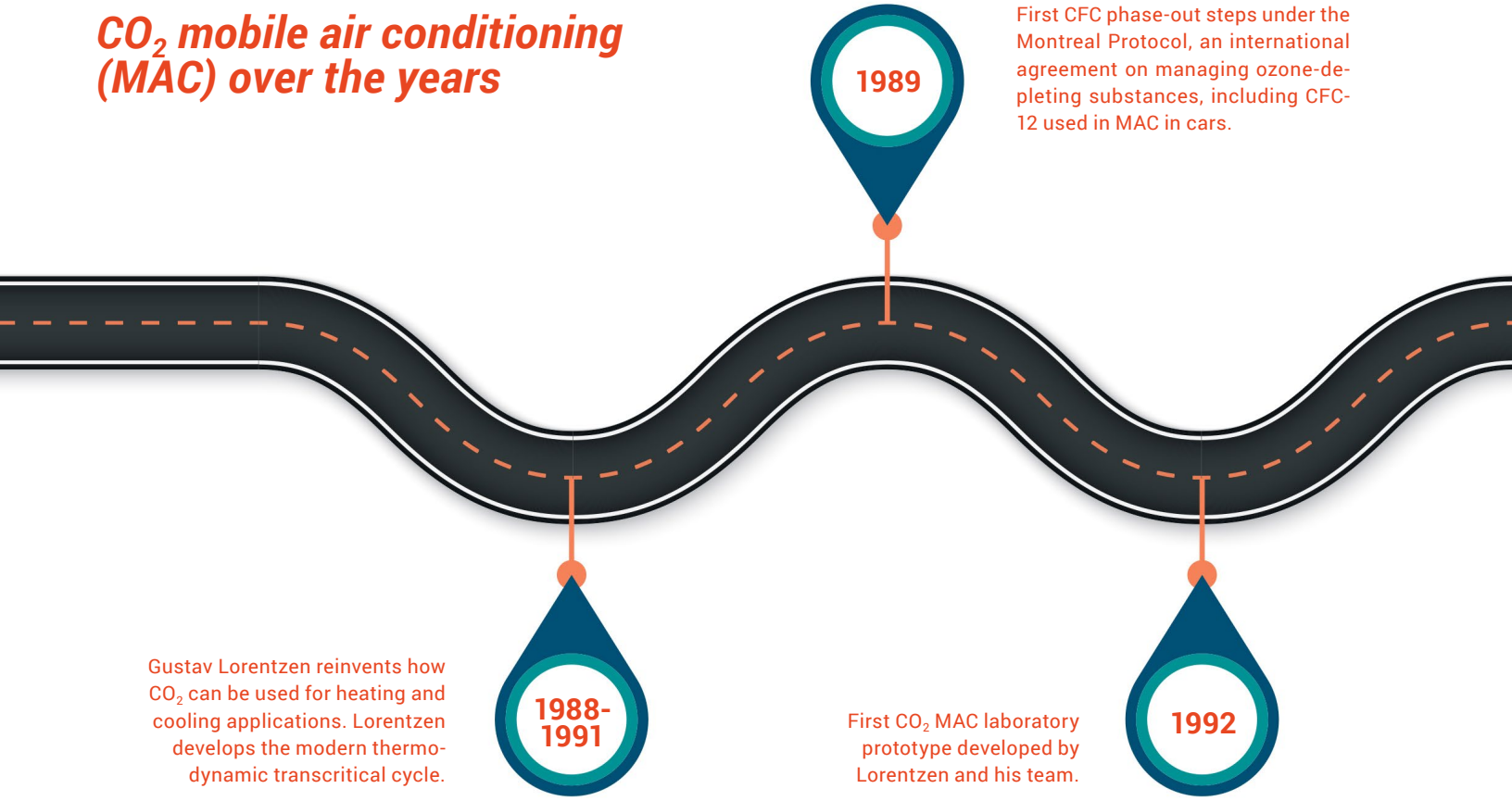
Since the reinvention of CO_2 as a refrigerant by Gustav Lorentzen, the Norwegian professor who developed the modern thermodynamic transcritical cycle, manufacturers and researchers have been looking into whether a CO_2 system could be a replacement for synthetic-refrigerant systems in cars – first systems with ozone-depleting CFCs, then with HFCs, and now with HFOs.

The bottom line: CO_2 can work for MAC, but so far its uptake in passenger vehicles has been almost exclusively limited to the European market, where about 30,000 CO_2 MAC cars provided mainly by Damiler and Volkswagen are on the roads. However, CO_2's prospects are getting stronger – especially for heat pumps in electric and hybrid vehicles.

Daimler has offered certain Mercedes-Benz models with CO_2 air-conditioning in Europe since the end of 2016. In the U.S. market, the German company is not yet ready to introduce CO_2 MAC. "In order to achieve the necessary standard of quality, we will begin by slowly phasing the new air-conditioning systems into production [in Europe]," said Catherine Gebhardt, product PR specialist, Mercedes-Benz USA. "A decision on the further use of this technology will be made on a case-by-case basis."

The U.S. Environmental Protection Agency (EPA) allows the use of CO_2 refrigerant in new vehicles, but with use conditions reflecting the 5-10-times higher pressures under which CO_2 systems operate compared to other MAC systems. The CO_2 MAC systems must also be designed such that in the event of leaks the resulting CO_2 concetrations don't exceed 40,000 ppm in the breathing zone.

CO_2 mobile air conditioning (MAC) over the years



HOW DID THE CO_2 MAC GET TO THIS POINT?

The first prototype CO_2 MAC system, developed by Lorentzen and his last PhD student, Jostein Pettersen, emerged in 1992. Their early results revealed that it outperformed an R12 MAC system, according to Pega Hrnjak, president of Urbana, Ill.-based Creative Thermal Solutions (CTS) and reesearch professor at the University of Illinois, Urbana-Champaign. Hrnjak has spent much of his career working on CO_2 MAC (See "Pega's Quest," *Accelerate America*, February 2018.)

The prototype was welcomed by car manufacturers and led to the establishment of a MAC research project called RACE, which ran from 1994 to 1997 and was supported by the European Union (EU). The project was carried out in conjunction with carmakers and MAC manufacturers and researchers, according to Professor Armin Hafner of SINTEF (Foundation for Scientific and Industrial Research), Trondheim, Norway.

The RACE project looked into many alternatives to R12, including R134a, R1234yf and CO_2. It demonstrated that, as a high-pressure fluid, CO_2 is less sensitive to pressure drops than R134a, delivering a higher coefficient of performance (COP), according to Hrnjak.

Subsequent research over the years supports the opinion that CO_2 is the best solution for MAC. However, refrigerant efficiency remains a divisive issue, according to Thomas Di Vito, head of mechanical compressor design, Sanden International.

"If you have a very good R134a system, you can have better efficiency overall than with CO_2," he said. "But if you have a very good CO_2 system, then in some regions like Europe, you can also have better efficiency. I would say that overall, it's comparable."

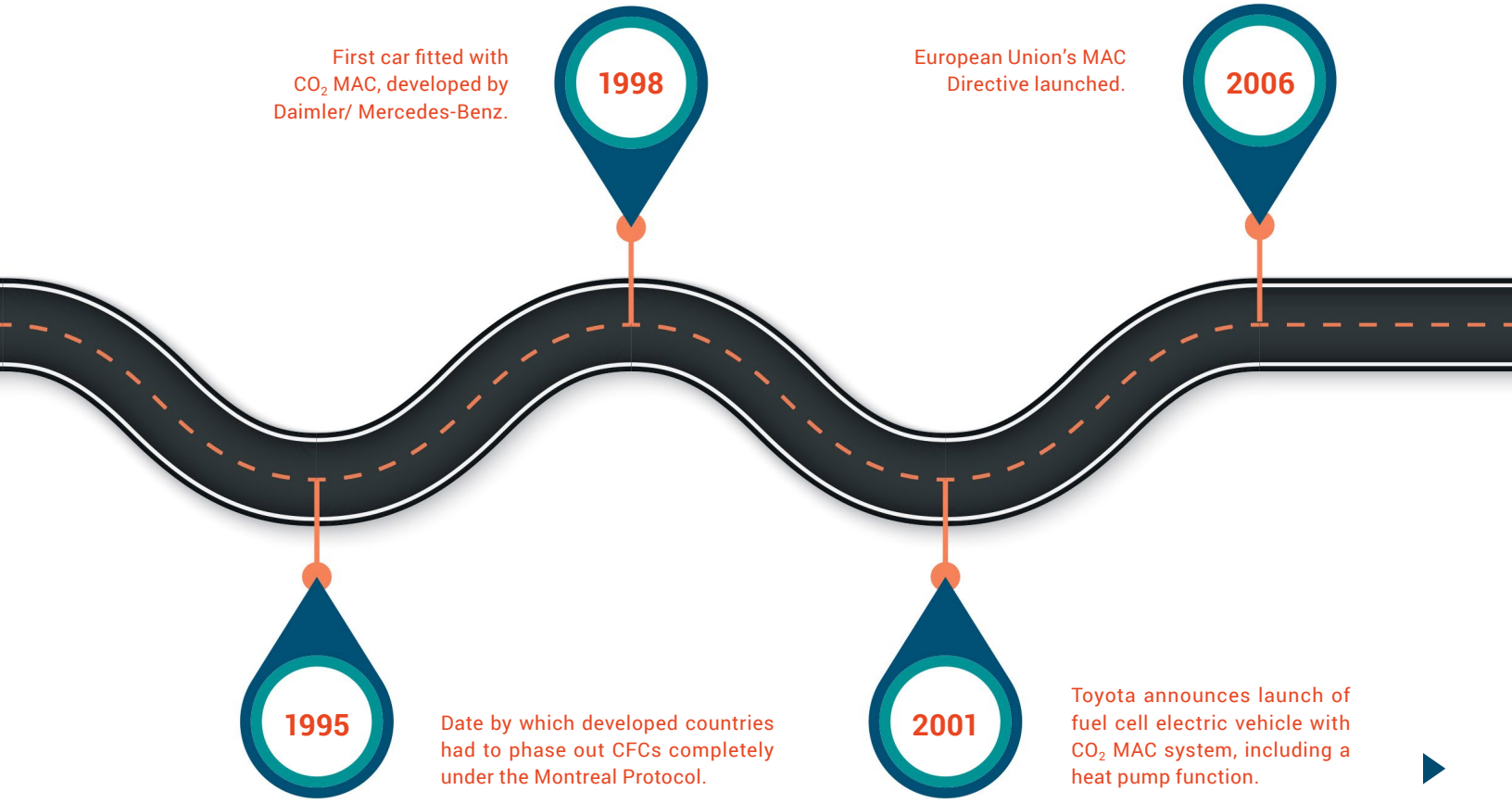
The question of efficiency has not been addressed openly, according to Michael R. Ingvardsen, incoming president of EU industry group MACPartners, which represents the MAC sector in Europe. "The companies involved in developing the CO_2 systems have been very good at keeping the technical information internal, and, therefore, it is difficult for an organization like MACPartners to document the pros and cons [of] CO_2."

