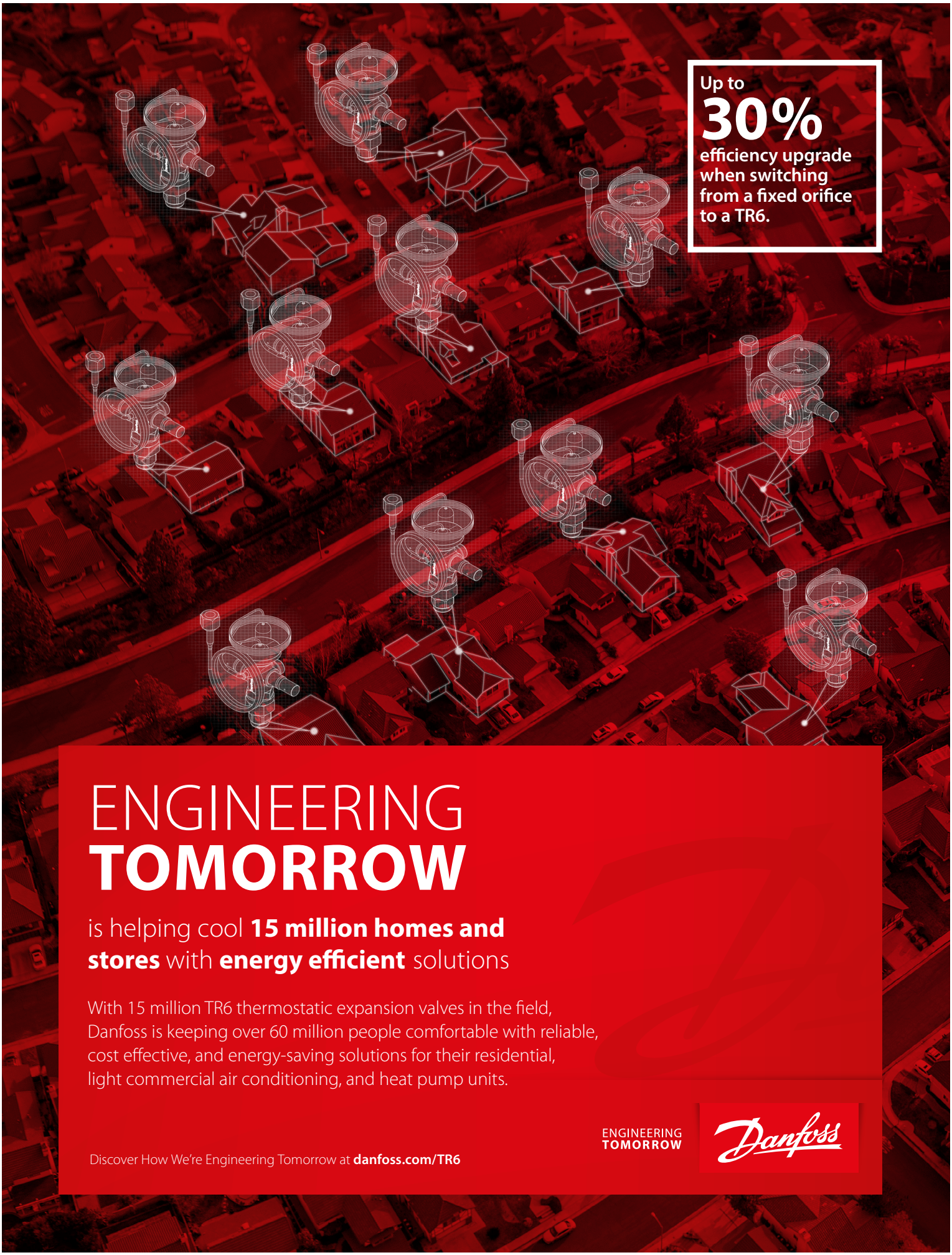
OCTOBER 2017

ACCELERATE

ADVANCING HVAC&R NATURALLY

AMERICA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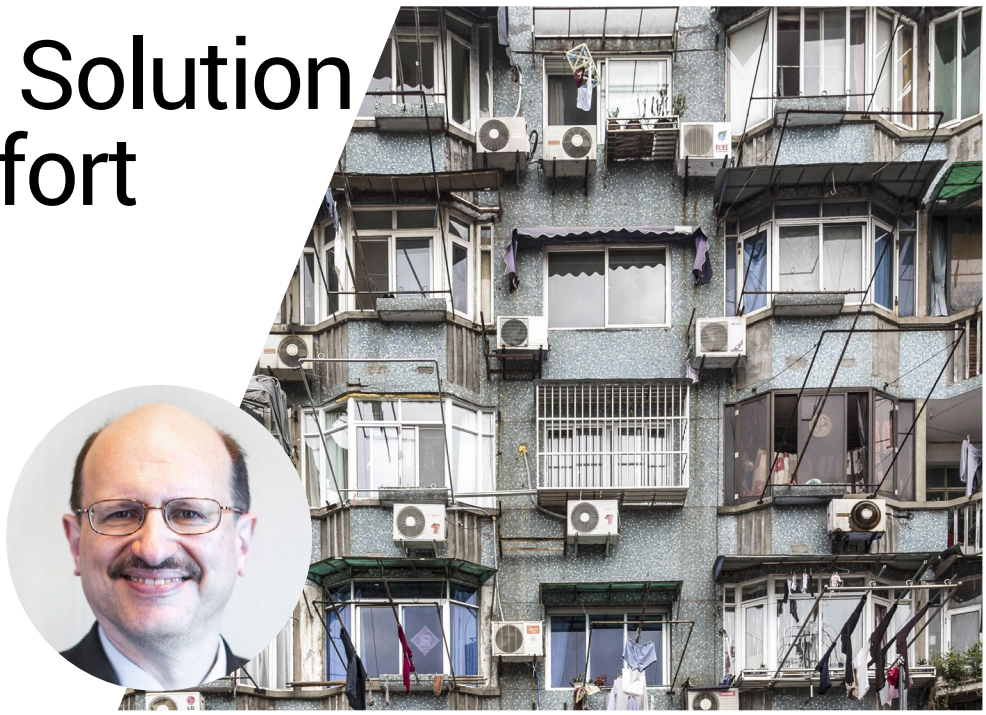
A Better Solution for Comfort Cooling

By Michael Garry



According to the California Air Resources Board (CARB), in 2013 stationary refrigeration generated 43% of the state's HFC emissions – one of the high-GWP short-lived climate pollutants that CARB aims to cut dramatically in the coming decades.

That's a serious chunk and reflective of the HFC emissions picture for the U.S. as a whole. It's the reason why *Accelerate America* has focused many of its stories on natural refrigerant systems for commercial and industrial refrigeration.

But the second biggest contributor of HFC emissions in California is stationary air conditioning (24% in 2013). On a global basis, residential air conditioning is growing rapidly as temperatures rise, particularly in developing economies. That, in turn, is feeding the warming trend even more.

Natural refrigerants have a critical role to play as a replacement for HFCs and R22 in comfort cooling systems. In this issue, our cover story (page 34) looks at one example – a low-charge ammonia chiller developed by OEM Azane for the Campbell Soup Company's manufacturing plant in Napoleon, Ohio.

In this instance, the chiller is enabling Campbell Soup to provide air conditioning from April to October in a labeling and packaging area located far from the engine room. It allows Campbell to avoid using an HFC-based chiller for the same job, and demonstrates how chillers with relatively small charges of ammonia located outside of a building can safely supply considerable cooling capacity for large commercial spaces.

This means that other building types, like office and retail buildings, could avail themselves of a natural refrigerant solution for air conditioning instead of units that use synthetic refrigerants. For example, in the U.K., Azane's parent company, Star Refrigeration, has installed a low-charge chiller on the rooftop of a Marks & Spencer department store.

The key question about natural refrigerant chillers is their energy efficiency compared to HFC units. The chiller installed at the Campbell plant is showing signs of having excellent efficiency numbers. Meanwhile, Creative Thermal Solutions (CTS), Urbana, Ill., has embarked on a study of the efficiency of other low-charge ammonia packaged systems.

Back in California, Paul Delaney, chief engineer at Southern California Edison (SCE) – one of the sponsors of the CTS study – is keenly interested in the energy results that come out of the study, so that SCE can begin incentivizing companies that install low-charge ammonia chillers.

Ammonia is not the only natural refrigerant that can support air conditioning – CO_2 and propane can as well. There are a growing number of examples in Europe of how transcritical CO_2 refrigeration systems can be tapped for heating and comfort cooling as well. And propane is proving to be an energy-efficient answer for residential air conditioners in countries like China and India. In the U.S., codes and standards are currently standing in the way of using propane and CO_2 in AC.

As the world heats up and more people turn to air conditioning, energy-efficient, negligible-GWP natural refrigerants will be needed to avoid making the world hotter still. ■ MG

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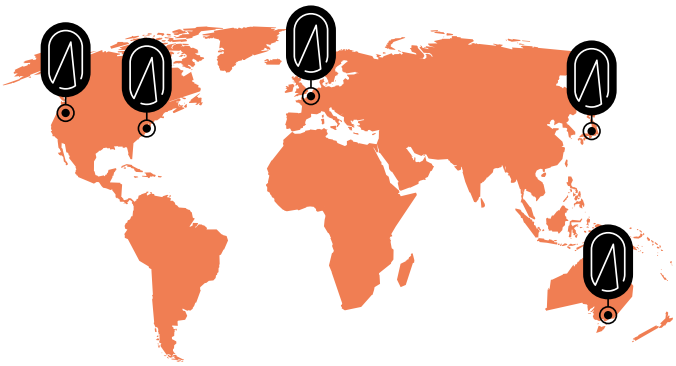
ACCELERATE

ADVANCING HVAC&R NATURALLY AMERICA

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.

http://acceleratena.com



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TRENDS

POLICY

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ABOUT ACCELERATE AMERICA

Letters to **the Editor**

ALDI's CO_2 Rollout

I'm personally not at all surprised at ALDI's rollout of transcritical CO_2 systems. ("Leader of the Rack," *Accelerate America*, September 2017.) We have seen other organizations like Sobeys in Canada take this approach.

I think transcritical CO_2 technology has matured to the point that pricing is getting to be very competitive with traditional systems, and the level of expertise on the contractor side has now developed where CO_2 is not considered new and uncharted territory. It's also been proven that the energy efficiency of the systems, if designed, installed and operated correctly, can be on par or exceed that of a traditional synthetic refrigerant system.

Lastly, and likely important to ALDI, is the future-proofing or mitigation against what may occur with legislation around traditional synthetic refrigerants. We constantly see the moving target of the Department of Energy, the Environmental Protection Agency, The EU F-Gas Regulation, etc., and this makes business planning hard. CO_2 tells a good story today and is a commitment to the future of the planet. And if you don't have to worry about huge future expenses for refrigerant, taxation or fines, it all makes business sense.

Darren A. Cooper
President
Renteknik Group
Burlington, Ontario, Canada

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.

The Real Potential of Ejectors

I was delighted to read your article "The Secret Sauce" in the September issue of *Accelerate America*. Coincidentally, my article on recent developments in ejector technology was published in the same issue, so the timing could not have been any better!

For a researcher working on ejectors for more than 10 years, it is truly exciting to see that Danfoss, Carel, and some other high-tech companies are now offering commercially available CO_2 ejectors (separate designs for liquid and gas, but also designs for two-phase ejectors). It's also exciting that system and component manufactures such as Hillphoenix and Dorin make immediate use of the technology by implementing it to improve the performance of their products.

These companies have recognized that the potential of the ejector to save energy is real and will enable market penetration at a fast pace.

Stefan Elbel
Chief Engineer
Creative Thermal Solutions
Urbana, Ill.,
Research Assistant Professor
University of Illinois at Urbana-Champaign

> *"If you don't have to worry about huge future expenses for refrigerant, taxation or fines, it all makes business sense."*

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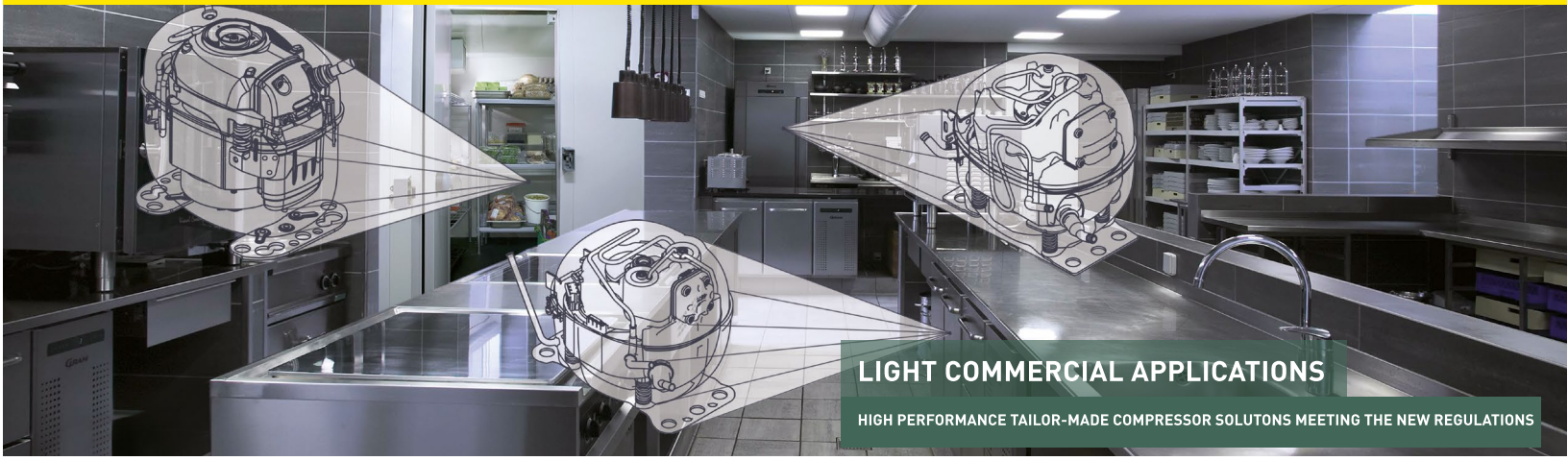

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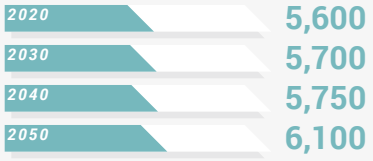
THE POTENTIAL IMPACT OF EPA SNAP AND KIGALI AMENDMENT ON U.S. HFC EMISSIONS

A Court of Appeals ruling has put in jeopardy the U.S. Environmental Protection Agency's Significant New Alternative Policy (SNAP) program, which has begun delisting HFC refrigerants. The U.S. Senate has not yet ratified the Kigali Amendment to the Montreal Protocol, which would phase down HFC emissions.

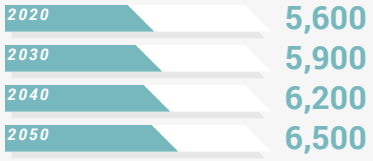
Here is a look at the impact both programs would have on HFC emissions in the U.S.