DEATH VALLEY SUCCESS

The first live test of a CO_2 MAC system in a car took place in 1998 in the hottest place on the planet – Death Valley in California – where it was compared to an R134a system. The CO_2 system cooled down the car's interior more quickly than the HFC one.

This propelled German and other international carmakers as well as MAC manufacturers forward. Sanden, along with Luk (a MAC supplier that subsequently became Ixetic and then Magna), worked on a mass-produced CO_2 MAC compressor system during the early 2000s.

"Unfortunately this was stopped for several reasons," Di Vito said. "There were a lot of technical hurdles."



But a further push came from the EU-wide MAC Directive, which entered into force in 2006, with the eventual aim of having MAC systems that used under-150-GWP refrigerants in passenger cars on the EU market by 2017.

Recognizing that the automotive industry needed to come up with a low-GWP MAC refrigerant, the German Association of the Automotive Industry (VDA), which includes major German and international carmakers (BMW, Daimler, Volkswagen, Chrysler and Ford), began looking into CO_2. In 2007 VDA announced – and confirned the next year – that CO_2 was the way to go.

"The light at the end of the tunnel seemed to be getting nearer. In late September 2007, representatives of R744.com (a news website devoted to CO_2-based technology, operated by *Accelerate America* publisher shecco) attended the 62nd International Automotive Exhibition (IAA) on commercial vehicles in Hanover, Germany, where they found many CO_2 components and systems available.

Behr Hella Service, a German MAC manufacturer which took part in the original Death Valley test, announced at IAA that it had conducted tests with a 100+ car fleet equipped with CO_2, recording strong cooling performance and energy efficiency compared to R134a systems. Behr also stated it would start preparing for mass production, given these results and the VDA's decision.

Alongside the pronouncements of OEMs and German car manufacturers, Japanese automaker Toyota also said it would start using CO_2 MAC. In the U.S., General Motors said it had placed an order for its first systems, numbering in the low five figures.

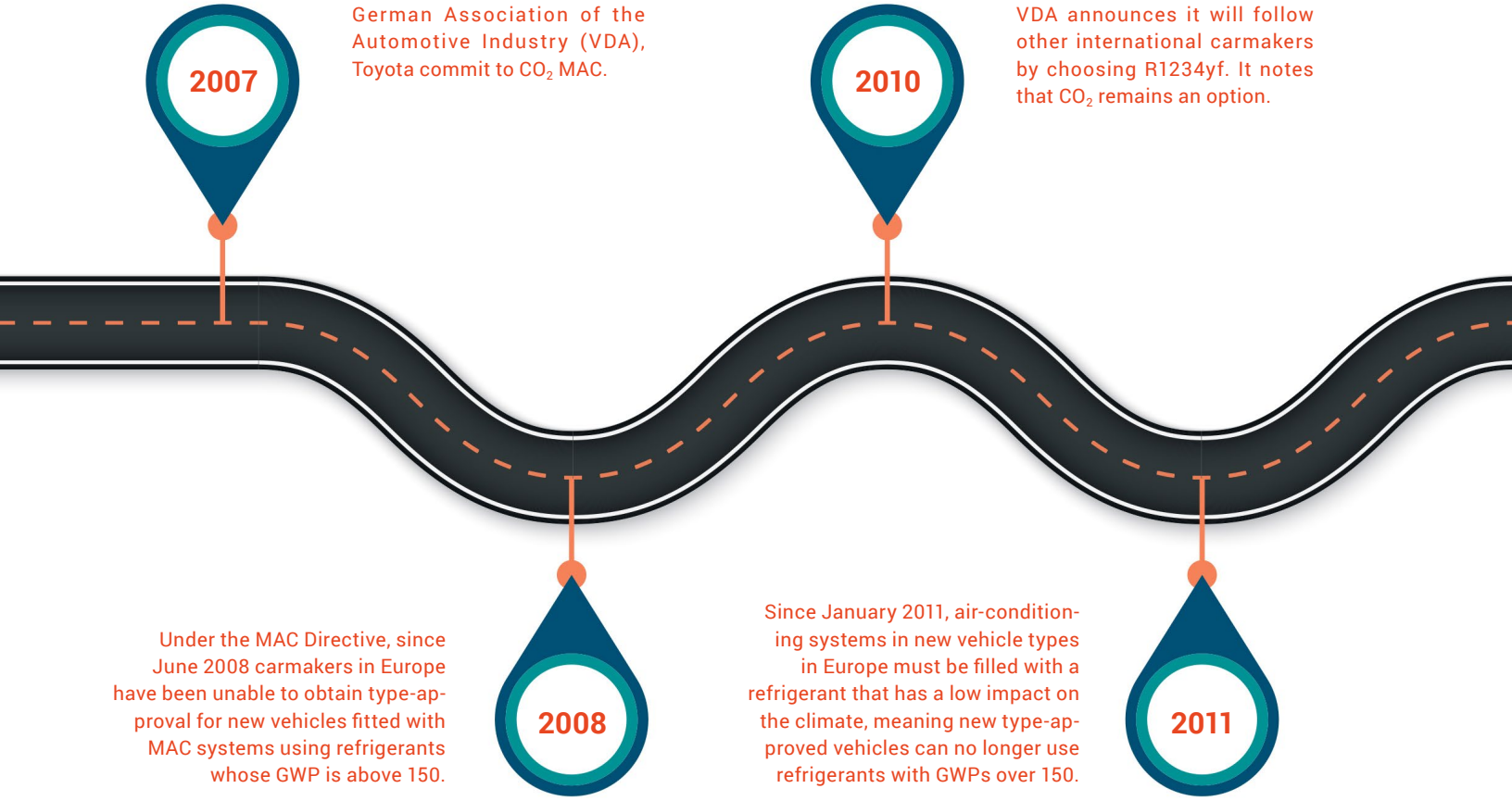
IMPACT OF HFOs

Some of the hopeful signs began to wear off, however, with the arrival of HFOs. "Until R1234yf was introduced in 2007, everyone expected CO_2 [would] be accepted," says CTS' Hrnjak.

Bur HFOs faced some early headwinds. In 2008, German environmental NGO Deutsche Umwelthilfe (DUH) began attacking the VDA for its failure to issue a concrete pledge to introduce CO_2, and warning against introducing R1234yf. This followed a test conducted by DUH simulating a traffic accident with an HFO-based MAC system, which resulted in scenes of the car on fire throughout the engine compartment. The combustion of the HFO also resulted in the release of "life-threatening" concentrations of the toxic hydrofluoric acid .

Despite these concerns, and a confirmation of the safety risk posed by the HFO from the German Federal Institute for Materials Research and Testing (BAM), the VDA announced in 2010 it would support R1234yf. VDA explained its decision by saying that it wanted "not an isolated solution but a global standard" and that R1234yf was more similar to R134a and was less of a change for the industry.

System costs appear to have played a very minor role in this decision. The price difference between R134a and R744 systems was little more than $200 per vehicle in 2007, Hrnjak said. But other factors were influential. At the time, both the German Federal Environment Agency (UBA) and DUH cited lobbying by the chemical industry as playing a role in R1234yf's success, while Sanden International's Di Vito explained that, at that time, CO_2 MAC was not a mature enough technology to meet the deadline set by the MAC Directive.



Whatever the reasons, this decision clearly stymied the progress of CO_2 MAC, particularly by affecting the component supply chain. "Lots of know-how was lost after the VDA's forced U-turn, when R1234yf was announced to be the solution for the next period," said SINTEF's Hafner.

Yet the use of R1234yf continued to be controversial. Daimler rejected the VDA's decision, and in 2012 chose to work towards introducing a CO_2 MAC system. It cited results from its own flammability tests, which had confirmed the DUH and BAM findings, as one reason for its decision. Daimler has since changed its mind amid pressure from the European Commission and the German Transport Authority – and the lack of readiness for CO_2 MAC technology. Daimler has used R1234yf in its vehicles since 2015, with "specific protective devices" in the event of a head-on collision.

Meanwhile, German carmakers Volkswagen, its Audi and Porsche brands, and BMW announced in 2013 that they would follow Daimler in considering CO_2 MAC to be the "long-term solution."

TURNAROUND FOR CO_2?

Then, in 2015, Volkswagen announced it would implement CO_2 MAC in two luxury models. Daimler's Mercedes-Benz committed to rolling out the natural refrigerant in its S- and E-Class models, and pledged to eventually put it in its A, B, and C-Class models as well. The VDA also published its much delayed standards for CO_2 MAC in cars.

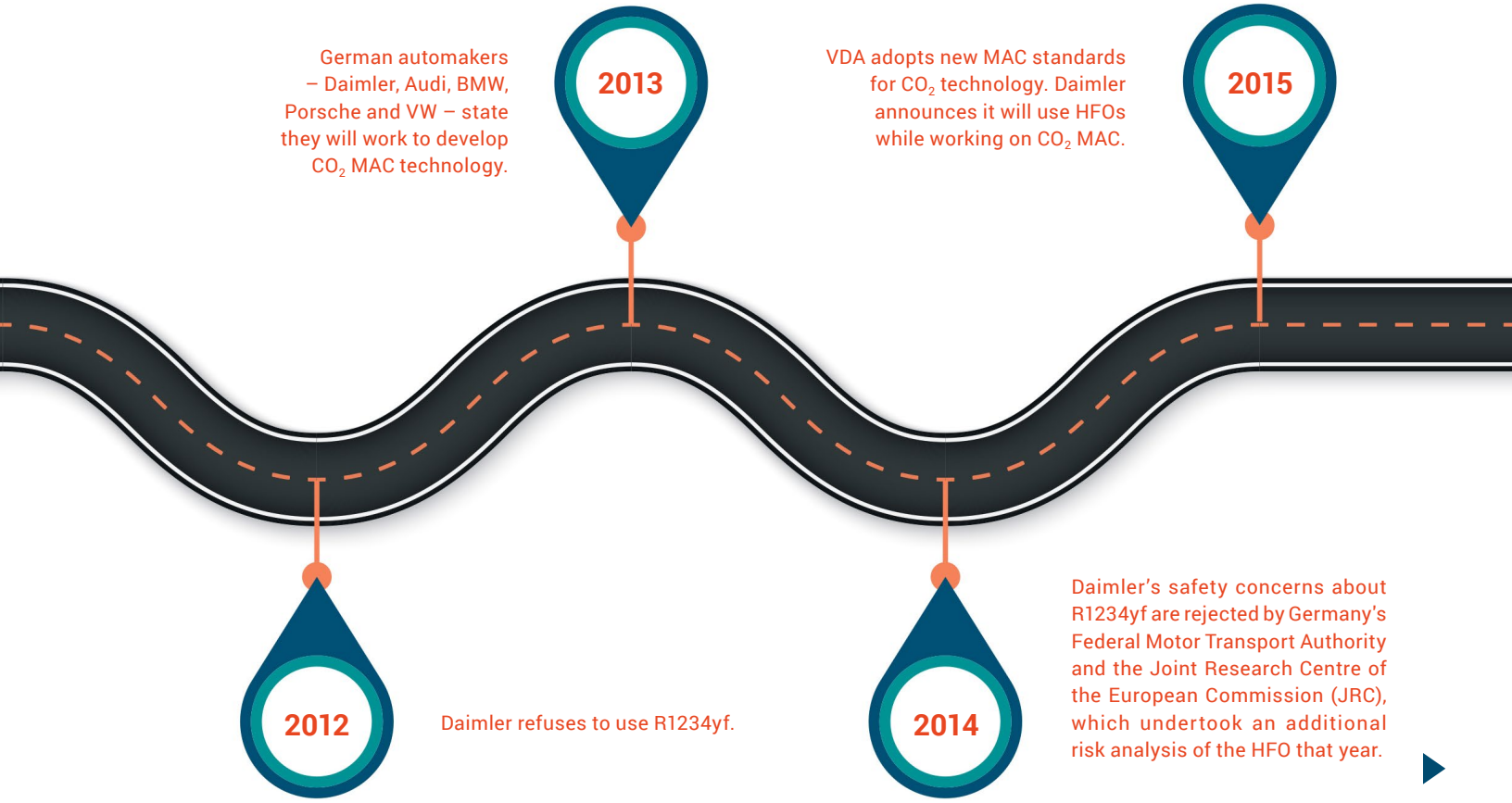
In August 2018, a Daimler spokesperson gave the following update: Since the end of 2016 in the European market, Daimler has offered a model of the S-Class Coupé (S 400 Coupé) with CO_2 air conditioning. In addition, in all variants of the S-Class (Sedan, Coupé & Cabriolet), the CO_2 air conditioning system is used in the main volume carriers S 560 and S 400 d. Also, in the E-Class, the CO_2 air conditioning system is available in some variants as part of optional thermotronic equipment.

Volkswagen also followed through with CO_2 for its Audi model, but its other CO_2 MAC offering – in the VW Phaeton – did not come to fruition as the car was discontinued, according to a company spokesperson. "I would like to confirm that the Volkswagen Group is continuing to announce that it will gradually equip its vehicle fleet with the refrigerant CO_2 (R744) for reasons of sustainability," she said. "From the point of view of environmental and climate protection, CO_2 is the preferred refrigerant for us in the long term."

BMW and Volkswagen brand Porsche appear not to have installed CO_2 in any of their car models. "Porsche continues to work on the technology within the group," a spokesperson said. "At present, no Porsche models with R744 are available."

A BMW spokesperson said the company still believes "R744 is a sustainable solution" but said that "developing for a wide deployment takes years, not months. An area-wide rollout scenario is therefore conceivable in the medium to long term."

Companies appearing to offer CO_2 components for MAC systems and heat pumps in cars in 2018 include Witzenmann, KAORI, KONFORT, Sensata, Panimpex, AVL Ditest, Bitzer, Denso, SANDEN, Sanhua, Behr, MAHLE, Valeo, and Ixetic (Magna-branded CO_2 compressors). Eberspaecher Suetrak, Konvekta and many others have systems available using CO_2 as a refrigerant for bus air-conditioning and heat-pump systems.



So far, an estimated 30,000 cars using CO_2 MAC have been sold in the Europeam market, according to Sanden. While this represents a modest success, a real transition to the natural refrigerant awaits further developments. "The transition towards CO_2 MAC requires a complete change in most of the production infrastructure," explained SINTEF's Hafner. "Tier 1 suppliers, manufacturing most of the MAC systems, need long-term contracts to be able to make this kind of investment. The OEMs do not always have a long-term perspective when it comes to investment.

"Several people developing CO_2 MAC systems still believe and understand why it would make sense to perform a complete switch on a global basis," Hafner added. "However, there are others working hard for this not to happen."

Training for CO_2 also remains a challenge for the MAC industry. "The installation will of course demand a technician that is certified to work on a CO_2 system," said MACPartners' Ingvardsen. But this would require specialized training that has yet to materialize on a large scale.

Meanwhile, HFOs – the most likely alternative to CO_2 – remain a matter of concern for environmental agencies in European countries. In 2017, a report on HFOs by the Norwegian Environment Agency recommended that a number of "knowledge gaps" needed to be addressed before the ultimate effect of R1234yf – in particular, its decomposition in the atmosphere into trifluoroacetic acid (TFA) – on the environment could be determined. It recommended a preemptive phase out of the refrigerant.

Similarly in 2018, Germany's UBA warned that TFAs could contaminate the water supply, and recommended adopting CO_2 for MAC instead.

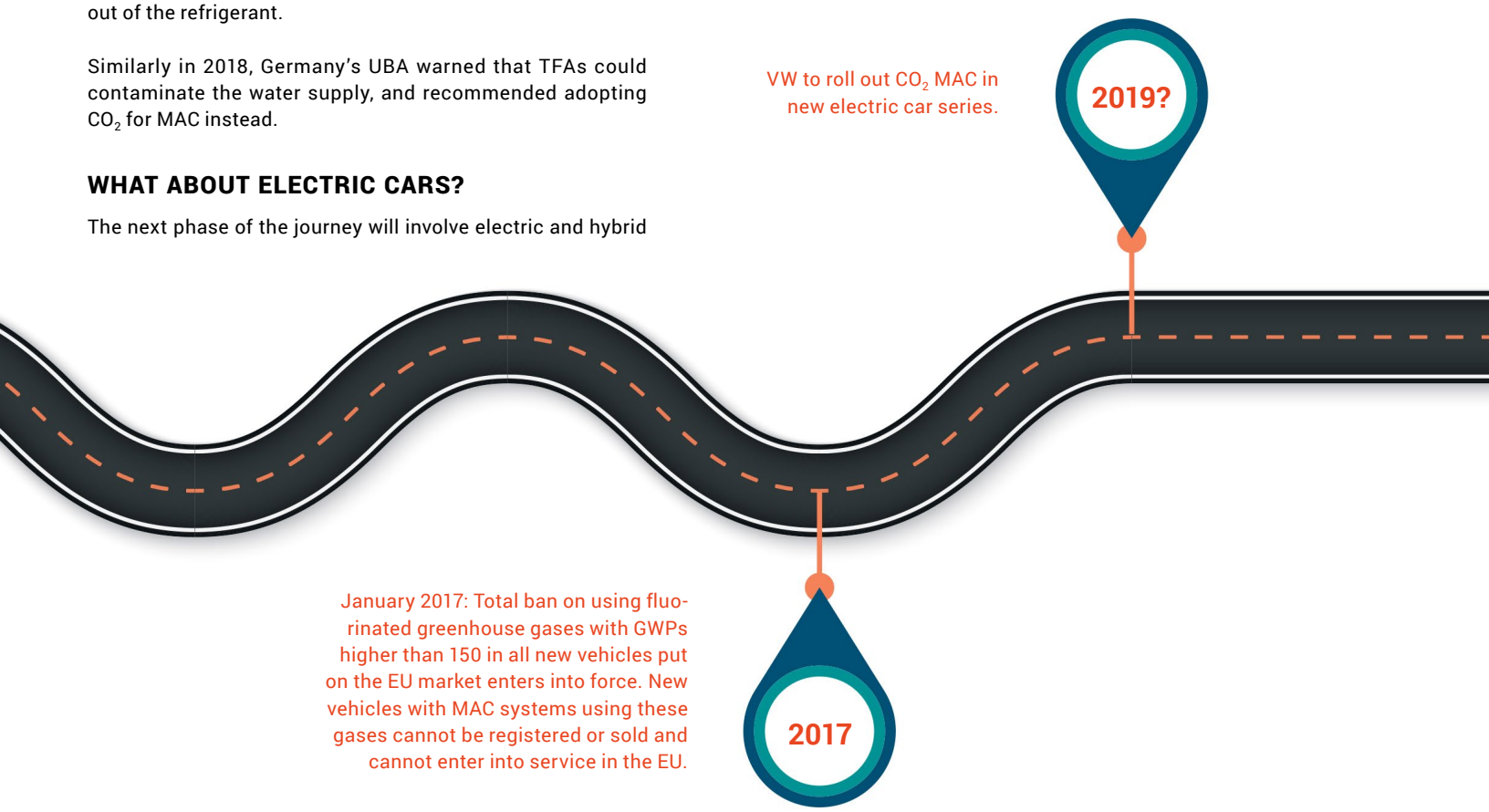
WHAT ABOUT ELECTRIC CARS?

The next phase of the journey will involve electric and hybrid cars, which are positioned to significantly influence the uptake of CO_2-based MAC systems. "For the next generation of vehicles, i.e. electric and hybrid cars, there is a need for heat pumps to increase their driving range, especially during the cold winter months," said Hafner, noting CO_2's excellent heat pump capabilities. The driving range can be improved by 30% with a CO_2 heat pump, according to some studies.

"Electric cars do not have waste heat or engines with internal combustion," says CTS' Hrnjak. "For that reason, the only source of the heat in winter time is the energy from the battery. A heat pump is the best way to rationally use electric energy stored in the battery, because you need only about one third of the energy."

Hrnjak also pointed out the disadvantages of using HFOs in MAC heat pumps. "HFOs are low pressure fluids," he said. "As such they are not appropriate for low-temperature applications." VW has recognized this. Its new "ID" electric car series uses CO_2, a spokesperson from the company said.

Other carmakers are investigating the heat pump potential of CO_2, according to Michael Matthias, head of engineering at Sanden International (Europe) Ltd.'s European technical center. "There is a lot of interest and the investigation is ongoing," he said. ■ CM



CO_2 SHINES AT FMI ENERGY

Progress on installations and development of transcritical technology is cited by Hillphoenix, AAA Refrigeration, RefPlus, Modine and Sporlan

— By Michael Garry

Scott Martin, Hillphoenix

Despite turmoil in U.S. regulations of HFCs, the adoption of transcritical CO_2 systems as well as the development of new transcritical technology progressed in North America in recent months, according to a number of companies interviewed at the Food Marketing Institute's Energy & Store Development Conference.

The conference took place in Atlanta, Ga., at the Sheraton Atlanta, from September 23-26.

The following interviews with OEM Hillphoenix, contractor AAA Refrigeration and three component makers (RefPlus, Modine and Sporlan) depict a growing market for transcritical CO_2 in the U.S. and Canada.

Hillphoenix Has 400+ Transcritical Sites

More than 400 Hillphoenix transcritical CO_2 systems are now installed in North America, the most of any supplier, said Scott Martin, director of business development and industry relations for the Conyers, Ga.-based OEM.

"When you walk into our factory, the [transcritical CO_2] units are everywhere. It's exciting!" said Martin.

The total number of transcritical systems from all suppliers in North America is 615+, according to shecco-Base estimates.