TOTAL U.S. GREENHOUSE GAS EMISSIONS

Business-As-Usual with Kigali
(Million Metric Tons of CO_2e)

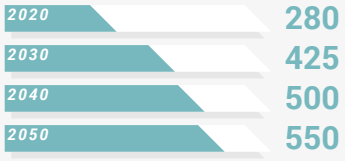


Business-As-Usual without Kigali
(Million Metric Tons of CO_2e)

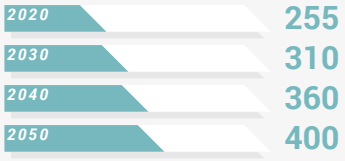


U.S. GREENHOUSE GAS EMISSIONS FROM HFCS

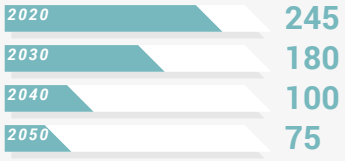
Business-As-Usual
(Million Metric Tons of CO_2e)



Emissions with SNAP Program
(Million Metric Tons of CO_2e)

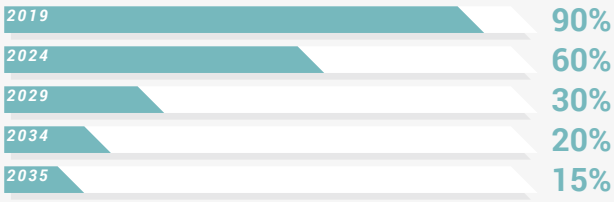


Emissions with Kigali Amendment
(Million Metric Tons of CO_2e)



REDUCTION IN U.S. HFC USE UNDER KIGALI AMENDMENT

(COMPARED TO 2011-2013 USE)



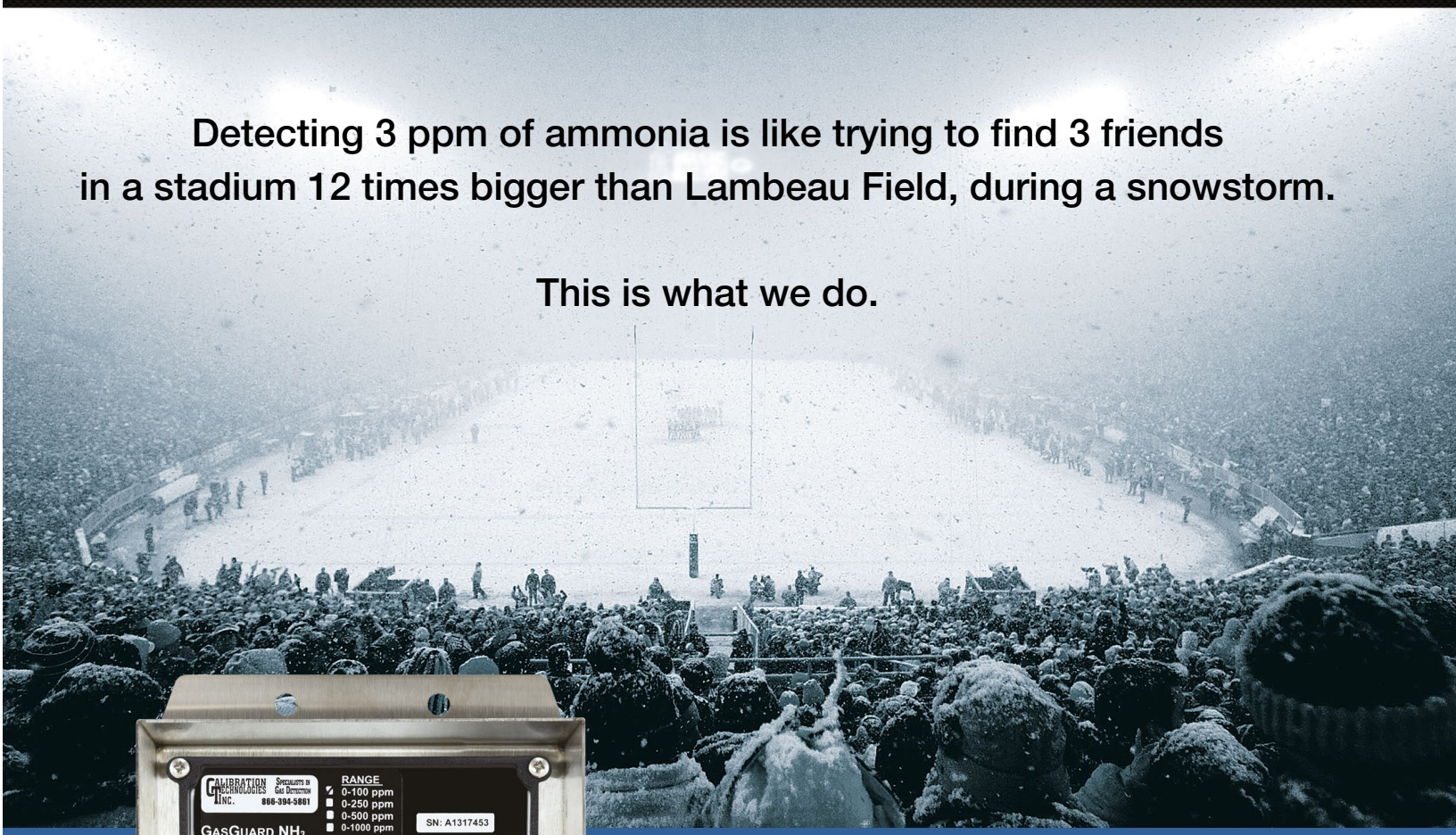
Total U.S. HFC Emissions Reduction though 2050 under SNAP Program: 3.6 billion metric tons of CO_2e
(more than half of total U.S. GHG emissions in one year)

Total U.S. HFC Emissions Reduction though 2050 under Kigali Amendment: 9.5 billion metric tons of CO_2e
(about 1.5 years of total U.S. GHG emissions)

Source: Energy Innovation Policy & Technology

Gas Sensors For Natural Refrigerants

Protecting People | Protecting Property



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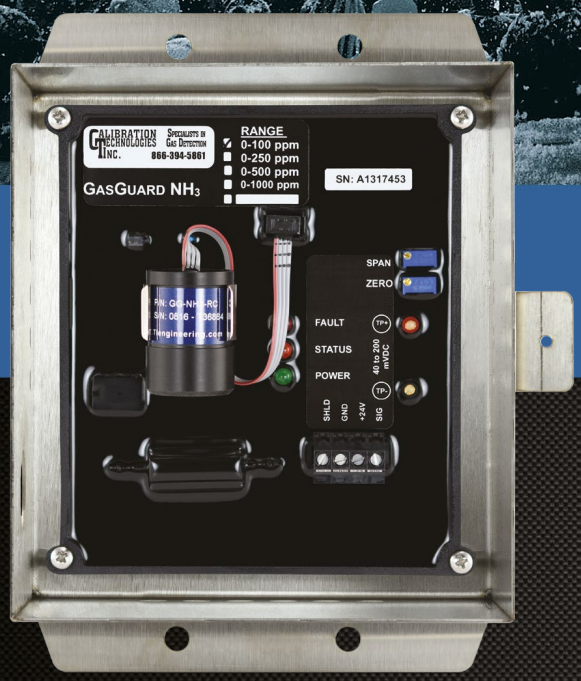

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EVENTS GUIDE
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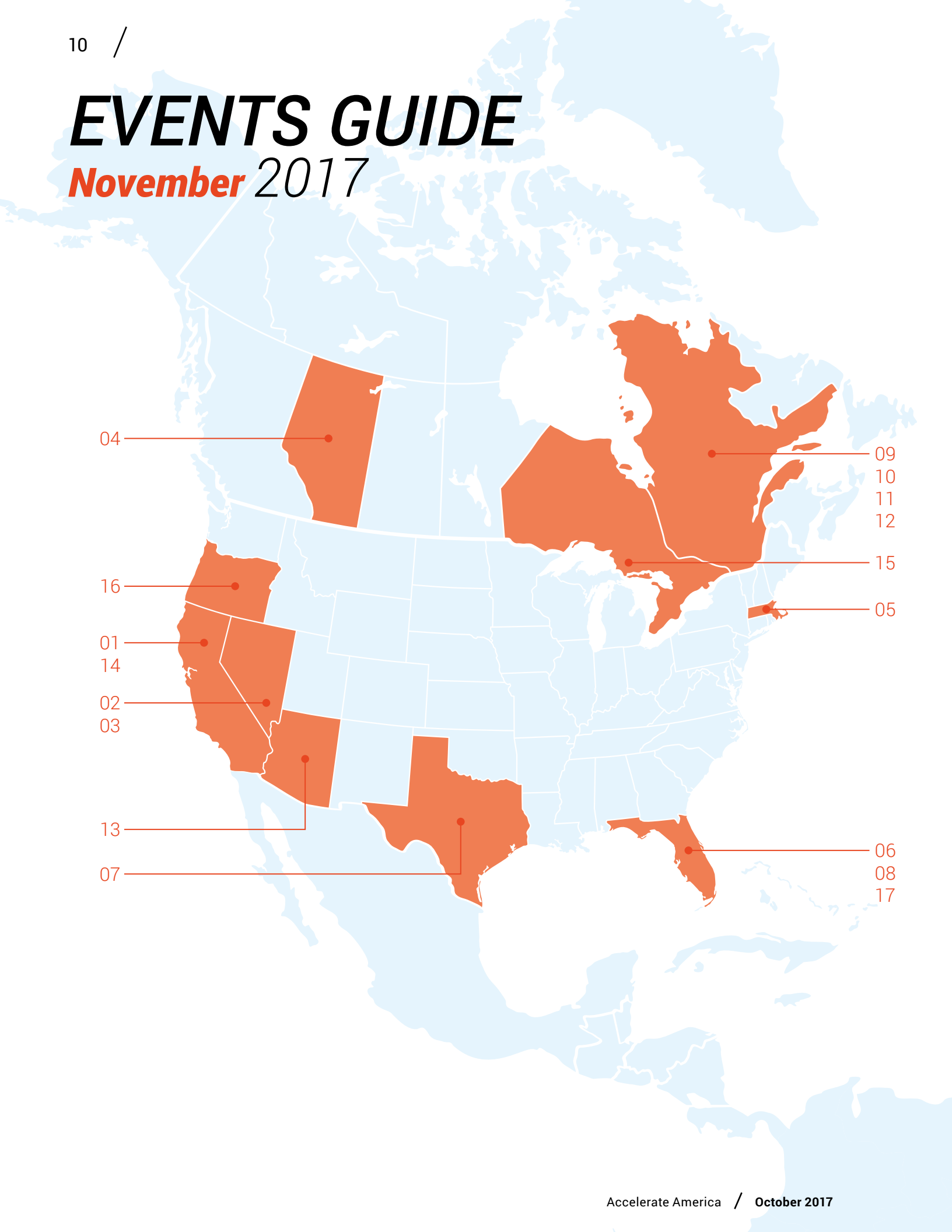


1 **The Institute of Heating and Air Conditioning Industries (IHACI) 38th Annual Trade Show**
Nov. 2, Pasadena, Calif.
http://www.ihaci.org/trade-show/

2 **20th Global Summit on Food Processing, Safety & Technology**
Nov. 6 - Nov. 8, Las Vegas, Nev.
http://foodprocessing.global-summit.com/

3 **4th International Conference on Green Energy & Expo**
Nov. 6 - Nov. 8, Las, Vegas, Nev.
https://greenenergy.conferenceseries.com/scientific-program/

4 **Buildex Calgary**
Nov. 8 - Nov. 9, Calgary, Canada
@BUILDEXshows
http://buildexcalgary.com/

5 **GreenBuild International Conference and Expo**
Nov. 8 - Nov. 10, Boston, Mass.
@Greenbuild
https://www.greenbuildexpo.com/en/home.html

6 **Air Conditioning, Heating & Refrigeration Institute (AHRI) Annual Meeting**
Nov. 12 - Nov. 14, Miami, Fla.
@AHRI_connect
http://www.ahrinet.org/News-Events/Meetings-and-Events.aspx

7 **Texas Energy Summit**
Nov. 13 - Nov. 15, Plano, Texas
https://catee.tamu.edu/

8 **The National Facilities Management and Technology (NFMT) Conference and Expo Orlando 2017**
Nov. 14 - Nov. 15, Orlando, Fla.
@nfmt_conference
#NFMTOrlando17
http://www.nfmt.com/orlando

9 **Sustainable Technologies for Air Conditioning Workshop**
Nov. 18, Montreal, Canada
https://www.sustainableacworkshop.com/

10 **59th Meeting of the Implementation Committee Under the Non-Compliance Procedure of the Montreal Protocol**
Nov. 18, Montreal, Canada
http://bit.ly/2x1T4b1

11 **Joint Meeting of the Bureau of the Tenth Conference of the Parties to the Vienna Convention and the 28th Meeting of the Parties to the Montreal Protocol**
Nov. 19, Montreal, Canada
http://conf.montreal-protocol.org/Lists/Meetings/Upcoming%20Meetings.aspx

12 **Joint 11th Conference of the Parties to the Vienna Convention and the 29th Meeting of the Parties to the Montreal Protocol**
Nov. 20 - Nov. 24, Montreal, Canada
http://bit.ly/2zwAZ6v

13 **The International Council of Shopping Centers (ICSC) Retail Green Conference — Redefining Sustainability**
Nov. 28 - Nov. 29, Scottsdale, Ariz.
@ICSC
https://www.icsc.org/events-and-programs/details/retailgreen-conference-sustainability-showcase1

14 **6th Annual North Coast Wine Industry Expo**
Nov. 30, Sonoma County, Calif.
@WINexpo
#WINexpo
http://www.wineindustryexpo.com/

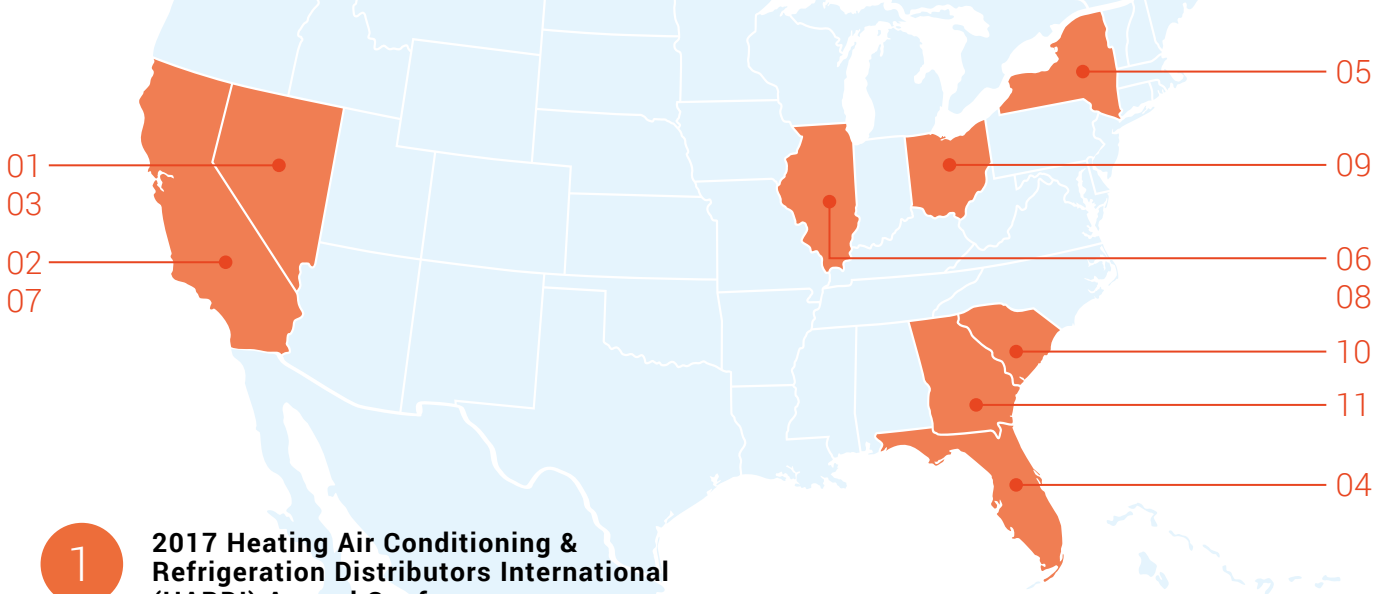
15 **The Buildings Show**
Nov. 29 - Dec. 1, Toronto, Canada
https://www.thebuildingsshow.com/en/home.html