ALDI US has been the leading user of Hillphoenix's transcritical units. As of June 2018, the chain had installed transcritical CO_2 systems – mostly from Hillphoenix – in 130 stores, according to Amber Hardy, director of energy management for ALDI.

Most of the more than 400 transcritical systems installed in North America are in supermarkets, though there are installations in ice rinks and cold-storage plants as well. Hillphoenix declined to say how many systems are separately in the U.S. and in Canada.

In June 2017, Martin reported that Hillphoenix had installed transcritical CO_2 in close to 300 stores in North America,

The ability of enhanced transcritical systems to operate efficiently in warm climates has helped spread sales throughout North America, including such hot locales as Palm Springs, Calif.; Florida, Alabama and South Texas, said Martin.

Most of the warmer-climate stores use adiabatic condensers, though Hillphoenix has begun testing other technologies; these include parallel compression in a Houston, Texas, store and three others; and an ejector in a Sprouts Farmers Market store in Woodstock, Ga. Some of the stores with parallel compression also use adiabatic compressors, Martin added.

CO_2 rack installed by AAA Refrigeration at Weis Markets

New York Contractor 'All In' for CO_2

AAA Refrigeration, finding lower energy consumption and competitive first/installation costs, has installed several transcritical systems, with more to come.

AAA Refrigeration Service, a contractor based in Bronx, N.Y., is "pushing people to go CO_2," said Peter Savage, AAA's project manager, controls division.

"We're all in for CO_2," he added.

AAA has installed several transcritical CO_2 systems to stores operated by DeCicco & Sons in Westchester County, N.Y. The contractor has a new transcritical project with a ShopRite store in Courtand, N.Y., and an upcoming one with DeCicco & Sons in a month, said Savage. In July, AAA installed a transcritical system with an adiabatic system at a new Weis Markets store in Randolph, N.J.

Most of AAA's transcritical installations include an adiabatic condenser to keep the system out of the transcritical mode. In one case, Savage said, AAA is retrofitting a misting system on a RefPlus gas cooler, which is less expensive that an adiabatic system. (See RefPlus story, page 32.)

Most of AAA's installations feature Hillphoenix transcritical systems.

Savage says that AAA is advising retailers that the cost of transcritical CO_2 system with an adiabatic condenser, including installation, is a little more than a traditional DX system with display cases that don't use controllers. But the transcritical cost would be less compared to a DX system with cases that use controllers. All transcritical systems use controllers.

Installation costs for CO_2 systems are lower because of small-diameter line size, which cuts labor and copper costs, said Savage.

From left: Mark Westphal, Modine; Lou Moffa, ebm-papst

In terms of energy costs, "every single piece of data that John [DeCicco, Jr., president of DeCicco & Sons] shows us has tremendous energy savings," said Savage.

Modine Installs CO_2 Gas Coolers

In a sign of the growth of transcritical CO_2 installations in the U.S., Modine Manufacturing, Racine, Wis., has installed its CO_2 air-cooled gas coolers at about 185 stores this year in North America, said an executive of the company.

Most of the installations were in new stores and took place "this summer," said the executive, Mark Westphal, director of sales and marketing, commercial and industrial solutions.

The installations were done for a handful of supermarket chains (one chain got the lion's share), with one or two gas coolers per store, depending on the size of the location. The stores were generally in northern climates, he noted, where high ambient temperatures are less common.

In warmer climates, U.S. stores with transcritical systems typically employ an adiabatic condenser rather than an air-cooled unit.

Westphal observed that larger supermarkets are still favoring transcritical CO_2

systems as their natural refrigerant technology, while smaller stores are beginning to opt for self-contained propane units. "For larger stores, CO_2 makes all the sense in the world," said Westphal.

He said he expects more transcritical systems to be installed in remodeled stores next year.

Modine Manufacturing got into the commercial and industrial coils and coolers business with the acquisition in 2016 of Memphis, Tennessee-based Luvata Heat Transfer Solutions.

The Modine CO_2 gas coolers use EC fans from ebm-papst, Farmington, Conn. Lou Moffa, market manager, ebm-papst, said the fans were 800-mm, 3 kW EC units; the latest model of those fans is the AxiBlade axial.

The EC fans "save energy, reduce noise and move more air," said Moffa.

RefPlus offers adiabatic misting system

While adiabatic condensers with pads have become a common condensing/gas cooling system for many transcritical systems, Canadian equipment maker RefPlus is marketing an alternative adiabatic system.

The system – the Opti-Mist Plus – uses atomizing nozzles to generate a fog of very fine water droplets, which evaporate to pre-cool ambient air entering a heat exchanger. This allows a CO_2 system to operate in "subcritical" mode for more hours and thereby improve efficiency in warmer climates.

Introduced three years ago, the system is installed at a Sobeys IGA store in Montreal that uses a transcritical system, said André Paré, vice president of sales & marketing for RefPlus, headquartered in Saint-Hubert, Quebec.

The Opti-Mist Plus "can be as efficient or more efficient than a system with pads," said Paré.

He noted that RefPlus didn't want to use pads, an evaporative medium, because they have to be removed in the winter and cleaned. The Opti-Mist Plus operates as a dry cooler during winter and mild months.

The Opti-Mist Plus system uses a given amount of water only once, in a single pass, The water is cleaned in a pumping station that has filters, UV lighting and a demineralizer. The misting device can be installed on any outdoor condensing unit with "hydrophobic coated fins," says RefPlus on its website.

The Opti-Mist Plus is lower cost and lower maintenance than a pad system, according to Tom Richgels, director of sales – USA for RefPlus. Its defining feature is that it's "so simple," he said.

At higher ambient temperatures, the unit maintains the condensing temperature at about 78°F, Richgels said.

RefPlus has installed more than 100 air-cooled condensers without a misting unit at Canadian stores, added Richgels.

Sporlan debuts upgraded CO_2 components

With the ongoing adoption of transcritical CO_2 refrigeration systems in North America, the Sporlan Division of Parker Hannifin introduced three new CO_2-related components for the North American market.

The new components include an electronic expansion valve (EEV), and rack and case controllers designed to make CO_2 systems more cost competitive, according to Sporlan. "We are expanding our CO_2 line to do more – faster speed, more powerful and better performance," said Clay Rohrer, business unit manager for Parker Hannifin, a Mayfield Heights, Ohio-based component maker.

The components are also lower cost "to be more competitive," said Rohrer. "One of the problems with CO_2 is the electronic valves are more expensive." CO_2 systems' cost is also boosted by the cost of case controls, he added.

The SPW EEV for CO_2 is a pulse width modulated (PWM) valve for evaporator coils.

The MT-700 series CO_2 controls platform covers racks, parallel compressors, ejectors and adiabatic or air-cooled condensers/gas coolers.

The S3C Bluetooth case controller can be used for CO_2 and other refrigerants. ■ MG

Arneg Bringing R290 Cases to U.S.

Arneg USA, a division of the Italian OEM Arneg, has started bringing new propane (R290)-based self-contained commercial cases into the U.S. market this year, according to a company executive.

Some of the air-cooled, island-style cases have already been installed in U.S. stores, said the executive, Howell Feig, vice president, sales & marketing for Arneg USA, in an interview at the FMI Energy & Store Development Conference in Atlanta last month.

Arneg has been offering propane self-contained cases in Europe for eight to 10 years. "We're going to be trying to migrate as many cases over to propane as we can, considering the charge limit," said Feig.

He is eagerly awaiting a vote by the IEC that would raise the charge limit for propane in commercial cases to 500 g from 150 g.

Feig previously worked for AHT Cooling Systems USA, a major manufacturer of propane cases in the U.S.

Arneg USA is manufacturing CO_2 cases for remote transcritical rack systems at its Lexington, N.C., headquarters, noted Heig.

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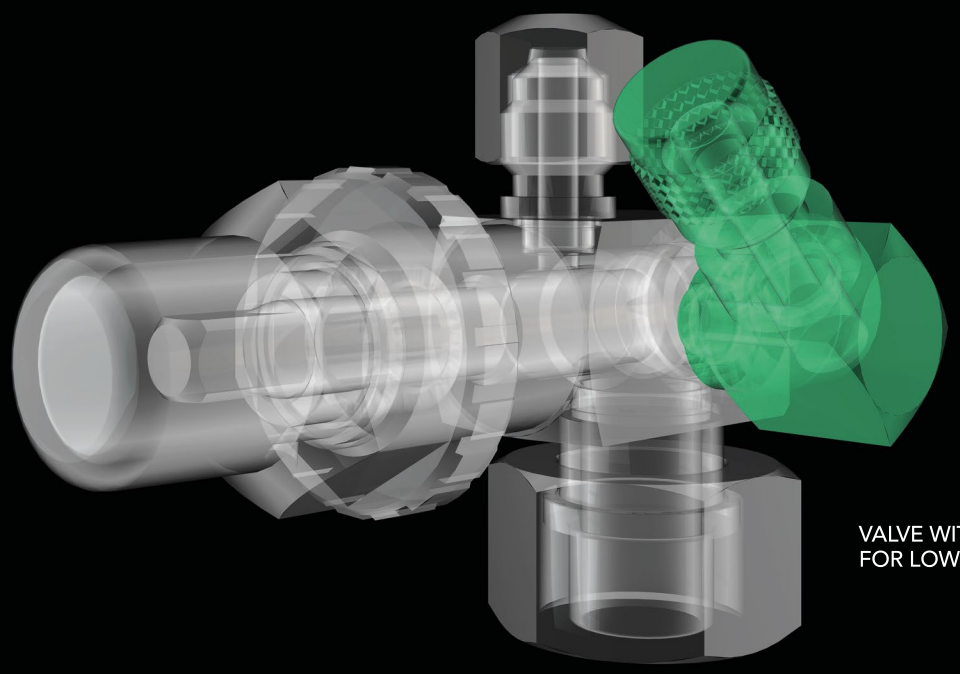

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Three States Follow California's Lead on HFCs

New York, Maryland and Connecticut vow to cut HFC emissions as California's Governor Brown signs Cooling Act

– By Michael Garry

Last month, the governors of New York, Maryland and Connecticut directed their states to reduce HFC emissions, following California's aggressive efforts to regulate the high-GWP gas.

The states are part of the U.S. Climate Alliance, a bipartisan coalition of governors from 16 states and Puerto Rico that is committed to reducing short-lived climate pollutants (SLCPs), including HFCs. Other states in the group are expected to also act on HFCs.

California has set the standard over the past few years on state action to slash emissions of HFCs and other SLCPs.

On August 30, the California legislature passed the California Cooling Act (Senate Bill 1013), which preserves Obama administration's Environmental Protection Agency (EPA) regulations on HFCs while creating an incentive program for HFC-replacing natural refrigerant systems. (See "California Passes Cooling Act," *Accelerate America*, September, 2018.) California Governor Jerry Brown signed the bill into law on September 13.

Funding for the Cooling Act's incentive program must still be allocated by the legislature so that the California Air Resources Board can form the program and initiate a stakeholder process to shape its scope and guidelines.

"Governor Brown's signing of the California Cooling Act will have positive impacts far beyond California by encouraging the global supply chain to adopt less-polluting and more energy-efficient cooling technologies," said Helena Molin Valdés, head of the Climate and Clean Air Coalition. "This bill will drive innovation, is good for business, and helps protect our planet. California is becoming a world champion in the super-pollutant field."

NY Governor Andrew Cuomo

New York follows suit

On September 10, New York became the first state to follow in California's footsteps as Governor Andrew M. Cuomo directed the state's Department of Environmental Conservation (DEC) to issue regulations phasing out the use of HFCs.

Like the California Cooling Act, the proposed New York regulations would adopt 2015 and 2016 rules (20 and 21, respectively) created under the EPA's Significant New Alternatives Policy (SNAP) program; the rules target a number of high-GWP HFCs for delisting from the program in various applications over the next several years.

In April, the EPA dismissed those rules pending a new rulemaking, in response to a U.S. Appeals Court ruling last year that narrowed the EPA's authority to regulate HFCs. The Supreme Court recently declined to hear the an appeal of the ruling. (See story, page 35.)

The New York proposal covers a range of new and retrofit applications, including food refrigeration equipment, cold storage warehouses and stationary air conditioning, with bans taking place between 2020 and 2024.

State funding is available to accelerate the reduction of HFCs more quickly, Cuomo's announcement said.

DEC will be seeking input on this proposal prior to proceeding with a formal rulemaking, with the intent of finalizing a rule in 2019.

"I encourage other states to join with New York and California to combat dangerous HFCs," Cuomo said.

The day after Cuomo's announcement, the Maryland Department of the Environment (MDE) said that it plans to develop regulations to phase out the use of the certain HFCs. This action will help Maryland meet its requirements under the state's Greenhouse Gas Emissions Reduction Act.

The MDE intends to develop regulations "similar to those in development in California, which would phase out the use of certain HFCs in foam products and in refrigeration equipment in retail establishments, such as supermarkets," the department said. "The phase out of HFCs will encourage the use of substances with lower greenhouse gas emissions" that are already available.

"Our administration is committed to climate leadership by preventing pollution and partnering with other states, businesses, and advocates to make critical progress toward protecting and preserving our environment." said Maryland Governor Larry Hogan.

"These fast-acting super pollutants are a major threat to our climate progress and deserve to be phased out at the state and federal level," said Ben Grumbles, Secretary of Maryland's Department of the Environment.

Connecticut acts

Finally, just days after the Maryland announcement, Connecticut Governor Dannel P. Malloy directed the Connecticut Department of Energy and Environmental Protection (DEEP) to develop regulations that will phase out the use of HFCs.

Malloy made the announcement in September while meeting with several of the nation's governors and leading scientists at the Global Climate Action Summit in San Francisco.

Over the next few months, DEEP will begin the rulemaking process to develop regulations to adopt the 2015 and 2016 changes to the SNAP program regarding HFCs.

"If the federal government will not act to mitigate the impacts of climate change, it is incumbent upon states to act to protect the one planet that we have," said Malloy. "By joining the Powering Past Coal Alliance, and phasing out the use of hydrofluorocarbons, Connecticut is sustaining its commitment to hold true to the goals of the Paris Agreement. MG

Supreme Court Won't Hear HFCs case

On October 9, the U.S. Supreme Court declined to hear the appeal of an August 2017 Court of Appeals case that restricted the Environmental Protection Agency's ability to regulate HFCs under the Significant New Alternatives Program (SNAP).

The ruling coincided with the first day on the Supreme Court of newly confirmed justice Brett Kavanaugh, who, in his former role as a judge on the U.S. Court of Appeals for the District of Columbia, wrote the 2-1 decision in the HFCs case, *Mexichem Fluor v. EPA*. Kavanaugh did not participate in the Supreme Court's decision to decline hearing the case.

The 2017 Court of Appeals decision, which has roiled the U.S. HVAC&R industry, was appealed to the Supreme Court by chemical companies Honeywell and Chemours and by environmental NGO Natural Resources Defense Council, who were intervenors in the case. The defendant in the case, the EPA, did not appeal. Moreover, in late August the EPA asked the Supreme Court not to hear the appeal, saying it no longer supports the type of regulation that the appeals court overturned.

In the Court of Appeals case, foreign chemical companies Mexichem and Arkema challenged the EPA's authority to regulate HFCs under the SNAP program, focusing on the the Rules 20 and 21 that delisted HFCs from the SNAP list of acceptable refrigerants.

The Court of Appeals agreed in part, saying the SNAP program could not justify replacing HFCs in existing equipment where the HFCs were used in lieu of ozone-depleting substances (ODS). But the court allowed HFCs to be prohibited from use in systems still using ODS.

In February, the EPA announced it would abandon Rule 20 altogether, going beyond the requirements of the Appeals Court decision, and initiated new rulemaking on how it would regulate HFCs in the future.

EPA PROPOSES TO RESCIND LEAK REPAIR RULES FOR HFC EQUIPMENT

Section 608 requirements for leak repair and maintenance – and possibly more – would go back to applying only to ozone-depleting substances; EPA will take comments until November 15

— By Michael Garry

In its latest effort to undo environmental regulations instituted by the Obama administration, the U.S. Environmental Protection Agency (EPA) on October 1 published a proposed rule that would rescind the leak repair and maintenance requirements for stationary refrigeration and air-conditioning equipment containing HFCs.

Those requirements were part of an update to Section 608 of the Clean Air Act issued on November 18, 2016. Under the update, the EPA extended the refrigerant management rules – originally designed for ozone-depleting substances (ODS) – to common ODS substitutes like HFCs.

Section 608 requirements generally apply to supermarkets and other end users of large refrigeration and air-conditioning equipment. It asks them to perform repairs for refrigerant leaks above a certain threshold, which in the 2016 update was lowered from 35% to 20% of annual refrigerant charge for supermarkets. Leak inspection and repair verification requirements under the updated rule are scheduled to take effect on January 1, 2019.

However, under the proposed rule, the EPA would revert to the original language of Section 608, which pertains only to leak repair and maintenance of ODS equipment.

The EPA, which held a public hearing on the proposed rule on October 16, will receive written comments on it until November 15. Comments can be submitted at www.regulations.gov, using EPA-HQ-OAR-2017-0629 as the Docket ID.

True Manufacturing, a producer of self-contained refrigeration cases, plans to voice objections to the proposed rule, said Charles Hon, its engineering manager.

“It’s a serious problem,” he said. “If it goes through, you can leak [HFCs].”

The agency is also requesting comment on whether it should also rescind additional requirements set forth in the 2016 rule pertaining to HFCs, such as the provision requiring purchasers or handlers to be Section 608-certified technicians. Hon said True opposes “people getting into the service industry who may not have the necessary skill sets.”

In addition, the EPA is proposing to extend by six to 12 months the January 1, 2019, date for when HFC appliances must begin complying with leak repair and maintenance provisions.

In the proposed rule – called “Protection of the Stratospheric Ozone: Revisions to the Refrigerant Management Program’s Extension to Substitutes” – the EPA says that the 2016 update, by covering HFCs, “exceeds EPA’s statutory authority.”

The EPA said its new proposed rule “would reduce the burden associated with the 2016 Rule by $39 million per year.” But it would also boost the need to purchase HFCs “for leaking appliances,” at a cost of $15 million per year, resulting in a net savings of “at least $24 million” per year, the agency said. Rescinding additional provisions of the 2016 rule would save an additional $4 million annually, the EPA said.

The EPA acknowledged that rescinding the HFC rule would add at least 3 million to 3.6 million metric tons of CO2e emissions annually.

Industry concerns

The EPA proposal is raising concerns in industry circles. "This proposal puts the industry in a tough position," said Danielle Wright, executive director, North American Sustainable Refrigeration Council (NASRC). "Everyone has been preparing for these regulations for a long time. To change them now creates uncertainty for the future, and uncertainty is bad for business. Federal programs like the EPA offer stability for the industry. Now, we are likely to see a patchwork of various state regulations that could vary and end up being more stringent."

Washington, D.C.-based Environmental Investigation Agency (EIA) harshly rebuked the proposal. “The proposed rollback of pivotal controls, intended to reduce superpollutant leaks from some of the highest leaking systems operating

Daniele Wright, NASRC

today, flies directly in the face of common sense," said Avipsa Mahapatra, EIA's climate campaign lead. "Having these measures in place not only would have reduced emissions equivalent to taking some 1.5 million cars off the road each year, it also would have made American industry more efficient in using controlled refrigerants."

Without the EPA restrictions on HFCs, she added, "only California currently has a program to limit leaks of such superpollutants. Facilities across the rest of the country now will be allowed to leak and vent unlimited quantities of HFCs with no accountability."

In response to an Appeals Court ruling in 2017, the EPA has already stepped back from Obama-era rules on HFC regulations under the agency's Significant New Alternatives Policy (SNAP) program, which called for the removal of high-GWP HFCs from the list of permitted ODS substitutes for new equipment. The agency is pursuing new rulemaking regarding HFC regulation. In the meantime, California has passed legislation adopting the EPA's HFC delisting rules enacted in 2015 and 2016, and last week three more states said they were following suit (page 34).

EIA is asking "those states and others to now also take up this issue of HFC refrigerant leaks in existing equipment," said Christina Starr, EIA's climate policy analyst. "We can't afford to wait for this rulemaking to be finalized to take action. Refrigerant leaks are a massive contributor to greenhouse gases, with U.S. supermarkets alone leaking emissions annually that are equivalent to 17 coal-fired power plants."

Noted Alec Johnson, author of the RefrigerantHQ.com blog, "As time goes on we're going to have additional states join the phase down, and I have a feeling this new announcement from the EPA is only going to fuel the desire for the states to take matters into their own hands." MG

WHAT THE PROPOSED RULE WOULD DO

The EPA's new proposed rule would rescind the following Section 608 requirements for appliances with 50 or more lbs of HFCs:

- Conduct leak-rate calculations when refrigerant is added to an appliance.
- Repair an appliance that leaks above a threshold leak rate.
- Conduct verification tests on repairs.
- Conduct periodic leak inspections on appliances that exceed the threshold leak rate.
- Report to EPA on chronically leaking appliances.
- Retrofit or retire appliances that are not repaired.
- Maintain related records.

EPA is also requesting comment on rescinding other provisions that were extended to HFCs, including the following:

- Anyone purchasing refrigerant for use in an appliance or handling refrigerants (e.g., air-conditioning and refrigeration service contractors and technicians) must be a Section 608-certified technician.
- Anyone removing refrigerant from a refrigeration or air-conditioning appliance must evacuate refrigerant to a certain level using certified refrigerant recovery equipment before servicing or disposing of the appliance.
- The final disposer (e.g., scrap recycler, landfill) of small appliances, like refrigerators and window air-conditioners, must ensure and document that refrigerant is recovered before final disposal.
- All used refrigerant must be reclaimed to industry purity standards before it can be sold to another appliance owner.