16 **Journal of Light Construction (JLC) Live Northwest 2017**
Nov. 29 - Dec. 1, Portland, Ore.
@JLCLIVE
https://nw.jlclive.com/en/home.html

17 **Companies Vs. Climate Change: U.S.A.**
Nov. 29 - Dec. 1, Miami, Fla.
@climateb2b
http://usa.solveclimatechange.com/index.php

EVENTS GUIDE

December 2017 / January 2018



1 **2017 Heating Air Conditioning & Refrigeration Distributors International (HARDI) Annual Conference**
Dec. 2 - Dec. 5, Las Vegas, NV
http://nova2017.com/

2 **9th Annual Next Level Summits (NLS) Food Quality Symposium**
Dec. 4 - Dec. 6, Indian Wells, Calif.
@nlsummits
http://nextlevelsummits.com/index.php?page=NLS-Food-Safety-Quality-Summit&SummitID=3

3 **Renewable Energy World International**
Dec. 5 - Dec. 7, Las Vegas, NV
http://www.power-gen.com/event-information/renewableenergyworldinternational.html

4 **Design & Construction Week**
Jan. 9 - Jan. 11, Orlando, Fla.
http://designandconstructionweek.com/

5 **National Retail Federation (NRF) Retail's BIG Show 2018**
Jan. 14 - Jan. 16, New York, NY
https://nrfbigshow.nrf.com/

6 **2018 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Winter Conference & International Air Conditioning, Heating, Refrigeration (AHR) Expo**
Jan. 20 - Jan. 24, Chicago, Ill.
https://www.ashrae.org/membership--conferences/conferences/2018-ashrae-winter-conference

7 **Winter Fancy Food Show**
Jan. 21 - Jan. 23, San Francisco, Calif.
https://www.specialtyfood.com/shows-events/winter-fancy-food-show/

8 **The International Air Conditioning, Heating, Refrigeration (AHR) Expo**
Jan. 22 - Jan. 24, Chicago, Ill.
@ahrexpo
https://ahrexpo.com/

9 **Mid-America Restaurant Expo 2018**
Jan. 28 - Jan. 29, Columbus, OH
@MidAmResExpo
http://www.midamericarestaurantexpo.com/aws/MARX/pt/sp/home_page

10 **42nd Annual Hotel, Motel & Restaurant Supply Show of the Southeast**
Jan. 30 - Feb. 1, Myrtle Beach, SC
http://www.hmrsss.com/

11 **International Production & Processing Expo**
Jan. 30 - Feb. 1, Atlanta, GA
http://www.ippexpo.org/

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IN BRIEF

CO_2

EMERSON CREATES COLD CHAIN GROUP

Emerson Commercial and Residential Solutions – a U.S. company that makes many components for systems that use natural refrigerants like CO_2 and ammonia – has formed a new "cold chain organization" focused on supporting temperature-sensitive and asset-optimization solutions "wherever commercial goods are moved, stored or sold," the company said in a statement. Emerson's cold chain organization "will offer customers a total-channel approach to protect foods and other critical cargo every step along the cold chain.". Within the cold chain organization, there are now market-focused teams focused on four sectors: food retail, foodservice, transportation and aftermarket distribution.

More information at:
http://bit.ly/2zKkpjA

TRADE SHOW

INNOVATION AWARD WINNERS ANNOUNCED

Winners of the 2018 AHR (International Air-Conditioning, Heating, Refrigeration) Expo Innovation Awards were announced for an awards ceremony that will take place during the AHR Expo, January 22-24 at McCormick Place in Chicago. Still to come is a "Product of the Year" recognition, which will be announced at the event. In the cooling category, Emerson won an award for its Copeland Scroll two-stage compressor, covering from one to 10 TR. Danfoss took home the award in the green building category for its Trocar TTH/TGH High Lift Compressor. An HFO-based refrigerant replacement for R404A/R507 – Option XP44 (or R452A), produced by Chemours – won the refrigeration category award.

More information at:
http://bit.ly/2zwL42C

HYDROCARBONS

SANDENVENDO DEBUTS R290 VENDING MACHINES

SandenVendo America – a Dallas, Texas-based manufacturer of commercial refrigeration and heating equipment – has introduced a line of vending machines with propane refrigeration systems, its first for the North American market. The company's other units use CO_2. The R290 refrigeration systems serve two types of SandenVendo America products: glass-front vending machines and stack-style vending machines. "Those two product lines carry a total of four different models and probably 25 variations of those four models," said SandenVendo America CEO and President Mike Weisser. "Sixty percent of everything we produce now has the ability to be produced in hydrocarbon if our customer chooses."

More information at:
http://bit.ly/2i5RRsM

CO_2

LMP INSTALLS CO_2 AT INDUSTRIAL PLANTS

Systemes LMP, the Canadian manufacturer of transcritical CO_2 systems for supermarkets, has done six transcritical installations at industrial plants this year, said Jeff Gingras, president, Systemes LMP, based in Laval, Quebec. Two plants were equipped with CO_2 systems last year. "The Quebec government is giving grants for CO_2 systems that makes up 80% of the cost premium," he said. He estimated the premium over an ammonia system to be 15%-20%, which he expects to drop. While CO_2 has been employed in industrial refrigeration in ammonia/CO_2 cascade systems, pure CO_2 transcritical systems are a fairly uncommon technology in industrial locations in North America.

More information at:
http://bit.ly/2y1v73h

POLICY

KIGALI: HALFWAY TO RATIFICATION

October 15 marked one year since the Kigali Amendment to the Montreal Protocol was signed by 189 countries. According to the Depositary, the United Nations Office of Legal Affairs, the 10 countries that have ratified Kigali and deposited the instruments of ratification at the UN include: Mali, the Federate State of Micronesia, the Marshall Islands, Rwanda, Palau, Norway, Chile, Tuvalu, the Democratic People's Republic of Korea (North Korea) and Australia. Twenty ratifications are required for the Amendment to take effect. The Amendment calls for a global phase-down of HFCs at different rates for developed and developing nations.

More information at:
http://bit.ly/2ijnT4I

HYDROCARBONS

DELFIELD BAGS DANFOSS ENERGY-EFFICIENCY AWARD

Multinational HVAC&R giant Danfoss has named Welbilt brand Delfield the winner of its EnVisioneer of the Year award for its use of Danfoss controls to convert equipment to natural refrigerant propane while significantly improving energy efficiency. In late 2016, Florida-based foodservice equipment manufacturer Welbilt finished converting its Delfield upright and under-counter commercial refrigeration display cases to propane (R290) from R404A. The propane units meet the U.S. Department of Energy's mandated 2017 efficiency requirements. Delfield is harnessing Danfoss thermostatic expansion valves and electronic controls.

More information at:
http://bit.ly/2zYJkQz

Hillphoenix® leads the industry in CO_2 refrigeration systems from every angle — in terms of technology, innovation, research and development and sheer numbers of installed systems. Are there other suppliers who've jumped on the CO_2 bandwagon? Of course. Your decision is an easy one: Work with the company who helped create and define the category. Or, settle for a me-too product with nothing new to offer. Hmmm...tough choice....

Trading Places

Traditionally used in commercial and industrial sectors, respectively, CO_2 and ammonia are crossing over into the other's territory

By André Patenaude

CO_2 and ammonia are two natural refrigerants that have historically played predictable roles in refrigeration. Ammonia (aka NH_3 or R717) has long been considered a highly efficient workhorse in low-temperature industrial refrigeration. In recent decades, CO_2 (R744) has emerged as a leading environmentally friendly alternative in commercial applications. But before we get too accustomed to these familiar roles, the tables are starting to turn.

Today, manufacturers are developing new refrigeration technologies that blur the lines between these traditional applications. Driven by sustainability objectives and regulatory compliance, these natural refrigerant technologies are turning up in the other's market space — with CO_2 becoming a viable option in industrial applications, and low-charge ammonia systems making inroads into commercial applications.

REGULATORY AND MARKET DRIVERS

On the regulatory front, CO_2 has the global hydrofluorocarbon (HFC) refrigerant phase-down to thank for gaining a foothold in commercial refrigeration. As a natural alternative with near-zero GWP, it is one of the few ultra-low GWP refrigerants to be listed as acceptable by the Environmental Protection Agency's (EPA) Significant New Alternatives Policy (SNAP).

CO_2 has minimal safety or toxicity barriers to adoption with respect to building/fire codes or local authorities having jurisdiction (AHJ). But be advised that in some regions, safety regulations are being developed to address piping best practices for managing CO_2's higher operating pressures.

On the other hand, ammonia has been the subject of increasing regulatory activity to address its potential toxicity concerns. The Occupational Safety and Health Administration (OSHA) requires operators to provide documentation for systems charged with 10,000 lbs of ammonia or more, according to its Process Safety Management of Highly Hazardous Chemicals standard.

> *"Manufacturers are developing new refrigeration technologies that blur the lines between these traditional applications."*

Operators of ammonia systems must always be prepared for rigorous inspections enforced by OSHA's National Emphasis Program (NEP) in process safety management industries, which includes ammonia-based refrigeration facilities. Since owners of large-charge ammonia systems have now incurred the added responsibility and expense of continuous recordkeeping, many operators are starting to reevaluate these traditional ammonia refrigeration architectures.

To avoid possible regulatory entanglements and alleviate potential safety concerns, a new trend is emerging that favors lower-charge ammonia systems and moving the natural refrigerant out of occupied spaces. But even with these considerations, operators may still need the approval of local AHJs to install ammonia systems.

Regardless of potential installation caveats, end users seeking to leave a smaller carbon footprint are formalizing sustainability strategies that include the following objectives:

- Deploying low-GWP, future-proof refrigerants
- Designing highly energy-efficient systems
- Constructing "green" facilities

Natural refrigerants like CO_2 and ammonia are helping businesses achieve these objectives.

EMERGING AND CONVERGING TECHNOLOGIES

Market dynamics are prompting both commercial and industrial operators to ask original equipment manufacturers (OEMs) which natural refrigerant options are available. In turn, OEMs are responding with new innovations and system technologies that borrow from traditional architectures and cross over into other market spaces. Let's look at some innovations that are indicative of this convergence.

NH_3/CO_2 cascade — Ammonia in commercial refrigeration

Owners of large (+100-TR) commercial HFC systems are evaluating smaller, lower-charge NH_3/CO_2 cascade systems. Some industrial OEMs are expanding their product portfolios to target this emerging niche for natural, energy-efficient systems. These NH_3/CO_2 cascade systems are designed to operate with very low charges of ammonia (100 pounds or less) on the high side of the refrigeration cycle (in a remote location, e.g., the roof) to chill the CO_2. Chilled CO_2 is then pumped into medium-temperature heat exchangers and sent to direct-expansion, low-temperature evaporators and CO_2-rated compressors. ▶

▶ CO_2 transcritical booster — CO_2 in industrial refrigeration

CO_2 represents a documentation-free refrigeration alternative to longtime owner/operators of large-charge ammonia systems; so some operators are turning to commercial OEMs with CO_2 expertise. CO_2 transcritical booster systems have proved viable in cooler regions, relying on an architecture that utilizes several compressors in parallel to meet the desired cooling requirement. CO_2 blast freezers are also effective in low temperatures, especially below -40 °F.

Smaller platform applications for ammonia

Both commercial and industrial operators with smaller facilities have many low-charge ammonia options to meet their cooling requirements and sustainability goals. Let's look at a few of these systems:

» NH_3 low-charge centralized. This remote, distributed architecture is designed to reduce the liquid line length and subsequent refrigerant charge. The system utilizes a compressor skid in a smaller engine room and a liquid receiver located on the roof directly above the evaporators (liquid overfeed).
» NH_3 direct expansion. Available in distributed or remote varieties, this system requires the circulation of much less refrigerant compared to the liquid overfeed method.
» NH_3 chiller with pumped CO_2 secondary. Here ammonia is used to chill CO_2 (volatile brine), which is then pumped into the refrigerated areas.
» NH_3 chiller with pumped CO_2 secondary, plus CO_2 cascade. This system combines an NH_3 chiller that provides the medium-temperature load via a CO_2 secondary design, plus a CO_2 cascade system for the low-temperature side.

It's important to note that contracting companies are also being affected by this market convergence. Just as commercial operators are turning to industrial service technicians with ammonia expertise, industrial customers are calling on commercial mechanics to assist with their emerging CO_2 applications.

MORE OPTIONS FOR END USERS

Owner/operators of commercial and industrial facilities have much in common. Both must attempt to balance capital expenditures, total cost of ownership and sustainability objectives in their selection of refrigeration systems. In any event, the blurring of lines between CO_2 and ammonia technologies in these markets is ultimately beneficial to all involved.

While many of the options discussed herein are currently being "trialed" by some of the most forward-thinking companies, the fact remains that end users now have access to more environmentally friendly options than ever before. This ongoing evolution will continue to drive OEMs to develop a greater diversity of options to meet end users' specific requirements.

André Patenaude is the director of food retail growth strategy, cold chain, for Emerson Commercial and Residential Solutions ■ AP

> *"It's important to note that contracting companies are also being affected by this market convergence."*

THE TALE OF THE TAPE: CO_2 VS. NH_3

CO_2 and ammonia are among the most eco-friendly, natural refrigerant alternatives available. OEMs continue to seek ways to exploit their efficiencies and mitigate their risks.

Ammonia
» 0 GWP and 0 ODP
» Toxic and slightly flammable
» Workhorse in cold storage, industrial refrigeration
» Architectures now evolving to utilize lower charges, preferably removed from occupied spaces
» Extremely efficient in a wide range of temperatures

CO_2
» 1 GWP and 0 ODP
» High pressure, low critical temperature, high triple point
» Non-toxic, non-flammable
» Foothold in commercial refrigeration as alternative to HFCs
» Effectiveness in low temperatures making inroads in industrial applications

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Getting Credit for **F-Gas Reduction**

Carbon credits coordinated by EOS Climate incentivize HFC reclamation and R22/CFC destruction as well as the installation of natural refrigerant-based systems

By Elise Herron

Food retailers and others in North America can earn valuable carbon credits while transitioning from R22 and HFCs to natural refrigerants, thanks to programs created by San Francisco-based EOS Climate, which is now part of Xpansiv Data Systems.

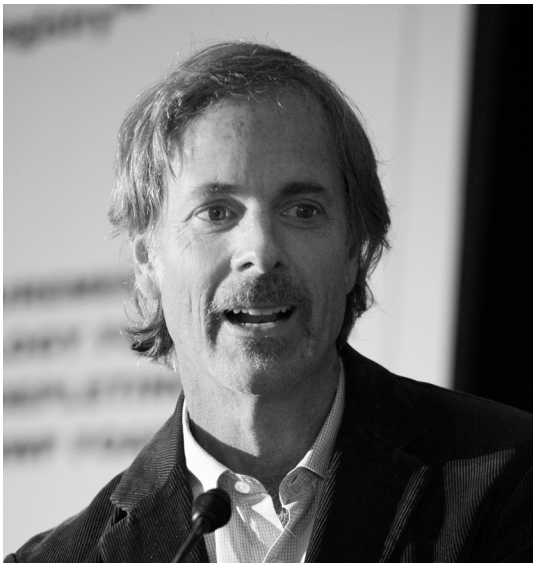
For example, in August, a program developed by EOS Climate was approved by the American Carbon Registry (ACR) so that carbon credits for the destruction of R22 are now available to the industry as part of ACR's Ozone Depleting Substances (ODS) Destruction Methodology.

This updated ODS destruction methodology expands the opportunities companies have to obtain carbon credits. Since 2009 supermarkets in North America have been able to destroy CFC refrigerants for carbon credits. Beginning in 2015 – under another ACR methodology originated by EOS – stores became eligible for credits by reclaiming and re-using HFCs or deploying advanced commercial refrigeration systems that use natural refrigerants.

Currently, the carbon credits for CFC destruction can be applied in a cap-and-trade (compliance) market like California. In both compliance and voluntary markets, all of the refrigerant-based credits can be sold or applied to a company's greenhouse-gas reduction program.

"You've probably heard about carbon offsets [credits], or 'verified emission reductions,'" said EOS Climate's co-founder and vice president, Jeff Cohen, last June at an ATMOsphere America session titled "Refrigerants in Transition: Market Incentives."

"[Carbon credits] represent a reduction in business as usual of one metric ton of CO_2," he continued, "so one carbon credit is an avoided or prevented emission of one metric ton of CO_2—or the equivalent of it."



Jeff Cohen, EOS Climate's co-founder and vice president

To date, Cohen said, the ODS destruction protocol that EOS Climate originated has generated nearly 11 million offset credits.

Cohen said the HFC reclamation and installation of advanced (natural refrigerant-based) systems are impactful environmental tools because they keep potent greenhouse gases from ever being produced.

"Deployment of advanced refrigeration systems using zero or low-GWP refrigerants can generate carbon credits today," Cohen said.

He added that EOS Climate is also "very enthusiastic about [the HFC reclamation] methodology and that type of credit. We think it can have a very significant impact in complementing the phase-down of HFC production. If you recycle more, you don't need to produce as much. It's a really important opportunity for cap-and-trade markets, but also just for companies to demonstrate their comprehensive activities around transitioning to low-GWP technologies." ▶

> *Deployment of advanced refrigeration systems using zero or low-GWP refrigerants can generate carbon credits today."*

CALIFORNIA-CANADA CONNECTION

In California, offsets for ODS destruction (including CFCs) are established compliance instruments for its cap-and-trade program, which caps allowable GHG emissions. The most recent ACR-approved offset methodologies – for HCFC destruction, HFC reclamation and deployment of advanced refrigeration systems – may be reviewed as part of the Golden State's efforts to update its cap-and-trade program.

California's Air Resource Board (CARB) Spokesperson David Clegern told *Accelerate America,* "This does not mean these protocols won't be considered in the future, but if that happens we will announce it at a public workshop."

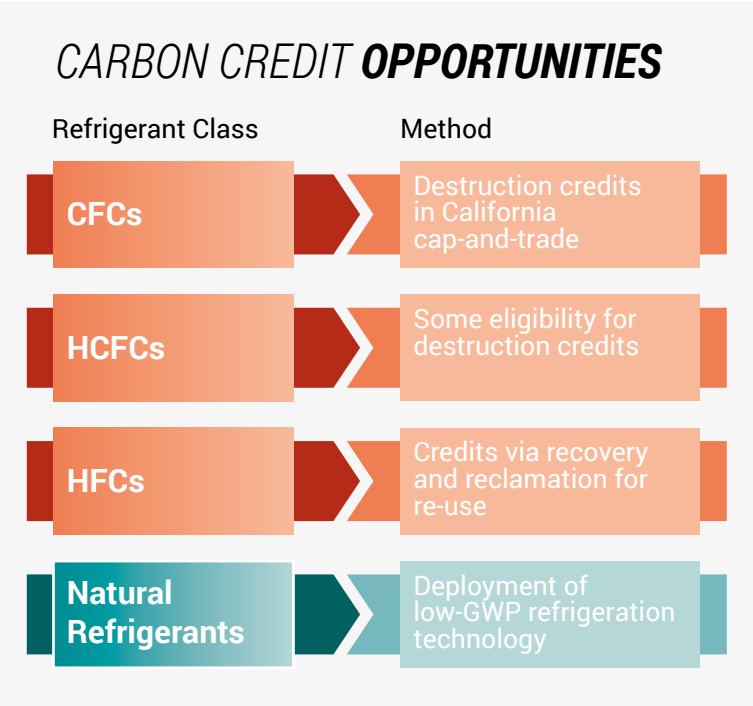
Canadian provinces Ontario and Quebec recently linked up with California's cap-and-trade market, meaning the new offsets could be included in those regulatory bodies in the near future as well. Destruction of CFCs is already eligible for carbon credits under the Quebec market.

"An increasing amount of action will be in Canada," Cohen said. "Several provinces will have a California-like program, so that includes offsets and it will propel projects like the ones we're talking about if those methodologies are approved."

For supermarkets located in voluntary markets outside California and Canada, there are still incentives to take advantage of the new offset methodologies.

"For non-compliance markets, in other words voluntary markets," Cohen said, "businesses can participate in this market and make their own internal sustainability goals and carbon reduction goals and also generate revenue to offset the cost of technology transitions."

Last year, in an effort to address the environmental impact of its 189 stores that still use high-GWP HFCs, Hannaford Supermarkets acquired 4,200 carbon credits generated from reclaimed HFC refrigerants.



At this time, according to Harrison Horning, director of equipment purchasing, maintenance and energy at Ahold Delhaize's Hannaford division, "[Hannaford] has not purchased any more credits or applied for credits." But, "This could change as natural or ultra-low-GWP refrigerants become more cost-effective for use in existing systems (for example, to replace R507A or R404A)."

Cohen told *Accelerate America* he thinks more retailers will start to utilize the advanced systems installment crediting as regulations shift toward low-GWP refrigerants.

He added that it's important for supermarkets to tune into the conversation about offsets to learn "how they can leverage the carbon markets to offset some of the costs involved in making these transitions.

"Timing is ripe for the industry to consider changes to their climate programs and how offsets can provide market-based incentives for natural refrigerants and other advanced technologies" ■ EH

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ALDI US's Transcritical Stores: 'Best of the Best'

At the FMI Energy Conference, the supermarket chain is recognized by the EPA for having the best GreenChill certified stores – another win for natural refrigerants

By Elise Herron and Michael Garry

In another sign of the growing importance of natural refrigerant systems in the U.S., ALDI US accepted the Best of the Best GreenChill award as part of an early-morning awards ceremony at the Food Marketing Institute Energy and Store Development Conference in Orlando, Fla., last month.

Tom Land, manager of the Environmental Protection Agency's GreenChill Partnership, presented the award to Amber Hardy, national project manager for energy management for ALDI US.

The Best of the Best award recognizes the best GreenChill certified store among all stores certified in the past year.

As of August 2017, 43 of ALDI's 69 transcritical CO_2 stores had been awarded GreenChill Platinum certification, with more new and remodeled transcritical stores in the process of receiving this certification. The Best of the Best award applies to all of ALDI's Platinum stores.

ALDI US is the No. 1 user of transcritical CO_2 refrigeration systems in the U.S. supermarket industry, and its aggressive store expansion and remodeling plans call for even more installations. (See "Leader of the Rack," *Accelerate America*, September 2017.)

ALDI US is the latest food retailer to receive the Best of the Best award for employing a natural refrigerant-based system. Since 2012, the award has gone to stores that use either transcritical or ammonia/CO_2 cascade systems. In addition, ALDI US's multiple Platinum certifications continue to tilt the percentage of Platinum-certified stores considerably toward those using natural refrigerant-only systems.

Tom Land, EPA, and Amber Hardy, ALDI US

DEMONSTRATING WHAT'S POSSIBLE

Since its inception in 2007, GreenChill – a voluntary program aimed at reducing refrigerant emissions and promoting advanced refrigeration technology that typically uses natural refrigerants – has grown to include 25 food retailing partner companies encompassing 10,000 stores in all 50 states. Currently, GreenChill partners account for roughly 28% of all U.S. supermarkets – a number that continues to grow as current partners build out new stores.

At the awards ceremony, held annually at the FMI Energy & Store Development Conference, Land presented data further showing the growth of natural refrigerant systems at GreenChill partner stores. "The GreenChill program continues to demonstrate what's possible in the supermarket industry," he said.

For example, Land noted that in 2016 the total number of refrigeration racks sold to partners increased for the first time since 2010, and 77% of those racks were part of advanced systems – a 58% increase from the prior year. Also in 2016, the racks sold represented the largest ratio of

From left: Tom Land, EPA, and Scott Martin, Hillphoenix

advanced to centralized DX in the history of the GreenChill program – with the percentage of centralized DX racks sold just 23%.

GreenChill offers annual Silver, Gold and Platinum certifications to any supermarket (not necessarily partner stores) that meet criteria for leaks and refrigerant charge (or use under-150 GWP refrigerants for Platinum). Land pointed out that the number of Platinum certifications has risen dramatically.

"We see the number of silver stores is growing, but the big change in 2016 was the number of Platinum stores," he said. "Achieving [Platinum] GreenChill certification is really difficult. For the first time, we broke 200 Platinum certifications. When I inherited the program four years ago, we were at 80."

Recognition of the retailer with the most GreenChill store certifications in the last year – the Store Certification Excellence award – went to Sprouts Farmers Market, which had 69 GreenChill certifications. For non-supermarkets, the same award went to OEM Hillphoenix (primary provider of transcritical systems to ALDI US) for supplying equipment to 181 certified stores.

Since the GreenChill program started recognizing stores for consecutive annual re-certification, Land said, the number of stores applying for re-certification has risen from previous years.

Five supermarkets received recognition for Store Re-Certification Excellence, which celebrates stores that successfully renewed GreenChill certifications five years in a row. Those supermarkets were: ShopRite in Brodheadsville, Pa., Sprouts Farmers Market in Grand Junction, Colo. and in Whittier, Calif., Weis Market in Windsor Mill, Md., and Whole Foods Market in Santa Rose, Calif.

Price Chopper Supermarkets, a Schenectady, NY-based supermarket chain, took home the "Distinguished Partner" award, which recognizes companies that have demonstrated innovation in achieving GreenChill's mission in the last year. Benny Smith, vice president of facilities for Price Chopper, accepted the award ■ **EH & MG**

GREENCHILL'S IMPACT ON LEAKS

For food retailers still phasing out of R22 and HFC refrigerants, reducing leaks is an important goal, one stressed by the Environmental Protection Agency's GreenChill Partnership.

At an early-morning awards ceremony at the Food Marketing Institute's Energy and Store Development Conference in Orlando, Fla., last month, Tom Land, manager of GreenChill, noted the progress GreenChill partners have made in reducing their leaks – what he termed "the GreenChill Effect."

Of the 25 GreenChill partners, he said, 20 have reduced or maintained their emissions rate since joining the program, including two that have reduced it by at least 80%, four by at least 60%, six by at least 30%, 11 by at least 20% and 16 by at least 10%.

"That's really, really notable," Land said of the emissions reductions.

The average GreenChill partner emission rate, Land said, was 13.9%. And the emission rate per store for 2016 was the lowest it's ever been.

An industry-wide adoption of similar low-emissions targets would have hugely beneficial consequences, Land said.

"If every supermarket in the country were to actually be at the GreenChill partnership emission level – 13.9% – we estimate that supermarkets would reduce annual emissions by 29 million metric tons of CO_2e, and save $213 million [in annual refrigerant replacement costs] in a year. Many of you have found that lowering your emission rate is saving you a lot of money. I applaud that; it's good for your bottom line and it's good for the environment."

Land handed out awards to the leading leak reducers. Winners of the Best Emissions Rate award were Giant Eagle – with a 2016 corporate-wide emission rate of 7.3% – and Port Townsend Food Co-op. The Most Improved Emissions Rate" went to Hanover Co-op Food Stores.

A record 11 GreenChill partners received the Superior Goal Achievement award for achieving their emissions rate goal (set below the previous year's goal): Giant Eagle, Weis Markets, Brookshire Grocery Company, City Market Onion River Co-op, Coborns, Hanover Co-op Food Stores, Kroger, Meijer, Port Townsend Food Co-op, Price Chopper and Target.

GreenChill partners that won the Exceptional Goal Achievement award for going above and beyond corporate emissions reduction goals were: Giant Eagle, Weis Markets, Brookshire Grocery Company, and City Market Onion River Co-op.

"2016 was a great year," Land said. "You guys had a great year as partners."

CARB Launches **Rulemaking for EPA SNAP Rules**

California agency seeks input for adopting EPA SNAP's HFC delisting rules and SLCP strategy's HFC phase-down plans.

By Elise Herron

The California Air Resources Board (CARB) held a public workshop October 24 as the first step towards adopting the Environmental Protection Agency (EPA) Significant New Alternatives Policy (SNAP) rules on HFC regulation. The workshop also addressed next steps on regulating HFCs through CARB's Short-Lived Climate Pollutants (SLCP) Strategy.

CARB hopes that California's adoption of the EPA SNAP rules on HFC delisting will eliminate some of the regulatory uncertainty following a controversial three-judge U.S. Court of Appeals for the District of Columbia ruling in August; the ruling barred the EPA from requiring companies to replace delisted HFCs from HVAC&R equipment with low-GWP substances (such as natural refrigerants) under the SNAP program.

That ruling has since been appealed by intervenors Chemours, Honeywell and the Natural Resources Defense Council (NRDC) – but not the EPA. There is no word yet from the full Appeals Court regarding whether it will rehear the case. (See story, page 27.)

Either way, California Senate Bill 1383 calls for a statewide 40% reduction in HFC emissions below 2013 levels by 2030, prompting CARB to take matters into its own hands.

"To put that into context," said Glen Gallagher, air pollution specialist with the research division of CARB at the workshop, "right now HFC emissions in California are about 20 million metric tons of CO_2e per year, and the goal is to reduce it to less than 10." Under a business-as-usual policy, HFC emissions would grow to 27 million metric tons of CO_2e by 2030.

Glenn Gallagher, air pollution specialist, CARB

As the regulatory body tasked with meeting that emissions reduction target, CARB has been relying on the EPA SNAP program to drive 24% of the state's HFC reductions. Another 45% percent is expected through the SLCP Strategy and 26% from the global HFC phase-down set by the Kigali Amendment to the Montreal Protocol a year ago.