Taking on Transcritical in Cold Storage

Pete Lepschat,
Henningsen Cold Storage

Photography by:
Thomas Patterson

A longtime ammonia user, Henningsen Cold Storage is testing transcritical CO_2 refrigeration in two widely separated locations – among the first all-CO_2 industrial plants in the U.S.

— By Michael Garry

Pete Lepschat, engineering services manager for Hillsboro, Ore.-based Henningsen Cold Storage, has heard all of the "common folklore" about transcritical CO_2 refrigeration, such as that it uses a lot of energy.

So he was expecting to see an energy penalty when he commissioned a comparison between a transcritical system's projected energy consumption and that of a low-charge central ammonia system.

But the transcritical CO_2 system turned out to be slightly more efficient and is expected to save 46,000 kWh/yr in electricity usage. "I was pleasantly surprised," he said in a recent interview with *Accelerate America*.

Supported by the promising energy data and other metrics, the transcritical system has been running since June 20 at family-owned Henningsen's new 111,000-sq-ft cold-storage facility in Grandview, Wash., supplying 187 TR of refrigeration capacity for a freezer (157 TR) and a dock area (30 TR).

This is the 95-year-old cold-storage operator's first transcritical system, one of a small number of such systems being used in industrial refrigeration facilities in the U.S. (See page 45.) Carnot Refrigeration supplied the system and PermaCold Engineering installed it.

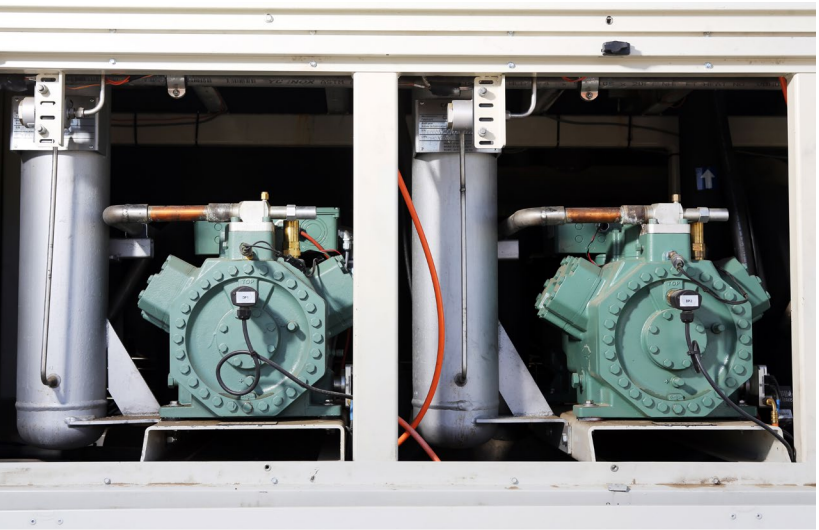
Henningsen put the transcritical system (rack and condenser) on top of the dock roof, a small area that was relatively easy to support and offered more accessibility for forklifts.

The CO_2 system represents a bold departure for a cold-storage operator that has relied primarily on ammonia for decades. "It's our first one, but I'm guardedly optimistic," he said.

And last month, Henningsen installed a second transcritical system, from Hillphoenix, at an existing plant in Scranton, Pa. (See page 41.) Henningsen also runs 10 central ammonia refrigeration plants (three with a low-charge configuration) and one leased facility using a synthetic refrigerant.

For the Grandview project Lepschat benefited from the advances transcritical refrigeration – more commonly employed in supermarkets– has made in the industrial sphere, particularly in Canada. "CO_2 is moving quickly in the market," he said. "So there's more information on it."

Though hopeful, Lepschat understands that the jury is still out on the two new transcritical systems as he collects data on their energy performance, maintenance requirements and overall reliability in the demanding environment of a cold-storage plant. "It needs to be proven with real-life measures over the first year," he said.



From top: Compressor rack control panel, transcritical CO_2 compressors

The following are specifications for the transcritical CO_2 system installed at Henningsen's Grandview, Wash., facility.

- System Provider: Carnot Refrigeration
- Storage areas: Freezer (100,000 sq ft; 0°F) and Refrigerated Dock (11,000 sq ft; 36°F)
- CO_2 charge: About 2,400 lbs
- Adiabatic Condenser/Gas Cooler: Güntner
- Capacities: 157 TR (Freezer); 30 TR (Refrigerated Dock)
- Compressors: Bitzer, Semi-Hermetic Reciprocating; 7 30-HP low stage, 6 60-HP high stage
- DX Evaporators: Güntner; 6 for freezer, 2 for dock
- Electronic Expansion Valves: Danfoss
- CO_2 Detection: Calibration Technologies Inc. (CTI)
- Defrost: Hot Gas

BECOMING READY FOR CO_2

Lepchat, a highly regarded refrigeration engineer who has been with Henningsen for 24 years (and is on the board of RETA), started looking at transcritical systems seriously about 14 months ago as an option for the new Grandview plant. Prior to that, for another plant that opened last year in Salem, Ore., he was not quite ready to take on transcritical technology and opted for the latest version of his low-charge centralized ammonia system (See "We have met the enemy, and he is liquid," *Accelerate America*, August 2017.)

The primary motivation Lepschat had for using CO_2 over ammonia is CO_2's relative safety. CO_2 has been used for decades in breweries, soft drink plants and other industrial settings, yet "I would be hard-pressed to find cases in an industrial setting of fatalities from CO_2," he said. "It's not non-toxic, but it's not nearly as toxic as ammonia."

In an enclosed area, where there is the potential for asphyxiation from CO_2, "you start to feel crummy and get a headache before it reaches a toxic level," he said. "So it is a little bit self-alarming." In any event, industrial areas tend to be too large to allow for that scenario, he added.

Lepschat also cites the opportunity a transcritical system affords to eliminate the regulatory burdens imposed on users of ammonia systems; "If you can avoid the cost and exposure to great liability from fines, why not?"

But CO_2 still had to pass muster as a practical and economical refrigeration system before Lepchat could support investing in it. Most importantly, he had to answer the question, "Is there any one thing that's going to make us say no?" he noted at the ATMOsphere America conference in June (sponsored by *Accelerate America* publisher shecco).

Lepschat first weighed transcritical CO_2 against other refrigeration options, such as the kind of low-charge central ammonia system he has installed over the past several years, low-charge packaged units, and even a packaged HFC unit.

He quickly eliminated the HFC unit because of the uncertainty surrounding its regulation due to HFCs' high GWP, its "brutal" energy performance and the high cost of HFCs ($30/lb). He also dismissed packaged ammonia systems because of their cost, driven in part by the need for roof upgrades to support their weight.

That left low-charge central ammonia as the baseline for comparison to transcritical. In particular, Lepschat compared transcritical's actual and sometimes projected costs to the costs associated with his low-charge ammonia central system in the Salem, Ore., plant that opened in 2017, which is similar in size and scope to the Grandview facility. (See chart, page 44.)

Next March at the IIAR Natural Refrigeration Conference & Expo in Phoenix, Lepschat plans to be part of a presentation comparing the costs of the Grandview facility's CO_2 system with those of the baseline low-charge ammonia central system in Salem.

ENERGY SAVINGS WITH CO_2

Among the key metrics that Lepschat analyzed were reliability (no late night calls that the system is down) and energy use, for which he could make projections. "These are the cornerstones of our business," he said.

Lepschat hired Energy350, Portland, Ore., to compare the energy consumption per hour of every component of the transcritical system and the baseline system for a given TR. The company projected there would be an electricity savings of 46,000 kWh/yr. Energy350 "has been amazingly accurate in the past with our ammonia plants," he said. "So I expect similar results."

Lepschat employs the cold-storage industry's energy consumption metric, which is kW/cu ft/yr. Henningsen's average across its warehouses is 0.4 (ranging from 1.1 to .27), compared to the IARW industry average of 1.21. "Energy efficiency is a big one for us," said Lepschat. "We've done a good job managing that."

Because of its projected energy efficiency, the transcritical system at Grandview earned a $262,000 energy incentive from a local utility (Pacific Power), which helped "level the playing field" for the CO_2 system, said Lepschat. (It was not included in his cost comparison.)

It is well known that the ambient climate affects a transcritical CO_2 system's energy efficiency. Notably, warm climates in the 80°F-90°F range complicate the condensation of CO_2, increasing the system's energy usage. While Grandview, Wash., has a moderate climate, its summers can be quite hot, as was the case this year.

THE SCRANTON CO_2 SYSTEM

Besides the geographic separation, Henningsen Cold Storage's other transcritical CO_2 system, – which went live on August 20 in a facility in Scranton, Pa. – differs in several ways from its first transcritical system in a Grandview, Wash., warehouse.

Most significantly, Scranton was an existing facility when the CO_2 system was installed while Grandview was new.

Henningsen purchased the Scranton plant in 2001, and initially used its 30,000-sq-ft freezer to store ice cream at -20°F. The R404A refrigeration equipment was in an engine room located in a building adjacent to the freezer. "It was an energy hog," said Pete Lepschat, engineering services manager for Henningsen Cold Storage.

About six years ago, Henningsen had an opportunity to shut down and remove the freezing system and install an R410 rooftop HVAC system that would chill pharmaceuticals at about 68°F. That arrangement lasted until last year.

Henningsen then decided to go back to using the Scranton building as a freezer, and took the HVAC unit out. But what would it use now as a refrigeration system? Not HFCs, and a central ammonia plant wouldn't work because of the proximity to a grade school. Low-charge ammonia packages could not be supported on the roof.

Lepschat settled on a 60-TR transcritical CO_2 system, provided by OEM Hillphoenix.

This transcritical system went into the existing engine room, so there was no savings from avoiding construction of an engine room. As a result the installed cost of the transcritical system was "slightly more" than the baseline HFC system.

Though the energy analysis was not as in-depth as it was for the Grandview facility, the transcritical system was projected to save around 47,000 kWh/yr.

"We decided it was a smart long-term investment," Lepschat said.

The Scranton facility's piping is made of a copper-iron alloy. Though much more expensive than the stainless steel used in Grandview, it was employed in Scranton because the smaller system there made the "cost delta" with the Grandview plant less, said Lepschat. In addition, the Scranton contractor was not experienced with the orbital welding needed for stainless steel.

Hillphoenix, known for its comprehensive CO_2 education, trained technicians working at the Scranton facility. The OEM also performs remote monitoring of the system.

Now having two transcritical systems from different OEMs, Henningsen will be able to compare the two in terms of controls, maintenance and other metrics, Lepschat said.

Early on, the Scranton system is running well, said Lepschat. "It's dependable."