"California cannot meet its HFC reduction goals by relying only on the global phase-down," Gallagher said. "Additional HFC reduction measures are needed."

CARB also recognizes the underlying environmental need for regulating HFCs. "They're the fastest growing source of greenhouse gases in California and also in the world," Gallagher said. "Just one pound of a refrigerant such as R404A or R507 being released into the atmosphere is the equivalent of driving one vehicle more than 4,000 miles."

Derek Hamilton, vice president of business development for Portland, Ore.-based shecco America, who attended the workshop, praised CARB's actions. "This is another example of California's leadership in the move towards natural refrigerants, and it will be warmly welcomed by the industry."

> *"Right now HFC emissions in California are about 20 million metric tons of CO_2e per year, and the goal is to reduce it to less than 10."*

Focus on stationary AC & R

Currently, stationary refrigeration and stationary air conditioning account for the largest percentage of HFC emissions in California – 43% and 24%, respectively, in the baseline year of 2013.

In its draft regulatory language, CARB plans to adopt only those provisions from the EPA SNAP rules 20 and 21 that delist high-GWP HFCs for stationary refrigeration and air conditioning. That would include: supermarket systems (new and retrofit), remote condensing units (new and retrofit), stand-alone (self-contained) refrigeration, refrigerated vending machines, retail food (refrigerated food processing and dispensing equipment), cold storage and chillers. For enforcement, CARB is considering recordkeeping, auditing, reporting and labeling, said Gallagher.

CARB is not adopting EPA SNAP rule provisions regarding mobile refrigeration and air conditioning or foam blowing agents because there are already state standards programs in effect for those applications.

If the courts uphold the SNAP rules pertaining to HFCs, CARB will go back to relying on the federal EPA regulations.

A draft of the regulation CARB is proposing for adoption of the EPA SNAP rules, as well as a link to leave a public comment, is available online at: https://ww2.arb.ca.gov/hfc-reduction-measures-rulemaking .

Comments on the draft regulation will be accepted until November 10 for a staff report will that be published in January 2018. Another 45-day public comment period will begin February 2018, and the regulation could go into effect mid-to-late 2018.

"We're still kind of at the early stages of proper enforcement," Gallagher said. "We would really welcome [industry] feedback on what might work best, or not." ▶

WAITING FOR A COURT DECISION ON APPEAL OF HFC RULING

In the absence of a response from the Environmental Protection Agency, the Natural Resources Defense Council (NRDC) and refrigerant manufacturers Chemours and Honeywell on September 22 asked the full U.S. Court of Appeals for the District of Columbia Circuit to rehear and reverse a three-judge panel's ruling that bars the EPA from regulating HFCs.

A response from the court is still pending.

In the case, Mexichem Fluor, Inc. v. EPA (Arkema was another plaintiff), the court panel ruled 2-1 on August 8 that the EPA cannot require companies to replace HFCs designated for HVAC&R equipment or other applications with low-GWP substances under the SNAP (Significant New Alternatives Policy) program; these low-GWP substances include natural refrigerants and HFOs.

NRDC, Chemours and Honeywell were intervenors in the case. Intervenors do not have as much standing as the EPA, which had until September 22 to appeal the ruling, but did not do so.

If the full court declines to rehear the case, the parties could file an appeal to the Supreme Court.

Meanwhile, the EPA's rules on HFCs – including the delisting of HFCs beginning this year – remain in force until the litigation is resolved.

The EPA could respond to the ruling by using the Toxic Substances Control Act to regulate HFCs, or explore implementing a "retroactive disapproval" of HFCs under the Clean Air Act. Alternatively, the U.S. Congress could adjust the Clean Air Act so it explicitly applies to HFCs as well as ozone-depleting substances, particularly if the Senate ratifies the Kigali Amendment to the Montreal Protocol.

SLCP Strategy moves forward

The second part of CARB's proposed HFC-reduction rulemaking is outlined in its SLCP Strategy, and would prohibit the use and sale of a range of synthetic refrigerants.

"The SLCP measures are in the final [strategy plan] that was published March 23 of this year," Gallagher said. "It has prohibitions on high-GWP refrigerants in new equipment and sales restrictions of very high-GWP refrigerants." CARB does not yet have draft regulatory language written for the SLCP plan.

Specifically, the plan includes, by 2021, prohibition of: refrigerants with a GWP of 150 or greater in new refrigeration systems containing 50 or more lbs of refrigerant; refrigerants with a GWP of 1,500 or greater in new refrigeration systems containing 20 to 50 lbs of refrigerant; refrigerants with a GWP of 750 or greater in new air conditioning systems containing two or more lbs of refrigerant; and refrigerants with a GWP of 150 or greater in new chillers (refrigeration or air-conditioning).

Regarding high-GWP refrigerants, the SLCP Strategy includes, by 2020, no production, import, sale, distribution or entry into commerce of refrigerants with a GWP of 2,500 or greater, and, by 2024, the same restrictions on refrigerants with a GWP of 1,500 or greater.

CARB will hold public workshops and stakeholder meetings on the proposed SLCP Strategy measures through summer 2018, with a potential effective date for the regulation of mid-2019.

While 2021 (when many of the new rules would take effect) is not far away, CARB said it believes the schedule to be feasible based on the fact that low-GWP refrigeration technology is currently available, with over 560 stores in North America estimated to be using CO_2-based refrigeration systems.

"There is an initial added cost of the low-GWP equipment at this time," Gallagher said, "but we believe this cost will continue to decrease with each year and it should achieve parity at some point with traditional systems."

CARB continues to seek state funding for natural refrigerant systems. Meanwhile, some utilities are starting to consider incentives programs for the installation of natural refrigerants; Sacramento Municipal Utility District (SMUD) is offering incentives for both energy- and GHG-reduction. (See "Game Changer," *Accelerate America*, May 2017.)

Gallagher also said CARB is considering barriers like cost, safety, codes and standards, education of local permitting agencies, and availability of trained technicians in its rulemaking process ■ EH

DOE'S DELAY OF WICF EFFICIENCY RULES

A six-month extension on enforcement of U.S. Department of Energy (DOE) efficiency rules for certain WICFs (walk-in coolers and freezers) was highlighted last month at the Food Marketing Institute's Energy and Store Development Conference in Orlando, Fla.

The DOE originally announced updated efficiency rules for WICFs in 2014, but AHRI and Lennox International filed a petition asking for judicial review of the rules. An industry-DOE Working Group later formed to negotiate new standards.

Efficiency standards for four low-temperature condensing units and two unit coolers (medium- and low-temperature) were set to be announced at the beginning of 2017, and take effect three years later. But the Trump administration delayed the announcement until July 27, giving the industry an extra six months before they take effect on July 27, 2020.

"Before [the rules] could get into the federal register, Trump got inaugurated and said 'freeze,' put this on hold,'" said Vince Zolli, vice president of engineering for KeepRite Refrigeration. "Then on July 27 [the rules] were released and put in the federal register."

The efficiency rules for four medium-temperature condensing units, which were not challenged in court, went into effect in June 2017 (and need to be complied with) – but they will not be enforced until January 1, 2020.

STUDY SHOWS **PROPANE CHARGE-LIMIT SCENARIOS**

Fire Protection Research Foundation lists safe charge caps for self-contained cases, including 1000 g in big-box grocery stores

By Elise Herron and Michael Garry

A study by the Fire Protection Research Foundation (FPRF) has determined what it considers safe propane charge limits for self-contained display cases in a range of settings.

For example, the study showed that a 1000 g charge in an appliance in a big-box grocery store is comparable in safety to a 150 g charge in a small commercial kitchen.

The study focused on the flammability hazards inherent in closed cases in commercial and retail kitchens. Its findings are significant because they suggest that it is safe to raise the charge limit of propane for wider use in commercial refrigeration under certain conditions. Currently, the Environmental Protection Agency caps the charge limit for propane in commercial appliances at 150 g.

The IEC subcommittee SC61C, which is raising the recommended international hydrocarbon charge limit in commercial refrigeration within the IEC 60335-2-89 standard, recently decided to move to the next stage in the process. (See story, page 31.)

Scott Davis, principal engineer for Gexcon US, presented the findings of the FPRF study in a session called "Understanding the Fire Hazard of Class A3 Refrigerants" at the Food Market Institute's Energy and Store Development conference in Orlando, Fla., on September 25. The FPRF, an affiliate of the National Fire Protection Association, Quincy, Mass., was supported in the research project by co-leaders Target Corp. and the North American Sustainable Refrigeration Council (NASRC).

"The need to increase this [charge] limit is growing as lower GWP refrigerants are required," Davis said.

In a summary slide, Davis listed the following propane charges in various commercial settings, each having the same risk factor as a 150 g charge in a small commercial kitchen:

- Up to 300 g in a 2,507-cu-ft deli or a 6,922-cu-ft kitchen
- Up to 600 g in a 3,178-cu-ft market
- Up to 1000 g in a 36,127-cu-ft big-box grocery store

> *"The need to increase this [charge] limit is growing as lower GWP refrigerants are required."*

ASSESSING FIRE RISK

The driving force of the study was to assess the fire risk involved with larger charges of A3 (flammable) refrigerants to determine if they can be used in a wider range of applications. Larger allowable charge sizes, Davis pointed out, equate to larger equipment that can run on R290. He estimates that the charge limit for propane will be raised in the near future.

In order to evaluate the risk posed by increasing the charge limit of propane, the study looked at both the "probability of having a release, fuel accumulating, and an ignition source present, and the consequence after the fuel is ignited," said Davis.

The study identified three potential hazards: overpressure, thermal radiation exposure and direct flame exposure.

There were two main types of propane leaks observed. The first was a high-pressure jet – a short duration, high momentum and low-charge leak – where the propane was diluted when the charge size and room volume were scaled properly. The ignition risk for this type of leak was centered on the location of the leak.

The next leak type resulted in the settling of heavier-than-air propane at the ground level – a bigger leak with low momentum and larger charge. Without a condenser fan, flammable volumes were observed to accumulate at floor-level and pose an ignition risk.

In the dispersion tests, there were "fixed conservative parameters," including low momentum releases (impinged jets), a completely sealed test room, no room ventilation and leak rates corresponding to larger hole sizes and liquid releases. Notably, both leak types were observed in test settings where there was no mitigating mechanical ventilation.

The study has been criticized by some industry experts for being too conservative in its approach, focusing mainly on worst-case scenarios and not employing conventional risk-assessment concepts. ▶

HIGHER CHARGE LIMITS: ONE STEP CLOSER

During a meeting on October 7 in Vladivostok, Russia, International Electrotechnical Commission (IEC) subcommittee SC61C, which is working on increasing the hydrocarbon charge limit in commercial refrigeration, took the next step in making that a reality.

The subcommittee decided to advance a draft amendment of the IEC 60335-2-89 standard for hydrocarbon charge in commercial refrigeration – prepared by Working Group WG4 – to the next stage in the process, known as the CDV (Committee Draft for Vote).

The final version of a draft amendment, which proposes to increase the propane charge limit to 500 g, will be prepared in December 2017.

The proposed charge limit is based on 13 times the low flammability limit (LFL) of propane. In order to ensure safety, the draft amendment will require a minimum room area where a system can be placed, and it has to pass a leakage test that will show the relative absence of flammable concentrations around the system, besides other construction requirements.

The charge limit increase will cover all safety classes of flammable refrigerants, but with different limits.

Standards from the IEC, a worldwide body that proposes rules governing how to use electrical, electronic and related technologies, influence the development of the market by providing manufacturers and customers with guidelines as to what is safe to use and buy.

The present international standard for hermetically sealed commercial refrigeration equipment limits the use of flammable refrigerants to 150 g. It is commonly accepted by experts that this limit does not allow manufacturers and end users to fully exploit the safe application of hydrocarbon refrigerants in this sector.

The CDV will be circulated for votes and comments by all national committees within IEC in December 2017 at the earliest. A vote on the CDV is expected in the first half of 2018. Provided that more than two-thirds of the committee members vote in favor, the draft will go to the final vote phase (Final Draft of International Standard) by the end of 2018, following an SC61C committee meeting in Busan, South Korea, in October 2018.

A new version of the IEC standard is expected at the beginning of 2019.

– Klara Skacanova

▶ However, Davis said that future research could reduce the "conservatism" of this study by "accounting for the considerably fast transient decay in accumulated fuel volume after the cabinet door is opened" and "incorporating a time-dependent ignition model."

FAN MITIGATION

With a condenser fan on in a properly scaled room, it's possible to mitigate risks so that the propane mixes and does not reach flammable levels, even at a 600 g charge. "The condenser fan prevented ignition in all events," Davis said.

If the condenser housing fan can be continuously operated, then both top-mounted and bottom-mounted condensing units can be designed with larger charges, but the charges "should be limited by some threshold value of the LFL [lower flammability limit], such as 20%-25% of the LFL," he said.

In addition, smaller charge sizes should be used if fan operation is not continuous, he said.

Other findings included: risk increases with charge size; servicing is a relatively small contributor to risk; density of ignition sources is significant; likelihood of in-cabinet releases is significant; top-mounted condensing units are generally lower risk when fans aren't always on; and when fans are always on, risk from top- and bottom-mounted units is similar.

To reduce the risk of external leaks, the study recommended operating the condenser housing fan "continuously or near continuously," said Davis. In addition, top-mounted condenser location results in reduced ignited-event frequencies due to the "mixing benefit of the height of the condenser."

To reduce the risk of internal leaks, he said, "ensure that the accumulated fuel volume is diluted prior to the door being opened" by, for example, passive venting near the base of the cabinet. Gas detectors that activate an extraction fan or lock the cabinet were also recommended.

The probability of an ignition event can be reduced by joining components in the refrigeration circuit "using brazed connections to reduce the likelihood of leaks," Davis said. In addition, all electrical equipment within a closed display case should be rated for "explosive atmospheres" ■ **EH & MG**

PROPANE SAVES ENERGY, SAYS NEW STUDY

The University of Birmingham – supported by Emerson – recently released a report finding that propane systems in supermarkets could save on energy consumption compared to HFC systems.

The report, "Retail Refrigeration: Making the Transition to Clean Cold," cites research on an integral (self-contained) propane system, showing that it has a lower total equivalent warming impact (TEWI) – combining CO_2e emissions from leaks and energy consumption – than a standard remote HFC system.

TEWI is reduced in integral hydrocarbon systems by 50%, with emissions associated with power consumption cut by 7.2%, when compared to HFC systems, the report said.

U.K.retailer Waitrose has opted for integrals running on propane or propene, according to the report, and has now converted 133 of its 292 stores, including 37 of its 50 convenience stores.

The retailer has also has reported good results compared to its previous remote system running on R404A. Each store that it has converted to an integral system saved 7% in electricity consumption and 60% in gas consumption, since the waste heat from the cooling loop is used to provide space heating.

– Charlotte McLaughlin

NatRefs ***for AC***

A low-charge ammonia packaged chiller is providing air conditioning at a Campbell Soup plant in Ohio, opening the door for ammonia chillers to take the place of AC units using HFCs and R22 in industrial and commercial spaces

By Michael Garry

Campbell Soup headquarters, Camden, N.J.


HEALTH &
WELL-BEING

Bing Cheng, manager of utilities engineering, Campbell Soup

In Napoleon, Ohio, in the northwest corner of the state, a giant Campbell's tomato soup can – 33 feet tall and 33 feet wide with the iconic red-and-white label – stands next to a Campbell Soup Company soup production plant. Passersby driving on state Route 110 just south of the Maumee River sometimes pull over to take a look or snap a photo, imbibing the aroma of fresh-cooked soup from the plant.

But the can is not there just as a roadside attraction – it contains up to 200,000 gallons of water for the facility's sprinkler system, according to *Ohio Magazine*.

What is less obvious about this location – but much more consequential – is another, much smaller metal container located next to the soup production building. (The site also includes a building for beverage production.) The container holds an air-cooled, low-charge ammonia chiller that generates cold glycol used by an air handler in the building to generate air conditioning – one of the first such chillers used for this application in North America.

The chiller/air handler delivers comfort cooling to a labeling and packaging section of the building where the red-and-white labels are applied to soup cans – and where a cool environment is needed to ensure proper adherence of the labels to cans. (The area did not have air conditioning previously.)

This year-old, packaged low-charge chiller, produced by Missoula, Mont.-based Azane (a division of U.K-based Star Refrigeration Group), is part of a new breed of low-charge ammonia packaged chillers also made by OEMs Mayekawa and Evapco. The chillers represent a new direction for the natural refrigerants industry in North America.

For one thing, they offer a portable, efficient and future-proof air conditioning alternative to industrial plants and potentially other large commercial and residential units currently using HFC or R22 chillers. Virgin R22 will no longer be available in North America in 2020, while HFCs are targeted for a global phase-down per the Kigali Amendment to the Montreal Protocol (with the U.S.'s status currently tied up in the federal courts; see story on page 26).

Ammonia's zero GWP and ozone depletion potential protects it from a phase-down, and in small charges ammonia falls below the 10,000-lb threshold for strict federal safety regulations.

"We estimate that 70% of all building types could be using ammonia packaged units, including office and retail buildings," said Mike Kallas, Azane's senior applications engineer, in a presentation at the ATMOsphere America conference last June.

Low-charge ammonia packaged chillers had been available in Europe for more than a decade before they emerged in the North American market. In one example, Azane's parent company, Star Refrigeration, installed a rooftop low-charge ammonia chiller at a Marks & Spencer department store in the U.K. The air-cooled unit generates chilled water at 43°F, using 213 lbs of ammonia to support a 160 TR load

> *"We estimate that 70% of all building types could be using ammonia packaged units, including office and retail buildings."*

(1.3 lbs/TR). The chiller only needs to be serviced one or twice annually, said Caleb Nelson, Azane's vice president of business development.

At a bakery in a populated area in Portland, Ore., Azane plans to install three low-charge ammonia chillers outside at ground level for air conditioning and some process cooling, each at 300 TR and 450 lbs of ammonia (1.5 lbs/TR). "We can go to a higher load by ganging packages together," said Nelson. The air-cooled units, using flooded plate heat exchangers for ammonia evaporation, received jurisdictional acceptance for overall environmental impact.

At ATMOsphere America, Kallas outlined a scenario for a supermarket where a low-charge packaged chiller stationed on the roof or on the ground could generate chilled glycol to condense CO_2 at subcritical temperatures for low- and medium-temperature display cases, while also delivering glycol for air conditioning; heat reclaimed from the system could generate hot water. "You could do refrigeration, air conditioning and heating with a low-charge ammonia chiller package," said Nelson.

Southern California Edison (SCE), one of California's largest utilities, is gathering data on the efficiency of low-charge ammonia packages, with an eye toward incentivizing their use as a replacement for R22 and HFC air conditioning and refrigeration units. "If you look at the opportunity, the biggest market is air conditioning," said Paul Delaney, senior engineer for SCE. "Using low-charge ammonia with a secondary loop fits the equation well for a number of applications."

SCE has partnered with the Electric Power Research Institute (EPRI) to support a new study of the efficiency, capacity and operational characteristics of low-charge ammonia units at Creative Thermal Solutions (CTS), Urbana, Ill. The study so far includes a water-cooled Evapcold unit from Evapco and an air-cooled Boreas chiller from Mayekawa. CTS has separately developed a 7-TR ammonia chiller with a charge of less than one lb. "That chiller works perfectly with a very high COP," said Pega Hrnjak, president, CTS and professor at the University of Illinois, Urbana-Champaign.

Far from the machine room

Another advantage of a low-charge ammonia chiller is that it offers industrial plants that deliver cooling from a remote machine (engine) room a lower-cost option for areas that would otherwise require extensive piping from the machine room. That was the case at the 60-year-old Napoleon soup plant. ▶

GREEN PLANT OF THE YEAR

Water tank for sprinkler system (and roadside attraction) at Campbell Soup plant, Napoleon, Ohio

Source: Alamy

Before Campbell Soup installed a low-charge ammonia packaged chiller to provide air conditioning at its manufacturing plant in Napoleon, Ohio, the facility was named 2014 Green Plant of the Year by *Food Processing* magazine.

The award was based on energy efficiency, innovative or alternative sources of energy, water use, green building construction, innovative design and economic sustainability.

Among its accomplishments, the plant:

- Transitioned to natural gas.
- Was recycling 95% of its materials.
- Installed a solar field with 24,000 panels, described as the largest in the U.S. supplying solar energy to a single private facility.
- Deployed a biodigestor that converts fruit-and-vegetable waste into methane to fuel two generators.
- Pretreats wastewater and funnels it back to the Maumee River.

Campbell said at the time that the Napoleon facility makes more than two-thirds of its beverage volume and over a third of soup volume in North America.

▶ "The Azane unit lent itself well because it's a good distance from the engine room," said Bing Cheng, Campbell's manager of utilities engineering, based at the company's Camden, N.J., headquarters. "We just put down a foundation pad outside, put the unit on top and hooked it up."

Using a flooded plate heat exchanger, 450 lbs of ammonia in the chiller cools a glycol solution to 44°F, and the glycol is piped to an air handler in the building, where the air is cooled to about 65°F. The chilled air is blown through ductwork to a section of the labeling area. The chiller is designed to supply glycol to two other air handlers for the same area that have not yet been installed. The total load requirement is 300 TR, at 1.5 lbs of ammonia/TR.

Cheng praised the portability of the chiller. "If your cooling needs change or you need refrigeration elsewhere at the plant or at another facility, you can move it to another location."

For more than two decades, Campbell Soup has been one of the industry leaders in shifting from large ammonia or R22 systems to low-charge systems. (See, Campbell's Low-Charge Recipe," *Accelerate Ammonia*, April 2016.) But rather than packaged systems, Campbell has opted to install self-designed low-charge ammonia skids in a centralized engine room, typically using ammonia as the primary refrigerant and glycol or chilled water as a secondary refrigerant piped to the cooling or freezing areas.

For example, since 2011, Campbell has converted four Pepperidge Farm bakeries from R22 to low-charge ammonia, with another facility in Denver, Pa., scheduled for conversion. At a bakery in Richmond, Utah, which was converted in 2013, the machine room houses low-charge ammonia/glycol skids dedicated to HVAC. At a bakery in Lakeland, Fla., converted in 2016, water is used instead of glycol with the low-charge unit because of the warmer ambient temperatures.

A number of Campbell's thermal facilities have small charge (less than 10 TR) HVAC units using HFCs, which Cheng plans to replace over time with a natural refrigerant option (low-charge ammonia and/or CO_2 systems). The Napoleon plant, for example, has two HFC "spot coolers" in production areas and others serving office space, said Allen Jackson, project foreman for Dunbar Mechanical, Toledo, Ohio, the plant's HVAC&R contractor.

"Down the road as HFC units break down, we typically design enough capacity in our low-charge ammonia [machine room] skids to replace the HFC units with air handling units that could use glycol or chilled water," said Cheng.

However, in the event an air conditioning load is far from the machine room (as in Napoleon) or the machine room lacks sufficient capacity, Campbell would consider installing more low-charge packaged units as a complementary solution, said Cheng. In fact, at its thermal plant in Paris, Texas, "we are looking to supplement the current machine room capacity," he noted. "Instead of expanding the machine room, which would be costly, we're looking at using an Azane unit to provide the new refrigeration load."

Though packaged low-charge ammonia chillers are new to the North American market, Jackson of Dunbar Mechanical was comfortable working with it, given his 30+ years of experience with ammonia systems. "It wasn't completely different," he said, though it was the first air-cooled system he has worked with.

Nonetheless, Azane spent a few days after the start-up on training for Dunbar and Campbell technicians, said Nelson.

Start-up of the Azane unit, which includes pressure and leak detection tests and on-site charging, may take a couple of weeks. But once it begins operation, the unit, with its industrial-quality design, is low maintenance compared to commercial HFC chillers that use copper pipes and hermetic compressors that are more prone to leaking or failure, Nelson said.

Jackson acknowledged that he originally had "reservations" about the Azane unit because it was air-cooled. But having worked on it for over a year, he pronounced it "a good system" that has been running well, requiring "very little" maintenance, and experiencing no ammonia leaks.

As for the hazard posed by ammonia in the unit, he said "there's always some danger working with ammonia," but added that it presents no risk to the public.

Structural advantages

In assessing the potential for a packaged low-charge ammonia chiller to supply air conditioning on a wide-scale basis, Nelson pointed out several factors weighing in its favor.

Azane chillers, which range in capacity from 40 to 340 TR, offer certain structural advantages, such as not requiring a machine room and being built off-site. Because of their proximity to the load, they eliminate the need for long ammonia piping, which, besides being expensive, may cause an efficiency penalty due to a suction line pressure drop and extra heat gain into the system.

In addition, the industrial construction of the chiller, incorporating steel piping and steel condenser tubing, allows it to run for 30+ years, said Nelson. By contrast, an HFC chiller may need to be replaced after 10-15 years.

And because they generally use an air-cooled condenser, the units require no chemical water treatment and offer savings on water and sewer bills, he said. The Azane chillers also include automatic oil return, saving the cost of manually draining oil.

Azane has also designed the chillers with four levels of safety to keep the ammonia contained inside the system in the event that the system pressure rises. "The control system will unload compressors, then ▶

SYSTEM SPECS

Key characteristics of the Azane chiller used for air conditioning at the Campbell Soup plant in Napoleon Ohio:

- » Load: 300 TR
- » Ammonia charge: 450 lbs (1.5 lb/TR)
- » Flooded plate heat exchanger
- » Air-cooled condenser with variable-speed EC fan motors
- » Ground installation
- » Glycol cooled to 44°F
- » Automatic oil return
- » Three ammonia leak detectors: compressor (500 ppm), evaporator (25 ppm) and relief header (25 ppm)
- » Two screw compressors

CO_2 AND R290 FOR AC

Ammonia is not the only natural refrigerant being tapped for air conditioning; outside the U.S., codes/standards allow CO_2 and propane to be used for AC.

For example, CO_2 in transcritical systems can also generate comfort cooling. Klaas Visser, owner of Australia-based KAV Consulting, in 2009 designed the first two-stage transcritical CO_2 refrigeration system with parallel compression that delivered refrigeration as well as office air conditioning and heating at an Australian food processing plant.

"When used for AC cooling, CO_2 refrigeration, if equipped with a water-cooled evaporative condenser, is more efficient than conventional refrigeration," said Visser. "Moreover, by integrating the AC and refrigeration duties into one system, the AC function may be combined with parallel compression … to remove "flash" CO_2 gas in high ambient temperatures."

In a European supermarket this year, ADM, Alfa Projekt, Rivacold and Frascold collaborated to install a transcritical CO_2 booster system with parallel compression that provides refrigeration, air conditioning and heat recovery.

Propane is another natural refrigerant being used for air conditioning in domestic applications outside the U.S. In China, all manufacturers of room air conditioners have designed an R290 product. According to FECO, part of China's Ministry of Environmental Protection, Chinese manufacturers are expected to deliver 100,000 R290-based split units this year.

Indian manufacturer Godrej & Boyce started producing energy-efficient R290 split home systems in 2012. Since then Godrej has sold 350,000 such units in the Indian market.

The use of energy-efficient natural refrigerants in the home air conditioner market is expected to become increasingly important as the planet warms and the demand for home cooling grows, especially in developing countries.

> *"We just put down a foundation pad outside, put the unit on top and hooked it up."*

Azane chiller

shut them down," Nelson explained. "If pressures still rise, redundant mechanical switches will kill power to the compressors. If pressures continue to rise in this case, then you likely have some external heat source – a building fire for example – and there is an emergency pressure control system built in that mechanically diverts high pressure gas to the low pressure side of the system."

If the pressure still rises, ammonia is released through a safety relief valve. That triggers leak detectors and ramps up the condenser fan speed to 100%, sucking fresh air into the chiller and dispersing the ammonia vapor 30-40 feet off the top of the unit "where it should continue to rise and dissipate further into the outside air," Nelson said. Detectors at the compressor, evaporator and relief header detect 500 ppm, 25 ppm and 25 ppm, respectively.

A machine room is required by code to have at least 30 air changes per hour of ventilation. That is not required of an outside unit, but Azane's chiller nonetheless offers 300 times that much, or 9,000 air changes per hour, noted Nelson. "Even if the fans failed, we would have several times the requirement for natural ventilation where no emergency ventilation is required."

Azane monitors the energy and performance of its chillers remotely. To save energy, air handler can include an economizer that brings in outside air and turns off the chiller when the ambient temperature is low enough.

At the Napoleon site, the chiller is performing "as-planned," said Nelson. This means that at full load (with three air handlers), seasonal performance will be close to 0.75 kW/TR, without VFD drives on the

HVAC glycol low-charge ammonia chiller package in machine room at Pepperidge Farm plant , Richmond, Utah

compressors. "So, the efficiency we're seeing is really a baseline for our standard offering," he said.

The next version of the chiller (Azane chiller 2.0) is offering seasonal performances well below 0.6 kW/TR, "and we're seeing a huge request for these already," said Nelson. "These are efficiencies the HFC chillers can't get to—even with every bell and whistle."

Nelson also cited a study done by a third-party engineering consultant for the city of Portland, Ore., that compared the TEWI (total equivalent warming impact) of Azane's low-charge ammonia air-cooled chiller designed for the Portland bakery with that of a code-compliant R507 water-cooled system. TEWI consists of both direct CO_2e emissions due to leaks and indirect CO_2e emissions due to energy consumption.

"To meet Oregon's energy-code requirement for using an air-cooled chiller greater than 100 tons of refrigeration, we had to show that its efficiency was equal to or better than the minimum efficiency of a water-cooled system," he said.

The efficiency of the Azane chiller was found to be 16% better than that of the water-cooled chiller, contributing to a 13.7% reduction in TEWI. On a direct emissions basis, the ammonia chiller reduced the TEWI by another 18.3%, resulting in a 32% lower TEWI.

In comparing the efficiency of air-cooled systems to that of evaporative-cooled systems, Nelson cited a 2016 IIAR-published study by VaCom Technologies concluding that in three of 11 U.S. cities, air-cooled systems used less energy on a yearly basis while in the majority of the other eight cities, air-cooled energy consumption was higher by less than 5%. On average, total operating costs were shown to be lower for the air-cooled option across the U.S., in some areas by as much as 21%.

"Energy is not your only utility bill," said Nelson. "With evaporative and water-cooled systems, you also pay higher water and sewer bills and pay for chemical water treatment."