But Lepschat gained confidence in transcritical's efficiency in warmer ambient temperatures from a presentation about "using CO_2 with ammonia-type equipment," given by Australian engineer Klaas Visser at an IIAR conference. "He showed that the continental U.S. – save for South Florida – is a viable place for CO_2," he said. Visser was among the "impartial" people "who helped me to justify this," he added.

So far, the Grandview system has been operating mostly during high-temperature months (June-September), which were "extraordinarily hot months up there," said Lepschat. "The expectation is that when it's very hot, CO_2 will pay an energy penalty, but it more than makes up for that penalty during the off-season."

Even during the hot period, the adiabatic condenser prevents the system from entering less-efficient transcritical mode for all but "a few hours," said Lepschat. "Anytime it's over 75°F outside, you need the adiabatic system to keep the condensing temperature subcritical. When it's 90°F outside, the condenser thinks it's 62°F."

In Grandview, the adiabatic process is helped by the dryness of the air. "It's semi-arid; sagebrush grows there," he said.

Because the transcritical system's energy savings is driven by the use of the adiabatic condenser, Lepschat opted for adiabatic rather than use a less expensive air-cooled condenser. "We wanted the system to operate as efficiently as possible," he said. "We were willing to pay extra for measures that will improve efficiency." He expects the greater efficiency to result in an ROI on the premium and "lifecycle savings."

He relied on the engineering expertise of Carnot in deciding not to purchase other energy-saving technology for the transcritical system, such as an ejector or parallel compression.

Lepschat will also reduce overall building energy costs by leveraging the CO_2 system's considerable heat from discharge gas. It will be used to warm the floor under the freezer and to minimize defrost in the freezer by getting rid of moisture in the dock area (preventing it from entering the freezer). He estimates that up to 90% of the load in the freezer is due to warm moist air infiltrating the freezer room and creating ice that needs to be defrosted.

"You still have to defrost, but it's a lot less often," he said. The system defrosts with hot gas.

OTHER SAVINGS

Energy is not the only area where Lepchst sees savings. The installed cost of the transcritical system was $534,000 less than that of the baseline system; this included the savings gained from not building a machine room, which ranged between $200,000 and $400,000.

Not having a machine room was also a time saver; an engine room takes six weeks to build while the transcritical system was built at Carnot Refrigeration's factory and installed in three hours.

Another plus for the transcritical system is that its evaporators hang in the same spot in the freezer room where ammonia evaporators hang in other buildings. "So structurally, there was no modification to the freezer box, which was familiar to us," he said.

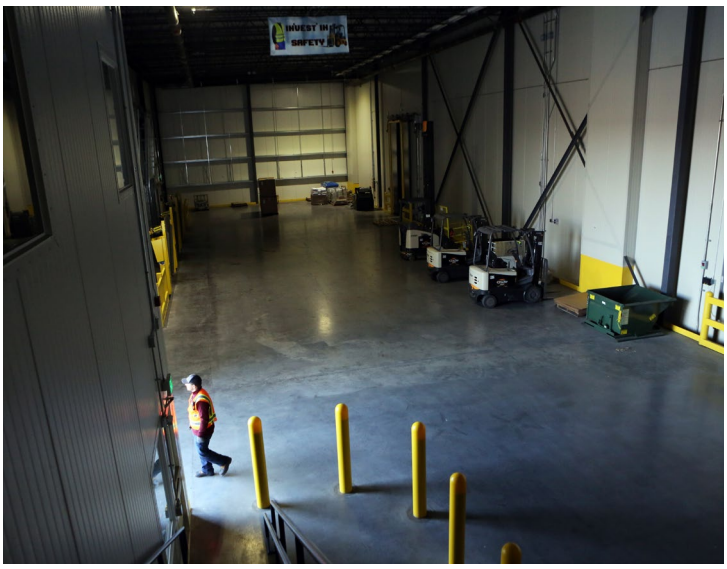
In anticipation of taking on more cold storage business, Lepschat left space for one more evaporator and two more compressors, gaining another 32 TR for the freezer that would be used to freeze product (the other freezer space is for storage). Henningsen did get the additional business, and the equipment was installed.

In addition, Lepschat decided to create another area within the existing facility where a second compressor rack/condenser system, supporting six more evaporators, could be installed to support additional business. Alternatively, Henningsen may decide to invest in a new adjoining building with its own transcritical system.

There are a number of changes in material and techniques that Lepschat had to make in transitioning from ammonia to CO_2. "You don't do things because you did it that way with ammonia," said Lepschat. "It might not be cost-effective, and it might be flat wrong."

For example, with the CO_2 system Lepschat employed corrosion-resistant stainless steel tubing in all suction and liquid lines connecting evaporators in the freezer and dock to the compressor rack and condenser/gas cooler, respectively. By contrast, he used arc-welded carbon-steel piping in the low-charge ammonia system.

The stainless steel tubing is welded via



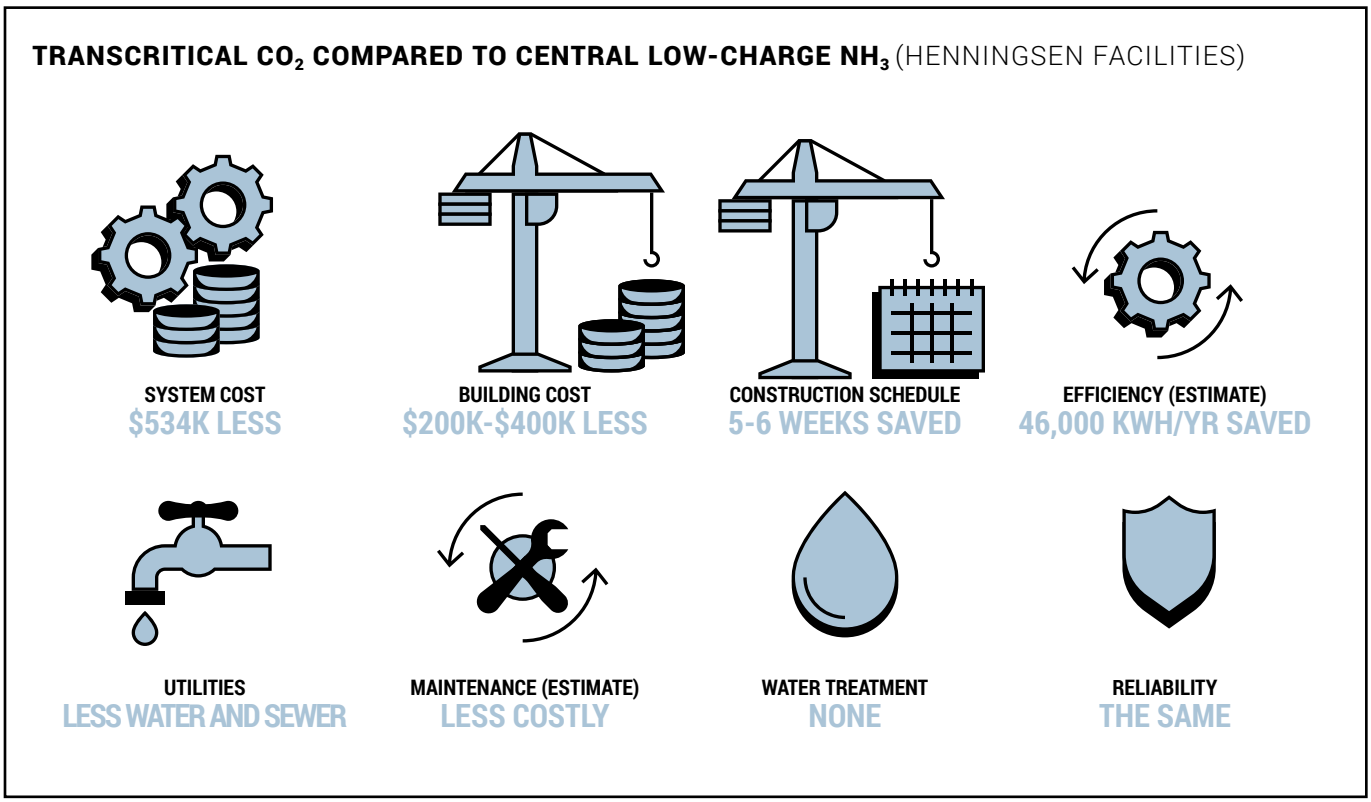
Clockwise from top:

Refrigerated dock area

Freezer

Adibatic condenser

Liquid and suction CO_2 pipes for freezer evaporators



machine-operated orbital welding, which is new for Henningsen and "a lot of people in the industry," said Lepschat.

While Henningsen's contractor, PermaCold Engineering, is familiar with orbital welding, this was the contractor's first field experience with the technique. "They learned how to do it outside," Lepschat said.

This is an example, he said, of PermaCold's willingness to "step out of the box" and work with a new technology. "You've got to find a contractor willing to do that; many are not."

Lepschat was able to limit the length of outside suction tubing to the compressor; the rest was inside the freezer with the evaporators. "That saved us on construction costs" and lessened welding done outside, he noted.

With the stainless steel tubing, he is also able to use Armaflex insulation, which is not possible with carbon steel. Armaflex is less expensive and easier to install, he said.

By using an adiabatic condenser rather than an evaporative condenser, Henningsen substantially reduces its water and sewer costs, noted Lepschat. "For the bulk of the year – fall, winter and spring – it will run without water," he said.

GOING TO SCHOOL ON CO_2

Another essential element for transitioning to new technology is training. Carnot Refrigeraton came to Grandview on two occasions – with more to come – to train technicians, both PermaCold's and his own. In addition, Lepschat has started sending Henningsen's technician to CO_2 classes at the Industrial Refrigeration Training Center (IRTC) in Lyndhurst, Va.

"We're going to all go to school together," said Lepschat. "My guys and my service company are going to get educated."

The training in all cases emphasizes "conceptual knowledge," he said. "We teach how it works because if they understand the theory of what's going on inside the pipes, they are much more effective in figuring out when something's not going right."

Some of the key issues technicians face in CO_2 systems are high pressures and the potential to form dry ice. "I'm satisfied in my mind there's no danger from pressure because of the system we installed and because of pressure testing," he said. "And the odds of dry ice in pipes are slim if you take the correct precautions and have the right training."

To ease the first-year learning period for Henningsen, Carnot monitors the system remotely from its Quebec headquarters on a 24X7 basis, using sophisticated technology, and oversees any required maintenance. "It's like NASA," said Lepschat. But when the one-year warranty expires, "we take that on ourselves," he noted.

Ultimately, once technicians are up to speed, he expects transcritical CO_2 to need less maintenance than central ammonia systems, which require many regulation-related and other activities that are not applicable to CO_2.

After some initial commissioning hiccups, the transcritical system has been "chugging along," said Lepschat. "It's not a dramatic system. It's almost boring to watch. You can stand next to it and have a conversation."

So far Lepschat's biggest challenge is the newness of the system. "We've never done it before," he said. "But we hadn't done a lot of things before we did them the first time." ■ MG

CO_2: RIGHT FOR INDUSTRIAL?