He also pointed out that the efficiency of evaporative condensers is highly dependent on effective chemical treatment and maintenance to prevent mineral deposits from collecting, adding that scale formation as thin as 1/32-inch will reduce condenser capacity by more than 25%.

Similarly, in regard to adiabatic condensers, "You have to be careful." he said "Pre-cooling pads introduce an air-flow restriction that penalizes the condenser efficiency, even when the adiabatic function is turned off at night and during colder seasons. The pads also act as an air filter and so are easily clogged with airborne debris that can penalize condenser fans and compressors even further."

In terms of capital cost, a low-charge ammonia package will have a lower first cost than a machine-room ammonia system, said Nelson. In comparison to an HFC chiller serving multiple air handlers, a comparable Azane chiller will be more expensive. However, with its efficiency advantage, "we should expect to see a payback over [the cost of] HFC chillers in the five-to-seven-year range, depending on application," he said.

In industrial facilities requiring larger capacities, non-standard operating conditions, or special forms of heat reclaim – not well accommodated by a standard HFC chiller – an ammonia chiller can show cost parity with an HFC option where multiple, non-standard packages are required, Nelson added.

Moreover, HFCs as a refrigerant class are facing an uncertain future as the target of a global phase-down under the Kigali Amendment to the Montreal Protocol. "HFC chillers are not designed for a refrigerant retrofit – they have to be replaced along with the refrigerant," said Nelson. "We use a future-proof refrigerant, so you can use the chiller as long as you maintain it."

For the Azane chiller 2.0, Azane is seeing the cost per ton of refrigeration drop by about 20% for larger models and about 50% for smaller models," he added. This "will also help get more ammonia into the HVAC market" ■ MG

A New Way to Boost Transcritical Efficiency

At a Whole Foods store in San Jose, Calif., a transcritical CO_2 system using an absorption chiller outperformed other natural refrigerant systems

By Elise Herron

In a study of five systems installed at stores in California, Whole Foods Market – one of the leading users of natural refrigerant systems in the U.S. – determined that a transcritical CO_2 system equipped with a lithium bromide absorption chiller was the most efficient across a range of locations.

The findings were presented last month by Tristam Coffin, director of sustainability and facilities for Whole Foods Market, in a webinar hosted by the Environmental Protection Agency's GreenChill Partnership. Coffin was joined by Mike Harvey, engineer for DC Engineering, and Tom Wolgamot, principal, DC Engineering.

In June, at the 2017 ATMOsphere America conference in San Diego, Coffin and Wolgamot presented a similar presentation about the efficiency and performance of different natural refrigerant-based system architectures in California Whole Foods stores.

Coffin said that building type and climate zone are the two most important considerations when deciding which type of refrigeration system to use. He added that the the many microclimates in California make the state an effective place to conduct case studies on how different systems work in varied environments.

He is a firm believer that there is no one "silver bullet" solution for every store.

Tristam Coffin, director of sustainability and facilities, Whole Foods Market

STORE COMPARISONS

The five Northern California stores using natural refrigerants all opened between 2013 and 2016, within a 40-mile radius of each other. They include:

- A four-year old cascade system, with CO_2 on the low side (DX for low temperatures and liquid overfeed for medium temperatures) and R407A on the high side, at a Castro (San Francisco) location.
- A three-year old transcritical CO_2 system with an air-cooled gas cooler at a Berkeley location.
- A two-year old cascade system with R717 (ammonia) on the high side and a Castro-type CO_2 arrangement on the low side at a Dublin (Bay Area) location.
- A year-old cascade system with R290 (propane) on the high side and a Castro-type CO_2 arrangement on the low side at a Santa Clara location.
- A three-year old transcritical CO_2 system with a de-superheater (subcooler) via an absorption chiller (driven by waste heat from combined heat and power) for high-side heat rejection at a San Jose location.

At the ATMOsphere America presentation, Coffin and Wolgamot included a store in Fremont, Calif., using an R407A DX system as the baseline.

The study showed that the transcritical system at the San Jose store – which was able to remain in subcritical mode when the absorption chiller was in operation – was more efficient than any of the other systems across a range of temperatures. It was significantly more efficient than the standard transcritical system in Berkeley and the cascade systems using ammonia and propane, and slightly more efficient than the cascade systems using R407A.

For example, at 60°F, the San Jose system consumed 1.0 kWh/MBH while the Berkeley system used 1.75 kWh/MBH. At 80°F, the numbers were 1.75 and 2.50, respectively. At 70°F, the San Jose system was at about 1.3 kWh/MBH, compared to 1.5 for the R407A/CO_2 cascade system and about 2.1 for both the ammonia and propane cascade systems.

In a look at projected energy use, the San Jose system was less than the baseline R407A baseline system at 65°F, 1.25 to 1.4; even at 90°F, they both consumed the same energy (1.75).

Coffin noted that other technologies that enhance the efficiency of transcritical systems include parallel compression, ejectors, adiabatic condensers and other types of subcooling.

Coffin also stressed the importance of calculating the Total Equivalent Warming Impact (TEWI) of refrigeration systems, which include both indirect emissions from power consumption and direct emissions from refrigerant leaks. Systems with high-GWP HFCs have much higher TEWI values than natural refrigerant systems.

"I think there's a lot of important detail that goes into the energy analysis," Coffin said. "But it's important that we're looking at TEWI, and our impact overall from both direct emissions and indirect emissions. Natural refrigerants emit about 1,500 times less CO_2e than R407A."

He also noted the importance of reliability. "Obviously the major end-goal is to sustain operations for the folks that are intending to sell broccoli in the stores," Coffin said.

Coffin compared the costs of the natural refrigerant-based systems with the baseline R407A DX system. He found the R407A/CO_2 cascade system 10% higher, the transcritical systems about 60% higher and the cascade systems with ammonia and propane more than 100% higher.

While natural refrigerant-based systems cost slightly more than the baseline store on average, Coffin said the price difference is starting to narrow as installations become more widespread.

"Generally speaking," he added, "on the transcritical side of things, we've seen that come down significantly in the last two to three years."

In closing his ATMOsphere presentation, Coffin advocated for more widespread adoption of natural refrigeration systems. He hopes to bring more people to the table discussing implementation and optimization of these systems.

Tom Wolgamot, principal, DC Engineering

"Custom systems are going to come at a premium," he said, "but standardization and wider adoption is really going to drive the cost down.

"It's in large part the reason why I'm really encouraging folks to get out there and take these presentations, and the lessons that you've learned and bring them to the folks that aren't at the table so that we can hopefully have them sitting at the table next year and in days to come" ■ EH

NATIONAL RECOGNITION

One of the benefits of being environmentally minded is recognition from federal partnerships like EPA's GreenChill program.

"As a GreenChill partner [Whole Foods has] 10 platinum certifications, five gold and six silver certifications currently," said Tristam Coffin, director of sustainability and facilities for Whole Foods Market, during a 2017 ATMOsphere America presentation. "We're hoping to increase those numbers every year. Energy efficiency, and overall reduced consumption, is really one of our major end goals."

The GreenChill certification program, according to the EPA's website, "recognizes individual stores for using environmentally friendlier commercial refrigeration systems."

And Whole Foods recently earned yet another GreenChill award, which was presented at Food Market Institute's Energy and Store Development Conference in Orlando, Fla. in September. This time the award was for Store Re-Certification Excellence – which recognizes supermarkets that have renewed GreenChill store certification for five consecutive years.

Target Exceeds 1,000 Propane Stores

The discounter continues the rollout of R290 display cases – its preference for self-contained refrigeration equipment

By Michael Garry

Minneapolis-based Target Corp., which operates more than 1,800 stores, now has self-contained display cases using propane (R290) refrigerant in more than 1,000 of them, with more to come.

Target's propane cases include larger units it purchases for stores as well as smaller beverage coolers provided by brands like PepsiCo, Coca-Cola and Red Bull. Each store carries more than 10 propane cases, on average.

"Target has been evaluating alternative refrigerants for several years and has determined that R290 is the preferred self-contained refrigeration solution," said Paul Anderson, the company's senior director of engineering, at a session on alternative refrigeration at the Food Marketing Institute's Energy & Store Development Conference, held last month in Orlando, Fla. "We did our tests and said, 'You know what, this is right for Target.'"

The reasons for this determination include:

- Propane has the lowest energy consumption of all HFC and natural refrigerants and a GWP of only three.
- Most manufacturers are supplying or are committed to supplying propane cases
- Contractors offer service capability for propane equipment.

"We worked closely with the suppliers, the manufacturers of that equipment, and also the contractors and said, 'Are you guys ready? Can you help us achieve this goal?' And hands down everybody said, 'We're ready,'" Anderson noted in an interview with *Accelerate America*.

ROBUST EFFICIENCY

Target has also been pleased with the energy efficiency of propane cases. In one beverage cooler study it performed, the chain found that an R134a case consumed 0.92 kW of power while a comparable R290 case consumed 0.43 kW, or 53% less. Anderson said that the energy comparison focused on the refrigeration system, which used standard (not variable-speed) compressors. He added that maintenance and repair of propane units are "very limited."

Paul Anderson, senior director of engineering, Target

Target's policy now is to require from its suppliers that all new and replacement stand-alone display cases with a capacity of under 2,200 BTU/hr use propane refrigerants.

Target's self-contained units are typically air-cooled, so it monitors the heat released into stores. "We do a heat balance on the store and we have our own internal threshold on where we think that [air-cooled] makes sense and where we may need to switch to water-cooled," said Anderson.

In fact, Target has installed water-cooled cases using HFOs throughout a number of small, urban stores. The retailer designed the equipment to accept propane when the charge limit for the hydrocarbon rises above 150 g. "They have all the safety components that they need to switch to propane," said Anderson. "I'd love to get to that point." The efficiency of water-cooled propane cases would still be high, even with the addition of the water loop, he added.

Target was a co-leader, with the North American Sustainable Refrigeration Council (NASRC), of a flammability research project conducted by the Fire Protection Research Foundation to determine the feasibility of higher propane charge limits. (See story, page 30.)

"I'm very excited with the outcomes of the study and the direction that it's providing all of us in the industry to safely use hydrocarbons as refrigerants in our systems," said Anderson ■ MG

Transcritical Update

Harrison Horning explains how Hannaford Supermarkets' transcritical CO_2 systems are faring – and his plans for additional retrofits

By Michael Garry

In July 2013, Hannaford Supermarkets installed the first transcritical CO_2 booster system in a U.S. supermarket, at a store in Turner, Maine. After that, the 189-store New England chain, a division of Ahold Delhaize, opened a second transcritical store in North Berwick, Maine, in 2015. This year it completed a transcritical retrofit in an existing store in Raymond, N.H. – among the first such retrofits in the U.S.

At the Food Marketing Institute Energy & Store Development Conference in Orlando, Fla., last month, *Accelerate America* talked to Harrison Horning, Hannaford's director of energy & facility services, about the transcritical stores and his plans for this technology.

Accelerate America: How are the first two transcritical systems functioning and how do they compare with your more traditional systems?
Harrison Horning: They've been working well. For the first one, we still contract with the supplier for some monitoring service so we have an ongoing expense there. But, with their 24/7 oversight, we feel that we're covered. The second one is handled by our own team, and it's a small store – 20,000-sq-ft. I'd say its maintenance and refrigerant replacement expenses are comparable to any other store of that size and vintage.

AA: What about energy-wise?
HH: Energy-wise they're probably both around 5% higher energy use than what we might have had with our standard system. But our standard prototype is a premium system that is optimized for our climate so we never really expected to do better than that. We wanted to at least get our feet wet with transcritical CO_2, and then be able to add features like parallel compression, possibly an adiabatic gas cooler, possibly ejectors and direct heat reclaim – the new features that we would expect to improve performance or bring it to par or maybe even better than our old standard.

AA: Are those additional features something you might add to the original stores? Or do you feel that the energy is sufficient?
HH: No, the energy is close enough, and GHG-wise we're way ahead. I think those features you would purchase with a new system are very difficult to retrofit. You could retrofit an adiabatic gas cooler, but you wouldn't want to do that until the old one was at the end of its life.

The third system we did in the existing store in New Hampshire does have parallel compression and direct heat reclaim, so we're going to learn about the benefits of those features and we'll expect the performance to be better than those earlier systems.

And in the heating season we'll be able to see if we are burning less propane to heat the store because we have better heat reclaim. We're expecting some good results

AA: Will you be doing more retrofits in existing stores with transcritical?
HH: We actually found three stores that are due for remodel that met our criteria to replace their refrigeration system with transcritical CO_2. But we decided that we would just do one and get some experience with it first. Now our task it to get some feedback about how it's working by the end of 2017.

This is our criteria for a retrofit: Is all the equipment at end of life? Is the piping at end of life? Do we have space where we can conveniently add these new transcritical racks? If so, that store would be a candidate and we could start the process. We're looking forward to that because the reality is we're not building a lot of new stores, and across the industry there are thousands of existing stores that have opportunities to use more natural refrigerants.

AA: And when you do build new stores, you plan to use transcritical systems?
HH: Yes, right now that's the new standard. We may pilot some other things like propane cases or maybe medium-temp glycol, but if we're just doing a standard new store today, I'd say it's transcritical CO_2. And we would expect the cost premium to be pretty minimal and something that we would get approval for ■ MG

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NATREFS GET HEARING AT FMI ENERGY

The annual Energy & Store Development Conference shines light on companies pursuing propane and CO_2 technology development

By Michael Garry and Elise Herron

The Food Marketing Institute's Energy & Store Development Conference, held last month in Orlando, Fla., is an annual opportunity for manufacturers of natural refrigerant systems and components to bring their products to the attention of the North American supermarket industry – still relatively early in its adoption of natrefs.

At the Manufacturer/Retailer Exchange, *Accelerate America* had a chance to speak with some of those companies. Here's a sampling of what they said.

HUSSMANN'S PROPANE CASES

Quentin Crowe, Hussmann

Hussmann, a Bridgeton, Mo.-based OEM, has developed new micro-distributed water-loop condensing units using propane refrigerant for display cases in small-format supermarkets.

The company previously installed such cases in 2013 to do most of the refrigeration at a new 83,000-sq-ft H.E. Butt Grocery Company (HEB) store in Austin, Texas, and for all low-temperature cases at a remodeled, 34,000-sq.-ft. Lowe's Market in Lubbock, Texas, in 2015.

Hussmann is supplying the propane units to a small-format food retailer, said Quentin Crowe, product manager for Hussmann, declining to name the retailer without its permission. He sees propane cases as potentially suitable for dollar and drug stores, in addition to supermarkets. "I think it's going to make an impact in the U.S.," he said last month at the FMI Energy & Store Development Conference.

But he stressed that it's important to find specially trained technicians to service the units. The retailer, he said, "has to own the service side."

Technicians inspecting propane units should perform an evacuation process and leak test, and seal the system, he said, adding that this type of protocol should be put in writing and signed by the technician. "That's to make sure the [cases] are certified to be safe when the technician leaves the store."

Crowe said the cases designed for the small-format food retailer are equal to or less than HFC units in energy consumption. At the Lowe's Market, the energy consumption of the propane condensing units was found to be 25% less than that of condensing units using R407F. (See "Food Retail Panel Discussion: Learning from Experience," *Accelerate America*, July-August 2015.) Each of the condensing units at that store contain 5 oz of propane, for a total of 170 oz.

TRUE'S ALTERNATIVE TO AIR-CURTAIN CASES

From left: Charles Hon and Todd Washburn, True Manufacturing

True Manufacturing, O'Fallon, Mo., is marketing a line of self-contained propane display cases with newly designed doors as an alternative to cases with air curtains, said Todd Washburn, director of sales & marketing, retail division, for True.

The air-cooled TVM line cases "are very efficient and have the same look as cases with air curtains because you don't see a lot of frame," said Washburn at True's booth at the FMI's Energy & Store Development Conference.

The energy consumption of seven TVM cases is equivalent to that of one air-curtain case of the same size, according to Washburn. "So, it drops your utility bill considerably, and is still an attractive offering."

True, one of the pioneers of self-contained propane cases for commercial applications, is continuing to broaden its portfolio of doored propane cases, Washburn said.

True's customer base has accepted its conversion to propane, he noted. "It's a non-issue. It's a True product, and it happens to be propane." In regard to propane's flammability, True has "done a good job educating our customers" and does not typically get pushback, he added.

DANFOSS'S EJECTOR

Jim Knudsen, Danfoss

At the FMI Energy & Store Development Conference, global component giant Danfoss continued to promote its CTM multi-ejector, which won the 2017 AHR Expo Innovation Award in the refrigeration category.

Working with a parallel compressor in a transcritical CO_2 system, the ejector saves between 10% and 20% on energy consumption (depending on the ambient temperature) compared to a conventional booster transcritical system, said James Knudsen, segment manager, food retail for Danfoss, with U.S. headquarters in Baltimore, Md.

The multi-ejector contains up to six ejectors of varying sizes, allowing it to modulate to different ejectors depending on load demands.

"The ejector is where most of our conversations start because it expands the [geographical] range [of transcritical systems]," he said, referring to the ability of the ejector to improve the efficiency of a transcritical system in a warmer climate, where it is more prone to operate in supercritical mode.

To date, the unit, which can serve as a gas or liquid ejector, is commercially available only as a gas ejector.

A Sprouts Farmers Market store in Woodstock, Ga., that opened in June became the first U.S. store to operate a transcritical system (from Hillphoenix) equipped with the Danfoss ejector. "Everything's running fine," reported Knudsen, adding that the transcritical system's energy consumption is being studied.

Other U.S. food retailers are asking about the ejector, particularly for southern locations, he said. "And all OEMs have samples in their labs."

In Europe, where transcritical systems are far more prevalent, about 150 stores are employing transcritical systems with the ejector, added Knudsen.

Knudsen delved into the way the ejector operates. In receiving CO_2 emanating from the gas cooler, "[an ejector] acts as an expansion valve," he said. Knudsen added that in lower temperature subcritical operation, "it's two-phase because there's liquid and gas coming off the gas cooler."

The ejector receives gas from the medium-temperature suction line and diverts it to a receiver where it combines with flash gas. "The flash gas is at a higher pressure so you can compress it using less energy," he explained. "That's where the energy savings comes from." The combined gases go to the parallel compressor – "a lower-energy compressor."

The ejector, he added, is "just a pressure pump – you can use it anywhere you need a pump." As a liquid ejector, it diverts liquid from a flooded evaporator that might otherwise make it back to a compressor.

ZERO ZONE'S TRANSCRITICAL INSTALLATIONS

From left: Jason Harren, David Padalecki, Dan O'Brien, Terence Smith and Gary Price, Zero Zone

Over the past 18 months, Zero Zone has supplied almost 10 CO_2 packages – a mix of transcritical booster systems and subcritical systems using a glycol loop – to a California pharmaceutical company, "with another 12 on the books," reported Dan O'Brien, vice president of sales & marketing for the OEM, based in North Prairie, Wis.

Zero Zone is also supplying a transcritical CO_2 system to a new store in the Pacific Northwest, said O'Brien. The climate there is "not real hot," so the system can "run a lot of the time in subcritical" without the aid of parallel compression or an ejector, he said.

Neither the retailer nor the pharmaceutical company could be identified without their permission ■ **MG + EH**

The Case for Propane

OEMs AHT, True and Novum explain why they are almost entirely committed to using propane in their display cases for foodservice applications – though the North America market hasn't caught up with them yet

By Elise Herron

On March 27, 2017, the U.S. Department of Energy's new energy efficiency standards for self-contained commercial refrigeration units went into effect, forever changing the market for this equipment.

OEMs making self-contained display cases for foodservice and food retail applications now have to comply with efficiency standards that are markedly stricter than the previous DOE standards. To that end, many OEMs have begun switching from HFC-based refrigeration systems to those that use hydrocarbons, particularly energy-efficient propane. Three of the OEMs that have led this transition are AHT Cooling Systems USA, True Manufacturing and Novum Refrigeration Technology.

As a result, the North American market has started to move in the direction of propane for self-contained commercial units. Yet many end users cling to HFC units, as long as they comply with the new DOE regulations.

At ATMOsphere America in June, representatives of AHT, True and Novum explained in a session on the future of foodservice why they have almost entirely committed to using propane in their equipment, offering the North American market an energy efficient, future-proof alternative to HFCs.

> *"These are factory-sealed systems. We build it out, you plug it in – it's a light installation."*

Howell Feig, national account manager at AHT Cooling Systems USA

AHT TAKES OFF IN NORTH AMERICA

An industry leader in utilizing propane, AHT Cooling Systems, based in Rottenmann, Austria, began researching use of this natural refrigerant in the early 1990s, said Howell Feig, national account manager, sales at AHT Cooling Systems USA, Ladson, N.C. Not many years later, the manufacturer was serially producing and installing propane-base systems in supermarkets around the world.

"We did the first supermarket installation back in 1997," said Feig, "and started serial production in 2002. We completed our first store in 2015 [in Europe] with all propane."

AHT entered the North American market in 2005 and decided in 2014 to migrate its whole line to propane.

Today, Feig said, AHT has installed over one million propane-based cases throughout the world – including 15,000 in North America. Most of the installations AHT does are in the food retail sector, but it also frequently works with the foodservice and convenience store industries.

"We've already migrated to this market approximately 80% of all cases to propane," Feig said, "and the rest will follow and complete that by early in 2018."

In North America, AHT has sold self-contained propane refrigeration cases to "well over 1,000 stores" (mostly outlets that have not used them before) this year, said Feig. That number approaches the number of stores equipped with propane cases between 2014 and 2016, he added. AHT's larger U.S. customers include Whole Foods Market and ShopRite stores.

AHT's propane units include wide and narrow island cases, spot bunkers and merchandisers, and upright frozen cases – all with doors or lids.

CO_2 is an increasingly popular natural refrigerant as well, but Feig said AHT ultimately chose propane for its ease of use and energy efficiency in plug-and-play cases.

"Our idea is to keep it simple," said Feig. "These are factory-sealed systems. We build it out, you plug it in – it's a light installation." Energy efficiency is another advantage; a study AHT did with Southern California Energy found 20% energy savings when R290 was used in place of R404A.

Full store installations are in the future for AHT, Feig said, but the 150 g charge limit makes running bigger or open units on propane difficult at the moment. One solution AHT designed for bigger units like doored freezer cases is the use of multiple circuits. AHT expects to be able to offer propane in small open vertical cases – as well as standard open multi-decks with multiple circuits – next year.

"With these being multi-circuit at the moment," Feig said, "we're working towards that full-store solution."

AHT is also working with industry committees to raise propane's charge limit. In the next few years, Feig guesses the charge limit will be raised to 300-500 g and begin to be implemented in the marketplace.

"Once that happens," he said, "it will allow for those cases that have multiple circuits to be reduced down to one circuit and become a bit more efficient."

> *"A majority of all our sales are in hydrocarbons."*

Charles Hon, engineering manager at True Manufacturing

TRUE'S SWITCH TO PROPANE

True Manufacturing started experimenting with propane-based refrigeration systems in 2006, according to Charles Hon, engineering manager at True. The company started selling propane products in the U.S. about six years later after the Environmental Protection Agency approved R290 for commercial applications.

"Now," Hon said, "a majority of all our sales are in hydrocarbons."

One of the main reasons True chose propane as its choice refrigerant was because of its minimal environmental impact.

"Low-GWP refrigerants are very important to the [industry]," Hon said. "R290 really requires less than half of the charge size of R404A and R134A – and you're talking GWP numbers from almost 4,000 to three. It has a huge environmental impact, but not only that – it has a huge energy efficiency impact." Moreover, the cost of True's propane units are equivalent to that of its HFC equipment.

When True started using R290 instead of R404A in one of its single-door self-contained freezers, Hon said, the energy efficiency for the equipment went up 23%. For True's two-door freezers, energy efficiency jumped 35% with the switch to R290.

Energy savings have occurred "across the board" after switching equipment to R290, Hon said. In fact, in 2016 True was awarded the Environmental Protection Agency's 2016 Energy Star Emerging Technology Award in the residential/commercial category for 42 of its cases. That award, according to Hon, is given to systems that use refrigerants with a GWP of less than 15 and are at least 5% more efficient than previous models. ▶

▶ "If we wanted to apply for more, we still have at least a dozen more [systems] we can add to the list," Hon said.

Given their energy and environmental impact, reliability and familiarity among technicians, True's decision to focus on systems that use propane as a refrigerant was not difficult, Hon said.

"We have a natural refrigerant that is very low-GWP. There's no reason to have another step because we're already there," Hon said. "We skipped the middle steps. Propane leads the self-contained market sector's needs for low-GWP, high-efficiency, higher reliability product because it just is that good."

Because of the benefits that the company has experienced by utilizing R290, it will continue offering propane-based systems almost exclusively (R134a is still available for those who want it), and hopes to be 100% propane by 2019.

"Right now 85% of all pieces of equipment we manufacture are available in propane today – ready to go," Hon said. "The market questions the serviceability, which we've covered completely. We've trained thousands of technicians so that the market is available to them. The market might not be quite ready for it, but we certainly are."

NOVUM'S REMOVABLE CASSETTES

Eoin Lennon, R&D manager at Novum

Novum's history of manufacturing self-contained display cases dates back over 50 years. In 1999, the Dublin, Ireland-based company designed and manufactured its first all-propane store.

"This was for a U.K. customer who today buys nothing but propane cases from us," said Eoin Lennon, R&D manager at Novum.

In 2010, Lennon said, R290 production really started gaining traction – and in the last three years all of Novum's European customers changed over to propane.

Hydrocarbon-based display cases have nearly become the company's production standard.

"We're now 100% production of R290 in Europe. The only HFC customers we still have are outside of the E.U.," Lennon said. "There's one or two left and we're working to get those changed over as well. We hope by 2018 or 2019 we'll be at 100% production of propane cases."

Novum's incremental change to propane, Lennon noted, was motivated by the benefits inherent in using the hydrocarbon as a refrigerant.

"The pros," Lennon said, "first of all, the obvious one, propane is very efficient. We've seen gains in some cases of up to 40%. It has a much higher heat transfer coefficient. It's similar to an HFC system configuration, so there's no big change in production. It runs very similar temperatures and pressures as R404A, so no big learning curve for technicians. It uses the same oil as HFCs. It has a lower discharge temperature. It's a great refrigerant overall."

As for the cons – there is a risk involved in working with propane. R290 is flammable in concentrations of 2% to 9%. But, Lennon said, Novum has designed a number of safety solutions to address ignition hazards.

Other issues Lennon noted are that some component parts are slightly more expensive for specific hydrocarbons; service technicians are not always trained for propane-based systems; and the charge limit is low at 150 g.

In order to get around the charge limit, "we redesigned all of our cases to achieve a gas charge level of under 100 g," said Lennon, "rather than 150."

To address the issue of technician availability, Novum developed a "cassette system" – a removable condensing unit – to streamline system servicing.

"A local maintenance guy can change the cassette in a couple of minutes and send the cassette to your local refrigeration service company for repair offsite," Lennon said, "during working shop hours." Hannaford Supermarkets is using Novum's cassette units in some New England stores.

"To wrap up," Lennon said, "propane has been selected as an efficient and reliable solution for self-contained cases. Novum has developed a simple, safe and effective solution for the end user and for the service providers" ■ EH

Climate Pros to Open **Training 'University'**

Chicago contractor's 10,000-sq-ft mock grocery store will support instruction on the CO_2 systems that it's installing and servicing in supermarket and cold-storage locations

By Elise Herron

One perceived barrier to natural refrigerant-based systems is a lack of training among contractors and technicians. With a large new training center soon to open, Climate Pros is working to change that.

In December, the 11-year-old contractor plans to open a 10,000-sq-ft training center, dubbed Climate Pros Inc. University (CPIU), at its 50,000 sq-ft Chicago headquarters to train its technicians on installing and servicing CO_2-based refrigeration systems – transcritical, cascade and secondary.

"We're building a mock grocery store," said Todd Ernest, Climate Pros' founder and CEO. "I've basically just carved out about 10,000 sq ft in the back of the warehouse. We're going to have a full DX parallel rack system and a transcritical CO_2 system, along with a glycol skid."

As of late October, Climate Pros had completed the "rack house" and erected the walls, and was planning to soon add equipment, which will come from vendors like Zero Zone and Carnot Refrigeration. Equipment vendors, including Hillphoenix, Danfoss, Emerson and Parker Sporlan, which have trained the contractor's technicians in the past, will continue to do so at CPIU, along with Climate Pros' own specialists. "CPIU is just going to formalize all that so we can say, 'Now we have a facility, this is where we go to train,'" said Ernest.

With its new training center, Climate Pros joins contractors like Source Refrigeration and Bronx, N.Y.-based AAA Refrigeration in educating technicians on natural refrigerants. Source also has a mock grocery store training center at its Anaheim, Calif., headquarters while AAA holds an annual Refrigeration Symposium in addition to in-house and field training.

While Climate Pros previously lacked a formal training space, Ernest said its employees have been ahead of the curve when it comes to working with CO_2 technology.

"We've always been focused on trying to stay ahead of whatever the technology is doing," he said. "We spend a ton of time, energy and money on just keeping our guys trained and up to par, or better, than most that are out there."

Todd Ernest, Climate Pros' founder and CEO

First transcritical installations

Climate Pros, which targets the supermarket sector, services over a dozen CO_2 systems in the Chicago area – in stores such as Mariano's (a Roundy's banner) for transcritical and Target and Walmart for mostly secondary.

"Transcritical is running great," said Ernest. "You don't see the high maintenance you used to see."

Climate Pros recently installed its first transcritical system at a Mariano's in Bloomingdale, Ill., and previously handled installation of a cascade CO_2 system at a Target store in Lake Bluff, Ill.

Next month, the company is also slated to begin installation of its first transcritical CO_2 system, from Carnot Refrigeration, in a cold storage area at a MaMa LaRosa Foods Italian-style dough plant in Taylor, Mich.

Over the years Climate Pros has expanded its operation to Wisconsin, Michigan, Ohio, Florida, Hawaii and most recently California, with plans to enter the Northeast next. In California, Ernest sees CO_2 becoming an increasingly popular choice of refrigerant for stores.

"We just got into the California market this year," Ernest said, "and we're already seeing CO_2 come out here as well, so we're figuring out how we're going to stay ahead and get our teams out here up to par so that they get the training they need" ■ EH

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