Because of the introduction of transcritical CO_2 systems, industrial refrigeration – for decades a tradition-bound industry reliant mainly on ammonia – has grown "complicated," said Terry Chapp, national business development manager, Danfoss, in a presentation at the ATMOsphere America conference in June. (ATMOsphere America is organized by *Accelerate America's* publisher, shecco.)

The complexity comes from industrial end users now having in CO_2 an additional option for their cold-storage or food processing plants. But it's one that actually simplifies their regulatory requirements while improving plant safety, noted Chapp.

CO_2 systems, he said, would be suited for industrial systems with a smaller capacity – from 50 TR to 300 TR – than ammonia systems, which can cover from about 100 TR to more than 2,500 TR. The pressure ratings for CO_2 industrial systems range from 754 to 1,250 and possibly higher.

In regard to the efficiency concern about CO_2 based on geography, Chapp said that adiabatic condensers and ejectors "have the potential to minimize this concern."

Chapp was generally optimistic about CO_2's prospects in industrial refrigeration. "While there are a limited number of transcritical CO_2 systems in existence in industrial refrigeration today, the number is growing," he said. "The experience has been positive and inquiries are accelerating."

Besides Henningsen Cold Storage's CO_2 systems in Grandview, Wash., and Scranton, Pa., other industrial transcritical facilities in the U.S. include a MaMa LaRosa Foods Italian-style dough plant in Taylor, Mich., and an upcoming Yosemite Meat processing plant in Stockton, Calif., expected to be one of the world's largest CO_2 facilities.

For end users, Chapp said, "total cost of ownership, at first glance, appears favorable for transcritical CO_2."

Many component manufacturers are also "investing heavily" in the future of industrial refrigeration, including makers of compressors, adiabatic condensers, expansion valves and controls, he said. ■ MG

The following are specifications for the transcritical CO_2 system installed at Henningsen's Scranton, Pa., facility.

- System Provider: Hillphoenix
- Storage area: Freezer (30,000 sq ft, 0°F)
- CO_2 charge: 1,600 lbs
- Adiabatic Condenser/Gas Cooler: Güntner
- Capacities: 103 TR (freezer)
- Compressors: Bitzer, Semi-Hermetic Reciprocating; 3 25-HP low stage, 4 40-HP high stage
- DX Evaporators: Colmac Coil; 8 for freezer
- Controls and Valves: Danfoss
- CO_2 Detection: Emerson CPC
- Defrost: Hot Gas

Evaporator at Grandview, Wash., facility

John Prall,
Embraco

THE CHANGING FACE OF R290 CASES

Embraco's John Prall reflects on how variable-speed compressors and rising charges will impact the market for self-contained commercial display cases

– By Michael Garry and Charlotte McLaughlin

Stand-alone cases using hydrocarbon refrigerants like propane or isobutane are on the rise in North American stores, particularly as supplements to remote cases.

Some small-format stores are even going with full-store line-ups of self-contained propane cases. (See story on Lidl, page 18.)

But the market for self-contained hydrocarbon cases is just beginning to take shape, as more efficient variable-speed compressors enter the marketplace, and higher charge limits are on the horizon.

To get an overview of the market, *Accelerate America* caught up with John Prall, applications engineer, for Brazilian compressor manufacturer Embraco.

> *"Variable speed brings you to another level of efficiency and capacity."*

Accelerate America: Tell us about Embraco's variable-speed compressors?

John Prall: We do both fixed speed and variable speed. Typically with fixed speed we are able to get some improvements in efficiency with each generation; our EMC family is a pretty big jump over the compressors that it is able to replace. But variable speed brings you to another level of efficiency and capacity. It's a more interesting discussion to have because of the higher levels of efficiency you can achieve at variable speed, mixed with a natural refrigerant. In variable speed, we have the FMX range of R600a compressors and our FMF family, which is for R290.

In the case studies we did with the FMX, it brings a lot of benefits outside of the fact that it's a natural solution with a higher efficiency – like lower noise levels and tremendously improved temperature stability.

AA: How common are variable-speed compressors in the marketplace?
JP: I think North America is going to be a little hesitant to move in that direction, mainly because our energy regulations are just not that tough compared to what you see in, say, Europe, where the cost of energy is high.

AA: What about the stricter 2017 U.S. Department of Energy standards?
JP: I think hydrocarbons allowed people to meet the DOE standards without variable speed, and we've made some significant improvements in efficiency with our fixed speed as well.

AA: So there is more uptake of variable speed in Europe?
JP: These products are new. So I would say if we talk in a year we will have a very different conversation about the volumes of these products.

AA: Is variable speed more expensive?
JP: Unfortunately yes. There is still an added cost to go to variable speed – you're adding an inverter and you're talking about a fairly complex compressor. But we are able to use smaller shell versions now than we could in the past, so we are able to mitigate some of those cost increases. The magnitude of the increase is dropping quite significantly next to where it was two years ago.

AA: Is the higher cost holding people back?
JP: That would be the first barrier.

AA: What about the ROI you get with greater efficiency?
JP: But who gets the ROI? The end user has to understand that value to drive the OEM to want to make that solution. It's going to be an investment for the OEM to develop a product around variable speed and then update their product lines. So if the end user is able to realize that efficiency benefit and is able to put a financial number to it, then they could work with their OEM of choice to develop a product around this type of solution.

I tend to believe food retailers would be one of the first to look into variable speed as they have a history of variable speed on parallel racks. Plus supermarkets really have an eye on their energy bills. I don't think that link is quite as solid in foodservice as it is with food retail because you have a distributor, not an OEM, selling equipment to a foodservice restaurant.

> *"The 150-g charge limit can make it very difficult to have a hydrocarbon-based solution that is financially sustainable."*

RISING HC CHARGE LIMIT

AA: How will the market be impacted by the IEC's proposal to raise the charge limit of R290 for commercial cases to 500 g from 150 g?

JP: The 150-g charge limit can make it very difficult to have a hydrocarbon-based solution that is financially sustainable for the end user. It's possible to make large cabinets with the 150-g charge, but the number of compressors required to meet the load is quite high and could add significant cost. But 500 g would eliminate this barrier.

AA: Will the higher charge limit bring down costs?

JP: Yes, for sure it would bring down the cost. Where you once needed 4 or 5 compressors for one large cabinet, you could get away with one or two. It makes the cabinet much easier to construct for the OEMs, leading to labor and material savings.

AA: And that will drive a lot more investment in R290?

JP: Yes, we're already expecting that. We have bigger compressors if the charge limit goes up. Anyway, the IEC is just one piece of the puzzle. It's just the first critical hurdle to raise the charge limit.

AA: After IEC's approval of the charge increase, would it take another year for the U.S. to adopt it?

JP: There are many groups in the U.S. that would have to approve the charge-limit change, including the EPA, UL and ASHRAE, before we could realize these benefits.

AA: Do you think R290 self-contained cases will become an alternative to central systems for food retailers?

JP: I tend to agree that in certain markets it just makes more sense. I would not expect a hypermarket to go that direction as much as small convenience stores between 5,000 and 15,000 sq ft. And of course they work as side loads, even in hypermarkets, if you want to put some refrigerated product in the store but not connect it to your central rack.

AA: What about doors on cases?

JP: From a sustainability standpoint no one can argue that doors are not the right answer. However you have the merchandisers, who at the end of the day drive their companies. I guess there is some loss of impulse buying when you add doors. But then there's the energy bill. So is it the lower energy bill with doors or more impulse buys without them? It's a financial decision.

AA: Tell us about your complete refrigeration system called the Plug n' Cool?

JP: Technically it's a sealed, full-refrigeration unit with the evaporator, the condenser and the compressor. It's a little more advanced than a condensing unit. A condensing unit would not have the evaporator because it only has what we call the high side – the condenser and compressor. By including the expansion device and evaporator, it's got all four of the major components, so it's a total refrigeration unit that you drop on the top of the case. The main benefit is that it is factory-charged, which improves reliability, and if there is a problem in the field, it is very easy to service.

AA: Is it available in U.S. market?

JP: Yes, we have been showing it for a couple of years, but now we're at a maturity level for that product, and we're really starting to bring the solution into this country. Having case studies in South America has really helped. One case study from Brazil features a family-owned store that used to run on R22. By switching over to an R290 system with the Plug n' Cool, he saved a lot of money. He's really in love with the system. I think it paints a nice picture. ■ MG & CM

GCCA LAUNCHES ENERGY EXCELLENCE RECOGNITION PROGRAM

Program allows cold-storage warehouses to track and improve efficiency, with best performers receiving awards

– By Michael Garry

The Global Cold Chain Alliance (GCCA) has started an "Energy Excellence Recognition Program," designed to recognize warehouse facilities that improve their energy efficiency.

The fee-based program allows participants to use interactive tools to track efficiency at each of their facilities, as well as receive progress reports with recommended next steps and links to resources.

The program is designed to help facilities to "identify and change energy consumption behaviors, improve energy efficiency and promote their efforts to current and potential customers," the GCCA said.

"We are excited to launch the Energy Excellence Recognition Program to recognize the work our members are doing to drive energy excellence in the cold chain," said Corey Rosenbusch, president & CEO, GCCA. "The program can also help warehouse organizations better partner with their customers on sustainability initiatives while creating greater efficiencies that may generate cost-savings for their facility."

Tracking performance

Using qualitative and quantitative assessment tools, the program allows a location to establish a baseline year with records, and then track performance over time "to identify challenges and opportunities for improvement," said GCCA.

Top performers will receive recognition (Gold, Silver and Bronze levels) based on their improvements in energy efficiency.

Program participants submit qualitative and quantitative data via two analytic tools – a facility data collection form and a web-based evaluation tool – available for download under "How to Enroll" at https://bit.ly/2ILAZEG.

The facility data-collection form is used to input facility data, including energy consumption, product throughput, wet/dry bulb temperatures, and facility characteristics. Each facility establishes a baseline year using historical data, and measures performance over time.

The self-administered web-based evaluation tool assesses energy culture and maturity across 12 modules, including management commitment, human and financial resources, energy KPIs, and operations.

Early adopters

The Energy Excellence Recognition Program was designed and developed by a task force of warehouse operators whose companies have been members in the International Association of Refrigerated Warehouses (IARW) – a GCCA Core Partner – over the past two years.

Members of the task force were allowed to be "Early Program Adopters"; over 61 facilities have already enrolled, including those run by Americold Logistics, Congebec Logistics and Hanson Logistics.

"It was a pleasure to assemble a multi-national team of industry leaders, specifically Congebec and Hanson Logistics, to craft a sustainable industry strategy to be adopted by all members globally," said David Stuver, member of the GCCA's Energy Excellence Task Force and senior vice president of distribution support and continuous improvement, Americold Logistics.

The GCCA Energy Excellence Recognition Program is open to all companies operating a temperature-controlled space. More details are available at https://bit.ly/2ILAZEG. ■ MG

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